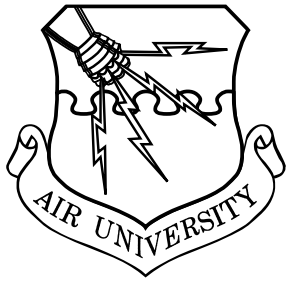


Airpower and the Environment

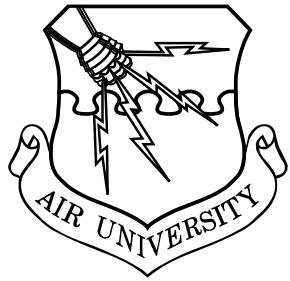
The Ecological Implications of Modern Air Warfare

Edited by
Joel Hayward

Air University Press
Air Force Research Institute
Maxwell Air Force Base, Alabama

July 2013

AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO



Airpower and the Environment

The Ecological Implications of Modern Air Warfare

Edited by
Joel Hayward

Air University Press
Air Force Research Institute
Maxwell Air Force Base, Alabama

July 2013

Library of Congress Cataloging-in-Publication Data

Airpower and the environment : the ecological implications of modern air warfare / edited by Joel Hayward.
p. cm.
Includes bibliographical references and index.
ISBN 978-1-58566-223-4
1. Air power—Environmental aspects. 2. Air warfare—Environmental aspects. 3. Air warfare—Case studies. I. Hayward, Joel S. A.
UG630.A3845 2012
363.739'2—dc23

2012038356

Disclaimer

Opinions, conclusions, and recommendations expressed or implied within are solely those of the author and do not necessarily represent the views of Air University, the United States Air Force, the Department of Defense, or any other US government agency. Cleared for public release; distribution unlimited.

Air University Press
Air Force Research Institute
155 North Twining Street
Maxwell AFB, AL 36112-6026
http://aupress.au.af.mil

Contents

About the Authors *v*

Introduction: War, Airpower, and the Environment: Some Preliminary Thoughts
Joel Hayward *ix*

1 **The Impact of War on the Environment, Public Health, and Natural Resources** 1
Victor W. Sidel

2 **"Very Large Secondary Effects": Environmental Considerations in the Planning of the British Strategic Bombing Offensive against Germany, 1939–1945** 9
Toby Thacker

3 **The Environmental Impact of the US Army Air Forces' Production and Training Infrastructure on the Great Plains** 25
Christopher M. Rein

4 **Airpower and the Targeting of a Nation's Energy Infrastructure** 43
Mark A. Olinger

5 **The Forest and the Trees: Aerial Eradication in South Vietnam and Afghanistan** 65
Evelyn Krache Morris

6 **Airpower and the Environment: Applications in Developing Countries** 83
Dan Henk

7	**Airpower and Collateral Damage: Theory, Practice, and Challenges** Phillip S. Meilinger	107
8	**Environmental Degradation and Conflict in Africa: How AFRICOM Can Help Africans** John T. Ackerman	133
9	**Toward a Stable African Continent: The Role of AFRICOM and the USAF in Building Partnerships through Environmental Security** Robert R. Sands	149
10	**"Making the Desert Green": The Effect of Environmental Considerations on the Deployment of the Israeli Air Force in the Negev** Tamir Libel	177
11	**Airpower and the Environment: Some Ecological Implications of Modern Warfare** Joel Hayward	197
	Abbreviations	225
	Bibliography	229
	Index	265

About the Authors

Dr. Joel Hayward, the editor of this volume, is a scholar, author, and poet. His career highlights include dean of the Royal Air Force College, director of the Royal Air Force Centre for Air Power Studies (RAF CAPS), head of King's College London's Air Power Studies Division, and professor of strategy at the Indonesian Defense University. He is the author or editor of eight books as well as dozens of book chapters and journal articles, some of which have appeared in German, Russian, Portuguese, Spanish, and Serbian translations. He lectures widely throughout Europe, Asia, and beyond on various topics. He is currently writing *An Ecological History of War: The Environmental Consequences of Warfare from Antiquity to the Present* for Cambridge University Press and *Prophet and Warrior: The Conduct and Justice of Muhammad's Military Campaigns* for Kube Publishing.

Dr. John T. Ackerman is an associate professor of national security studies at the Air Command and Staff College (ACSC), Maxwell AFB, Alabama. He is also the International Security Studies course director for the ACSC Department of Distance Learning. Dr. Ackerman's research efforts include exploration into the international relations implications of global climate change, security implications of global and regional environmental degradation, and the national security ramifications of strategic future trends.

Dr. Dan Henk, a social anthropologist, is the director of the US Air Force Culture and Language Center. He is a former US Army officer with combat experience in Vietnam and Grenada and military service in Europe and Africa. His recent publications have explored defense budgeting in African countries, evolving military roles and missions, and emerging definitions of *security*. A monograph in 2006 analyzed the evolution of South Africa's armaments industry. His latest book, *The Botswana Defense Force in the Struggle for an African Environment* (Palgrave Macmillan, 2007), assessed the Botswana Defense Force in environmental security operations.

Dr. Tamir Libel holds a BA in history from Tel Aviv University and an MA and PhD from Bar-Ilan University, both in political studies. He was a postdoctoral fellow at the BESA Center for Strategic Studies and is a Legacy Heritage Fellow at the Kinneret Research Center on Peace, Security, and Society at the Kinneret College of the

Sea of Galilee, Israel. His PhD dissertation compares changes in Western professional military education institutions between 1991 and 2003. He has published several peer-reviewed journal articles and presented papers on military education, Israeli military doctrine, and airpower at major international conferences.

Dr. Phillip S. Meilinger is a retired US Air Force colonel who served 30 years as a command pilot, staff officer, and educator. He received a PhD in military history from the University of Michigan and has taught at the US Air Force Academy and the US Naval War College and was dean of the School of Advanced Airpower Studies. Upon retiring from the military he worked as a defense analyst in Washington, DC. He is the author of eight books and over 85 articles on military theory and operations.

Evelyn Krache Morris is a doctoral candidate in history at Georgetown University. Her chapter draws on research for her dissertation, "Into the Wind: Kennedy and the Use of Chemicals in Vietnam." She holds a Royden B. Davis Fellowship at Georgetown. Ms. Krache Morris has a BA from Tufts University and an AM from the University of Chicago.

Mark A. Olinger, a retired US Army officer, received his BS in business administration from California Polytechnic State University, Pomona, and an MS in national security strategy from the National Defense University. He is also a graduate of the National War College. His career culminated as director of operations for the Defense Energy Support Center, Fort Belvoir, Virginia. His publications include *Logistics and the Combatant Commander: Meeting the Challenge* (2008) and *Conceptual Underpinnings of the Air Assault Concept: The Hogaboom, Rogers, and Howze Boards* (2006).

Lt Col Chris Rein is a PhD candidate at the University of Kansas, where Dr. Adrian Lewis advises him. From 2005 to 2008, he served as an assistant professor in the Department of History at the US Air Force Academy in Colorado Springs, Colorado. He earned a BS in naval architecture and marine engineering from the Massachusetts Institute of Technology in 1992 and an MA in history from Louisiana State University in 2001.

Dr. Robert R. Sands is a professor of anthropology at the Air Force Culture and Language Center (AFCLC) at the Air University

and is responsible for designing curricula that infuse concepts of culture across the spectrum of professional military education and training. He is also director of the MINERVA Initiative for Energy and Environmental Security. He received his PhD in anthropology from the University of Illinois and his MA in anthropology from Iowa State University. Dr. Sands has authored six books and numerous chapters and articles on topics such as environmental security, building partnerships and sustainability, sport and culture, ethnographic theory, and origins of religion.

Victor W. Sidel, MD, is a distinguished university professor of social medicine at Montefiore Medical Center and Albert Einstein College of Medicine and adjunct professor of public health at Weill Cornell Medical College. He has been president of the American Public Health Association, Physicians for Social Responsibility, and International Physicians for the Prevention of Nuclear War. He is coeditor with Dr. Barry Levy of *War and Public Health, Terrorism and Public Health,* and *Social Injustice and Public Health*, all published by Oxford University Press.

Dr. Toby Thacker is a lecturer in modern European history at Cardiff University. He is the author of *Music after Hitler, 1945–1955* (Ashgate, 2007), *The End of the Third Reich: Defeat, Denazification, and Nuremberg 1944–1946* (Tempus, 2006), and most recently, *Joseph Goebbels: Life and Death* (Palgrave Macmillan, 2009). He is embarking on a comparative study of three towns in Britain, Germany, and France in the aftermath of the First World War.

Introduction

War, Airpower, and the Environment: Some Preliminary Thoughts

Joel Hayward

Twenty years ago the Norwegian prime minister, Gro Harlem Brundtland, stated, "We are living in an historic transitional period in which awareness of the conflict between human activities and environmental constraints is literally exploding."[1] We have come a long way in the subsequent two decades. Environmental responsibility now lies at the forefront of our Western world perspective and is constantly growing in importance. Ecological activism, which used to be a fringe movement, has now become mainstream. In 2007 Al Gore and the Intergovernmental Panel on Climate Change won the Nobel Peace Prize (and an Oscar!) for their efforts to raise environmental awareness. Greenpeace, which uses "non-violent, creative confrontation to expose global environmental problems," alone has no fewer than 220,000 members in the United Kingdom and 2.8 million worldwide. Ecologists, environmentalists, activists, lobbyists, and of course strategists are already turning their attention to ecological aspects of modern warfare, including land mines, cluster ordnance, erosion and soil damage, air pollution, deforestation, nuclear testing and proliferation, oil spillage and fires, depleted uranium contamination, disposal of ordnance, and so forth. It seems likely that such concerns will also become increasingly mainstream. As a consequence, governments and their armed forces will be paying more attention to the serious ecological ramifications of conflict. Some already are. The *Global Strategic Trends* paper published by the British Ministry of Defence's Development, Concepts and Doctrine Centre (DCDC) illustrates the importance now being placed on these matters by some British strategists.[2]

Balancing strategic and operational needs with both military and environmental ethics is certainly not impossible, and responsible armed forces are already beginning to think about how best to balance what superficially seem to be (but actually are not) competing imperatives. Air forces face the greatest challenges. During both peace and war they have far greater carbon footprints than armies

and navies. They use potentially more devastating ordnance. Their targets traditionally include objects in or near population centers and the aquifers, waterways, soils, and food sources that sustain them. Also, because of historic targeting trends that appear likely to continue for some years—a feature of several chapters herein—air forces cause far worse damage to environmentally significant production, storage, and distribution infrastructure, much of which is based on petroleum, oil, lubricants, or chemicals.

The manufacture and testing of aircraft are themselves major industrial undertakings that have always, and especially during wartime, damaged local ecosystems, sometimes substantially and perhaps in some cases permanently. Even when airframes were made mainly of canvas stretched over wood, the need for certain types of strong and light wood resulted in both deforestation and, paradoxically, the planting of new forests for future generations of aircraft that were never built. Although this may seem to have been environmentally cost-neutral, the planting of certain tree species in new regions permanently modified and upset fragile ecosystems.[3] By the time of the Second World War, when most aircraft were composed mainly of various metals and alloys and relatively little wood, the industrial pollution caused by the aircraft industry was staggering (after all, *hundreds of thousands* of aircraft were built, a great portion of them were destroyed, and all the rest were later scrapped). Authors within this volume have addressed aspects of this pollution, although there is still much more for scholars to research and write.

Military aircraft have also consumed unimaginable quantities of fuel on training and operational sorties, adding negatively to the greenhouse effect. During World War II, military consumption of aviation fuel represented approximately half of all fossil fuels consumed throughout that dark period. Scholarly work has now begun to quantify the consumption, but it has not become an area of great academic activity. This author hopes that some bright aspiring doctoral student might one day be sufficiently motivated to provide a sustained piece of research that will qualitatively and quantitatively analyze the impact of the Second World War on both the oil industry and the physical environment itself.

Aside from reconnaissance, surveillance, and information-gathering, military aircraft have traditionally been used in three other key roles: control of the air (that is, to gain at least local air

superiority so that all friendly air and surface operations can occur without undue hindrance or danger); air mobility (lifting people and supplies to, from, and within theaters); and attack (striking enemy objects to coerce, deny, or punish). All roles have ecological ramifications.

Yet it is in the attack role that airpower has created the most controversial and publicly visible environmental consequences. Even aside from atomic and nuclear weapons (which have been covered splendidly in many other books), the bullets, shells, rockets, and bombs fired or released from military aircraft have devastated both urban and rural areas. From the first Zeppelin raids on French, British, and other cities and towns in 1914 and 1915 through to the most recent Israeli strikes on Gaza, air attacks against cities and citizens have not only razed buildings and taken lives; they have caused frightful public health hazards and polluted soil and waterways.

Likewise, in a less publicized but no less harmful manner, air attacks against enemy forces and infrastructure in rural areas (and sometimes directly against the rural environment itself, as in Vietnam) have impacted nature with dramatic negativity. Even during the First World War some air forces directly targeted the enemy's forests and other natural ecological features.[4] Various authors in this volume chronicle and analyze the tremendous destruction from the air of both urban and rural areas, especially during World War II, the Vietnam War, and the 1999 Yugoslavian war. Although their chapters generally make for grim reading—from which we can all learn—they also reveal more positively that at times decision makers in recent years have intervened to ensure that polluted regions gain at least a degree of remediation. After NATO's 1999 air war against Yugoslavia, for example, the United Nations Environmental Program did what the attacking NATO states would not do: it provided thorough and expensive postwar environmental remediation.

We should of course make one point clear: air forces are not alone in causing ecological harm. As revealed by a number of excellent books—the best of which is undoubtedly *The Environmental Consequences of War*, edited by Jay E. Austin and Carl E. Bruch,[5] although it is now a dozen years old—armies and navies have also created and continue to create ecological harm, usually entirely unwittingly. In my own chapter, I touch on some of the harm done

throughout the twentieth century by war fighters who had no awareness of the ecological consequences of their actions.

The decommissioning and disposal of ordnance once caused few concerns for governments and their air forces. Following both world wars, air forces (like armies and navies, who were equally unconcerned about ecological consequences) got rid of massive amounts of no-longer-needed bombs and other ordnance, as well as overstocks of spare parts and other materiel, simply by dropping them into the world's oceans or burying them within the ground. The scholars within this book touch on these unfortunate practices and highlight the fact that, at least in partial defense of those who committed these acts, during the first half of the twentieth century no governments or militaries possessed adequate scientific knowledge upon which to make better decisions. Less happily, this book demonstrates that the safe and environmentally harmless decommissioning and disposal of ordnance have only *very recently* become issues for air forces in developed nations (which are no further behind than the armies and navies in those nations). This book also reveals that, although no scandalously harmful disposal now occurs—that we know of—there is still a long way to go before we can state categorically that all unwanted ordnance and other materiel are disposed of without detrimental effects.

I know from my own experiences working with the Royal Air Force (RAF), and from previous experience with other air forces, that the disposal of oil and lubricants is now taken far more seriously than it was even 20 years ago when I commenced my career as a professional military educator. Indeed, air forces in developed nations are not only looking at the disposal of petroleum products, they are also exploring—and some making significant strides with—the entire issue of sustainability as it pertains to petroleum, oil, and lubricants. Within the British Ministry of Defence, for example, the RAF has led its sister services in the examination of fuel efficiency and the exploitation of alternative fuel sources, including the wider application of biofuels and synthetic fuels across the land, sea, and air environments. As far back as 1999, RAF aircraft were among the first in the world certified to fly on up to 50 percent non-crude-oil-derived synthetic fuel.[6] Since April 2008, several RAF aircraft types have been certified to use 100 percent synthetic fuel. Efforts continue to achieve wider use of synthetic fuels for ships and land vehicles. Other major armed forces, including

those of the United States, have made as much progress and in some cases are now the world leaders in this aspect of sustainability

According to a report in *Stars and Stripes*, the US military forces—which use around 2 percent of the nation's fuel—are themselves acutely aware of the need to reduce their reliance on fossil fuels and to increase efficiency as a means of offsetting the seemingly inexorable rise of fuel costs.[7] Although there is considerable room for improvement, and the primary motivation is economic and not ecological, the US military has continually reduced its consumption and increased its efficiency year by year. It simply has to do so. As Tom H. Hastings wrote a decade ago:

> The militaries of the world consume about as much energy as the entire economy of Japan—approximately six percent of the global annual energy budget. A US-made F-16 fighter warplane burns more fuel in an hour than the average US car does in one year. Militaries account for nine percent of the iron and steel consumed each year.[8]

Hasting's view is, like that of many ecologists, rather antagonistic toward the military, yet, when discussing Gulf War I, he was correct in asserting "the oil consumed was staggering." As he wrote:

> Just one division of armored tanks burned more than 600,000 gallons of fuel per day; each F-15 in after burner gulps down 240 gallons per minute; four entire aircraft carrier groups "had" to throttle their way across the planet's oceans to assemble in the Persian Gulf in order to wage war to protect their ability to throttle their way around the Earth. Just *one* of those carriers—not counting its retinue of smaller warships—the USS *Independence*, turned two million gallons of carbon-based fossil fuel into heat and airborne waste. The estimate of the 46-day war total oil consumption by the US-led UN forces to protect cheap oil: more than 900 million gallons.[9]

It should be pointed out that, even in terms of aviation, the military is not the biggest culprit. In 1976, civil aviation (passenger and cargo) consumed 64 percent of all aviation fuel, with the military consuming 36 percent. By 1992, the ratio had changed dramatically, with civil aviation consuming 82 percent and military aviation 18 percent. This ratio is predicted to change to 93 percent and 7 percent respectively by 2015, and to 97 percent and 3 percent by 2050.[10] Explaining this is not difficult. Not only has there been a massive increase in passenger air travel and airfreight, but there has also been a substantial decrease in the number of military aircraft. The latter has resulted from the vastly different nature of airpower from, say, World War II, when great air fleets were needed to perform

missions that today can be undertaken by single squadrons. Additionally, the increased multifunctionality of today's combat aircraft has reduced the number of aircraft types that an air force needs.

Both civil and military aviation manufacturers are working zealously to make aircraft that are less environmentally damaging, with quieter engines, less carbon emissions, and far less nitrogen oxide emissions. As currently configured, at least, the tremendous improvement in jet engine efficiency (70 percent since the 1950s) and noise reduction (75 percent) is unlikely to continue, because engine and airframe designs are most likely reaching the limit of developmental potential.[11] The future generation of aircraft, manufactured largely from composites and with advanced fly-by-wire controls, will probably feature unconventional shapes allowing highly efficient new engine mounting and wing configurations and ultra-low maintenance levels. Aircraft manufacturers are evaluating, testing, and developing new materials and new designs, even though this does not come cheaply, because they recognize that not only will the "customers" be pressing increasingly harder for greater efficiency and environmental responsibility, but the environmental lobby will be equally trenchant. Aircraft manufacturers are already factoring into their design and production processes ways of ensuring that when these aircraft reach the end of their lives, the composite parts—designed to be as environmentally harmless as possible—can be removed and reutilized easily and efficiently and with minimal waste or scrapping. With this in mind, tomorrow's military aircraft graveyards may look very different from today's seemingly endless landscapes of corroding and contaminating metal and other materials.

Books on ecology, of which there is an increasing number, tend to be rather negative; that is, they focus on the great harm that humans have done to the physical environment. I am pleased that, along with evidence of both harm and remediation, this book contains chapters of a different nature (weak pun intended). Several of the scholars who contributed chapters have highlighted the fact that military forces now take far more care of the environment than ever before and that many, even in less-developed regions such as central Africa, have developed strategies to minimize all harm and even to do environmentally beneficial activities. Humans live in constantly changing physical environments and are often vulnerable, along with all other living things, to not only natural change, but

also man-made changes. It is heartening that some military forces, utilizing the speed, reach, and intelligence-gathering capabilities of air assets, are providing highly positive contributions to conservation efforts and the maintenance and protection of ecological protection zones. It is a positive story and it brings richness and variety to this book.

JOEL HAYWARD, PhD
Lincolnshire, United Kingdom 2012

Notes

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

1. Quoted in Antoine, "International Humanitarian Law and the Protection of the Environment in Time of Armed Conflict," 517.
2. *Global Strategic Trends*, http://www.dcdc-strategictrends.org.uk/.
3. One of the best short pieces on the impact of war on the world's forests is McNeill, "Woods and Warfare in World History."
4. Hayward, "Air Power, Ethics and Civilian Immunity during the Great War and Its Aftermath."
5. Austin and Bruch, eds., *Environmental Consequences of War*.
6. Minister of State, Ministry of Defence, Baroness Taylor of Bolton.
7. Weaver and Svan, "US Military Looks to Cut Fuel Costs."
8. Hastings, *Ecology of War & Peace: Counting Costs of Conflict*, 96.
9. Ibid., 97.
10. Penner et al., eds., *IPCC Special Report*, 4.
11. Gardner, "How Green Is Your Contrail?"

Chapter 1

The Impact of War on the Environment, Public Health, and Natural Resources

Victor W. Sidel

Those who fly aircraft in every country of the world deserve our praise. They perform heroic services every day, such as fighting widespread fires, flying into hurricanes to determine their characteristics, and rescuing and evacuating stranded or injured people from disasters. Their service in defense of their nations under attack in war is legendary. As Winston Churchill said in the House of Commons on 20 August 1940, "The gratitude of every home in our Island, in our Empire, and indeed throughout the world, except in the abodes of the guilty, goes out to the British airmen who, undaunted by odds, unwearied in their constant challenge and mortal danger, are turning the tide of world war by their prowess and by their devotion. Never in the field of human conflict was so much owed by so many to so few."[1]

Yet airpower can be used for destructive purposes as well. While there are examples from before the 1930s, that decade saw a dramatic increase in destructive use. An iconic example is the 1937 German bombing of Guernica, a small Basque town in northern Spain, during the Spanish Civil War. The wanton killing of civilians became a symbol for the use of airpower in war and was immortalized by Pablo Picasso in his painting *Guernica* for the Spanish Pavilion in the 1937 Paris Exposition. Nazi bombers were used at the start of World War II in raids on cities in Poland, the Netherlands, and the United Kingdom.

The Royal Air Force's (RAF) use of airpower at the beginning of the war was defensive—against enemy air raids on cities and towns, including London and Coventry—and in rescue services at Dunkirk. The Allies then began to use airpower in offensive operations. By the end of 1940, the RAF was bombing Munich and Mannheim in retaliation for the bombing of London and Coventry. The United States joined in air attacks on German cities starting in 1942. On both sides, the rationale for these attacks on civilian populations, along with the collateral damage to munitions plants and arms transport, was to damage morale and reduce the enemy's will to continue the war. The

later attacks on Dresden and Hamburg by RAF and US Army Air Forces (USAAF) bombers intensified this strategy.

US military aircraft in the Pacific were employed for the same tactic, beginning with the 1942 bombing of Tokyo and other targets by the Doolittle Raiders.[2] Then in March 1945, B-29s dropped incendiary bombs on the three largest cities of Japan (Tokyo, Osaka, and Nagoya). The attacks on Tokyo killed an estimated 84,000 people, injured 41,000, and made one million people homeless.[3] The dropping of atomic weapons on Hiroshima and Nagasaki in 1945 was a continuation of this strategy using a new weapon whose blast, thermal energy, and ionizing radiation could kill close to 100,000 people and injure tens of thousands more with a single bomb.[4]

Following World War II, the use of airpower to harm people and destroy property continued. Air operations in Vietnam caused extensive casualties and physical destruction that were euphemized as "collateral damage." The bombing of Cambodia, the full extent of which was not revealed until President Clinton did so in 2000, took place from 1964 to 1975.[5] Similar damage was inflicted on Kosovo, Iraq, and Afghanistan. On 14 June 2009, the chief of the United Nations' mission to Afghanistan criticized air operations that led to the deaths of hundreds of civilians.[6]

Although airpower's capacity to cause long-lasting and possibly irreversible damage to the environment has added a new dimension, reports—some of them apparently apocryphal—of war-related environmental damage began long before the development of aircraft. A frequently cited example is from the Third Punic War (second century BC): the Romans are said to have salted the fields of Carthage after they conquered it.[7] A century later, Calgacus, a Caledonian chieftain, inspired his troops to fight by warning them that their Roman enemy used "robbery, butchery and rapine." He added, "They create a desolation and call it a peace."[8]

Closely related are the ways in which military forces attempted (long before the development of airpower) to cause indiscriminate damage to health. In 1347 Mongols attacking the walled city of Caffa in what is now the Ukraine catapulted the corpses of those who had died of the plague into the city. In North America in 1763, Lord Jeffery Amherst, commander in chief of British forces, suggested to the besieged commander of Fort Pitt that blankets in which smallpox victims had slept be given to the enemy. A delegation of Delaware

Indians visiting the fort seeking its surrender received "two blankets and a handkerchief out of the smallpox hospital."

In recent years, protecting our planet from long-lasting and possibly irreversible change has become an important issue, producing attempts to reorder priorities and practices in many sectors of human life, including the use of energy for production and transportation and the ways we act in our daily lives. A new term, *ecological damage*, describes effects that are longer lasting and more severe than environmental damage. One result of the concern about ecological damage is the protection of endangered species and the negotiation of the Convention on Biological Diversity, which has now been ratified by more than 175 countries. The convention commits ratifying countries to the protection of ecosystems, which it defines as a "dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit."[9] In other words, an ecosystem is a group of interdependent organisms which share the same habitat. Damage to ecosystems from cumulative causes, such as environmental pollution, threatens the existence not only of species defined as "endangered," but ultimately of *Homo sapiens* as well.

Environmental changes, in contrast to ecological changes, generally are changes to physical structures such as air, water, and soil, which may be reversible. Environmental damage can also refer, more broadly, to social, economic, and cultural changes. Such changes, when limited in duration and scope, can indeed be survivable or even beneficial to a species in the short run, but care must be taken that the intensity or duration of these changes does not result in irreversible damage.

The advent of airpower during the twentieth century provided a series of terrible but probably reversible examples of damage to human beings and to the environment. Examples include the Nazi bombing of Guernica, Warsaw, Rotterdam, London, and Coventry, followed by the Allied bombing of Hamburg, Dresden, and other cities in Germany. The Japanese bombing of Pearl Harbor was followed by the United States using incendiary bombs to destroy much of Kyoto and Tokyo. In my assessment, which is not universally embraced,[10] these responses were roughly proportional to the provocation and, although terribly damaging, for the most part followed the guidelines that define conduct during a just war.

The capabilities of airpower to cause long-lasting environmental and ecological damage intensified dramatically at the end of World

War II. The most striking examples are the use of nuclear weapons on Hiroshima and Nagasaki and the testing of thermonuclear weapons of far greater yield in the 1950s and following decades. These weapons, whose consequences included long-lasting, ionizing radiation, appeared to cross a threshold for destructiveness and ecological damage. Some of those who developed the weapons recognized the crossing of a moral threshold. J. Robert Oppenheimer quoted from the *Bhagavad Gita*: "I am become death, the destroyer of worlds."[11]

Other instances of environmental and ecological damage caused by airpower followed. One example is the use of depleted uranium (DU) in missiles and shells. DU is a waste product mainly from the production of enriched uranium for nuclear weapons. British and US armed forces have used it in the Middle East and in the former Yugoslavia.[12]

Another example is the use of vast quantities of petroleum products in military training and in war, which depletes nonrenewable natural resources and undoubtedly contributes to global warming. American service personnel in Afghanistan and Iraq in recent years have used about 3.5 million gallons per day. Over the course of a year that amounts to 1.3 billion gallons. For every serviceperson stationed in these theatres, two others are in training or transit, and the Department of Defense (DOD) must move millions of tons of arms, ammunition, food, fuel, and equipment every year by plane or ship. The DOD is the world's leading consumer of petroleum, and an April 2007 estimate suggests that the Pentagon might consume as much as 14 billion gallons every day, greater than the daily total consumption of Sweden or Switzerland. It is impossible to identify how much of this total is due to consumption by military aircraft, but since one F-15 using full afterburner power consumes 60,000 pounds of fuel per hour per engine, military aircraft use is surely a significant part of the total consumption.[13]

Airpower can also cause ecological damage when aircraft are used to destroy nuclear power plants, spreading plutonium-239 with a half-life of 24,100 years. Aircraft that spray herbicides such as Agent Orange may not only spread cancer-causing contaminants such as dioxin, but also cause damage to complex ecological systems such as mangroves.[14] The production of bomb craters may lead to standing pools of water that in some climatic regions are breeding grounds for mosquitoes that spread malaria and other diseases. Even limited use of nuclear weapons, some have predicted, could result in widespread

cooling, agricultural failure, famine, and infectious disease. Such uses of airpower not only cause individual instances of human and environmental damage, but may irreversibly damage ecosystems when they happen repeatedly and widely.

Another less discussed way airpower can inflict potentially irreversible and widespread environmental damage is as a weapon of terrorism. Nation-states, individuals, and groups have long used other forms of indiscriminate attack to create fear. But the use of aircraft creates what might be called an "ecological" level of fear. The "shock and awe" at the start of the attack on Iraq is one example. Others include using fuel-laden commercial aircraft in the attacks on the World Trade Center and the Pentagon or aircraft dropping napalm (jellied gasoline) in Vietnam, dropping white phosphorus in crowded urban areas in Gaza, and dropping cluster bombs. Ninety-five nations signed the Convention on Cluster Munitions in Oslo in December 2008, but the United States, which used cluster bombs in the former Yugoslavia, Afghanistan, and Iraq, has not yet signed. These attacks not only kill and maim people, but may lead to long-lasting and perhaps irreversible conditions in which people carry their distrust of other individuals and nations into their social relationships.

Unmanned drone aircraft present another way airpower can create fear, adding another element to warfare. When drone aircraft are operated directly by human beings, some element of human responsibility for consequences may be present. When controllers far from the scene of battle operate them, human responsibility for consequences may be lacking.[15]

Drones have been used in Afghanistan to target individual human beings. This practice is ethically troubling and may be counterproductive in a "war against terrorism." Not only can targets be misidentified, but by international law there must be no reasonable alternative, such as capture, to killing a targeted civilian. To warrant execution the target must be actively participating in an attack on others. The use of lethal force must be proportionate to the immediate threat. In this case, too, the use of aircraft brings a warring nation closer to the borderline of illegal and unethical activities.[16]

What can be done to keep the changes brought by the use of aircraft in war from causing irreversible damage to the environment, health, and natural resources? Other chapters in this book deal with legal responsibilities, reparations, and responsibility for repairing the reversible environmental damage. But, as in other areas of public

health, the answer must lie in prevention of adverse health consequences that cannot be effectively reversed. Prevention of the environmental and ecological consequences of war, whether caused by airpower or not, ultimately lies in preventing human conflicts from becoming armed conflicts. Indeed, some have wondered whether the damage war causes to people and to the environment is making war as an extension of foreign policy obsolete. A just war, as enumerated over the centuries and recently restated by the Roman Catholic Church, must meet the following criteria:

- the damage inflicted by an aggressor on the nation or community of nations must be lasting, grave, and certain;
- all other means of putting an end to it must have been shown to be impractical or ineffective;
- there must be serious prospects of success; and
- the use of arms must not produce evils and disorders graver than the evil to be eliminated.[17]

The power of modern warfare means of destruction, particularly through airpower, should weigh heavily in evaluating actions against the last of these criteria for a just war.

Orville Wright, commenting in 1917 on his invention, said, "When my brother and I built the first man-carrying flying machine we thought that we were introducing into the world an invention which would make further wars practically impossible."[18] The damage that airpower makes possible also led to a prediction by Winston Churchill in the House of Commons in 1933 that "Air power may either end war or end civilisation."[19]

Wright and Churchill were not the first to predict an end to war based on technological destructiveness. As Alfred Nobel wrote to Bertha von Sutner, recipient of the first Nobel Peace Prize, "Perhaps my factories will put an end to war even sooner than your Congresses; on the day when two army corps will be able to annihilate each other in a second, all civilised nations will recoil with horror and disband their troops."[20] But such technological fixes have not succeeded in preventing war. The problem is moral. To end war, military forces, in this case those who fly and support air forces, would need to refuse to conduct operations that would violate the principles of *jus in bello*

(justice in war). Perhaps books like this and others will help point the way to moral constraints on the role of these forces in war.[21]

Notes

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

1. Churchill, speech, 20 August 1940.
2. Lawson, *Thirty Seconds over Tokyo*.
3. Craven and Cate, eds., *Army Air Forces in World War II*, vol. 5: *Pacific: Matterhorn to Nagasaki June 1944 to August 1945*, 614–17.
4. Rhodes, *Making of the Atomic Bomb*, 599.
5. Owen and Kiernan, "Bombs over Cambodia."
6. Hewitt, "Place Annihilation," 257–84.
7. Susan Stevens, "Legend of the Destruction of Carthage," 39–41.
8. Tacitus, *De vita et moribus Iulii Agricolae,* as translated by William Peterson quoted in Bromwich, "Euphemism and American Violence."
9. United Nations Convention on Biological Diversity, available at http://www.cbd.int/.
10. See Grayling, *Among the Dead Cities*.
11. Bird and Sherwin, *American Prometheus*, ix.
12. Fairlie, "Depleted Uranium." [Editor's note: see Joel Hayward's chapter 11 in this volume for a different perspective on DU.]
13. Frumkin, Hess, and Vindigni, "Energy and Public Health"; and Klare, "Pentagon v. Peak Oil."
14. Grotto and Jones, "Agent Orange's Lethal Legacy."
15. "60 Drone Hits Kill 14 Al-Qaeda Men, 687 Civilians," *News* (Pakistan).
16. Mayer, "Predator War"; and Shane, "C.I.A. to Expand Use of Drones."
17. "Just War Doctrine."
18. McFarland, ed., *Papers of Wilbur and Orville Wright*, 76.
19. Churchill, debate, 14 March 1933.
20. Tagil, "Alfred Nobel's Thoughts about War and Peace."
21. See Hayward's essay in this volume, "Airpower and the Environment: Some Ecological Implications of Modern Warfare." Also see Byman, Waxman, and Larson, *Air Power as a Coercive Instrument*; Wrage, ed., *Immaculate Warfare*; Sidel, Levy, and Slutzman, "Prevention of War and Its Environmental Consequences"; Leaning, "Tracking the Four Horsemen"; and Sidel, "Impact of Military Preparedness."

Chapter 2

"Very Large Secondary Effects"

Environmental Considerations in the Planning of the British Strategic Bombing Offensive against Germany, 1939–1945

Toby Thacker

While environmental damage is a common consequence of war, it should never be a deliberate aim.

—Kofi Annan

Between September 1939 and May 1945 the Royal Air Force (RAF) carried out a sustained bombing offensive against Germany, starting with tentative raids using small numbers of aircraft to attack German warships. The offensive grew to a furious crescendo in early 1945, when fleets of four-engine bombers carrying huge loads of incendiary and high-explosive bombs were dispatched almost nightly, and sometimes by day, to a wide range of targets in Germany. Since the inception of this campaign, and particularly with the turn to "area bombing" in 1941, debate has focused on the military effects of the bombing offensive and its ethical dimensions.

Until very recently, the environmental consequences of the British bombing may have been considered, if at all, only as an unfortunate side effect of a campaign directed against military objectives or against "morale," that intangible factor which so preoccupied British theorists and practitioners of bombing.[1] When German writers, after a long silence, turned their attention to the bombing of their country, they have been in the forefront of those who have included damage to the environment in the indictment drawn up against the architects of the British bombing. In the essay, *On the Natural History of Destruction*, W. G. Sebald singled out Marshal of the RAF, Sir Arthur Harris, arguing that he "liked destruction for its own sake, and was thus in perfect sympathy with the innermost principle of every war, which is to aim for as wholesale an annihilation of the enemy with his

dwellings, his history, and his natural environment as can possibly be achieved."[2]

This chapter asks if environmental considerations were a factor in the planning of the British strategic bombing offensive of the Second World War. It then offers some reflections on why environmental considerations were not more prominent in the extensive and unfolding debates about the purposes of that offensive.

From the relatively safe vantage point of the early twenty-first century, it is clear that in addition to injuries and deaths and the destruction caused to the neighborhoods in Germany by the British bombing, there was an environmental cost, as yet not measured. Four main areas can be isolated: (1) The burning of huge quantities of aviation fuel, the explosion of thousands of tons of ordnance, and, above all, the deliberate creation of huge fires in German cities had as one consequence the release of large quantities of carbon dioxide into the atmosphere.[3] (2) The RAF's focus on trying to destroy German oil supplies and oil production facilities released numerous other toxins into the atmosphere, the land, and the water around "oil targets." (3) The deliberate attacks on the German chemical industry, and the less-focused attacks on large and small industrial centers, inevitably caused the release of dangerous chemicals onto nearby land and into the atmosphere, rivers and lakes, and groundwater supplies. (4) There was incalculable damage to all kinds of wildlife and to wildlife habitats.

Since the 1961 publication of the four-volume official history of the British bombing offensive and the earlier publication of memoirs by key figures (most notably Winston Churchill and Arthur Harris) in the evolution of British bombing policy, historians have scrutinized the debates surrounding the development of bombing from the air since 1914 and the evolution of British policy before and during World War II.[4] A number of recent histories have examined—with varying degrees of objectivity—the wartime debates about the best use of Britain's growing bomber force in the changing circumstances of the Second World War and the heated arguments over whether aircraft were best employed attacking specific "military objectives" or in "area bombing" intended to damage German morale. Most commentators also noted the concern of politicians, airmen, and bombing campaign critics for the potential damage to Germany's architectural and cultural heritage and the destruction of churches, museums, art galleries, libraries, archives, and their contents.[5] None have explored the extent to which "environmental" considerations were a

part of the wartime debates. To explore this we need to return to the primary documents.

Britain declared war on Germany with a specific plan to attack the natural environment. The "Western Air Plans" of 1 September 1939 detailed various options open to the RAF in the event of war with Germany. One of these, Plan W. A. 11, was for "attack on forests."[6] The RAF did not immediately exercise this option, as all the armed forces were restricted to attacking only "purely military objectives in the narrowest sense of the word" to avoid provoking the Germans into starting "unrestricted air warfare."[7] Once the Germans attacked the Low Countries and France in May 1940, Britain revised this policy and, as the situation worsened in June 1940, revived its plan to attack the natural environment in Germany. By this time, many prewar assumptions about bombing had been revealed as unfounded. The war entered a critical phase with the collapse of the French Army and the evacuation of the British Expeditionary Force from Dunkirk. Pressure on the RAF's Bomber Command to help alleviate the crisis and a spell of exceptionally dry summer weather on the continent combined to provoke a directive from the deputy chief of the Air Staff to Air Marshal Charles Portal (then in charge of the Bomber Command) which included a section on "Destruction of Crops and Forests." Portal was instructed:

> The time to attack crops in Germany is within the next two or three weeks, and the new "pellet" incendiary will be available in quantity early in July. You should be prepared to distribute the "pellets" over selected areas in Germany immediately after the current moon phase and a separate directif [*sic*], forwarding a map of the suggested areas, will be sent to you in the near future.

The directive continued:

> As you are aware, there are extensive areas of coniferous forests in Germany which are believed to be extremely vulnerable to incendiarism at this time of year. Some of these are in the vicinity of important military objectives and aerodromes, where a forest fire might have valuable results in dislocating German military and industrial activities apart from the moral effect.

"Crops and forests" were one of five separate objectives specified in this directive. The aircraft industry, communications, mine-laying in German coastal waters, and oil preceded it and were given greater priority.[8] The situation was very fluid. A new 4 July 1940 directive instructed Portal that attacks on forests should be "discontinued," but

that he should still prepare to use the incendiary "pellet" against crops. On 24 July, Portal was told that

> When suitable weather conditions obtain, attacks may be resumed against forest areas in Germany in accordance with the directives forwarded to your headquarters in Air Ministry letters dated 24th and 26th June, 1940. Among the areas suggested in the attachments to those letters, it is felt that the Harz Mountains would provide a valuable focus for a concentrated attack both from the material and psychological standpoints.
>
> In this connection, I am to say that consideration has been given to the possibility of utilising the existing stocks of incendiary "pellets" in conjunction with normal bombing operations in order to take advantage of the diversions and alarms which may be caused through these potential sources of fire scattered over a wide area. It is considered that, when the weather is dry, there is a reasonable chance of a number of "pellets" starting fires on the extensive stretches of heath land and similar ground which is widespread throughout Western Germany, and thus adding to the demoralising and psychological effect of our operations. Authority is being sought for the employment of the "pellets" in this way and you will be notified immediately this is obtained.[9]

One wonders what the Air Staff imagined the "demoralising and psychological effect" of causing extensive heath and forest fires in Germany might have been. Was there a sense that the Germans were particularly sensitive to nature and proud of their landscape and, as a result, would have been particularly troubled by its destruction? We will probably never know.

Although these plans came to naught, they are, when combined with other statements made at this time, very revealing. A "Committee on Preventing Oil from Reaching Germany" was established, making its Fourth Report to the government on 4 June 1940, as the evacuation at Dunkirk came to an end. It stated:

> Oil targets are, from the Royal Air Force point of view, highly desirable objectives, particularly because they are vulnerable to air attack because attack upon them gives rise to very large secondary effects by way of fire and explosions. The majority of the chief oil plants in Germany are remote from centres of civil population. Therefore attack on oil plants is likely to cause fewer casualties among civilians than other targets.[10]

The chiefs of staff, in a report to the War Cabinet on 25 May 1940, urged bombing attacks on German oil targets.[11] Unlike the proposed attacks on forests and crops, Bomber Command from 16 May had already started night attacks on oil targets in Germany. It is clear that

in the desperate circumstances of the summer of 1940, as RAF leaders realized that existing Bomber Command forces were not able to seriously impact any of the numerous targets being attacked, the British had few scruples about creating extensive fires in German forests, on farmlands, and on heaths, nor about causing huge fires and explosions in oil plants, with "very large secondary effects." Indeed, they clearly thought this a preferable alternative to causing death or injury among the civilian population.

The broader idea of influencing people by attacking their crops and other means of sustenance was indeed well established in British aerial doctrine, although it had only previously been used on "primitive peoples" and "recalcitrant tribes" in outlying areas of the British Empire as part of what in the 1920s and 1930s was termed "Air Control." Charles Townshend documented how a 1922 Air Staff memorandum listed, under the heading "Forms of Frightfulness," methods for breaking the morale of a colonial tribe. One method was to poison the water supplies with crude oil.[12] Throughout the 1920s and 1930s, the cattle and other livestock of "recalcitrant tribes" in outlying areas of the empire, notably in Africa, were targeted in "air policing" operations—typically in preference to the actual members of the tribe.[13] As late as 1937, the RAF's "Manual of Air Tactics" contained a rationale for setting crops and forests on fire, noting that this had been used in "outlying areas as a punishment against primitive peoples."[14] Underlying these forms of attack within the broader doctrine of "Air Control" was a concern to find ways of coercing people while restricting casualties to a minimum. The same concern was transferred into emerging plans for bombing Germany in the first year of World War II.

Between the dry summer of 1940 and the appointment of Arthur Harris to lead Bomber Command in February 1942, there appears to have been no resurrection of the idea of attacking crops, forests, or heaths in Germany. These ideas never appealed to Harris, who, despite his background in the practical application of "Air Control" in India and in Iraq, was committed to "the policy of destroying industrial cities" in the fight against Germany.[15] The prolonged debate in Britain over the merits of "area bombing," which followed the presentation of the Butt Report in August 1941 and the "Area Bombing Directive" in February 1942, did not engage with environmental considerations. The debate was mainly about the most effective ways of

waging war against Germany, and to a lesser extent, the ethical legitimacy of directing attacks on working-class housing in German cities.[16]

Another prewar plan with potentially significant environmental implications was resurrected—initially against Harris's wishes—and constitutes a unique case for this study: the attack on the Ruhr dams in May 1943. In a recent book, which has attracted wide attention in Germany, Jörg Friedrich states:

> The questionable method in the battle of the Ruhr belongs to the yet barely explored genre of environmental war. . . . The researchers for the operation had encountered the question of what would happen if a lightning strike with weapons was directed against two dams in the Ruhr; in all likelihood a modern biblical flood, which would work in two ways: firstly through the tidal wave released, and secondly through the resulting shortage of water in the whole Ruhr area.[17]

Friedrich produces no evidence from British sources to support these assertions, but gives a graphic description of the flooding in the Möhne-Ruhr valley and in the Eder valley following the successful attack on the dams by Lancasters of 617 Squadron. He focuses on the civilian deaths and injuries, but also notes the drowning of livestock, and states, "the whole fish population was exterminated" in the Möhne-Ruhr valley. After describing how the two dams were rapidly repaired, he states, "The potential of the environmental attack was not plumbed any further after this." He suggests that the British maintained their focus on fire raids on cities after May 1943 because they were was more profitable to them than attacks on the environment, such as the "Dambusters Raid."[18]

Friedrich is replicating a view that was widespread in Germany in the aftermath of the Dambuster Raid. This raid appeared, to the survivors of flooded areas lying immediately below the dams, as an attempt to drown them and their livestock en masse and to cause huge environmental damage to carefully managed agricultural land. A report sent to Dr. Joseph Goebbels, who was charged with responsibility for coordinating the German response to the British bombing offensive, stressed these aspects of the "catastrophe" visited upon the people in the Möhne and Ruhr valleys. It highlighted the deaths of thousands of people and the destruction of animals of all kinds as well as houses, industrial premises, and agricultural land. Describing how people living on both sides of the Ruhr had lost everything they possessed, the report stated that the "work of a few hours made deserts of sand and shingle from land which has been fertilised and culti-

vated for years." Describing effects further down the valley, the report continued: "Agriculture and industrial facilities have been for the most part exterminated."[19]

This focus on the immediate damage caused by flooding was also present in the public opinion report prepared immediately after the Dambusters Raid by the security forces of the SS (*Schutzstaffel*). The report listed the "devastation caused by masses of water" as the main consequence of the attack and the first of the proofs understood by "wide parts of the population" that there was "a cold-blooded planning of the air war in the enemy camp."[20]

In contrast, most British policy makers and historians argue that the *primary* intention of the attacks was to cause a shortage of water in the industrial cities downstream, thus restricting armaments production. Harris said that a secondary consequence of breaching the dams would be to cause widespread flooding and consequent damage. The breach of the Möhne Dam released a flood of 130 million gallons, but the destruction caused by flooding was not, and was never expected to be, as serious as the subsequent shortage of water for industrial purposes.[21]

The argument that the dams raid was primarily intended as an attack on German industry is restated by the author of an oral history explaining the genesis of the raid: "Barnes Wallis was essentially a peace-loving man, but he felt strongly that the right way forward was to destroy the dams, and thereby the Ruhr's industrial power source."[22] Wallis explained the attack as "an engineer's way of stopping the war. . . . If we rob them of all their water supply, they couldn't produce steel and the war would come to an end."[23]

According to Guy Gibson, Wallis provided a more differentiated rationale for the attack when first explaining the mission to him:

> Between them they [the Möhne and Sorpe dams] hold back about 75% of the total water available in the Ruhr Valley. If they were both to be breached, the consequent shortage of water for both drinking and industrial purposes might be disastrous. Of course, the damage caused by floods if they were breached quickly would result in more damage to everything than has ever happened in this war.[24]

This is similar to the version presented on the National Archive website, which presents a number of official documents on the raid. Part of the introductory preamble to these reads,

> In February 1943, the Assistant Chief Designer at Vickers Armstrong, Barnes Wallis, revealed his idea for "air attacks on dams" which would deprive the German arms industry of its vital water supply and cause a "disaster of the first magnitude."[25]

Charles Webster and Noble Frankland stated in 1961, perhaps a little defensively, "The sudden catastrophe which inundated the areas lying below the two dams was local, temporary, and largely agricultural."[26] In their appraisal of the raid, Webster and Frankland put as the *last* of a list of results "a considerable area of agricultural land flooded."[27] This view is undermined by the way British propaganda after the Dambusters Raid represented the whole event. Photographs showing extensive flooding were published in Britain and in pamphlets dropped over occupied Europe, with captions celebrating the damage caused by the inundations. This was of course, far more visible as an effect of the attack than the notional damage to war production.

In 1953 Denis Richards and Hilary Saunders presented a view which was closer to that of Friedrich's, who notes how the British, in their bombing, sought to harness the power of natural forces, like fire and water. Richards and Saunders wrote:

> It had long been determined to add water as well as fire and high explosive to the list of plagues scourging the Ruhr. . . . To breach the [Möhne] dam meant the release of this water, which, gushing through the valley of the Ruhr would not only cause widespread, possibly disastrous, flooding, but would also affect electricity supplies in the most highly industrialised area possessed by the enemy.[28]

Robin Neillands presented a similar view in 2001, writing that in 1940 Barnes Wallis believed that if the dams were blown up this would "let out a tidal wave of water to swamp the surrounding countryside."[29] In the end, the British planners and executors of the raid knew that if they were successful, they would cause incalculable damage and loss of life through flooding, as well as creating a shortage of water for power and for drinking. One of the pilots involved, Flt Lt David Shannon, bluntly expressed how the combined effects of the attacks on the dams were intended: "We were to strike a blow against the Hun."[30]

There was a steady intensification of the British bombing offensive against Germany through the remainder of 1943 and into 1944. Whether measured in sorties flown or in the tonnage of bombs dropped, there was a huge increase in the destructive power of Bomber Command's attacks.[31] The diversion of Harris's force in the

spring and summer of 1944 to support the Normandy invasion and to destroy V-1 and V-2 missile launch sites brought some relief to the German population but not to the environment. The focus on German oil targets in the autumn and winter of 1944 inevitably caused great environmental damage. In the last months of the war, as the German armies conducted a dogged resistance, the bombing campaign reached a furious climax. More sorties were flown and more bombs were dropped in these final months than in the whole previous campaign.[32] Some of the most destructive raids of the war, including the notorious attack on Dresden, were carried out in this final phase of the offensive.

The British government received information about the effects of the bombing by reports and photographs regularly presented to the War Cabinet by Bomber Command. Many of these photographs showed enormous fires burning after attacks on individual targets, and others displayed great devastation to landscapes surrounding targets. The annotations to some of these photographs appear—unfortunately if not actually—to rejoice in the destruction and to celebrate a job well done, and in so doing, demonstrate a horrifying complacency. Some captions refer specifically to the environmental damage. The caption to a photograph taken after the attack on the Dortmund-Ems Canal on 21 and 22 November 1944 pointed out "the river has overflowed and flooded the surrounding countryside."[33]

The "Weekly Résumé" of the military situation presented to the War Cabinet on 15 February 1945, while noting that one million tons of bombs had been dropped on Germany and Austria since the beginning of the war, referred specifically to the attack on Dresden where "1,471 tons of H. E. [high explosives] and 1,175 tons of incendiary bombs were dropped, leaving the town well ablaze with smoke rising to 15,000 feet."[34] This echoed details in the "Summary of Operations Night 13/14 February" sent to Bomber Command Headquarters, which had stated, "smoke was reported up to 15,000 Ft and all crews report an excellent attack with fires visible for 100 miles."[35] The "Weekly Résumé" for 22 February 1945 referred to the renewed attacks on Dresden, noting, "On the 15th, 685 Fortresses . . . attacked Dresden and Cottbus, following the heavy attack on the former city on the previous day and night."[36] Harris, when asked a few days later by one of Churchill's secretaries about the effect of the raid on Dresden, replied, "Dresden? There is no such place as Dresden."[37]

Misgivings about the consequences of the bombing also grew in these final months, but those concerns—raised by both opponents and supporters of the bombing—were almost exclusively focused on the deaths and injuries of civilians and on the destruction of the man-made environment in Germany. It remains to ask why there was so little consideration given at a high level to the environmental consequences of the bombing campaign. Three strands to the answer are presented here.

First, we must bear in mind the understanding the British planners had of the environmental damage that they might be causing. It would be foolishly anachronistic to imagine that politicians and airmen in the 1930s and 1940s had anything like the appreciation they might have today of the environmental consequences of their actions. To give one example, the theory that increased levels of carbon dioxide in the atmosphere were a cause of global warming, so closely connected in the public mind today with the burning of aviation fuel, had indeed been put forward by the British scientist Guy Callendar in 1938.[38] There is no evidence whatsoever to suggest that Churchill, Harris, Portal, or even scientific advisers like Solomon "Solly" Zuckerman or Frederick Lindemann knew before 1945 that the release of carbon dioxide into the atmosphere threatened to change the earth's climate irreversibly. It was not until after the dropping of the atom bombs on Hiroshima and Nagasaki that people became aware that environmental damage on a really huge scale might transcend national boundaries. The notion that attackers might hurt themselves as much as their enemies by causing environmental damage simply did not exist before 1945.

Of course the British planners knew that individual consequences of the bombing, such as the release of oil or other contaminants into water supplies, would damage the environment, but they could reasonably assume that these consequences would be local and temporary. It is striking that even the most articulate opponents of the bombing during the war, and indeed in the half-century after the war, focused their criticism on precisely those consequences of the bombing which were discussed by the planners—the death and injury of civilians and the destruction of Germany's cultural heritage. Even that most vociferous of critics, F. J. P. Veale, made no mention of environmental considerations when he renewed his polemic against "terror bombing" in 1968.[39]

The whole idea of "ecological damage" and the discourse of "environmentalism" have emerged since the Vietnam War. It is only in the

last 20 years that scholars and diplomats have really engaged with the broader topic of war and the natural environment. A protocol was added in 1977 to the Geneva conventions of 1949 stating in part, "It is prohibited to employ methods of warfare which are intended, or may be expected, to cause widespread, long-term, and severe damage to the natural environment."[40] One will search in vain for the terms Friedrich uses in 2002—*environmental war* and *environmental attack*—in documents from before May 1945.

This shift in perceptions about warfare, and about the natural world, may be illuminated with reference to the concept of *mentalités*, an idea that has been developed largely by French and German historians. Their concerns were not merely with the temporary outlook of any given group or individual, but with deeper, underlying, sometimes inaccessible attitudes, which shape collective approaches to a given situation. Typically, they see these attitudes as formations, which develop and change very slowly over the course of decades and even centuries. In the words of German historian Klaus Hatchel,

> Such collective dispositions channel notions, attitudes, and ideas in two ways: *positively* by guiding individuals within the group in a particular direction, without there being any outright coordination or explicit agreement among them; or *negatively* by blocking out or repressing other conceivable options that would appear astonishingly self-evident to uninitiated outsiders.[41]

This approach can help us understand many aspects of the British bombing offensive planning, but it is particularly relevant to the idea of the environment, which is so markedly absent from virtually all of the extensive written records of this process. What appears obvious to us today was not necessarily so in the 1940s.

It is perhaps ironic that, among the politicians, airmen, and scientists who planned the British bombing, it was that most maligned figure, Arthur Harris, who commented most explicitly on what we would now call "environmental" consequences of their actions. In most cases—for example, when Harris commented on the "prolonged and bitter opposition" met by the RAF from bird lovers to its plans to use various places in Britain as bombing ranges—he was utterly contemptuous of these objections.[42] What is relevant is that he, and presumably others, were aware of environmental considerations. They simply did not treat them with anything like the significance we would anticipate today.

Second, there was a common assumption among the planners that if there were damaging side effects of the bombing, insofar as these were visited upon the Germans, it was a fate they richly deserved. Another remark in Harris's memoirs is illuminating in this regard. Referring to the deliberate flooding of Walcheren Island in October 1944 by bombing and breaching its seawalls, Harris reveals again that he was aware of the environmental consequences of this action:

> The flooding of the fertile soil of Walcheren, which it was believed could not be restored to its original condition within many years, was a most unfortunate necessity of war, but access to the port of Antwerp was essential for all future operations by land on the Western front. And, in any case, the wholesale destruction of property is, in my view, always justified if it is calculated to save casualties.[43]

Harris restates his concern to minimize casualties, but what is also revealing is that he comments in such specific detail about the environmental consequences of this particular action. Nowhere else in his memoir does he demonstrate anything like this; we may reasonably presume that he was not equally concerned with the destruction of the environment in Germany. His concern for the "fertile soil" of Walcheren—in the Netherlands—is not, for example, paralleled by any similar concern for the agricultural land devastated by the Dambusters Raid in May 1943. It would be a mistake, in discussing any consequence of the British bombing of Germany, not to take into consideration the feelings about Germany provoked by its own record since the very start of the war.

Third, and most important, we need to understand the nature of the war the British fought between 1939 and 1945. This is a consideration which feeds into any future debate about the environmental consequences of the deployment of airpower. The politicians and airmen—and their scientific advisers—who directed the British strategic bombing campaign believed that they were fighting for their national survival. Many had personal experience of the grim struggle between 1914 and 1918 to draw upon and knew that in Germany they faced an utterly ruthless, resourceful, and determined enemy. This straightforward sense of duty is evident in Barnes Wallis, the kindly, sensitive man who designed the most destructive weapons used by Bomber Command. It will be remembered that Wallis had recognized that, for example, destroying the Ruhr dams would cause damage to "everything" below them, not just to German industrial production. A colleague commented, "Barnes Wallis was a Victorian, and a great

'Empire' man, and the country meant an awful lot to him, so anything he could do which he thought would help the country, that's what he felt he was put upon this earth to do."[44]

Zuckerman serves as another example of an influential scientist who devoted his intellect to the perfection of weapons of war. For example, he tried to maximize the blast effect of British bombs, without apparent environmental scruples.[45]

If we are to understand the evolution of British aerial strategy, we need to take full account of the precise context in which it emerged. The British decision not to bombard "fuel and oil producing plants, refineries, and storage installations" in September 1939 was not motivated by environmental or humanitarian concern, but by a desperate hope of avoiding German aerial attacks on Britain. The turn toward area bombing and the decision to concentrate resources on the development of a huge bomber force took place against a backdrop of sustained German bombing of British cities at a time when Britain and its empire stood alone. Note that the German bombing of Britain, and indeed its conduct of war in all theaters outside Germany between 1939 and 1945, was not, for all the later trumpeting of the allegedly "green" credentials of National Socialism, in any way tempered by environmental sensitivities.[46]

Even late in the war, when Britain's bomber force had become a weapon of terrible destructive force, its planning took place against a background of sustained attack on British civilians by flying bombs and rockets and of extraordinarily difficult fighting on land in northwestern Europe. The idea that attacks on German oil or transportation targets should be called off because of potential damage to the environment would have appeared utterly ludicrous to the British planners, even in the late stages of the war.[47] Briefly consider the application of a similar concern to other aspects of the war. When the *Bismarck* left Gdynia in May 1941 bound for the North Atlantic, should the government have directed British submarines and aircraft not to attack it lest thousands of tons of fuel oil from the ship's bunkers be released to contaminate the sea?

It could be that in the circumstances of a limited war, a government, and its air force, can afford to consider the environmental implications of any proposed deployment of airpower. Few would disagree that this ought to have been a factor in the minds of NATO strategists during the aerial campaign against Serbia in 1999. Since the 1977 addition of Article 35.3 to the Geneva conventions, this is a

binding obligation for signatories to those conventions. On 5 November 2001 the United Nations General Assembly adopted Resolution 56/4 declaring 6 November annually an International Day for Prevention of the Exploitation of the Environment in War and Armed Conflict.[48] This has added international weight to the obligation to have regard for the natural environment in war. It was not a luxury that Churchill, Harris, and others responsible for the planning of British strategic bombing felt they enjoyed between 1939 and 1945.

Notes

1. A rare exception was geographer Kenneth Hewitt, who, in developing his theory of "place destruction," argued that "area bombing . . . became a form of extermination aimed at the whole spectrum of human, or more exactly, civil ecology." Hewitt, "Place Annihilation," 260.

2. Sebald, *On the Natural History of Destruction*, 19.

3. It is significant in this context that the title of a recent German study of the British bombing is titled simply (in English) *The Fire*. Friedrich, *Der Brand*.

4. Webster and Frankland, *Strategic Air Offensive against Germany*; Churchill, *Second World War*; and Harris, *Bomber Offensive*.

5. For a balanced summary, see Hastings, *Bomber Command*, 201–10, 417–25.

6. Appendix 6, "Western Air Plans 1st September 1939," in Webster and Frankland, *Strategic Air Offensive against Germany*, 99–102.

7. "Bombardment Policy," CAB/66/8/16, The National Archives (United Kingdom), Kew (hereafter TNA), which contains the instructions issued just before the start of the war.

8. "Air Vice-Marshal W. S. Douglas (deputy chief of the Air Staff) to Air Marshal Sir Charles Portal," in Webster and Frankland, *Strategic Air Offensive against Germany*, 115–17.

9. Ibid., 118–19. The wording of the directive suggests that there had already been some attacks on forests. I have found no other reference to these attacks actually taking place. The Air Ministry pamphlet *Bomber Command* provides considerable detail about attacks on the first four objectives specified in the directives of 20 June and 4 July 1940, but makes no reference to attacks on crops, forests, or heathlands in Germany. Ibid., 121–23.

10. Fourth Report of Lord Hankey's Committee on Preventing Oil from Reaching Germany Committee, 4 June 1940, TNA CAB/66/8/21.

11. Report by the Chiefs of Staff Committee, 25 May 1940, TNA CAB/66/7/48: Report by the Chiefs of Staff Committee.

12. Townshend, "Civilization and 'Frightfulness,'" 142–62.

13. Killingray, "'A Swift Agent of Government,'" 429–44. I am grateful to Neil Fleming for alerting me to this reference.

14. Webster and Frankland, *Strategic Air Offensive against Germany*, note 1.

15. Harris, *Bomber Offensive*, 88.

16. It is not the purpose of this chapter to revisit these debates. For an important example of a wartime contribution which does not consider environmental considerations, but focuses entirely on the effectiveness of bombing, see the "Memorandum by O. L. Lawrence," in Webster and Frankland, *Strategic Air Offensive against Germany*, vol. 4, 214–19.

17. Friedrich, *Der Brand*, 102. All translations from German here are my own unless otherwise indicated.

18. Ibid., 104–5.

19. "Die Katastrophe an der Möhnetalsperre und Ruhr, Bericht 2," 27 August 1943, R 55/20738, Bundesarchiv, Außenstelle, Berlin, Germany.

20. "Meldungen aus dem Reich, Nr. 385, 24 May 1943," in Boberach ed., *Meldungen aus dem Reich*, Band 13, 5277–85.

21. Harris, *Bomber Offensive*, 159.

22. Arthur, *Dambusters*, 39.

23. Ibid., 43.

24. Ibid., 57.

25. TNA, "The Idea," http://www.nationalarchives.gov.uk/dambusters/idea.htm.

26. Webster and Frankland, *Strategic Air Offensive against Germany*, vol. 2, 168.

27. Ibid., 291.

28. Richards and Saunders, *Royal Air Force 1939–1945*, vol. 2, 291–92.

29. Neillands, *Bomber War,* 229–30.

30. Arthur, *Dambusters*, 150.

31. Although it is not the subject of this chapter, we should note in passing that the daylight bombing of Germany by the American Eighth Air Force, which commenced in January 1943 and intensified thereafter, was conducted with a similar disregard for environmental consequences.

32. For a statistical overview of sorties flown and tonnage of bombs dropped, see Webster and Frankland, *Strategic Air Offensive against Germany*, vol. 4, appendices 40 and 41.

33. "Summary of Operations of Bomber Command," TNA CAB/66/59/39.

34. "Weekly Résumé (no. 285) of the Naval, Military, and Air Situation," 15 February 1945, TNA CAB/66/62/3.

35. "Summary of Operations Night 13/14 February."

36. TNA CAB/66/62/11: "Weekly Résumé (no. 286) of the Naval, Military, and Air Situation," TNA AIR 14/3080.

37. Colville, *Fringes of Power*, 562.

38. Weart, *Discovery of Global Warming*.

39. Veale, *Advance to Barbarism,* 180–85. Veale's critique was first advanced in 1948.

40. Article 35.3 of the 1977 Protocol I Additional to the Geneva conventions of 1949, in Reichberg and Syse, "Protecting the Natural Environment in Wartime."

41. Hentschel, *Mental Aftermath*, 2.

42. Harris, *Bomber Offensive*, 26–27.

43. Ibid., 237. The Walcheren operation was conducted outside of Germany, in support of Allied ground forces, and therefore lies outside the scope of this study. I refer to it here insofar as it illustrates Harris's thinking.

44. Ibid., 43, citing Norman Boorer.

45. Zuckerman, *From Apes to Warlords*. Zuckerman makes no reference to what we would now call environmental concerns in his record of his wartime service.

46. For an introduction to this topic, see "The Nature of German Environmental History."

47. Arthur Harris defended the continuing offensive in the aftermath of the raid on Dresden in characteristically forthright manner, stating, "I do not personally regard the whole of the remaining cities of Germany as worth the bones of one British grenadier." Harris to Air Marshal Sir Norman Bottomley, 29 March 1945, in Hastings, *Bomber Command*, 450–53.

48. United Nations General Assembly Resolution 56/4, also available online at http://www.un.org/Depts/dhl/resguide/r56.htm.

Chapter 3

The Environmental Impact of the US Army Air Forces' Production and Training Infrastructure on the Great Plains

Christopher M. Rein

In the twentieth century, aerial conflict demonstrated its potential to inflict devastating damage on the environment, as evidenced by the wholesale destruction of German and Japanese cities during World War II (WWII), the widespread defoliation in Southeast Asia during the Vietnam War, and the targeting of petroleum infrastructure during the conflicts in Southwest Asia. However, airpower's most lasting environmental damage may often be inflicted long before the first sortie is launched. The industrial production, training, and maintenance infrastructure required to equip and prepare air forces for combat requires a substantial contribution of natural resources and, if not properly managed, can have long-term detrimental effects on the environment.

Today, current and former US Department of Defense (DOD) and Department of Energy (DOE) facilities across the country have soil and groundwater contaminated with carcinogenic chemicals, persistent heavy metals, and even radioactive materials that will remain for hundreds, if not thousands of years. To make matters worse, the agency charged with assessing damage and initiating remediation and restoration, the US Army Corps of Engineers, has at times been overwhelmed with the scope of the contamination and the high costs of containment and restoration. This category of damage must be included when assessing the environmental impact of the employment of air forces.

In the early stages of the Second World War, the US Army Air Forces (USAAF) embarked on a massive production and training program that would convert it from a token force with few modern aircraft to the world's largest and arguably most advanced air force by 1945. The rapid expansion of the force and successful employment in theaters around the globe were remarkable accomplishments and critically contributed to the eventual Allied victory. While this re-

markable story of American industrial capacity, organization, and deployment is well known, often a chapter is omitted. The production facilities for both munitions and aircraft, as well as the training and maintenance facilities established to meet the wartime emergency, left a toxic legacy that continues to plague the communities that hosted and supported these facilities. The purpose of this chapter is to examine that legacy and explore the repercussions for modern practitioners of airpower.

The Great Plains

The American Great Plains formed an attractive locale for government and defense officials charged with expanding the USAAF's production and training infrastructure. The region boasted a variety of factors that made it ideal for wartime planners.[1] First, the Great Plains encompass the geographical center of the lower 48 states. Locations there offered the maximum distance from either coast, increasing protection from aerial attack and sabotage. Because of these geographic advantages, the Air Force would later place the majority of its Cold War–era strategic assets, including intercontinental ballistic missile (ICBM) sites, bomber bases, and even its command and control facilities in the region. Today, all of the Air Force's bomber and strategic communications aircraft and ICBM silos remain on or near the Great Plains.

Aside from its strategic geographic location, the region offered several other features that made it attractive for a large aerial infrastructure. First, it was, and remains today, one of the most sparsely populated areas of the country. Given the low population densities, the USAAF would not significantly endanger lives with accidents and would have little difficulty locating vast expanses for training and weapons ranges.[2] The low population densities recently had been exacerbated by a man-made ecological disaster, commonly known as the Dust Bowl. Encouraged by cheap land and liberal homesteading laws, settlers had expanded into the more arid regions and plowed up the hardy prairie grasses that kept the topsoil in place. Drought returned to the region in the early 1930s, causing crops to fail and leaving no vegetation to anchor the topsoil. When windstorms moved across the largely treeless region, the topsoil was stripped and, in some cases, transported as far away as the east coast. These storms,

known as dusters, plagued the region throughout the Great Depression and further contributed to low population densities as many residents abandoned failed farms in search of relief.[3]

The Dust Bowl and resulting depopulation of rural areas had the ironic result of facilitating the establishment of wartime production facilities across the plains. Some farmers and their families left the land and congregated in cities, looking for work or relief programs. Others remained on their farms but had become disenchanted with their prospects and were quick to embrace other opportunities when they arrived. By 1940 the plains held an underutilized population that could be quickly employed in the new armaments and aircraft production facilities. A 1942 survey found that 50 percent of the workers at Boeing-Wichita had farm backgrounds. Further, a rural upbringing often translated well into war industries work. Craig Miner, in his history of Kansas, relates the observations of the personnel director at the Boeing-Wichita factory who believed that "persons from modern farm backgrounds did especially well in aircraft manufacturing jobs. . . . Nearly all Kansas farms are highly mechanized and Kansas farmers have learned the use of power machinery as well as hand tools."[4]

Cities such as Wichita, Oklahoma City, and Fort Worth owe much of their remarkable wartime growth to a combination of these factors. Wichita's population increased from 114,634 in 1940 to 176,316 in 1944.[5] While much of the available labor was unfamiliar with modern manufacturing techniques, a technical background combined with training and relief programs initiated during Pres. Franklin Roosevelt's "New Deal" to provide the necessary expertise. As a result, production facilities in these cities and others, such as Omaha, Kansas City, and Tulsa, had little difficulty finding workers to staff aircraft production centers. Often the limiting factor was not available labor, but a shortage of housing and public utilities to shelter the new employees. In one newly constructed housing area near Wichita, untreated sewage was discharged directly into the Arkansas River, presenting a public health hazard for residents downstream.[6]

Weather was another factor that made the Great Plains region an attractive location for training bases. Portions of the area average over 300 days of sunshine per year, as the Rocky Mountains to the west wring out the moisture of east-moving storms. With a prevalence of excellent visual flying conditions, low precipitation, and brief periods of poor weather, the region remains popular for military

flight training. Even today, over half of the Air Force's undergraduate pilot training (UPT) bases are located on the plains, including the only combined Euro-NATO joint jet-fighter training facility at Sheppard AFB, Texas. Other UPT bases include Vance AFB, Oklahoma, and Laughlin AFB, Texas. Only Columbus AFB, Mississippi, and Moody AFB, Georgia are located outside the Great Plains region. Unfortunately, the scarcity of rainfall in the region often exacerbated environmental damage. Low rainfall rates resulted in comparatively few flowing rivers. Within the more than 2,000 miles between the Mexican and Canadian borders, only four major river systems—the Rio Grande, Arkansas, Platte, and Missouri—travel all the way from their source in the Rockies to the Gulf of Mexico. Much of the region west of the 100th meridian averages less than 20 inches (50 centimeters) of rain annually, making residents highly dependent upon subterranean groundwater, a source especially vulnerable to contamination. In addition, the relatively low flow rate in some of these rivers makes it difficult to adequately dilute pollutants discharged into them. All of these factors worsened environmental damage, especially the pollution of surface and groundwater.

Production Facilities

In May 1940, President Roosevelt, in response to events overseas and lobbying by Army Air Corps leaders, ordered the expansion of the aircraft industry to permit production of 50,000 planes per year.[7] Military production had totaled only 2,195 planes in 1939.[8] To achieve this incredible increase in production, owners of existing factories in Baltimore, Long Island, Buffalo, Long Beach, and Seattle had to expand their facilities. But it soon became clear that the increased capacity at existing sites would be insufficient. The War Department began to contract with manufacturers to operate new production facilities that the government would build and then lease to them. The War Department decided to locate many of these new facilities on or near the Great Plains. These new factories eventually contributed a substantial portion of many of the more common types of aircraft employed by US and Allied air forces during the war (table 1).

It is difficult to assess the environmental impact of many of these facilities. In most cases the plants ceased production after the war but were occupied by other activities under war reutilization programs.

Table 1: Aircraft types produced on the Great Plains

Type Facility	Number Produced	Percent of Total Production
Heavy Bombers		
B-24		
Consolidated–Fort Worth	2,743	
Douglas–Tulsa	964	
North American–Dallas	966	
Total	4,673	24.3 percent (4,673/19,204)
B-29		
Martin–Omaha	515	
Boeing–Wichita	1,595	
Total	2,110	54.1 percent (2,110/3,898)
Medium Bombers		
B-25		
North American–Kansas City	6,608	67.3 percent (6,608/9,816)
B-26	1,585	30.7 percent (1,585/5,157)
Martin–Omaha		
Transport Aircraft		
C-47		
Douglas–Oklahoma City	5,319	51.3 percent (5,319/10,368)
Pursuit Aircraft		
P-51		
North American–Dallas	4,552	31.0 percent (4,552/14,686)
Trainer Aircraft (All Types)		
Boeing, Beech, and Cessna–Wichita	20,628	37.0 percent (20,628/55,712)

Adapted from Irving Holley, Jr., *Buying Aircraft: Materiel Procurement for the Army Air Forces* (Washington, DC: Office of the Chief of Military History, 1964), appendix B, 576–79.

For example, the Douglas plant in Oklahoma City is currently occupied by Tinker AFB. Omaha's Martin plant became the site of Offutt AFB, home to Strategic Air Command (SAC) headquarters during the Cold War. In 1948 the US government sold the North American plant in Kansas City to General Motors to produce automobiles for their Chevrolet and Pontiac lines.

Of all the new production facilities erected on the plains, only one has remained in continuous production. The Lockheed-Martin facility near Fort Worth, known as "Air Force Plant 4," is also the only WWII-era plant to be listed on the Environmental Protection Agency's (EPA) National Priority List (NPL). The NPL, or "Superfund" list, is a collection of the most heavily contaminated sites in the country. Listing a site allows the EPA to establish and implement appropriate cleanup plans.[9] At the Fort Worth plant, aggressive programs to pump groundwater contaminated with trichloroethylene (TCE), a known carcinogen, through filtration plants have, according to the EPA, reduced the threat to 13,000 residents, including those nearby at the former Carswell AFB. However, the EPA has detected contaminants in several underground aquifers above the main aquifer used for drinking water in the area.[10] The facility produced over 2,000 B-24s during WWII and has been in continuous use since, producing B-36, B-58, F-111, and F-16 aircraft and components for F-22 aircraft types. The similarity of pollutants used during these various periods makes it difficult to determine exactly when the most serious damage occurred.

Airframe production is only one of the required steps in a successful sortie launch. The completed airframe must be fueled and armed before it is ready for a crew. While it is beyond the scope of this study to examine the significant environmental repercussions of petroleum extraction and refinement in the United States, it is sufficient to note that a large percentage of Allied petroleum resources, including 90 percent of all 100-octane aviation fuels, came from US wells and refineries, some of which were located on the southern plains. Through the Defense Plant Corporation, the US government built and leased refineries across the nation, including several in the region. By 1945 American refineries were producing 514,000 barrels a day of 100-octane aviation fuel, up from 40,000 barrels per day in 1940.[11]

The Army Ordnance Corps established and operated munitions production plants in several Great Plains states. A number of these facilities are now on the EPA's Superfund list, including the Rocky Mountain Arsenal, near Denver; the Kansas Army Ammunition Plant (AAP); Cornhusker AAP in Nebraska; and the Lone Star and Longhorn AAPs in Texas. All of these facilities opened during WWII, and several remained in operation during subsequent conflicts. All eventually left their mark on the environment.

The Cornhusker AAP, near Grand Island, Nebraska, is a classic case of the unintended consequences of wartime production methods.

Built in 1942, the facility produced 330,562 1,000-pound bombs, 20,698 2,000-pound bombs, and 1.5 million 260-pound fragmentation bombs, in addition to 11,476,545 105-millimeter artillery shells during the war.[12] The DOD inactivated the facility after the war but reactivated it during the conflicts in Korea and Vietnam before finally closing it permanently. In preparing the site for sale, the Army "did extensive clean up on the plant itself, but a trail of contaminated water outside the boundaries complicated efforts to transfer the facility."[13]

The Cornhusker AAP offers a stark reminder of the lingering costs to communities that hosted production and training facilities during WWII. Toxic chemicals from the facility were held in 56 different earthen impoundments across the 19-square-mile site, the EPA said. "Releases from the surface impoundments have contaminated approximately 500 private wells," and "polluted groundwater has migrated off the site and has been detected as far as 7 miles beyond the plant's border."[14] Perhaps encouraged by the potential sale of the site, the Army Corps of Engineers has embarked on an aggressive cleanup program, excavating and incinerating contaminated soil and extracting and pumping contaminated groundwater through a filtration system before returning it to the ground. The EPA estimates that this action has shrunk the offsite contamination plume and that it will be "below cleanup levels" in three to five years.[15]

The remediation programs came too late for one Grand Island resident. In 1978 Chuck Carpenter, a junior high school science teacher, bought a home in the Le Heights section of Grand Island. In 1982 the *Grand Island Independent* reported that the Army had detected a highly toxic explosive compound known as "RDX" in the facility's groundwater but assured residents that it would take "over a century" for the contaminants to reach the town. RDX is a unique compound used exclusively in the manufacture of military explosives, linking it definitively to the ammunition plant. Later investigations revealed that the plume of contaminants was moving at a rate of "three meters per day" and would reach the town in "just four years."[16] As early as 1980, the Army became aware of the contamination and that it was migrating across the installation boundary. The Army released no information to the public for four years, while conducting tests and collecting information. In 1984 Army officials finally acknowledged that "more than half of the 467 private wells" in sections of Grand Island, including Le Heights, had "extremely elevated levels of RDX."[17] Concerned about his family's health but unable to sell a

home that had lost two-thirds of its value, Carpenter abandoned his home and declared bankruptcy. The Army refused to provide any compensation, alleging that the chemicals were released prior to the Korean War, when dumping was "legally permissible."[18] The Army eventually agreed to pay to connect residents to a city water supply but has not addressed the collapse in property value as a result of pollutants discharged from the facility.

The Air Force's primary mission during the Cold War was not delivery of conventional munitions in case of a conflict with the Soviet Union. Air Force bombers, missiles crews, and tactical fighters sat on nuclear alert, ready to launch atomic weapons at a moment's notice. But in his analysis of environmental damage in Japan during WWII, William Tsutsui noted that "plant and animal life seem to have been relatively unaffected by the bombs." Further, "the atomic bombs—like the incendiary attacks—were tremendously and tragically destructive for one species: *Homo sapiens*. When viewed from a less anthropocentric viewpoint, however, the environmental implications of direct combat in Japan during World War II are far more ambiguous."[19] Even so, production and testing of these weapons left an enormous scar on the American landscape.

In 1992, Michele Gerber detailed the effects of radiological contamination that will linger for millennia at the Hanford Site in Washington State.[20] While this and other nuclear production facilities were operated by the DOE, the DOD was a primary customer. The damage inflicted at these sites must be included in the cost of waging aerial warfare, even in a deterrence role, during the latter half of the twentieth century.

Bombing and Gunnery Ranges

In addition to manufacturing facilities, which left behind a toxic legacy, the military impacted the environment by locating large numbers of training facilities across the plains. Kansas supported 16 different Army airfields, up from only two during the prewar period.[21] These fields were used for training, from primary flight training to processing crews for overseas movement. Four of the bases—Great Bend, Pratt, Smoky Hill, and Walker—were dedicated to training B-29 crews. The new bomber required large ranges for both gunnery and bombardment training. Fortunately for the USAAF, sparsely popu-

lated areas of western Kansas were ideally suited for this purpose. The Army established three gunnery ranges in Ellis, Ness, and Gove Counties and three bomb ranges in Trego and Graham Counties. The Gove County range covered 218,880 acres and displaced 150 farm families. Local farmers were not always happy with the compensation provided and petitioned their elected officials in an unsuccessful attempt to seek redress.[22]

In addition to the hazard from aircraft straying off the range, training exercises occasionally set prairie fires that quickly spread to neighboring ranches, threatening livestock and buildings.[23] One west Kansas resident, E. J. Montgomery, wrote his senator to complain. "The planes do not stay in their range, the bullets pass over my place and I live four miles from the range."[24] The Oakley newspaper rationalized: "It is unpleasant that many people will be temporarily ejected from their homes, especially after the struggle of the dust years to regain financial independence, but such conditions exist when a nation is at war."[25]

The fire risk and loss of productive agricultural and grazing lands may have been responsible for the adoption of an area that did not require anyone to relocate. Farmers near Great Bend petitioned the Army to use Cheyenne Bottoms, a nearby 41,000-acre wetland, as a bombing and gunnery range during the war.[26] Cheyenne Bottoms has been described as the single most important wetland for migrating waterfowl and shorebirds between the Arctic tundra and the Gulf of Mexico.[27] Fortunately, the USAAF's use appears to have had little long-term negative effect. Despite the presence of spent projectiles and shell casings, a 1984 comprehensive survey of the wetlands found no excessive levels of heavy metals. The few areas with noticeable concentrations of lead in surface water had been heavily used by waterfowl hunters for years, and the appreciably lower levels in adjacent areas closed to hunting suggest that spent lead shotgun pellets were a far likelier source of contamination.[28]

After World War II, the newly independent Air Force sought to maintain bombing and gunnery ranges in Kansas to support the bases that remained open. The Army had operated Camp Phillips, an infantry training camp, on a 42,000-acre site near Salina and the Smoky Hill Army Airfield (AAF).[29] Recognizing the site's potential as a range, the Army retained control after the war rather than returning it to the original landowners, eventually transferring Camp Phillips to the Air Force. After Smoky Hill AAF closed in the 1960s, the Kan-

sas Air National Guard assumed control of the range and operates it as the Great Plains Joint Regional Training Center.[30] The range is covered by large expanses of native prairie grasses that are carefully managed by the range operators. Spraying for invasive species and controlled burns make it one of the most intensively managed tracts of native tallgrass prairies in the state. A 2007 study found that "the size and generally good condition of this largely unfragmented tallgrass prairie makes it a valuable reservoir of biological diversity for the Great Plains."[31] While the threat for contamination from unexploded ordnance remains, the intensive management demonstrates the potential for modern air forces to be good stewards of environmental resources. Had the military not retained control of Smoky Hill after WWII, it likely would have returned to agricultural production and become significantly less useful to many species of wildlife.[32]

Ranges in other areas are not as free from environmental damage as the Smoky Hill Range. The former Lowry AFB, located southeast of Denver, served as an aircrew-training center during WWII. The USAAF operated a 100-square-mile range in Arapahoe County southeast of Denver to support aircrew training for B-17, B-24, and B-29 crews. The range remained in operation through the Korean conflict before being closed in 1962. The DOD transferred large portions of the range to the state of Colorado and private landowners, but the presence of unexploded munitions required the Army Corps of Engineers to conduct an extensive site cleanup.[33] However, the most significant environmental damage on the range occurred on a portion transferred to the city of Denver in 1965 and used as a landfill for toxic chemicals. The "Lowry Landfill" has been designated as an EPA Superfund site due to the presence of metal plating wastes, industrial solvents, and radioactive wastes.[34]

So far I have focused only on USAAF production and training facilities. The US Navy also operated a number of facilities on the Great Plains, including a naval ammunition plant at Hastings, Nebraska, and primary flight training facilities in Olathe and Hutchinson, Kansas, and Norman, Oklahoma. However, the vast majority of naval aviation training occurred in coastal and marine environments, which often contain far more sensitive ecosystems. The more recent disputes over environmental damage at naval bombing and gunnery ranges on the islands of Vieques, Puerto Rico, and Kaho'olawe, Hawaii, demonstrate that the USAAF was comparatively fortunate to have a number of inland sites available for training. Some of those

sites may have even benefited from military use. As Edmund Russell and Richard Tucker have noted, "military bases have often been de facto nature preserves. By building up small areas while leaving most of the bases open for training and maneuvers, bases have sometimes created well-guarded sanctuaries for species." Russell and Tucker do not "argue that one should create bases and bombing ranges to preserve wildlife," but they note the "complex, surprising and often ironic ways in which war and nature interact."[35]

Operational and Maintenance Bases

In comparison with production and training facilities, the permanent bases established on the Great Plains proved to be the most intrusive and environmentally damaging facilities. While most lasted only as long as the war, those that remained released substantial quantities of toxic materials into the ground. Air bases in particular may be slightly more susceptible to this type of contamination than other facilities for several reasons. First, they require large quantities of potentially toxic liquids, most notably jet fuels, to accomplish their missions. These compounds are often stored in underground storage tanks (UST) to protect them from fragmenting explosives in case of attack and to reduce vertical obstructions in the airfield environment. Aboveground storage tanks could potentially intrude into the flight paths of landing and departing aircraft and also block instrument landing signals. Unfortunately, the burial of storage tanks makes it more difficult to detect leakage and failure, exacerbating the potential for release of toxic substances into the soil and groundwater.

Two Air Force facilities on the Great Plains have had significant issues with chemical release and groundwater contamination. Smoky Hill, later Schilling AFB, near Salina, Kansas, and Tinker AFB, near Oklahoma City, have released sufficient quantities of chemicals into the ground over the years to seriously threaten the water supplies of nearby residents. The most common pollutant is TCE, a persistent chemical. When first introduced as an industrial solvent, TCE quickly gained favor among maintenance specialists for its highly effective degreasing properties. Unfortunately, TCE is persistent in the environment and is a known carcinogen.[36] Even as early as 1942, the USAAF's field service section reminded users "the toxicity of this material and of all halogenated hydrocarbons generally is well known."[37]

Schilling and Tinker discharged sufficient quantities of TCE into the ground to pollute local aquifers, threatening drinking water supplies for on- and off-base residents. While current regulations prohibit the reckless discharge of TCE and other chemicals into the environment, decades of abuse have left a toxic legacy of varying severity at both sites.

Smoky Hill AAF was established in 1942 and served as a B-29 training, processing, and staging base during WWII. It remained in service after the war and in 1957 was renamed in honor of Col David C. Schilling, a native of Leavenworth, Kansas, who was killed in an auto accident in England. As a member of the 56th Fighter Group (Zemke's Wolfpack), Schilling amassed 33 "kills" during WWII. The SAC base hosted two bomb wings composed of B-47 bombers and KC-97 tankers.[38] In 1960 an Atlas-F missile wing was also headquartered at the base, with the actual missiles located at 12 dispersed sites across central Kansas. In November 1964 Air Force officials elected to close the base, surprising local officials who scrambled to find new occupants for the facility.[39] Today, the Salina Airport Authority operates the airfield as a municipal facility, while a number of commercial and educational enterprises also occupy the site, including the Salina Area Technical School and the campus of Kansas State University at Salina.

When the base closed, local officials were absorbed with preparing the site for new occupants. The thought of potential contamination was not a major consideration, despite a provision in the deed, which apparently absolved the US government of any liability for restoration or other damages.[40] Fortunately for the city, the Comprehensive Environmental Response, Compensation, and Liability Act, passed by Congress in December 1980 and later amended by the Superfund Amendments and Reauthorization Act of 1981, required the DOD to comply with all EPA guidelines, even at sites already transferred to the private sector. In 1986 the DOD established the Formerly Used Defense Sites program and placed it under the authority of the Army Corps of Engineers to assess environmental damage and engage in remediation activities. The corps has spent $3.9 billion on the program as of 2006 and estimates that it will take a total of $18.7 billion to complete remediation at the more than 4,600 sites in the program.[41] Later estimates raise this total to as high as $35 billion.

One of the main problems in addressing the issue is the number of new sites that continue to be added to the list. This was the case when the extent of Schilling AFB's contamination was first discovered in

the early 1990s. In 1993 the corps hired a contractor to complete a site investigation. Based on the results, the corps agreed to "remove or abandon in place" 107 USTs. Even this action required the Salina Airport Authority's cooperation, as the corps dug in its heels, stating that since "non-DOD parties used petroleum products at the former Air Force Base property following DOD ownership, the Corps does not intend to clean up petroleum in soils or groundwater as a separate contaminant unless it imposes imminent and substantial risk and has been identified as the sole responsibility of DOD."[42]

Discoveries of contaminated areas outside those originally tested in 1993 resulted in the corps conducting a second site investigation in 1998. The city of Salina disputed some of the findings in the second survey, only to be told that they "had no formal role in the process."[43] The city engaged with the EPA, which conducted an "expanded site investigation" that firmly tied source areas to DOD activities. In January 2006 the corps released a study of the TCE plume extending from under the base and determined that it would not reach the city's water wells for 75 years. Four months later, the corps was forced to admit it had made a mistake in its calculations and that the plume would reach the water wells serving the town's 45,679 residents in less than 10 years.[44]

Unlike Schilling, Tinker AFB continues as an active base today, despite its status as an EPA Superfund site. Established in 1942 at a cost of over $21 million, the base employed nearly 15,000 workers and served as a repair and modification center for the B-29 bomber.[45] It remained in active service after the war as one of five air logistics centers in the Air Force. As the Cold War began, the Air Force attempted to curtail some of the worst wartime excesses and address the pollution released from its facilities. By 1950 regulations required that "military authorities in the Continental United States will cooperate with civil authorities in preventing the pollution of surface or underground waters by sewage or industrial wastes from Air Force installations and activities."[46] Yet as late as 1984, Tinker was still discharging industrial waste into storm drains. In congressional testimony, the chief of the Water Quality Division of the Oklahoma Water Resources Board noted that "when the base was built, storm drains often legally carried industrial wastes. However, this practice is no longer acceptable."[47] Unfortunately, not all lines had been rerouted to collection tanks, and hazardous waste was still being discharged directly into local creeks. By December 1990 some local wells were so

badly contaminated that the base began supplying nearby residents with bottled water until they could be connected to municipal water supplies, which took place between September 1993 and May 1994.[48]

Conclusion

It is clear that the Air Force's infrastructure has inflicted considerable environmental damage on the Great Plains. In almost every case, the US government has acknowledged its role in the contamination. Legislation passed in the early 1980s has forced the DOD to participate in cleanup efforts, even at facilities no longer under DOD control. After a slow start, the Army Corps of Engineers now spends considerable time and effort in assessment and remediation programs, both at facilities on the plains and across the country. However, the impact will linger long after final cleanup efforts are complete. In most cases, the corps will be unable to remove all the pollutants, and some cleanup efforts will cease when testing reveals concentrations have dropped below levels considered dangerous to human health. Yet, the fact remains that the Air Force inflicted serious damage on the environment.

It should be noted that the environmental philosophy that permeated the service during the earlier period was not unique. Many private industries followed equally callous disposal policies during that era, and many have not been as engaged as the DOD in remediation efforts. The Army Air Forces had a vital mission during World War II, and the increases in efficiency and time must be weighed against the millions who suffered under despotic regimes that were toppled only by force. Some might argue that the Cold War presented an equal threat. The costs must be weighed against the benefits.

Still, the Army and the Air Force colluded in activities that threatened the health of residents near their bases. The question of acceptable endangerment leads down a path toward determining which lives are most worth protecting, with a consideration of both immediate and longer-term threats and orders of magnitude. Military forces have long operated under the concept of acceptable "casualty rates" and "collateral damage" and seem to be more comfortable with the idea that some must suffer so that many survive. Today, the service's tolerance for collateral and environmental damage is well below where it was 75 years ago. For example, current Air Force hazardous

materials regulations emphasize that individuals and commanders can be held personally liable for the release of pollutants at their bases. Yet, the legacy of years of reckless discharge will linger and continue to affect relations with host communities.

Having once clamored for military facilities as engines of economic development, the public is now far more wary of their presence. A recent attempt by the Army to expand its Pinyon Canyon maneuver area on the high plains of Colorado met widespread opposition from an odd coalition of antimilitary groups and more-conservative ranchers and landowners. Efforts to expand existing military facilities are often met with suspicion by local residents, whose trust has been compromised by efforts to disguise or delay notification of previous environmental threats. The current period of financial retrenchment and a shrinking share of the defense budget magnify the billions spent to remediate previous environmental damage. Perhaps there is no truer example that an ounce of prevention equals a pound of cure. Already, there is evidence that the current operating requirements reduce DOD cleanup expenditures and make it more difficult for state and federal regulatory agencies to compel compliance.[49] All of these factors impact current and future readiness and the Air Force's ability to accomplish its mission.

In this century, aerial weapons have demonstrated the ability to inflict devastating damage on remote battlefields. Yet, as William Cronon has observed in his work on nineteenth-century Chicago, "the ecological place of production (grows) ever more remote from the economic point of consumption, making it harder and harder to keep track of the true costs and consequences of any particular product."[50]

Certainly this is true for airpower. As the sites of employment expand further from the points of production, it is easy to lose sight of the true costs of developing and employing weapons from the sky. However, in any accounting of the impact of aerial warfare on the environment, these production costs, which sometimes far exceed those resulting from the weapon employment, must be included in the final tally.

Notes

1. White, *It's Your Misfortune*, 497. He notes that factors that had initially stalled development in the American West (remoteness, aridity, and low populations) all worked in its favor to attract defense activities during the war.

2. "Hundreds Mourn Family Killed in Marine Jet Crash," *San Diego Union-Tribune*, 11 December 2008. The utility of locating air bases away from population centers was recently demonstrated by a mishap involving a Marine F/A-18 aircraft that killed a family of four near MCAS Miramar.

3. Worster, *Dust Bowl.*

4. Miner, *Kansas*, 312.

5. Ibid., 312–13.

6. Hurt, *Great Plains during World War II*, 56.

7. Simonson, *History of the American Aircraft Industry*, 119.

8. Bilstein, *Enterprise of Flight*, 77.

9. Environmental Protection Agency (EPA), "What Is Superfund?"

10. EPA, "Current Status, Air Force Plant 4."

11. Yergin, *Prize*, 365.

12. Wit, "Social and Economic Impact," 153.

13. Ibid., 162.

14. EPA, "Cornhusker Army Ammunition Plant."

15. Ibid.

16. Shulman, *Threat at Home*, 74, 77.

17. Ibid., 78.

18. Ibid., 81.

19. Tsutsui, "Landscapes in the Dark Valley," 199.

20. Gerber, *On the Home Front*.

21. "US Army and Air Force Wings over Kansas," 129–57, 334–60. The prewar fields were the post airfields at Forts Leavenworth and Riley.

22. R. A. Fouts to Sen. Arthur Capper, letters, 20 July and 30 October 1943, "Gove County Gunnery Range" folder, Box 11, Arthur Capper Papers.

23. Hurt, *Great Plains*, 276.

24. E. J. Montgomery to Sen. Arthur Capper, letter. Capper Papers.

25. Undated, unidentified newspaper clipping, "Gove County Gunnery Range" folder, Box 11, Capper Papers.

26. McMullen to Sen. Arthur Capper, telegram, 13 November 1943, "Air Bases-Hays" folder, Box 1, Capper Papers.

27. Zimmerman, *Cheyenne Bottoms*.

28. Biological Survey, "Cheyenne Bottoms," 52.

29. 184th Bomb Group, *Cultural Legacy of the Smoky Hill Air National Guard Range*.

30. "Kansas Governor Hosts Ribbon Cutting," news release.

31. Busby et al. *Natural Features Inventory,* ix.

32. Ibid., 7, 253.

33. Colorado Department of Public Health and Environment, "Former Lowry Bombing and Gunnery Range."

34. Colorado Department of Public Health and Environment, "Lowry Landfill Site."

35. Tucker and Russell, *Natural Enemy,* 11.

36. US Department of Health and Human Services, "Fact Sheet."

37. US Army Air Forces, Field Service Section, Technical Bulletin, 25 March 1942, Schilling AFB Files, Kansas Department of Health and Environment, Topeka, KS.

38. "US Army and Air Force Wings over Kansas," 348–49.

39. Olson, "Salina's Response."

40. "Quitclaim Deed for Schilling Air Force Base," 465.
41. US Army Corps of Engineers, "Formerly Used Defense Sites Program."
42. "Fact Sheet," Kansas Department of Health and Environment.
43. "Schilling Air Force Base Project," 2.
44. "2000 Census: Corps Admits Miscalculation," *Salina Journal*, 5 May 2006.
45. Hurt, *Great Plains*, 243.
46. US Air Force Regulation 91–9.
47. US House, "Review of Hazardous Waste Cleanup," 89.
48. US Department of Health and Human Services, "Public Health Assessment, Tinker."
49. One source claims that between 2001 and 2004, the DOD cut its cleanup budget by 57 percent. "Cleanup Fights Stall," *USA Today*.
50. Cronon, *Nature's Metropolis*, 340.

Chapter 4

Airpower and the Targeting of a Nation's Energy Infrastructure

Mark A. Olinger

As the last Imperial Japanese Navy aircraft departed Pearl Harbor, a majority of the US Pacific Fleet lay in ruins. Despite the tremendous success of the surprise attack, Japanese naval leaders and air planners had committed a strategic error. Despite their vulnerability to aerial attack, storage tanks holding more than four million barrels of fuel critical to the US military remained intact in what would become the Pacific theater of operations. The strategic implications of the Japanese attack are obvious—to protect or attack an energy infrastructure, one must understand its purposes, how it is constructed, and its vulnerabilities. On 7 December 1941, the energy-based sector of a nation's economy was a viable target requiring critical analysis, particularly during large, fast-paced, high-intensity operations. In the last half of the twentieth century, the majority of these targets were attacked using airpower.

When considering energy infrastructure as a potential target, one thinks of World War II. Prior to that war, much thought had been given as to how one might actually go about destroying the petroleum-based sector of a nation's economic infrastructure. As the war progressed, it became evident that strategic centers of gravity were not always within reach. The US experience in Vietnam serves as an example of the inappropriate employment of airpower due to ignoring enemy requirements and the availability of sanctuaries inside North Vietnam and neighboring countries. The Gulf War and Iraq in 2003 saw the integration of Iraq's energy infrastructure into the overall campaign plan. The core issue: by attacking a nation's energy infrastructure in either an unlimited or limited war, were strategic objectives obtained at the expense of that nation's economic future and civilian population? In shifting the focus to current and future trends, the energy-based sector of a nation's economy offers a wide and dispersed target set to air planners. At question is whether targeting energy infrastructures might be useful, and if so, when and what should be

attacked; and what are the collateral effects, the impact on the environment, and the law of war implications.

Modern warfare is destructive and has a significant impact on a nation. It requires not only balanced military forces that are organized, trained, and equipped to defend a state's national interests, but also economic infrastructures capable of supporting those forces. Economic infrastructures provide large, vulnerable targets susceptible to various types of enemy attacks. While some targets have little value, this is not the case with energy. Petroleum-based products will remain a viable world energy source for the foreseeable future. As of 1 January 2009, known global crude oil reserves were estimated between 1,184.2 and 1,342.2 billion barrels. World oil consumption has dropped sharply since the middle of 2008 in response to the global economic downturn and higher prices.[1]

Airpower Theory and Interwar Planning

Between the two world wars, military theorists from several nations advocated what they called "strategic" bombing as the logical and obvious way to employ aircraft. To the thinkers who emerged from the Great War and believed in the future of airpower, the strategic employment of its capabilities was considered the panacea that would avoid future senseless slaughters. A number of men arrived at these conclusions more or less independently. In Great Britain, Hugh Trenchard ("father of the Royal Air Force") was less of a theorist than the others, with his ideas limited in scope. Pierre Vauthier of France was the principal protagonist in that country, and the United States had Billy Mitchell.[2]

The first theoretical "prophet" of airpower was an Italian named Giulio Douhet, who published *Command of the Air* in 1921. The book was a fully developed theory of airpower and its potential. Douhet saw the airplane as the perfect offensive weapon with none of the limitations of ground or naval power. Based on his own positive and negative experiences in World War I, he concluded that the airplane was capable of inflicting overwhelming destruction. With the proper amount of airplanes appearing over an enemy's capital and industrial centers, chaos would occur and cause the immediate collapse of the enemy's government and industrial base. The bomber would always get through, because there was no effective defense against it. Douhet

stated empathically that "the fundamental principle of aerial warfare is this: to resign oneself to endure enemy aerial offensives in order to inflict the greatest possible offensives on the enemy."[3] He pointed out that his theory of war and employment of airpower, brutally conducted but concluded quickly, was far more humane than what had occurred in the world war. His proposals were hugely influential among airpower advocates, arguing that the air arm was the most important, powerful, and invulnerable part of any military. With Douhet, airpower had its first coherent theory. Air forces would no longer be considered auxiliaries and should be a nation's primary instrument of war.

In 1922 Douhet met the like-minded American airpower theorist Billy Mitchell on a visit to Europe, and soon an excerpted translation of Douhet's *Command of the Air* began to circulate in the US Air Service. Mitchell's book *Winged Defense* was published in 1925. In it he argues that airpower had become a main force in war instead of an auxiliary to the other services and would continue to be a dominating factor. In hindsight, Mitchell was more of a propagandist than a theorist, and his ideas were more limited in scope than those of others. As a result of Douhet's proposals, air forces allocated greater resources to their bomber squadrons than to their fighters. Prewar planners, on the whole, vastly overestimated the damage bombers could do and equally underestimated the resilience of civilian populations. Given the technological advances made during the 1920s and 1930s, the possibility of unlimited war continued to expand. During this period, little practical experience existed when it came to targeting national economic infrastructure. Serious thought on the subject was not considered until the late 1930s when the US Army Air Corps Tactical School (ACTS) and the British Air Ministry began to study the utility of targeting a nation's energy infrastructure, specifically the petroleum-based sector. The ACTS laid the foundation for economic analysis and industrial targeting while advocating a strategic airpower doctrine. Believing that a nation's ability to wage war was directly related to its ability to convert raw materials into weapons, strategic bombing of a nation's industrial base or economic infrastructure became the American approach.

At the same time, the British were also busy analyzing how best to destroy an adversary with airpower.[4] After a series of studies conducted during 1936, the British Industrial Intelligence Center recognized that targeting the oil industry was key. Therefore, the British

prioritized oil industry targets along with various other target sets in a series of 13 war plans known as the Western Area Plans (WAP), published on 1 October 1937. Particularly, WAPs 5 and 6 dealt with the oil industry. The latter was the basic plan to destroy the core of German fuel production and supply: 14 synthetic oil plants and as many major oil refineries. In 1939, the British Air Ministry directed a series of studies to locate the key points within critical sectors of the German economy.[5] British leaders sought target sets containing only a few targets whose destruction would have an immediate effect on the enemy's will to resist. To qualify, a target set had to be of major importance to a nation's military, be concentrated in a few locations, have no appreciable redundant capacity in or out of the country, and be incapable of quick repair or replacement or quick dispersal without loss of production.

At the heart of US doctrine as it entered World War II was the idea that the ultimate aim in war was to destroy the morale of the people. Planners believed that this objective could best be met by destroying vital links in the industrial economic structure that was already strained by the requirements of war. This approach assumed that adequate intelligence would be available on the location of these vital links and once attacked that they would not be restored for many months. Likewise, unescorted mass bomber formations would penetrate enemy defenses and destroy assigned targets.[6] Energy infrastructure was a prime target—specifically the petroleum industry. The rise of airpower made possible unprecedented violence on population centers, factories, and economic infrastructures.

Unlimited Warfare: World War II

During the course of World War II the petroleum-based sector was the primary target in a variety of warfare. On 22 February 1940, Sir Cyril Newall, chief of the British Air Staff, agreed that the Royal Air Force (RAF) Bomber Command should attack targets in accordance with WAP 6 if Germany invaded the Low Countries. By mid April 1940, the British became convinced that German refined petroleum stocks were desperately low and that any further reduction would force Germany into a crisis situation. Five days after the German invasion of the Low Countries in May 1940, Bomber Command began flying missions against Germany's petroleum-based energy

sector in the Ruhr Valley using WAP W. A. 4(c).[7] Great Britain's air offensive strategy continued to target the petroleum-based sector throughout most of 1940. In September 1940, the overly optimistic British chiefs of staff believed that Germany's refined oil stocks might be exhausted by June 1941.

In October 1940 a significant change occurred within the Air Ministry and Bomber Command. Bomber Command's Charles Portal replaced Newall as chief of the British Air Staff, and Sir Richard Peirse, an advocate of precision bombing, replaced Portal at Bomber Command. This had a massive impact upon the future of the bombing policy. Unlike Newall, Portal had firsthand experience in Bomber Command and knew its limitations far better. His views on its use were directly translated into an Air Ministry directive. The two principal objectives were now the oil plan and destruction of enemy morale.[8] Competing target sets and a lack of suitable long-range aircraft prevented realization of campaign objectives. Competing target sets in 1941 included German U-boats, U-boat construction yards and maintenance facilities, bombers, aircraft factories, and airfields. These target sets reflected the demands of the Battle of the Atlantic with German submarines and the Battle of Britain with the Luftwaffe.

The US Army War Plans Division submitted the first of the major target studies on 11 August 1941. Entitled *Munitions Requirements of the Army Air Forces*, it was commonly referred to as Air War Plans Division-1 (AWPD-1). This plan reflected ACTS doctrine that an air force should conduct precision aerial attacks against critical targets in an enemy's national economic structure to eliminate the ability to resist. Critical to the planning introduced in AWPD-1 was the disruption of German electrical power and transportation systems, destruction of petroleum systems, and, if necessary, the undermining of morale.[9] In the case of the petroleum-based sector, AWPD-1 planners identified German synthetic oil plants as high value or essential targets. At the time, synthetic oil plants were responsible for 60 percent of the German aviation gasoline (AVGAS) production. Eighty percent of the AVGAS was produced by 27 refineries located in western and central Germany about 1,000 miles from bases in England. These 27 refineries became the primary petroleum-based-sector targets for US bombers. Two minor plans—AWPD-4, *Air Estimate of the Situation and Recommendations for the Conduct of War*, and the Plan for the Initiation of Air Force Bombardment in the British Isles—listed oil as a priority target before the next major war plan, AWPD-42,

Requirements for Air Ascendancy, 1942, set responsibilities and revised targeting priorities.[10] AWPD-42, developed in the late summer of 1942, set forth the planning requirements for the number of combat aircraft required to achieve complete air superiority in Europe combined with the results of bombing efforts to date. The plan served as the basis for US Army Air Forces (USAAF) strategic planning. AWPD-42 also established a division of labor between the USAAF and the RAF bomber forces. The US Eighth Air Force pursued a precision daylight bombing campaign against critical elements of Germany's war economy. At night the RAF would continue its area-bombing offensive in an effort to break enemy morale.

Operation Chastise was the official name given the aerial attacks on German dams in the Ruhr Valley on 16 and 17 May 1943. Prior to the war, the industrial base of Germany had been identified by the British Air Ministry as an important strategic target, and the dams in that area were considered as particular targets. Besides electrical power, the dams provided water into the canal transport system. There were three primary targets for Operation Chastise—the Möhne, Sorpe, and Eder Dams—and three alternative targets—the Lister, Ennerpe, and Diemel Dams. The Möhne and Sorpe Dams controlled about 75 percent of the water supplied to the Ruhr basin. The Eder Dam regulated the flow of the Eder River, the principal tributary of the Weser River. It also provided electrical generating stations and a pumped storage station for power load equalization.[11] The tactics to attack the dams had been carefully considered, and analysis indicated that repeated strikes with large bombs would be effective in breaching them. RAF 617 Squadron, using a specially developed "bouncing bomb", carried out the raid. Nineteen Lancaster bombers took off to attack the targets. The raid was a success, despite the loss of eight aircraft and crews; the Möhne and Eder Dams were breached, causing a catastrophic flooding of the Ruhr Valley, while the Sorpe Dam sustained only minor damage.[12] Bomber Command conducted a bomb damage assessment as soon as possible using a photographic reconnaissance Spitfire from 542 Squadron, arriving over the Ruhr just after first light. The pilot, Flying Officer Frank Fray, described the experience:

> When I was about 150 miles from the Möhne Dam I could see the industrial haze over the Ruhr area and what appeared to be a cloud to the east. On flying closer I saw that what had seemed to be cloud was the sun shining on the floodwaters. I looked down into the deep valley which had seemed so peaceful

> three days before but now it was a wide torrent. The whole valley of the river was inundated with only patches of high ground and the tops of trees and church steeples showing above the flood. I was overcome by the immensity of it.[13]

Photographs taken of the breached dams showed floodwaters sweeping through the Ruhr valley, damaging factories, houses, and power stations; railway and road bridges disappeared. The raid disrupted water and electricity supplies in a key German war munitions manufacturing area. Secretary of State for Air, Sir Archibald Sinclair, called the raid "a trenchant blow for victory."[14]

The Combined Chiefs of Staff (CCS) directed that the strategic bombardment of Germany receive top priority, with the US Eighth Air Force flying from air bases in England, the US Fifteenth Air Force flying from air bases in the Mediterranean and Italy, and the RAF Bomber Command teamed to conduct the combined bomber offensive. Refined oil products became the fifth priority target set behind Germany's aircraft industry, submarine yards, transportation networks, and electrical power. The plan specified the complete destruction of 23 of 27 synthetic oil refineries and crude oil refineries in Romania, including Ploesti; the overall goal was a 47 percent reduction in refined oil products. To achieve these goals required accurate and current strategic intelligence. The CCS direction reaffirmed that requirement in support of air targeting, and the London-based Economic Objectives Unit of the US Office of Strategic Services provided part of the solution. Political considerations prevented formal prioritizing of the list of potential targets, but the top three target sets were fighter aircraft, ball bearings, and petroleum.[15]

The Ploesti refineries were targeted, beginning with a daring and costly low-level attack in August 1943. These attacks had only limited effects; oil deliveries increased until April 1944 when the attacks were resumed by the Fifteenth Air Force.[16] The Fifteenth Air Force was directed to execute four broad air campaigns against the Axis target sets: oil capabilities, air forces, communications, and ground forces. Most critical of the oil target sets were the refineries in Ploesti, which contributed about 30 percent of the entire Axis supply of oil and gasoline. One hundred and fifty German and Romanian fighters in addition to 250 heavy antiaircraft guns defended Ploesti. The Fifteenth Air Force, with the cooperation of RAF 205 Group bombers, began a series of raids on 5 April 1944, attacking the Ploesti refineries 19 times before the campaign ended on 19 August. USAAF and RAF bombers flew 5,287 sorties and dropped 12,870 tons of bombs. Ten

dive bombers, 39 escort fighters, and 237 heavy bombers—15 from the RAF—were lost; the results were good despite the losses.[17] At the end of the campaign the refineries were reduced to only 10 percent of their normal rate of activity. The average production rate was reduced by 60 percent from April to August.

In late August 1944, the Russian occupation eliminated this source of supply; dependence on the synthetic plants became even greater. Following the Ploesti raids, the USAAF and RAF dropped 10,000 tons of bombs on three synthetic oil plants in Silesia and one in Poland. By February 1945, their combined production was reduced to 20 percent of what it had been in June 1944.[18]

The petroleum-based energy sector did not receive significant attention from the Allied planners until May 1944. Previously, only about 1 percent of all Allied bombs dropped had targeted this sector. With the reduction of German airpower, oil became the priority target in the German economy. A preliminary attack was launched on 12 May 1944, with another on 28 May; the main blow was not struck until after D-day. The Germans viewed the attacks as catastrophic. Albert Speer, the minister of armaments and war production for the Third Reich, said,

> On that day the technological war was decided. Until then we had managed to produce approximately as many weapons as the armed forces needed, in spite of their considerable losses. But with the attack of nine hundred and thirty-five daylight bombers of the American Eighth Air Force upon several fuel plants in central and eastern Germany, a new era in the air war began. It meant the end of German armaments production.[19]

Synthetic oil production declined steadily, and by July 1944 every major plant had been hit. When the attacks began, these plants produced an average of 316,000 tons per month, but production fell to 107,000 tons in June and 17,000 tons in September. Output of AVGAS from synthetic plants dropped from 175,000 tons in April to 30,000 tons in July and 5,000 tons in September. Production recovered in November and December but was a fraction of pre-attack output for the rest of the war. The Germans took steps to repair and reconstruct the refineries, but synthetic oil refineries were vast, complex structures and could not be easily dispersed. Consumption of oil exceeded production from May 1944 until the end of the war. Accumulated stocks were rapidly used up and in six months were almost exhausted. The German armed forces sharply felt the loss of oil production.[20]

Programs of dispersal and underground construction were incomplete when the war ended.

Synthetic oil refineries returned to partial production in a remarkably short time but were attacked again. The IG Farben factory at Leuna, Germany's second-largest synthetic oil plant and second-biggest chemical operation, serves as an example of repetitive targeting. Leuna was protected by a highly effective smoke screen and the heaviest antiaircraft concentration in Europe. Aircrews viewed the Farben Leuna synthetic refinery as the most dangerous and difficult mission of the air campaign. Although it was attacked on 12 May and put out of production, postwar investigation of plant records and interrogation of Farben Leuna's officials established that several thousand men restored partial operation in about 10 days. The refinery was attacked again on 28 May but resumed partial production on 3 June and reached 75 percent of capacity in early July. The refinery resumed production two days after an attack on 7 July, reaching 53 percent of capacity on 19 July. An attack on 20 July shut the plant down again but only for three days; by 27 July production was back to 35 percent of capacity. Attacks throughout July, August, and September halted production, but it resumed on 14 October. The Farben facility at Leuna reached 28 percent of capacity by 20 November. Six more attacks in November and December were largely ineffective because of adverse weather. Production increased to 15 percent of capacity in January and remained at that level until near the end of the war. From the first attack to the war's end, production at Leuna averaged 9 percent of capacity.[21]

There were 22 attacks on Leuna—20 by the Eighth Air Force and two by the RAF. Due to the urgency of keeping this plant out of production, many missions were flown in difficult bombing weather. Consequently, bombing accuracy was not high compared with other targets. On clear days, only 29 percent of the bombs landed inside Farben Leuna's gates; on radar raids the number dropped to just over 5 percent. Allied crews flew a total of 6,552 bomber sorties against the plant and dropped 18,328 tons of bombs over an entire year.[22]

Except for isolated raids, the German power grid was not a priority target set during the war. This was partly due to the belief that it was highly developed and that losses in one area could be compensated by switching power from another. This assumption proved false in a postwar investigation conducted by the US Strategic Bombing Survey.[23] The German power grid was in a precarious condition from the outset

and became more unstable as the war progressed, as confirmed by statements of a large number of German officials, confidential memoranda of the National Load Dispatcher, and secret minutes of the Central Planning Committee. The destruction of five large generating stations in Germany would have caused a loss of 8 percent of the total capacity, both public and private. Destruction of 45 plants would have caused a capacity loss of almost 40 percent, and the destruction of 95 plants would have eliminated over 50 percent of the entire generating capacity of the country. The shortage was sufficiently critical that any significant loss of output would have directly affected essential war production. Generating and distribution facilities were relatively vulnerable, and their recuperation was difficult and time consuming.[24] Postwar evidence indicates that, had the power grid—electric generating plants and substations—been made a priority target set as soon as it became within range of Allied air attacks, the destruction would have had serious effects on Germany's war production.

Energy infrastructure was a vital target during World War II, and the effort's benefit was significant. Allied airpower was able to gain and maintain air superiority as Allied armies drove across Europe, overrunning the German war machine. Ultimately, the war offered numerous lessons that are still applicable today: the need for strategic intelligence; realization that doctrine is not a synonym for targeting; recognition that centers of gravity are not necessarily subject to attack; the need to anticipate the collateral effects of air attacks; and recognition that gaining air superiority is critical. The US Air Force exited World War II with the continued belief that the strategic bombing mission was the decisive military instrument of war.[25]

Limited Warfare: Vietnam

Whereas World War II was an unlimited war, Vietnam was a limited one. Four major characteristics of limited wars include (1) what is limited for one party may be total for another, (2) they may be costly and prolonged, (3) prolonged limited wars generally enjoy much less public support than other types of war, and (4) the duration and cost of war generally increases when limitations are imposed. As warfare becomes limited, the role of the energy-based sector and its associated products must change as well.[26] In true Clausewitzian fashion, it

was political and not military objectives that drove the air campaign against North Vietnam.

Air planners and strategists sought to weaken North Vietnam's will to resist by destroying its capability to fight. As a result, they chose what they thought to be key sources of military and economic power as primary targets. In an operation code-named Rolling Thunder, they used three targeting criteria: reduce North Vietnamese assistance from external sources; destroy war resources already in North Vietnam; and harass, disrupt, and impede the movement of men and materials to Laos and South Vietnam.[27] When Operation Rolling Thunder began on 2 March 1965, a majority of the energy-sector targets were off limits due to geographical constraints imposed by Pres. Lyndon Johnson on the Joint Chiefs of Staff (JCS) and air planners. When President Johnson expanded the war in the summer of 1965, the JCS sought to increase the use of airpower.[28]

In August 1965 a revised air campaign plan was submitted that called for attacks against military installations in Haiphong and Hon Gay, the mining of ports, and raids on transportation networks north of Hanoi. The plan encompassed further attacks on airfields, air defense sites, other military facilities in Hanoi, petroleum storage areas, electrical power stations, and the remaining industrial targets in Hanoi and Haiphong. The JCS's intent in targeting the petroleum infrastructure was to reduce North Vietnam's capability to provide transportation to the general population, impact the economy, and interdict the movement of supplies and troops south.[29] Due to conflicting political objectives, such as the need to end the war quickly and to prevent Russian involvement, senior Johnson administration policy makers did not back the JCS. As a result, US aircrews attacked only 126 of the 240 proposed targets by the end of October 1965. Of the remaining 114 targets, 104 were in areas that were geographically constrained.[30]

The following month, senior US defense officials recommended an evolving five-month air campaign that would conclude with attacks on the petroleum infrastructure and the mining of Haiphong harbor. The JCS called for an immediate acceleration in scale, scope, and intensity of the bombing, beginning with airstrikes against the petroleum target sets. They assumed that if the supply of petroleum products could be eliminated, the flow of supplies, materiel, and troops would slow, or stop, causing the insurgency in South Vietnam to wither away.[31]

The fact that North Vietnam possessed no oil fields or refineries and imported 170,000 metric tons of fuel in 1965, mostly through Haiphong, supported the JCS case. The Haiphong tank farms, apparently the critical link in the system, held about 72,000 metric tons. Ninety-seven percent of North Vietnam's petroleum storage capacity could be found in 13 sites, of which four had already been destroyed. The JCS believed that destruction of the Haiphong tank farm, combined with eight other major storage areas, would cause more damage than an attack on any other single target set.[32] However, intelligence indicated that numerous small petroleum storage sites and drum storage capabilities were beginning to appear. If the energy sector were to be a suitable target, timing was critical to interdict the supply system.[33]

It was not until the winter of 1965–66 that support for airstrikes began to grow. President Johnson authorized attacks against six small petroleum storage facilities in lightly populated areas at the end of May 1966. By mid June, the president's advisors convinced him to authorize airstrikes against the remaining energy-sector targets, including the storage facilities in Hanoi and Haiphong. Resumption of the airstrikes began on 29 June 1966 and continued through August. While 70 percent of their petroleum bulk storage had been destroyed, the North Vietnamese still possessed a significant amount of reserve storage, mostly in areas that were off limits inside of North Vietnam.[34] As the summer wore on, North Vietnam continued to import petroleum products that were dispersed at small storage sites in quantities sufficient to meet wartime requirements.

According to the Defense Intelligence Agency, the invulnerability of the dispersed petroleum infrastructure meant an increased cost in munitions, fuel, and loss of aircraft and aircrew. The end of airstrikes against the petroleum infrastructure came on 30 August 1966 when the Jason Summer Study was released; 47 top US scientists stated that North Vietnam was a subsistence agricultural economy that presented a difficult, challenging, and unrewarding array of target sets to be attacked by airpower. This study estimated that only 5 percent of North Vietnam's fuel requirements were required for logistics flow to the South, suggesting the air campaign could not possibly achieve its goal.[35] By the fall of 1966, US military and civilian leaders had given up any expectation of the North Vietnamese energy infrastructure being the critical link in maintaining its military and economy. Subsequently, they shifted their attention to other industries. Six years

later, a short but intense air campaign ended US participation in this limited war.

Overall, the US attempt to destroy North Vietnam's energy infrastructure can be defined as a strategic failure. Planners had overestimated the North's dependence on the port facilities at Haiphong. After airstrikes destroyed the dock facilities, tankers simply offloaded their cargoes into waiting barges, which dispersed the petroleum products among concealed storage sites along waterways. When bulk distribution became a challenge, the North Vietnamese simply switched to drums, making distribution easier, faster, and more efficient. Simple innovation reduced their reliance upon vulnerable storage and distribution facilities.[36]

Why did air planners target the energy infrastructure—specifically, the petroleum sector—if it was not essential? The answer is simple: they were guilty of mirror imaging. What worked in World War II was expected to work in Vietnam. Even if the air planners were able to overcome mirror imaging, they lacked accurate and timely strategic intelligence to support targeting.[37] The US intelligence community was focused on the Soviet Union, basically ignoring the rest of the world. Furthermore, the air planners were unprepared for limited warfare, failed to analyze properly the enemy, and had to deal with the issue of sanctuary.

By definition, a sanctuary is a "place of refuge or protection for someone who is being chased or hunted" and is a self-imposed restraint.[38] North Vietnam enjoyed the benefits of sanctuary in China. The United States also recognized certain areas within North Vietnam as being off limits in an effort to keep hostilities from escalating into unlimited warfare. Communist forces, lines of communication, and the limited petroleum industry were able to operate in a safe environment, while the targeting and destruction of the energy-based sector became more difficult and less efficient. The only way to have eliminated or marginalized the petroleum industrial base would have been to interdict it before it arrived for end use.[39]

The Gulf War

The bombing of Iraq during the Gulf War, described at the time as an air campaign against Iraq's offensive military capabilities, was broader in its intent and target selection. During the 43-day air cam-

paign, the United States and its allies sought to achieve some of their strategic objectives by targeting the Iraqi society. The air campaign was not aimed solely at Iraq's military, but included targets that were bombed primarily to create a potential postwar leverage over the Iraqi leadership rather than to influence the course of the war itself. The planners sought to damage or destroy key infrastructure that could not be repaired or rebuilt without foreign assistance. They selected a number of targets with the expectation that bombing them would amplify the impact of international economic sanctions on the Iraqi society, compelling Saddam Hussein to withdraw Iraqi forces from Kuwait to avoid a ground campaign.

Preliminary planning for an air campaign based on 27 strategic Iraqi targets in a notional "Southwest Asia contingency" plan began five days after Iraq invaded Kuwait. Revisions added additional targets, and when the air campaign began on 17 January 1991, the list included slightly more than 400 targets concentrated in an area between the Tigris and Euphrates Rivers. Additional intelligence gathered after the war began and additional bombing capabilities expanded the target list to over 700 targets. The targets were divided into 12 sets: leadership; command, control, and communications; air defense; airfields; nuclear, biological, and chemical weapons; railroads and bridges; Scud missiles; conventional military production and storage facilities; oil facilities; electricity; naval ports; and Republican Guard forces.[40] The majority of these target sets directly linked to Iraqi offensive military capabilities, but two categories—electrical and oil facilities—had a long-term impact on the Iraqi populace.

Of the more than 700 targets on the expanded list, 28 were identified as key nodes of the electrical power grid. The United States and its allies flew 215 sorties against the electrical infrastructure using unguided bombs, cruise missiles, and laser-guided bombs. At least nine targets were transformers, each estimated to take a year to repair. Other targets included main generator halls, with an estimated five-year repair time. Between the sixth and seventh days of the air campaign, the Iraqis shut down what remained of their national electrical power grid. By the end of the war, 17 of 20 Iraqi generating plants were damaged or destroyed; 11 were determined to be total losses. Within four months of the war's end, Iraq's electrical power grid had reached only 20 to 25 percent of its prewar capacity of 9,000 to 9,500 megawatts, roughly its 1920 generating capacity before reliance on refrigeration and sewage treatment became widespread.[41]

Bombing some of the electrical facilities did reinforce other strategic goals while weakening air defenses and communications between Baghdad and its field army.

Attacks on Iraqi oil facilities resulted in a similar combination of military and civilian effects. Coalition air forces dropped an estimated 1,200 tons of explosives in 518 sorties flown against 28 oil infrastructure targets.[42] The planners intended to obtain complete cessation of refining capability without damaging or destroying most of Iraq's crude oil industrial base. They believed the lack of refined petroleum products would deprive the Iraqi military of its ability to maneuver. Among the oil facilities targeted were major storage tanks, gas and oil separators, distilling towers, and pipelines. The target set included the major K2 pipeline junction near Baiji connecting the northern Iraq oil fields, an export pipeline to Turkey, and a reversible north-south pipeline inside Iraq.[43] All three of Iraq's large, modern refineries—the 110,000 barrel-a-day Daura facility outside Baghdad, the 150,000 barrel-a-day Basrah refinery, and the 300,000 barrel-a-day Baiji facility in northern Iraq—were attacked.[44] The Daura and Basra refineries were badly damaged early in the air campaign; the Baiji refinery was not bombed until its final days.

In a potentially protracted war, destroying Iraq's ability to refine oil and produce ammunition, as well as its stockpiled reserves, made sense. At the same time, US Air Force planners sought only to damage temporarily Iraq's economic infrastructure by precisely targeting easy-to-replace elements of key facilities rather than destroying those facilities outright. These plans were thwarted by the military community's deeply ingrained standard operating procedures. Wary of underestimating Iraq, air planners inflicted massive damage on the country's economic infrastructure. The Gulf War also highlighted the unforeseen consequences of disrupting the highly interconnected critical infrastructure of a modern industrialized country. Attacks on dual-use power facilities caused cascading damage throughout the water purification and sanitation systems, exacerbating a public health crisis.[45]

The United States and its allies, using unguided bombs, cruise missiles, and precision-guided munitions, hit the targets they intended to hit: electrical facilities, oil refineries, and the sustaining distribution networks. For the US Air Force, the Gulf War demonstrated what airpower strategists and proponents had argued since Billy Mitchell published *Winged Defense* in 1925: airplanes could defeat an

enemy by flying over its defensive perimeter and directly attacking its economic, energy, and military cores. This war also showed why the indirect effects of airpower must be planned in the same level of detail as the direct ones.

In the years following the Gulf War, these lessons were rapidly incorporated into targeting policy. During the four-day Operation Desert Fox in December 1998, air planners focused strikes on command, control, and intelligence targets rather than on dual-use infrastructure. They destroyed numerous Ba'ath security, intelligence, and military targets while sparing power and telephone systems. The sole energy infrastructure target, authorized after hard bargaining by planners, was an oil refinery linked to smuggling. It was temporarily crippled in a strike that disabled the site for six months while minimizing pollution. US Army attack helicopters played an important role in the plan for Desert Fox and the deployments and contingency plans that preceded it, such as Desert Thunder in January 1998. Five months after Desert Fox, new types of munitions were used during Operation Allied Force to disable Serbian electrical networks, greatly reducing permanent damage.[46]

Iraq in 2003

The Iraqi military had been greatly reduced by early 2003. The operational problem was how to overcome quickly a static Iraqi defense to support a high-intensity ground war beginning almost simultaneously with an air campaign. In such a situation, slowly maturing attacks on Iraqi dual-use industrial infrastructure would not be particularly useful from a military point of view.[47] US leaders, policy makers, strategists, and planners recognized that targeting certain forms of economic and energy infrastructure causes more disruption to civilians than to the enemy military and reduces the risk to allied forces. Moreover, such attacks may cause collateral damage, a particularly sensitive issue given the uncertain US mandate for war. Air attacks against dual-use facilities were automatically assumed to cause collateral damage and required special authorization to be included in the target sets.

When Saddam refused to abdicate power and leave Iraq in 2003, US and coalition forces launched an attack on the morning of 20 March. US aircraft dropped several precision-guided bombs on a

bunker complex where the Iraqi president was believed to be meeting with senior staff. This was followed by a series of air and cruise missile strikes directed against government and military installations. US and coalition forces invaded Iraq from Kuwait in the south and from the sea. In southern Iraq, US forces advancing northward faced the greatest resistance from irregular groups of Ba'ath Party supporters known as Saddam's Fedayeen. British forces, deployed around the southern city of Al-Basrah, faced similar resistance from paramilitary and irregular fighters. Despite fears that Iraqi forces would engage in a scorched-earth policy, destroying bridges, dams, critical infrastructure, and setting fire to Iraq's southern oil wells, retreating Iraqi forces did little damage. In fact, large numbers of Iraqi troops simply chose not to resist the advance of coalition forces. Securing the oil infrastructure was very important to mitigate damage done at the end of the Gulf War. While retreating from Kuwait, the Iraqi army set numerous oil wells on fire in an attempt to disguise troop movements and distract coalition forces. Prior to the 2003 invasion, Iraqi forces mined some 400 oil wells around Basrah and the Al-Faw peninsula with explosives.

Coalition forces launched an air and amphibious assault on the Al-Faw peninsula on 20 March to secure the oil fields. Warships of the UK Royal Navy, Navy of the Republic of Poland, and Royal Australian Navy supported the amphibious assault. The US 15th Marine Expeditionary Unit, a special forces unit of the Republic of Poland, and the UK Royal Marines 3 Commando Brigade attacked and captured the port facilities of Umm Qasr and Az Zubayr to destroy Iraqi resistance and enable follow-on humanitarian assistance. They encountered heavy resistance by Iraqi troops. Meanwhile the British Army's 16 Air Assault Brigade secured the oil fields in southern Iraq while Polish commandos and Navy SEALs captured offshore oil platforms, preventing their destruction. Despite the rapid advance of the invasion ground forces, about 44 oil wells were destroyed and set ablaze by Iraqi explosives or by incidental fire.[48] Coalition forces quickly capped the wells and extinguished the fires, preventing the ecological damage and loss of oil production capacity that occurred at the end of the first Gulf War. The swift invasion led to collapse of the Iraqi government and its military forces in about three weeks, allowing coalition forces to seize and secure the Iraqi oil infrastructure with only limited damage.

Final Analysis and a Look to the Future

When fighting an unlimited war requiring years of combat to defeat an enemy, destroying the enemy's energy infrastructure makes sense. Such targeting may be inappropriate in a limited war against a nation where the populace is not free to alter its leadership. In either type of warfare, the energy infrastructure is targeted because the nation and its citizens heavily depend on it. Strategists and planners will continue to see the energy target sets as leveraged. From a military perspective, electricity is indispensable and impossible to stockpile. Damaging or destroying removes the supply immediately, and backup sources are neither powerful nor reliable enough to replace the lost facilities. Targeting lessons learned during previous wars are still being applied and include the need to

- ask if energy is always a primary target,
- question if only certain aircraft or platforms can attack certain targets,
- obtain effective and actionable intelligence at both the tactical and strategic levels,
- consider the potential postwar impacts or ramifications of targeting energy infrastructure,
- and prepare to plan around or address the presence of sanctuaries.

In planning for the future, one logically seeks to use past experience combined with current intelligence. This study of targeting energy infrastructure is no different. This strategy is probably recognized as useful in an unlimited war but one may question its effectiveness during a limited war.

Petroleum-based energy is not likely to be replaced by any alternative energy sources for military use in the short term. Cost will not be the limiting factor, but rather the lack of a developed industrial base to sustain the alternative energy sources. Given the varying utility of targeting energy in past conflicts, will it remain a valid target in the future? The answer is an overwhelming yes. As the Gulf War and Iraq in 2003 have demonstrated, energy will remain a critical target in future conflicts. Since time is of the essence in limited warfare, it makes sense to target selected energy infrastructure. However, leaders

and planners must not overlook the possibility of a protracted war that becomes unlimited. To meet these conditions, a flexible targeting methodology must be used to achieve immediate or long-term effects as required. That methodology would be to first strike military tactical targets for immediate effect and then strike critical elements of the energy supply chain. The sources for energy products should only be struck last, should the need arise. Retired US Army colonel Douglas A. Macgregor sums up the implications for future policy makers, commanders, strategists, and planners:

> Senior officers on the operational level are central to the drama that translates strategic goals into tactical action. They must not only constantly link the strategic and tactical levels but comprehend the actions of their opponents in a similar context. How they interpret missions and employ their forces dominates operations.[49]

When discussing warfare, most people tend to think of force on force, soldier against soldier. Employing airpower against multiple target sets that include the energy infrastructure attacks everything that allows a nation to sustain itself. Understanding historical precedents is important in the success of any future targeting strategy, including that of a nation's energy infrastructure. While a number of conflicts are available for study, World War II, Vietnam, the Gulf War, and Iraq in 2003 offer the best perspectives. In World War II, the Allies fought an unlimited war against Germany and Japan. In Vietnam, limited warfare had become the practice with the goal of avoiding unlimited warfare. Energy targeting in past wars has taught many lessons that are applicable today.

- Strategic intelligence is a must.
- Doctrine is not a synonym for targeting.
- The risk of mirror imaging is a constant threat.
- The ability to gain air superiority is critical.
- Centers of gravity are not necessarily subject to attack.
- The indirect effects of airpower must be planned in the same level of detail as the direct ones.
- A plan must be developed to attenuate sanctuaries.

The fact remains that a nation's energy sector is an extremely suitable target set today and in the future. Given current and future technological developments, it is possible to identify, target, interdict, seize,

and, when required, destroy the critical components of a nation's energy infrastructure, greatly enhancing the probability of victory.

Notes

1. US Energy Information Administration (EIA), *Short-Term Energy Outlook*.
2. Stokesbury, *Short History of Air Power*, 126.
3. Ibid., 172.
4. Wuesthoff, "Utility of Targeting," 3–4.
5. Ibid., 4.
6. McMullen, "United States Strategic Bombing," 16.
7. Wuesthoff, "Utility of Targeting," 4.
8. University of Leeds, *British Strategic Bombing*, 39.
9. Wuesthoff, "Utility of Targeting," 4–5.
10. Ibid., 5.
11. T. Jones, *617 Squadron Operational Record Book 1943–1945*, AIR 8/1238: Air Chief Marshall Charles Portal to Gen Sir Alan Brooke, letter, 27 March 1943, 11–14.
12. Ibid., AIR 27/2128, 20–21.
13. Foggo and Burke, "I Captured Proof."
14. British Broadcasting Corporation, "1943: RAF Raid Smashes German Dams."
15. Wuesthoff, "Utility of Targeting," 5–6.
16. *United States Strategic Bombing Surveys*, 21.
17. Skelly, "References to Ploesti."
18. Ibid.
19. McMullen, "United States Strategic Bombing," 26.
20. *United States Strategic Bombing Surveys*, 21–23.
21. Ibid., 22.
22. Ibid., 22–23.
23. Ibid., 33.
24. Ibid., 33–34.
25. McMullen, "United States Strategic Bombing," 41.
26. Wuesthoff, "Utility of Targeting," 11.
27. Ibid., 33–34.
28. Clodfelter, *Limits of Airpower*, 85.
29. Ibid., 88.
30. Wuesthoff, "Utility of Targeting," 12.
31. Clodfelter, *Limits of Airpower*, 90.
32. Gravel, *Pentagon Papers*, vol. 4, 60.
33. Ibid.
34. Ibid., 109.
35. Ibid., 109–20.
36. Gravel, *Pentagon Papers*, vol. 3, 111.
37. Gravel, *Pentagon Papers*, vol. 4, 109–11.
38. *American Heritage Dictionary*.
39. Wuesthoff, "Utility of Targeting," 15–16.
40. Gellman, "Allied Air War."

41. Ibid.
42. Ibid.
43. Ibid.
44. EIA, *Iraq Energy Data*.
45. Knights, "Infrastructure Targeting."
46. Ibid.; and Mason, "US Army Apache Helicopters," 7.
47. Knights, "Infrastructure Targeting."
48. Dao, "Nation at War: Commandos"; Dao, "Nation at War: Navy Special Warfare Group"; Klare, "Oil War"; and "Battle for Al Faw."
49. Macgregor, "Command and Control," 32.

Chapter 5

The Forest and the Trees

Aerial Eradication in South Vietnam and Afghanistan

Evelyn Krache Morris

One of the many challenges in Afghanistan is the prevalence of poppy cultivation. Poppies thrive in the hot, dry climate of southern Afghanistan, but are hardy enough to grow throughout the country. Besides this environmental affinity, there are other compelling reasons why the crop has become the country's major export. Poppy resin is refined into raw opium and then transformed into purer opium and heroin; it is durable and easy to transport, and it becomes more lucrative at every step. The revenues from poppies fund not only the Taliban insurgency but assorted other strongmen, militias, and criminals, all of whom have an interest in keeping the central government weak and ineffectual. Stopping the flow of opium, and the money it generates, is an important part of stabilizing the country.

Aerial eradication is one method proposed to disrupt the opium trade. Poppy fields are sprayed with herbicide, killing the plants and reducing the resin supply available for processing and resale. The plan sounds straightforward but is fraught with obstacles. The United States already stumbled on some of these obstacles during a similar effort in South Vietnam. There, the targets were food crops, but the challenge was similar: to destroy the resources available to insurgents with minimal investment of manpower and money.

Proposed aerial eradication in Afghanistan shares some of the same challenges the United States encountered when conducting eradication operations in South Vietnam. These include a taxing and poorly understood environment, chemical herbicides that are potentially damaging to already fragile ecosystems, and the public perceptions of herbicide use. However, the obstacles to aerial eradication in Afghanistan are more difficult than those in South Vietnam.[1]

Afghanistan has been torn by almost 30 years of war. The damage has been not only political, but economic and environmental. The Soviet Union, in its attempt to conquer the country, waged economic war. Soviet policy was to starve the mujahedeen resistance by destroying

the country's agriculture. Then, after the Soviet defeat, the Taliban's "fundamental neglect of economic development" caused further damage.[2] The Afghan environment was also badly injured during these years. Environmental degradation is a serious problem because of Afghanistan's reliance on agriculture. About 70 percent of Afghans' foodstuff and most of the country's licit gross domestic product comes from agriculture despite having only 12 percent arable land.[3]

Environmental Problems

The two most significant environmental problems are an enormous number of landmines and a pervasive water shortage. The Soviet invaders mined orchards and fields, effectively closing fertile land to cultivation and considerably reducing the amount of arable land.[4] Author and international development consultant Joel Hafvenstein noted, "Afghanistan as a whole was one of the most heavily mined countries on earth. The United Nations guessed it would take a decade just to clear the most dangerous areas."[5] Mine removal has proceeded slowly. Many main roads are not yet cleared; rural fields are even less safe. The presence of so many landmines sharply reduces not only the amount of land available for cultivation, but also the ability of farmers to get products to market.

Lack of water also handicaps Afghanistan's licit agriculture. The Soviet war, combined with a devastating multiyear drought, wreaked havoc. Many irrigation systems destroyed during the war have not been rebuilt. Much of the land is too dry for crops such as cotton and wheat. These stresses on the soil helped start a cycle of desiccation and soil loss. Fruit trees that had not been shattered during the war died from lack of water, either because of the ruined irrigation systems or because of the drought itself. This die-off, in turn, led to erosion of the remaining soil.[6] For an economy dependent on agriculture, the extent of environmental damage from mines and lack of water has been an enormous handicap.

In the midst of these economic and environmental difficulties, one crop has flourished: the opium poppy (*Papaver somniforum*). In some ways, opium is the best of all environmental and economic crops. Being easy to grow, transport, store, and monetize makes it an attractive crop for farmers and buyers. Hafvenstein asks, not entirely rhetorically, "How do you convince a farmer to give up the perfect crop?"[7]

This question needs to be answered to eradicate or even significantly reduce the poppy trade in Afghanistan.

Poppy Cultivation

The environment of Afghanistan is very hospitable for poppies, making them relatively easy to grow and highly productive. "Afghanistan's soils, climate, and altitude have also made its poppy cultivation more productive than is cultivation in other major opium-producing regions."[8] Poppies do not require much fertile soil or irrigation, which makes them well suited for present-day Afghanistan. With so much soil off limits because of mines, and the remaining land often arid, a plant that is not particularly finicky can become very attractive.

To grow poppies, farmers need almost no initial investment. Fertilizer may improve yields, but only a supply of seeds is necessary for a poppy field. In contrast, "legal agriculture necessitates substantial prefinancing, as irrigation and fertilizer are quite costly."[9] Afghani farmers often cannot afford products such as fertilizer, even if they have access to them. Poppies do not require such luxuries and do not require much time investment. Fruit trees may require years to produce marketable crops; poppies need just several months, from spring planting to fall harvest. Given the uncertainties of life in Afghanistan, this is no small advantage.

Labor is the main constraint in poppy cultivation. Labor requirements, however, are not much of a burden. Given the lack of other jobs, there is plenty of available labor. Furthermore, because poppies are grown at home, women can contribute their labor.[10] Women are forbidden from working outside of the home under strict interpretations of Islam; poppy cultivation taps into this underused labor pool. Harvesting the resin is particularly labor-intensive. Itinerant workers score each seedpod individually, and very carefully, to extract all of the resin produced by each poppy flower. Once the resin is drawn from the poppies, it must be transported to local refineries for transformation into raw opium.

Transporting the resin is easier than transporting other agricultural products. Again, poppies show their suitability for Afghanistan. Many agricultural commodities would not survive the trip to market; poppy resin is a highly profitable exception. The transportation network in Afghanistan is badly frayed. "Eighty percent of Afghanistan's

population lives in rural communities which are only thinly connected by roads."[11] Light, packable poppy resin need not travel over the roads. If the roads are impassable, farmers and traffickers can load resin or raw opium onto all-terrain vehicles or even camels.

There are few easy ways to get legal products to market, and the surcharges levied by those controlling the roads make many crops economically unattractive. Opium, however, always has access to the market since many people have great interest in getting the resin to where it needs to go. Thus, farmers are better able to monetize their crop of opium than, for example, their almonds. Traffickers help them do this, "occasionally pick[ing] up raw opium directly from farmers, relieving them of the need to undertake an expensive trip to regional markets on a poor road system."[12]

The resin's durability is an advantage in storage as well. Raw opium requires no refrigeration, a major advantage in a country where even the capital city does not have reliable electricity. Only about 15 percent of the country has access to electricity; the percentage with 24-hour refrigeration is smaller still.[13]

Opium can be stored for many years.[14] This durability allows suppliers to manipulate perceptions of availability. Huge stockpiles of opium may be little more than legends, but given opium's durability, they are plausible.[15]

The ease of opium storage changes the economics of poppy production. This durability allows producers, or their agents, to manage carefully the amount of resin and opium coming to market to stabilize the price. This is similar to how the Organization of the Oil Exporting Countries (OPEC) manages the world oil supply. Hermann Kreutzmann, among others, believes that the Taliban's dramatic cuts in Afghan poppy cultivation in 2001, so loudly announced in the press, may be an economically rational response to a glut rather than a religiously motivated prohibition. Prices quickly rose "tenfold the following year," allowing opium dealers to make substantially more money than they would have before the ban.[16] Year-by-year trends mean little given that the supply coming to market can be carefully managed; only steady, multiyear declines might indicate that total supply is decreasing.

The ease of growing, transporting, and storing resin does not alone make opium attractive. The final and most important advantage that poppies have over other agricultural crops is that they are easy to monetize. Resin finds willing buyers; farmers benefit economically

from selling the produce from their poppy fields. Disagreements exist about whether farmers are coerced into growing poppies, but even analysts who believe that cultivation is largely imposed admit that "at the same time, it holds true that poppy is a valuable cash crop which offers about ten times higher returns than wheat crops."[17] Furthermore, poppy cultivation is not limited to farmers trying to stave off destitution. "Growing poppies is . . . not simply about survival in the face of grinding poverty, but also upward mobility."[18] Even more affluent farmers find the returns from poppies attractive.

Debt is another reason why some in Afghanistan grow poppies. The ease with which buyers can resell opium gum, the unprocessed harvest of the pods, has entrenched a sharecropping system in Afghanistan. Many farmers do not own their own land; some landlords pay well for poppy, and even forbid the growth of other crops.[19]

A cycle of indebtedness, known as the *salaam* system, traps even more farmers. They presell their poppy crops before the growing season at below-market prices, receiving money and supplies to sustain them through the growth and harvest of a new crop, which the lender takes as payment.[20] When the lender takes the crop, it can be resold at a substantial profit; there are always willing buyers. This structure has helped keep many small growers in the poppy business. Having many smaller suppliers gives purchasers a good deal more leverage; if one farmer balks at a price, plenty of others will agree to it. Many small producers mean that few poppy farmers can achieve any kind of leverage over the opium producers or exporters.

The bulk of the money does not accrue to the farmers but to the refiners and traffickers. "Narcotics trafficking is regarded by some as [*sic*] core impediment to the US mission in Afghanistan, generating what US commanders estimate to be about $100 million per year for the Taliban."[21] This approximate number does not include money going to other subversives or criminals that are not part of the Taliban.

Aerial Interdiction

The poppy economy is only one aspect of an extremely complicated foreign policy problem for the United States: how to stabilize Afghanistan under a benign central government with a limited investment of money and manpower. The revenue from opium production flows to the Taliban, other antigovernment groups, and various

criminals, all having different interests than those of the United States. Cutting off this funding source, given the limited US resources in Afghanistan, is a difficult problem. One proposal, seemingly straightforward, is to kill the poppies. Aerial eradication appears to be an attractive solution.

But one also has to consider the demands of a casualty-averse public. Aerial eradication fits this consideration. Manual eradication in rural Afghanistan is an extremely risky method for drug control. Even Afghanistan's own soldiers have met resistance. "Predictably, the Afghan government eradication teams that actually attempted to carry out their orders, rather than simply accepting bribes, have frequently met with armed resistance from peasants, even in the restricted and relatively safe areas where they have been deployed."[22] US troops would face similar, if not more acute, resistance. Should casualties result from these operations, the political fallout could handicap US efforts in Afghanistan. Awkward questions about mission creep could arise. Even if there were no US casualties, the number of adversarial interactions between US troops and Afghani civilians could increase. This increase is, presumably, something the United States would rather avoid.

Finally, aerial eradication is very easy to explain and publicize. Charts and PowerPoint slides showing the number of acres sprayed, sorties flown, and the gallons of chemical sprayed are clear, persuasive, and reassuring. Pictures of sprayed fields and dead plants seem to prove progress in the fight against the Taliban and illegal drugs.

Although aerial eradication might seem a plausible option for reducing the amount of poppy, the decision to spray herbicidal chemicals should be made cautiously. The United States has an unhappy history with aerial eradication and counterinsurgency (COIN). In early 1962, as part of Operation Ranch Hand, Pres. John F. Kennedy authorized the use of chemicals, primarily the arsenical Agent Blue, to destroy rice, manioc, and other food crops in South Vietnam.[23] The rationale for this decision, supported by South Vietnamese president Ngo Dinh Diem was that aerial eradication would prevent crops from falling into the hands of National Liberation Front soldiers. The North Vietnamese forces would thus fail in their efforts to overthrow the South Vietnam government, in part because of lack of food.

The United States brought herbicides into South Vietnam in violation of the 1954 Geneva Agreements, which partitioned Vietnam along the 17th parallel and forbade foreign intervention in the country's

war. The United States did not sign the agreement but pledged to uphold it. Since providing military equipment to either the North or the South was prohibited, the United States transported the chemicals in anonymous barrels, distinguished only by the colored bands around them. The South Vietnamese air force conducted the spraying missions, but the equipment, advisors, and chemicals were all American.

The scheme did not work. North Vietnamese soldiers and allies in the South got the food they required to wage war against the Diem government. Furthermore, the rural South Vietnamese whose lands were sprayed saw their fields die off, losing the produce from those fields. Understandably, these people resented the spray campaign.[24] The United States was unable to hide its involvement in the operation, despite concerted efforts to do so.[25] The perception that the United States was making war on Vietnamese peasants was very difficult to counteract. It also undermined the legitimacy of the South Vietnam government at a time when that government was increasingly under threat.

Aerial eradication efforts in South Vietnam and in Afghanistan have some striking similarities. A sense of control over an unfamiliar and dangerous environment may be part of the attraction of an aerial spray campaign. There are significant environmental challenges to aerial spraying in each country—each has climate and weather extremes, and both environments are very different from those found in the United States. Spraying also entails using herbicides, which are powerful chemicals. Finally, in each case, aerial spraying makes up only one piece of a complicated COIN puzzle.

The United States has a long history of attempting to control frightening new lands. The Homestead Act of 1862 is the best-known example, but historians have documented others beginning from the earliest settlements.[26] These efforts have included settlement, forced migrations, and deforestation. The themes of reclamation and cleansing pervaded discussions of the South Vietnamese landscape. "Plans call for burning over the defoliated areas where they have dried out sufficiently. This will drive out any Viet Cong still taking cover there, and will facilitate later planned reclamation of much of the area for crops."[27] National Security Council member Robert Komer was blunter than most: "After Laos, and with Berlin on the horizon, we cannot afford to go less than all-out in cleaning up South Vietnam."[28] The same is true for Afghanistan. As in South Vietnam, the environmental and logistical challenges fit within this larger narrative

of American history: taking action to civilize a wilderness. In working with an Afghan officer on an eradication campaign, a US contractor dismissed claims that it was too late in the growing season for eradication.[29]

Battling the environments in South Vietnam and Afghanistan has proved formidable because they are both so extreme and different from any found in the United States. The United States has no ecosystems like those found in South Vietnam. The US Air Force tested its spray equipment at Eglin AFB on the North Florida coast; however, the tropical plants and the extreme heat, rain, and humidity of South Vietnam are not found in Florida or anywhere else in the United States.

The punishing climate of southern Afghanistan, with blistering hot days and freezing nights, is found only in the western US deserts; this area does not share Afghanistan's challenging terrain. One senior Defense Department official observed that

> Getting into Afghanistan, which we need to do as quickly as we can possibly do it, is very difficult because . . . next to Antarctica, Afghanistan is probably the most incommodious place, from a logistics point of view, to be trying to fight a war. . . . It's landlocked and rugged, and the road network is much, much thinner than in Iraq. Fewer airports, different geography.[30]

A more prosaic difficulty with spraying in South Vietnam or Afghanistan is the climate's effects on equipment. In South Vietnam, the US Air Force was initially unprepared for the demands of triple-digit heat and torrential rains on its spraying equipment. The equipment soon malfunctioned under the strain. The climate in Afghanistan, although obviously very different, is also wearing. Extremes of heat and cold, combined with dust that works its way into all machinery, take a toll on aircraft and equipment. Furthermore, because Afghanistan is landlocked, access to fuel and spare parts is very limited.

Locating poppy fields is not difficult. They can "[stretch] as far as the eye could see: intense fuchsia blossoms in brilliant seas of green."[31] Rice paddies are an almost surreal green; they, too, are easy to spot. Precise application of herbicide, however, is considerably more difficult than just locating the fields. Temperature, wind patterns, and local ecology are only three of the factors that can determine where exactly the sprayed chemicals land.[32] In the southern United States, a region Americans understood better than South Vietnam, controlling forest growth through spraying proved almost prohibitively difficult. In

South Vietnam, the herbicides' instability became apparent even before they were loaded onto the planes. Fumes from chemicals stored at Tan Son Nhut Air Base killed surrounding vegetation, including two flame trees. Even empty barrels were unsafe; about 1 percent of the chemical remained after the contents were emptied, and this small percentage was enough to kill plants near the barrel.[33]

Perhaps the most important similarity is that, in each case, aerial eradication makes up only part of a larger COIN effort. In addition to evaluating the efficacy and practicality of aerial interdiction by itself, decision makers had to grapple with how this tactic might affect the achievement of broader goals. To complicate matters further, decisions about interdiction competed with decisions not just about other COIN tactics, but also with choices about broad COIN strategies—as well as with policy decisions in other parts of the world. A decision to use aerial herbicides is complicated, but it is only one piece of a complex problem, which in turn is embedded in challenges. This was true for the United States in South Vietnam and is also true for efforts in Afghanistan.

Within this context, aerial eradication can imply a level of US commitment that does not exist. Spraying can send misleading messages about what the United States is willing to do. The public images of spraying suggest that nothing is off limits. The starkness of sprayed rice paddies or a bare field may imply that the United States is prepared to go as far as needed in its COIN efforts. This was not the case in South Vietnam and is not the case in Afghanistan. The illusion that these chemicals signify some sort of commitment affects US allies and adversaries. One proponent of spraying wrote in the *New York Times* that US allies should "help in [an aerial eradication] effort or stand down and let us do the job."[34] Given the self-imposed limits on the US efforts in Afghanistan, this stance may lead to a role that the United States is not willing to play.

Even a relatively limited commitment may prove difficult. The ostensible goal in both countries is to change the behavior of the local populace through eradication. In South Vietnam, the goal was that rural Vietnamese would not supply the insurgents; in Afghanistan, the goal is that farmers will not grow poppies. According to some proponents, total eradication may not be needed to lead to changes in behavior. Douglas Wankel, a former Drug Enforcement Agency official who is now a private US government contractor, led an eradication campaign in Afghanistan's Uruzgan province. He notes,

> We're not able to destroy all the poppy—that's not the point. What we're trying to do is lend an element of threat and risk to the farmers' calculations, so they won't plant next year. . . . It's like robbing a bank. If people see there's more money to be had by robbing a bank than by working in one, they're going to rob it, until they learn there's a price to pay.[35]

In South Vietnam, the United States was equally confident in predictions about the effects of spraying. At a high-level conference on Vietnam on 23 July 1962,

> [Gen Paul D.] Harkins outlined for the conferees the plan developed in Saigon and explained that fields abandoned by Montagnards as they moved to strategic hamlets needed to be sprayed in order to keep those crops from falling into guerrilla hands. . . . The Secretary inquired of Ambassador Nolting as to whether crop destruction would cause negative propaganda inside South Vietnam. Nolting responded that destroying crops abandoned by Montagnards should cause no problem.[36]

Nolting was wrong. A later RAND Corporation study indicated that defoliation and crop destruction had built widespread and lasting antipathy toward the United States. As far as many rural Vietnamese were concerned, outsiders, who previously did not intervene for good or bad, were suddenly deeply involved in their day-to-day affairs, determining what and where they could farm. Not surprisingly, many resented this sudden and heavy intrusion. A RAND study noted, "The reaction to spraying operations which destroy civilian crops is almost unanimously hostile."[37] Aerial spraying did influence the local population but perhaps not always in the direction the United States preferred.

The same dynamic may hold true in Afghanistan. Rural South Vietnam and rural Afghanistan have long-standing traditions of local governance and a tenuous, if not hostile, relationship with their national government, a relationship that aerial spraying further erodes. Should spraying become widespread, many rural farmers, otherwise largely disconnected from the capital, would have their most direct contact with Kabul and Washington through the spray of a crop duster. This has already led to increased hostility toward the US and Afghan governments in sprayed areas.[38] Estrangement from the central government provides opportunities for extra-governmental forces to build influence and power. These local actors have their own agendas, which may or may not match those of the Karzai government or the United States. Many are also deeply, and very profitably, involved in the opium trade.[39]

Although the national government may be remote to rural dwellers, its survival is an important motive for aerial eradication. Internal forces threatened Diem's regime in the early 1960s and the Karzai government currently. Crops targeted for eradication fund groups that undermine the stability and the very existence of the US-backed regime. Depriving the communists and their allies of food was clearly in the interest of the Diem government if the communists conquered South Vietnam. Pres. Hamid Karzai must cope with insurgencies and opponents that receive considerable revenue from the drug trade and are working to destroy his government.

Environmental Damage

Environmental damage is another potential consequence of aerial eradication. While most officials in the early 1960s dismissed environmental safety, the issue receives a great deal more attention today. However, when discussing eradication in South Vietnam and Afghanistan, the public message is that herbicidal chemicals are perfectly safe. In the case of Vietnam, it is now quite clear that the United States sprayed poorly understood chemicals. Despite pronouncements that these agents were safe, insurance companies, environmental activists, and scientists all had questions (and reservations). As Rachel Carson warned of widespread damage from defoliants, Illinois insurance companies tightened underwriting standards for farmers who used these chemicals.[40] The academic and corporate scientific communities also had persistent concerns.[41]

In the debate over eradication in Afghanistan, the Bush administration expressed confidence that poppies could be killed with no unanticipated environmental consequences. Thomas Schweich, a senior counternarcotics official in the administration, dismissed concerns: "Drug lords use [glyphosate] in their gardens in Kabul. . . . My assistant at the time was a Georgia farmer, and he told me that his father mixed glyphosate with his hands before applying it to their orchards." Others, however, are not so sanguine. Studies indicate that various formulations of glyphosate can persist in the soil and have been linked to cell damage.[42] The impact of glyphosate on an environment as degraded as Afghanistan's can only be guessed.

The eradication dilemma in Afghanistan differs from the one in South Vietnam because the situation in Afghanistan is geometrically

more complicated. Opium interdiction is a problem affecting US policies regarding not only Afghanistan, but also Pakistan and Iran (two major transit points for Afghani opium) and Great Britain, the NATO ally responsible for counternarcotics in Afghanistan under the 2001 Bonn Agreement.[43] The phrase "fighting the Taliban" simplifies the problem to meaninglessness. The Taliban are involved in the drug trade, but to what extent has been disputed for years. In addition, other people and organizations are profiting from illegal opium; some are affiliated with the Taliban, and some are not.

Karzai's position in Afghanistan is even more compromised than was Diem's. Karzai has active political opposition; by 1961, Diem had neutralized most of his. Karzai's vulnerability may obviate his willingness to allow aerial spraying. Any negative effects may be blamed on his government, weakening it still further. Antigovernment forces, in their efforts to show the Karzai government as uncaring and a Western puppet, can use consequences that may be tangentially linked to spray campaigns. Should there be a bad harvest or another drought, opponents might plausibly argue that the United States, aided and abetted by the Afghan government, caused it.

The depth of the Karzai family's involvement in the drug trade also poses problems. There are swirling rumors about the complicity of the president's brother, Ahmed Wali Karzai, in the illegal drug trade. Another brother has substantial investments in property and car dealerships in areas rife with illegal drug activity.[44] The vast majority of Afghan poppy cultivation takes place in the southern provinces, especially Helmand, which are the base of Karzai's support. Spraying poisonous chemicals on the fields of his Pashtun countrymen may not be a high priority for Karzai.

The United States would have to be visibly and publicly responsible for spraying, unlike in Vietnam. Aerial spraying in Afghanistan would have to occur without the comforting fiction that it was an activity performed and controlled by Afghanistan's own sovereign government. In Vietnam, the United States kept its national fingerprints off of the spraying operations to the greatest extent possible. The US Embassy in Saigon, the US Information Agency, and the State Department made elaborate plans to deflect responsibility for defoliation and crop destruction onto the government of South Vietnam.[45] Even this pretence would be impossible in Afghanistan; the US role in spraying would be enormous and obvious. This would forestall charges of duplicity but make conclusions about meddling and war

making on the Afghan people quite easy to draw. One author observed that "even if a private company such as DynCorp, which has experience spraying in Colombia, carried out such an operation secretly and both the Kabul government and the international community denied any knowledge or authorization, the United States, which controls Afghanistan's air space, would inevitably receive the blame as a bully sentencing poor Afghan Muslims to starvation."[46]

Instead of evading the Geneva Agreements' restrictions, as it did in South Vietnam, the United States would have to manage its allies' prohibitions on defoliant and herbicide use to undertake an aerial eradication program in Afghanistan. This is a big disadvantage, given the importance of allied troops in Afghanistan. John Lee Anderson in *The New Yorker* observed, "The Europeans are adamantly opposed [to chemical spraying]—just look at the whole genetically-modified-crop debate in Europe. If they decided to spray over the next few months, we would need to have an information campaign on spraying, telling the Afghans they're not going to have two-headed babies, but also telling them so in Europe, in The Hague, and in Rome."[47] The United States dropped leaflets during Operation Ranch Hand, but there was still lasting public relations damage. In the case of spraying poppies, public backlash and a reduction or withdrawal of coalition troops could hamper the overall effort in Afghanistan.

A saying commonly attributed to the Taliban is, "The Americans have watches, but we have time."[48] This may describe the COIN campaign in general, but it is almost certainly true in the case of aerial eradication. In South Vietnam, spraying a rice paddy could kill the plants and reduce the insurgents' supply of rice for that season. In Afghanistan, the time horizons of a spray campaign, focused on immediate and visible results, versus those of a trafficker are very different. Killing poppies is an ambiguous achievement. Even if an entire field is eradicated, the supply-and-demand dynamics of opiates make this almost irrelevant. If the supply of resin goes down materially, then middlemen should be able to rebalance the market by processing and selling the previously stored product. If the supply of illegal drugs declines, then the dominant suppliers and dealers would pick up market share at the expense of less powerful ones, as happens in legal and illegal industries alike. The rice fields of Vietnam filled a very different economic role, one that did not generate extraordinary revenues or profits and did not attract numerous competing buyers or sellers.

To reduce poppy cultivation in the near and far term will take a multiyear effort and have steep environmental costs. Because poppies are an annual crop and their resin so easy to store, spray campaigns would have to happen every year to kill that year's crop and force existing stockpiles into the market to meet demand. The repeated application of powerful chemicals could have a serious impact on the Afghan environment, making it even more difficult to replace poppies with other crops. In the worst case, as occurred in parts of South Vietnam, the landscape becomes sterilized.[49] Under these conditions, crop substitution becomes impossible. The damage from herbicides on Afghanistan's soil, already taxed by decades of war, could be considerable. Whatever effects glyphosate or other herbicides might have on fields in the southern United States, those effects may not remain the same in such a radically different, and compromised, environment.

The role of money is the biggest difference in the cases of Afghanistan and South Vietnam. In Afghanistan, the money the crops generate finances crime and corruption throughout the Middle East and Central Asia. The targeted crops in South Vietnam were not as valuable, did not have as wide a market, and easily reached consumers. Rice required relatively little processing after harvest, and manioc required none. Communist troops could seize harvests, or even fields, and gain a food supply that did not require much further effort.

Poppies, on the other hand, do not have much value when still in the field. The real money is made and the largest benefits accrue once the resin is harvested and refined. Each step in the process adds value and generates revenue for the growers, harvesters, or refiners. The poppies are not moneymakers. These funds go, if only in part, to fund the Taliban.[50]

The amount of money generated by poppies severely distorts the Afghan economy because it makes up so much of the country's total revenue. As Rory Stewart in the *London Review of Books* described the situation: "There is almost no economic activity in the country, aside from international aid and the production of illegal narcotics."[51] To complicate matters further, a significant percentage of that international aid comes into Afghanistan to fight the illegal drug trade. Alternate sources of income would need to make up the shortfall from aid reduction as well as from poppy reduction.

Aerial eradication would affect rural citizens before it affected nongovernmental organizations. Money is why farmers grow poppies, and for some, the loss of a poppy crop might drive them more

deeply into debt.[52] Gretchen Peters, a journalist who has worked extensively to understand and document the problem, puts it bluntly: "Wide-scale spraying would play into the hands of traffickers and terrorists. If implemented, this policy would drive up opium prices, thus increasing profits for drug dealers and the Taliban, and make life even harder for already debt-ridden Afghan farmers—exactly the results the US government and NATO don't want."[53]

All of this is not to say that eradicating the poppies and damming the flow of money and illegal drugs are not worthwhile goals. However, depending on how this goal is defined, aerial eradication may not be an effective route toward achieving it. The first question that must be asked is what does *success* look like? This question has dogged US efforts in Afghanistan, and not just in the context of poppies or spraying.

If the goal is *stability*, depending on how that word is defined, poppies may help rather than hinder. A certain level of safety and predictability is necessary for economic transactions to occur, whether legal or illegal. Hafvenstein implies that poppies may not be the force for anarchy they seem to be. "Our target area was Helmand province, which was both an oasis of relative calm in the heart of the Taliban resistance and the foremost drug-producing region in the country."

Poppies provide jobs, and jobs foster stability. As a rule, farmers are active, vigorous men. Insurgents target farmers who have no crops and few job prospects. If the insurgency has a ready supply of cash, perhaps from the illegal drug trade, it becomes even more attractive to a disaffected and unemployed man. In rural Afghanistan, nonagricultural jobs are in short supply. Even in the few urban areas, jobs are limited, particularly for the majority of potential workers who are illiterate and unskilled.[54]

It is also unclear what the farmers would do with non-poppy crops. In order to monetize them, as they do poppies, they have to sell them. Other countries would need to open their markets to agricultural imports, a politically formidable goal given the power of the farm lobbies in the United States and Western Europe. Even getting agricultural crops to market within Afghanistan is a nearly insurmountable problem because of the lack of secure roads. Journeys are too dangerous and take too long to make economic sense.

Various local militias have taken root along with the poppies, promoting a sort of stability. There remains a strong bias toward local governance, but not because local leaders have political legitimacy or

local support. Rather, leaders may gain and hold their positions through the buildup of private militias, paid for through drug revenues. Furthermore, these same leaders, because of their influence, may be particularly attractive to foreign intelligence services. An informer among their ranks could prove useful enough to justify, if not blindness, some myopia toward the ongoing production and sale of illegal drugs.

Aerial eradication is an imperfect solution to a difficult problem. The hurdles that the United States encountered in the early 1960s during another eradication campaign give some indication of just how challenging an Afghanistan campaign might be. In fact, spraying the poppy fields in Afghanistan would be an even more complicated campaign than crop destruction in South Vietnam.

This is not to say that aerial spraying could not play a role in breaking the cycle of indebtedness, unemployment, and violence that has taken hold. However, considerations about the appropriateness of spraying would have to include the potential economic and environmental effects of a successful campaign, however defined. If herbicides further damage the Afghanistan environment and farmers are left with even fewer choices of how to support themselves and their families, the results for Afghanistan and the United States could be devastating.

Notes

1. Because of the complexity and opaqueness of the illegal drug trade, this chapter does not rely on statistics about drug production, pricing, or use. David MacDonald, an advisor to the United Nations, rightly warns that "certainly all official estimates and figures emanating from Afghanistan, right up to the present day and whether collected by government or international agencies, are subject to wide variation and should be treated with caution." MacDonald, *Drugs in Afghanistan*, xxii.
2. Felbab-Brown, "Afghanistan," 56.
3. Glaze, *Opium and Afghanistan*, 2.
4. Chayes, *Punishment of Virtue*, 188.
5. Hafvenstein, *Opium Season*, 47.
6. Chayes, *Punishment of Virtue*, 149–50.
7. Hafvenstein, *Opium Season*, 10.
8. Clemens, "Opium in Afghanistan," 409.
9. Aras and Toktas, "Afghanistan's Security," 46.
10. Clemens, "Opium in Afghanistan," 409.
11. Robichaud, "Buying Time in Afghanistan," 8.
12. Felbab-Brown, "Afghanistan," 57.

13. Katzman, *Afghanistan*, 4.
14. Felbab-Brown, "Afghanistan," 57.
15. Peters, *Seeds of Terror*, 237.
16. Kreutzmann, "Afghanistan and the Opium," 613. Other authors who assert this include Hafvenstein, *Opium Season*, 215; Chayes, *Punishment of Virtue*, 85; and Blanchard, *Afghanistan*, 8.
17. Kreutzmann cites the *World Drug Report 2006* (Vienna: United Nations Office on Drugs and Crime, 2006), 212. Kreutzmann, "Afghanistan and the Opium," 609.
18. Felbab-Brown, "Afghanistan," 59.
19. Blanchard, *Afghanistan*, 9.
20. Kreutzmann, "Afghanistan and the Opium," 617; and Blanchard, *Afghanistan*, 9.
21. Katzman, *Afghanistan*, 20.
22. Felbab-Brown, "Afghanistan," 62.
23. Stellman et al., "Extent and Patterns of Usage," 682.
24. Betts and Denton, *Evaluation of Chemical Crop Destruction*, xi–xii.
25. Buckingham, *Operation Ranch Hand*, 23.
26. See, for example, Cronon, *Changes in the Land*; Nye, *America as Second Creation*; and E. Morgan, *American Slavery*.
27. National Security Files, Countries—Vietnam, Box 203, Subjects—Summary of Suggested Courses of Action (1961), John F. Kennedy Presidential Library (JFKL).
28. US Department of State, *Foreign Relations of the United States*, 236.
29. Anderson, "Taliban's Opium War."
30. Mufson and Pincus, "Major Challenges for Pentagon."
31. Peters, *Seeds of Terror*, 2.
32. Burns, "Use of Aircraft for Foliar Applications," 92.
33. Buckingham, *Operation Ranch Hand,* 39; and Stellman et al., "Extent and Patterns of Usage," 685.
34. Schweich, "Is Afghanistan a Narco-State?"
35. Anderson, "Taliban's Opium War."
36. Buckingham, *Operation Ranch Hand*, 72.
37. Betts and Denton, "An Evaluation of Chemical Crop Destruction," 13.
38. Van Ham and Kamminga, "Poppies for Peace," 72.
39. Giustozzi, "War and Peace Economies," 82.
40. Carson, *Silent Spring*, 60–61; and "14th Custom Spray School."
41. For examples, see McDermid, ed., *Use of Chemicals*; and Mullison, "Volatility of Several Salts," 287.
42. Albers et al, "Influence of Organic Matter"; and Benachour and Séralini, "Glyphosate Formulations."
43. Blanchard, *Afghanistan*, 8.
44. Katzman, *Afghanistan*, 10.
45. Buckingham, *Operation Ranch Hand*, 28–29; Telegram #235, Edward Murrow to Frederick Nolting, 11 March 1963, National Security Files, Countries, Vietnam, General, 3/1/62–3/17/63, Box 197, Document 12, 1, 2, JFKL; and Telegram #497 from Rusk to Nolting, 14 November 1962, National Security Files, Countries, Vietnam, General, 11/11/62–11/25/62, Box 197, Doc 1, JFKL.
46. Felbab-Brown, "Afghanistan," 63.
47. Anderson, "Taliban's Opium War."

48. Robichaud, "Buying Time in Afghanistan," 1.
49. David Biggs (professor of Southeast Asian and environmental history, University of California, Riverside), personal communication, 11 September 2009.
50. Katzman, *Afghanistan*, 20.
51. Stewart, "Irresistible Illusion," 3.
52. Blanchard, *Afghanistan*, 9.
53. Peters, *Seeds of Terror*, 7.
54. Katzman, *Afghanistan*, 52.

Chapter 6

Airpower and the Environment

Applications in Developing Countries

Dan Henk

The early twenty-first century marked one of those pivotal times in world affairs when relationships between individuals and between societies seemed to be in flux. Remote parts of the globe became visible to a worldwide audience, national boundaries posed increasingly little obstacle to the flow of information and ideas, and people in many societies subscribed to broad new notions of security. The comfortable *paradigmata* of the past no longer satisfied the yearnings of the present and increasingly appeared inadequate to the challenges of the future. Human relationships seemed to be changing, and this was not the sum of it all. Passions were energized by many contending ideas, including those concerning our connection to the cosmos and our relationship to the natural environment.

Environmental angst, once a preoccupation of eccentrics and radicals, went "mainstream" to the point of becoming cliché. Yet an increasing worldwide awareness of environmental issues produced little global consensus; the world's citizens held widely divergent views on threats to (or from) the environment, environmental stewardship, sustainability, and rights of access to natural resources. By the early twenty-first century it was also increasingly evident that the world's climate was changing, partly due to man's activities, and that the results (while not clearly foreseeable) would likely be more harmful than helpful to human life on the planet. These and other environmental topics stimulated intense debates among scholars, policy makers, and activists. Almost every "environmental" issue ultimately devolved into contentious disagreements over public policy.

As the new century began, the scattered public sector responses to environmental challenges begged at least two questions: (1) whether or not military establishments could be allocated significant environmental roles without endangering delicate relationships between government and civil society or compromising traditional military

functions, and (2) whether or not there are meaningful environmentally relevant roles these security establishments could effectively play. In the first decade, neither question was definitively answered by existing theory or practice.

This chapter proposes partial answers to the second question. It does not delve deeply into the topic of evolving military roles and missions. It avoids a treatment of civil-military relations and offers no conclusions as to the propriety of employing military institutions in pursuit of society's environmental ends. Instead, it identifies some roles that militaries could play if asked to do so.

Military establishments are not homogeneous in composition or in function. The assessment taken here is much more enlightening if focused on the capabilities of particular organizational actors. Hence the chapter spotlights the potential role of airpower—and the contribution that a relatively sophisticated air force could make—to environmental ends. Likewise, environmental activities do not occur in a vacuum but in particular places. Application of airpower is meaningful only if contextualized to the political realities of a natural and cultural environment. Some of the world's most trenchant environmental dilemmas—and some of the most hopeful prospects for progress on environmental issues—can be found in developing countries in southern Africa. That region is the geographic focus for this chapter, with the implication that at least some of what is true for southern Africa will apply elsewhere (with appropriate contextual adjustment).

Security Sector not Spared

Since the mid 1980s, a substantial worldwide discourse has emerged on the security implications of environmental issues.[1] Some scholars have challenged the notion that security and the environment should be linked, but those scholars represent a minority view that does not generate much current traction.[2] Rather, the world's leaders now recognize that environment plays a role in virtually all national and international efforts to promote long-term development, reduce destabilizing want, and attenuate violent conflict.[3]

Security agencies have not been exempt from this international environmental conversation. Many governments have looked to the security sector for some environmentally related activity. National intelligence organizations increasingly are asked to assess the political and

security implications of environmental trends. Police agencies and judiciaries enforce growing bodies of environmental law. Defense establishments are held to ever-stricter standards of environmental accountability, as are broader international military coalitions. Both the United Nations (UN) and the North Atlantic Treaty Organization (NATO) now publish environmental policy guidance for military operations.[4] Some governments have harnessed their militaries to environmental ends, as evident in the antipoaching operations of countries like Botswana, Brazil, and Mozambique.

What has not emerged to date is any substantial advocacy for the targeting of military establishments at wide-ranging environmental ends. No military constituency has made a strong public case for its greater involvement in environmental issues.[5] With a handful of exceptions, national governments have not assigned prominent environmental roles and missions to armed forces.[6] In fact, it is easy to anticipate the complaints of military leaders if their organizations suddenly were saddled with such responsibilities, as well as the complaints of environmental activists worried about militarizing the environment.

Yet the fact that militaries have not engaged in sophisticated environmental roles does not suggest that they are incapable of performing them. At various times in human history military establishments undertook significant shifts in function and ethos to successfully address the peculiar needs of sovereign or society. Twenty-first-century airmen would do likewise if directed. However, airpower and the environment probably do not give an initial impression of significant overlap. Making the case that they could requires a brief excursion into the nature of airpower and contemporary thinking about the environment.

Implications of Airpower

Western military scholarship still respects the dicta of nineteenth-century Prussian thinker Carl von Clausewitz, and none of his writing is more often quoted than "war is . . . a true political instrument, a continuation of political activity by other means."[7] In this line of reasoning, neither military establishments nor their capabilities are ends in themselves, but means to larger political ends. The same is true of more narrowly delimited military capabilities like airpower. No matter how that capability may be defined, a Clausewitzian paradigm

would classify it simply as one among many military capacities employed by a nation-state within a range of policy instruments available to pursue its national interests.

A standardized international definition of airpower is somewhat problematic. Each nation maintains a unique inventory of interests and parcels military roles and responsibilities rather differently. Military establishments exhibit distinctive national traditions, structures, and doctrine, so a definition is partially dependent on peculiar historical and cultural circumstances. However, a universally acceptable and minimalist definition of airpower would identify its one key feature: an ability to use the atmosphere as the peculiar medium in which a security-related end is pursued (or the atmosphere as a medium that is leveraged to apply a military capacity). Western militaries add the dimension of space to the notion of airpower, inferring a concern for missiles, satellites, and other space vehicles (and the protection from threats posed by such vehicles).[8]

The notion of airpower itself has certainly not been static, generating a continuing spate of controversies. Aerial reconnaissance of the battlefield dates back to manned balloons. But the advent of powered flight in the early twentieth century shifted the focus to the packaging and delivery of coercive power. Early airpower debates centered on emphasizing the priorities for delivering that coercion: whether priority should be given to the direct support of ground forces, defense from adversary use of the air, or attack on the adversary heartland. World War I experiences contributed to fierce controversies on these issues, propelled by men like Giulio Douhet in Italy, Hugh Trenchard in the United Kingdom, and Billy Mitchell in the United States.[9] World War II intensified the earlier obsession with delivery of coercive power—US airpower ultimately delivered the most lethal technology of that era—but also sowed the seeds of other important roles, including strategic aerial reconnaissance and the airlift of men and materiel.

These new airpower roles matured during the Cold War. Delivery of coercive power at the tactical, theater, and strategic levels remained a key concern, although airmen per se were not always in charge of this function.[10] In America, and elsewhere, airmen typically bore much of the responsibility for protecting the heartland from aerial attack, though responsibilities for air defense were scattered among ground, air, and sea services. Despite some dispersion of tactical aerial surveillance responsibilities, airmen and airpower continue to play a large and growing role in surveillance and reconnaissance. For its

part, strategic surveillance in the developed countries tends to be an airpower function shared with—and overseen by—national intelligence services. Short-range tactical air transport (emphasizing rotary-wing aircraft) is often a ground forces function, while airmen flying fixed-wing aircraft continue to dominate the longer-range airlift and continue to control strategic aerial transport, along with the logistics and communications to support it.[11]

Evolving new roles endow airpower with attributes most relevant to this discussion. During the Cold War, the worldwide scope of strategic attack, strategic lift, and strategic surveillance pushed American Airmen to develop broad, global perspectives. In the wake of the Cold War, a proliferation of international interventions in complex humanitarian emergencies around the world almost inevitably resorted to US strategic airpower. This placed demands not only on the technological and managerial prowess of US Airmen, but also upon their ability to work effectively with coalition partners, international humanitarian organizations, and host-nation civil societies.

Along with the interventions by international coalitions in complex humanitarian emergencies came an increasing emphasis on taking care of people—human populations traumatized by violence or natural disaster. Those activities included at least some concern for conflict management along with the provision of materiel for basic human needs and delivery of emergency health care. By 2010 the US Air Force had developed a well-refined and tested tactical capability to quickly install the management of such functions "on the ground" through activation and deployment of a contingency response group.

After 2001 US involvement in conflicts in Iraq and Afghanistan brought an expansion of US military roles into activities which may loosely be characterized as national reconstruction. Airmen, along with other military personnel, were heavily involved with the details of local government and civil society, assisting in providing both the physical and economic security required to rebuild the shattered lives of local communities and reestablishing the capability of security forces and the legitimacy of host-nation political authorities. America's Airmen had acquired some responsibility for managing social change within civil societies.

Meanwhile, airpower's location within the dimensions of air and space brought some interesting corollaries. By the early twenty-first century, the ability to conduct military operations within these dimensions inferred considerable technological sophistication. The

associated equipment was some of the most advanced ever produced. This equipment required intensive education for its operators as well as organizational and individual sophistication in the processes of production, fielding, and maintenance. Twenty-first century air operations demanded substantial management skill to oversee even the most routine activities.[12]

Airpower in developed nations also required a long-term focus. Technology was developed and applied in costly, long-term acquisition programs, generating sophisticated equipment which then remained in use for decades. Egregious acquisition errors inevitably squandered scarce resources and posed substantial security risks. These factors dictated a clear requirement for higher-ranking airmen to see a future with some clarity and manage the risks with some dexterity.

Military leadership, whether in airpower or any other domain of military endeavor, heavily focuses on solving problems and overcoming obstacles—typically in circumstances of adversity, ambiguity, and intercultural complexity. Such roles demand a capacity to establish coherence and order in inherently disordered surroundings, along with significant technological and management capabilities to overcome the problems. But the successful accomplishment of these roles also requires proficiency in "people skills": building teams, harmonizing efforts, and motivating diverse individuals and groups to work together towards common goals. Because of the unique technological demands and the unforgiving lethality of error, airpower demands a substantial inventory of all these skills. When brought into nonmilitary activities, the men and women in uniform who managed America's air operations in peace and war generally have proven to be competent leaders, good organizers, and effective technical experts.[13]

When it comes to airpower per se, the managerial oversight and many of the actual operations are similar to other public sector activities. For instance, the same kind of expertise and equipment required for contingency planning and military airlift is regularly applied to natural disaster response or to the surge capabilities of commercial mail carriers. Strategic air operations require robust, reliable, long-range logistics and communications capabilities which have obvious utility for rapid, long-range movement of any commodity. Air and space surveillance provides rapid warning of dangerous military adversaries but could also be used to track natural environment changes. For responsive reporting on atmospheric conditions, some air forces maintain their own weather services. In short, airpower

carries within it the seeds of many nonmilitary public and private sector functions.

Airpower's unique, inherent capabilities also make it in many cases *the* military capability most suited to extending the reach of the state and enhancing its capabilities. Particularly in circumstances where infrastructure is underdeveloped or deteriorated (an all too common characteristic of the developing world), airpower provides national leaders with otherwise unequalled options for flexible, rapid response to the remotest reaches of the state and beyond. In cases of dire national emergency, few institutions can equal a reasonably competent and well-equipped air force in supporting the symbolic and redistributive mandates of state power. The qualities required for typical roles in military management and leadership, along with the scientific and technical expertise required for effective deployment of airpower, suggest that senior airmen may be uniquely equipped among their public sector colleagues to assist in addressing a nation's environmental priorities.

Defining *Environment*, Connecting Dots

The discussion earlier noted a lack of global consensus on environmental issues. Difficulty in achieving that consensus may be due in large part to the loose conceptual boundaries of the domain itself.[14] "Environmental" issues comprise an amorphous mass of assorted topics that do not always appear closely connected or even inherently related, and the issues elide easily into other domains such as health and livelihood. Although the boundaries of the field are ambiguous, it is useful to identify several of the broader categories of environmental concerns before turning to a discussion of possible roles for airpower.

Natural resources comprise one area of environmental concern and are also subject to substantial controversy. (The resources themselves may range from minerals, to water, to flora and fauna in the natural environment, to soils, air, and other natural features.) Here, societies exhibit a variety of apprehensions. One is centered on rights to access—questions of legitimacy in exploiting the resources and the propriety of methods employed in that exploitation. This calls attention to some of the most difficult yet important roles played by political authorities—establishing societal consensus on rights of access

to natural resources, achieving transparency and accountability in administering those rights, and distributing the associated benefits so that the issues do not become politically destabilizing. A related question is how to preclude exploitation of natural resources by unauthorized actors. Another relates to conservation and sustainability—how to exploit natural resources in a responsible way that avoids, attenuates, or otherwise manages the problem of resource depletion.

An associated environmental concern is "biodiversity"—an interest in preserving and protecting the various forms of life on the planet. This is now increasingly based on a conviction that mankind is impoverished by the extinction of any form of life and by regret at the loss of potential contributions to human well-being. (A smaller but vocal ecocentric community argues for the criticality of biodiversity out of a conviction that all forms of life have an equal right to coexist with humankind.[15]) By the mid 1990s, biodiversity had become a mainstream concern within an attentive Western public sensitized to poaching of megafauna in Asia and Africa—with the very real prospect that wildlife species like the Siberian tiger and rhinoceros faced imminent extinction.[16]

Another topic overlapping "natural resources" is the natural environment's capability to sustain human health and well-being—or to threaten it. As noted earlier, overuse depletes resources. The more immediate threat is the contamination of air, soils, and water resources which compromises their use for human livelihoods—imperiling human health or menacing food chains upon which humans are dependent. African environmental threats, such as drought, flooding, typhoons, volcanic eruptions, and effluence of toxic volcanic gasses, range widely.

Some environmental problems attack human populations directly. For instance, the natural environment in tropical zones incubates diseases that can take a devastating toll on the life or health of human populations, sometimes (as with the hemorrhagic fevers of central Africa) appearing with terrifying suddenness and lethality. Such diseases can also be quickly borne by human hosts along modern transportation routes directly into the population centers of the developed world. Some environmental threats emanate from unwise economic development practices, whether these are the toxic chemicals left over from mineral extraction, waste from electricity generation plants, or soils contaminated beyond use from accumulated salts in poorly managed irrigation schemes. Many threats arise from complicated

interactions of multiple factors, such as the depletion of atmospheric ozone and the resulting dangerous increases in ultraviolet radiation on the earth's surface. Some environmental threats are stimulated by human activity; others are not.

Climate impacts many other environmental variables, and climate change has unsurprisingly become an issue of great concern as well as great controversy. In recent years the issue became entangled with global political wrangling over causality and responsibility. Greenhouse gasses, thought to be a primary cause, result mainly from the combustion of fossil fuels that powers the conveniences and industries of the world. International efforts to contain and reverse that combustion had proven relatively ineffectual until 2010, but the issue had the attention of world leaders and an attentive international public. It was nonetheless apparent that real progress on this issue would require painful and politically fraught choices, where long-term benefit demanded short and midterm sacrifice.

Even a superficial overview of these various environmental domains and issues points to complex interconnectedness. Many of the categories significantly overlap each other and also extend into other domains of human endeavor, whether economic development, subsistence, or quality of life. A satisfactory solution to virtually any single environmental dilemma requires a simultaneous resolution of problems stemming from the second- and third-order effects of that solution. Put another way, real progress in addressing environmental concerns almost inherently requires holistic "systems thinking" about all the impacted fields along with the capacity to achieve "buy-in" across affected communities of human actors. It also requires approaches that do not sacrifice the future for the political convenience of the present. Here, the unique skills and understandings of military leaders may give them an advantage as contributors to the management of a society's environmental equities. Military leaders (and particularly airmen) have a unique preparation among the professions for connecting scientific with technical expertise, people skills, and holistic long-range thinking to address problems that are partly anchored in the material universe and partly in the world of ideas and culture.

The Southern African Environmental Scene

The thought of Africa conjures up interesting and contrasting environmental stereotypes in the developed West. On one hand, the continent enjoys a quaint reputation for the richness of its fauna—particularly the spectacular megafauna. On the other hand are images of catastrophe, environmental disaster, conflict over resources, scarcity, disease, and human suffering.[17]

Perhaps two-thirds of Africa's people depend wholly or in part on subsistence agriculture. For populations whose livelihoods—and lives—are at the mercy of an unpredictable natural environment, the factors of precipitation, soils, predatory insects, and disease loom very large. African dependence on subsistence agriculture is compounded by the inadequacies of weak states that offer little safety in times of difficulty. While the ramifications of climate change are debated by scholars and policy makers in developed countries, African farmers and herders experience its effects every day, having seen precipitous declines in precipitation in some areas, more frequent droughts (with increasing severity), and decreasing predictability of weather patterns in general since the mid twentieth century.[18] The impact of climate change is compounded by (in some respects perhaps caused by) expanding human populations and human activities, such as deforestation and the overplanting or overgrazing of marginal land, leading to desertification and decreased carrying capacity of the land.[19]

Subsistence agriculture is by no means the only focus of environmental concern. For millions of residents of Africa's urban and periurban environments, access to clean air and clean water is problematic at best. Given the limitations of fresh water resources in some areas, access to any water may be a significant problem for some African urban areas in the intermediate future.[20] Rapid, uncontrolled urbanization has imposed severe challenges on city authorities, whose capacity to extend urban sanitation infrastructure into growing squatter communities is almost uniformly limited, resulting in heavy use of scarce distribution resources and the inadequate processing of waste. The continent's escalating deforestation is kindled in large part by a demand for charcoal—the only fuel affordable for cooking and heating in much of urban Africa. On winter days, African cities often are enveloped in palls of carcinogenic charcoal smog.

African conflict has its own unfortunate connections to Africa's environmental problems. Some of the continent's conflict has been stimulated or prolonged by struggles over mineral resources such as diamonds and coltan. These struggles deny environmental benefits to local societies and empower exploitative and sociopathic warlords while encouraging egregious human rights abuses. In regions of conflict, African states have difficulty maintaining control of natural resources, including precious minerals and wildlife, resulting in wanton and unsustainable exploitation.[21] African conflict typically results in flows of refugees and displaced persons, with concomitant fouling of water resources, deforestation, poaching, destruction of wildlife habitat, and epidemic human diseases. In some areas, legacies of past conflict include huge swaths of rural land seeded with chemical contaminants or landmines that continue to kill or maim humans and animals.[22]

Economic development in Africa also has not been kind to the environment.[23] The emphasis on mineral exploitation since the colonial era has left in its wake the toxic environments of environmentally unfriendly extraction and refining. An expansion of the transportation infrastructure has enabled illegal harvesting and poaching of flora and fauna in once inaccessible areas. Like livestock ranchers everywhere, African herders are not sympathetic to wildlife that competes for grazing and water, preys on their cattle, or transmits disease—and they often use modern technology to eliminate such threats, with unfortunate second- and third-order effects for the rest of the environment. The fossil fuels that generate electricity for growing populations of African consumers tend to be "dirty," contributing to high levels of unhealthy atmospheric particulates, as do mineral and petroleum refineries and other industries weakly restrained by environmental regulations. Particulates enter the air from fleets of urban vehicles whose exhaust systems go largely unregulated. The environment is further plagued by the all too frequent unfortunate accidents—such as contamination of a critically important aquifer in water-poor Botswana by nitrates leaching out of local commercial chicken farms.

Africa's ability to deal with its many environmental problems is limited. African leaders—faced with a host of urgent problems and pressures from constituents and international actors and constrained by woefully inadequate resources—are obliged to make difficult choices. Environmental issues are rarely the most immediate and

pressing of their concerns, and often are deferred in favor of more urgent priorities. In fact, African leaders and common citizens pay attention to environmental issues mainly when these significantly overlap other areas of greater concern such as human health and economic development. Then, too, African environmental concerns can be significantly at odds with those of their external partners. Africans are skeptical of the agendas of Western environmental activists who prioritize conservation and the well-being of wildlife over the well-being of people.

Although Africans face difficult environmental dilemmas, they have demonstrated a willingness and ability to find solutions, particularly in the southern region. Several southern African countries have made explicit national commitments to the environment in published policy statements. The region as a whole (in the form of the Southern African Development Community) has committed itself to commendable environmental objectives.[24] Southern African countries have demonstrated an impressive commitment to work together on environmental issues through such initiatives as the three-nation Permanent Okavango River Basin Water Commission or the ambitious Kavango Zambezi Transfrontier Conservation Area, the latter a project to tie the national park systems of five countries together in an enormous human development and environmental conservation scheme.[25] Of particular interest to this discussion is the fact that several southern African countries have assigned environmental roles to their military establishments. While there is currently no region-wide consensus on such roles, a local precedent is firmly established.

Two broad and somewhat overlapping categories define southern African public-sector environmental programs. The broadest is natural resources management, which breaks down into several divergent streams. A second category may be described as mitigation of threats to human health and well-being that emanate from the natural environment, a category that also diverges into a variety of different programs and approaches. These two broad streams are not particularly connected in public policy—either at the national level or in the region as a whole. If both categories and all their various divergent streams were effectively integrated into a synergistic, overarching environmental program, the region could probably achieve significant efficiencies, along with a better capability to partner with internal and external allies and a greater effectiveness in pursuing the particulars. Regrettably, the present situation lacks that unity of approach.[26]

The Regional Embrace of Human Security

By 2010 most southern African countries subscribed to the broad new conceptualizations of security generally categorized under the rubric of "human security."[27] The term was popularized by the UN in the early 1990s and, by the turn of the century, was thoroughly embedded in UN agencies and approaches.[28] The UN portrayed its new security model as "people-centered" (rather than state-centered); the most basic components were freedom from fear and want. The formula consisted of various constituent parts, prominently including "environmental security" that protected people from the short- and long-term ravages of nature, man-made threats in nature, and deterioration of the natural environment.

The broader definitions of security did not resonate everywhere, and some scholars challenged the human security paradigm as a whole, while others rejected the notion that the environment and security should be linked.[29] Not all the world's scholars are equally enthusiastic about the government embrace of environmental agendas. Some are naturally suspicious of any governmental interest in the environment and are worried that "securitizing environmental issues [risks] state co-option, colonization and emptying of the environmental agenda."[30] Such differences are also evident in arguments over the meaning and implications of environmental security, a construct that continues to elude a widely accepted definition.[31] Early on, African scholars supported the new "security" thinking and tended to endorse the broader definition exemplified in the UN conceptualization. As early as the 1990s, human security themes were prominent in the thinking of African officials and academics.[32] Interestingly, *environment* appeared in most of the new African definitions of security, either in terms of a human right to a healthful environment or in terms of rights by common citizens to environmental resources.[33]

Initially, the broader models of security left little room for the coercive agencies of the state and seemed to deny security-sector officials any exclusive right to define the subject. The new thinking questioned the relevance of the traditional military establishments themselves. However, a few countries bravely endeavored to adapt the broader models of security to military roles and missions. One of the most remarkable was post-apartheid South Africa. After 1994 that country made a very concerted effort to realign its military to its new national priorities and commitment to human security.[34] South

Africa's foundational document for its new military establishment articulated a whole new philosophy of national defense, capturing one of the most expansive definitions of security on record and offering a clear environmental dimension:

> National security is no longer viewed as a predominantly military and police problem. It has broadened to incorporate political, economic, social, and *environmental* matters . . . security is an all-encompassing condition in which individual citizens . . . *inhabit an environment which is not detrimental to their health and well-being* [emphasis added].[35]

The linkages in the South African white paper were not foreign to officials in other African countries. By the twenty-first century, southern Africans had established a conceptual relationship between militaries and environmental security in their region, though they were far from a full exploration of its possibilities and a long way from unanimous endorsement of the notion of employing militaries in such roles.[36] However, two southern African countries have pursued environmental security through resort to military force, Botswana and Mozambique.

By the mid 1980s, Africa's megafauna were severely threatened, particularly elephants and rhinos. Networks of well-armed criminals with links to the Persian Gulf and Far East sponsored much of the slaughter.[37] In Botswana, as in other parts of Africa, commercial poachers threatened the wildlife, along with the closely associated tourist industry, and assaulted local citizens living near the national conservancies. Botswana deployed its defense force into those conservancies in 1987, initiating a successful, long-term effort to halt egregious, commercial megafauna poaching. National park protection continues to be an important military mission for Botswana.[38]

In the mid 1990s, the southern African country of Mozambique elected to use part of its military in an environmental security role. Here, its navy was recruited into an innovative partnership sponsored by the World Wildlife Fund (WWF), an international environmental advocacy group. Within this partnership, the Mozambican navy works closely with the Ministry of Fisheries and local civil society groups to protect natural resources and enforce environmental law on the country's inland waterways.[39]

Two African countries' successful use of military force in an environmental security role does not validate that usage as a universal norm. Nor does it prove that military deployment is the best solution

to the commercial poaching problem. However, it does suggest that African security agencies can play useful environmental security-niche roles in carefully defined circumstances.

Beyond Botswana and Mozambique, in 2010 South Africa was the only southern African country with a serious military involvement in environmental security. It maintained a small environmental office within its National Defense Force headquarters and was concerned with a broad range of environmental issues, although its focus was limited almost exclusively to military installations and their immediate environs. South Africa employed its air force in routine coastal patrolling to secure its maritime resources, drawing aircraft from a Cape Town squadron and linking that to coastal law enforcement. Just as significantly, it served as a bridge to military environmental activities in other African countries, hosting consultations on environmental issues among military officials. These initiatives suggested that senior leaders in African militaries were open to possible roles in regional environmental initiatives.[40]

Since the activation of the Africa Union (AU) in 2002, Africans have engaged in productive consultations with each other to address their regional security dilemmas. These years have witnessed the initial outlines of a continent-wide security architecture conceived and created by Africans, involving a system of regional standby brigades for peace support operations and a centralized early-warning crisis tracking center.[41] This new security architecture potentially can attenuate many security-related problems, including those connected to the environment. Many of Africa's crises have profound environmental ramifications, and it is inevitable that any intervention in complex humanitarian emergencies deal with at least some environmental aspects of human security.

With the end of the Cold War, Africans engaged with external security actors, among them the United States and the EU, in fundamentally new ways. One of the novel features of these post–Cold War relationships has been a growing commitment to mutual partnerships intended to reduce instability and insecurity while promoting human rights along with sustainable human and economic development. African connections with the United States since 2007 have been troubled by the activation of a new military command—the US Africa Command—to oversee US security interests in the region. However, despite African suspicion of American intentions, the new US military entity is fundamentally oriented towards partnership, coop-

eration, and multisector/whole of government relationships.[42] The same is true of the deeper though less visible relationship emerging between the AU and the EU.[43] While environmental security has not been a strong feature of these security partnerships to date, a good potential and an excellent forum now exist.

Airpower: A Potentially Useful Contributor

The bottom-line concern here is the role that airpower could play in efforts by southern Africans to deal with their environmentally related problems and issues. The challenge now is to speculate on how all this might tie together, leading to observations on the applicability of airpower at three different levels: (1) the technical characteristics of airpower; (2) contemporary airpower roles; and (3) the unique skills of airmen.

An argument was offered earlier that airpower provides the state with unmatched capacity to extend its physical reach through rapid, agile airlift. This applies to any state priority, including reaction to environmentally related crises. Perhaps just as important is the potential of modern airpower to provide state authorities with timely all-source surveillance. Currently fielded technology allows aircraft—both manned and unmanned—to collect information from radar, video imagery, and electronic signals.

At least one southern African country—Botswana—uses airpower in combined-arms military operations against armed criminals targeting its wildlife resources. In this case, airpower provides both tactical surveillance and airlift. While these technical capabilities of airpower are applicable to environmentally related national and regional issues, their full potential has not been maximized anywhere (including southern Africa). For instance, space-based sensors could be particularly useful in providing analysts and policy makers with timely environmental information. It is not hard to envision air force analysts charged with responsibilities for collecting, analyzing, and reporting that kind of information.

Existing airpower missions hold the seeds of potential environmental roles. One of the most obvious is the airpower obsession with weather—environmental factors that impact the safety and capacity of aerial vehicles. The same military expertise that tracks weather conditions for flight could facilitate similar weather-related roles: providing warning of dangerous weather conditions, tracking longer-

range environmental trends for policy makers, and assessing impacts of weather phenomena on human safety, human livelihoods, and national infrastructure. Airpower also offers prospects for employing technology such as satellites and manned or remotely piloted aircraft to conduct scientific surveillance of the environment, ranging from measuring atmospheric particulates and ambient radiation to tracking levels of desertification and deforestation.

The contemporary connection of military airpower to human need (to address complex humanitarian emergencies) also has implications for helping human populations cope with environmental threats. For instance, air forces now routinely deliver medical care to populations traumatized by deadly epidemic disease. It is not difficult to picture air force analysts following trends in human and livestock disease (typically having climatological ramifications) and advising on quick responses to disease outbreaks. The same may be true of similar environmental threats, such as crop disease and damaging insects.

The technological characteristics of airpower offer potential environmental applications, but the most important contribution may be a purely human factor—the capabilities of airmen themselves. Given the ambiguous, interrelated, and complex nature of environmental issues, the capacity of the nation-state to address them requires analysts and planners that think scientifically, holistically, and long-range. Those managing these efforts must establish priorities and chart a clear path to identified ends. Contemporary military leaders excel at these roles. Most military education now emphasizes problem analysis and effective planning, and the military profession has a well-deserved reputation for skills in these areas.

Airmen bring both a particular depth in harnessing sophisticated technology to a wide range of requirements and a profound institutional understanding of the man-machine interface. Since airmen must understand both the science of the technology they use and the natural environment (particularly the atmosphere) in which it is used, they are uniquely suited among the military services to connect the dots between the development of environmental policy, the planning for its implementation, and at least some of the implementing programs.

A Partnership Angle

Military leaders in southern Africa and elsewhere are unlikely advocates for expanded environmentally related roles, and neither they nor the policy makers they serve are inclined to endow military establishments with primary responsibility for environmental issues in the near future. Military involvement in a society's environmental equities, if any, will probably always involve a subordinate and supporting role to other government and civil society actors. However, military personnel and military technology could make important contributions in a variety of such roles, whether in data collection and analysis, provision of logistic support to other state and civil society actors, natural disaster and health threat mitigation, or strategic and operational planning. The state should also require military organizations to model environmental stewardship and assure that military planning deliberately considers environmental factors in all operations. This is as true for airpower as for any other military engagement.

The environment is important in its own right, but it also is a logical candidate for transnational partnerships and relationship building. Many environmental problems are regional and transnational and can serve effectively as relatively benign "bridging issues" (similar to coal and transportation infrastructure in post–World War II Europe), connecting partners that are significantly at odds with each other over other concerns. This is true within southern Africa and true between southern Africans and external parties.[44] Southern Africans should be most receptive to such partnerships if the ultimate mutual objective is enhanced human security. Cooperation to mitigate environmental threats and promote health, well-being, and economic development will resonate with Africans. A narrow, exclusive focus on biodiversity (e.g., protecting wildlife) probably will not.

Southern Africans may elect to task their militaries with substantially greater environmental roles, but it is unlikely they will do so without encouragement, resourcing, and perhaps some modeling from external military partners. As discussed in the unique airpower roles, that probably would include at a minimum offers of education and training specifically targeted at environmental management, environmental analysis, and use of technology for collection of scientific information.

The relationship could conceivably involve far more. If the AU implements its ambitious vision of a robust continental security in-

frastructure, including a crisis tracking center, environmental security should take its rightful place among the other components of human security—and environmental threats could be as carefully monitored as any other menace to human well-being. This may particularly be a domain in which EU countries could offer resources and expertise. It may also be an opportunity for both developed Western countries and their African partners to think about the use of military human and technical resources to address the burgeoning environmental threats of the twenty-first century.

The time is ripe for the kinds of partnerships that could make southern Africa a showcase of international cooperation on issues of environmental security, with enormous potential benefits to Africans and to humanity as a whole. If airmen and airpower were asked to play a productive part, they could make a significant contribution.

Notes

1. Ullman, "Redefining Security," 129–53; Matthews, "Redefining Security," 162–77; Homer-Dixon, "On the Threshold," 76–116; Homer-Dixon, *Environmental Scarcity and Global Security*, 5–40; Homer-Dixon, *Environment, Scarcity and Violence*; Homer-Dixon and Blitt, *Ecoviolence*; Thakur, "United Nations and Human Security," 52; Kaplan, "Coming Anarchy," 44–77; Stoet, *Human and Global Security*; Homer-Dixon, "Debating Violent Environments," 89–96; and Brauer, *War and Nature*.

2. Dalby, "Contesting an Essential Concept," 3–32; Levy, "Is the Environment a National Security Issue?" 35–62; Kakonen, *Green Security*; Deudney, "Case against Linking Environmental Degradation," 461–76; and Deudney, "Environment and Security," 23–28. For a useful overview of contemporary approaches to environment and security, see Brown, "Environment and Peace," 3. For interesting discussions of the controversies surrounding the concept of environmental security, see Foster, "Environmental Security," 373–95; and Dalby, "Security, Modernity, Ecology," 95–134.

3. As an example, note the assertion of former UN secretary general Kofi Annan that "our efforts to defeat poverty and pursue sustainable development will be in vain if environmental degradation and natural resource depletion continue unabated," quoted in Dodds and Pippard, *Human and Environmental Security*, xvi.

4. United Nations Department of Peacekeeping Operations, "Environmental Policy for UN Field Missions"; and NATO STANAG 7141.

5. A case has been made by others. Singh, "Role of the Military"; Henk, *Botswana Defence Force*; and Mosher et al., "Green Warriors."

6. It is important to note that some military establishments have assumed significant environmental responsibilities, perhaps best exemplified by the US Army Corps of Engineers, which historically has been heavily involved in domestic US river basin and wetland management, applying that expertise on a limited basis in contingency operations overseas. Note also that the US Army Environmental Policy Institute was created to assist Army leadership in policy formulation and implemen-

tation related to the environment. However, military involvements in environmental issues almost inevitably are limited and typically focused on one environmental domain while neither holistic nor comprehensive.

7. Clausewitz, *On War*, 87.

8. A useful discussion is offered by Lambeth, *Transformation of American Airpower*, 233–59. The publication is a RAND Corporation study, suggesting a close connection to the thinking of senior US Air Force thinkers and leaders.

9. For Douhet's ideas, see Brodie, *Strategy in the Missile Age*, 71–105. For Trenchard, see Meilinger, "Trenchard and Morale Bombing," 243–70. For Mitchell, see Clodfelter, "Molding Airpower Convictions," 79–114. For current implications, see Lambeth, *Transformation of American Airpower*, 260–96.

10. For example, attack on the adversary's heartland from the air tended to be the unique prerogative of airmen until the advent of strategic missiles. At that point, America's newly independent Air Force assumed this role without much controversy, while the Soviet Union opted to create an entirely new ground-based service (the Strategic Rocket Forces) to conduct intercontinental attack from space.

11. An interesting overview of the evolution of these airpower roles is provided by Mets, *Reflections of a Middling Cold Warrior*.

12. Organizing and supervising a space vehicle launch were epitomes of this expertise. Yet the normal air operations of flight planning and air traffic control, often taken for granted by common citizens enjoying the benefits, were no activities for amateurs.

13. In the late 1950s, the eminent Harvard political scientist Samuel Huntington made a compelling case for regarding military officership as a profession in the United States. According to the model he offered, a profession required (among other attributes) a unique expertise gained through intensive, specialized education. He argued that the professional expertise of the military officer was "the management of violence" on behalf of the state. Not surprisingly, Huntington's model became quite popular with military professionals, but by the early twenty-first century the conclusions he reached in the 1950s no longer did full justice to the expertise he had sought to describe. Had Huntington written his book in 2010 he might well have described the unique expertise of the military officer as simply "management," or even better, "leadership." Huntington, *Soldier and the State*.

14. For commentary on domain boundaries, see Homer-Dixon, "On the Threshold," 88; Sills et al., *Environmental Security*, xi; Speth, *Red Sky at Morning*, 30–33; and Henk, "Environment, the US Military," 100.

15. Henk, "Environment, the US Military," 99–100.

16. Blaike, Blaike, and Blaike, "Elephants, People, Parks and Development," 735–51; Martin, "Yemeni Rhino Horn Trade," 13–16; Martin, "Report on the Trade in Rhino Products," 13–20; Vigne and Martin, "Taiwan," 23–25; Western, "Undetected Trade in Rhino Horn," 26–28; Barbier et al., *Elephants, Economics and Ivory*; Balfour and Balfour, *Rhino*; Douglas-Hamilton and Douglas-Hamilton, *Battle for the Elephants*; Leader-Williams, *World Trade in Rhino Horn*; Bonner, *At the Hand of Man*; Ricciuti, "Elephant Wars," 14–35; Ellis, "Of Elephants and Men," 53–69; Sas-Rolfes, *Rhinos*; and du Bois, "Illegal Trade in Endangered Species," 28–41.

17. Regrettably, a half century of dramatic population growth, urbanization, and economic development, as well as the devastations of armed conflict, has severely threatened Africa's once rich wildlife. Biodiversity is far from the most significant

environmental issue in the minds of either most African citizens or their political leaders. For the issues of global economic disaster (including African implications), see Kaplan, "Coming Anarchy," 44–77; Homer-Dixon, "On the Threshold," 76–116; Homer-Dixon, *Environmental Scarcity and Global Security*; "Environmental Scarcities and Violent Conflict," 5–40; Homer-Dixon, *Environment, Scarcity and Violence*; Homer-Dixon, "Debating Violent Environments," 89–96; Homer-Dixon and Blitt, *Ecoviolence*; Bannon and Collier, *Natural Resources and Violent Conflict*; Berdal and Malone, *Greed and Grievance*; Kansteiner and Morrison, *Rising U.S. Stakes in Africa*, 88–103; and Lake et al., *More than Humanitarianism*, 28–76.

18. Ackerman, "Most Vulnerable Continent," 141–66. For the southern African region, see Tyson, "Climatic Change in Southern Africa," 241–58; Chenje and Johnson, *State of the Environment in Southern Africa*; and Tsheko, "Rainfall Reliability."

19. Burgess, "Environment and Human Security," 36–41.

20. Schwartz and Singh, *Environmental Conditions*; Godschalk, "Waging War over Water," 110–33; Klare, *Resource Wars*; and Swatuk, "Environmental Cooperation in Southern Africa," 143–45.

21. Feleke, "From Greed to Grievance," 185–99; and Smilie, Gberie, and Hazleton, *Heart of the Matter*.

22. A useful overview is provided in Austin and Brunch, *Environmental Consequences of War*. For another broad overview that touches on many of the issues, see Purkitt, *African Environmental and Human Security*.

23. For fascinating insights by an African scholar who has paid a high personal price for his courage in calling attention to these issues, see Turton, "Resource Allocation and Xenophobic Violence," 111–23.

24. Esty et al., *2005 Environmental Sustainability Index*; South African Department of Environmental Affairs and Tourism, "Overview of Integrated Environmental Management"; Republic of Botswana, *Vision 2016*, 6–7; *Southern African Development Community*; and Swatuk, "Power and Water," 210–47.

25. For an excellent overview of southern African cooperation on river basin development and conservation, see Turton, Ashton and Cloete, eds., *Transboundary Rivers*. For historical detail on the Permanent Okavango River Basin Commission, see Pinheiro, Gabaake, and Heyns, "Cooperation in the Okavango River Basin," 105–18. For a description of the Kavango-Zambezi initiative, see Henk, "Human and Environmental Security in Southern Africa."

26. For a more detailed discussion of the southern African environmental scene, see Henk, "Environment, the US Military," 98–117.

27. For a brief overview of the debate, see Matthews, "Redefining Security," 162–77; Baldwin, "Concept of Security," 5–26; Buzan, Waever, and de Wilde, *Security*; Smith, "Increasing Insecurity of Security Studies," 72–101; Zacarias, "Redefining Security," 31–52; and Cilliers, *Human Security in Africa*.

28. *Human Development Report*, 1993; and *Human Development Report*, 1994.

29. Deudney, "Case against Linking Environmental Degradation," 461–76; Deudney, "Environment and Security," 23–28; Kakonen, *Green Security*; Levy, "Is the Environment a National Security Issue?" 35–62; and Dalby, "Contesting an Essential Concept," 3–32.

30. Barnett, *Meaning of Environmental Security*, 157; and Dalby, *Environmental Security*.

31. Dalby, "Security, Modernity, Ecology," 95–134; Foster, "Environmental Security," 373–95; and Swatuk, "Environmental Security," 203–36.

32. Solomon and van Aardt, eds., *Caring Security in Africa*; Swatuk and Vale, "Why Democracy Is Not Enough," 361–89; Muloongo, Kibasomba, and Kariri, *Many Faces of Human Security*; and Hendricks, *From State Security to Human Security*.

33. Okoth, "New East African Community,"158–59. Two years before the UN endorsed "human security," the celebrated *Kampala Document* published by the African Leadership Forum (and supported by the Organization of African Unity and the United Nations) offered a definition of security very close to the later UN conceptualization. *Kampala Document*, 9. By the early twenty-first century, African scholars in seven nongovernmental research organizations across the continent had come together to form the African Human Security Initiative with a specific agenda of measuring the performance of African governments in promoting human security, insisting on accountability to human security principles (www.africanreview.org). By that point, the new African Union had agreed on a Common African Defence and Security Policy with a particularly nuanced and robust articulation of its human security foundations. See Cilliers, *Human Security in Africa*.

34. Ferreira and Henk, " 'Operationalizing' Human Security," 501–25; and R. Williams, "Defence in a Democracy," 205–23.

35. *South African White Paper*, 1.

36. African militaries in general have a relatively unsavory reputation in Africa, in many cases well deserved. This reputation undermines effective communication within African public sectors and compromises the willingness of officials outside the security sector to communicate with their military counterparts. For further discussion of these issues, see Howe, *Ambiguous Order*, 27–72.

37. Blaike, Blaike, and Blaike, "Elephants, People, Parks and Development," 735–51; Martin, "Yemeni Rhino Horn Trade"; Martin, "Report on the Trade in Rhino Products"; Vigne and Martin, "Taiwan"; Western, "Undetected Trade in Rhino Horn"; Barbier et al., *Elephants, Economics and Ivory*; Balfour and Balfour, *Rhino*; Douglas-Hamilton and Douglas-Hamilton, *Battle for the Elephants*; Leader-Williams, *World Trade in Rhino Horn*; Bonner, *At the Hand of Man*; Ricciuti, "Elephant Wars," 14–35; Ellis, "Of Elephants and Men," 53–69; Sas-Rolfes, *Rhinos*; and du Bois, "Illegal Trade in Endangered Species."

38. Henk, "Botswana Defence Force," 170–91; Henk, "Biodiversity and the Military"; and Henk, *Botswana Defense Force*.

39. "Strategic Partnership." For additional details, see http://wwf.panda.org/who_we_are/wwf_offices/mozambique/.

40. Thomas Schultheis (US European Command environmental officer, Stuttgart-Vaihingen, Germany), personal communication with author, 24 February 2005; Lt Col Brian P. Smith (US Air Force, chief of the Office of Defense Cooperation), interview by the author, 11 June 2005, Pretoria, South Africa; and Col Seakle Godschalk (director of the Environmental Office in the Headquarters, South African National Defence Force), communications with the author, 2004–2006, Pretoria, South Africa. See also Godschalk, "Protecting Our Environment," 24–27.

41. Cilliers, *African Standby Force*.

42. "Symposium," 1–99; and Ploch, *Africa Command*. For some African concerns, see Malan, "AFRICOM."

43. For illustrative detail, see *The Africa-EU Strategy Partnership*; and Toth, "Historical Duty or Pragmatic Interest?"

44. For the European analogy, see Haas, *Beyond the Nation-State*. Significantly, at a time when military-to-military relations between the United States and two countries in southern Africa were fraught by political disagreement, amicable military cooperation and communication continued over issues of the environment. Henk, "Environment, the US Military," 107–10.

Chapter 7

Airpower and Collateral Damage

Theory, Practice, and Challenges

Phillip S. Meilinger

One of modern history's scandalous myths is that countries at war attempt to limit casualties among civilians. Although true for some countries in some circumstances, the past century clearly demonstrates that huge numbers of civilians were killed in war. At times, this slaughter was deliberate and a matter of government policy. The genocidal policies of Hitler, Stalin, and Mao Zedong come readily to mind.

In addition, one expert on war casualties states that "technology" killed 46 million civilians during twentieth century wars. Of these, 24 million were killed by small arms, 18 million by artillery and naval gunfire, three million as a result of "demographic violence," and a further one million due to air attack. He noted that the figure of one million dead from air attack might be higher, but certainly less than two million.[1] Despite this relatively low figure for the number killed due to air attack, airpower acquired a questionable reputation that lingered for years. Often, air bombardment was associated with the city attacks of World War II—Dresden, Tokyo, and Hiroshima. Horrible as these incidents were, the numbers dying due to air attacks were a small percentage of the total number of noncombatants killed throughout the war (around 5 percent). Moreover, since World War II the numbers killed by air strikes have declined dramatically. The conflicts of the past two decades have demonstrated a new capability to fight effectively with airpower while at the same time limiting risk to those on the ground.

This chapter focuses on four areas: (1) the theory of air warfare as it applies to collateral damage; (2) the practice of airpower, which at first did not live up to the promises of the theorists, but whose effectiveness increased dramatically with the use of precision-guided munitions; (3) current perceptions of airpower; and (4) challenges ahead.

Air warfare over the past three-plus decades has significantly lowered collateral damage. The increasing use of precision weapons and

improvements in intelligence gathering tools have made it easier to discriminate between military and civilian targets and to strike only those of a military nature. Moreover, this capability greatly reduces the attacker's risk. Modern air warfare reduces casualties among both the attackers and the attacked, making it an increasingly efficient, effective, and humane tool of US foreign policy. Unfortunately, ground war remains extremely deadly, and the use of weapons such as landmines and cluster munitions continues to exact a high toll on civilians. International law, ostensibly designed to limit the suffering of civilian noncombatants in war, falls short in important areas. Deadly activities and weapons—largely policy weapons such as sieges and economic sanctions—continue to kill civilians and cause untold suffering. These horrific weapons should now become our focus.

The Theory

The Law of Armed Conflict governs whether or not a war is just as well as what actions are permissible in it. Some laws have been agreed to by international treaty, as in the Geneva conventions of 1949. In the absence of codified law, nations turn to customary usage or the just war tradition that has developed over several centuries and has, seemingly, consistently stressed the immunity of noncombatants.[2]

The inauguration of balloon flight during the nineteenth century presented potentially new dangers to civilians, so in 1899 delegates from 26 nations met at The Hague to discuss limitations on the use of airships as weapons. Attendees agreed to a prohibition on the dropping of explosives from balloons to remain in effect for five years. When the stricture lapsed in 1904, an attempt was made to reinstate it. The prohibition was not renewed since only Britain and the United States supported an extension.[3] This was the only international attempt to limit air war prior to 1914. World War I saw strategic bombing conducted by all major belligerents. These attacks were highly inaccurate due to the primitive navigation and bombing equipment of the day.[4] Even so, bombing claimed only a small number of noncombatants—1,413 dead in Britain and perhaps a few thousand more scattered throughout the rest of Europe.[5]

In contrast, nearly 15 million died in the war, and this carnage had a profound impact on survivors. After the armistice the great powers began discussing disarmament, and a commission of jurists met at

The Hague in 1922–23 to draw up guidelines for regulating air warfare. Rules were drafted, but political and military leaders rejected the restrictive and impractical language. As a result, no country ratified the treaty.[6] More talks at the Geneva Disarmament Conference in 1932 also proved fruitless.[7]

As war approached in 1938, the League of Nations passed a nonbinding resolution prohibiting the intentional bombing of civilian populations, bombing of other than military objectives, and attacks that negligently imperiled the civilian population.[8] This was a meager effort, and in 1938 British jurist J. M. Spaight wrote, "The law of bombardment is very far from being clear. . . . It is indeed in a state of baffling chaos and confusion that makes it almost impossible to say what in any situation the rule really is. . . . From one point of view one might say, indeed, that there is no law at all, for air bombardment."[9]

Military commanders attempted to modify the existing rules regarding war on land and sea but were not successful. For example, armies could bombard a defended fortress even if it contained civilians—Atlanta in 1864, Paris in 1871, Alexandria in 1882, and Port Arthur in 1904. Using these precedents, Airmen later reasoned that when Allied bombers flew over German-occupied Europe and were shot at by tens of thousands of antiaircraft guns and intercepted by hundreds of enemy fighters, all of Nazi-occupied Europe was, in effect, a "defended fortress." Of greater relevance (and confusion), international law permitted navies to shell undefended fortresses and cities to destroy the military stores and facilities—Canton in 1856, Tripoli in 1911, Beirut in 1912, and German coastal raids against England in 1914 and 1916. Sailors were given wider latitude in shelling civilians because navies could not occupy a port as an army could. Aircraft, like ships, could not occupy a city, defended or otherwise, so the permissive rules of sea warfare were more applicable to air war.[10] Debates continued, but limitation attempts failed because the airplane offered an escape from the hecatomb of the world war. No one wished to return to the trenches, so military and civilian leaders were reluctant to emasculate a weapon offering relief from that nightmare.

Political and military leaders' ambivalence in addressing the legal issues regarding air warfare was also present among those devising a doctrine for employing the new weapon that offered both great hope and great uncertainties. Theorists and practitioners believed the airplane revolutionized warfare by allowing different strategies, doctrine, and organization. Novelists such as Jules Verne and H. G. Wells

imagined aerial navies raining bombs and terror on urban populations, causing panic and pressure for peace. Some early military theorists took a similar approach. Italian general Giulio Douhet described airpower's destructive potential and paradoxical peaceful intent in terms that echoed the dire predictions of the novelists:

> Who could keep all those lost, panic-stricken people from fleeing to the open countryside to escape this terror from the air? A complete breakdown of the social structure cannot but take place in a country subjected to this kind of merciless pounding from the air. The time would soon come when, to put an end to horror and suffering, the people themselves, driven by the instinct of self-preservation, would rise up and demand an end to the war—before their army and navy had time to mobilize at all![11]

Air leaders in Britain and the United States rejected such apocalyptic visions and instead argued that airpower would shorten wars and make them less bloody. They theorized that it was possible, in principle, to shoot the gun out of the enemy's hand—to disarm by disrupting the enemy's industrial war production.

The British Royal Air Force (RAF) and the US Army Air Forces (USAAF) entered World War II with doctrines stressing precision bombing of enemy industrial centers. The RAF operations manual stated that the civilian populace was not, as such, a legitimate target. Area bombing was rejected—"all air bombardment aims to hit a particular target," and in every case "the bombing crew must be given an exact target and it must be impressed upon them that it is their task to hit and cause material damage to that target."[12] In August 1939, the month before Germany invaded Poland, the chief of the Air Staff (CAS) sent a message to the head of Bomber Command stating RAF policy in clear terms: "we should not initiate air action against other than purely military objectives in the narrowest sense of the word, i.e., Navy, Army and Air Forces and establishments, and that as far as possible we should confine it to objectives on which attack will not involve loss of civil life."[13] During the campaign in France the following year, the CAS reiterated this policy in a message to RAF commanders—the intentional bombing of civilian populations was illegal; commanders should identify objectives struck in advance; attacks must be made with "reasonable care" to avoid undue loss of civilian lives; and the provisions of international law must be observed.[14] War's realities would soon put these idealistic goals to the test.

Bombing doctrine in the United States was similar. Officers at the Air Corps Tactical School at Maxwell Field, Alabama, believed that a

country's economy was complex but fragile. Key nodes within that economy—the transportation system or specific factories that manufactured crucial industrial components—were disproportionately vital to smooth operation. If this "industrial web" were disrupted, the entire system would suffer debilitating shock waves.[15] The USAAF war doctrine manual listed several potential target systems: raw materials, rail and motor transport, power plants, factories, steel mills, oil refineries, and other similar establishments. There was no mention of targeting population centers or popular will.[16] As in Britain, Douhet's city-busting theories were rejected for a focus on the industrial infrastructure that made a nation's war economy operate.

Although humane standards were important, military efficiency also played a role. An enemy country contained thousands of potential targets—things of value or of importance—but only finite numbers of bombs, planes, and crews were available. Which targets were more vital than others? Prioritization was necessary to separate the critical from the trivial, and industrial strength seemed a logical top candidate.

In addition, airpower strategists in Britain and the United States believed that the precision bombing of military targets would not only disrupt the war economy, but would cause revulsion among the populace who would then clamor for peace. In other words, an air war was so potent that it would deter war, but if war broke out, it would be over quickly, and the number of people killed would be fairly small—especially as compared to the 15 million that died in the Great War. Airpower would humanize war.[17]

Although this notion seems peculiar today, such thinking underpins the nuclear deterrence doctrine operating since the early 1950s. Nuclear war would be so awful as to be unthinkable; therefore, it will not occur (that is, as long as one is prepared to wage it). It was no coincidence that the motto of the Strategic Air Command—the custodian of US nuclear-armed bombers and missiles throughout the Cold War—was Peace Is Our Profession. The nuclear deterrent posture, backed by thousands of nuclear weapons among a number of countries, remains in place today.

The Practice

World War II proved to be far different than predicted. Airpower did not deter armed conflict as had been hoped—although neither

did land power, sea power, or the policy of appeasement. Nor did airpower ensure a short war, although it did make the war shorter—especially in the Pacific.

Germany had bombed urban centers in the Spanish Civil War (Guernica) and in the opening stages of World War II (Warsaw and Rotterdam). In 1940 it was England's turn. In the summer of 1940 Hitler gleefully predicted to Albert Speer:

> Have you ever seen a map of London? It is so densely built that one fire alone would be enough to destroy the whole city, just as it did over two hundred years ago. Göring will start fires all over London, fires everywhere, with countless incendiary bombs of an entirely new type: thousands of fires. They will unite in one huge blaze over the whole area. Göring has the right idea: high explosives don't work, but we can do it with incendiaries; we can destroy London completely. What will their firemen be able to do once it's really burning?[18]

France's fall in June 1940 left Britain alone against Germany, and the ensuing blitz against British cities left the country reeling. Tens of thousands of civilians died under German bombs, but surrender was unthinkable. Yet, Britain could not retaliate with its army—that had been thrown off the continent at Dunkirk—or with an overstretched navy fighting for its life against German submarines and land-based aircraft. The only hope of hitting back at Germany and eventually winning the war lay with Bomber Command, but operations quickly demonstrated that prewar doctrine had been unrealistic. British bombers were too small, too slow, too vulnerable, and too few. German fighters and antiaircraft guns decimated the attackers, so Bomber Command retreated to the safety of night, something for which it was neither trained nor equipped. (The Luftwaffe also suffered problems when bombing Britain in daylight, so the blitz was carried out at night.) Worse, dismal winter weather adversely affected navigation, target acquisition, and bombing accuracy. The Butt Report of 1941 revealed that only 33 percent of bombs dropped during British night attacks fell within five miles of the intended targets; strike accuracy on moonless nights was even more inaccurate.[19] Although Britain's intent was precision bombing, in practice, it became area bombing. Aircrew survival dictated night area attacks, and there was little alternative other than not to attack at all.[20] Moral constraints bowed to military necessity, and this led air leaders down a precarious path.

By early 1942 the RAF's night offensive was targeting German cities, partly out of frustration over abysmal bombing accuracy and partly in retaliation for similar attacks on British cities by the Luftwaffe. The

November 1940 German raid on Coventry had been a turning point—Prime Minister Winston Churchill then directed the RAF to aim for city centers on missions over Germany. "Our plans are to bomb, burn, and ruthlessly destroy in every way available to us the people responsible for creating this war," Churchill said.[21] Air Marshal Arthur Harris, who took over Bomber Command in February 1942, agreed with his civilian superiors about the concept of area attacks.

Philosopher Michael Walzer has examined the moral implications of area attacks.[22] Early in the war British leaders argued that a combination of reprisal, revenge, and military necessity made city bombing both necessary and acceptable. Although rejecting the motivations of reprisal or revenge—in my view far too summarily—Walzer looked closely at the rationale of military necessity. Arguing that the triumph of the Nazi state was too terrible to contemplate, he conceded that in the dark days of 1941, before the Soviet Union and the United States entered the war, Britain's future looked bleak. Britain's only hope of hurting Germany and ultimately achieving victory was through strategic bombing. Given the inaccuracy of the night strikes, it was obvious that thousands of civilians would die if such a strategy were employed. Viewing this strategy as a "supreme emergency," Walzer concluded that although distasteful, it was morally acceptable. However, he then argued that this justification evaporated when the Allies began winning the war. With the specter of defeat no longer looming, Allied armies closing in on the Reich, and bombing accuracy greatly enhanced, city busting lost its necessity and acceptability. At least that is the position of a philosopher writing several decades after the event.

At the time, ultimate victory was not obvious, and J. M. Spaight, the British jurist who had complained of air war's lack of legal guidelines, argued in 1944 that total war meant factory workers and transportation systems were "warriors," not noncombatants. An attacker was therefore "fully entitled to put them out of action." In addition, German cities were all "battle-making towns" and thus legitimate military targets.[23] A more recent study echoes this view. "The cities of Europe and their inhabitants represented not merely another target among many. They stood at the epicenter of modern warfare. They were sites of production; they delivered essential economic and demographic resources to battle." The urban populations "were more than passive victims."[24] War in practice was considerably different from war in theory, and people of intellect and integrity could disagree even on the most basic premises.

US air doctrine also evolved during the war. The USAAF's losses during daylight strikes were severe, culminating in the Schweinfurt mission of 14 October 1943, when 60 B-17s and more than 600 crewmen were lost—over 20 percent of the attacking force. Nonetheless, American air leaders clung tenaciously to their daylight precision bombing doctrine, convinced that only a daylight precision campaign made sense. An invasion of France offered no hope of success before mid 1944, and something had to be done to take the war into Germany and relieve pressure on the Soviets, who were already talking about a separate peace—the route they had taken in 1917. Britain and the United States could not allow that to happen.

The Pacific air campaign also posed problems for the USAAF. Bombing accuracy was worse than in Europe because of the greater distances involved and the unexpected 200 mile-per-hour jet stream at 35,000 feet where the B-29s generally flew. In addition, Allied intelligence concerning Japan's economy was inadequate, due to the closed nature of Japanese society.[25] Japanese industry was less centralized than in Europe—rather than located in large factories near towns, numerous small shops were spread throughout the cities. To destroy an aircraft assembly complex, the Allies had to identify and strike several dozen "cottage factories" or destroy a large section of the city, eliminating the dozens of small factories it contained. Area bombing could be done at night with less risk to the attackers, but it crumpled the idea of not targeting the population that had been US doctrine for two decades.

The war had to be won, however, and Japan was a particularly tenacious opponent—more than 20,000 Americans died at Iwo Jima and Okinawa; the Japanese defenders suffered nearly 150,000 fatalities. Moreover, on Okinawa over 160,000 civilians died—caught in the crossfire between the opposing armies.[26] One can debate the numbers of projected casualties that would have resulted in the planned Allied invasions of the home islands, but such landings would likely have cost millions of American and Japanese lives. Air attacks, culminating in the two atomic strikes, seemed an expedient alternative and no less inhumane than starvation of the civilian populace through the slowly tightening naval blockade or the vicious and bloody land campaigns already scheduled.[27]

An important issue often overlooked regarding strategic bombing attacks concerned efforts taken by defenders to thwart the bomber crews. Germany and Japan were trying to decrease the accuracy of

Allied attacks. Indeed, the RAF's move to night operations in 1940 was a result of successful German air defenses. But at night, the Germans blacked out city lights and jammed radio navigation signals designed to help the bombers pinpoint their targets. To fool the USAAF bombers in daylight, the Germans and Japanese built fake factories, camouflaged real ones, and built smoke generators to deliberately obscure targets. They launched hundreds of interceptor planes and thousands of artillery shells to shoot down the bombers. These activities greatly distracted the bomber crews, making their aim less accurate. Consequently, they often missed the intended targets and bombed something else, resulting in civilian casualties.[28] Who was responsible for this collateral damage—the crews that dropped the bombs or the defenders that deliberately worked to make those bombs hit something else, usually innocent people? Unquestionably, many noncombatants were killed in the Allied air attacks of World War II, but relative to the total number of deaths in the war, air attack—as had been predicted by prewar air theorists—was a surprisingly discriminate weapon.

Perhaps 40 million civilians died during World War II. Of those, the US Strategic Bombing Survey states that 635,000 died in Germany and Japan due to Allied air attacks.[29] The Germans and Japanese claim the number is higher. Hans Rumpf, Germany's general inspector for fire services during the war, estimates that over 600,000 died in Germany alone. He states that a further 182,000 civilians died in other European countries as a result of air attack, including 60,000 in Britain killed by German bombs, rockets, and missiles.[30] Even so, these numbers are a fraction of the total war dead. For example, over six million people died at the hands of the Japanese; however, less than 600,000 of those died via air attack. Indeed, the Japanese murdered over 100,000 Chinese at Nanjing using small arms and swords.[31] Thus, even if using the maximum of two million dead due to air attack, 95 percent of the civilians killed in World War II were claimed by genocide or traditional means of land and sea warfare; they were shot, shelled, or starved to death or succumbed to disease.

The plight of civilians subjected to air attack—at least as practiced by the West—improved after 1945. Many noncombatants died in both the Korean and Vietnam Wars, but statistics for the Korean War are unreliable.[32] Guenter Lewy, professor emeritus of political science at the University of Massachusetts, provides plausible figures for Vietnam. According to his research, around 587,000 North and South

Vietnamese civilians were killed in the fighting. Of those, the Vietcong assassinated 39,000 South Vietnamese people, and another 65,000 civilians died in US bombing operations over North Vietnam. The bulk of the Vietnamese noncombatant dead, 483,000, were killed in South Vietnam. Based on admissions to South Vietnamese hospitals between 1967 and 1970, Lewy estimates that 66.5 percent of all injuries resulted from mines, mortars, guns, or grenades. Shelling or bombing injured the other 33.5 percent. If these percentages are used for the entire war, if we assume that the number of those injured by shelling or bombing are equal (Lewy does not break this category down), and if we assume that those killed met their fates in the same percentages as did those who were wounded—and these are big ifs—then of the 587,000 Vietnamese civilians that Lewy states were killed during the war, around 146,000 (25 percent) died from air attacks. The other 75 percent, over 440,000 people, were killed by ground or naval action.[33]

The number of civilian casualties in conflicts involving the United States has dropped dramatically since Vietnam. Greenpeace estimated that 5,000 Iraqi civilians were killed by air attack in the 1991 Gulf War, but other researchers put the figure at less than 1,000.[34] Although thousands of tons of bombs were dropped on Iraqi targets during Desert Storm, damage to the civilian population was minor, which amazed Western observers. Milton Viorst wrote, "Oddly, it seemed, there was no Second World War–style urban destruction, despite the tons of explosives that had fallen. Instead, with meticulous care—one might almost call it artistry—American aircraft had taken out telecommunications facilities, transportation links, key government offices, and, most painful of all, electrical generating plants."[35] Another visitor, Erika Munk, wrote in similar terms, "We expected to find enormous unreported destruction. . . . Instead we found a city whose homes and offices were almost entirely intact, where the electricity was coming back on and the water was running. . . . I think the reason we didn't see more destruction was that it wasn't there." Munk estimated that the maximum number of civilians killed during the six-week air campaign was 3,000.[36] This is a sizeable figure, but not in comparison to the estimated one million plus Iraqis (most of them children) who, according to the United Nations Children's Fund and the World Health Organization, died as a result of UN sanctions put in place before the war but not lifted until after the second Gulf War of 2003.[37]

The next sizable conflict involving the United States was in 1995 when force was used to halt the fighting in Bosnia. According to Serbian president Slobodan Milosevic, perhaps 25 civilians died from NATO's three-week air campaign. To stop the ethnic cleansing by the Serbs in Kosovo, NATO launched Operation Allied Force in 1999. After a 78-day air campaign, Milosevic capitulated. Despite the duration and intensity of this air campaign, Human Rights Watch estimated that fewer than 500 civilians were killed.[38]

Statistics for the wars in Afghanistan and Iraq are inconsistent, running from 500 to 1,300 dead in Afghanistan through 2002, and from 3,000 to 7,000 dead for the first six months of the Iraq campaign.[39] Human Rights Watch states that "the ground war caused the vast majority of deaths," noting that ground-launched cluster bomb munitions caused 90 percent of all civilian casualties at al-Hilla.[40]

The Iraq Body Count (IBC) provides another account of civilian casualties in Iraq. This organization has determined that through 2008, about 85,000 Iraqi civilians died as a result of the war. Of these, about 9,500 were the result of air strikes (11.3 percent of the total). Significantly, not only have the numbers of civilian deaths decreased since 2005, but the percentage of deaths attributable to air attack has also decreased to 2.6. In other words, the IBC calculates that over 97 percent of the 60,922 Iraqi civilians killed since 2005 have been the victims of ground warfare.[41]

The Israelis went through a similar trend in their military operations against Hezbollah and Hamas. Prior to 2004 the ratio of noncombatants to terrorists killed was around 1:1. At that point the Israeli Air Force changed its rules of engagement, tactics, ordnance, and intelligence procedures. The ratio improved to 1:12 in 2004, 1:28 in 2005, and 1:24 in the first half of 2007. In the second half of 2007 the ratio was a remarkable 1:100. However, the Israelis note that operations in densely populated areas in southern Lebanon and Gaza, where significant Israeli ground forces were employed and which required extensive air support, once again pushed the ratio down to around 1:1.[42]

The low numbers of deaths due to airstrikes are remarkable, especially when compared to the alternatives of sanctions or a traditional land campaign. In the ambush and subsequent firefight between US Army Soldiers and Somalis in Mogadishu in October 1993, for example, 18 Americans were killed and another 82 wounded, but between 500 and 1,000 Somali civilians were gunned down in that 24-hour period.[43]

What has caused the remarkable drop in casualties in air warfare? Largely, it is a result of precision-guided munitions (PGM). Although PGMs were used in the Vietnam War, Desert Storm was the first conflict where they played a major role. There are various types of PGMs: electro-optical, infrared, cruise missiles using ground-tracking radar, and laser-guided bombs. The laser-guided bomb was the most widely heralded "new" weapon of Desert Storm. Because of cockpit videos necessary to track laser bombs, the world saw memorable film clips of bombs flying down airshafts and through bunker doors. Nonetheless, of the more than 200,000 bombs dropped during Desert Storm, fewer than 17,000, or slightly more than 7 percent, were PGMs.[44] Only a small percentage of aircraft in the US inventory were equipped to drop such weapons.

Following Desert Storm the numbers and types of PGMs increased. PGM use increased to 35 percent over Kosovo in 1999. In Afghanistan the number jumped to 56 percent, and in Operation Iraqi Freedom (OIF) 70 percent of all bombs dropped were PGMs. All US strike aircraft can now deliver these munitions.[45] The types of PGMs available have also expanded and been improved to allow greater accuracy and flexibility. The global positioning system–aided joint direct attack munition (JDAM), which can bomb through clouds or sandstorms, made its debut over Kosovo. A laser-guided JDAM, first employed in Iraq in August 2008, allows precision strike against moving targets.[46] The standard figure given for JDAM accuracy is five meters, but those who employed the weapons in OIF say accuracy was far better than advertised.[47]

Yet, PGMs are only as good as the intelligence used to guide them. If it is now possible to put a bomb through a specific window of a particular building, then it is essential to ensure that it is the correct window. Sensors have grown in number and resolution capability over the past two decades. Space-based cameras and radar can produce resolutions of a few feet. Airborne sensors have a similar performance, and spotters on the ground have sophisticated Global Positioning System (GPS) rangefinders and laser designators to accurately locate and mark potential targets.

The impact of increased PGM use has been profound. One PGM is equivalent to dozens if not hundreds of unguided bombs in the effects that it achieves—neutralizing the target. Besides lowering the risk to the attacking aircrew (fewer aircraft/sorties are needed, thus putting fewer crewmembers at risk), PGM use dramatically reduces the amount of collateral damage.

Perceptions of Air War and the Use of Force

Yet the negative reputation that airpower had been saddled with after World War II was difficult to shake. Strategic bombing brought to mind Dresden or Hiroshima.[48] Those events were certainly horrible, but it is important to remember that far more civilians died in the siege of Leningrad (over one million) than died in all of the bombing raids on Germany and Japan combined.[49]

Why did airpower get such bad press through the end of the Cold War? Several possible explanations exist. First, the psychological trauma produced by aerial destruction can be profound: it can occur with little or no warning and in a greatly compressed period of time. Land and sea warfare effects are generally felt only over the long term. The Romans destroyed Carthage as totally as the United States did Hiroshima, but it took the Roman legions several years; it took one B-29 two minutes. It was the conquest of time, not of matter, that so shocked the world.

Second, airpower is violent and graphic, whereas a blockade is seen as nonviolent and bloodless. A RAND study refers to airpower, and especially any collateral damage caused by it, as being "mediagenic." The study notes that collateral damage incidents are four times more likely to be reported on television than in the print media.[50]

Third, some view airpower as less noble than close combat and question the "morality of distance." A Marine Corps general recently commented: "There comes a point when a country puts young folks at risk because it becomes important for them to defend a certain way of life. . . . From a Marine point of view, we can't lose our honor by failing to put our own skin on the line."[51] To those of such ilk, it is only honorable to kill if there is a good chance you will be killed in return. Such thinking is, to me, astonishingly foolish. Airpower offers a far more intelligent and humane alternative.

Dramatic advances in weapons technology permitting previously impossible accuracy have been crucial to limiting collateral damage; yet a tension remains between risk to friendly forces and accuracy seeking to limit collateral damage, and sometimes this issue is misunderstood. For example, during the 1999 Kosovo air campaign allied aircraft were directed to remain above 15,000 feet to avoid enemy ground fire. Some have argued that this policy was immoral or illegal because it induced inaccurate bombing, thus increasing collateral damage and civilian casualties.[52]

In truth, a PGM is most accurate when dropped from medium to high altitude, because that allows time for the weapon to correct itself in flight. If dropped from a lower altitude, the weapon will have less kinetic energy, and its steering fins will have less time to correct the aim; the weapon will usually hit short. From the pilot's perspective, higher altitude also allows time to identify the target at sufficient distance, designate it (if laser guided), and launch the weapon. The optimum altitude to ensure accuracy is above 15,000 feet for PGMs against a fixed target.

In contrast, the optimum drop altitude to ensure accuracy for nonguided munitions is lower than for a PGM. Even so, target acquisition by the aircrew remains a limiting factor; coming in too low at 500 knots makes it nearly impossible to acquire the target, line up, and drop the bomb accurately. As a result, the best altitude for delivering unguided weapons is around 5,000 feet. However, this places the aircraft right in the thick of fire from ground defenses. Air commanders resolved this dilemma by keeping aircraft at medium altitudes but restricting the use of non-PGMs to areas where there was little or no chance there would be civilian casualties or collateral damage.

A difficulty arises when attacking mobile targets, where the key factor becomes identification. Is the column below comprised of military or civilian vehicles; if both, which are which? At medium altitudes it is difficult to make such a distinction. On 14 April 1999, near Djakovica, Kosovo, NATO pilots attacked what intelligence sources had identified as—and which indeed appeared to be—a military column. It is now known the column also contained refugees—the Serbs illegally commingled military and civilian vehicles. As a result, several dozen civilians were killed in the airstrikes.[53] Could this accident have been avoided if the aircraft had flown at a lower altitude? Perhaps. Indeed, NATO then changed the rules, allowing aircraft in certain circumstances to fly lower to ensure target identification. There is a tradeoff in such instances: if flying lower increases the risk to aircrews, at what point does the risk of misidentifying a target override the risk of losing a plane and its crew? If incurring friendly losses meant the shattering of the alliance, was that preferable to Milosevic continuing his atrocities unchecked?

The drive to limit civilian casualties and collateral damage has generated great scrutiny among military planners. Since the air campaign in Kosovo, a special software program has been used, appropriately termed "Bugsplat," which predicts the amount of damage that

could occur for a given airstrike. Planners examine a computer-generated map of the target area that contains details regarding the size, construction materials, and function of surrounding buildings. Planners can specify the type of bomb used, warhead size, attack path, fuse setting, and other factors for a specific target. The computer program then estimates how much damage, if any, would occur to nearby buildings if a munition hit on target or if it missed. Based on the results, planners can then modify the size of the warhead, weapon type, attack path, and other variables to drive the anticipated damage results lower.[54] In some cases, the target might be avoided altogether if Bugsplat indicates that significant collateral damage would occur.

Even so, mobile targets pose special problems. Because of their nature, aircrews have less time to determine their identity. For example, if a suspected Scud missile launcher is seen headed for a tunnel, the pilot must quickly decide to either hit it—and risk that it is actually a civilian fuel truck—or hold up, allowing the vehicle to escape. If it is a Scud, it could reemerge an hour later, after the aircraft is gone, and launch, perhaps against civilian targets. Finding the means to accelerate the decision making for hitting mobile/fleeting targets to enhance military effectiveness, while still assuring the protection of civilians, will not be an easy task.

The Challenges Ahead

Jus ad bellum and *jus in bello* are different but related concepts: the first refers to reasons for going to war, and the second relates to actions during the war itself. There is a separation between these concepts because military actions in war should not be judged according to the validity of the reasons politicians chose to prosecute the war. Combatants may not exceed the law just to remove a particularly nasty opponent. This is not the case in Islamic law where a just cause allows "any means to further that cause."[55] Indeed, Osama bin Laden argued that since the United States is evil and makes war on Muslims, all Americans are likewise guilty and deserve to die—making no distinction between military and civilians.[56]

Regardless, for a variety of reasons, the separation between *jus in bello* and *jus ad bellum* is breaking down. Internationally sanctioned interventions are more prevalent, being justified as humanitarian. In

some cases, like Kosovo and Afghanistan, the West partly justified intervention to prevent genocide and other war crimes committed in civil wars (thereby setting controversial precedents). Since intervention was justified in moral terms (*jus in bello*), the application of force had to be above reproach (*jus ad bellum*). The world expected much higher standards of conduct from coalition forces in Kosovo, Afghanistan, and Iraq than were required of those they were fighting.

Part of the problem is that military planners are tied to an archaic, Clausewitzian view of war that emphasizes the destruction of the enemy's armed forces.[57] Targeting is therefore considered legal because it is applied to military forces and those things that support them.[58] For example, a factory making military equipment is a legitimate military target. A factory making women's dresses might be attacked because it is owned by the enemy dictator's brother and striking it increases pressure on the dictator to make peace. Many lawyers would argue that striking that target would be illegal since the target was not "military" per se. Such a view stems from an outdated view of warfare. Airpower makes coercive strategies increasingly possible—with less loss of life and damage to both sides. The law must catch up to airpower's increasingly effective coercive capacity.[59]

Another dilemma concerns the requirement that military commanders protect the lives of their own forces and not put them at undue risk, while simultaneously limiting noncombatant casualties and property damage. Deliberate commingling military targets with civilians has aggravated this dilemma. Examples include placing surface-to-air missile sites on or near hospitals and schools, installing a military communications center in the basement of Baghdad's al-Rashid Hotel, or simply using civilian refugees as shields, as the Serbs did in a military encampment in the woods near Korisa, and as the "Fedayeen" did south of Baghdad.[60]

Those activities were illegal, but what response is appropriate? Allowing these practices to go unpunished is rewarding bad behavior, but is there an alternative to turning the other cheek, especially when the price for doing so could be increased military casualties?

This is a contentious issue that centers on an interpretation of the rules of discrimination and proportionality. Tactically, the United States generally responds by using more PGMs, more accurate PGMs, nonlethal weapons, and restrictive rules of engagement. Examples include coalition aircraft at times using concrete-filled bombs to limit collateral damage and certain types of military targets, like bridges,

being struck only at night to minimize the possibility of injury to civilians. But what if these efforts at mitigation are insufficient?

Targeting lies at the heart of this. Some targets are considered "preplanned" while others are not. The problem of "pop-up" or fleeting targets has already been noted: what if a target presents itself and there is little time to analyze it? Then what if the enemy ground forces are attacking friendly troops? This situation, termed "troops in contact," has proved an especially thorny problem. Ordinarily, preplanned targets are thoroughly vetted in advance of an airstrike to ensure that intelligence has identified the correct target and that collateral damage will be held to a minimum—the Bugsplat process noted above. The degree of collateral damage expected determines the necessary level of authority—the air commander, the theater commander, or even the president—required to authorize the airstrike. In a troops-in-contact situation, this process is bypassed. Forces under attack on the ground often call in airstrikes to assist them. The strike location provided might be GPS coordinates or might just be a rough description of a building the enemy is firing from. Pilots then do their best to identify the enemy location and deploy their weapons to effectively strike that location. It is in this situation where most mistakes occur.

Human Rights Watch completed a study of collateral damage incidents in Afghanistan and determined that the vast majority of cases where air-delivered weapons caused civilian casualties were troops-in-contact situations. The statistics are compelling. Of 35 airstrikes involving collateral damage during 2006 and 2007, only two were preplanned strikes. Over 95 percent those airstrikes involved troops in contact—instances when the rigorous safeguards taken to avoid collateral damage were necessarily bypassed.[61] Out of 5,342 airstrikes flown by coalition air forces that dropped "major munitions" during 2006 and 2007, a mere 0.66 percent of that total caused collateral damage.[62] Yes, any mistake is deplorable, but that is still a remarkably small number.

It should thus not come as a surprise when the US death toll in Afghanistan began building toward a new high in 2009 that an Army spokesman stated bluntly, "It is what we expected. We anticipated that with forces going in, increased number of troops, increased engagement, you are going to have increased casualties."[63] The solution to lowering casualties, on both sides, seems apparent: avoid putting in ground forces.

The priceless ruins of ancient Babylon have suffered grievously at American hands. The US Army actually turned these ruins into a military base, Camp Alpha, causing "major damage" according to the United Nations Educational, Scientific, and Cultural Organization. The report of the UN's cultural agency stated that "foreign troops and contractors bulldozed hilltops and then covered them with gravel to serve as parking lots. . . . They drove heavy vehicles over the fragile paving of once-sacred highways." When fortifying this new base, the Soldiers "built barriers and embankments . . . pulverizing ancient pottery and bricks that were engraved with cuneiform characters." Among the structures suffering most was the famed Ishtar Gate; the damage will be extremely difficult if not impossible to repair.[64]

It is of more than passing interest that the former Russian Federation ambassador to Afghanistan, Zamir Kabulov, believes that the United States has repeated all the major mistakes that the Soviet Union made after invading Afghanistan nearly 30 years ago. He stated, "After we changed the regime, we should have handed over and said goodbye. But we didn't. And the Americans haven't either." Kabulov is especially critical of President Obama's plan to send in more ground troops—the same strategy that backfired on Moscow: "The more foreign troops you have roaming the country, the more the irritative allergy toward them is going to be provoked." The Taliban seem to agree with that assessment, as they stated in an interview conducted by a British reporter. The subsequent article's title says it all: "The More Troops They Send, The More Targets We Have."[65] This is a depressing prophecy.

It is alarming, but should not be surprising, that recent polls show that Afghanis blame the United States and NATO more than the Taliban for their country's travails: only 47 percent have a favorable opinion of the United States, and 25 percent actually hold that attacks on US/NATO forces are justified.[66]

Such animosity appears to be mutual. A US Army report on the mental health of Soldiers and Marines serving in Iraq contained some remarkable findings. When asked, 62 percent of Marines and 53 percent of Soldiers responded that they felt noncombatants need not be treated with dignity and respect. Worse, 60 percent of all Marines surveyed and 45 percent of all Soldiers stated that they would not report a unit member that they saw killing an innocent noncombatant. These are astounding findings, reported by the military itself, which cast an ominous cloud on ground operations.[67]

Aircraft were first used in war in 1911 when Italy fought the Ottoman Empire in Libya. When an Italian aircraft bombed Turkish infantry positions, the Turks claimed, falsely, that it had struck a hospital and killed several civilians.[68] It would seem that the propaganda value of collateral damage caused by air attack, both real and imagined, was recognized nearly as quickly as the importance of bombing itself. Given the seriousness of collateral damage incidents, it is surprising that the US military has not been more proactive in investigating incidents and then releasing findings. When asked about this, one high-ranking military public affairs officer responded that such activities "were not command essential."[69] This is shortsighted. The military's access to numerous sensors, videos, pilot reports, and reports from personnel on the ground means that no one is better able to determine the facts.[70] If this responsibility is abdicated, then someone else will fill the information vacuum with reports, probably inaccurate and fragmentary, that will be accepted as true. The Israelis have formed special teams that accompany all ground units into action with the mission to conduct "operational verification." Armed with video cameras and tape recorders, they "document the story in real time" to counteract the tales spread by terrorists.[71]

The "war on terror" highlights many of the challenges noted above. Terrorists often use illegal methods and weapons to achieve their goals; yet they are often shielded from the consequences of their illegal acts. Terrorists often operate in urban areas, deliberately commingling with civilians and occupying protected structures such as mosques and schools. They are well aware that the United States and other Western countries will be loath to strike—which they would be legally entitled to do—for fear of collateral damage and international censure. Terrorists are capable of blending into the civilian populace, making it extremely difficult to track them, much less strike them.[72] These are all formidable challenges for any type of military force to address, including airpower.

Conclusions

We must confront what one could cynically call "the myth of noncombatant immunity." The noble attempts to reduce the suffering of noncombatants during war only paste a fig leaf on the problem. In reality, civilians have always suffered the most in war. This was never

truer than in the twentieth century, when estimates of those who died in war ranged as high as 175 million, the majority of whom were noncombatants. Worse, the number of civilians dying in war as a percentage of total deaths has increased dramatically over the past century. These statistics indicate that the principle of noncombatant immunity is at best a goal we have tried unsuccessfully to achieve, but at worst a myth that hides the truth. Innocent people have always suffered the most in war, especially in the traditional forms of land and sea warfare. Throughout the past century, indiscriminate killers included unrestricted submarine warfare, landmines, blockades, sanctions, sieges, artillery barrages, starvation, and genocide—as well as some bombing operations in World War II, Korea, and Vietnam.

Centuries of evidence show that blockades, sanctions, and sieges have a percolating effect: they start killing at the bottom levels of society and slowly work their way upwards. Over one million civilians died at Leningrad during World War II, while more than 20,000 civilians died at Sarajevo in 1993; yet sieges are still legal under international law.[73] Regarding blockades, the more than 800,000 German civilians who died as a result of the Allied starvation blockade in World War I were not soldiers, politicians, or even factory workers.[74] Instead, the first to die were the old, the young, and the sick. Eventually, and only very slowly, did the effects reach the upper levels of society. Such odious results also were the norm in Iraq during the 1990s as a result of sanctions imposed by the UN to pressure Saddam Hussein, sanctions that killed over one million civilians; it was not Saddam Hussein and his generals who went to bed without their supper.

The sanctions imposed on Haiti between 1991 and 1993 in an attempt to push out the military junta in power were similarly egregious. During those two years the Haitian economy was devastated: unemployment soared to 70 percent, inflation doubled, GDP dropped 15 percent, and 1,000 children died each month as a direct result of the legally levied sanctions.[75] Small wonder that two observers wrote a critical and cynical article on the matter titled "Sanctions of Mass Destruction."[76]

Some have argued that such suffering is the fault of the country's leaders, who refuse to give in or who hoard food and medicine for themselves—and not the responsibility of those who impose these deadly sanctions. History shows, however, that countries usually react to attacks in war by accepting casualties to achieve their objectives, and they will protect whatever allows them to continue the

fight. They will sacrifice the weakest segments of society so that the strong can fight on. Nations at war for their survival (or at least the survival of their leaders) cannot afford to take a "women and children to the lifeboats first" stance. Thus, dozens of cases over several centuries demonstrate what should have been anticipated after the US and UN leaders imposed sanctions on Iraq and Haiti. It is disingenuous to claim afterwards that they did not know the gun was loaded. In truth, blockades and sanctions are deliberately genocidal policies that must be outlawed.

It is time to return to the basics. If the intent of international law is to limit civilian deaths in war, then we should look at the past century to see what methods of war and which weapons have been most destructive and move for legislation to limit them. The arithmetic is clear. The biggest killers have been blockades, sanctions, sieges, landmines, artillery, small arms, genocide, starvation, and despotic rulers who murdered their own people to consolidate power. These are the areas that the law should examine, rather than concern itself with putting further restrictions on airpower, which has proven to be, as Marc Garlasco from Human Rights Watch has stated, "probably the most discriminate weapon that exists."[77] To continue to put additional restrictions on what targets can be attacked from the air, with what weapons, and in what manner, makes little sense. It may reduce the number of civilians killed in war by a hundred people here or there, but it will ignore the hundreds of thousands who die in traditional forms of war. Focusing on airpower, as if it were the real problem, is akin to rearranging the deck chairs on the *Titanic*.

It must be our goal and the main focus of the law to employ weapons and strategies that limit collateral damage and civilian casualties. Clearly, the events of the past two decades have revealed the stark contrast between the discriminate and precise nature of air warfare—especially as conducted by the United States and its allies—and that of land warfare. But even more to the point, the appalling slaughter of one million Iraqi civilians as the consequence of UN-imposed sanctions must become the primary focus of the legal community. There is a gaping hole here that must be filled; yet it is barely even acknowledged. War is indeed hell. People suffer in war, innocent people, and this is precisely why countries try to avoid war and why they decide to end it. The challenge is to fight only when it is necessary and then to exercise forbearance in war, while also achieving the stated political objectives. Airpower now offers the greatest possibility of achieving

these diverse goals, which means international law must turn its focus to the far more prevalent and deadly threats.

Notes

1. Elliot, *Twentieth Century Book of the Dead*, 154, 161. According to Elliot, "demographic violence" is when government forces fire on protestors.

2. For historical background on the just war tradition, see James Turner, *Just War Tradition*. For an update, see his *Morality and Contemporary Warfare*. It is an ironic paradox that at the same time international efforts to put legal restrictions on war have increased over the past century, so have the number of noncombatants killed.

3. Royse, *Aerial Bombardment*; and Watt, "Restraints on War," 57–65.

4. Kennett, *First Air War*; and Fredette, *Sky on Fire*.

5. Royse, *Aerial Bombardment*, 181. Of note, 10 times as many British noncombatants were killed on ships attacked by German submarines or that struck German mines than were killed by German air raids (13,333 and 1,620 dead, respectively). Micheal Clodfelter, *Warfare and Armed Conflicts*, 427.

6. Wyman, "First Rules of Air Warfare"; Brune, "Effort to Regulate," 183–85; and P. Williams, "Legitimate Targets in Aerial Bombardment," 574–76.

7. For an overview of the attempt to put limits on war, and especially airpower, see Meilinger, "Clipping the Bomber's Wings," 306–30.

8. Leroy, "Limitations on Air Warfare," 27. For the text of the resolution, see Schindler and Toman, *Laws of Armed Conflict*, 221–22.

9. Spaight, "Chaotic State of the International Law," 25. Spaight had been a British delegate to The Hague Commission of Jurists in 1922–23.

10. For a discussion of the attempt to shoehorn air operations into laws designed for war on land and at sea, see Parks, "Air War"; and Spaight, *Air Power and the Cities*. Of interest, more than three decades after World War II, the US Air Force published a manual on the legal aspects of air warfare in which it defined cities located behind enemy lines as "defended fortresses." US Air Force Pamphlet 110–31, *International Law*.

11. Douhet, *Command of the Air,* 58. The book was written in 1921 and revised in 1927, but the first English translation did not appear until 1942.

12. Royal Air Force, *War Manual*, I/10. This reasoning was the same as that espoused by Prime Minister Neville Chamberlain before the House of Commons in June 1938. Meyer, "Tearing Down the Façade," 152.

13. Air Chief Marshall Newell to Air Chief Marshall Ludlow-Hewitt, message, 23 August 1939, The National Archives, Kew, UK (TNA): AIR 75/8.

14. Chief of the Air Service to all Air Officers Commanding, message, 4 June 1940, TNA: AIR 8/283.

15. For the best overviews of US air doctrine prior to World War II, see McFarland, *America's Pursuit of Precision Bombing*; and Biddle, *Rhetoric and Reality in Air Warfare*. For typical examples of Air Corps Tactical School (ACTS) lectures on the subject of strategic bombing of an industrial web, see "ACTS: Bombardment Text" and "ACTS: Bombardment Aviation."

16. US Army Field Manual 1-5, *Employment of Aviation*, 36.

17. Ader, *Military Aviation*, 27.

18. Sebald, *On the Natural History of Destruction*, 103–4. At the time, Albert Speer was Hitler's chief architect; later he would become the minister of armaments production. Reichsmarschall Herman Göring commanded the Luftwaffe.

19. Webster and Frankland, *Strategic Air Offensive against Germany*, vol. 4, 205–13. Due to improvements in radar/radio navigation and bombing aids, accuracy improved throughout the war. By the end of 1944, more than 80 percent of RAF bombs were falling within three miles of the aim point. US Strategic Bombing Survey (USSBS), "Description of RAF Bombing."

20. Britain attempted a starvation blockade of Germany, like it had imposed in World War I, but Hitler had overrun so much of Europe that the blockade had only a minor effect. Nevertheless, there were local shortages and hardship, especially in Greece, where starvation threatened the populace with "decimation" in 1942. Medlicott, *European Blockade*, vol. 2, 272. See also Beaumont, "Starving for Democracy," 57–82.

21. Webster and Frankland, *Strategic Air Offensive against Germany*, vol. 2, 215; and Batchelder, *Irreversible Decision*, 175.

22. Walzer, *Just and Unjust Wars*, 253–63. A similar argument is made in Cohen, *Arms and Judgment*, 129–44.

23. Spaight, *Bombing Vindicated*, 76–77, 112.

24. Funck and Chickering, *Endangered Cities*, 5.

25. Craven and Cate, *Army Air Forces in World War II*, vol. 5, 3–175, 507–756.

26. Feifer, *Tennozan*, 533.

27. For projected Allied casualty figures, see Giangreco, "Casualty Projections," 521–82. For the Japanese decision to surrender, see Asada, "Shock of the Atomic Bomb," 477–512. The invasion of Kyushu, set for 1 November 1945, envisioned 767,000 Allied troops, and that of Honshu, planned for February 1946, projected the use of more than one million Allied troops. There were at least three million armed Japanese defenders throughout the home islands. On average, the United States suffered 35 percent casualties when attacking Japanese positions throughout the war (about 30 percent of which were deaths); Japanese losses were far higher: 95 percent dead (very few Japanese surrendered or were captured). Thus, if these averages would have held true for the projected invasions of the home islands, the Allies could have expected around 180,000 dead, while the Japanese would have lost nearly three million military dead. Civilian deaths (based on the Okinawa campaign) would have been horrendous.

28. Note that the same was true for the Germans. British air defenses forced them to attack at night, and British defenses also included blackouts and electronic warfare to baffle German bombers. See R. V. Jones, *Wizard War*.

29. *United States Strategic Bombing Surveys*, 36, 92.

30. Rumpf, *Bombing of Germany*, 164–65. He gives no sources for his estimates. M. Clodfelter, *Warfare and Armed Conflicts*, 490, 526–27, 543–44, gives lower estimates.

31. Rummell, *Death by Government*, 4, 148, 152; and Katsuichi, *Nanjing Massacre*, xiii.

32. M. Clodfelter, *Warfare and Armed Conflicts*, 234. He states that 129,000 South Korean civilians were murdered by the communists, with another 115,000 killed in the fighting (the cause of death is not given). In addition, up to one million civilians died in the North, most due to famine and disease. Close to one million combatants also died during the war.

33. Lewy, *America in Vietnam*, 442–51. The math: 587,000 – 39,000 (Vietcong murders) = 548,000; 548,000 – 65,000 (bombing of North) = 483,000; 483,000 x 16.75 percent

(percentage of civilians presumed killed by air in South) = 80,902; 80,902 + 65,000 = 145,902 total dead to air attacks; 145,902 ÷ 587,000 = 24.8 percent.

34. Arkin, Durrant, and Cherni, *On Impact*, 46; and Heidenrich, "Gulf War," 108–25. Arkin, Durrant, and Cherni also note on page 15 that at least 50,000 Kurds and Shiites were killed by Saddam in the abortive uprisings of summer 1991.

35. Viorst, "Report from Baghdad," 58.

36. Munk, "New Face of Techno-War," 583.

37. United Nations Children's Fund, "Child and Maternal Mortality," 10; and Garfield, "Morbidity and Mortality."

38. Owen, *Deliberate Force*, 161. For Kosovo, see Human Rights Watch, *Civilian Deaths*, 5.

39. The Project on Defense Alternatives (PDA) estimates that between 1,000 and 1,300 civilians died in Afghanistan as a result of air attack. Conetta *Strange Victory*, 6. Perhaps 3,750 civilians died in Iraq. Conetta, "Disappearing the Dead," 1, 3. The Iraq Body Count (IBC) organization gives the higher figures. IBC, "Dossier of Civilian Casualties."

40. Human Rights Watch, *Off Target*, 13.

41. The IBC website contains a number of studies dealing with Iraqi civilian deaths. For the early period see IBC, "Dossier of Civilian Casualties." The IBC continues to update its figures at www.iraqbodycount.org. The highest casualty figures are given by a Johns Hopkins University study; its estimates are more than six times greater than other agencies. Even so, the percentage of deaths it cites as caused by air attacks through 2006 (13 percent) is similar to the percentage provided by the IBC. Burnham et al., "Human Cost of the War." This study has been severely criticised due to its methodology; see "Author of Shocking Iraq Study," 1. A recent study gives a slightly smaller number for total deaths, but the percentage of civilians killed by air attack remains the same. Hicks et al., "Weapons That Kill Civilians."

42. These statistics were provided to the author in July 2009 by Lt Col Roni Amir of the Israeli Air Force.

43. Bowden, *Black Hawk Down*, 333.

44. Cordesman, " 'Instant Lessons' of the Iraq War," 88.

45. Ibid.

46. Schanz, "Focused Lethality."

47. Wall and Barrie, "US, UK Eye Upgrades." The article gives an average accuracy figure of 2.4 meters for the JDAM.

48. Carlino, "Moral Limits," 15–29; and Crane, "Sky High."

49. Glantz, *Battle of Leningrad*, 543, 547. The primary causes of civilian deaths in Leningrad were starvation, artillery fire, and small arms fire.

50. Larson and Savych, *Misfortunes of War*, 2–3.

51. "Panel Touts Robots' Future," *Virginian-Pilot*.

52. Former president Jimmy Carter termed Operation Allied Force "excessively brutal." See *Washington Post*, 27 May 1999, A-33; and novelist Norman Mailer said it was "obscene." See *Washington Times*, 24 May 1999, A-27.

53. Human Rights Watch, *NATO Deaths*, 9–10.

54. Graham, "Military Turns to Software." The name derives from the color-coded products that depict splotches where different degrees of damage are likely to occur upon weapon impact.

55. Rauert, "Influence of Just War," 75.

56. Laden "Letter to the American People."

57. Clausewitz, *On War*, 258. The book contains several statements such as, "permit us to make the following unequivocal statement: 1. Destruction of the enemy forces is the overriding principle of war, and, so far as positive action is concerned, the principal way to achieve our object."

58. For an interesting discussion of targeting civilian leaders, see Lotrionte, "When to Target Leaders."

59. For an excellent discussion, see Meyer, "Tearing Down the Façade," 152.

60. Human Rights Watch, *NATO Deaths*, 19–22. For a detailed account, see Central Intelligence Agency, *Putting Noncombatants at Risk*.

61. Human Rights Watch, " 'Troops in Contact,' " 2–5.

62. Air Forces Central Combined Air and Space Operations Center, "2004–2008 Combined Forces Air Component Commander." These statistics include only those on which "major munitions" were dropped. This term does not include sorties that expended 20 or 30 millimeter cannon fire or rockets. Obviously, if those sorties were included (the number is unknown), then the percentage that caused collateral damage would be even lower.

63. King and Barnes, "Deadly Afghan Day Signals," 12. In mid 2009, new procedures were instituted that restricted ground troops from calling in air strikes, and this lowered collateral damage. See "Air Strike Rules," 11.

64. Bakri, "Babylon's Ancient Wonder."

65. Abdul-Ahad, "More Troops They Send."

66. Cohen and Agiesta, "Poll of Afghans Shows Drop." The British Parliament's report on Afghanistan also refers to the "cultural insensitivity" of US troops and the "scandal-ridden matter of treatment of detainees." See United Kingdom Parliament, "Eighth Report," sect. 2, para. 28 and 30.

67. Office of the Surgeon, "Mental Health Advisory Team," 35–37. Curiously, these questions were not asked in the Army's follow-up report released in March 2008. It is because of these disturbing facts that the Army has formed a Center of Excellence for the Professional Military Ethic at West Point in a belated attempt to heighten moral, ethical, and legal standards among Soldiers. It does not appear the Marine Corps has taken a similar step.

68. Boyne, *Influence of Air Power*, 8.

69. For example, see "5,558 Iraqis Killed since Occupation," *Dallas Morning News*. In 2004 a two-star admiral in charge of US Central Command public affairs used these words in speaking to me.

70. It took over four months for US Central Command (CENTCOM) to release its findings regarding the 8 April 2003 firing of a US tank round into the Palestine Hotel, killing two journalists and wounding several others. It is difficult to understand why this report could not have been completed and released within days of the shooting. Human Rights Watch has called for the military to establish an agency to investigate quickly all incidents of alleged collateral damage and then report their findings to the world. See Human Right Watch, "Troops in Contact," 8.

71. Dunlap, "Lawfare," 36–37.

72. The magnitude of this problem is increasing as women and children are now being used in suicide attacks. "Insurgents Using Teens," *Chicago Tribune*; and S. Carter, "Taliban Buying Children."

73. M. Waxman, "Siegecraft and Surrender," 402.

74. Bell, *History of the Blockade*, 672. Bell states that 762,736 German civilians starved to death during the war due to the Allied blockade, and another 66,466 died of tuberculosis and other lung diseases caused by the lack of fat, oils, and milk in their diets (the absence of which were also due to the blockade).

75. D. Waxman, "Sanctions," 40.

76. Mueller and Mueller, "Sanctions of Mass Destruction."

77. Dunlap, "Lawfare," 36.

Chapter 8

Environmental Degradation and Conflict in Africa

How AFRICOM Can Help Africans

John T. Ackerman

Environmental degradation is a global challenge. Several studies of the environmental impact of human activities on the planet have identified significant negative, unsustainable, and potentially irreversible trends.[1] Water, land, and air quality in some regions has become significantly degraded, and biodiversity, renewable natural resources, and ecosystem services have been deleteriously impacted around the globe. Environmental degradation can also generate serious regional security repercussions. These security implications are most obvious on the African continent, because a majority of Africans rely very heavily on subsistence farming/fishing, ground water/precipitation, and hand processing of natural resources, and consequently are directly dependent on the natural environment for basic subsistence. The increasing dependency of a rapidly growing African population on a shrinking natural resource base has and continues to create conflict. For example, "Environmental degradation can exacerbate conflict, which causes further environmental degradation, creating a vicious cycle of environmental decline, tense competition for diminishing resources, increased hostility, intercommunal fighting, and ultimately social and political breakdown."[2]

The linkages between environmental degradation and conflict are complex and underexamined, but they should be a concern for the leaders of US Africa Command (AFRICOM). AFRICOM's primary objective is "building African security capacity so our partners can prevent future conflict and address current or emerging security and stability challenges."[3] This mission will not be obtainable or sustainable unless AFRICOM personnel understand the criticality of natural resources and take a proactive approach to reduce environmental degradation, protect and sustain natural resources, and mitigate conflict over the environment. AFRICOM, in conjunction with other US

government agencies, can bring the knowledge, expertise, and resources needed to make Africa more stable and secure by making its environment more stable and secure.

Environmental Degradation and Conflict in Africa

Environmental degradation in Africa can be explored from several perspectives. To analyze this issue comprehensively, we can dissect it into five major subheadings: land, water, climate, plants and animals, and people.[4] Each topic can be viewed as to how degradation is or is not affecting it. Some background information about Africa and environmental degradation there should also help illuminate key challenges.

At present, the rich and diverse African biodiversity is threatened by a confluence of climate change, habitat destruction, poaching, and surging populations.[5] Rapidly increasing populations are modifying land-use patterns, demanding more clean water, and stressing animal and plant communities throughout Africa. All these environmental changes are occurring across an ecologically diverse continent populated by equally diverse people.

Africa is the second largest and second most populous continent behind Asia. It contains a vast variety of natural resources including approximately 30 percent of all of the earth's minerals.[6] Forty percent of the world's gold, 60 percent of the cobalt, and 90 percent of the planet's platinum are found in Africa.[7] The continent is also home of the Nile, the longest river in the world; the Sahara, the biggest desert in the world; the Namib, the oldest desert; and the shortest continental coastline.

Land

Environmental degradation of land results from processes that reduce the capacity of the land to produce sustenance or resources. These can include desertification, deforestation, soil erosion, salinization, and other natural and anthropogenic processes. Comprehensive review of public information and peer-reviewed reports indicates that Africans in 32 countries consider land degradation a preeminent environmental challenge.[8]

The geography of Africa is quite interesting and diverse. African land is mostly arid (60 percent), and most of the land (65 percent) is degraded either naturally or anthropogenically. Thirty-one percent of

African pasture lands and 19 percent of forests are degraded in some form or another—while only 10 percent of all African land is considered prime farmland and another 25 percent is rated as having low to moderate potential for sustainable agriculture. While 20 percent of Africa's overall land area is forested, an average of 40,000 square kilometers (0.6 per cent) are deforested every year. The areas that are vulnerable to desertification and home to over 20 million Africans are expanding, increasing pressure on land natural resources. In 1950, the hypothetical individual share of the land could be calculated at 13.5 hectares/person; in 2005 it had dropped to 3.2 hectares/person and is predicted to be 1.5 hectares/person in 2050.[9] Land degradation is obviously increasing, although restoration efforts have been successful in a few areas with reforestation, soil enhancement, and erosion control programs.

Water

Water is another environmental resource that is often the focus of intense competition and conflict. "Changes in water quality and quantity—in freshwater environments (lakes and rivers) and in coastal and marine environments—rank among the most challenging environmental and social issues that Africa currently faces." Water pollution and water scarcity were specifically identified in several African states as critical environmental issues.[10] Land and water conditions are affected by ongoing changes in Africa's varied and unique climate zones. The recent and rapid increases in global average temperatures are driving a variety of transformations to Africa's climate, increasing environmental degradation. Rainfall patterns and growing seasons are changing, sea levels are rising, water stress is spreading, ecosystems are being transformed, and disease vector ranges are being altered.[11]

Africa is the second driest continent after Australia; therefore, 75 percent of Africans rely upon groundwater as their major source of drinking water. Water resources are unevenly distributed in Africa with some areas having abundance while other areas suffer from scarcity. Scientists estimate that more than 300 million of Africa's almost one billion people face water scarcity and stress challenges. Africa contains approximately 3,930 cubic kilometers of renewable water resources, representing less than nine percent of the global total, while per capita consumption of water is 31 cubic meters per year for its

almost a billion people.[12] Scientists estimate that an additional 250 million Africans will face water scarcity challenges as a result of global climate change.[13] Pressures on water resources are clearly increasing. For example, Lake Chad in northern Africa has been shrinking as a result of climate change and increasing agricultural demand.[14] In other areas, cooperation and water management processes are preserving vital watersheds. The Okavango Delta presents a spectacular case of how coordinated wetland management is preserving the world's largest inland delta.[15]

Climate

Not only is Africa the second driest continent, it is also the world's hottest. It has six climatic zones: tropical wet, tropical summer rainfall, semiarid, arid, highland, and Mediterranean. Some of these zones contain spectacular biodiversity. The Fynbos region in the Cape Province of South Africa, for example, has the highest rate of general endemism in the world. The seasonal and diurnal variation in some of Africa's climatic zones is amazing. For instance, the temperature variation seasonally in the Democratic Republic of the Congo is only 1.4°C, while temperature swings between the coldest and hottest month in the Sahara Desert can exceed 20°C. One interesting fact is that Africa is the lightning center of the planet and has more lightning flashes per square kilometer that anywhere else.[16] Africa's variation in climate also enables enormous continental biodiversity.

Plants and Animals

Africa's plants and animals are varied, plentiful in some regions and endangered in others. The world's largest bird (ostrich) and largest land mammal (African elephant) both reside in Africa. Large populations of mammals, such as wildebeests and zebras, migrate across African savannahs by the thousands. Additionally, 98 percent of Madagascar's land mammals, 92 percent of its reptiles, 68 percent of its plants, and 41 percent of its bird species are found only on this island. The Congo basin contains the second largest area of intact rain forests after the Amazon basin. The rich African biodiversity includes eight of the world's 34 biodiversity hotspots. Nevertheless, African biodiversity is declining steadily, as more than 120 plant species have become extinct and another 1,771 are threatened with extinction.[17]

The critical factor in reversing the decline of biodiversity and environmental degradation in general involves human activities.

People

Africa is home to 965 million people and is considered by many to be the birthplace of mankind. It is the second most populous continent, with a population density of 32.6 people per square kilometer. The population is unevenly distributed, with some areas—for example in the Sahara—with very few permanent towns or villages, while areas such as the Nile River Delta are extremely densely populated. In 2005, over 60 percent of Africans still lived in rural areas, but the number moving to urban areas is rapidly increasing. While approximately 57 percent of all Africans are still employed in agricultural activities, urban growth in Africa is the highest in the world. Africa's overall population growth rate of 2.32 percent annually (almost double the 1.24 percent global rate) is the highest in the world, and 20 of the 30 fastest growing countries are African states.[18] This places enormous pressure on agriculture to feed the growing populations, which in turn places even more pressure on natural habitats and environmental resources.

Wars on the African continent have also had serious and lasting effects on the natural environment and on Africa's human populations. For example,

> The social dislocation caused by war is a further cause of environmental damage. Floods of refugees in particular can threaten natural resources such as water and forests. The Rwandan conflict and the events that it triggered in the Democratic Republic of the Congo (DRC, ex-Zaire) became a major cause of deforestation in central Africa. One casualty was Africa's first national park, the Virunga National Park, on the border between the DRC and Rwanda. The World Conservation Union [International Union for Conservation of Nature] (IUCN) reported that in six months, the Rwandan refugees and Hutu soldiers from camps around the town of Goma in the DRC had deforested some 300 square kilometers of Virunga National Park in their search for food and wood. At the height of the crisis, the IUCN estimated that some 850,000 refugees were living within or close to the park and took between 410 and 770 tons of forest products out of the park daily. In the confusion, Zairian soldiers were raiding the park for timber to sell to refugees and relief organizations. Similar destruction became a feature of civil and cross-border conflicts across much of Africa in the 1990s.[19]

Roving bands of guerrilla and other unconventional forces can do great harm to natural resources and entire ecosystems when they live off the land or plunder resources to buy arms and food. The recent

conflict in Rwanda resulted in the mass slaughter of the mountain gorillas in the Virunga National Park. The widespread loss of centralized or sovereign control over natural resources throughout Africa as a byproduct of civil war or violent conflict continues to lead to extensive environmental degradation.

Reactions of state and regional governmental organizations to growing environmental degradation vary throughout Africa. Some countries have been unable to find the means to reduce conflict while others have adapted and mitigated environmental degradation, thereby reducing conflict and insecurity. Two contrasting cases where state reactions to environmental degradation challenges were dissimilar and consequent stability and security outcomes were also vastly different, the Sudan and Niger, are discussed below. Examination of these two cases can yield potential lessons for AFRICOM leaders that may help efforts to increase their capacity to enhance Africa's stability and security in the future.

Case Studies: Degradation and Conflict

The relationship between conflict and environmental degradation in Africa is often complex and multicausal. Case studies of environmental degradation in the Sudan and Niger—analyzed within the five domains of land, water, climate, plants and animals, and people—reveal some of the specific pressures and challenges, which can then become focal points for AFRICOM efforts to help Africans help themselves.

Sudan

A case study of the Sudan by the United Nations Environment Program (UNEP) identified environmental degradation as a major factor contributing to violent conflict. Years of ethnic conflict; population displacement; weak, corrupt, and biased governance; uncontrolled exploitation of natural resources; and little or no investment in sustainable development significantly contributed to instability and insecurity as well.[20] In the Darfur region of Sudan, years of drought exacerbated by desertification and population growth led nomadic pastoralists to move herds of cattle and goats into land occupied primarily by subsistence farmers. A vicious conflict ensued, with as many as 450,000 people killed by fighting and disease and approximately 2.4 million people displaced from their homes.[21]

The UNEP's analysis indicates a very strong link between land degradation, desertification, and conflict in Darfur. Northern Darfur—where exponential population growth and related environmental stress have created the conditions for conflicts to be triggered and sustained by political, tribal, or ethnic differences—can be considered a tragic example of the social breakdown that can result from ecological collapse. Long-term peace in the region will not be possible unless these underlying and closely linked environmental and livelihood issues are resolved.[22]

Environmental issues have been and continue to be contributing causes of conflict. Competition over oil and gas reserves, Nile waters and timber, as well as land use issues related to agricultural land are important causative factors in the instigation and perpetuation of conflict in Sudan. Confrontations over rangeland and rain-fed agricultural land in the drier parts of the country are a particularly striking manifestation of the connection between natural resource scarcity and violent conflict. In all cases, however, environmental

factors are intertwined with a range of other social, political, and economic issues.[23]

Land degradation, competition for scarce water supplies, changing precipitation patterns contributing to drought and desertification, widespread destruction of forested ecosystems by refugees, and large, uncontrolled population movements all contributed to instability and insecurity in this troubled region. While Sudan presents a clear example of environmental degradation intertwined in a circular relationship with violent conflict, Niger offers an opposing case study where environmental degradation initiated innovative, proactive processes that improved ecological conditions and contributed to enhanced security and stability.

Niger

During the 1970s, Niger was in the grip of an enormous drought. The Sahel region, already characterized as an arid region of variable rainfall and low-fertility soils, is home to most of Niger's people. Threats of desertification and land degradation forced the rural farmers in this enormous dry land to change their relationships with the land and with each other. Systematic ecosystem management processes designed to restore environmental conditions and agricultural productivity were adopted throughout the region. Specifically, farmers adopted simple, low-cost environmental management techniques that enabled natural regeneration of trees and shrubs. The techniques, collectively known as farmer-managed natural regeneration (FMNR), involved uncomplicated forest, soil, and water conservation programs.[24] The results have been spectacular. US Geological Service (USGS) scientists compared aerial photographs from the 1970s to photos taken in 2005 and were astonished by the widespread environmental transformations. Over five million hectares of land in Niger now show regeneration of vegetation.

Today, agricultural parklands replace the windswept fields of the 1970s. On-farm tree densities have increased ten- to twentyfold. Village sizes have also dramatically increased in the area, generally by a factor of three—a direct indicator of rural population growth. The changes were equally surprising on the rocky slopes and plateaus east of Tahoua, almost totally denuded in 1975. A patchwork of terraces and rock bunds constructed to stem soil erosion, trap precious rainfall, and create micro catchments for planting and nurturing trees

now extends throughout the region. Trees now occur on most plateaus, and farmers have taken advantage of the new environment to plant fields of millet and sorghum between the ribbons of trees. Windbreaks of mature trees crisscross the wide Maggia Valley and its tributaries. Many of the valleys now have dikes and low dams to create ephemeral lakes. As their waters recede in the dry season, farmers plant vegetables. A vibrant dry season market gardening economy has developed. Large tracts of valley lands are now green with produce, including onions, lettuce, tomatoes, sweet potatoes, and peppers. Many interviews with villagers at all sites confirm that there has been notable environmental improvement since the 1970s. Farmers point to the increase in woody cover, the diversity of high-value trees, and the rehabilitation of the productive capacity of tens of thousands of hectares of degraded land. The projects of the 1970s and 1980s demonstrated what could be done, giving villagers options. Since then, there has been a huge spread effect, particularly in farmer-managed natural regeneration—a significant change in the way farmers maintain their fields, allowing high-value trees to grow in their fields.[25]

Changes in ecosystem management have improved the environment across all five domains in Niger. Degradation of the land is been markedly reduced, erosion decreased, fertility enhanced, and agricultural productivity dramatically improved. Even though rainfall levels are still below historic levels before the 1970s drought, farmers have learned to capture scarce rainfall, and groundwater levels have risen in some areas. Niger has been experiencing many of the climatic changes that affect the Sudan, and yet its farmers are adapting to the changing conditions without the violence and instability seen in the Sudan. In addition, the biodiversity of the area has been greatly increased by expansive terracing and planting of trees. Scientists assert, "Farmers have reacted proactively to the large-scale land degradation that occurred during the droughts of the 1970s and 1980s, and have begun protecting their resources on a massive scale, encouraging natural regeneration, rebuilding their soils, and harvesting scarce rainfall." Even though the population of Niger has doubled since the 1970s, Niger's rural farmers have decentralized control over natural resources, increased land/food security, and empowered local people to care for their own resources.[26] Importantly, for other "Sahelian countries facing the triple challenges of population growth, desertification, and climate change, FMNR also offers a cheap and effective model to improve farm productivity and reclaim precious land from the dunes." Conflict still occurs over property rights and access to natural resources but large-scale violence and population displacements have not been a consequence of environmental degradation and change in Niger.[27]

The dramatic differences in how people in the Sudan and Niger reacted to environmental degradation and change illustrate the need for more study into the intricate relationships between environmental degradation and conflict. The lessons learned from these two disparate outcomes also offer opportunities for AFRICOM to learn from the processes and measures applied successfully and unsuccessfully and provide focused, proactive, constructive assistance to Africans as they learn to help themselves.

Overall Recommendations

AFRICOM has the potential to contribute significantly to stability and security in Africa. By building positive relationships with African

militaries and governments, AFRICOM personnel can build Africa's capacity to adapt to and mitigate environmental change. The following recommendations are offered for AFRICOM consideration.

1. **"Help Africans operationalize their knowledge of the relationships between the environment and security—Prepare and provide training/education material on environmental security."**[28]

Exemplified by the Sudan and Niger, environmental degradation is a threat to the environmental and national security of all African states. Degradation contributes to conflict, both violent and nonviolent, across Africa. AFRICOM can employ focused environmental security curricula to help increase the awareness of individual African states and select regions to the impending challenges to their stability and security created by continued environmental degradation.

AFRICOM should work toward establishing centers of excellence that address environmental security issues. These centers could prepare environmental security training and education curricula that investigate and provide responses to local, state, and regional linkages between environmental degradation and conflict.[29]

2. **"Share environmental information/data with African states in an easily accessible manner."**[30]

African states on the whole lack access to up-to-date, advanced, and comprehensive environmental information/data. When simple, scientifically based ecosystem management processes were implemented in Niger, stability and security increased. In the Sudan, where these processes and other good governance procedures were not applied, violence and instability erupted. Without accurate and current environmental information, African states cannot make informed security decisions for the future.

AFRICOM can either provide environmental information directly to selected states or assist in the creation of environmental information databases that are transparent, easily used, and accessible to as many citizens as possible. Additional environmental information can be obtained from "after action reports" from various agencies (Department of State, USAID, World Food Program, Peace Corp, etc.) to see how they support environmental activities in Africa. Reports from the USGS have been crucial in determining what went right in Niger. Information also can be acquired from contractors and from

allies such as Italy, the United Kingdom, and France who provide environmental support in Africa.[31]

3. **"Assist African militaries to facilitate, inculcate, and disseminate an African environmental ethic—focused on mission, community, and environment—understanding ecosystem services and causal relationships."[32]**

US military forces are currently struggling to develop a comprehensive environmental ethic that extends to contingency and peacekeeping operations.[33] Progress includes the US Army's environmental sustainability ethic of "mission, community, and environment," which could provide a template upon which African states and AFRICOM can begin a dialogue with military professionals on the relationships between ecosystem services, environmental security, and conflict.[34] An African environmental ethic can prevent degradation and augment security. Perhaps African Contingency Operations Training and Assistance funds could be used to initiate the process of instilling an environmental ethic in interested African militaries.[35]

4. **"Expand the use of state partnership programs (SPP) and US National Guard personnel to train African militaries for natural disaster and environmental mitigation responses."[36]**

Many SPP personnel and US National Guard units are experts at responding to natural and environmental disasters. African militaries can benefit from this expertise through training on how to respond to environmental disasters like floods, droughts, and disease pandemics. SPP personnel and US Guardsmen also understand the importance of environmental mitigation procedures and could share their extensive knowledge with African military professionals with AFRICOM assistance.

5. **"Help African militaries purchase and utilize available environmental monitoring and early warning devices."[37]**

Many African states lack a proactive solution to the natural and environmental disasters that often weaken and disable state security. AFRICOM professionals can assist acquisition of early warning and natural disaster monitoring devices by selected African militaries. If African militaries, and in particular air forces, can increase their monitoring and response capabilities to natural and environmental disasters, they will enhance their security competencies, public image, and professionalism.

One concept to consider is "fractional ownership," where African states or regional organizations can lease expensive environmental monitoring equipment. Fractional ownership or leasing "could be a concept explored by US Foreign Military Sales" and/or international corporations and the overall process "could foster growth of real African regional capability" to respond to environmental crises and disasters even if the process started bilaterally or unilaterally.[38]

6. "Assist African environmental security specialists to train others."[39]

Establishing a core cadre of African environmental security specialists will have multiple benefits. These specialists can create targeted programs that address African environmental security challenges and responses and help professionalize African militaries. AFRICOM can provide training, expertise, and a curriculum that will make this effort possible.

7. "Assist Africans to mitigate environmental degradation by migrants and refugees."[40]

Environmental refugees and migrants fleeing environmental degradation and conflict challenge every African state's limited security and economic resources. Mass movements of displaced individuals and families place a huge burden on the refugee camps and on the local environment. AFRICOM can help African militaries locate refugee camps in sustainable locations, construct camps that reduce environmental and security challenges, and proactively prevent environmental degradation from happening in the first place.

8. "Inform African militaries of US environmental security expertise and capabilities."[41]

A specialized segment of US military and governmental professionals have extensive expertise in environmental security, degradation, and mitigation issues. The in-depth and practical knowledge of these professionals can be used to reduce environmental degradation and conflict in Africa. AFRICOM should provide African military leaders with information on these capabilities and opportunities for US environmental security professionals to share their proficiencies with their African counterparts.

One method to share information could involve building "social networks" between AFRICOM staff members, African environmentalists, African environmental security experts, and other agencies, components, and even nongovernmental environmental agencies.

An environmental security social network could enhance sustainable environmental practices and processes and augment stability and security operations. In addition, personal handheld communication devices could improve communications reliability, speed, and access in all of Africa without an expensive supporting land infrastructure. Social networks and personal handheld devices would be invaluable as tools for strategic environmental security communications.[42] Nevertheless, local environmental knowledge should not be discounted; simple word-of-mouth, low-tech communication can be very effective, and inclusion of often marginalized groups (women and young men) should be a focal point of all communication and environmental security strategies.[43]

9. **"AFRICOM should concentrate on those environmental security projects that provide visible results measured against realistic milestones."**

AFRICOM must hold engagement partners accountable and continually move those partners toward becoming self-sufficient contributors.[44] Various studies have shown that when individuals and groups become accountable and responsible for managing environmental assets and have the capacity to manage ecosystems effectively, then cooperation, ownership and stewardship values, and sustainability of the resources increase visibly.[45]

10. **"Assist Africans in building aviation capacity or air domain development (ADD)."**[46]

AFRICOM can help African states build ADD, which will enhance air safety, expand trade, promote security/stability, and improve surveillance, control, and protection of natural resources by developing civil-military partnerships between AFRICOM aviation organizations and African states. ADD will enable African states to overcome transportation infrastructure limitations that plague many states throughout the continent.[47]

Conclusions

AFRICOM can become a positive, proactive force on the African continent helping Africans help themselves. US military forces, environmental organizations, and government agencies have enormous expertise and knowledge on environmental change and the challenges

and opportunities it can create. AFRICOM must help Africans build environmental, economic, and social capital to ensure stability and security. The processes AFRICOM supports should ensure Africans are provided with expert, current, and relevant environmental management information; gain secure and equitable control over their natural resources; and are empowered to make community-based decisions concerning these resources. The frameworks and institutions that enable the supporting processes all have working antecedents in the United States and other developed states, and AFRICOM can assist process adaption by Africans for Africans.[48] Information, expertise, secure resource ownership, frameworks, and institutions can give Africans the tools to protect the land, water, climate, biodiversity, and people from further environmental degradation and the added devastation of linked violent conflict. The goals of these efforts are to help Africans reduce environmental degradation, protect and sustain natural resources, and mitigate conflict over the environment. AFRICOM's charge is to become a strategic, operational, and tactical enabler.

Notes

1. See United Nations Environment Program (UNEP), *GEO-4*; *2008 Living Planet Report*; and Millennium Ecosystem Assessment, *Ecosystem and Human Well-Being*.
2. UNEP, *Africa*, 57.
3. Ward, *United States Africa Command*, 11.
4. UNEP, *Africa*, chap. 1, PowerPoint presentation, slide 5.
5. Ibid, xi.
6. Ibid., chap. 1: PowerPoint slide 4.
7. Ibid., x.
8. Ibid., 19, xii.
9. Ibid., xi, 19, 13.
10. Ibid., 20, xii.
11. Ibid., 14; and Boko, "Africa," 435.
12. Ibid., xi, 6.
13. Boko et al., "Africa," 435.
14. UNEP, *Africa*, 52–55.
15. Henk, *Botswana Defense Force*.
16. UNEP, *Africa*, 9, 11, 8, 29.
17. Ibid., 220, 23.
18. Ibid., 14, x, 13.
19. Pearce, "From Viet Nam to Rwanda.
20. UNEP, *Sudan*, 6.
21. UNEP, *Africa*, 60.

22. UNEP, *Sudan*, 7.
23. Ibid., 6.
24. *World Resources Report,* 143–45.
25. UNEP, *Africa*, 16–17; and Tappan, "RE: Extent of Natural Regeneration."
26. UNEP, *Africa*, 17.
27. *World Resources Report,* 155, 157.
28. Burgess, ed., *Air Force Symposium 2009*, 8.
29. Ibid., 6.
30. Ibid., 8.
31. Ibid., 4.
32. Ibid., 8.
33. Mosher et al., *Green Warriors.*
34. Schoomaker and Brownlee, *Army Strategy for the Environment*, 2.
35. Burgess, *Air Force Symposium 2009*, 5.
36. Ibid., 8.
37. Ibid.
38. Ibid., 31–32.
39. Ibid., 8.
40. Ibid.
41. Ibid., 9.
42. Ibid., 28–29.
43. *World Resources Report,* 156.
44. Burgess, *Air Force Symposium 2009*, 5.
45. *World Resources Report*.
46. Peltier and Thomas, "Air Domain Development in Africa."
47. Ibid., 111.
48. Ibid., 111–57.

Chapter 9

Toward a Stable African Continent

The Role of AFRICOM and the USAF in Building Partnerships through Environmental Security

Robert R. Sands

Environmental security is no longer a concept in fringe discussions of environmentalists and others interested in conservation or applied ecology. Recently it has entered into the broader context of human security and thus becomes integral to the human endeavor to maintain and survive—including conflict resolution, protection and sustainment of natural resources, mediation and perhaps acceleration of globalization, and the quality of life of indigenous/marginalized peoples.

Environmental security is a fundamental component of long-term stability and progress in Africa. It is essential in developing lasting peaceful relationships among local indigenous peoples and between public and private sectors under fledging local and oftentimes unstable national governments. Environmental security also offers opportunities for developing and sustaining partnerships between various US agencies and other organizations, including the US Department of Defense (DOD) and those of African partner nations and their populaces.

In Africa, the development of conservation zones—lands set aside for national parks and wildlife refuges; community-based conservation (CBC) projects, including community-based natural resources management (CBNRM) programs; and transfrontier conservation areas (TFCA)—promotes environmental security and has offered a means to attenuate and resolve some conflicts. At the same time, conservation zones promote biodiversity, enhance environmental and natural resource management, and offer economic development for indigenous and/or marginalized peoples.

Human security in general and environmental security specifically—concerns keenly shared by many African nations and individual Africans—represent potential opportunities for the United States

to build partnerships that could significantly increase the influence of US African Command (AFRICOM), the newest combatant command within the DOD.

A 2009 AFRICOM/Air University symposium featured a track on environmental security, which identified ways AFRICOM could engage in partnering for lasting and meaningful influence. One workshop featured discussion of conservation zones, such as TFCAs and peace parks (PP).[1] The workshop proposed several initiatives and roles where AFRICOM, and specifically the US Air Force (USAF), could promote environmental security in Africa.

This chapter offers analysis of the mutual benefits to US national security interests, African governments, and marginalized populations accruing from promotion of environmental security by building partnerships. Utilizing airpower as an engagement capacity, partnership building can aid in the development and sustainment of conservation zones in Africa.

- This chapter proposes that promoting environmental security is both an end in itself and a critical component of human security. As such it will aid in legitimizing nation-states and ultimately promote stability in Africa. Application of the concept of "conservation zones" can be effective in promoting environmental and human security.
- It proposes that US foreign policy should include environmental security programs as means for building partnerships for stability in foreign nation-states. AFRICOM, and specifically the Seventeenth Air Force, can play a vital role in the success of environmental security programs.
- It defines the various types of conservation zones in Africa and explores three primary benefits—sustainment of biodiversity, an engine for economic development, and a means of conflict management—that can result from successful conservation zones. One specific type of conservation zone, CBC programs, offers unique partnership opportunities to address human and environmental security at a local community level. Effective partnership building should not just be at national levels.
- It offers a specific case study of a successful CBC program, the Northern Rangeland Trust (NRT) in Kenya, with a brief illustration of how AFRICOM could engage an array of aviation and

USAF resources to benefit the development and sustainment of the NRT, thereby promoting lasting and effective partnerships with local and ultimately national governments.

Use of the NRT as a partnership-building model would also provide an example of how such engagements would occur and identify elements, like education and training in cross-cultural competence, necessary for success.

Human (and Environmental) Security: The New Security Strategy

Stability in Africa and elsewhere requires human security; the guarantee of human rights is necessary for lasting sovereign governments. The concept of human security was established by the United Nations (UN) beginning in the 1990s.[2] The notion of human security has been redefined to mean that state security requires the safety of individuals and the well-being of local communities rather than national military power.[3] "This kind of security redirected attention away from the nation-state and toward individuals and local communities. In addition to protection from physical violence, it offered safety from chronic threats like hunger, disease, severe economic deprivation, or political repression."[4]

Crucial to human security is environmental security—protecting people from the short- and long-term ravages of nature, deterioration of the natural environment, and man-made threats to the environment, while guaranteeing access to and preserving natural resources. The concept of environmental security has grown beyond the concern of species and habitat protection to a concern for survivability of the planet. Developing and sustaining environmental security in Africa offers military and nonmilitary organizations an opportunity to engage in mutually beneficial partnerships with African partner nations and their local populations, thereby promoting stability and ultimately benefiting US national security.

Building Partnerships

Arguably, the most important military component of the struggle against violent extremists is not the fighting we do

> *ourselves, but how well we help prepare our partners to defend and govern themselves.*
>
> —*National Defense Strategy*, June 2008

A government's legitimacy requires an ability to provide human security. Building partnerships has become an important instrument of the DOD and US foreign policy in promoting stability in partner nations. It is defined as "Airmen interacting with international airmen and other relevant actors to develop, guide, and sustain relationships for mutual benefit and security."[5]

The USAF is developing partnership-building doctrine predicated on the continued and increasing importance of establishing and sustaining partnerships that will evolve into long-term alliances. Partnership building includes the following concepts important to the USAF:

1. Security assistance can encompass a variety of interactions ranging from passing conversations to formalized agreements. Partnership-building activities include humanitarian assistance, medical readiness exchanges, exchange programs with military members and civilians in professional military education and topical education/training in specific areas (civil engineering, environmental management, technological schools, etc.), and the more traditional military-to-military programs such as collaboration in exercises and weapons programs.

2. Actors involved in partnership building include those from local to international authorities and nongovernmental organizations (NGO). Partnerships develop across a spectrum of methods and relationships. Collaboration and strong, vital relationships are the currency involved.

3. Successful partnerships are built on courses of action and resources that can bring immediate and longer-term benefits. The focus of the partnership is its sustainability over the long term. However, the most successful partnerships see a gradual drawdown in US resources and involvement.

4. Aviation and airpower can promote the prosperity of all nations, especially those that work toward human security. Some policy makers might recognize that aviation can provide a wide range of benefits, but few fully comprehend airpower as a strategic

investment in national and human security. It can catalyze legitimacy, project national sovereignty, and accelerate internal stability and regional security. Airpower can also be an engine for economic, technological, and intellectual development, generating infrastructure essential to the internal and external strength of a nation. Connecting aviation to local leaders/communities could promote the development and sustainment of human security and result in successful partnership building.[6]

Environmental Security and Conflict

We live in a world of ongoing conflict, rapidly increasing population, and dwindling resources. Recently, the effect of kinetic operations has become increasingly relevant. Current US military strategy and doctrine have recognized environmental security concerns in tactical and operational planning and policies.[7] It is understood, however, that military stability operations—that is, kinetic operations, including conflict and postconflict operations, staged domestically and from foreign bases—impact the environment greatly. Understanding the ecological footprint of conflict and postconflict operations to human/environmental security and managing this footprint to minimize the effect on the natural resources and human populations are necessary for the success of postconflict physical, social, and cultural reconstruction and long-term sustainability. Along these lines, environmental security "best practices" for military operations outside the continental United States (CONUS) have developed from the environmental programs found at all military installations inside CONUS, including a suite of processes (environmental baseline surveys, environmental impact statements, etc.).

AFRICOM, Partnership Building, and Environmental Security

This chapter argues that militaries can also be engaged to promote and sustain environmental security in many areas of the developing world, or in areas that are caught in the pincers of human and/or environmental crises, in addition to being deployed into conflict situations. Militaries offer unique command and support structures that include capabilities, technologies, and a "military culture" that can

develop and sustain environmental security in the entire continent of Africa as well as conflict areas such as the Middle East, Southwest and Southeast Asia, South America, and elsewhere. Providing resources to nations and local communities needing environmental security support in terms of mutual benefits and cooperation can minimize perceptions of militarization or military colonialism.

The standing up of AFRICOM represents a departure from traditional forms of US military engagement, growing from a desire to create a combatant command that could engineer a "whole of government approach" for positive influence by engaging in collaborative relationships with partner nations and other organizations across the African continent.

> USAFRICOM better enables the Department of Defense to work with other elements of the U.S. government and others to achieve a more stable environment where political and economic growth can take place. USAFRICOM is committed to supporting U.S. government objectives through the delivery and sustainment of effective security cooperation programs that assist African nations build their security capacity to enable them to better provide for their own defense.[8]

The leadership of ARFICOM includes representation from the Department of State (DOS), the DOD, the US Agency of International Development (USAID), and other government agencies involved in Africa. AFRICOM also seeks to engage humanitarian organizations involved in Africa issues and common concerns.

This paradigm shift in US military-civilian relations reflects the changing face of foreign relations in an increasingly "globalized" twenty-first century. The end result of US involvement in a continent as diverse as Africa, and with many countries still struggling from the aftermath of colonialism, points toward reconstruction and stability operations as primary concerns for US foreign policy and a potential DOD opportunity in building partnerships with African nations. Dr. Dan Henk observed that historic patterns of foreign policy initiatives in African environmental security indicate that interagency dysfunction and stove piping would exist in stability operations projects undertaken within the traditional combatant command approach.[9] AFRICOM exists as a means of harnessing the efforts and strengths of several agencies to engage in a range of programs—including military-to-military, military-to-civilian, and civilian-to-civilian—to promote a "stable and secure" African environment and to promote human security.

A host of African, non-African governmental, and nongovernmental organizations and funding will be necessary to develop and sustain environmental security programs in local, regional, and international partnerships. Both non-African and African militaries can and will need to play critical roles in providing support. In Africa, where most nation-states are in their infancy and human security is constrained by a host of factors—little or no infrastructure, ethnic conflict, and environmental crises, both man-made and natural, resulting in natural resource loss, disease, and famine—the notion of "security" cannot be tied to the traditional concept of defending national integrity but should reflect a more human-centric perspective. Historically, militaries in Africa supported dictatorships and juntas whose social, cultural, and economic policies undermined human/environmental security. Many African countries have resisted or at least approached AFRICOM with trepidation due to this history. In the past, colonial powers protected Africa from the Africans. Resources flowed out—diamonds, minerals, oil—even Africans, up to the nineteenth century—and many of those resources still continue to leave, with benefits accruing only to a tiny percentage of Africans. With independence rolling across the continent in the mid-to-late twentieth century and new governments unable to govern effectively, human life and natural resources were and are victims of civil wars, terrorism, and cross-border conflicts. In many parts of Africa, the militaries have contributed to destabilizing countries and to genocide, ethnic cleansing, and marginalization of ethnic and cultural groups not in power. This perception of militaries, past and present, has led to the concept of "militarization" and has initially stained the efforts of AFRICOM. Dealing with the perception of militarization and thus abating resistance to stability operations will be the burden of organizations such as AFRICOM.

AFRICOM, and thereby the USAF, can bring to bear unique capabilities and technologies through building partnerships, particularly in the development and sustainment of national and international conservation zones, TFCAs, PPs, and CBC programs. The conservation zone can be understood in terms of three primary benefits: sustainment of biodiversity, development and sustainment of economic development, and a vehicle for conflict management and resolution.[10] There are several types of conservation zones, including TFCAs, PPs, and CBC programs. Each offers opportunities for developing and sustaining partnerships with Africans.

The CBC programs offer opportunities for developing lasting partnerships with African communities that can promote the development of human security beyond what national government organizations can provide.[11] One CBC program in northern Kenya suggests how the USAF through partnership building can develop and promote sustained partnerships at the level of local communities—considered critical in promoting stability in developing and conflict-prone nation-states.

Conservation Zones

The environment, as we have discussed, is a critical component to guaranteeing human security for Africans. The development and implementation of conservation zones that incorporate local communities and governmental organizations in managing land for multiple purposes can promote stability. The development of ecological areas/conservation zones to promote sustainability and stability has a long history. The birth of national parks and forests in the United States is just one example of such use. More recently, the use of conservation zones in Africa and other areas, such as North/South Korea, the Middle East, Southeast Asia, and nations in and around the former Soviet Union, has been promoted as a means of conflict resolution.

Conservation zones are based on three general benefits or pillars of sustainability:

1. sustainability of biodiversity through conservation [conservation and management of natural resources, including water (hydroelectric) and land resources such as forests and wildlife] and preservation of the "commons" to reduce conflict over depletion of resources; [12]

2. management and sustainability of economic development both locally and regionally through the engines of ecotourism and community-based land use programs; and

3. sustainability of regional peace and stability through conflict resolution to include bilateral and multilateral relations between nations.[13]

Conservation zones refer to ecologically protected areas whose boundaries and land use have been agreed upon by local, national,

and/or consortia of national governments and NGOs. At the local community level, conservation zones can create governance that is often far more influential and beneficial to local populations than national governments, especially where the national government lacks a strong presence in areas more rural and distant from the government centers.

There are three basic types of conservation zones in Africa. The first, transnational, has borders established by national governments and maintained by a consortium of governments. These not only engage indigenous and local populations, but also depend on successful international cooperation to create, sustain, and protect natural and human resources in and around the conservation areas. A second type includes areas within national borders (e.g., wildlife refuges and national parks). The third type engages local populations in establishing and managing natural resources areas for sustaining wildlife and promoting local economic development. Community-based natural resources management (CBNRM) programs in southern Africa, originating in the 1980s and piloted in Kenya, Tanzania, and other countries, exemplify these.[14] Rural communities that live in nontenable or marginal agricultural lands in and around wildlife- or game-rich habitats or migratory routes are empowered to manage the natural resources for economical benefit through ecotourism. Management of these community-based areas creates local governance that often becomes the de facto decision maker in community issues and a tie to the national government.

Environmental stress rarely respects national boundaries, and it may be beneficial for countries and regions to cooperate to alleviate similar or mutual problems.[15] Concentrating on environmental peacekeeping instead of environmental problems and environmental security entails interactions that can be building blocks for future cooperation.[16] Protected areas—transfrontier protected areas, transboundary protected areas, or transfrontier conservation areas (TFCA) that straddle national or regional boundaries—are often called peace parks.[17] Peace parks are found primarily in past conflict, postconflict, or potential conflict regions.

Generally, TFCAs are ecological "protected areas" developed between nation-states sharing a political boundary. There is usually some regular communication and information sharing between TFCA partners. TFCAs may or may not have contiguous boundaries and/or contain human use land areas.[18] The development of TFCAs

in Africa has been especially successful in facilitating the resolution of territorial conflict and promotion of environmental sustainability. TFCAs have also become "important symbols and outright manifestations of the peace process."[19] For conservationists, TFCAs are an enforceable means for protecting biodiversity. For national militaries, they become an area without human population encroachment. Recently, however, TFCAs have become refuge areas or staging platforms for rebels. TFCAs also represent economic development for local indigenous groups or privately sponsored ecotourism companies. They offer pharmaceutical companies or NGOs interested in preserving agricultural biodiversity a genetic "warehouse" of potential natural resources or information.

Ecotourism is an engine that can drive both funding and livelihoods for those who live in and around the TFCA.[20] TFCAs such as the Great Limpopo Transfrontier Park (GLTP) that straddles the boundaries of Mozambique, South Africa, and Zimbabwe offer places to live within and adjacent to park boundaries

Peace parks date from 1932 and the development of the Waterton-Glacier International Peace Park on the border between the United States and Canada.[21] Organizations such as the World Commission on Protected Areas of the International Union for Conservation of Nature (IUCN), the World Wildlife Fund (WWF), and the United Nations University for Peace have worked in some way to further the concept of promoting peace through building peace parks. According to the IUCN, a PP must promote a "clear biodiversity objective, a clear peace objective and cooperation between two countries or subnational jurisdiction." The UN University for Peace defines PPs as protected areas where "there is a significant conflictive past."[22] Others have defined "Parks for Peace" as "transboundary protected areas that are formally dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and to the promotion of peace and cooperation."[23] Clearly, PPs focus on sustaining peaceful relations between nations, promoting environmental sustainability, and preserving access to natural resources.

Peace parks provide a collaborative alternate solution to barricaded borders, thereby mitigating tensions. They have been used successfully in regional areas either prone to conflict or in a postconflict condition, such as the border between Kuwait and Iraq.[24] The Korean demilitarized zone is a nature corridor untouched for 50 years and an opportunity for engagement in collaborative efforts to maintain habitats

and reintroduce species, promote novel cooperation in international relations, and symbolize peace.[25] The Siachen Glacier region has been and continues to be a region of conflict between India and Pakistan; "combat over a barren, uninhabited nether world of questionable strategic value is a forbidding symbol of their lingering irreconcilability."[26] A "Transboundary Peace Park," to be bilaterally managed by both India and Pakistan, has been proposed that could end the ongoing "low-intensity border war between the two nations."[27] A frontier peace park in the Mesopotamian marshlands between Iran and Iraq is in the preliminary stages. The goal is to bring Shia and Sunni together and to restore sensitive marshlands necessary for biodiversity and agriculture damaged by decades of conflict.[28] The boundary land between Afghanistan and Pakistan also has been proposed for a series of TFCAs.[29]

The development of TFCAs featured peace parks in early 1990s Africa.[30] Peace parks came into being through discussions of common interests, first between South African WWF president Anton Rupert and Mozambique's president Joachim Chissano in 1990, with later support of the newly elected South African president, Nelson Mandela. The Peace Parks Foundation was established in 1997. The foundation was a collaboration of the governments of Mozambique, Zimbabwe, and South Africa and NGOs such as the WWF of South Africa and the World Bank.

There are several successful peace parks in southern Africa, including the GLTP, Kibira National Park, Virunga National Park, and the Volcanoes National Park, which make up the Great Lakes TFCAs of Burundi, Democratic Republic of Congo, and Rwanda. The ambitious Kavango–Zambezi (KAZA) Transfrontier Peace Parks Initiative includes five African countries—South Africa, Botswana, Mozambique, Zimbabwe, and Angola.[31] The KAZA has remained in the planning stage for several years due to the political instability of some members leading to internal conflict. The implementation of such an initiative only underscores the potential benefits of TFCAs to nations and their neighbors. While analysis is ongoing, organizations such as the Peace Parks Foundation in South Africa continue to promote peace parks, leaving the potential for engagement in partnership building open.[32]

Community-Based Conservation Programs—A Unique Opportunity for Building Partnerships

Community-based conservation programs represent a new conservation ethic in Africa as elsewhere in the last two decades.[33] The colonial conservation ethic, "protectionist (fortress) conservation," was state-controlled, "top-down" management and has given way to a management approach based on "inclusive, participatory, community-based endeavors."[34] Initially labeled as CBNRM projects when first developed in Africa in the 1980s, programs were established in countries under different acronyms but with the common goals of community participation leading to natural resources management, recovery and sustainment of at-risk wildlife, and community development. In Namibia, the CBNRM program was labeled "LIFE" (Living in a Finite Environment), and in Zimbabwe it was labeled "CAMPFIRE" (the Communal Areas Management Program for Indigenous Resources).[35] Today these programs are found in many African countries and are subject to growing pains specific to local, national, and international governments. Also, the national and international NGOs that represent powerful and competing interests may or may not promote conflict resolution, attenuation, and management.

Top-down approaches of national and state governments in the development and sustainment of national parks now create difficulty in adapting to the community-based conservation ethic and translation of that ethic into successful community development and sustainment of local natural resources to the benefit of community residents.[36] The heart of making CBC programs successful requires allying the twin goals of conservation (including biodiversity) and economic development (socioeconomic benefits to local communities). Likewise, these goals must be reconciled with those of all stakeholders. Efforts of NGOs such as the WWF and The Nature Conservancy can promote conservation through limited land use that marginalizes the benefits to the local communities.[37]

Other difficulties lie in articulation between the efforts and management of government organizations and the participation of the local communities. This is apparent in the operation of national parks and refuge areas where the needs of indigenous peoples are not considered. Lately, national governments in countries such as Kenya and Tanzania have promoted the development of conservation areas that

have incorporated those indigenous traditional land users in the management and sustainment of parks.

The Ngorongono Conservation Area (NCA) in Tanzania offers indigenous populations residence within and adjacent to park boundaries. Even though limiting their traditional subsistence strategies—for example, pastoralism for the Masai—the NCA park development and sustainment can offer employment, experience, and training/education.[38] Yet there is also evidence that the Masai culture and specifically its relationship to wildlife have dramatically been altered, and the local indigenous cultures and life ways—herding and grazing cattle—fragmented. Even though local Masai have been included in park management in some capacities, they are not active or meaningful participants. In addition, Masai ecological knowledge, including "geographical understanding of the landscape . . . to ecological knowledge and resource management process" honed over centuries of local subsistence, is not taken into consideration in the discourse shaped by the hegemony of Western conservation approaches. This local knowledge is based on a continuing ecological repository of orally compiled observation and interaction with natural resources that lies beyond the "science" of conservation and must be integrated into CBC to be an effective program.[39]

In Tanzania, as elsewhere (South Africa, Malawi, Uganda, Zimbabwe, and outside of Africa), there is a problematic dialogue between the more "official" entities of government, NGOs and donor agencies/organizations that represent the power brokers, and the local communities themselves. Oftentimes there is a lack of adequate representation to establish or reconcile an effective management that considers both goals of conservation and economic development. An effective CBC program requires that the resource brokers consider "how to reshape their own institution and agendas to really *fit* communities—with their diverse needs, knowledge, and complex social and ecological structures—into conservation" (emphasis in the original).[40]

The Western notion of "community" may also bias the application of CBC. Western notions of geopolitical boundaries, such as villages, applied to seasonal transhumance subsistence, mobile agricultural, or food forager cultures (these strategies are most likely those practiced by indigenous populations in and around CBC lands) constrain the consideration of conservation approaches and limit the application of natural resources for economic development. Conservation zones offer a multitude of engagement points that could be utilized in

developing partnerships through promotion of human and environmental security. At the same time, AFRICOM, other DOD, or DOS efforts to frame the activity and the relationships in terms of promoting sustainable African success in conservation zones must apply caution to partnership activity.

Contemporary CBC Programs: Land Trusts and the Kenya Land Conservation Trust

In 2005, the Kenyan government incorporated the Kenya Land Conservation Trust (KLCT). The trust encompasses CBC programs that "extend beyond protected areas" and the acquisition of critical pieces of land integral to national conservation efforts.[41] Protected areas in Kenya account for only 8 percent of its land. This leaves large parcels of wildlife habitat outside the protection of governmental agencies such as the Kenya Wildlife Service (KWS) and the Ministry of Lands and Housing when it comes to protecting against "incompatible" land use practices "emanating from population increases . . . and the consequent conversion of land for agriculture, subdivision, settlements and livestock loss" and potential use by criminal or terrorist organizations.[42] Leaders from national and local private sectors, civil society, and landowners join a diverse trust board featuring African Wildlife Foundation (AWF), KWS, and the Ministry of Lands and Housing. This provides a venue for "active" participation in communities where the KLCT will be operating. Various mechanisms are used to ensure conservation, to include land purchases, easements, leases, and management agreements.

Besides facilitating the KLCT, the AWF has initiated the African Heartlands Program that emphasizes conservation of African wildlife through protection of "large, cohesive conservation landscapes."[43] As indicated above, many of the critical ecological "corridors" that help sustain wildlife through migratory routes as well as necessary tracts of habitat are not under protection afforded by national governmental agencies. Local communities or even state agents without means to protect or sustain conservation of natural resources falling within individual or community boundaries or designated land tenures mostly own these corridors. The development of land trusts has brought private lands under conservation and facilitated development of natural resources management plans that promote synchroni-

zation of multiple land uses that benefit both biodiversity and human livelihood. The African Heartlands Programs as of 2005 had initiated CBC programs to benefit communities in Mozambique, Tanzania, and Botswana.

CBC programs offer a unique partnership-building opportunity at community levels to address environmental and, in general, human security at the ground level. The partnerships are developed in a complex coalition that would include national government agencies; the more grounded the community, the more viable the relationship between community and national government. Strengthening this frequently tenuous relationship between government and communities in many African nations promotes stability.

Another example of a CBC program in Kenya is the Northern Rangeland Trust (NRT). The NRT was prompted by support from the Lewa Conservancy, a private land trust in northern Kenya. The success of the NRT suggests a potential model of CBC that could be exported to other areas of Africa, and AFRICOM could be a means to assist in the development and sustainment of these programs.

Lewa Wildlife Conservancy and Northern Rangeland Trust

A Case Study

Arguably one of the most successful CBC programs in Kenya, perhaps on the continent, is the partnership between the nonprofit Lewa Wildlife Conservancy (LWC), a 62,000-acre former privately owned cattle ranch, and the Northern Rangeland Trust, a collection of local communities north of the conservancy that have designated communal land for wildlife preservation. The former owners of Lewa Downs, now the LWC, primarily herded cattle until 1983 but also operated a successful wildlife "ecotourist" program fueled by the now-endangered black rhino and Grévy's zebra, as well as elephant, lion, leopard, and African buffalo. With the black rhino approaching extinction due to poaching in the early 1980s, the owners set aside and fenced part of the ranch as a rhino sanctuary. A decade later the sanctuary was expanded and converted to a general wildlife sanctuary to include the entire ranch and adjoining Ngare Ndare Forest Reserve.

The LWC has also addressed social and health issues within local communities as well as those adjacent to its boundaries. It has created a very efficient wildlife "security" force that cooperates with the Kenya Wildlife Service and features a variety of security technologies to maintain an effective deterrent to poaching. Occasionally, the LWC security partners with the KWS and community conservation programs in antipoaching missions.

The northern rangelands contain a precarious environmental situation; "the long-term conservation of wildlife in Kenya's northern rangelands is inextricably linked to the fate of the local pastoralist communities."[44] The LWC has taken an active role in northern Kenya, fostering a conservation and wildlife preservation ethic to combat the negative effects of human intervention from overgrazing and livestock, poaching, and ethnic violence. There is a connection between the conservation of wildlife and preservation of biodiversity in northern Kenya with the development of the local pastoralist communities. CBC initiatives in Kenya, as elsewhere in Africa, rest on the development of wildlife and habitat, with ecotourism as a driver of economic development. The efforts and resources supplied by governments and NGOs are crucial to these initiatives. The drive for economic sustainability often overshadows the absolute need to involve the local community at every step of the developmental process. The evolution of the NRT is an example of a CBC initiative that weaves into its expression the critical piece of community governance and management.

Land ownership is a defining attribute of the NRT and supports the notion of conservancy independence. Ownership empowers communities to make informed decisions that relate to community needs. However, the majority of Kenya's CBC initiatives tend to focus on generating economic benefits for the community through ecotourism. The real needs—to establish a solid foundation for local governance and sustainability of that initiative—come second. As a result, community participation from the outset is largely passive and tends to become overly dependent on long-term support from the government and NGOs. The NRT has approached development with goals customized to each conservancy and based on the needs of local communities. This approach promotes a solid and accountable foundation for investment from a variety of sources into the conservancies and cultivates independence from the specific interests of each of the organizations. Investment is applied to directly support conservation *and* to community institutions that may indirectly support

conservation and the development of the community. In others words, success of the conservancy fosters community development.

In 2004, LWC personnel collaborated with national and local governments and conservation groups to establish the NRT. The main problems and their solutions in development of the NRT followed the three pillars of conservation zones discussed earlier: sustainability of biodiversity, economic development, and conflict resolution. The NRT encompasses 1.5 million acres and is home to "approximately 60,000 pastoralists of different ethnic origin including Samburu, Rendille, Laikipiak Maasai and Meru."[45] The trust stretches across a large swath of traditional African megafauna habitat, yet each of the trust's conservancies contains a unique constellation of animal and plant species that require specific conservation and local economic development.

Goals of the NRT are to

- ensure the conservation, management, and sustainable use of the natural resources within the trust area;
- promote and develop tourism and all other environmentally sustainable income-generating projects within the trust area;
- promote culture, education, and sports of the residents of the trust area;
- promote better health of the residents of the trust area through the provision of better health services and facilities;
- alleviate poverty of the inhabitants of the trust area through improved social services, provision of employment, and establishment of community-based enterprises; and
- promote and support trusts, corporations, NGOs, and other charitable organizations with similar objects to those of the trust.[46]

The NRT has organized around a governance structure that relies on representation of individual conservancies through a democratically elected council of elders and a board of trustees with a set tenure of service. An executive director coordinates trust operations by funneling decisions through the community development department, the research and monitoring department, the livestock and rangelands manager, and the business and enterprise manager. Individual conservancies allocate almost 50 percent of their ecotourism income toward an annual operating budget, with the remainder going to

community institutions and services for community development (e.g., education, social services, health care, etc.).[47]

Individual conservancies follow a similar administrative structure, with the traditional community leadership empowering a community conservancy board that directs operations through the four departments similar to those mentioned above. Conflict resolution teams reconcile resource use when grazing and other disputes arise. The teams consist of respected elders led by a retired chief who "maintain peace through mediation, dialogue and advice." Team members receive formal training in an array of conflict resolution techniques as well.[48]

The northern rangelands are unique in Kenya, perhaps in all of Africa. There are no physical boundaries or fencing that would impede the natural movement of wildlife. The NRT acts to secure this area through individual conservancies that work locally in concert with other conservancies to maintain wildlife and a broader ecological mosaic strategy that guarantees the necessary wildlife migration through the rangelands.

The success of the individual conservancies depends on effective management of the NRT and external support from a variety of organizations. This also depends on effective ecological monitoring and a sound security program that support the wildlife, habitat, and communities. Tools necessary for ecological monitoring and a viable security program include "radio communications equipment, a direct communication channel, weapons (dependent on government policy), uniforms, binoculars, GPS units, camping equipment for mobile security teams, computer and office resources, airstrips, and other infrastructure."[49]

A sound ecological strategy can rely on the resources of the conservancy managers, governmental organizations, and nonprofit ecological conservation organizations for evaluation of the ecological management program to provide flexibility in adapting to changing conditions and to coordinate management strategies with developmental potential. Inherent in the NRT and its individual conservancies is a community "participation" monitoring program that combines both quantitative ecological monitoring and localized participatory qualitative monitoring. This prioritizes species monitoring, promotion of trust and individual conservancy collected data, and initial analysis by NRT technicians. Satellite remote sensing and aerial survey data complement the conservancy-collected data.[50] Monitoring programs consist of ground and aerial monitoring and

surveys of wildlife species, habitat vegetation, rangeland conditions, and game bird species to promote sustainable management practices. This straightforward approach provides communities with information for critical decision making on conservation and development activities.

The northern Kenyan rangelands have struggled with the effects of political instability in neighboring Somalia and Ethiopia in the form of terrorism. The Kenyan government and local communities have resolved some of the human insecurity; however, activities such as poaching continue to plague the ecological security and success of the NRT itself. The trust engages a security network that spans the entire range, including an active, well-trained, and well-resourced security team. The operations of the security program are also closely allied with organizations such as the KWS and Kenyan police. For security operations that require additional support, resources such as aerial reconnaissance, dogs, and armed forces are available from the Lewa Conservancy.

The NRT and AFRICOM/USAF: A Model for Building Successful Partnerships

Air and space capabilities can aid in meeting human security needs through effective governance, promoting national and local security, and meeting the sociocultural needs of the people. The modern standards that ensure safe and effective air and space operations require infrastructure development that benefits both civil and military use. Aiding the development of air and space capabilities can include a range of activities that includes military-to-military, military-to-civilian, and civilian-to-civilian contacts. Activities could include civil (human security) operations through civil aviation training, humanitarian response activities, promotion of medical assistance in rural and marginalized communities, assistance in building the necessary infrastructure to support both civil and military aviation, development of training exchange programs for personnel in both civil and military aviation, peacekeeping, and other activities. USAF partnership building could involve robust application of air and space assistance in the development and sustainment of aviation capability to both partner nation governments and local communities.

AFRICOM could provide support in seven specific areas to TFCAs and peace parks to promote partnership building. These areas directly support environmental security in those conservation areas developed and supported primarily by governmental and NGO agencies:

1. Provide environmental security education/training and regional cooperation training to African militaries.
2. Assist African governments and militaries in creating security for TFCA (e.g. the Botswana Defense Force).[51]
3. Assist with knowledge sharing related to piracy, poaching, trafficking, terrorism, and other illicit transboundary activities.
4. Assist with knowledge sharing to identify and maintain areas suitable for designation as a TFCA.
5. Facilitate the TFCA programs with the assistance of DOD environmental and natural resource managers.
6. Assist Africans in environmental remediation programs to mitigate and return natural environments to sustainability following human impact such as post-demining environmental mitigation.
7. Provide cross-cultural education/training programs to all involved stakeholders. Develop program assessment measures to include short- and long-term ethnographic studies to ensure that development and sustainment of conservation zones is both effective and sensitive to the local peoples and culture in and around the conservation zones.[52]

The NRT offers opportunities where AFRICOM could apply support to localized and community-based conservation programs. AFRICOM support would allow individual communities/conservancies to be primary stewards of the ecological and human security. As has been argued, environmental security can promote human security for those far from the effective reach of their national government. The NRT conducts partnership-building activities at low levels of security assistance or civil-military operations, and standard interagency coordination at the country–team level should be adequate. This does not minimize the effectiveness of such activity. The populations affected may not be large or sophisticated in the means of economic development, but the vast area in the NRT and the need to guarantee "ownership" of that land as a barrier/buffer to the violence

from bordering nation-states and organized criminal activities such as poaching are critical for human security in Kenya. For this security to be realized, the local populations need to be fully engaged in control of the land and be able to make a living off the land.

Aviation and USAF Support

Aviation and aviation support infrastructure are key to many of the operations, development of the NRT, and the individual conservancy programs. Northern Kenya, like so many other rural areas on the continent, lacks the infrastructure of basic local roads as well as national or international highways. Aviation becomes a necessary means of travel and transport connecting local communities, such as the community conservancies of the NRT, and also connecting them to services from national agencies and organizations. There are several areas where AFRICOM/USAF could provide assistance.

Security Assistance

Aerial support would be critical for developing and maintaining an effective security program for wildlife, residents, and visitors. Aviation enables reconnaissance for identifying poachers and other criminal and terrorist activities. The Lewa Conservancy has developed this capability, and aerial reconnaissance support over the vast area of the NRT would be very beneficial. Transport of security forces can be done more effectively and rapidly through aviation resources. Providing equipment such as light aircraft, maintenance programs and parts, and training for security forces to develop and maintain human and technological resources would also be beneficial. Local security forces could benefit from programs along the lines of International Military Education and Training through DOD professional military education programs across the services and, for aviation, through Air University.

Ecological Management

Ecological monitoring programs would also benefit from an increased use of aviation and space. Aerial surveys of wildlife (specifically the migration routes), of grassland usage, and of the maintenance of livestock-free zones are essential to sustaining viable

populations. Since the NRT's ecological monitoring is done through the local conservancies, land "truthing" wildlife populations requires coverage on foot. Aviation can provide transportation to and from monitoring areas. The use of satellite remote sensing can provide survey data across the entire NRT that will complement monitoring at an individual conservancy level.

Economic Development

Aviation would promote economic development of the NRT and individual conservancies through wildlife-based enterprises that would include transportation of tourists and resources to and from wildlife areas and transport into facilities that support tourism.

Humanitarian and Emergency Care

Localized humanitarian crises as well as emergency care and medical response capability can also benefit from aviation resources. Transport of medical personnel and supplies and patients would be more effective with aviation.

Technology and Research Transfer

The USAF, through its environmental management programs and adherence to sound stewardship principles and application of innovative science, can also provide cutting-edge technology to apply to trust and individual conservancy programs. Providing educational opportunities/internships to NRT and conservancy employees through exchange programs with environmental management programs and/or partnership programs with academic programs would be useful to sustaining the success of conservancies.

Conditions for Success

There is ample opportunity for partnership building to assist local communities in stabilizing their own human security needs, which ultimately will allow the solidification of a sovereign government to meet and sustain human security over the long term. For environmental security based and directed at local communities' partnership programs to be successful, certain conditions need to be met. These include cultural awareness of the African people and education/

training of US/DOD personnel in cross-cultural competence.[53] Cross-cultural competence would facilitate mapping the necessary relationships to engage a pilot project like the NRT; identifying the human, technological, and material resources that might be useful to the NRT; and producing the "lessons learned" for future projects similar to the NRT.

Cross-Cultural Competence

Implicit in developing and sustaining partnerships with African nations and the many ethnic and tribal groups that make up the cultural landscape of the continent is successful cross-cultural interactions. The USAF promotes cross-cultural competence as an applied suite of knowledge, skills, and attitudes that prepare Airmen to operate successfully in culturally complex situations without an extensive regional or culturally specific experience and linguistic competency.[54] Knowledge of the foundational concepts and domains of culture and enhancing behaviors such as cultural relativism will promote and sustain communicating, relating, and negotiating skills necessary to work across cultural barriers.

Mapping the Relationships

AFRICOM continues to define its scope and nature of operations on the African continent as well as develop an internal "rhythm" for its three components, DOS, DOD, and USAID, to work together to build partnerships. Identifying and mapping the necessary organizations/agencies critical for success of an NRT partnership are necessary prior to the planning phase of such an endeavor. Initially, those departments within AFRICOM that would play a role in planning and implementation would need to coordinate their efforts through the ambassador and the country team. The country team would initiate the outreach necessary to Kenyan governmental organizations and agencies responsible for contacting local community/conservancy officials to query on initial in-country visits that would begin to explore the potential for applying human and other resources to the NRT. Clearly, the sensitivity of the role of AFRICOM in supporting such projects would best be facilitated by a coordinated effort worked through the country team.

Modeling CBC Programs

CBC programs like the NRT offer a means for developing and sustaining human security in large areas with relatively low population density. Community conservation programs promote stewardship by local communities with a dual benefit of promoting biodiversity and a sustainable local economy in areas that are usually marginal in both agricultural value and economic development. In the case of the NRT, the benefits accrued by individual conservancies are magnified by the relationships each has with the larger trust and with the Lewa Conservancy. More land, especially more contiguous land, is brought under community control, while human and material resources needed by individual conservancies can be pooled to minimize cost. AFRICOM could then play a pivotal role in helping identify and develop CBC programs in other areas of Kenya and the rest of the continent.

Further Study

The complexity of agencies and organizations that would be instrumental in brokering a successful program of assistance to the NRT is indeed a labyrinth and must be mapped to find the most effective pathway. This study has established the foundation for considering an approach to partnership building through the need for environmental security in Africa. It has examined conservation zones as a possible avenue toward partnership building, specifically a recently established CBC program that might afford a pilot study of engaging AFRICOM. Further research and analysis should be accomplished to ascertain the value of whether this type of partnership in Africa can be successful and mutually beneficial. A study directed at the feasibility of a project like the NRT as a model for building partnerships through similar environmental security/sustainability projects in other regions of Africa would be beneficial and should consider the following goals:

1. identify stakeholders for establishing the viability of such projects;
2. conduct capability needs assessment to identify the potential human, technological, and material resources that the DOD and AFRICOM could provide that would benefit the NRT and other CBCs; and

3. initiate/participate in preliminary discussions with US governmental agencies and NGOs that would play important roles in the success of such projects (e.g., Kenyan Wildlife Services, Kenyan Land Trust officials, Lewa Conservancy, and the NRT board).

Conclusion

Promoting African stability through development and eventual sustainability of human security by Africans is a necessary condition for successful promotion of US foreign interests. Environmental security efforts such as CBC programs offer positive and viable partnership building opportunities for AFRICOM. Using the NRT as a feasibility model and/or pilot program should be explored to include further research on the types of human and technological resources that would benefit it with an eye on developing sustainability by the local conservancies and building initial relationships between AFRICOM and country teams and with those Kenyan local and national officials and other necessary personnel. Such a model or pilot would also provide its own case study of how such engagement would occur and identify conditions such as education and training in cross-cultural competence that would be necessary.

Notes

1. Burgess, *Air Force Symposium 2009*.

2. Initially, human security was defined in the United Nations Development Program, *Human Development Report 1993*, 2; and later in 2003, United Nations Commission on Human Security, *Human Security Now*.

3. United Nations Commission on Human Security, *Human Security Now*, 1.

4. Ferreira and Henk, "'Operationalizing' Human Security," 1. See also Sands, "Letters to AFRICOM No. 3," 27–40; and United Nations Development Program, *Human Development Report 1994*. The latter states on page 22,

> The concept of security has far too long been interpreted narrowly: as security of territory from external aggression, or as protection of national interests in foreign policy or as global security from the threat of a nuclear holocaust. It has been related more to nation-states than to people. Forgotten were the legitimate concerns of ordinary people. . . . For many of them, security symbolized protection from the threat of disease, hunger, unemployment, crime, social conflict, political repression and environmental hazards.

5. Adapted from the March 2009 LeMay Center Building Partnerships (BP) Symposium, 6–8 January 2010, session 1. This definition acts under the premise that "Airmen" are active duty, reserves, civilians, etc. (see Air Force Doctrine Document [AFDD] 1). The reference to Airmen in the definition supposes that they are performing aviation-related activities.

6. Adapted from draft AFDD 3-20, *Building Partnerships*.

7. Mosher et al., *Green Warriors*.

8. United States Africa Command, "About U.S. Africa Command."

9. Henk, "Environment, the US Military," 98–117.

10. Sands, "Letters to AFRICOM No. 3," 27.

11. Ibid., 30.

12. Hardin's notion of the "tragedy of the commons" describes how multiple stakeholders can negatively impact a shared ecology if their self interest overrides shared management and efforts toward sustainability. Hardin, "Tragedy of the Commons."

13. Sands, "Letters to AFRICOM No. 3," 31.

14. Henk, "Environment, the US Military."

15. Brock, "Peace through Parks."

16. See Conca and Dabelko, *Environmental Peacekeeping*.

17. The many definitions of the "protected" zone or areas that cross some formal or political boundary are in reality very closely allied in concept. See Hsiao, "Peace Parks."

18. *Southern African Development Community Protocol on Wildlife Conservation*, 2. See also Sandwich et al., *Transboundary Protected Area*.

19. Weed, "Central America's Peace Parks," 177.

20. Timothy, "Cross-Border Partnership."

21. Ramutsindela, "Scaling Peace and Peacemakers"; and Ali, "Introduction."

22. Hsiao, "Peace Parks," 1.

23. Sandwich et al., *Transboundary Protected Area.* See also Ali, "Introduction."

24. Alsdirawi and Faraj, "Establishing a Transboundary Peace Park."

25. Healy, "Korean Demilitarized Zone"; and Kim, "Preserving Korea's Demilitarized Corridor."

26. Kemkar, "Environmental Peacemaking," 3.

27. Ibid., 23.

28. Stevens, "Iraq and Iran in Ecological Perspectives."

29. Fuller, "Linking Afghanistan with Its Neighbors."

30. Brock, "Peace through Parks."

31. Henk, "Human and Environmental Security."

32. Peace Parks Foundation, http://www.peaceparks.org/Home.htm.

33. Bajracharya, Furley, and Newton, "Impacts of Community-Based Conservation"; Hulme and Murphree, "Communities, Wildlife, and the 'New Conservation' in Africa"; and Hulme and Murphree, eds., *African Wildlife and Livelihoods.*

34. Goldman, "Partitioned Nature," 1.

35. Henk, "Environment, the US Military," 108–9; and Metcalfe, "Campfire."

36. Goldman, "Partitioned Nature"; Campbell and Vainio-Mattila, "Participatory Development and Community-Based Conservation"; and Balint and Mashinya, "Decline of a Model Community-Based Conservation Project."

37. Benjaminsen, Kepe, and Bråthen, "Between Global Interests and Local Needs."

38. McCabe, Perkin, and Schofield, "Can Conservation and Development Be Coupled among Pastoral People?"
39. Goldman, "Partitioned Nature," 856.
40. Ibid.
41. "Kenya Land Conservation Trust Formed."
42. Ibid.
43. Gichohi, "From the Desk of the Vice President for Programme."
44. Northern Rangeland Trust, http://www.nrt-kenya.org.
45. Ibid.
46. Ibid.
47. Ibid.
48. Ibid.
49. Ibid.
50. Ibid.
51. See Henk, "Environment, the US Military."
52. Sands, "Letters to AFRICOM No. 3."
53. Cross-cultural competence (3C) can be defined as "the ability to adapt effectively in cross-cultural environments." Sands, "Cultural Relativism," 13. The DOD has identified 3C as a necessary enabler for mission success in culturally complex environments such as deployments. In today's changing military engagements, as represented by counterinsurgency, counterterrorism, and building partnerships, and specific to the engagements proposed to aid in environmental security, 3C would be a critical set of knowledge, skills, and abilities to develop and engage. Services across the DOD are instituting education and training programs in 3C, and 3C is and will be advanced to civilians within the DOD.
54. Air Force Culture and Language Center, http://www.culture.af.edu.

Chapter 10

"Making the Desert Green"

The Effect of Environmental Considerations on the Deployment of the Israeli Air Force in the Negev

Tamir Libel

This chapter attempts to analyze the influence of environmental considerations on the Israeli Air Force (IAF) with regard to strengthening the force and educating its members on environmental concerns. This is accomplished through a case study of a major force generation initiative—the redeployment of the IAF into the Negev region in southern Israel—the largest infrastructure project that the IAF has carried out for decades.

The chapter is divided into three sections. The first reviews the impact of the IAF on Israel's natural environment. The second analyzes the effects of environmental considerations on the redeployment in the Negev, describes steps taken by the IAF to reduce environmental damage during construction of the infrastructure there, and stresses environmental education activities initiated in the southern IAF bases. The third part concentrates on the effects of environmental considerations on IAF operations. The chapter concludes with a summary of the overall effects of environmental considerations on the IAF.

The IAF and the Environment in Israel

Government policy on environmental issues in Israel is determined by the Ministry for Protection of the Environment (MPE). The ministry espouses a comprehensive, systematic approach that considers the implications on the entirety of environmental resources. The activities of the Israeli Defense Force (IDF) have great potential for harming the environment. These activities create a variety of pollutants: liquid and solid waste, sewage, hazardous materials, noise, and radiation. The potential for damage is great since the IDF and the Israeli defense system affect, directly or indirectly, 47 percent of the

area of the state of Israel—30 percent of state lands are used for military exercises, 4 percent are military installations, 1 percent comprise defense system installations, and security restrictions are imposed on 12 percent. Restrictions such as limiting the height of construction or fixing a flight path prevent full land use.[1] The MPE and the IDF began to institutionalize the links between them in 1997. At the ministry, the deputy director of supervision and public relations is in charge of liaison with the IDF. In the IDF, the environmental section in the General Staff's Planning Division, established in 1997, is in charge of coordinating all IDF activities with the MPE. As an indication of the importance the ministry assigns to its link with the IDF, it financed the position of head of the environmental section until 2002.

The IDF began to give greater attention to environmental issues in the 1990s. In December 1996, the Planning Division established a steering committee to coordinate the IDF's environmental activities. The deputy head of the Planning Division established the scope of the committee's activities in November 1997, determining that the membership of the committee would represent the services, the territorial commands, and other entities. The head of the Strategic Planning Branch in the Planning Division serves as committee chair, outlining the policy of the IDF in this matter, instructing military commands with regard to long-term planning, following up on application of the decisions, and initiating and promoting projects.

The Planning Division set up five secondary committees in 1998 that are subordinate to the steering committee: oils and fuel, waste and recycling, hazardous materials, commands, and procedures. Significant progress began in February 1999 when the vice chief of staff officially approved the document outlining the environmental policy of the IDF, detailing the objectives, and providing the operational means to attain them. It begins:

> The IDF is aware of the potential environmental effects of its ongoing activities, and undertakes to act on the matter from a national standpoint, and according to the directions developing in the field of quality of the environment in Israel. Out of concern for quality of the environment that is a component of the quality of life in Israel, the IDF has decided that environmental aspects will constitute an integral part in the totality of considerations on military action, and *on condition* (emphasis in original) that they do not harm the operational ability of the IDF to fulfill security demands; the IDF will initiate activity to increase awareness of the values of environmental protection among officers and soldiers, while creating a change in the current image of the army in this sphere; it is important to convey this message to the commanders, to

> furnish them with relevant knowledge and to awaken in them the desire and commitment to act to protect the environment that is the quality of our life; within the IDF's work program a planned integration of environmental considerations will be carried out in order to avoid harming the environment in IDF installations and to reduce their harmful effect on the environment in Israel, out of a commitment and persistent effort to observe all the laws and regulations with regard to environmental protection that apply to the IDF.[2]

These policies were not put into practice, and disputes arose between the IDF and the MEP. The ministry frequently complained to military authorities about the lack of information about possible sources of pollution. In general, the IDF did not act methodically to pass on information about various pollutants that were discovered in its facilities that could have a real effect on the environment.[3] Due to this lack of information from the IDF, the MPE was forced to locate hazards in military bases from sampling and observation posts outside the bases or from citizens' reports. Its ability to test in the bases is restricted. Even after MPE inspectors received permission to carry out inspections, the military frequently refused them entry to the bases.[4]

The partial realization of IDF environmental policy is reflected in the corps' annual project schedule. The policy required that each service and command be required to prepare an annual project schedule concerning protection of the environment that would determine how it would advance the environmental objectives of the IDF. As of March 2004 the IAF had an "environmental master plan" for the years 2001 to 2005. This was in contrast to the other services that did not formulate a perennial master plan. The IAF planned to allocate approximately 6.5 million new Israeli shekels (NIS) in 2001. In practice, the service spent only 4.4 million NIS (75 percent) that year. In 2002 the service planned to allocate 5.30 million shekels but spent only 2.67 million (50 percent).[5] The main reason for the underallocation in practice was large cuts in the Israeli defense budget that began in 2000. These cuts were necessitated by the economic crisis that affected Israel due to the Second Intifada (that started in December 2000) and the world hi-tech crisis in the year 2000.

Among the IDF services, there is special importance regarding protection of the environment in the IAF, for better or worse, due to the potential scope of its effects. The IAF affects the environment in three ways. First, the physical infrastructure of the service has significant environmental implications. One reason is that, due to the small scale of Israel, most of the bases are located near large concentrations

of population. In the event of war, IAF bases would be primary targets of the enemy. Therefore, there is a danger that civilian communities close to the bases would suffer significant environmental damage.

Second, IAF activity in the national airspace has environmental implications. The small area of the state of Israel and the plethora of aerial threats against it imbue the IAF with considerable influence on the policy determining use of Israeli airspace. This policy, particularly the fixing of military and civilian flight paths, has significant environmental implications. Third, the Israel Defense Forces is a "people's army" and not a professional force. Accordingly, it carries out an extensive array of educational activities intended to enrich the world of its soldiers as citizens in a democratic state. For well over a decade, the IAF has been carrying out courses about the environment as part of its educational activities. This has a great potential for influencing the attitudes of the soldiers and officers regarding quality of the environment.

As noted, the present study focuses on the first aspect—the effect of the physical infrastructure of the IAF on the environment in Israel. This topic is of special interest because most of the primary bases in northern or central Israel were built during the British Mandate period and used by the British Royal Air Force. As a result, they suffer from antiquated infrastructure that does not comply with modern standards. Two of the air force bases, Ramat David in northern Israel and Hatzor in the center of the country, were discovered to be main sources of surface and underground water pollution. The Hatzor base had been a major pollution source for many years. In 1983 a leak of 20,000 cubic meters of jet fuel caused pollution measuring 300 meters long, 2,000 meters wide, and 90 centimeters deep in the Coastal Aquifer, one of the three main water sources in Israel. The Ramat David, the central base in the north, has documented repeated fuel leaks since 1974. These leaks were caused by overfilling underground fuel tanks, bad maintenance of the fuel pipes, flooding of the fuel tanks on rainy days, spilling of surplus jet fuel from planes to the ground, cleaning of planes with jet fuel and flushing the waste to the ground, leaks from the fuel lines, spillage from fuel tanks, and flushing of the surplus fuel into absorbing pits.[6] These leaks caused pollution in the Kishon River and its streams and also in reservoirs in the settlements of Nahalal and Kfar Yehoshua.[7]

The cases of pollution led to talks between the IAF, the IDF, the Defense Ministry, the Water Commission (the regulatory authority

of the water system in Israel), and the Mekorot Company (a government-owned company holding the monopoly on developing the water system in Israel). The discussions dealt with ways of solving the pollution in the Coastal Aquifer caused by the Hatzor base. The prolonged discussions led to conclusions that there had not been proper treatment of the jet fuel tanks and installations, both in Hatzor and in Ramat David. In both bases corrosion was found in the underground pipes used to transport huge quantities of jet fuel. Accordingly, the corrosion was the main source of the many leaks. The IAF was aware for many years that the solution to the problem was installation of cathodic protectors on the jet fuel tanks to help prevent corrosion. However, in practice they were installed only after 2003.[8]

The slowness of the IAF and the IDF to treat the sources of pollution caused anger among governmental supervisory and law-enforcing elements in charge of environmental quality. In 2006, Baruch Weber, head of the Polluted Industrial Areas and Land Department in the MPE, stated, "The IDF needs to map the pollution, fix priorities and begin to deal with the matter. We held discussions and talks with various elements in the armed forces, and I regret to say that no real progress has been made, not at a satisfactory pace." Weber also claimed that the IDF made it difficult for the MPE to enforce the law. "We know about problems in a number of bases, but when our inspectors want to check what is going on in other bases, they don't succeed in passing the guard at the gate." He claims that the IDF used out-of-date equipment and control systems when more-modern equipment could have prevented this pollution. He says, "The problem in the IDF is chiefly awareness. A soldier that spills fuel is not aware that the fuel seeps into and reaches springs."[9]

These claims were correct, partially, with regard to the IAF. It preferred to avoid investing in local solutions that would have prevented some of the pollution. Instead it invested in building new alternative infrastructure based on lasting development principles. The head of the quality control branch at the IAF staff in 2006, Lt Col Shai Kidon, claimed, "In the past they used to spill the oil into the channels in the area of the Hatzor base and it seeped into the earth and reached underground water." At that time the question of pollution was not dealt with in the force as it is nowadays. During recent years the base has been approved by the Standards Institution of Israel, and today there are no cases of environmental pollution. The matter of treating the

damage that was caused earlier is being examined at present by Mekorot and the Defense Ministry.[10]

Transferring the hub of the service's activity to the new bases in the Negev included the potential for solving several main problems involving the environment. First, the infrastructure that the service established in the Negev was built from the start in accordance with progressive standards. Unlike the antiquated infrastructure at bases in the north and center of the country, the new infrastructure was built with an awareness of the need to avoid pollution. Second, although the Negev constitutes 60 percent of the area of the state of Israel, only about 10 percent of the country's population lives there. The air force bases in the Negev, unlike those in the north and center of the country, mostly are not located near civilian population centers. Accordingly, they enjoy a greater freedom of action since they do not disturb the civilian population with noise.[11] Third, the redeployment of the IAF in the Negev has the potential in the long term to remove some of the restrictions on airspace in the north and center of the country. In addition, reduction of IAF activity in these areas reduces, in itself, environmental damage.

Deployment of the Israeli Air Force in the Negev after Withdrawal from the Sinai

Israel's victory in the 1967 war dramatically expanded its airspace area. These areas, specifically the Sinai Peninsula, opened up training areas for the Israeli Air Force. The force hurried to use this opportunity, preparing to use Egyptian airfields abandoned during the war and setting up air control units.[12] After the 1973 war, the IAF even built modern bases in Sinai. The peace agreement signed between Israel and Egypt in 1979 mandated that Israel remove all civilian and military presence in the Sinai Peninsula by April 1982. The treaty not only ended the dispute between Israel and Egypt, but also this idyll of open flying spaces. The IAF recognized that it would have to return and train in the limited airspace of Israel, within the 1967 borders. Pressure on Israeli airspace also was expected to be greater than before the war of 1967 because the lessons of the 1973 war pointed to the need to expand the IAF.

The IAF began to plan its redeployment within Israel immediately upon the signing of the peace agreement. One of the first decisions

was to build a high-quality infrastructure that would serve the force for many years to come. The service avoided as much as possible using temporary buildings. The redeployment was called the Ramon Operation, after the Ramon Crater in the Negev, and was carried out in two stages. Operation Ramon A included the evacuation of IDF forces from Sinai, transferring the area to the Egyptians, and redeployment of the IDF within Israel. Operation Ramon B included the redeployment of IDF forces in the Negev and in Judea and Samaria. This was carried on over a number of years and ended in the mid 1980s.[13] The main issues that the service dealt with concerning Operation Ramon are reflected in the words of the IAF's tenth commander, Gen Amos Lapidot (December 1982 to September 1987):

> Today we fly, more or less, within the Green Line and a little over Judea and Samaria. This is a very narrow area, making exercises difficult and causing congestion in air activity, and as a result there occur exceptions to flight safety rules, exceptions likely to cause an increase in the number of accidents. To a certain extent disturbance of the civilian population increases; for example, sonic booms over residential areas. In this respect the return of the Sinai Peninsula was for the IAF the loss of an ideal training ground. . . . I regard the withdrawal and contraction with the confines of the Green Line as one of the most difficult challenges, for the reasons I have stated. The second challenge is the resettlement and redeployment in new bases and the third challenge—the absorption of sophisticated and modern equipment.[14]

The focus of the IAF's redeployment was, as stated earlier, in the Negev, which served as the principal reserve land of the state of Israel. As such, it was the only area where one could build the extensive infrastructure of new airfields. Even before the start of the Ramon Operation, the IAF had many units in the Negev. However the Ramon Operation was expected to increase the military presence there significantly. It was feared that the dramatic growth in the scope of military activity would adversely affect the fabric of civilian life in the Negev. The Israeli government prepared in advance to deal with the matter. The Ministry of Defense initiated a number of interministerial committees to coordinate the redeployment of the IDF in the Negev. The IDF and government ministries decided that the military project would be a tool for the advancement of civilian development of the region. Atypically, civilian regional planning objectives of various government ministries were integrated into military programs. However, it is possible that the main environmental effect of the Ramon program was that it fixed, irreversibly, the military and civilian

allocations of land use in the Negev. Most of the area assigned to the IDF was used as training grounds and not for building infrastructure.[15]

The main involvement of the IAF in Operation Ramon was in Ramon B. In this operation the IAF managed a giant construction project that included the establishment of three new airfields: Ramon, Uvda, and Nevatim. The Ramon and Uvda bases had been established by the United States and were already operative during the withdrawal from the Sinai Peninsula in March 1982. The Nevatim base was built by the Israeli defense system. The IAF also enjoyed the allocation of training areas in the Negev. It received live-fire training ranges in areas of the western Hanegev Mountain and in the northern Arava.[16] The IAF was also involved in another aspect of the redeployment at the borders of the Green Line. The redeployment in the Negev obligated the closing of airspace to civilian aircraft and a revision of civilian flight paths. The IAF cooperated with the Ministry of Transport and Road Safety and the Civil Aviation Authority in the revision of Israeli airspace.[17]

Redeployment of the IAF in the Negev from the Year 2000

In the 1990s the IDF and the IAF were under growing pressure to transfer army camps from the center of the country to the periphery. This pressure stemmed partially from the desire of civilian elements to use the land that the IDF would vacate for civilian purposes. However, it also reflected a growing awareness of the pollution caused by military bases to the soil and underground water, decreasing toleration of noise nuisance, and lastly, air pollution caused by the activity of the IAF. To a lesser extent was the fear of damage to the population concentration in the center of the country in the event of ground-to-ground missile attacks against the military bases in the region.[18] With the passing of time, this pressure partially bore fruit when the defense system agreed to vacate some of its bases. Most of the units involved were slated to move to the Negev. The IDF prepared plans for redeployment under the name "The IDF Goes South." The IAF part in the plan was called "IAF to the South." These plans were integrated into the civilian development plan for the Negev—Negev 2015. The main points of the plan, which set a strategic vision for the development of

the Negev for the years 2005 to 2016, were approved by the Israeli government on 20 November 2005.

The transfer of thousands of families of career officers to the Negev due to the military redeployment was a central component of the plan. Moving families of IDF officers, belonging to the upper-middle class in Israel, to the Negev was perceived as beneficial to economic activity and physical development there.[19] Together with its contribution to the promotion of civilian development objectives, the IDF regarded the IDF Goes South as a chance to create a military center of gravity in the south of the country—a new center of gravity that would improve the operational capabilities of the IDF should its bases in the center of the country be attacked.[20]

The IDF Goes South plan was different in a number of aspects from Operation Ramon, in which the IDF set up expansive new infrastructures. In IAF to the South, the IAF focused on extending the existing military infrastructure. Almost no new bases were established. Each one of the services established a special administration to plan the redeployment in the Negev. Similar to the military-civilian cooperation in Operation Ramon, the planning process took into account the possible effects on the way of life, infrastructure, and economic life of the citizens in the Negev. The IAF administration was the first to implement plans for redeployment. The first step was the closure of the base in Lod, in the center of the country, and the transfer of its units to the southern base at Nevatim. The IDF invested a huge amount of money, in Israeli terms, in extending the infrastructure at Nevatim: approximately 1.6 billion NIS (350 million US dollars).

According to Col Zvi Tweezer, head of the administration of IAF Goes South,

> The Lod base is very old fashioned, having been built bit by bit over the years, and from the standpoint of infrastructure that we built in Nevatim, there is no doubt that we have made a great improvement over what the unit has been used to till now. The change begins with a long, state-of-the-art, runway, progresses to upgraded parking slots for planes plus advanced communications infrastructure, ending with an extensive improved defense cover that will be built in the base.[21]

The construction work in Nevatim began in June 2004. The units from the Lod base, the main base for the IAF's transport squadron, transferred to Nevatim in August 2009.[22]

The extension plan of the infrastructure at the Nevatim base paid special attention to quality of the environment. Among other things,

a power station powered by natural gas will be built in the base with a production capacity that exceeds the anticipated needs of the base. The surplus electricity created is intended to serve also the nearby civilian settlements. Similar to many IDF bases, the base had internal sewerage prone to leakage. The IAF administration planned to connect the base to the regional sewage treatment facility to reduce the risks of polluting soil and underground water.[23]

The increased emphasis on environmental considerations in the IAF plans reflected a greater change in the service's perception of the subject. The service began to understand that environmental damage has negative implications in operational, economic, and even social terms. Toward the end of the first decade of the twenty-first century, the IAF invested a great deal in its contacts with the MPE, answering a call from the ministry to the IDF to increase cooperation between them. The ministry demanded that the IDF, as the largest consumer of resources in Israel, help by reducing its harmful effects on the environment. Among other matters, the ministry called for improved coordination in allotting money from the defense budget to protect nature and to reconcile the goals of the ministry with military development plans. According to a senior source in the ministry,

> We have a solution for each environmental problem that arises and we would be happy to deal with it. The complexity is caused when there is a lack of reporting of damage. The amount of requests from commanders nowadays is greater than in the past but still not enough. Reporting straight after an incident has occurred enables reduction of damage, even when it is a question of water or ground pollution.

In his view the greatest stumbling block when working with the IDF is the lack of budget coordination. "There is readiness on behalf of the commanders responsible for projects in the field. Allocation of resources for that purpose is more complicated."[24]

A meeting took place between then-commander of the IAF, Brig Gen Eliezer Shakedi and the then-director of the MPE Shai Avital in December 2007 that turned out to be a historic milestone. Also attending the meeting were personnel of the MPE, IAF base commanders from the south, and relevant officers from IAF headquarters. The top echelons of the IAF proposed strengthening its activity in the environmental field and pointed out several possibilities, such as recycling of sewerage and solid waste, reusing drain water, creating solar electricity, building drain water systems for irrigation, and

implementing green building, environmental education, and the transition from diesel fuel to natural gas, among others.[25]

The increasing cooperation between the MEP and the IAF led to positive results in the southern IAF bases. For example, in the Ramon base in 2007, one of the officers was put in charge of treating the environmental damage. On his initiative the base began to recycle the waste it created extensively. The command of the base actively helped and set up a site designated for sorting the waste. It also issued a directive ordering the soldiers to evacuate the waste in the base to the sorting site and set up a recycling goal of 80 percent of the base's waste. The recycling was expected to yield financial profit, since the recycling companies began to buy the sorted waste. According to the Ramon base commander, Col Avishai Halevi,

> Those that serve in the base do not perceive recycling to be a burden, but as a small investment that contributes to the protection of the environment, and which also helps us to make a profit that helps us to improve the welfare of the soldiers. In almost every place on the base there is a Green corner where waste for recycling is sorted and oils drained. We understand that we have the obligation to the soil, and we have to find new ways to recycle and not to return harmful substances.[26]

The focus of environmental considerations in planning the redeployment of the IAF in the Negev was reflected in educational activities in the service's bases in the south. From its inception the IDF considered itself, as the people's army, obligated to investing in the promotion of the education of its personnel, and traditionally, these programs dealt with love of the land and the history of the Jewish people and of the state of Israel. During the 1990s, these educational programs began to deal also with environmental topics.[27] This was especially prominent in the southern IAF bases where educational programs were developed that were meant to raise the awareness and broaden the knowledge of soldiers regarding quality of the environment.

The IAF base at Uvda developed a range of programs demonstrating the potential in educating conscripted soldiers (aged 18–21) to promote awareness of the environment in Israeli society. It was decided in 2006 to establish an ecological park integrating mud buildings in the base. In the park sitting areas, a *tabun* (clay oven) for baking, environmental benches, and statues were designed and all constructed from mud and recycled materials. The park was built under the leadership of six women from the families in the base, who had learned to build from mud in Kibbutz Lotan. The kibbutz residents

are experts in ecological subjects and run projects on the matter. In the words of Tahal Biran, the project's coordinator at the time and resident of the military families' neighborhood, "We have for a long time been looking for a project connected to the environment. In the kibbutz we took a course on building from mud, and right now we are applying what we learnt in a first attempt to build the ecological park." She argues that the clay earth and the weather of the Negev enable the creation of mud buildings in a particularly efficient manner. According to her, the project succeeded to enlist all the families living in the neighborhood during 2006. "The children in school and the families provide the domestic waste, and thus help the environmental sculpture." After the end of the first stage, the soldiers at the base took responsibility for the project.[28] Another educational initiative that crystallized at the base in 2007 was the "Sabbath of Values." Each weekend, military and civilian rabbis alternately gave lessons on Judaism, Zionism, love of one's country, and protection of the environment.[29]

As part of the effort of the IDF and the IAF to aid civilian authorities in the Negev, a program was formulated called "Sites and Values." The program was developed at the initiative of the Educational and Youth Corps and the *Beit Morasha* of Jerusalem (literally, "Home of Tradition"), a civilian educational center. Within the framework of Sites and Values, soldiers at the base adopted the cover sands in the eastern Uvda valley. The cover sands are chalk sand dunes constituting the habitat of rare plants and many species of animals. The soldiers helped the inspectors of the Israel Nature and Parks Authority southern district to maintain the site. Likewise, the base planned workshops on values at the site. In the words of the then-education officer of the base, 2nd Lt Noa Kenan, "We regarded the cover sands as a source for acquiring values for the soldiers of the base. The adaptation of animals to the desert environment and the aridness is impressive, and it is comparable to values such as the adaptation of the fighter to his/her environment and to self-discipline." According to her, the site will be used for instilling love of homeland and the importance of settling the Negev and for the creation of a link between those serving at the base and the environment in which they live. The base command also planned to help maintain and protect a nearby archaeological site called *Mikdash Hanamerim* (Temple of the Tigers). In the temple, 16 illustrations of tigers were found, made from small tablets of local limestone. This rare find, which is estimated to be

thousands of years old, was not protected against all-terrain vehicles. The base command, in cooperation with inspectors and ecologists from the southern district in the Israel Nature and Parks Authority, intends to fence the site.[30]

Operational Implications of Environmental Considerations on IAF Activity

The growing awareness in the IAF of environmental considerations also had implications on its operations. These implications found expression in several areas.

Damage to the Civilian Environment in the Event of Attacks on Bases

In most of Israel's wars there were hardly ever attacks on IAF bases within the 1967 borders. The environmental damage likely to be caused in the event of ground-to-ground missiles being fired at IAF bases was exposed during the Second Lebanon War (July–August 2006). During this war thousands of rockets were fired at northern Israel, including at several main IAF bases. One of those hit was the northern aerial control unit located on Mt. Meron. The unit is situated in the heart of a nature reserve that constitutes a natural habitat of rich vegetation and many animals. Rockets falling in the reserve ignited blazes that destroyed many thousands of square meters (or *dunams*, which are the area of 1,000 square meters) of natural forest. After the war ended, during the months of August and September 2006, several *dunams* of natural forest were felled next to the base to minimize potential damage in a future war. Although this was likely to harm the animals and plants existing in the nature reserve, the Israel Nature and Parks Authority deemed it a necessary step. Guy Cohen then Israel Nature and Parks Authority inspector in charge of the Mt. Meron Reserve said, "During the war we visited the base several times because we wanted to comprehend the extent of the base's responsibility and also to minimize the damage that such a felling would cause to nature, and to us, who protect it." The IAF hired a contractor that carried out the work of thinning the trees. All in all, about ten *dunams* of natural forest were felled inside the base and up to a distance of 15 meters from the base fence.[31]

Increase in Restrictions on Exercises

At the end of the twentieth century and the beginning of the twenty-first, the IAF was required to prepare for action on a wide range of missions. It played a crucial part in the military action in the Second Intifada, 2000–2005, and in the Second Lebanon War. In these conflicts the IAF was required to operate in urban environments densely populated with civilians. Simultaneously, it prepared for the possibility that it would be required to act against countries far away from Israel and even for the event of a conventional war. However, the IAF is being increasingly restricted in its ability to train. The proximity of the bases to civilian population centers in the north and the middle of the country created severe noise disturbances. In several cases the IAF decided to limit the hours of activity in the bases.[32] In other cases, certain training contours, such as low-level flights, led to angry complaints from civilians. As a result, it is possible that its ability to train in an optimal way was harmed.[33]

Development of Simulators and Cooperation with Foreign Air Forces

The lack of training areas led the IAF to invest in two kinds of partial solutions. The first was the development of advanced simulators.[34] The investment was expressed both in the systems themselves, meant to be as realistic as possible, and in the training of the simulator operators.[35] The simulators enabled IAF pilots to train on contours they were forbidden to fly because of safety and environmental protection restrictions. The IAF aspired to develop systems that would enable communication between different simulators. This capability, when achieved, would enable joint training in the simulator for combat, helicopter, and transport pilots.

The second partial solution was creating cooperation with foreign air forces, beginning in the 1990s. One of the main aims was to attain the opportunity to train in foreign countries. Thus, the IAF could train, for the first time since the withdrawal from Sinai, in vast spaces. As opposed to Sinai, where it was only possible to train under desert conditions, IAF squadrons began to train overseas in varying environments.[36] Together with training in recognized international exercises such as Red Flag in the United States or Maple Flag in Canada, the IAF trained in states such as Italy and Turkey.[37] The cooperation between the Israeli and Turkish air forces was especially fruitful.

In the words of Brig Gen Ram Shmueli, who played a central part in his capacity as head of the Combat Training Branch at IAF Headquarters, "In my first job as Head of Branch for Combat Training I managed to lead the IAF to one of the most important strategic connections—cooperation with the Turkish Air Force. When I began my post I made it my mission to bring about combined exercises with a foreign air force. Not that I had an inkling of how to do this but I felt that this was important." At that time, then-Prime Minister Yitzhak Rabin decided to establish diplomatic ties with Turkey, and Shmueli notes,

> Suddenly the opportunity we had been looking for arose. At the highest echelons it was decided to send a group from the General Staff to the Turkish Air Force to build a foundation of cooperation. As Head of the Branch for Combat Training I was chosen to be head of the delegation sent to Ankara. . . . The first talks were characterized by suspicion and tension on both sides. Both we and the Turks did not know what the other side thought and what exactly the aim of this idea was. Little by little, meeting after meeting, the chilly atmosphere thawed.[38]

The cooperation between the Israeli and Turkish air forces was quite close and included joint exercises in both countries. Over the years it expanded to multinational exercises with additional air forces. The cooperation ran into difficulties in October 2009 after the Anatolian Eagle exercise was cancelled. The planned American, Turkish, and Israeli air force combined exercise was cancelled by the Turkish government.[39] The incident illustrated the growing security importance that Israel attributes to cooperation between the IDF and foreign armed forces and the resulting dependence created on foreign states.

Conclusions

Since the 1990s, the IAF has shown increasing sensitivity to the effects of its bases and their activities on the environment in Israel. This is part of a growing awareness by the IDF of its influence on environmental quality as Israel's largest consumer of resources. The present study found that the IAF devoted considerable attention to environmental topics in two spheres: physical infrastructure and education. The IAF is aware of the environmental implications of its physical infrastructure due to pollution damage resulting from the antiquated infrastructure in the Ramat David and Hatzor bases. As early as the Ramon Operation in the 1980s, the IAF recognized the

advantages of a high-standard, permanent infrastructure. Nevertheless, at that time the main attention was devoted to financial gains resulting from ignoring this need. The planners of the IAF Goes South project paid a lot of attention to environmental issues. The IAF made a conscious decision to avoid as much as possible the renovation of its out-of-date infrastructure in its bases in the north and center of the country. Instead, projects were integrated that were intended to minimize damage to the environment and to bring about a reduction in the consumption of energy in the redeployment to the southern bases. The growing recognition by the IAF of the implications of its activities on the environment constitutes a large part of the changes in the civil-military relations in Israel. In the past, Israeli society revered the IDF as the realization of Zionist values. After the debacle of the 1973 war and, even more strongly, since the 1982 Lebanon War, Israeli society began to show growing criticism toward the IDF.[40] This criticism enabled the formation of pressure groups that demanded the IDF change its policies on specific matters.[41]

The IDF succeeded over the years in adopting policies intended to reduce possible criticism. For example, in the 1980s and 1990s, parents who had lost their sons in training accidents criticized IDF safety procedures and methods of inquiry into training accidents.[42] As a result, the IDF improved safety procedures in exercises and succeeded in dramatically reducing the number of accidents. The military even took care to publish these facts in the media to avoid future criticism. The attention that the IAF directed at environmental issues in the project IAF Goes South is similar to the IDF's policy in other areas with a high public profile. The IAF probably would not have given attention to environmental issues had the Israeli public not shown increasing awareness of the economic, social, and health damage stemming from environmental pollution.

Proof of the IAF's utilitarian attitude toward handling the environmental damage it caused was expressed by the negligible financial allocation to the issue. As previously mentioned, the IAF did not even use its entire meager environmental budget allotment in the years 2001–2002. It even refused to extensively treat the damage caused by fuel leaks in the bases at Ramat David and Hatzor. Officially, the IAF declared that the out-of-date infrastructure in the bases would be renovated within the framework of a multiyear plan. The practical significance of this declaration was that many years would pass

before the rehabilitation of the antiquated infrastructure that continued to be a possible source of pollution.

The second field in which the IAF acted extensively to promote environmentalism was that of education. It initiated a range of creative activities to promote awareness of quality of the environment in its soldiers and officers. It is possible that the principal influence of the IAF's operations will be in this field. Since the beginning of the decade, many thousands of enlisted soldiers who have been exposed to these activities have been released from the IAF. If the educational programs were effective, these young people internalized the need to become aware of environmental issues and have been instructed how to contribute to environmental protection. The traditional educational elements in the IDF and in the IAF derived, as pointed out previously, from the IDF being a "people's army." The essence of the activity was in promoting those values regarded as having a national consensus. The changes in civil-military relations and the widening schisms within Israeli society resulted in some educational activities in the IDF becoming controversial. From this angle, environmental issues that are a "consensus" in Israeli society helped educating elements in the IAF prove that they could contribute to developing the manpower of the service and its image.

It seems that the IAF did not clearly recognize the connection, indirect but significant, between growing Israeli environmentalism and the growing restrictions on its operational activity within the state of Israel until recently. This may be the main reason for the lack of consideration of the environmental implications of IAF operations. Because the Israeli Air Force has been fighting constantly since its establishment, its organizational culture inclines toward consideration of force employment at the expense of force generation. Accordingly, the role of environmental considerations is limited if they are not included in the planning and execution of operations. This approach contradicts the growing attention of the international community to environmental considerations in attacking infrastructure targets such as fuel tanks or power stations.

In spite of the reservations mentioned, the very fact that environmental considerations had a practical effect on the largest IAF infrastructure project in decades is a significant innovation. The activity of the service in this field is demonstration of a possible contribution of armed forces to improving the quality of life and development of the whole of society.

Notes

1. Israel State Comptroller, "Treatment of the Ministry of Defense," 78.
2. Ibid., 88–89.
3. Ibid., 80–82.
4. Ibid., 83.
5. Ibid., 89–90.
6. Oren and Regev, *Land in Khaki*, 426.
7. Ibid.
8. Ibid.
9. Weiss and Salome, "Ministry of the Environment Claims."
10. Ibid.
11. Despite the sparse population in the Negev, during extensive activity such as annual exercises, the residents of the Negev complain about the noise of the planes. See Buchbut, "Training for Long Runs."
12. Habakuk, "First Sixty Years," 69.
13. Oren and Regev, *Land in Khaki,* 102–3.
14. Lapidot, "Special Interview," 6–9.
15. Oren and Regev, *Land in Khaki,* 104–5.
16. Ibid., 105–9.
17. Ibid.
18. Ibid., 168.
19. Ibid., 187.
20. Ibid., 181.
21. Arden, "Conquering the Negev," 6.
22. Oren and Regev, *Land in Khaki,* 186.
23. Arden, "Conquering the Negev," 6.
24. Karni, "In the Ministry for Protection of the Environment," 9.
25. "IAF Will Promote Environmental Issues."
26. Wolff, "Soldiers Recycle," 15.
27. Israel State Comptroller, "Treatment of the Ministry of Defence," 93–94.
28. "Uvda Base: Deep in the Mud," 16.
29. Wolff, "Uvda Base," 17.
30. Karni and Avior, "Uvda Base," 18.
31. Karni, "After the Fighting," 18; and Karni, "Animal, Plant and Vegetable," 13.
32. Ashkenazi, "Grounded due to Ceramics Class," 28.
33. Ibid.
34. On the importance of simulators in the IAF, see Pfeffer, "Under Simulated Fire"; and Yehoshua, "New in the Air Force."
35. Concerning the simulator systems, see Sharon, "New," 9–11. Electronic version available at http://www.iaf.org.il/454-18564-HE/IAF.aspx. For the training of simulator operators, see Pfeffer, "Under Simulated Fire."
36. The IAF utilised exercises in foreign countries for training long-range squadrons. The growing threats against the state of Israel from distant countries such as Iran magnified the importance of the IAF's ability to operate at long range. See Shuval, "Italian Job." The IAF does not normally practice for long-range flights in simulators. See Pfeffer, "Under Simulated Fire."

37. The IAF participated in Red Flag in 1988 as an observer. In 1998 the IAF renewed its participation as an observer and even participated later on. See Peled-Fleischer, "Israeli Pilots Took Part," 8–12; and Shuval, "Italian Job." Shuval claims that cooperation between the Israeli and Italian air forces began in 1999 and that they include periodic joint exercises.

38. Rosenberg, "Man, Earth and the Heavens." Electronic version available at http://www.iaf.org.il/1102-18386-he/IAF.aspx.

39. At the time of writing, no one knows for certain why it was cancelled. In Turkey they claimed that the exercise was cancelled due to the negative Turkish public opinion toward Israel as a result of the IDF activity in the "Cast Lead" operation in Gaza at the beginning of 2009, or due to the anger of the Turkish defense system about a problematic arms deal with Israel. For example, see Eichner, "Turkey Soothes."

40. Concerning changes in civil-military relations in Israel, see in particular Cohen, *Israel and its Army*.

41. In fact, the activities of feminist pressure groups led to the integration of women in the flying course of the IAF during the 1990s. Cohen, *Israel and its Army*, 76.

42. Peri, "Civil-Military Relations in Israel in Crisis."

Chapter 11

Airpower and the Environment

Some Ecological Implications of Modern Warfare

Joel Hayward

This chapter examines the complex relationship between warfare (especially airpower), international humanitarian ethics, and environmental ethics. My philosophical framework should be easy to understand. Although I recognize intrinsic worth in the natural environment—it has a value in its own right regardless of what humans gain from it—I am primarily concerned with its instrumental value. That is, I argue from an anthropocentric vantage point that we should safeguard the environment and its myriad complex ecosystems because humans are part of those ecosystems and their security, health, and happiness depend entirely upon them. I see no conflict or inconsistencies between environmental ethics and the ethics of war. Western warriors increasingly understand that the environment is in many ways the collective property of all humanity, including future generations, and that responsible stewardship is critical regardless of the good and bad governments and regimes that might exist at any given time within man-made boundaries. In this respect the environment is highly akin to "cultural property" protected from damage or deliberate destruction by the 1954 Hague Convention for the Protection of Cultural Property.[1] The significance of the physical environment is actually inestimably greater than the "property of great importance to the cultural heritage of every people"—including unique architecture, archaeological sites, and other objects of artistic, historical, or cultural importance—that the convention considers inherently valuable and morally inappropriate as targets of military action.

Note: A version of the chapter "Air Power and the Environment: Some Ecological Implications of Modern Warfare," by the editor of this volume, has appeared in *Air Power Review* 12, no. 3 (Autumn 2009): 15–41 and is published here with permission of the *APR* editors.

Moreover, the West's ethical framework for understanding armed conflict, "just war," forms a sizeable chunk of its warrior code. Within this code, warfare is a regrettable activity directed against the culpable, undertaken only when a better state of peace is the likely outcome and if the good accomplished outweighs the harm done. Deeply embedded within just war are concepts of proportionality and discrimination. In terms of *jus in bello* (the criteria for fighting wars "cleanly"), proportionality means that military forces must not undertake any actions in which the incidental harm would be excessive in relation to the likely military benefit. Throughout my own career of teaching military officers, I have ordinarily summarized this concept by encouraging them never to use more force or to cause more damage than is necessary to guarantee the attainment of just military goals. Similarly, discrimination means that military forces may only wage war on combatants and military objects and must act purposely and painstakingly to ensure that civilians suffer no more harm than military necessity demands. It is thus eminently logical that, as Western warriors are framing their use of force in terms of minimizing suffering while doing good—all the while protecting the innocent, including those on the other side—they should understand the importance of minimizing harm to the very environment and habitat that sustain the innocent. It is equally reasonable that, as the purpose of military activity is a better state of peace, it would be incongruous to inflict damage upon the innocents within the opposing state, and possibly within neighboring states, that lasts well beyond the end of conflict and complicates the restoration of harmony.

Lastly, I strongly disagree with those ecologists who assert that we need to take an absolutist stance against all military activities that result in any ecological harm. Our just war criteria are adequate as a guide for military planners and practitioners. Both proportionality and discrimination involve careful calculations that render some regrettable harm acceptable when balanced against the greater good being achieved. I accept this line of reasoning and argue, not for absolutist prohibitions, but for the inclusion of ecological protection in all military planning and for it to be weighed expertly, along with the likely need for postwar remediation activities, among the factors that will ultimately determine the justifiability of military actions.

This chapter draws on the Kosovo conflict as its central case analysis to give readers something recent upon which to reflect that does not involve the emotionally charged "war on terror." (Equally powerful

examples of environmental harm caused by airpower and other forms of military force can also be found during that so-called war.) The chapter is not intended as the last word on the subject of the real and potential ecological ramifications of modern airpower but merely as a first word. It aims to demonstrate some complexities within the closely intertwined relationship between defense and security priorities, international humanitarian law, the Western just war framework, and environmental ethics. It offers several observations and asks a set of questions in the hope that readers will feel prompted to seek their own answers. It is my belief that air forces should engage these issues proactively, addressing them on their own terms with judgment and at a realistic tempo before public pressure and special interest groups might compel defense ministries to make sweeping changes, some of them possibly rushed and unhelpful.

Since ancient times armies have often consciously used the natural environment as a weapon against opponents. They have poisoned wells, salted fields, burned crops, and done other ecologically harmful things. In 1945, for example, German officers who feared an Allied attack intentionally flooded 20,000 hectares of agricultural land in the Netherlands, leaving it unusable for crops until the Dutch finally reclaimed the land four months later after a massive rehabilitation program. I began thinking about the ecological implications of modern air warfare when, as an undergraduate, I studied the environmental damage caused by the RAF bombing of the Möhne and Edersee dams in May 1943 and the USAF atomic bombing of Hiroshima and Nagasaki in August 1945. I was surprised most of all to learn the full extent of the American defoliation program during the Vietnam War, which represented a watershed in the relationship between warfare and the environment. Between 1962 and 1971, US aircraft sprayed 3,640 square kilometers of South Vietnam's croplands, deep vegetation, and jungles with 55,000 metric tons of herbicides and defoliants to destroy the plant-based ecosystem for the purpose of disrupting agricultural food production and destroying plant cover for the Vietcong.[2] Its effects were dreadful for Vietnam's ecosystems and, most infamously, for human health.

My thinking about the relationship between warfare and the environment began to focus in March 1999 when NATO airpower began wrecking Yugoslavian (especially Serbian) infrastructure in a well-intended but poorly conceived attempt to coerce Slobodan Milosevic's government into protecting and granting more freedom to the beleaguered

Albanian ethnic majority of Kosovo and Metohija. I felt disappointed that, even in our era of effects-based operations and precision-strike capabilities, NATO chose to wreck almost all major oil refineries, petrochemical installations, and fertilizer works, as well as their tankage areas. NATO thereby spilled harmful oil and toxic chemicals into the soil, aquifers, and waterways—including into the Danube River, the crucial economic artery of several uninvolved nations—and created carcinogenic, mutagenic, toxic, and perilous airborne pollution. These acts were widely publicized and highly controversial. Like many concerned observers, I wondered why, in a war fought for humanitarian purposes, with a highly commendable, almost obsessive desire to ensure the totally accurate placement of ordnance to minimize immediate civilian deaths, NATO nonetheless seemed reckless with Yugoslavia's natural environment.

I began researching this particular issue in July 2006 after feeling equally disquieted when Israeli Air Force airstrikes created a dreadful six-mile-wide and 100-mile-long oil slick along the Lebanese coast by striking an oil storage depot at the Jiyeh power plant, about 19 miles south of Beirut, flooding 15,000 tons of oil into the Mediterranean and causing the worst-ever oil spill in that sea. A further 25,000 tons burned for 27 days, reportedly "spewing a toxic cloud into the air and causing a rain of toxic oil downwind."[3]

Targeting oil infrastructure from the air is not new. During the Second World War, for instance, both Allied and Axis air forces considered oil production, refinement, storage, and transportation facilities, and systems as integral to their enemies' viability and survivability. Even the Luftwaffe, which was designed and utilized primarily for battlefield interdiction and attack, bombed Caucasian oilfields in 1942 in an angry attempt to punish the Soviet Union.[4] During the last three months of the Pacific War, the USAAF conducted a weighty campaign aimed at destroying Japan's oil infrastructure.[5] The greatest counter-oil campaigns occurred during 1943 and 1944, when the USAAF struck the Romanian oilfields and refineries that supplied a large portion of Germany's oil and both the RAF and the USAAF wrecked synthetic fuel plants across Germany.[6]

The targeting of oil sharply divided senior Allied air commanders, but only because some of them passionately argued against its purported strategic effectiveness and not because anyone felt gravely worried about the natural environment.[7] Decades before scientists began expounding concerns about "acid rain," "sustainability," "carbon

emissions," and the "greenhouse effect," and during a war in which neither side worried much about the suffering of enemy populations, these great campaigns caused levels of local environmental harm that were not analyzed in any of the major postwar bombing surveys and which would be unacceptable in any of today's limited wars.[8]

I would not dream of casting stones at our valiant forebears. It would be wrong to impose the widespread ecological values of today onto previous generations. Moreover, we cannot attribute responsibility for large-scale oil pollution during the Second World War solely to air forces. For example, navies, equally unaware of the long-term harm likely to occur, targeted and sank not only fuel-laden warships, but also each other's merchant ships, including oil tankers. Indeed, the combined gross registered tonnage of the oil tankers sunk was 1,235,097, with a total oil-carrying capacity of as much as 17,171,183 barrels or 2,592,380 tons.[9] That is the equivalent of one *Exxon Valdez*–size spill occurring every month of World War II.

Petroleum, oil, and lubricants (often simplified as "POL") infrastructure remained a primary target set for airpower planners throughout the Cold War and following decades and featured prominently, for example, in the USAF and USN Rolling Thunder and Linebacker bombing campaigns against North Vietnam.[10] In 1988 the most celebrated airpower thinker of recent times, John Warden III, maintained that the "petroleum chain . . . still remains a potentially key target simply because a modern military machine cannot function without fuel."[11] Indeed, Warden argued that, along with electricity, oil was a major center of gravity (one of his five "rings") and that carefully focused attacks on the oil chain would denude the enemy of energy. Warden's ideas influenced the Gulf War of 1991, during which coalition air forces wrecked Iraqi oil storage and distribution installations—but not all long-term export infrastructure—as part of a campaign aimed at paralyzing Saddam Hussein's state and forces.[12] (The Iraqis created far more devastating environmental harm when they detonated more than 700 Kuwaiti oil wells, igniting over 600 of them, and discharged more than six million barrels of crude oil directly into the Persian Gulf. Happily for airpower advocates I must note that precision airstrikes by USAF F-111Fs against pumping stations and manifolds actually stemmed that horrific flow.[13]

Warden and other air strategists of his generation did not analyze (and to be fair probably gave no thought to) the key problem with destroying or damaging oil infrastructure as opposed to merely

disrupting distribution. They ignored the fact that liquid hydrocarbons and the chemicals utilized in their refinement are potentially extremely damaging to ecosystems. The explosive or incendiary force of ordnance either burns the petroleum upwards, creating potentially deadly air pollution which may cause dreadful health problems in the short term (but thankfully seldom causes lingering harm after the pollution dissipates), or spills it into the ground, with the potential for long-lasting and calamitous contamination of soils, aquifers, and waterways. The *Commentary on the 1977 Additional Protocols to the Geneva Conventions* states, "As regards the destruction and setting alight of refineries and petroleum storage facilities, it is hardly necessary to stress the grave danger that may ensue for the civilian population."[14]

NATO's 1999 attacks on Yugoslavian refineries and petrochemical and fertilizer installations at Pančevo, Novi Sad, and elsewhere created such demonstrable environmental pollution—with the wreckage, spills, fires, and billowing clouds being captured on the camcorder of local inhabitants as well as more expertly by journalists—that when the Serbian government accused NATO of creating an environmental catastrophe, it was not a lone voice. Even the relevant watchdog agencies within the United Nations and other reputable and nonpartisan interstate bodies expressed strong concerns about the attacks. Neither they nor Western media could brush aside the Serbian governmental allegations (which exaggeratedly described the violence as "ecocide") as merely unverifiable and unwarranted anti-NATO propaganda.[15] With many scores of thousands of Serbians evacuating towns and villages to flee clouds of toxic chemicals, with slicks in the Danube, and with smoke plumes moving eastward over Romania, Bulgaria, Moldova, Ukraine, and the Black Sea,[16] it was impossible to deny that, even if only in the short term, the attacks had an adverse and widely dispersed environmental impact.[17]

NATO argued emphatically that the 100 or so industrial facilities it bombed throughout Serbia were "dual-usage" installations and thus legitimate targets according to sections of the 1977 Additional Protocol I to the 1949 Geneva conventions. For example, NATO described the Pančevo refinery and works, the largest petrochemical complex in the Balkans,[18] as a "strategic target" that "provided oil and other elements to support the Yugoslav Army. By cutting off these supplies [NATO] denied crucial material to the Serbian forces fighting in Kosovo."[19] Although civilian facilities are ordinarily strictly off limits, Article 52(2) does indeed permit attacks on those facilities

"which by their very nature, location, purpose, or use make an effective contribution to military action and whose total or partial destruction, capture or neutralization, in the circumstances ruling at the time, offers a definite military advantage."

The moral "double-effect" principle embedded within *jus in bello* also permits the targeting of dual-usage infrastructure and makes allowance for incidental civilian deaths if those deaths are *unavoidable*. Yet, it permits this targeting only if it is *solely* intended to affect the capability of the opponent's armed forces. If NATO's intent was also to demoralize the Serbian population to generate additional pressure for the Milosevic regime to capitulate, then the double-effect principle no longer justifies these actions.[20]

Unfortunately, this seems to have been the case. Even if one chooses to argue that oil refineries were providing fuel for military operations as well as for civilian consumption, and were thus reasonable dual-usage targets, it is harder to make an equally strong case for pharmaceutical factories, car factories, and even fertilizer plants.[21] The view that NATO wanted to put pressure on Milosevic through squeezing and scaring his people by wrecking things around and among them gains support from the US military's own reported admission to Human Rights Watch that NATO destroyed some targets that were not legitimately "dual-usage" and did so because they were "symbolic" and "psychologically lucrative."[22] Human Rights Watch found that such actions were "done more for psychological harassment of the civilian population than for direct military effect." This conclusion is reinforced by an ironic source: the NATO joint air component commander, Lt Gen Michael C. Short. "If you wake up in the morning," he told the *Globe and Mail* on 26 May 1999, "and you have no power to your house and no gas to your stove and the bridge you take to work is down and will be lying in the Danube for the next 20 years, I think you begin to ask, 'Hey, Slobo[dan], what's this all about? How much more of this do we have to withstand?' "[23] Perhaps with a boast, he later said that he had wanted the Serbian leadership "to wake up to a city that was smoking."[24] He even admitted that he had warned Serbian air force commanders, "The speed and the violence and the lethality and the destruction that is going to occur is beyond anything that you can imagine. . . . If you force me to go to war against you, Belgrade will never look that way again—never in your lifetime, or your children's lifetime. Belgrade and your country will be destroyed if you force me to go to war."[25]

Even ignoring this unusual ethical position, NATO failed to explain convincingly why its remarkably precise and thus potentially highly discriminate air force needed to destroy the storage tanks, thus burning or spilling staggering quantities of liquid hydrocarbons and chemicals, rather than less harmfully targeting the adjacent but separate refinery installations, or, far better still, precisely hitting the more discrete river port, road, and rail nodes to stop loading, transportation, and distribution of the oil and chemicals.[26] NATO did publicly explain on 3 May 1999 that it had damaged Serbia's main electricity stations and thus robbed the Serbian population of 70 percent of its electricity. Spokesman Jamie Shea even publicly stated that Milosevic would thus know that NATO "has its fingers on the light switch. . . . We can turn the power off whenever we need to and whenever we want to."[27] Yet NATO's information campaign included no real effort to explain why it was setting ablaze and flooding oil and chemicals in refineries and storage facilities instead of merely "switching off" those installations by accurately targeting their internal and external sources of electricity. Aircraft did target and destroy local transformers at the sites, interrupting their functionality, so it is less clear why NATO still chose to inflict such heavy and dangerous damage to the plants, oil, and chemical tanks. Further, NATO did not explain why, after a European Union total oil embargo of Yugoslavia came into effect on 30 April 1999[28]—NATO's chief spokesman claimed on that date, "the tap is being turned off all across Europe,"[29]—it continued to burn and spill huge quantities of oil and chemicals right up until the conflict's last days.

During the war NATO responded to accusations of grave environmental harm in a very strange fashion. Aware that the world rightly felt horror at the expulsion and panicked flight of 850,000 Kosovars, NATO exaggerated the physical harm being done to their abandoned dwellings by the Serbian army and by Serb paramilitaries. It maintained at one point that there were then "200 burning villages, town and cities" across Kosovo.[30] After presenting exaggeration, it then relativized the environmental harm being committed by both NATO and the ethnic cleansers.

> We see a lot of smoke, the smoke is coming from all of these burning villages in Kosovo and if you're talking about environmental damage, I think the "scorched earth" policy applied to Kosovo, the destruction of livestock, the destruction of rivers and roads and communication routes, the destruction of the agriculture, the slaughtering of a large percentage of the cattle and the

> livestock, is going to be much more significant in the long term and incidentally require a lot more money to fix than the repair of some oil refineries.[31]

This tu quoque defense ("You can't criticize us for our wrongdoing because you're doing it too!") was disingenuous at best and dishonest at worst. Some Serbian regular army units and paramilitary groups did atrocious, murderous things in Kosovo, but they did not apply a "scorched earth" policy to the province, let alone cause or threaten a long-term environmental catastrophe involving the destruction of permanent natural features and resources. And the complaints leveled against NATO related to the imperilment of human life and widespread and potentially enduring damage to fragile ecosystems, not to the cost of repairing oil refineries.

NATO's inadequate explanations and attempts at justifications did little to assuage concerns all over the world about its *jus in bello* proportionality. Even worse, NATO's actions and media ops failures resulted in accusations—and even formal charges presented at the International Court of Justice—of willful and criminal contravention of Articles 35(3) and 55(1) of the Additional Protocol I explicit prohibition against "widespread, long-term and severe damage to the natural environment." Unlike other provisions of the same protocol, no exception can be made for "military necessity."[32]

Convincing critics that the level of wreckage remained proportionate was always going to be far more difficult for NATO than justifying the inclusion of the installations in its target sets. People believe what they see, and in 1999 they saw colossal destruction. I use the word *colossal* here with no hyperbole. It may surprise some readers to learn that in total, NATO burned far more oil and dangerous chemicals into the air or spilled far more into the Serbian soils, aquifers, and waterways in its 1999 air war than the 10.8 million gallons (257,000 barrels or 38,800 tons) of crude oil that the *Exxon Valdez* had spilled following its highly controversial grounding off the Alaskan coast in 1989.[33]

At Pančevo alone, NATO air attacks caused the release of 80,000 tons of oil and oil products,[34] most of which burned wildly from ruptured tanks, poisoning the air only 12 miles from Belgrade's 1.5 million inhabitants with deadly substances including sulphur dioxide, nitrogen dioxide, carbon monoxide, polyaromatic hydrocarbons, and lead. The Pančevo raids also spilled over 2,000 tons of toxic dichloroethane into soils and groundwater, burned around 250 tons of vinyl

chloride monomer (which would have produced toxic dioxins and hydrochloric acid), and flooded around 250 tons of liquid ammonia and eight tons of metallic mercury, some of which entered a canal leading straight into the Danube.[35] Desperately weighing the lesser and greater of two evils, the site managers themselves released the liquid ammonia, knowing that a direct hit on stored ammonia had the potential to kill large numbers of people.[36] Another 73,000 tons of crude oil and oil products burned or seeped into the groundwater in the northern city of Novi Sad.[37] Elsewhere throughout Serbia (and Kosovo itself), heavy metals, sulfur dioxide, ammonia, and other caustics escaped from burning industrial facilities into the air, soil, groundwater, and rivers, causing large-scale evacuations and leaving many experts convinced that the impact of the toxic releases would reach—as they did—far beyond Yugoslavia's borders.[38]

This is not to suggest that the long-term ecological consequences of the destruction at Pančevo and other sites exceeded those of the infamous *Exxon Valdez* spillage. The latter occurred in a highly fragile ecosystem in an area along the Alaskan coast so remote that cleanup proved tragically slow, difficult, and incomplete. Little of the spilled oil could be burned. While the unburned oil produced airborne toxins, burning would have reduced the destruction of flora and fauna caused by the concentrated surface "slick." This evaporated and decomposed far more slowly in the low temperatures than it would have under similar circumstances in a more temperate climate.[39]

One cannot deny, on the other hand, that the environmental contamination at and around NATO's Serbian industrial targets was, at least in the short term, so obviously severe that it greatly reduced NATO's positive press from being extremely successful at minimizing civilian deaths caused *directly* by bombing.[40] Moreover, the environmental destruction alienated many influential observers, including former Soviet president Mikhail Gorbachev and others, who had agreed with NATO's aims of ending ethnic violence and caused very unhelpful domestic controversy in NATO nations.[41]

Serbia employed a clever media strategy to draw the world's attention to the level of its environmental suffering. They were aware that no objective scientific teams were in country who could verify or challenge its claims during the conflict and that NATO would have few options for countering its information (or *mis*information) strategy.[42] This is something important for military planners nowadays to ponder. If their campaigns or missions cause even what *appears* to be

large-scale ecological damage, their political leaders will find it difficult to mount a credible defense against charges of catastrophic harm. Garnering and maintaining popular support for wars of choice that involve no direct threats to sovereignty or key interests are not easy, even within apparently reasonable contexts. But in this era of widespread public concern for the environment, politicians will find it easier to maintain support for their actions if they do not seem to be doing harm while claiming to be doing good.

In response to continued reports of widespread environmental harm, the Regional Environmental Center for Central and Eastern Europe, assisted by a variety of specialist-contracted experts, undertook the very first objective study of environmental conditions in Serbia.[43] It reported that, while thankfully there was "no evidence of a large-scale ecological catastrophe . . . the environment in the whole territory of Yugoslavia was affected as a result of the military conflict." It also found that pollution was "very severe in the vicinity of targeted industrial complexes . . . and many valuable ecosystems were disturbed."[44] It considered it too early to offer evidence-based opinions about the long-term effects, but warned that the environmental damage that had occurred or that might in the future included threats to ecosystems (especially river systems) and human health caused by exposure to toxic or carcinogenic substances.

At almost the same time, the very concerned UN Environment Program took the unprecedented step of hastily forming a Balkans task force to assess the environmental consequences of NATO's air campaign. This was the first time that the UN had ever integrated environmental issues as a central part of a postconflict humanitarian effort. Led by former Finnish environment minister Pekka Haavisto, the task force visited the wrecked refineries and industrial complexes in the weeks immediately after the cessation of violence and released its findings four months later. It detected four major ecological "hot spots" of grave concern that needed urgent attention (Pančevo, Kragujevac, Novi Sad, and Bor), but added that permanent degradation of soils and waterways seemed unlikely. The UN team recognized that some of the environmental pollution apparently predated the NATO strikes, while some of it resulted from them. The task force nonetheless added that urgent attention would be needed, irrespective of the cause, "if further damage to human health and the environment is to be avoided."[45]

The task force's report was not accepted by all scientists and interested bodies. Many considered it a "political" report supporting a predetermined conclusion and relying on hasty and imperfect research and an inadequate methodology.[46] Better studies, the critics asserted, contradicted the task force's findings. They pointed to a parallel short-term study by the World Wide Fund for Nature that highlighted the broader transboundary and ecosystem implications of the discharged toxic chemicals and offered the less-positive summation that "toxic contamination in Yugoslavia is spreading."[47] The politically neutral Swiss-based FOCUS team of humanitarians and scientists that spent several months in 1999 assessing postwar damage throughout Serbia also offered this somber assessment: "Destruction of many potentially dangerous objects on FRY [Federal Republic of Yugoslavia] territory caused the threat of ecological catastrophe."[48] Likewise, focusing especially on Novi Sad, two Belgrade scientists identified "catastrophic pollution."[49] They reported that, although airborne pollution was "extreme but short-lived," the pollution of the soil and surface and groundwater was long term. "The pollution in these zones," they asserted, "especially in the Danube river basin, is a hazard for the further degradation of the environment, and a risk for the human health."[50] Similarly, and perhaps most notably, the US-based Institute of Energy and Environmental Research (IEER) expressed serious concerns in its 2002 assessment.[51] Particularly at Pančevo, chemical releases occurred "which pose potentially long-term threats to the local population and local environment."[52] The IEER noted that, while it was impossible to be precise or to predict future circumstances with certainty because of a lack of available prewar baselines, persistent toxins, carcinogens, and other pollutants entering the ecosystems looked likely to have long-term negative consequences, including for human health. The IEER was very careful to apportion responsibility fairly and even criticized Serbia for its prewar record of industrial pollution at some sites. It nonetheless reserved its strongest criticism for NATO for its inclusion of some of the petrochemical infrastructural targets and the excessive level of their physical destruction, reporting, "persuasive evidence indicates that humanitarian law may have been violated in the NATO bombing campaign, notably with respect to the bombing of Pancevo."[53] The IEER went so far as to recommend:

> The entire issue of bombing civilian facilities to accomplish military objectives needs to become the subject of a rigorous public inquiry. Such an inquiry should include consideration of immediate and/or environmental and health damage that could be inflicted on the country or in neighboring countries sharing ecosystems with the countries at war.[54]

Given that NATO undoubtedly intended Operation Allied Force as a positive humanitarian intervention—with the ending of ethnic violence as the primary objective—even on balance, such environmental degradation and explicit criticisms of it can only be considered ultimately counterproductive. It weakens moral positions. Ethicist Alex J. Bellamy argues that humanitarian interventions place additional burdens of justice upon political leaders and military commanders more than many other expressions of warfare. He notes that planners must pay particular attention to the selection of targets involving civilian objects and that "in humanitarian interventions, failure to exhibit due care casts serious doubt on the legitimacy of the operation as a whole."[55]

Just as any physician is morally obliged to cause no harm while seeking to remedy a patient's malady, or at least to minimize all possible harm created by the treatment, responsible government institutions need to balance their security priorities and moral considerations with other influential factors, which nowadays include environmental ethical considerations. It is not beyond reason to foresee a near future in which ecologists will sit alongside lawyers in campaign planning staffs and air targeting cells to offer advice or direction on the potential harm likely to be caused in specific missions. Their expertise in helping air planners to minimize harm to the very people they are trying to support should be welcomed, not feared. The moral shift away from old-fashioned concepts of collective responsibility, in which populations are punished or permitted to suffer harm because of the actions of their governments, as well as the strengthening of international legal protections of civilians, greatly increases the onus upon air planners to minimize every form of so-called collateral damage.

I disagree with some ethicists and lawyers who argue that, because of the likely release of "dangerous forces," attacks on oil and petrochemical installations should be prohibited in the same ways that dams, dykes, and nuclear generators are protected under the provisions of Article 56 of the Additional Protocol I. Because meticulously planned and very precise attacks on oil targets need not cause "severe

losses among the civilian population," as defined by Article 56, I cannot accept the position that air planners must *never* target oil or petrochemical installations. When balancing competing priorities, particularly when a patient's life is threatened, even the most compassionate of physicians may judge it necessary to dispense a treatment—chemotherapy, for example—that will kill peripheral healthy cells even as it targets the source of the threat to life. Of course, no doctor would prescribe these terrible treatments unless the patient's illness was grave. Likewise, continuing with this analogy, the implementation of any significant environmentally risky or destructive measures should only be contemplated in military contexts involving tremendous need, such as tipping-point moments in struggles of national survival. Ethicist Michael Walzer argues that during such "supreme emergencies," a fear exists beyond the ordinary fearfulness of war, caused by dangers beyond the ordinary dangers of war (he means the imminence of defeat and enslavement),[56] and that such fear and danger may well require extreme measures that override ethical norms and may even contravene law.[57]

NATO made a reasonable case in 1999 that the world community should not tolerate Serbian maltreatment of Kosovars. It represented a grave affront to Western core values. Yet the scale of ethnic violence, while sufficiently distressing to merit efforts to end it, did not constitute enough of a grievance—let alone anything close to a "supreme emergency"—to warrant the scale of violence by NATO to inadvertently pose serious health risks to both Serbian and Kosovar civilian populations and thereby cause much short-term and some long-term harm to the environment and its ecosystems of the Balkans.

Even without the gravity of the disputed issues of legality and morality, NATO's destruction of Yugoslavian oil infrastructure did not even accord with sound military strategizing. Planners who target an enemy's cardinal energy systems must know that, with the exception of electricity, which can be quickly interrupted, it will take a relatively long time for the desired effects of a counter-oil campaign to kick in. Destroying petrochemical installations, refineries, and storage facilities will inevitably reduce the enemy's ability to operate its armed forces effectively, but it will not do so swiftly, much less immediately, especially if the enemy armed forces are (as Yugoslavia's were) adaptable, lying low, and not engaged in significant fuel-consuming movements or maneuvers. Destroying enough oil infrastructure to paralyze armed forces will necessitate a massive and focused attack, or a

lengthy and constant series of attacks. Even after 78 days of increasingly powerful attacks, NATO had only destroyed around 40 percent of Serbia's military fuel stocks.[58] While a counter-oil strategy might superficially seem eminently sensible for campaigns predicted to be protracted—and my view is that any such campaigns should be undertaken only with tremendous care, proportionality, precision, and thought for the future—it is not an especially useful modus operandi for brief coercive strikes, particularly those with humanitarian goals.

We should not forget that the NATO planners intended Operation Allied Force to be a short and sharp *coercive* mission along the lines of Operation Desert Fox against Iraq in December 1998. Indeed, Pentagon spokesman Kenneth Bacon announced on the eve of the first strikes on Serbia, "We have plans for a swift and severe air campaign."[59] Likewise, Secretary of State Madeleine Albright herself stated on 24 March 1999, "I don't see this as a long-term operation. I think it is achievable within a relatively short period of time."[60] The fact that Operation Allied Force lasted 78 days cannot disguise the fact that it was intended to coerce Milosevic into changing his mind on the violence in Kosovo within two or three days. As Tom DeLay, the US House majority whip, commented one-third of the way through the campaign, "the Secretary of State, the Secretary of Defense, and the Chairman of the Joint Chiefs of Staff told us that this was no big deal, that we were going to bomb for a couple of days, 48 hours, and then stop bombing, and Milosevic would come to the table."[61] Permanent destruction of oil refinement and storage facilities and other chemical works was thus at odds with the original rationale of the mission and makes little sense unless one attributes to NATO air planners a recognition sometime in April—as I do—that their coercive strategy had failed and that the campaign had changed from coercion, to denial, and then to punishment.[62]

Moreover, astute and politically smart strategists and planners might want to reflect on the likelihood that in today's ecologically aware world, massive or sustained attacks on petrochemical installations—especially on their tank farms, which will cause sizeable poisonous spills and huge toxic fires—will generate politically destabilizing arguments about proportionality, and thus the operation's justice. Refuting public allegations over proportionality is not something a military wants to find itself doing. It will have few objective and easily understandable criteria upon which to build a defense. The just war concept of proportionality pertaining to noncombatants is complex

and not helpfully defined in international humanitarian law. The legal explanation of proportionality is codified in Articles 51.5(b) and 57.2(a) (iii) of the Additional Protocol I, which states that it is prohibited for the military to engage in any action "which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated."[63] A breach nowadays constitutes a war crime under the Statute of the International Criminal Court.[64] Unhelpful ambiguity exists on how anyone can objectively determine when an attack crosses the threshold and becomes "excessive" (it is a comparative concept, not a measurable absolute concept) and how anyone can compare and evaluate such dissimilar values as civilian harm and military gain. Yet the consensus view and the *jus in bello* norm is that when waging war on combatants and military objects, military forces must act painstakingly, deliberately, and carefully to ensure that civilians suffer no more harm than military necessity demands. Suggesting that the drafters of the Additional Protocol I also meant ensuring that the quality and habitability of the environment are not degraded would be hyperbolic. The environmental movement was far less motivated, powerful, and ubiquitous in 1977 than it is now. Yet, it is not unreasonable to foresee that (as I believe and recommend) a strengthening of both ethical and legal definitions will come to include these concepts.[65]

Tightening legislation is necessary. Opponents of any attacks that purportedly cause environmental harm and who desire to see prosecutions made against the perpetrators are currently not helped by the ambiguity of the wording in the Additional Protocol I, which prohibits "widespread, long-term and severe damage to the natural environment," regardless of the military objective.[66] The problem with this prohibition, of course, is that currently it is almost impossible to measure that sort of damage in specific and objective terms. Moreover, the adjectives "widespread, long-term and severe" are joined by the conjunction *and*, implying a cumulative triple standard that must be fulfilled. In other words, even an attack on a petrochemical plant that caused widespread and horrific ecological harm might fail to meet this standard unless critics could demonstrate that its effects could also be measured in years, if not decades.[67]

Some critics of environmental degradation caused by air attacks have attempted to reduce this timescale by drawing upon the 1977 Convention on the Prohibition of Military or Any Other Hostile Use

of the Environmental Modification Techniques (ENMOD), written as a consequence of widespread criticism of the disastrous US defoliation program in Vietnam. The ENMOD was promulgated in 1978 and was ratified by the United States in 1980.[68] The ENMOD bans "military or any other hostile use of environmental modification techniques having *widespread, long lasting or severe* effects as a means of destruction, damage or injury to any other State Party" (emphasis added).[69] The Conference of the Committee on Disarmament defined these terms for the purpose of the ENMOD treaty in an Understanding Regarding the Convention:

a) "Widespread": encompassing an area on the scale of several hundred square kilometers;

b) "Long-lasting": lasting for a period of months, or approximately a season; or

c) "Severe": involving serious or significant disruption or harm to human life, natural and economic resources or other assets.[70]

Interestingly, the three criteria mentioned in the ENMOD are joined by the conjunction *or*, rather than the *and* of the Additional Protocol I, meaning that it may not be necessary to fulfill a cumulative standard. Moreover, the Committee on Disarmament's explanation that *long-lasting* might mean "a period of months, or approximately a season," seems to suggest a more readily defined and reasonable threshold that would make prosecutions for environmental harm during wartime more likely. Indeed, if these criteria were applied to NATO's targeting selection process, the worst of the aforementioned attacks on petrochemical installations in Serbia, especially the destruction of Pančevo, might have been prohibited. Aaron Schwabach, an American law professor who has written extensively on the NATO campaign, concluded that it seemed "likely" that the damage at Pančevo would meet "at least one of these requirements."[71] Unfortunately for critics of NATO's war, the ENMOD prohibitions do not automatically include all attacks leading to environmental harm, but only those activities undertaken deliberately to manipulate the environment's natural processes (e.g., by changing weather patterns or by widespread defoliation). Even more unhelpful for those who seek to minimize environmental harm during wartime, the Committee on Disarmament's definition was not intended as a definition of the Additional Protocol I (in addition to the ENMOD), and

it is not even formally incorporated into the terms of the ENMOD. In other words, the definition actually serves to confuse matters, not to clarify them.

Given this lack of clarity over timescales, making a compelling legal case that a state has committed excessive harm to the environment is always going to be highly problematic immediately after the cessation of any hostilities, at least without new laws or a strengthening of existing laws. Compounding this problem is the fact that demonstrable—as opposed to merely threatened or even likely—human health problems (e.g., unusual cancers) or damage to ecosystems may take years to appear. Also, within contexts in which little baseline public health and environmental information exists, such damage may never be readily measurable, let alone placed within an objective and provable analysis of causation. The emotions surrounding warfare, with inevitable finger pointing from both sides, also make this type of analysis particularly problematic.

This was precisely the problem that Yugoslavia and various NGOs faced when they tried to bring a case against NATO before the International Criminal Tribunal for the Former Yugoslavia (ICTY). To the dismay of many international legal experts and human rights groups, who accused her of accepting unbalanced evidence in favor of NATO,[72] Carla Del Ponte, the ICTY prosecutor, informed the UN Security Council on 2 June 2000 that she had decided not to open a criminal investigation into any aspects of NATO's 1999 air campaign.[73] She specified that although NATO undoubtedly made mistakes, she felt "satisfied that there was no deliberate targeting of civilians or unlawful military targets by NATO during the campaign." More importantly for the purposes of this study, while accepting a finding that NATO had caused "some" damage to the environment, Del Ponte rejected assertions that the tribunal should prosecute NATO for causing excessive ecological harm. The main problem was not that the United States and France had never ratified the Additional Protocols of 1977. (This was of course true. The United States has still not ratified them, and France only did in November 2001.) Rather, Del Ponte accepted a review committee's finding that the "imprecise" phrasing in the Additional Protocol I meant that it was extremely difficult to determine when any attacks during any wars had caused environmental harm exceeding the protocol's threshold, especially as "long-term" would (despite the ENMOD-related advice) need to be "measured in years rather than months." The committee

noted that, while it had "led to criticisms by ecologists," the vagueness of the standard meant that, "on the basis of information currently in its possession, the environmental damage caused during the NATO bombing campaign does not meet the Additional Protocol I threshold."[74] The issue of intent also created a problem:

> The requisite *mens rea* [measure of intent] on the part of a commander would be actual or constructive knowledge as to the grave environmental effects of a military attack; a standard which would be difficult to establish for the purposes of prosecution and which may provide an insufficient basis to prosecute military commanders inflicting environmental harm in the (mistaken) belief that such conduct was warranted by military necessity.[75]

The current vagueness of international humanitarian law is also a problem for critics of air forces that use ordnance that the public considers extremely ecologically harmful, such as white phosphorus bombs, cluster munitions, and depleted uranium (DU) rounds. All three of these ordnance types have undeniably effective military roles when used only against enemy combatants. Yet, for different reasons, each one causes such highly controversial unintended secondary effects that many people consider *any* use to be reckless. Most environmentalists condemn them all as environmentally harmful. I also tend not to like their usage, especially in close proximity to civilians, but that is mainly because I recognize that the use of any contentious weapons will create destabilizing controversy and add to unwanted propaganda battles. Moreover, I am not convinced that an adequate scientific consensus exists to allow me to argue with certainty, for example, that even the 30,000 DU shells fired at 112 locations in and around Kosovo by USAF A-10s caused (or will cause) serious and long-term environmental harm and that DU-contaminated areas should be treated with anything more than the "precautionary approach" recommended by the UN's environmental watchdog organization.[76] Science may in time demonstrably undermine the UN's position, and I am mindful that the defoliation of Vietnam by Agent Orange and other defoliants has caused severe human health and environmental harm despite early US beliefs that no long-term harm to humans would occur.[77]

Cluster bombs are different from white phosphorus and depleted uranium shells in that they produce no secondary toxins that can cause chemical actions on life processes that might kill or harm humans, animals, or other living things. Yet they have a worse and more clearly proven influence on the natural environment. Cluster bombs'

primary harm comes when widely spread and highly volatile unexploded submunitions cause the death and maiming of innocent people after—sometimes *long* after—the cessation of hostilities. Ninety-eight percent of the 11,044 recorded and verified casualties of cluster munitions in recent wars have been civilians.[78] In terms of the environment, cluster munitions have a very deleterious effect. Hundreds of thousands of fearful farmers in modern warzones avoid tilling submunition-contaminated fields, irrigating contaminated groves or orchards, and raising livestock on contaminated grasslands. This has a seriously negative impact on local economies and on ecosystems. Cluster munitions also cause health and hygiene problems by creating malnutrition and denying safe access to water. In these ways they cause foreseen but unintended harm similar to, although individually far more lethal than, antipersonnel landmines. During NATO's war on Serbia, USAF and RAF (and a small number of Dutch) aircraft dropped a confirmed minimum of 1,254 cluster bombs in Kosovo (531 by the RAF, which mainly targeted fielded forces and their weapons).[79] They scattered no fewer than 234,123 submunitions.[80] With a failure rate calculated at 7.8 percent, this means that NATO left 18,261 unexploded submunitions in or on the ground in Kosovo, none of them having self-destruct fuses. Thankfully, nearly all have now been located and cleared,[81] although 2,500 remain in Serbia proper,[82] and Kosovo's litter of USAF and RAF cluster submunitions has caused 152 postwar civilian casualties.[83]

Within the first year after the war's end, elements within the British government were unhappy with the RAF's heavy use of cluster munitions. On 23 May 2000, a report of the Foreign Affairs Select Committee of the House of Commons concluded: "We recommend that the UK Government consider carefully the experience of the use of cluster bombs in the Kosovo campaign to determine in future conflicts whether they are weapons which pose so great a risk to civilians that they fall foul of the 1977 Protocol and should not be used in areas where civilians live."[84] Likewise, on 23 October 2000, a report of the Defence Select Committee of the House of Commons concluded that "our major contribution to the bombing campaign was in the form of unguided cluster bombs—a contribution of limited military value and questionable legitimacy."[85] It is therefore unfortunate that the RAF used them again (although nowhere as prolifically as the British Army) in Iraq in 2003, alongside the USAF, which had also used them in Afghanistan in and after 2001. Israel's air force, but especially

its army, likewise used staggering quantities of cluster munitions in its 2006 campaign against Hezbollah insurgents and terrorists, leaving one million unexploded submunitions across southern Lebanon.[86] The unintended death and maiming rates of civilians in all three campaigns have been high and regretted and have seemed to undo some of the good that the various air forces and armies were trying hard to achieve.

A widespread Western consensus has quickly emerged that cluster munitions violate the *jus in bello* principles of proportionality and discrimination so grievously that they must be classed as weapons *mala in se*, which means "bad in themselves," irrespective of any legal prohibitions. The logic framing this consensus is consistent with both international humanitarian law and just war principles. It argues that, because military forces nowadays can reasonably determine from objective analyses of recent conflicts that almost all cluster-bomb victims will be civilians who will suffer death, maiming, and environmental harm for many years after their initial use for military purposes, their harm cannot reasonably be balanced against any good achieved.

Modern wars have included many things *mala in se*, such as rape, torture, ethnic cleansing, and chemical and biological weapons. Cluster munitions are the most recent addition to this category. In February 2007, 46 national representatives met in Oslo to endorse a call by Norwegian foreign minister Jonas Gahr Støre to conclude a new legally binding instrument that will prohibit the production, stockpiling, transfer, and use of cluster munitions and to provide adequate resources to assist survivors and clear contaminated areas. Subsequent International Oslo Process meetings occurred in Peru (May 2007), Austria (December 2007), New Zealand (February 2008), and Ireland (May 2008). In Dublin, 107 countries adopted the treaty text, and they opened a signature process in Oslo on 3 December 2008. The convention will enter into force six months after 30 states have submitted their instruments of ratification to the secretary general of the United Nations. Four states have now done so. The United States has neither signed nor ratified the convention, although in March 2009 President Obama took a highly commendable first step by permanently banning the US sale of all cluster munitions except those (which is a tiny amount) that leave behind less than 1 percent of their submunitions as duds.[87] The United Kingdom has gone even further. It responded to the emerging *mala in se* consensus on cluster munitions

responsibly and decisively by banning them in three stages: first, on 20 March 2007, by withdrawing all of the RAF's 3,650 RBL755 "dumb" cluster bombs and their 536,550 submunitions as well as the British army's 43,200 multiple-launch M26 rockets and their 27,820,800 submunitions; second, in May 2008, by withdrawing the remaining army cluster munitions which had (inadequate) self-destruct fuses; and third, in December 2008, by signing the convention outlawing all cluster ordnance.[88]

Even if we accept a *jus in bello* argument that in any particular conflict a belligerent may foresee but not intentionally cause some environmental harm, we should also accept the *jus post bellum* argument that after the end of hostilities and the restoration of what we hope will be a better state of peace, the restoration of the quality of life of the affected innocents should occur as fully as swiftly as possible. As the UN explains, this is not only a moral obligation; it is a practical part of peacemaking and nowadays extends to the human habitat and even beyond. "Environmental conditions—from the air that people breathe and the water they drink, to the ecosystems that support forestry, farming and fishing—have a crucial influence on the success of efforts to rebuild shattered communities and livelihoods. Only by ensuring environmental security can the wider goals of postconflict reconstruction and human development be sustained."[89] In the case of the Kosovo conflict the infrastructural damage was substantial and the environment harm severe in places. Swift remediation was crucial.

The United Nations Environment Program (UNEP) took the unprecedented step of assuming responsibility for postwar remediation, concluding that "it was evident that, not only had people been through untold pain and suffering, but that the environment had suffered as well."[90] It therefore immediately undertook to create a strategy to unite concerned nations in a program to clean up the worst pollution and contamination to minimize long-term risks to Serbs, Kosovars, and others. Its own 1999 task force, which had identified the four heavily polluted "hot spots" around Pančevo, Kragujevac, Novi Sad, and Bor, served as the basis of its feasibility study to define the exact scientific and financial requirements for urgent cleanup projects at those and maybe other locations. In March 2000, cleanup measures for the four worst hot spots featured prominently as priority projects at the funding conference organized under the auspices of the Stability Pact for South Eastern Europe. By the late summer of 2000, following positive initial responses from many governments

and pledges from several European countries to support additional activities, the UNEP commenced a major environmental cleanup project at conflict-caused contamination sites in Serbia (including Kosovo). Over the next four years the UNEP mitigation and remediation project helped to secure fresh drinking water, remediated contaminated soil and groundwater, removed and treated scores of tons of extremely hazardous chemicals and waste, rehabilitated wastewater treatment capacities, installed environmental monitoring stations, and strengthened national and local environmental management capacities.

Donor countries had pledged a total of $20 million, but several reneged altogether or reduced their contributions. The UNEP had to make do with $12 million and could not do everything it had wanted.[91] Its efforts nonetheless made a highly positive difference. After four years of intense industrial site, soil, and groundwater remediation work at the worst sites, the UNEP announced in May 2004 that, while the cleanup programs had only addressed the most urgent issues, they had made such substantial progress with them that the ecological hot spots no longer warranted that label and that the programs could be turned over to the Serbian government.[92] There was, and still is, much work left to Serbia to do before anyone can reasonably conclude that all environmental damage has been entirely negated.

It has now been 10 years since NATO airpower destroyed Serbian refineries and petrochemical installations and five since the UNEP ended its partial environmental cleanup campaign. Yet, Serbia is still deeply troubled by NATO's ostensible disregard of ecological responsibility. Unusually higher cancer rates, for instance, are still attributed to the effects of NATO's bombing campaign and even to its use of depleted uranium.[93] Establishing the verity of such claims is beyond my professional expertise and might not even be possible for an oncologist or a public health expert because of a lack of both baseline evidence and objective, thorough studies and because of Serbia's continuing poor record of industrial pollution.[94]

Conclusions

This study has demonstrated that modern airpower has unequalled capacity for destructiveness within the human habitat and interrelated ecosystems of an opponent's state. Traditional target sets *still*

include a lot of industrial plants and infrastructure that contain highly toxic and carcinogenic chemicals which can, if discharged through attacks, cause severe damage to the natural environment and its flora and fauna, not to mention human health. Any such environmental harm nowadays has far greater potential for causing destabilizing controversy within the environmentally aware public than ever before. Existing international humanitarian law is not yet adequate to discourage protagonists during the heat of war from attacking some things that perhaps should only be targeted under unique circumstances, with extraordinary care, and after weighing potentially wider implications. Existing conventions should be strengthened or new laws created. Yet, the *jus in bello* concepts of proportionality and discrimination embedded within our just war code already *are*—or would be if more widely understood—an eminently reasonable basis for constraining the injudicious use of force against objects that have the potential for environmental harm. Western warriors already conceptualize their use of violence in terms of minimizing suffering while doing good, all the while protecting the innocent, including the opponent's. It is a short and easy step of logic that they should understand the importance of minimizing harm to the habitat of the innocent. It is equally logical that, as the purpose of armed violence should always be a better state of peace, warriors will want to avoid inflicting damage upon the innocents within the opposing state, and possibly within the wider region, that might last well beyond the end of conflict and therefore complicate the restoration of lasting peace. One of the lessons we should learn from the Kosovo conflict—indeed, from Afghanistan, Iraq, and Lebanon as well—is that most military commanders and planners are not adequately familiar with the key environmental sciences and are therefore not best placed to foresee all *unwanted* consequence as they plan operations and missions to achieve *wanted* effects. The inclusion of ecologists alongside lawyers in campaign planning staffs and air targeting cells to offer advice or direction on the potential harm likely to be caused in specific missions will at least partially strengthen the way that environmental factors can be "brought in from the cold." Their expertise in helping planners to minimize harm to the very people they are trying to support should be welcomed, not considered intrusive.

Notes

1. *Hague Convention for the Protection of Cultural Property*, Art. 1(a).
2. Leaning, "War and the Environment," 278.
3. Steiner, "After the Bombs." See also United Nations Environment Program, *Lebanon Post-Conflict Environmental Assessment*, especially 42–46; Carassava, "U.N. Pledges $64 Million"; Black, "Environmental 'Crisis' in Lebanon"; and Milstein, "Lebanon Oil Spill."
4. See Hayward, "Too Little, Too Late."
5. *United States Strategic Bombing Survey (Pacific War), Crude Oil Production and Refining*.
6. For Germany's reliance on oil and the wartime consequence of this dependence, see Hayward, "Hitler's Quest for Oil." See also Pearton, *Oil and the Romanian State*; and Stout, *Fortress Ploesti*.
7. Buckley, *Air Power in the Age of Total War*, 163; and Jacobs, "British Strategic Air Offensive," 147, 150, 167.
8. Austin and Bruch, eds., *Environmental Consequences of War*, 120.
9. Stephens, *Vulnerability of Total Petroleum Systems*, 42–44.
10. Mark Clodfelter, *Limits of Air Power*; and Frankum, *Like Rolling Thunder*.
11. Warden, *Air Campaign*, 39.
12. Davis, *On Target*; and Keaney, "Surveying Gulf War Airpower."
13. Hallion, *Storm over Iraq*, 231.
14. Sandoz et al., eds., *Commentary on the Additional Protocols*, 669.
15. This colorful phrase even made it into mainstream publications. See, for example, Joksimovich, "Militarism and Ecology."
16. Vukmirovic et al., "Regional Air Pollution," 741.
17. Gopal and Deller, *Precision Bombing, Widespread Harm*, 25; United Nations Environment Program and United Nations Center for Human Settlements (Habitat), *The Kosovo Conflict*, 32; and Carter and Turnock, eds., *Environmental Problems of East Central Europe*, 403.
18. Booth, "NATO Bombs Left a Toxic Slough."
19. Hedges, "Serbian Town Bombed by NATO."
20. Reichberg and Syse, "Protecting the Natural Environment," 463; and Ceulemans, "NATO Intervention in the Kosovo Crisis." Also see Meyer, "Tearing down the Façade," 172–73, 176–77, 181.
21. Gopal and Deller, *Precision Bombing, Widespread Harm*, 76.
22. Meyer, "Tearing down the Façade," 100; and "*Un cahier spécial sur le Kosovo*."
23. Short also said, "At some point, you make the transition from applauding Serb machismo . . . to thinking what your country is going to look like if this continues." Drozdiak, "Commander of Air War Says Kosovo Victory Near."
24. Tirpak, "Washington Watch."
25. Public Broadcasting Service, "War in Europe."
26. Austin and Bruch, eds., *Environmental Consequences of War*, 652.
27. NATO Briefing, 3 May 1999. Shea's speech can be found in Shea and Jertz, "Press Conference."
28. Cortright and López, eds., *Smart Sanctions*, 95.
29. Shea and Marani, "Press Conference," 30 April 1999.

30. Shea and Marani, "Press Conference," 19 April 1999.

31. Shea and Marani, "Press Conference," 30 April 1999.

32. Austin and Bruch, eds., *Environmental Consequences of War*, 651; and *Operational Law Handbook 2000*, 17–18.

33. Figures published on the website of the *Exxon Valdez* Oil Spill Trustee Council, "Oil Spill Facts."

34. United Nations Environment Program and United Nations Center for Human Settlements (Habitat), *Kosovo Conflict*, 31, 34.

35. *Assessment of the Environmental Impact*, esp. § 4.1.1 and 4.1.2; Popovska and Sopova, "Pollution of the Balkans"; Carter and Turnock, *Environmental Problems of East Central Europe*, 403; and Austin and Bruch, eds., *Environmental Consequences,* 649.

36. Gopal and Deller, *Precision Bombing, Widespread Harm*, 32, 33; United Nations Environment Program and United Nations Center for Human Settlements (Habitat), *Kosovo Conflict*, 34.

37. United Nations Environment Program and United Nations Center for Human Settlements (Habitat), *Kosovo Conflict*, 47.

38. Ibid.; and C. Morgan, "Collateral Damage."

39. An excellent early study of pollution caused by warfare in arctic regions can be found in Stockholm International Peace Research Institute, *Warfare in a Fragile World*, 114–25, 151.

40. According to the International Criminal Tribunal's *Final Report to the Prosecutor,* NATO's campaign killed 495 civilians and wounded a further 820. See § V(53).

41. For an example of Gorbachev's concerns, see Gorbachev, "Poison in the Air." A trawl of the Internet will produce hundreds of archived mainstream media reports of the ecological damage caused by NATO's campaign.

42. Bacevich and Cohen, eds., *War over Kosovo*, 15.

43. *Assessment of the Environmental Impact*.

44. Ibid., "Executive Summary."

45. United Nations Environment Program and United Nations Center for Human Settlements (Habitat), *Kosovo Conflict*, 9, 11.

46. See C. Morgan, "Collateral Damage." In her 2000 paper, the late Dr. Janet M. Eaton, a Canadian biologist and activist, typified these critics, noting that the task force, "although composed of many expert scientists from around the world, was very limited in duration, lacked breadth and scope, failed to have within its mandate assessment of the impact on human health and lacked the cooperation of NATO authorities to either locate or assess the impact of depleted uranium weapons in spite of widespread concern and warnings about the ecological and health implications." Eaton, "Ecological and Health Consequences."

47. World Wide Fund for Nature, "Danube Carpathian Program."

48. *FOCUS Assessment Mission*.

49. Martinovic-Vitanovic and Kalafatic, "Consequences of War."

50. Ibid.

51. Gopal and Deller, *Precision Bombing, Widespread Harm*.

52. Ibid., 85.

53. Ibid., 86.

54. Ibid., 13.

55. Bellamy, *Just Wars*, 213.

56. See Orend, "Is There a Supreme Emergency Exemption?"

57. Walzer, *Just and Unjust Wars*, 251–62.

58. Bacevich and Cohen, *War over Kosovo*, 24.

59. See Hayward, "NATO's War in the Balkans," 2.

60. Ibid.

61. Ibid., 3. See also Daalder and O'Hanlan, *Winning Ugly*, 91–93, 209; and Henriksen, *NATO's Gamble*, 5, 199.

62. Observing the conflict as it unfolded, I noticed a dramatic change of operational intensity and tempo in the fourth week of April 1999, coinciding with the NATO Summit in Washington. See Hayward, "NATO's War in the Balkans," 10. Eminent British defense commentator John Keegan saw the same shift, noting that NATO began to "visit a true blitz on the Serb homeland." Keegan, "Please Mr Blair."

63. *Protocol Additional to the Geneva Conventions*, Art. 51 (5)(b) and Art. 57 (2)(b).

64. United Nations, *Statute of the International Criminal Court*, Art. 8(2)(b)(iv). The statute modifies "excessive" with the adjective "clearly" and "military advantage" with "overall," thereby emphasizing both the need for clarity and the importance of avoiding assessments of individual attacks in total isolation.

65. Rodin, "Ethics of Asymmetric War," 162.

66. Austin and Bruch, eds., *Environmental Consequences of War*, 651.

67. International Criminal Tribunal, *Final Report to the Prosecutor,* § I (15); and Austin and Bruch, eds., *Environmental Consequences of War*, 652.

68. See Dieterich, " 'Law of War' and Ecology," 137–60.

69. *Convention on the Prohibition*, Art. I.

70. Quoted in Gopal and Deller, *Precision Bombing, Widespread Harm*, 75.

71. Schwabach, "Environmental Damage," 129.

72. For example, see Benvenuti, "ICTY Prosecutor"; Ronzitti, "Is the *Non Liquet* of the Final Report?"; and "Amnesty International's Initial Comments."

73. International Criminal Tribunal, *Final Report to the Prosecutor.*

74. Ibid., § 4 (A)(17).

75. Ibid., § 4 (A)(23).

76. United Nations Environment Program, *Depleted Uranium in Kosovo*; and United Nations Environment Program, *Depleted Uranium in Serbia and Montenegro*.

77. Cf. "Defoliating Viet Nam."

78. *Fatal Footprint*, 41.

79. Secretary of State for Defence Geoff Hoon, House of Commons Hansard Written Answers for 19 January 2000; Minister of State for the Armed Forces Adam Ingram, House of Commons Hansard Written Answers for 16 November 2001; *Cluster Munitions in Kosovo*, 9, 10; and Norton-Taylor, "US Deploys Controversial Weapon."

80. *Cluster Munitions in Kosovo*, 9. See the very close NATO figures quoted by the International Committee of the Red Cross in *Cluster Bombs and Landmines in Kosovo*, 6.

81. *Cluster Munitions in Kosovo*, 43.

82. "2,500 NATO Cluster Bombs"; and Fawkes, "Scars of NATO Bombing."

83. *Cluster Munitions in Kosovo*, 46.

84. House of Commons, Foreign Affairs Select Committee, Fourth Report.

85. House of Commons, Defence Select Committee, Fourteenth Report.

86. Secretary of State for International Development Hillary Benn, House of Commons Hansard Written Answers for 18 December 2006; and *Fatal Footprint*, 35.

87. "Obama Takes US Closer to Cluster Bomb Ban."
88. Hewson, "Cluster Weapons Ban Leaves Gap in UK Inventory"; and Norton-Taylor, Walker, and agencies, "Cluster Bomb Treaty."
89. *From Conflict to Sustainable Development*, 7.
90. Ibid., 6.
91. Marković, "Serbia."
92. United Nations Environment Program, Press Release, 7 May 2004.
93. Cf. Zimonjic, "BALKANS: Fallout of Bombing."
94. Cf. "Serbs Call for Restrictions on Noxious Factory Emissions."

Abbreviations

AAF	Army airfield
AAP	Army ammunition plant
ACTS	Army Air Corps Tactical School
ADD	air domain development
AFRICOM	US Africa Command
AU	Africa Union
AVGAS	aviation gasoline
AWF	African Wildlife Foundation
AWPD	Air War Plan Divisions
CAMPFIRE	Communal Areas Management Program for Indigenous Resources
CAS	chief of the Air Staff
CBC	community-based conservation
CBNRM	community-based natural resource management
CCS	Combined Chiefs of Staff
CENTCOM	US Central Command
COIN	counterinsurgency
CONUS	continental United States
DOD	Department of Defense
DOE	Department of Energy
DOS	Department of State
DRC	Democratic Republic of the Congo
DU	depleted uranium
ENMOD	environmental modification
EPA	Environmental Protection Agency
EU	European Union
FMNR	farmer-managed natural regeneration
FMS	foreign military sales
FUDS	formerly used defense sites
GLTP	Great Limpopo Transfrontier Park
GPS	Global Positioning System
IAF	Israeli Air Force
IBC	Iraq Body Count Project
ICBM	intercontinental ballistic missile
ICTY	International Criminal Tribunal for the Former Yugoslavia

IDF	Israeli Defense Forces
IEER	Institute of Energy and Environmental Research
IUNC	International Union of Conservation of Nature
JCS	Joint Chiefs of Staff
JDAM	joint direct attack munition
KAZA	Kavango–Zambezi
KLCT	Kenya Land Conservation Trust
km	kilometer
KWS	Kenya Wildlife Service
LIFE	Project Living in a Finite Environment
LWC	Lewa Wildlife Conservancy
MPE	(Israeli) Ministry for Protection of the Environment
NATO	North Atlantic Treaty Organization
NCA	Ngorongono Conservation Area
NGO	nongovernmental organization
NIS	new Israeli shekels
NPL	National Priority List
NRT	Northern Rangeland Trust
OIF	Operation Iraqi Freedom
OPEC	Organization of the Oil Exporting Countries
PDA	Project on Defense Alternatives
PGM	precision-guided munitions
POL	petroleum, oil, and lubricants
PP	peace parks
RAF	Royal Air Force
SAC	Strategic Air Command
SPP	state partnership programs
SS	*Schutzstaffel*
TCE	trichloroethylene
TFCA	transfrontier conservation areas
TNA	The National Archives, Kew, UK
UN	United Nations
UNEP	UN Environment Programme
UPT	Undergraduate Pilot Training
USAAF	United States Army Air Forces
USAF	US Air Force
USAID	US Agency of International Development

USGS	US Geological Service
USSBS	US Strategic Bombing Survey
UST	underground storage tank
WAP	Western Area Plan
WWF	World Wildlife Fund
WWII	World War II

Bibliography

"14th Custom Spray School: Flame Cultivation, Face Flies among Topics at Illinois Conference." *Agricultural Chemicals* 17, no. 3 (March 1962): 68–72.

"60 Drone Hits Kill 14 Al-Qaeda Men, 687 Civilians," *The News* (Pakistan), 10 April 2009. http://www.thenews.com.pk/TodaysPrintDetail.aspx?ID=21440&Cat=13&dt=4/10/2009.

184th Bomb Group, Kansas National Guard, Pamphlet. *The Cultural Legacy of the Smoky Hill Air National Guard Range*. Undated. Kansas Collection. Spencer Memorial Library, University of Kansas.

2008 Living Planet Report. World Wildlife Fund. http://assets.panda.org/downloads/living_planet_report_2008.pdf.

"2,500 NATO Cluster Bombs Still Out There." *B29 News*, 11 March 2009.

"5,558 Iraqis Killed since Occupation." *Dallas Morning News*, 24 May 2004.

Abdul-Ahad, Ghaith. "Inside the Taliban, the More Troops They Send, the More Targets We Have." *The Guardian*, 15 August 2009. http://www.guardian.co.uk/world/2009/aug/15/fighting-taliban-in-afghainsten-war.

Ackerman, John T. "The Most Vulnerable Continent: Africa and Global Climate Change." In *African Environmental and Human Security in the 21st Century*, edited by Helen Purkitt, 141–66. New York: Cambria Press, 2009.

"ACTS [Air Corps Tactical School]: Bombardment Aviation," 1 January 1938. File 168.7001–28. Air Force Historical Research Agency (AFHRA), Maxwell AFB, AL.

"ACTS: Bombardment Text," 1 October 1933. File 248.101–9. AFHRA, Maxwell AFB, AL.

Ader, Clément. *Military Aviation*. Maxwell AFB, AL: Air University Press, 2003.

The Africa-EU Strategy Partnership: A Joint Africa-EU Strategy. Africa-EU Summit, Lisbon, Portugal, 8–9 December 2007. http://www.fanrpan.org/documents/d00454/Africa-EU_strategy.pdf.

Air Force Culture and Language Center. http://www.culture.af.edu.

Air Force Doctrine Document (AFDD) 3-20. *Building Partnerships*, draft, undated.

Air Forces Central [AFCENT] Combined Air and Space Operations Center. "2004–2008 Combined Forces Air Component Commander Air Power Statistics." AFCENT Public Affairs, 31 December 2008.

Air Ministry [United Kingdom]. Pamphlet. *Bomber Command: The Air Ministry Account of Bomber Command's Offensive against the Axis, September 1939–July 1941*. London: Her Majesty's Stationary Office (HMSO), 1941.

"Air Strike Rules Seen Cutting Civilian Deaths." *Washington Times*, 6 August 2009.

Albers, Christian N., Gary T. Banta, Poul Erik Hansen, and Ole S. Jacobsen. "The Influence of Organic Matter on Sorption and Fate of Glyphosate in Soil—Comparing Different Soils and Humic Substances." *Environmental Pollution* 157, no. 10 (October 2009): 2865–70.

Ali, Saleem. "Introduction: A Natural Connection between Ecology and Peace." In *Peace Parks: Conservation and Conflict Resolution*, edited by Saleem Ali, 69–82. Cambridge, MA: MIT Press, 2007.

Alsdirawi, Fozia, and Muna Faraj. "Establishing a Transboundary Peace Park in the Demilitarized Zone (DMZ) on the Kuwait/Iraq Borders." *Parks* 14, no. 1 (2004): 48–55.

The American Heritage Dictionary of the English Language. New York: American Heritage, 1971.

"Amnesty International's Initial Comments on the Review by the International Criminal Tribunal for the Former Yugoslavia of NATO's Operation Allied Force." http://www.essex.ac.uk/armedcon/story_id/000135.htm.

Anderson, Jon Lee. "The Taliban's Opium War: Letter from Afghanistan." *The New Yorker* 83, no. 19 (9 July 2007). http://www.newyorker.com/reporting/2007/07/09/070709fa_fact_anderson.

Aras, Bulent, and Sule Toktas. "Afghanistan's Security: Political Process, State-Building and Narcotics." *Middle East Policy* 15, no. 2 (Summer 2008): 42–48.

Arden, Elad. "Conquering the Negev." *Bemahane*, 21 December 2007 [Hebrew].

Arkin, William, Damian Durrant, and Marianne Cherni. *On Impact: Modern Warfare and the Environment: A Case Study of the Gulf War*. London: Greenpeace International, May 1991.

Arthur Capper Papers. Kansas State Historical Society, Topeka, KS.

Arthur, Max. *Dambusters: A Landmark Oral History*. London: Virgin Books, 2008.

Asada, Sadao. "The Shock of the Atomic Bomb and Japan's Decision to Surrender: A Reconsideration." *Pacific Historical Review* 67 (November 1998): 477–512.

Ashkenazi, Avi. "Grounded due to Ceramics Class." *Yediot Aharonot*, 27 July 2005 [Hebrew].

Assessment of the Environmental Impact of Military Activities during the Yugoslavia Conflict: Preliminary Findings. Szentendre, Hungary: Regional Environmental Center for Central and Eastern Europe, 1999.

Austin, Jay E., and Carl E. Bruch, eds. *The Environmental Consequences of War: Legal, Economic, and Scientific Perspectives*. Cambridge: Cambridge University Press, 2000.

"Author of Shocking Iraq Study Accused of Bad Ethics." *Houston Chronicle*, 5 February 2009.

Bacevich, Andrew J., and Eliot A. Cohen, eds. *War over Kosovo: Politics and Strategy in a Global Age*. New York: Columbia University Press, 2001.

Bajracharya, Siddhartha, Peter Furley, and Adrian Newton. "Impacts of Community-Based Conservation on Local Communities in the Annapurna Conservation Area, Nepal." *Biodiversity and Conservation* 15, no. 8 (July 2006): 2765–86.

Bakri, Nada. "Babylon's Ancient Wonder, Lying in Ruins." *Washington Post*, 29 July 2009, C1.

Baldwin, David. "The Concept of Security." *Review of International Studies* 23, no. 1 (1997): 5–26.

Balfour, Daryl, and Sharna Balfour. *Rhino: The Story of the Rhinoceros and a Plea for Its Conservation*. Cape Town, South Africa: Struik Publishers, 1991.

Balint, Peter, and Judith Mashinya. "The Decline of a Model Community-Based Conservation Project: Governance, Capacity, and Devolution in Mahenye, Zimbabwe." *Geoforum* 37, no. 5 (September 2006): 805–15.

Bannon, Ian, and Paul Collier, eds. *Natural Resources and Violent Conflict: Options and Actions*. Washington, DC: The World Bank, 2003.

Barbier, Edward B., Joanne C. Burgess, Timothy M. Swanson, and David W. Pearce. *Elephants, Economics and Ivory*. London: Earthscan, 1990.

Barnett, John. *The Meaning of Environmental Security: Ecological Politics and Policy in the New Security Era*. London: Zed Books, 2001.

Batchelder, Robert C. *The Irreversible Decision, 1939–1950*. Cambridge, MA: Houghton Mifflin, 1962.

"The Battle for Al Faw." *Return to the Gulf, Operation Telic, March–May 2003*. http://www.britains-smallwars.com/gulf2/AlFaw.html.

Beaumont, Joan. "Starving for Democracy: Britain's Blockade of and Relief for Occupied Europe, 1939–1945." *War and Society* 8 (October 1990): 57–82.

Bell, A. C. *A History of the Blockade of Germany, 1914–1918*. London: HMSO, 1937.

Bellamy, Alex J. *Just Wars: From Cicero to Iraq*. Cambridge, UK: Polity Press, 2006.

Benachour, Nora, and Gilles-Eric Séralini. "Glyphosate Formulations Induce Apoptosis and Necrosis in Human Umbilical, Embryonic, and Placental Cells." *Chemical Research in Toxicology* 22, no. 1 (2009): 97–105.

Benjaminsen, Tor, Thembela Kepe, and Stine Bråthen. "Between Global Interests and Local Needs: Conservation and Land Reform in Namaqualand, South Africa." *Africa: The Journal of the International African Institute* 78, no. 2 (2008): 223–244.

Benvenuti, Paolo. "The ICTY [International Criminal Tribunal for the Former Yugoslavia] Prosecutor and the Review of the NATO Bombing Campaign against the Federal Republic of Yugoslavia." *European Journal of International Law* 12, no. 3 (2001): 503–29.

Berdal, Mats, and David Malone, eds. *Greed and Grievance: Economic Agendas in Civil Wars*. Boulder, CO: Lynne Rienner Publishers, 2000.

Betts, Russell, and Frank Denton. *An Evaluation of Chemical Crop Destruction in Vietnam*. Santa Monica, CA: RAND Corp., 1967.

Biddle, Tami Davis. *Rhetoric and Reality in Air Warfare: The Evolution of British and American Ideas about Strategic Bombing, 1914–1945*. Princeton, NJ: Princeton University Press, 2004.

Bilstein, Roger E. *The Enterprise of Flight: The American Aviation and Aerospace Industry*. Washington, DC: Smithsonian Scholarly Press, 2001.

Bird, Kai, and Martin J. Sherwin. *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer*. New York: Vintage Books, 2006.

Black, Richard. "Environmental 'Crisis' in Lebanon." *BBC News*, 31 July 2006.

Blaike, Abel, Nick Blaike, and Piers Blaike. "Elephants, People, Parks and Development: The Case of the Luangwa Valley, Zambia." *Environmental Management* 10 (1986): 735–51.

Blanchard, Christopher M. *Afghanistan: Narcotics and US Policy*. Washington, DC: Congressional Research Service, 2009.

Boberach, Heinz, ed. *Meldungen aus dem Reich: Die geheimen Lageberichte des Sicherheitsdienstes der SS 1938–1945* [*Messages from the Reich: The Secret Management Reports of the Security Service of the SS*], vol. 13. Herrsching, Germany: Manfred Pawlak Publishing Company, 1984.

du Bois, Kathleen E. "The Illegal Trade in Endangered Species." *African Security Review* 6, no. 1 (1997). http://www.iss.co.za.

Boko, Martin, I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo, and P. Yanda. "Africa." In *Climate Change 2007: Impacts, Adaptation and Vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* edited by M. L. Parry, O.F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson, 433–67. Cambridge: Cambridge University Press, 2007.

Bonner, Raymond. *At the Hand of Man: Peril and Hope for Africa's Wildlife*. New York: Alfred A. Knopf, 1993.

Booth, William. "NATO Bombs Left a Toxic Slough." *Washington Post*, 21 July 1999.

Bowden, Mark. *Black Hawk Down: A Story of Modern War*. New York: Atlantic Monthly Press, 1999.

Boyne, Walter J. *The Influence of Air Power upon History*. Gretna, LA: Pelican Publishing Co., 2003.

Brauer, Jurgen. *War and Nature: The Environmental Consequences of War in a Global World*. Lanham, MD: AltaMira Press, 2009.

British Broadcasting Corporation. "1943: RAF Raid Smashes German Dams." *On This Day, 1950–2005, 17 May*. http://news.bbc.co.uk/onthisday/hi/dates/stories/may/17/newsid_3623000/3623223.stm.

Brock, Lothar. "Peace through Parks: The Environment on the Peace Research Agenda," *Journal of Peace Research* 28, no. 4 (November 1991): 407–23.

Brodie, Bernard. *Strategy in the Missile Age*. Princeton, NJ: Princeton University Press, 1965.

Brown, Oli. "Environment and Peace: Steady Progress since 1972." Contribution to the International Conference on Environment, Peace and Dialogue among Civilizations, Tehran, Iran, 9–10 May 2005. http://www.iisd.org/pdf/2005/security_env_peace_iran.pdf.

Brune, Lester H. "An Effort to Regulate Aerial Bombing: The Hague Commission of Jurists, 1922–1923." *Aerospace Historian* 29 (September 1982): 183–95.

Buchbut, Amir. "Training for Long Runs." *Maariv*, 22 May 2009 [Hebrew].

Buckingham, William A. *Operation Ranch Hand: The Air Force and Herbicides in Southeast Asia, 1961–1971*. Washington, DC: Office of Air Force History, 1982.

Buckley, John. *Air Power in the Age of Total War*. London: University College of London Press, 1999.

Bundesarchiv [Federal Archive], Außenstelle [Foreign Office], Berlin, Germany.

Burgess, Stephen F., ed. *Air Force Symposium 2009: US Africa Command (AFRICOM)—31 March–2 April 2009*. Final Report. Maxwell AFB, AL: Air University, 2009.

———. "Environment and Human Security in the Horn of Africa." *Journal of Human Security* 4, no. 2 (2008): 36–41.

Burnham, Gilbert, Shannon Doocy, Elizabeth Dzeng, Riyadh Lafta, and Les Roberts. "The Human Cost of the War in Iraq: A Mortality Study, 2002–2006." Baltimore, MD: Bloomburg School of Public Health, Johns Hopkins University, 2006.

Burns, Paul Y. "Use of Aircraft for Foliar Applications of Herbicides in Southern Forests." In *The Use of Chemicals in Southern Forests*, edited by Robert W. McDermid, 92. Baton Rouge: Louisiana State University Press, 1961.

Busby, William H., J. M. Delisle, C. C. Freeman, K. Kindscher, H. Loring, D. E. Nimz, and C. J. Schmidt. *A Natural Features Inventory of the Smoky Hill ANG* [Air National Guard] *Range, Kansas*. Open-file Report 137. Lawrence: Kansas Biological Survey, September 2007.

Buzan, Barry, Ole Waever, and Jaap de Wilde. *Security: A New Framework for Analysis*. Boulder, CO: Lynne Rienner Publishers, 1998.

Byman, Daniel L., Matthew C. Waxman, and Eric Larson. *Air Power as a Coercive Instrument*. Santa Monica, CA: RAND Corp., 1999.

Campbell, Lisa, and Arja Vainio-Mattila. "Participatory Development and Community-Based Conservation: Opportunities Missed for Lessons Learned." *Human Ecology* 31, no. 3 (September 2003): 417–37.

Carassava, Anthee. "U.N. Pledges $64 Million for Cleanup of Oil Spill off Lebanon." *New York Times*, 18 August 2006.

Carlino, Michael A. "The Moral Limits of Strategic Attack." *Parameters* 32 (Spring 2002): 5–29.

Carson, Rachel. *Silent Spring*. 40th anniv. ed. New York: Mariner Books, 2002.

Carter, F. W., and David Turnock, eds. *Environmental Problems of East Central Europe*. London: Routledge, 2002.

Carter, Sara A. "Taliban Buying Children to Serve as Suicide Bombers." *Washington Times*, 1 July 2009.

Central Intelligence Agency. *Putting Noncombatants at Risk: Saddam's Use of 'Human Shields.'"* Washington, DC: Central Intelligence Agency, January 2003.

Ceulemans, Carl. "The NATO Intervention in the Kosovo Crisis: March–June 1999." In *Moral Constraints on War: Principles and Cases*, edited by Bruno Coppieters and Nick Fotion, 205–28. Lanham, MD: Lexington Books, 2002.

Chayes, Sarah. *The Punishment of Virtue: Inside Afghanistan after the Taliban*. New York: Penguin Books, 2007.

Chenje, Munyaradze, and Phyllis Johnson, eds. *State of the Environment in Southern Africa*. Harare, Zimbabwe, and Maseru, Lesotho: Southern African Research and Documentation Centre/Southern African Development Community/World Conservation Union, 1994.

Churchill, Winston. Debate. House of Commons, London, 14 March 1933. Hansard Digitisation Project. http://hansard.millbanksystems.com/people/mr-winston-churchill/1933.

———. *The Second World War*. 6 vols. London: Cassell and Co., 1948–1954.

———. Speech. House of Commons, London, 20 August 1940. Hansard Digitisation Project. http://hansard.millbanksystems.com/people/mr-winston-churchill/1940.

Cilliers, Jakkie. "The African Standby Force: An Update on Progress." Occasional Paper 160. Pretoria, South Africa: Institute for Security Studies (ISS), March 2008.

———. *Human Security in Africa: A Conceptual Framework for Review*. Monograph for the African Human Security Initiative, 2004. http://www.africanreview.org.

Clausewitz, Carl von. *On War.* Edited and translated by Michael Howard and Peter Paret. Princeton, NJ: Princeton University Press, 1976.

"Cleanup Fights Stall New Uses for Old Bases." *USA Today*, 14 October 2004.

Clemens, Jeffrey. "Opium in Afghanistan: Prospects for the Success of Source Country Drug Control Policies." *Journal of Law and Economics* 51, no. 3 (August 2008): 407–32.

Clodfelter, Mark. "Molding Airpower Convictions: Development and Legacy of William Mitchell's Strategic Thought." In *The Paths of Heaven*, edited by Phillip S. Meilinger, 79–114. Maxwell AFB, AL: Air University Press, 1997.

———. *The Limits of Airpower*. New York: Free Press, 1989.

Clodfelter, Micheal. *Warfare and Armed Conflicts: A Statistical Reference to Casualty and Other Figures, 1500–2000*. Jefferson, NC: McFarland & Company, 2002.

Cluster Bombs and Landmines in Kosovo: Explosive Remnants of War. Geneva: International Committee of the Red Cross, 2000.

Cluster Munitions in Kosovo: Analysis of Use, Contamination and Casualties. London: Land Mine Action, 2007.

Cohen, Jon, and Jennifer Agiesta. "Poll of Afghans Shows Drop in Support for U.S. Mission." *Washington Post*, 10 February 2009.

Cohen, Sheldon M. *Arms and Judgment: Law, Morality, and the Conduct of War in the Twentieth Century*. Boulder, CO: Westview Press, 1989.

Cohen, Stuart A. *Israel and Its Army: From Cohesion to Confusion*. London and New York: Routledge, 2008.

Colorado Department of Public Health and Environment. "Former Lowry Bombing and Gunnery Range." http://www.cdphe.state.co.us/hm/flbgr.htm.

———. "Lowry Landfill Site." http://www.cdphe.state.co.us/hm/flbgr.htm.

Colville, John. *The Fringes of Power: 10 Downing Street Diaries 1939–1955*. New York and London: W. W. Norton & Co., 1985.

Conca, Ken, and Geoffrey Dabelko. *Environmental Peacekeeping*. Washington, DC: Woodrow Wilson Center Press, 2002.

Conetta, Carl. "Disappearing the Dead: Iraq, Afghanistan, and the Idea of a 'New Warfare,'" Research Monograph No. 9. Cambridge, MA: Commonwealth Institute Project on Defense Alternatives (PDA), 18 February 2004.

———. *Strange Victory: A Critical Appraisal of Operation Enduring Freedom and the Afghanistan War.* Cambridge, MA: Commonwealth Institute PDA, 2002.

Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques. http://fletcher.tufts.edu/multi/texts/BH700.txt.

Cordesman, Anthony M. "The 'Instant Lessons' of the Iraq War." Report. Washington, DC: Center for Strategic and International Studies, April 2003.

Cortright, David, and George A. López, eds. *Smart Sanctions: Targeting Economic Statecraft*. Lanham, MD: Rowman & Littlefield Publishers, 2002.

Crane, Conrad C. "Sky High: Illusions of Airpower." *National Interest* 65 (Fall 2001): 116–22.

Craven, Wesley F., and James L. Cate, eds. *The Army Air Forces in World War II*. Vol. 5, *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*. 1952. New imprint, Washington, DC: Office of Air Force History, 1983.

Cronon, William. *Changes in the Land: Indians, Colonists and the Ecology of New England*. Rev. ed., New York: Hill and Wang, 2003.

———. *Nature's Metropolis: Chicago and the Great* West. New York: W. W. Norton & Co., 1991.

Daalder, Ivo H., and Michael E. O'Hanlan. *Winning Ugly: NATO's War to Save Kosovo*. Washington, DC: The Brookings Institution, 2000.

Dalby, Simon. "Contesting an Essential Concept: Reading the Dilemmas in Contemporary Security Discourse." In *Critical Security Studies*, edited by Keith Krause and Michael C. Williams, 3–32. London: University College Press, 1997.

———. *Environmental Security*. Minneapolis: University of Minnesota Press, 2002.

———. "Security, Modernity, Ecology: The Dilemmas of Post-Cold War Security Discourse." *Alternatives* 17, no. 1 (1992): 95–134.

Dao, James. "A Nation at War: The Commandos, Navy Seals Easily Seize 2 Oil Wells." *New York Times*, 22 March 2003.

———. "A Nation at War: Navy Special Warfare Group, Cat and Mouse on Iraq's Crucial Waterways." *New York Times*, 24 March 2003.

David, Ahikam Moshe. "Beit Shean's Residents to the IAF [Israeli Air Force]: 'Quiet,'" *Yediot Aharonot*, 14 August 2009 [Hebrew].

Davis, Richard G. *On Target: Organizing and Executing the Strategic Air Campaign against Iraq*. Washington, DC: US Air Force History and Museums Program, 2002.

"Defoliating Viet Nam." *Time*, 23 February 1968. http://www.time.com/time/magazine/article/0,9171,837961,00.html.

Deudney, Daniel. "The Case against Linking Environmental Degradation and National Security." *Millennium* 19, no. 3 (1990): 461–76.

———. "Environment and Security: Muddled Thinking." *Bulletin of the Atomic Scientists* 47, no. 3 (April 1991): 23–28.

Dieterich Jr., Michael D. " 'Law of War' and Ecology: A Proposal for a Workable Approach to Protecting the Environment through the Law of War," *Military Law Review*, no. 136 (1992): 137–60.

Dodds, Felix, and Tim Pippard, eds. *Human and Environmental Security: An Agenda for Change*. London: Earthscan, 2005.

Douglas-Hamilton, Iain, and Oria Douglas-Hamilton. *Battle for the Elephants*. New York: Viking Press, 1992.

Douhet, Giulio. *The Command of the Air*. Translated by Dino Ferrari. New York: Coward-McCann Inc., 1942.

Drozdiak, William. "Commander Of Air War Says Kosovo Victory Near; Belgrade Seen Giving In within Two Months." *Washington Post*, 24 May 1999, 1.

du Bois, Kathleen E. "The Illegal Trade in Endangered Species." *African Security Review* 6, no. 1 (1997). http://www.iss.co.za.

Dunlap, Jr., Charles J. "Lawfare: A Decisive Element of 21st-Century Conflicts?" *Joint Force Quarterly* 54 (3rd Quarter 2009): 34–39.

Eaton, Janet. "Ecological and Health Consequences of the NATO Bombings of Pancevo and other Petrochemical and Chemical Industrial Complexes." International Action Center. http://www.iacenter.org/warcrime/jeaton.htm.

Eichner, Itamar. "Turkey Soothes: Don't Jump to Conclusions due to the Postponement of the Exercise." *Yediot Aharonot*, 13 October 2009 [Hebrew].

Elliot, Gil. *The Twentieth Century Book of the Dead*. New York: Scribner's, 1977.

Ellis, Stephen. "Of Elephants and Men: Politics and Nature Conservation in South Africa." *Journal of Southern African Studies* 20, no. 1 (1994): 53–69.

Environmental Protection Agency. "Cornhusker Army Ammunition Plant." http://www.epa.gov/region7/cleanup/npl_files/ne2213820234.pdf.

———. "Current Status, Air Force Plant 4," 30 December 2008. http://www.epa.gov/earth1r6/6sf/pdffiles/0603610.pdf.

———. "What Is Superfund?" http://www.epa.gov/superfund/about.htm.

"Environmental Scarcities and Violent Conflict: Evidence from Cases." *International Security* 19, no. 1 (1994): 5–40.

Esty, Daniel C., Marc Levy, Tanja Srebotnjak, and Alexander de Sherbinen. *2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship*. New Haven, CT: Yale Center for Environmental Law and Policy, 2005.

Exxon Valdez Oil Spill Trustee Council. "Oil Spill Facts." http://www.evostc.state.ak.us/facts/qanda.cfm.

"Fact Sheet," 8 November 2005. Correspondence Box. Schilling AFB File. Kansas Department of Health and Environment (KDHE), Topeka, KS.

Fairlie, Ian. "Depleted Uranium: Properties, Military Use and Health Risks." *Medicine, Conflict and Survival* 25, no. 1 (January–March 2009): 41–64.

Fatal Footprint: The Global Human Impact of Cluster Munitions. Brussels: Handicap International, 2006.

Fawkes, Helen. "Scars of NATO Bombing Still Pain Serbs." *BBC News*, 24 March 2009.

Feifer, George. *Tennozan: The Battle of Okinawa and the Atomic Bomb*. New York: Ticknor and Fields, 1992.

Felbab-Brown, Vanda. "Afghanistan: When Counternarcotics Undermines Counterterrorism." W*ashington Quarterly* 28, no. 4 (Autumn 2005): 55–72.

Feleke, Elisabeth. "From Greed to Grievance: Natural Resources and Conflict in Africa." In *African Environmental and Human Security in the 21st Century*, edited by Helen E. Purkitt, 185–200. Amherst, NY: Cambria Press, 2009.

Ferreira, Realize, and Dan Henk. "'Operationalizing' Human Security in South Africa." *Armed Forces and Society* 35, no. 3 (April 2009): 501–25.

FOCUS Assessment Mission 2 to the Federal Republic of Yugoslavia: Ecology, 18 July to 13 August 1999. Bern: FOCUS: Greece-Russia-Switzerland-Austria Humanitarian Relief Operation Planning and Coordination Unit, 1999.

Foggo, Daniel, and Michael Burke. "I Captured Proof of Dambusters' Raid." *Sunday Telegraph*, 1 January 2001.

Foster, Gregory D. "Environmental Security: The Search for Strategic Legitimacy." *Armed Forces and Society* 27, no. 3 (Spring 2001): 373–95.

Fredette, Raymond. *The Sky on Fire: The First Battle of Britain, 1917–1918*. New York: Holt, Rinehart, and Winston, 1966.

Friedrich, Jörg. *Der Brand: Deutschland im Bombenkrieg 1940–1945* [*The Fire: Germany in the Bombing 1940–1945*]. Munich, Germany: Propyläen Publishing, 2002.

From Conflict to Sustainable Development: Assessment and Clean-Up in Serbia and Montenegro. Geneva: United Nations Environment Program, 2004.

Frumkin, Howard, Jeremy Hess, and Stephen Vindigni. "Energy and Public Health: The Challenge of Peak Petroleum." *Public Health Reports* 124, no. 1 (January–February 2009): 5–19.

Frankum, Ronald Bruce. *Like Rolling Thunder: The Air War in Vietnam, 1964–1975*. Lanham, MD: Rowman & Littlefield Publishers, Inc., 2005.

Fuller, Stephan. "Linking Afghanistan with Its Neighbors through Peace Parks: Challenges and Prospects." In *Peace Parks: Conservation and Conflict Resolution*, edited by Saleem Ali, 291–312. Cambridge, MA: MIT Press, 2007.

Funck, Marcus, and Roger Chickering. *Endangered Cities: Military Power and Urban Societies in the Era of the World Wars*. Boston: Brill Academic Publishers, 2004.

Garfield, Richard. *Morbidity and Mortality among Iraqi Children from 1990 through 1998: Assessing the Impact of the Gulf War and Economic Sanctions*. Campaign against Sanctions on Iraq, July 1999. http://www.casi.org.uk/info/garfield/dr-garfield.html.

Gellman, Barton. "Allied Air War Struck Broadly in Iraq: Officials Acknowledge Strategy Went beyond Purely Military Targets." *Washington Post*, 23 June 1991.

Gerber, Michele Stenehjem. *On the Home Front: The Cold War Legacy of the Hanford Nuclear Site*. Lincoln: University of Nebraska Press, 1992.

Giangreco, D. M. "Casualty Projections for the U.S. Invasions of Japan, 1945–1946: Planning and Policy Implications." *Journal of Military History* 61 (July 1997): 521–82.

Gichohi, Helen. "From the Desk of the Vice President for Programme: No Wildlife Conservation without Land Conservation." *African Heartland News*, September–December, 2005. http://www.awf.org/documents/AHN_September-December2005.pdf.

Giustozzi, Antonio. "War and Peace Economies of Afghanistan's Strongmen." *International Peacekeeping* 14, no. 1 (January 2007): 75–89.

Glantz, David M. *The Battle of Leningrad, 1941–1944*. Lawrence: University Press of Kansas, 2002.

Glaze, John A. *Opium and Afghanistan: Reassessing U.S. Counternarcotics Strategy*. Carlisle Barracks, PA: Strategic Studies Institute, US Army War College, 2007.

Godschalk, Seakle K. B. "Protecting Our Environment for a Quarter Century." *SA* [South Africa] *Soldier* 9, no. 10 (2002): 24–27.

———. "Waging War over Water in Africa." *Forum* 4 (2000): 110–33.

Goldman, Mara. "Partitioned Nature, Privileged Knowledge: Community-Based Conservation in Tanzania." *Development and Change* 34, no. 5, 833–62.

Gopal, Sriram, and Nicole Deller, *Precision Bombing, Widespread Harm*: *Two Case Studies of the Bombings of Industrial Facilities at Pancevo and Kragujevac during Operation Allied Force, Yugoslavia 1999*. Tacoma Park, MD: Institute for Energy and Environmental Research, 2002.

Gorbachev, Mikhail S. "Poison in the Air: The Environmental Cost of the Kosovo Conflict Must Be Exposed." *The Guardian*, 18 June 1999.

Graham, Bradley. "Military Turns to Software to Cut Civilian Casualties." *Washington Post*, 21 February 2003, A18.

Gravel, Mike. *The Pentagon Papers: The Defense Department History of United States Decisionmaking in Vietnam*. 4 vols. Boston: Beacon Press, 1971.

Grayling, Anthony. *Among the Dead Cities: The History and Moral Legacy of the WWII Bombing of Civilians in Germany and Japan*. New York: Walker & Company, 2006.

Grotto, Jason, and Tim Jones. "Agent Orange's Lethal Legacy: For U.S., A Record of Neglect: Poisonous Defoliants Still Exact a Toll in U.S., Vietnam." *Chicago Tribune*, 4 December 2009. http://www.chicagotribune.com/health/agentorange/chi-agent-orange1-dec04,0,1766354.story.

Haas, Ernst B. *Beyond the Nation-State*. Stanford, CA: Stanford University Press, 1964.

Habakuk, Moti. "The First Sixty Years: Part Two." *Air Force Journal* 180 (2008): 69 [Hebrew].

Hafvenstein, Joel. *Opium Season: A Year on the Afghan Frontier*. Guilford, CT: Lyons Press, 2007.

The Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict, 14 May 1954. http://portal.unesco.org/en/ev.php-URL_ID=13637&URL_DO=DO_TOPIC&URL_SECTION=201.html.

Hallion, Richard. *Storm over Iraq: Air Power and the Gulf War*. Washington, DC: Smithsonian Scholarly Press, 1992.

Hardin, G. "The Tragedy of the Commons." *Science*, New Series 162, no. 3859 (13 December 1968): 1243–48.

Harris, Arthur. *Bomber Offensive*. London: William Collins, Sons and Co. Ltd., 1947.

Hastings, Max. *Bomber Command*. Reprint, London: Pan Macmillan, Ltd., 1981.

Hayward, Joel. "Hitler's Quest for Oil: The Impact of Economic Considerations on Military Strategy 1941–42." *The Journal of Strategic Studies* 18, no. 4 (December 1995): 94–135.

———. "NATO's War in the Balkans: A Preliminary Analysis." *New Zealand Army Journal*, No. 21 (July 1999), 1–17.

———. "Too Little, Too Late: An Analysis of Hitler's Failure in August 1942 to Damage Soviet Oil Production." *The Journal of Military History* 64, no. 3 (July 2000): 769–94.

Healy, Hall. "Korean Demilitarized Zone Peace and Nature Park." *International Journal on World Peace* 24, no. 4 (December 2007): 61–83.

Hedges, Chris. "Serbian Town Bombed by NATO Fears Effects of Toxic Chemicals." *New York Times*, 14 July 1999.

Heidenrich, John G. "The Gulf War: How Many Iraqis Died?" *Foreign Policy* 90 (Spring 1993): 108–25.

Hendricks, Cheryl, ed. *From State Security to Human Security in Southern Africa: Policy Research and Capacity Building Challenges*. ISS Monograph no. 122. Pretoria, South Africa: ISS, 2006.

Henk, Dan. "Biodiversity and the Military in Botswana." *Armed Forces and Society* 32, no. 1 (January 2006): 273–91.

———. *The Botswana Defense Force and the Struggle for an African Environment*. New York: Palgrave Macmillan, 2007.

———. "The Botswana Defence Force and the War against Poachers in Southern Africa." *Small Wars and Insurgencies* 16, no. 2 (June 2005): 170–91.

———. "The Environment, the US Military and Southern Africa." *Parameters* 34, no. 2 (Summer 2006): 98–117.

———. "Human and Environmental Security in Southern Africa: The Kavango-Zambezi (KAZA) Transfrontier Conservation Area Project." In *African Environmental and Human Security in the 21st Century*, edited by Helen Purkitt, 213–36. New York: Cambria Press, 2009.

Henriksen, Dag. *NATO's Gamble: Combining Diplomacy and Airpower in the Kosovo Crisis 1998–1999*. Annapolis, MD: Naval Institute Press, 2007.

Hentschel, Klaus. *The Mental Aftermath: The Mentality of German Physicists 1945–1949*. New York: Oxford University Press, 2007.

Hewitt, Kenneth. "Place Annihilation: Area Bombing and the Fate of Urban Places." *Annals of the Association of American Geographers* 73, no. 2 (June 1983): 257–84.

Hewson, Robert. "Cluster Weapons Ban Leaves Gap in UK Inventory." *Jane's Defense Weekly*, 10 April 2007.

Hicks, Madelyn Hsiao-Rei, Hamit Dardagan, Gabriela Guerrero Serdán, Peter M. Bagnall, John A. Sloboda, and Michael Spagat. "The Weapons That Kill Civilians: Deaths of Children and Noncombatants in Iraq, 2003–2008." *New England Journal of Medicine* 360, 16 April 2009.

Homer-Dixon, Thomas. "Debating Violent Environments." Environmental Change and Security Project Report 9. Washington, DC: Woodrow Wilson Institute, 2003.

———. *The Environment, Scarcity and Violence*. Princeton, NJ: Princeton University Press, 1999.

———. *Environmental Scarcity and Global Security*. New York: Foreign Policy Association, 1993.

———. "On the Threshold: Environmental Changes as Causes of Acute Conflict." *International Security* 16, no. 2 (1991): 76–116.

Homer-Dixon, Thomas, and Jessica Blitt, eds. *Ecoviolence: Links among Environment, Population and Security*. Lanham, MD: Rowan and Littlefield, 1998.

House of Commons. Defence Select Committee. Fourteenth Report, 23 October 2000, at para. 305. http://www.parliament.the-stationery-office.co.uk/pa/cm199900/cmselect/cmdfence/347/34722.htm#a64.

———. Foreign Affairs Select Committee. Fourth Report, 23 May 2000, at para. 151. http://www.publications.parliament.uk/pa/cm199900/cmselect/cmfaff/28/2814.htm#a44.

Howe, Herbert M. *Ambiguous Order: Military Forces in African States*. Boulder, CO: Lynne Rienner Publishers, 2001.

Hsiao, Elaine. "Peace Parks: A Natural Alternative." *University for Peace: Peace and Conflict Monitor*. http://www.monitor.upeace.org/archive.cfm?id_article=456.

Hulme, David, and Marshall Murphree. "Communities, Wildlife, and the 'New Conservation' in Africa." *Journal of International Development* 11 (1999): 277–85.

Hulme, David, and Marshall Murphree, eds. *African Wildlife and Livelihoods: The Promise and Performance of Community Conservation*. Portsmouth, NH: Heinemann Publishing, 2001.

Human Development Report, 1993. New York: United Nations Development Program, 1993. http://www.undp.org/hdro/93.htm.

Human Development Report, 1994. New York: United Nations Development Program, 1994. http://www.undp.org/hdro/94.htm.

Human Rights Watch. *Civilian Deaths in the NATO Air Campaign*. New York: Human Rights Watch, February 2000.

———. *NATO Deaths*. New York: Human Rights Watch, 2000.

———. *Off Target: The Conduct of the War and Civilian Casualties in Iraq*. New York: Human Rights Watch, 2003.

———. *'Troops in Contact': Airstrikes and Civilian Deaths in Afghanistan*. New York: Human Rights Watch, September 2008.

"Hundreds Mourn Family Killed in Marine Jet Crash." *San Diego Union-Tribune*, 11 December 2008.

Huntington, Samuel P. *The Soldier and the State: The Theory and Politics of Civil-Military Relations*. Cambridge, MA: Harvard University Press, 1957.

Hurt, R. Douglas. *The Great Plains during World War II*. Lincoln: University of Nebraska Press, 2008.

"The IAF Will Promote Environmental Issues." *Channel 7*, 5 December 2007 [Hebrew].

"Insurgents Using Teens in Attacks." *Chicago Tribune*, 7 June 2009.

International Criminal Tribunal for the former Yugoslavia. *Final Report to the Prosecutor by the Committee Established to Review the NATO Bombing Campaign against the Federal Republic of Yugoslavia*. http://www.icty.org/sid/10052.

Iraq Body Count. "A Dossier of Civilian Casualties, 2003–2005." http://reports.iraqbodycount.org/a_dossier_of_civilian_casualties_2003–2005.pdf.

Israel State Comptroller. "The Treatment of the Ministry of Defense and Israel Defense Forces in the Issue of Protection of the Environment in the IDF," *Annual Report 55A*. Jerusalem: Governmental Printing House, 2004, [Hebrew].Jacobs, W. A. "The British Strategic Air Offensive against Germany in World War II." In *Case Studies in Strategic Bombardment*, edited by R. Cargill Hall, 91–182. Washington, DC: US Air Force History and Museums Program, 1998.

Joksimovich, Vojin. "Militarism and Ecology: NATO Ecocide in Serbia." *Mediterranean Quarterly* 11, no. 4 (2000): 140–60.

Jones, R. V. *The Wizard War: British Scientific Intelligence, 1939–1945* (New York: Coward, McCann, and Geoghegan, 1978).

Jones, Tobin, ed. *617 Squadron Operational Record Book 1943–1945*. Bicester, UK: Binx Publishing, 2002.

"Just War Doctrine." *Catholic Answers*. http://www.catholic.com/library/Just_War_Doctrine_1.asp.

Kakonen, Jyrki, ed. *Green Security or Militarized Environment*. Aldershot, UK: Dartmouth Publishing Co., Ltd., 1994.

The Kampala Document: Towards a Conference on Security, Stability, Development and Cooperation. New York: African Leadership Forum, 1992.

Kansas Biological Survey. *Cheyenne Bottoms: An Environmental Assessment*. Lawrence: University Press of Kansas, 1987.

"Kansas Governor Hosts Ribbon Cutting for Great Plains Joint Regional Training Center." News Release. The Adjutant General, Kansas National Guard, 28 March 2008. http://www.kansas.gov/ksadjutantgeneral/News%20Releases/2008/08-033.htm.

Kansteiner III, Walter H., and J. Stephen Morrison. *Rising U.S. Stakes in Africa: Seven Proposals to Strengthen U.S.–Africa Policy*. Washington, DC: Center for Strategic and International Studies, 2004.

Kaplan, Robert. "The Coming Anarchy." *Atlantic Monthly* (February 1994): 44–77.

Karni, Maya. "After the Fighting, 10 Dunams of Natural Forest in the Area of Mt. Meron Will Be Thinned Out." *Bemahane*, 15 September 2006 [Hebrew].

———. "Animal, Plant and Vegetable." *Bemahane*, 1 September 2006 [Hebrew].

———. "In the Ministry for Protection of the Environment They Call to the IDF: 'Report More to Us about Environmental Damage in the Bases'." *Bemahane*, March 2007 [Hebrew].

Karni, Maya, and Yishai Avior. "Uvda Base: Adopting the Negev Dunes." *Bemahane*, 29 December 2006 [Hebrew].

Katsuichi, Honda. *The Nanjing Massacre*. New York: M. E. Sharp, Inc. 1999.

Katzman, Kenneth. *Afghanistan: Post-Taliban Governance, Security, and U.S. Policy*. Washington, DC: Congressional Research Service, 2009.

Keaney, Thomas A. "Surveying Gulf War Airpower." *Joint Force Quarterly*, Autumn 1993, 25–36.

Keegan, John. "Please Mr. Blair, Never Take Such a Risk Again." *Daily Telegraph*, 6 June 1999.

Kemkar, Neal. "Environmental Peacemaking: Ending Conflict between India and Pakistan on the Siachen Glacier through the Creation of a Transboundary Peace Park." *Stanford Environmental Law Journal* 25, no. 1 (2005): 1–56.

Kennett, Lee. *The First Air War, 1914–1918*. New York: Free Press, 1991.

"The Kenya Land Conservation Trust Formed." *African Heartland News*, September–December 2005. http://www.awf.org/documents/AHN_September-December2005.pdf.

Killingray, David. "'A Swift Agent of Government': Air Power in British Colonial Africa, 1916–1939." *Journal of African History* 25, no. 4 (1984): 429–44.

Kim, Ke Chung. "Preserving Korea's Demilitarized Corridor for Conservation: A Green Approach to Conflict Resolution." In *Peace Parks: Conservation and Conflict Resolution*, edited by Saleem Ali, 239–60. Cambridge, MA: MIT Press, 2007.

King, Laura, and Julian E. Barnes. "Deadly Afghan Day Signals More Ahead." *Chicago Tribune*, 7 July 2009.

Klare, Michael T. "Oil Wars." *TomDistpatch.com*, 9 October 2004. http://www.tomdispatch.com/post/1888/.

———. "The Pentagon v. Peak Oil: How Wars of the Future May Be Fought Just to Run the Machines That Fight Them." *TomDispatch.com*, 14 June 2007. http://www.tomdispatch.com/post/174810/.

———. *Resource Wars: The New Landscape of Global Conflict*. New York: Henry Holt, 2001.

Knights, Michael. "Infrastructure Targeting and Postwar Iraq." *Policy Watch* no. 725 (14 March 2003). http://www.washingtoninstitute.org/templateC05.php?CID=1603.

Kreutzmann, Herman. "Afghanistan and the Opium World Market: Poppy Production and Trade." *Iranian Studies* 40, no. 65 (December 2007): 605–21.

bin Laden, Osama. "Letter to the American People." Transmitted after 11 September 2001. http://www.globalsecurity.org/security/library/report/2002/021120-ubl.htm.

Lake, Anthony, Christine Todd Whitman, Princeton N. Lyman, and J. Stephen Morrison. *More than Humanitarianism: A Strategic U.S. Approach to Africa*. Independent Task Force Report no. 56. New York: Council on Foreign Relations, 2006.

Lambeth, Benjamin S. *The Transformation of American Airpower*. New York: Cornell University Press, 2000.

Lapidot, Aharon. "Special Interview with the Commander of the Israeli Air Force, General Amos Lapidot." *Air Force Journal*, 132 (1983) [Hebrew].

Larson, Eric V., and Bogdan Savych. *Misfortunes of War: Press and Public Reactions to Civilian Deaths in Wartime*. Santa Monica, CA: RAND Corp., 2007.

Lawson, Ted W. *Thirty Seconds over Tokyo*. Washington, DC: Potomac Books, 2002.

Leader-Williams, Nigel. *The World Trade in Rhino Horn: A Review*. Species in Danger Series. Cambridge, UK: TRAFFIC International, 1992.

Leaning, Jennifer. "Tracking the Four Horsemen: The Public Health Approach to the Impact of War and War-Induced Environmental Destruction in the Twentieth Century." In *The Environmental Consequences of War: Legal, Economic, and Scientific Perspectives*, edited by Jay E. Austin and Carl E. Bruch, 384–401. Cambridge: Cambridge University Press, 2000.

———. "War and the Environment." In *Life Support: The Environment and Human Health*, edited by Michael McCally, 273–84. Cambridge, MA: MIT Press, 2002.

Leroy, Howard S. "Limitations on Air Warfare." *Air Law Review* 12 (January 1941): 27.

Levy, Marc A. "Is the Environment a National Security Issue?" *International Security*, Fall 1995, 35–62.

Lewy, Guenter. *America in Vietnam*. New York: Oxford University Press, 1978.

Lotrionte, Catherine. "When to Target Leaders." *Washington Quarterly* 26 (Summer 2003): 73–86.

MacDonald, David. *Drugs in Afghanistan: Opium, Outlaws, and Scorpion Tales* (New York: Pluto Press, 2007).

Macgregor, Douglas A. "Command and Control for Joint Strategic Actions." *Joint Force Quarterly*, no. 20 (Autumn/Winter 1998–99): 25–33.

Malan, Mark. "AFRICOM: A Wolf in Sheep's Clothing?" Testimony to the [US] Senate Foreign Relations Committee/African Subcommittee on African Affairs. 110th Cong., 1st sess., 1 August 2007.

Marković, Sasa. "Serbia: Airing Grievances." *Transitions*, 28 September 2004.

Martin, Esmond Bradley. "The Report on the Trade in Rhino Products." *Pachyderm* 11 (January–June 1989): 13–20.

———. "The Yemeni Rhino Horn Trade." *Pachyderm* 8 (January–June 1987): 13–16.

Martinovic-Vitanovic, Vesna, and V. Kalafatic. "Consequences of War Destruction of Oil Refinery-Novi Sad (Yugoslavia) on the Danube and Its Biota." *Journal of Environmental Protection and Ecology* 3, no. 2 (2002): 370–376.

Mason, Brad. "US Army Apache Helicopters and US Air Force Expeditionary Forces: Implications for Future Military Operations." Occasional Paper no. 22. Maxwell AFB, AL: USAF Center for Strategy and Technology, Air War College, June 2001. http://www.au.af.mil/au/awc/awcgate/cst/csat22.pdf.

Matthews, Jessica Tuchman. "Redefining Security." *Foreign Affairs* 68, no. 2 (Spring 1989): 162–77.

Mayer, Jane. "The Predator War: What Are the Risks of the C.I.A.'s Covert Drone Program?" *The New Yorker*, 26 October 2009, 36–45.

McCabe, J. Terrence, Scott Perkin, and Claire Schofield. "Can Conservation and Development Be Coupled among Pastoral People? An Examination of the Maasai of the Ngorongoro Conservation Area, Tanzania." *Human Organization* 51, no. 4 (1992): 353–66.

McDermid, Robert W., ed. *The Use of Chemicals in Southern Forests*. Baton Rouge: Louisiana State University, Forestry Symposium, 1960.

McFarland, Marvin W., ed. *The Papers of Wilbur and Orville Wright*. New York: McGraw-Hill, 2001.

McFarland, Stephen L. *America's Pursuit of Precision Bombing, 1910–1945*. Washington, DC: Smithsonian Books, 1995.

McMullen, John K. "The United States Strategic Bombing Survey and Air Force Doctrine." Master's thesis, School of Advanced Airpower Studies, Air University, Maxwell AFB, AL, 1 June 2001. www.au.af.mil/au/awc/awcgate/saas/mcmullen.pdf.

Medlicott, William Norton. *The European Blockade*. 2 vols. London: HMSO, 1952.

Meilinger, Phillip S. "Clipping the Bomber's Wings: The Geneva Disarmament Conference and the Royal Air Force, 1932–34." *War and History* 6 (July 1999): 306–30.

———. "Trenchard and Morale Bombing: The Evolution of the Royal Air Force before World War II." *The Journal of Military History*, April 1996, 243–70.

Metcalfe, Simon. "Campfire: Zimbabwe's Communal Areas Management Program for Indigenous Resources." Paper prepared for the Liz Claiborne and Art Ortenberg Foundation Workshop on Community-Based Conservation. http://www.resourceafrica.org/documents/1993/1993_campfire_BG.PDF.

Mets, David R. *Reflections of a Middling Cold Warrior: Should the Army Air Corps Be Resurrected?* Maxwell AFB, AL: Air University Press, December 2009.

Meyer, Jeanne M. "Tearing Down the Façade: A Critical Look at the Current Law on Targeting the Will of the Enemy and Air Force Doctrine." *Air Force Law Review* 51 (2001): 143–82.

Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being: Synthesis*. http://www.maweb.org/en/Synthesis.aspx.

Milstein, Mati. "Lebanon Oil Spill Makes Animals Casualties of War." *National Geographic News*, 31 July 2006.

Miner, Craig. *Kansas: The History of the Sunflower State, 1854–2000*. Lawrence: University Press of Kansas, 2002.

Minister of State for the Armed Forces Adam Ingram. House of Commons Hansard Written Answers for 16 November 2001. http://www.publications.parliament.uk/pa/cm200102/cmhansrd/vo011116/text/11116w17.htm#11116w17.html_spnew3.

Morgan, Claude V. Z. "Collateral Damage of the Environmental Kind." *Mother Jones*, 6 September 2000.

Morgan, Edmund. *American Slavery, American Freedom*. New York: W. W. Norton and Company, 2003.

Mosher, David E., Beth E. Lachman, Michael D. Greenberg, Tiffany Nichols, Brian Rosen, and Henry H. Willis. "Green Warriors: Army Environmental Considerations for Contingency Operations from Planning through Post-Conflict." RAND Report. Santa Monica: CA: RAND Arroyo Center, 2008.

Mueller, John, and Karl Mueller. "Sanctions of Mass Destruction." *Foreign Affairs* 78 (May/June 1999): 43–53.

Mufson, Steven, and Walter Pincus. "Major Challenges for Pentagon in Getting Fuel to U.S. Troops in Afghanistan." *Washington Post,* 15 December 2009.

Mullison, Wendell R. "The Volatility of Several Salts and Esters of 2,4-D As Determined by the Response of Tomato, Bean, and Cotton Plants." *American Society for Horticultural Science* 53 (1949): 287.

Muloongo, Keith, Roger Kibasomba, and Jemima Njeri Kariri. *The Many Faces of Human Security: Case Studies of Seven Countries in Southern Africa*. Pretoria, South Africa: ISS, 2005.

Munk, Erika. "The New Face of Techno-War." *The Nation*, 6 May 1991, 583.

NATO Standardization Agreement (STANAG) 7141, *Joint NATO Doctrine for Environmental Protection during NATO-led Activities,* 5th Edition, 20 Feb 2008.

"The Nature of German Environmental History." *German History* 27, no. 1 (January 2009): 113–30.

Neillands, Robin. *The Bomber War: The Allied Offensive against Nazi Germany*. Woodstock, NY: Overlook Press, 2001.

Northern Rangland Trust. http://www.nrt-kenya.org.

Norton-Taylor, Richard. "US Deploys Controversial Weapon." *The Guardian*, 12 October 2001.

Norton-Taylor, Richard, Peter Walker, and agencies. "Cluster Bomb Treaty: Signing of Ban on Production Begins." *The Guardian*, 3 December 2008.

Nye, David E. *America as Second Creation: Technology and Narratives of New Beginnings*. Cambridge, MA: MIT Press, 2004.

"Obama Takes US Closer to Cluster Bomb Ban." *The Guardian*, 13 March 2009.

Office of the Surgeon, Multinational Force-Iraq, and Office of the Surgeon General, US Army Medical Command. "Mental Health Advisory Team (MHAT) IV, Operation Iraqi Freedom 05-07." Full Report, 17 November 2006.

Okoth, P. Godfrey. "The New East African Community: A Defense and Security Organ as the Missing Link." In *Africa at the Crossroads: Between Regionalism and Globalization*, edited by John Mukum Mbaku and Suresh Saxena, 147–62. Westport, CN: Praeger Publishers, 2004.

Olson, Norris D. "Salina's Response to the Closing of Schilling Air Force Base." Master's thesis, University of Kansas, 1968.

Operational Law Handbook 2000. Charlottesville, VA: Judge Advocate General's School, US Army, 2000.

Oren, Amiram, and Rafi Regev. *A Land in Khaki: The Geographic Dimension of Defense in Israel*. Jerusalem: Carmel, 2008 [Hebrew].

Orend, Brian. "Is There a Supreme Emergency Exemption?" In *Just War Theory: A Reappraisal*, edited by Mark Evans, 134–53. Edinburgh: Edinburgh University Press, 2005.

Owen, Robert C., ed. *Deliberate Force: A Case Study in Effective Air Campaigning*. Maxwell AFB, AL: Air University Press, 2000.

Owen, Taylor, and Ben Kiernan. "Bombs over Cambodia." *Walrus*, October 2006, 62–69.

"Panel Touts Robots' Future Combat Role." *Virginian-Pilot*, 28 January 2009.

Parks, W. Hays. "Air War and the Law of War." *Air Force Law Review* 32 (January 1990): 1–226.

Pearce, Fred. "From Viet Nam to Rwanda: War's Chain Reaction." *The UNESCO Courier: Planet,* May 2000. http://www.unesco.org/courier/2000_05/uk/planet.htm.

Pearton, Maurice. *Oil and the Romanian State 1895–1948*. Oxford: Oxford University Press, 1971.

Peled-Fleischer, Mical. "Israeli Pilots Took Part in Exercise of USAF." *Air Force Journal*, 119 (1998) [Hebrew].

Peltier, Jean-Philippe N., and Meer Thomas. "Air Domain Development in Africa: A Reasonable Proposition." *Air & Space Power Journal*, Summer 2009, 111–13.

Peri, Yoram. "Civil-Military Relations in Israel in Crisis." In *Military, State and Society in Israel*, edited by Daniel Mamam, Eyal Ben-Ari, and Zeev Rosenhek, 114–15. New Brunswick, NJ, and London: Transaction Publishers, 2001.

Peters, Gretchen. *Seeds of Terror: How Heroin Is Bankrolling the Taliban and Al Qaeda*. New York: Thomas Dunne Books, 2009.

Pfeffer, Anshell. "Under Simulated Fire." *Ha'aretz*, 10 April 2009 [Hebrew].

Pinheiro, Isidro, Gabaake Gabaake, and Piet Heyns. "Cooperation in the Okavango River Basin: The OKACOM [Okavango River Basin Water Commission] Perspective." In *Transboundary Rivers, Sovereignty and Development* edited by Anthony Turton, Peter Ashton, and Eugene Cloete, 105–18. Pretoria, South Africa: African Water Issues Research Unit, University of Pretoria, 2003.

Ploch, Lauren. *Africa Command: US Strategic Interests and the Role of the US Military in Africa*. Washington, DC: Congressional Research Service, 10 March 2008.

Popovska, Nevena, and Jasmina Sopova. "The Pollution of the Balkans." *UNESCO Courier*, May 2000.

Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I). http://www.icrc.org/ihl.nsf/INTRO/470.

Public Broadcasting Service. "War in Europe: NATO's 1999 War against Serbia over Kosovo, Interview of Gen Michael C. Short." *Frontline*, n. d. http://www.pbs.org/wgbh/pages/frontline/shows/kosovo/interviews/short.html.

Purkitt, Helen, ed. *African Environmental and Human Security in the 21st Century*. Amherst, NY: Cambria Press, 2009.

"Quitclaim Deed for Schilling Air Force Base." Saline County Deed Book 267, 9 September 1966. Schilling AFB Files. KDHE, Topeka, KS.

Ramutsindela, Maano. "Scaling Peace and Peacemakers in Transboundary Parks: Understanding Glocalization." In *Peace Parks: Conservation and Conflict Resolution*, edited by Saleem Ali, 1–22. Cambridge, MA: MIT Press, 2007.

Rauert, Tyler. "The Influence of Just War Perspectives: Implications for U.S. Central Command." *Joint Force Quarterly* 50 (Fall 2008): 73–78.

Reichberg, Gregory, and Henrik Syse. "Protecting the Natural Environment in Wartime: Ethical Considerations from the Just War Tradition." *Journal of Peace Research* 37, no. 4 (2000): 449–68.

Republic of Botswana. *Vision 2016: Towards Prosperity for All*. Gaborone, Botswana: Government Printing Office, 1997.

Rhodes, Richard. *The Making of the Atomic Bomb*. New York: Simon & Schuster, Inc., 1986.

Ricciuti, Edward. "The Elephant Wars." *Wildlife Conservation* 96, no. 2 (1993): 14–35.

Richards, Denis, and Hilary Saunders. *Royal Air Force 1939–1945*. Vol. 2. 1953. Reprint. London: HMSO, 1974.

Robichaud, Carl. "Buying Time in Afghanistan." *World Policy Journal* 24, no. 2 (Summer 2007): 1–10.

Rodin, David. "The Ethics of Asymmetric War." In *The Ethics of War: Shared Problems in Different Traditions*, edited by Richard Sorabji and David Rodin, 153–68. Aldershot: Ashgate Publishing Ltd., 2006.

Ronzitti, Natalino. "Is the *Non Liquet* of the Final Report by the Committee Established to Review the NATO Bombing Campaign against the Federal Republic of Yugoslavia Acceptable?" *International Review of the Red Cross* no. 840 (2000): 1017–28.

Rosenberg, Ran. "Man, Earth and the Heavens." *Air Force Journal* 151 (2003) [Hebrew].

Royal Air Force. Air Publication (AP) 1300. *War Manual*, February 1940.

Royse, M. W. *Aerial Bombardment and the International Regulation of Warfare*. New York: Harold Vinal Publisher Ltd., 1928.

Rummell, R. J. *Death by Government*. New Brunswick, NJ: Transaction, 1995.

Rumpf, Hans. *The Bombing of Germany*. New York: Holt, Rinehart and Winston, 1963.

Sandoz, Yves, Philippe Eberlin, Hans-Peter Gasser, and Claude F. Wenger, eds. *Commentary on the Additional Protocols of 8 June 1977 to the Geneva Conventions of 12 August 1949*. Geneva: International Committee of the Red Cross, 1987.

Sands, Robert. "Cultural Relativism and the Convergence of Ethnography and 3C [cross-cultural competence]." *Military Intelligence Professional Bulletin*, PB-34-12-1 (January/March 2012): 13–19.

———. "Letters to AFRICOM No. 3: Transfrontier Conservation Areas and AFRICOM: Conflict Resolution and Environmental Sustainability." *Air & Space Power Journal: Africa and Francophonie* 2, no. 11 (Summer 2010): 27–40.

Sandwich, Trevor, Clare Shine, Lawrence Hamilton, and David Sheppard. *Transboundary Protected Area for Peace and Co-operation*. http://www.iucn.org/about/union/commissions/wcpa/wcpa_puball/wcpa_pubsubject/wcpa_transboundarypub/?2176/Transboundary-Protected-Areas-for-Peace-and-Cooperation.

Sas-Rolfes, Michael. *Rhinos: Conservation, Economics and Trade-Offs*. London: Institute of Economic Affairs, 1995.

Schanz, Marc V. "Focused Lethality: USAF Seeks Weapons with Less Boom but More Precision and Flexibility." *Air Force Magazine* 91, no. 12 (December 2008): 36–39.

"The Schilling Air Force Base Project: Executive Summary," Document C5-085-03013-5, Schilling AFB Files, KDHE, Topeka, KS.

Schindler, Dietrich, and Jiri Toman. *The Laws of Armed Conflict: A Collection of Conventions, Resolutions and Other Documents*. Dordrecht, Netherlands: Martinus Nijhoff Publishers, 1988.

Schoomaker, Peter J., and R. L. Brownlee. *The Army Strategy for the Environment: Sustain the Mission, Secure the Future*. Arlington, VA: Army Environmental Policy Institute, November 2005.

Schwabach, Aaron. "Environmental Damage Resulting from the NATO Military Action against Yugoslavia." *Columbia Journal of Environmental Law* 25 (2000).

Schwartz, Daniel, and Ashbindu Singh. *Environmental Conditions, Resources and Conflicts*. New York: United Nations Environmental Program, 1999.

Schweich, Thomas. "Is Afghanistan a Narco-State?" *New York Times*, 27 July 2008.

Sebald, W. G. *On the Natural History of Destruction*. Translated by Anthea Bell. New York: Random House, Inc., 2003.

———. *On the Natural History of Destruction*. 1999. Reprint. London: Penguin, 2004.

Secretary of State for Defence Geoff Hoon. House of Commons Hansard Written Answers for 19 January 2000. http://www.publications.parliament.uk/pa/cm199900/cmhansrd/vo000119/text/00119w16.htm#00119w16.html_spnew6.

Secretary of State for International Development Hillary Benn. House of Commons Hansard Written Answers for 18 December 2006. http://www.publications.parliament.uk/pa/cm200607/cmhansrd/cm061218/text/61218w0005.htm#06121816000225.

Serbian-American Alliance of New England. http://www.sane-boston.org/recentcrisesn.html.

"Serbs Call for Restrictions on Noxious Factory Emissions, Residents of Industrial Zone near Belgrade Stage Second Demonstration." *Associated Press*, 20 November 2006. http://ngo.ro/pipermail/mediu_ngo.ro/2006-November/007156.html.

Shane, Scott. "C.I.A. to Expand Use of Drones in Pakistan." *New York Times*, 3 December 2009. http://www.nytimes.com/2009/12/04/world/asia/04drones.html.

Sharon, Hila. "New: The F-16A/B Simulator Will Show Pilots Views Unique to Israel." *IAF Journal* 117 (1997) [Hebrew].

Shea, Jamie, and Giuseppe Marani, "Press Conference." *NATO's Role in Kosovo,* 19 April 1999. http://www.nato.int/cps/en/natolive/opinions_27602.htm.www.nato.int/kosovo/press/990430a.htm.

———. "Press Conference." *NATO's Role in Kosovo,* 30 April 1999. http://www.nato.int/kosovo/press/990430a.htm.

Shea, Jamie, and Walter Jertz. "Press Conference." *NATO's Role in Kosovo*, 3 May 1999. http://www.nato.int/Kosovo/press/p990503b.htm.

Shulman, Seth. *Threat at Home: Confronting the Toxic Legacy of the U.S. Military*. Boston: Beacon Press, 1992.

Shuval, Lilach. "The Italian Job." *Israel Today*, 19 October 2009 [Hebrew].

Sidel, Victor W. "The Impact of Military Preparedness and Militarism on Health and the Environment." In *The Environmental Consequences of War: Legal, Economic, and Scientific Perspectives*, edited by Jay E. Austin and Carl E. Bruch, 426–43. Cambridge: Cambridge University Press, 2000.

Sidel, Victor W., Barry S. Levy, and Jonathan E. Slutzman. "Prevention of War and Its Environmental Consequences." In *Environmental Consequences of War and Aftermath*, edited by Tarek A. Kassim and Damià Barceló, 21–40. Berlin: Springer-Verlag, 2009.

Sills, Joe B., Jerome C. Glenn, Theodore J. Gordon, and Renat Perelet. *Environmental Security: United Nations Doctrine for Managing Environmental Issues in Military Actions*. Vol. 1. Atlanta, GA: Army Environmental Policy Institute, July 2002.

Simonson, Gene Roger, ed. *History of the American Aircraft Industry: An Anthology*. Cambridge, MA: MIT Press, 1968.

Singh, Joseph G. "Role of the Military and Military Technology in Environmental Protection and Nature Conservation." Paper presented at the Hague Conference on Environment, Security and Sustainable Development. The Hague, Netherlands, 12 May 2004. http://www.envirosecurity.org/conference/presentations/session8/ESSD_Session_8_Joseph_G_Singh.pdf.

Skelly, Patrick G. "References to Ploesti, Rumania from the USAAF WWII [United States Army Air Forces World War II] Chronology, 12 June 1942 to 17 October 1944." *Military History Network*, *milhist .net*. http://www.milhist.net/usaaf/ploesti.html.

Smilie, Ian, Lansana Gberie, and Ralph Hazleton. *The Heart of the Matter: Sierra Leone, Diamonds and Human Security*. Ottawa: Partnership Africa Canada, 2000.

Smith, Steve. "The Increasing Insecurity of Security Studies: Conceptualizing Security in the Last Twenty Years." *Contemporary Security Policy* 20, no. 3 (1999): 72–101.

Solomon, Hussein, and Maxi van Aardt, eds. *Caring Security in Africa*. ISS Monograph no. 20. Pretoria, South Africa: ISS, 1998.

South African Department of Environmental Affairs and Tourism. "Overview of Integrated Environmental Management." Information Series O. Pretoria, South Africa: Department of Environmental Affairs and Tourism, 2004.

The Southern African Development Community Protocol on Shared Watercourse Systems. Gaborone, Botswana: Southern African Development Community, 1995.

The Southern African Development Community Protocol on Wildlife Conservation and Law Enforcement. Gaborone, Botswana: Southern African Development Community, 1999.

South African White Paper on Defence, 1996. Pretoria, South Africa: Department of Defense, 1998.

Spaight, James Molony. *Air Power and the Cities*. London: Longmans, Green, and Co., 1930.

———. *Bombing Vindicated*. London: Geoffrey Bles, 1944.

———. "The Chaotic State of the International Law Governing Bombardment." *Royal Air Force Quarterly* 9 (January 1938): 1–42.

Speth, James G. *Red Sky at Morning: America and the Crisis of the Global Environment*. New Haven, CT: Yale University Press, 2004.

Stearn, E., and A. Stearn. "Smallpox Immunization of the Amerindian," *Bulletin of the History of Medicine* 13, no. 601, 1943.

Steiner, Richard. "After the Bombs, Environmental Calamity." *Seattle Post-Intelligencer*, 10 September 2006.

Stellman, Jeanne Mager, Steven D. Stellman, Richard Christian, Tracy Weber, and Carrie Tomasallo. "The Extent and Patterns of Usage of Agent Orange and Other Herbicides in Vietnam." *Nature* 422 (17 April 2003): 681–87.

Stephens, M. M. *Vulnerability of Total Petroleum Systems*. Washington, DC: US Department of the Interior, Office of Oil and Gas, 1973.

Stevens, Michelle. "Iraq and Iran in Ecological Perspectives: The Mesopotamia Marshes and the Hawizeh-Azim Peace Park." In *Peace Parks: Conservation and Conflict Resolution* edited by Saleem Ali, 313–32. Cambridge, MA: MIT Press, 2007.

Stevens, Susan T. "A Legend of the Destruction of Carthage," *Classical Philology*, 83 no. 1 (1988): 39–41.

Stewart, Rory. "The Irresistible Illusion." *London Review of Books* 31, no. 13 (9 July 2009): 3–6.

Stockholm International Peace Research Institute. *Warfare in a Fragile World: Military Impact on the Human Environment*. London: Taylor & Francis Group, Inc., 1980.

Stoet, Peter. *Human and Global Security: An Explanation of Terms*. Toronto: University of Toronto Press, 1999.

Stokesbury, James L. *A Short History of Air Power*. New York: William Morrow and Company, 1986.

Stout, Jay A. *Fortress Ploesti: The Campaign to Destroy Hitler's Oil Supply*. Drexel Hill, PA: Casemate Publishers, 2003.

"A Strategic Partnership: Ministry of Defense (*Marinha de Guerra* [Navy]) and WWF [World Wildlife Fund]-Mozambique." Presentation. *Republic de Mozambique*, *Ministerio de Defensa* EASWIO [East Africa and Southwest Indian Ocean] Maritime Security Conference, Antananarivo, Madagascar, July 2006.

Swatuk, Larry. "Environmental Cooperation in Southern Africa." In *Environmental Peacemaking*, edited by Ken Conca and Geoffrey Dabelko, 143–45. Washington, DC: Woodrow Wilson Center Press, 2002.

———. "Environmental Security." In *Advances in the Study of International Environmental Politics*, edited by Michele Betsill, Kathryn Hochstetler, and Dimitris Stevis, 203–36. New York: Palgrave Publishers Ltd., 2006.

———. "Power and Water: The Coming Order in Southern Africa." In *The New Regionalism and the Future of Security and Development*, edited by Björn Hettne, András Inotai, and Osvaldo Sunkel, 210–47. London: Palgrave Publishers Ltd., 2001.

Swatuk, Larry A., and Peter Vale. "Why Democracy Is Not Enough: Southern Africa and Human Security in the Twenty-First Century." *Alternatives* 24, no. 3 (1999): 361–89.

"Symposium: The Troubled Rise of AFRICOM." *Contemporary Security Policy* 30, no. 1 (April 2009): 1–99.

Tacitus. *Agricola*. In "Euphemism and American Violence," by David Bromwich, *New York Review of Books*, 3 April 2008. http://www.nybooks.com/articles/archives/2008/apr/03/euphemism-and-american-violence/.

Tagil, Sven. "Alfred Nobel's Thoughts about War and Peace." *Nobelprize.org*, 20 November 1998. http://nobelprize.org/alfred_nobel/biographical/articles/tagil/index.html.

Tappan, Gray. "RE: Extent of Natural Regeneration in Niger." Frame-Community.http://www.frameweb.org/ev_en.php?ID=52653_20&ID2=DO_DISCUSSIONPOST_LIST.

Thakur, Ramesh. "The United Nations and Human Security." *Canadian Foreign Policy* 7, no. 1 (1999): 51–59.

Timothy, Dallen. "Cross-Border Partnership in Tourism Resource Management: International Parks along the US-Canada Border." *Journal of Sustainable Tourism* 7 (September 1999): 182–205.

Tirpak, John A. "Washington Watch: Short's View of the Air Campaign." *Air Force* 82, no. 9 (September 1999): 43.

Toth, Norbert. "Historical Duty or Pragmatic Interest? Notes on EU and AU [African Union] Security Issues." *African Security Review* 16, no. 3 (September 2007): 112–16.

Townshend, Charles. "Civilization and 'Frightfulness': Air Control in the Middle East between the Wars." In *Warfare, Diplomacy, and Politics: Essays, in Honour of A. J. P. Taylor*, edited by Chris Wrigley, 142–62. London: Hamish Hamilton, Ltd., 1986.

Tsheko, Rejoice. "Rainfall Reliability, Drought and Flood Vulnerability in Botswana." *Water SA* 29, no. 4 (July 2003): 23. http://www.wrc.org.za.

Tsutsui, William. "Landscapes in the Dark Valley: Toward an Environmental History of Wartime Japan." In *Natural Enemy, Natural Ally: Toward an Environmental History of War*, edited by Richard P. Tucker and Edmund Russell. Corvallis: Oregon State University Press, 2004.

Tucker, Richard P., and Edmund Russell, eds. *Natural Enemy, Natural Ally*. Corvallis: Oregon State University Press, 2004.

Turner, James. *Just War Tradition and the Restraint of War*. Princeton, NJ: Princeton University Press, 1981.

———. *Morality and Contemporary Warfare*. New Haven, CT: Yale University Press, 1999.

Turner, Stansfield. *Caging the Genies: A Workable Solution for Nuclear, Chemical, and Biological Weapons*. Jackson, CO: Westview Press, 1999.

Turton, Anthony. "Resource Allocation and Xenophobic Violence in South Africa." In *African Environmental and Human Security in the 21st Century*, edited by Helen Purkitt, 111–23. New York: Cambria Press, 2009.

Turton, Anthony, Peter Ashton, and Eugene Cloete, eds. *Transboundary Rivers, Sovereignty and Development*. Pretoria, South Africa: African Water Issues Research Unit, University of Pretoria, 2003.

Tyson, P. D. "Climatic Change in Southern Africa: Past and Present Conditions and Possible Future Scenarios." *Climatic Change* 18 no. 2–3 (April 1991): 241–58.

Ullman, Richard H. "Redefining Security." *International Security* 8, no. 1 (1983): 129–53.

"*Un cahier spécial sur le Kosovo*: New figures on Civilian Deaths in Kosovo War." *Le Monde diplomatique*, 8 February 2000. http://www.monde-diplomatique.fr/cahier/kosovo/hrw022000-en.

United Kingdom Parliament. "Eighth Report: Global Security: Afghanistan and Pakistan." Foreign Affairs Committee, July 2009. http://www.publications.parliament.uk/pa/cm200809/cmselect/cmfaff/302/30202.htm.

United Nations. *Statute of the International Criminal Court*, 17 July 1998. http://untreaty.un.org/cod/icc/statute/romefra.htm.

United Nations Children's Fund (UNICEF). "Child and Maternal Mortality Survey." 1999 Preliminary Report. Baghdad: UNICEF, July 1999.

United Nations Commission on Human Security. *Human Security Now: Protecting and Empowering People*. New York: United Nations Commission on Human Security, 2003.

United Nations Convention on Biological Diversity. http://www.cbd.int/.

United Nations Department of Peacekeeping Operations/Department of Field Support. "Environmental Policy for UN Field Missions," June 2009.

United Nations Development Program. *Human Development Report 1993: People's Participation*. http://hdr.undp.org/en/reports/global/hdr1993/.

———. *Human Development Report 1994: New Dimensions of Human Security*. http://hdr.undp.org/en/reports/global/hdr1994/.

United Nations Environment Program. *Africa: Atlas of Our Changing Environment*. New York: Division of Early Warning and Assessment, United Nations Environment Program, 2008.

———. *Depleted Uranium in Kosovo: Post-Conflict Environmental Assessment*. Geneva: United Nations Environment Program, 2001.

———. *Depleted Uranium in Serbia and Montenegro: Post-Conflict Environmental Assessment in the Federal Republic of Yugoslavia*. Geneva: United Nations Environment Program, 2002.

———. *GEO-4, Global Environment Outlook: Environment for Development*. http://www.unep.org/geo/GEO4/report/GEO-4_Report_Full_en.pdf.

———. *Lebanon Post-Conflict Environmental Assessment*. New York: United Nations Environment Program, 2007.

———. Press Release, 7 May 2004. http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=397&ArticleID=4479&l=en.

———. *Sudan: Post-Conflict Environmental Assessment*. http://postconflict.unep.ch/publications/UNEP_Sudan.pdf.

United Nations Environment Program and United Nations Center for Human Settlements (Habitat). *The Kosovo Conflict: Consequences for the Environment and Human Settlements*. New York: United Nations, 1999.

United Nations General Assembly Resolution 56/4. *Observance of the International Day for Preventing the Exploitation of the Environment in War and Armed Conflict*. 13 November 2001.

United States Africa Command. "About U.S. Africa Command." http://www.africom.mil/AboutAFRICOM.asp.

United States Strategic Bombing Survey. "Description of RAF Bombing." Study no. 64A, January 1947, Exhibit H.

United States Strategic Bombing Survey, Overall Report (European War). Washington, DC: Government Printing Office, 30 September 1945.

United States Strategic Bombing Survey (Pacific War), Crude Oil Production and Refining. Washington, DC: Government Printing Office, 1946.

United States Strategic Bombing Surveys (European War) (Pacific War). Maxwell AFB, AL: Air University Press, 1987.

University of Leeds. *The British Strategic Bombing of Germany: What Factors Affected the Decision To Embark on a Policy of Area Bombing?* http://www.leeds.ac.uk/history/studentlife/e-journal/Henry_Alex.pdf.

US Air Force Pamphlet (AFPAM) 110–31. *International Law: The Conduct of Armed Conflict and Air Operations*, 19 November 1976, V/7–13.

US Air Force Regulation 91–9. *Environmental Program in Foreign Countries*, 27 October 1950.

"US Army and Air Force Wings over Kansas." Part 1. *Kansas Historical Quarterly* 25 (Summer 1959): 129–57.

———. Part 2. *Kansas Historical Quarterly* 25 (Autumn 1959): 334–60.

US Army Air Forces, Field Service Section. Technical Bulletin, 25 March 1942. Schilling AFB Files. KDHE, Topeka, KS.

US Army Corps of Engineers. "Formerly Used Defense Sites Program." https://eko.usace.army.mil/usacecop/pub/ecop/what_we_do/fuds/.

US Army Field Manual (FM) 1-5. *Employment of Aviation of the Army*, April 1940.

US Department of Health and Human Services. "Fact Sheet." Agency for Toxic Substances and Disease Registry. http://www.atsdr.cdc.gov/tfacts19.pdf.

———. "Public Health Assessment, Tinker." http://www.atsdr.cdc.gov/HAC/PHA/tinker/tafb_p2.html.

US Department of State. *The Foreign Relations of the United States, 1961–1963*. Vol. 1, *Vietnam, 1961*. Washington, DC: Government Printing Office, 1988.

US Energy Information Administration (EIA). *Iraq Energy Data, Statistics and Analysis—Oil*. Washington, DC: EIA, June 2009. http://www.eia.doe.gov/emeu/cabs/Iraq/Oil.html.

———. *Short-Term Energy Outlook*. Washington, DC: EIA, 11 August 2009. http://www.eia.doe.gov/emeu/steo/pub/contents.html.

US House. *Review of Hazardous Waste Cleanup and Disposal Efforts at Tinker Air Force Base*. House Committee on Government Operations. 98th Cong., 2nd sess., 13 December 1984.

"Uvda Base: Deep in the Mud." *Bemahane*, 15 December 2006 [Hebrew].

Van Ham, Peter, and Jorrit Kamminga. "Poppies for Peace, Reforming Afghanistan's Opium Industry." *Washington Quarterly* 30, no. 1 (Winter 2006–2007): 69–81.

Veale, F. J. P. *Advance to Barbarism: The Development of Total Warfare from Serajevo to Hiroshima*. London: Mitre Press, 1968.

Vigne, Lucy, and Esmond Bradley Martin. "Taiwan: The Greatest Threat to Africa's Rhinos." *Pachyderm* 11 (January–June 1989): 23–25.

Viorst, Milton. "Report from Baghdad." *New Yorker*, 24 June 1991, 58.

Vukmirovic, Z., L. Lazic, I. Tosic, and M. Unkasevic. "Regional Air Pollution Originating from Oil-Refinery Fires under War Conditions." In *Air Pollution Modeling and Its Application XIV*, edited by Sven-Erik Gryning and Francis A. Schiermeier, 741–43. New York: Springer Publishing, 2001.

Wall, Robert, and Douglas Barrie. "US, UK Eye Upgrades to Newest Weapons." *Aviation Week and Space Technology*, 26 April 2004, 26.

Walzer, Michael. *Just and Unjust Wars*. New York: Basic Books, 1977.

Ward, William E. *United States Africa Command: 2009 Posture Statement*. Statement of General William E. Ward, US Army, Commander, United States Africa Command, before the Senate Armed Services Committee and the House Armed Services Committee, 17–18 March 2009. Kelley Barracks, Stuttgart, Germany: US Africa Command Public Affairs Office, 2009.

Warden, III, John A. *The Air Campaign: Planning for Combat*. Lincoln, NE: toExcel Press, 2000.

Watt, Donald C. "Restraints on War in the Air before 1945." In *Restraints on War*, edited by Michael Howard, 57–65. London: Oxford University Press, 1979.

Waxman, David E. "Sanctions: The Invisible Hand of Statecraft." *Strategic Review* (Winter 1998): 39–45.

Waxman, Matthew C. "Siegecraft and Surrender: The Law and Strategy of Cities as Targets." *Virginia Journal of International Law* 39 (Winter 1999): 354–434.

Weart, Spencer. *The Discovery of Global Warming: Revised and Expanded Edition*. Cambridge, MA: Harvard University Press, 2008.

Webster, Charles, and Noble Frankland. *Strategic Air Offensive against Germany 1939–1945*. 4 vols. London: HMSO, 1961.

Weed, Timothy. "Central America's Peace Parks and Regional Conflict Resolution." *International Environmental Affairs* 6, no. 2 (Spring 1994): 175–90.

Weiss, Ayal, and Yael Salome. "The Ministry of the Environment Claims: 'The IDF Pollutes the Ground in Some Bases.'" *Bemahaneh*, 6 January 2006 [Hebrew].

Western, David. "The Undetected Trade in Rhino Horn." *Pachyderm* 11 (January–June 1989): 26–28.

White, Richard. *It's Your Misfortune and None of My Own*. Norman: University of Oklahoma Press, 1993.

Williams, Paul W. "Legitimate Targets in Aerial Bombardment." *American Journal of International Law* 23 (July 1929): 570–81.

Williams, Rocky. "Defence in a Democracy: The South African Defence Review and the Redefinition of the Parameters of the National Defence Debate." In *Ourselves to Know: Civil-Military Relations and Defence Transformation in Southern Africa*, edited by Rocky Williams, Gavin Cawthra, and Diane Abrahams, 205–23. Pretoria, South Africa: ISS, 2003.

Wit, Tracy Lyn. "The Social and Economic Impact of World War II Munitions Manufacture on Grand Island Nebraska." *Nebraska History* 71 (Fall 1990): 151–63.

Wolff, Pinchas. "The Soldiers Recycle—and Earn Money." *Bemahane*, 9 March 2007 [Hebrew].

———. "Uvda Base: Learning Judaism on 'Shabbat of Values.'" *Bemahane*, 4 May 2007 [Hebrew].

World Resources Report 2008: Roots of Resilience—Growing the Wealth of the Poor. Washington, DC: World Resources Institute, 2008.

World Wide Fund for Nature. "Danube Carpathian Program, 1999." http://www.panda.org/crisis/background.html.

Worster, Donald. *Dust Bowl: The Southern Plains in the 1930s*. Oxford: Oxford University Press, 1982.

Wrage, Stephen D., ed. *Immaculate Warfare: Participants Reflect on the Air Campaigns over Kosovo, Afghanistan and Iraq*. Westport, CT: Praeger Publishers, 2003.

Wuesthoff, Scott E. "The Utility of Targeting the Petroleum-Based Sector of a Nation's Economic Infrastructure." Master's thesis, School of Advanced Aerospace Studies. Maxwell AFB, AL: Air University Press, 1994. http://aupress.maxwell.af.mil/digital/pdf/paper/t_wuesthoff_utility_of.pdf.

Wyman, Richard H. "The First Rules of Air Warfare." *Air University Review* 35, no. 3 (March–April 1984): 94–102. http://www.airpower.au.af.mil/airchronicles/aureview/1984/mar-apr/wyman.html.

Yehoshua, Yossi. "New in the Air Force: A Simulator for Helicopters." *Yediot Aharonot*, 23 May 2005 [Hebrew].

Yergin, Daniel. *The Prize: The Epic Quest for Oil, Money and Power*. New York: Free Press, 1993.

Zacarias, Agostinho. "Redefining Security." In *From Cape to Congo: Southern Africa's Evolving Security Challenges*, edited by Mwesiga Baregu and Christopher Lansberg, 31–52. Boulder, CO: Lynne Rienner Publishers, 2003.

Zimmerman, John. *Cheyenne Bottoms, Wetland in Jeopardy*. Lawrence: University Press of Kansas, 1990.

Zimonjic, Vesna Peric. "BALKANS: Fallout of Bombing 'Continues to Kill.'" *Inter Press Service*, 18 March 2009. http://www.ipsnews.net/news.asp?idnews=46176.

Zuckerman, Solly. *From Apes to Warlords: The Autobiography of Solly Zuckerman*. London: Hamish Hamilton, Ltd., 1971.

Index

15th Marine Expeditionary Unit, 59
205 Group, 49
542 Squadron, 48
617 Squadron, 14, 48

ACTS. *See* Air Corps Tactical School
ADD. *See* air domain development
Afghanistan, 2, 4–5, 65–80, 87, 117–18, 122–24, 159, 216, 220
Africa, 13, 84–85, 90, 92–101, 133–140, 142–47, 149–51, 154–73
African Union (AU), 97, 98, 100
African Wildlife Foundation (AWF), 162
AFRICOM. *See* US Africa Command
Agent Blue, 70
Agent Orange, 4, 215
Ahmed Wali Karzai, 76
air control, 13
Air Corps Tactical School (ACTS), 45, 47, 110, 125, 166, 200
aircraft production, 27
air domain development (ADD), 16, 86, 146, 215
Air Ministry (United Kingdom), 12, 45–48
air pollution, 184, 202
Air War Plans Division-1 (AWPD-1), 47
Air War Plans Division-4 (AWPD-4), 47
Air War Plans Division-42 (AWPD-42), 47–48
Albright, Madeleine, 211
Al-Faw Peninsula, 59
Amherst, Jeffery, 2
Angola, 159
area bombing, 9–10, 13, 21, 110, 112, 114
Arkansas River, 27–28
AU. *See* African Union
Austin, Jay E., xi
  The Environmental Consequences of War, xi
aviation fuel, 10, 18, 30
Avital, Shai, 186
AWF. *See* African Wildlife Foundation
AWPD-1. *See* Air War Plans Division-1
AWPD-4. *See* Air War Plans Division-4
AWPD-42. *See* Air War Plans Division-42
Az Zubayr, Iraq, 59

Baiji, Iraq, 57
Basrah, Iraq, 57, 59
Battle of Britain, 47
Battle of France, 110
Battle of the Atlantic, 47
Beirut, Lebanon, 109, 200
Belgrade, Serbia (Former Yugoslavia), 203, 205, 208
Bellamy, Alex J., 209
biodiversity, 90, 100, 133–34, 136–37, 142, 147, 149–50, 155–56, 158–60, 163–5, 172
Biran, Tahal, 188
von Bismarck, Prince Otto, 21
Boeing-Wichita, 27
Bomber Command (Royal Air Force, UK), 11–13, 16–17, 20, 46–49, 110, 112–13
Bosnia (Former Yugoslavia), 117
Botswana, 85, 93, 96–98, 136, 159, 163, 168
British Expeditionary Force, 11
British Industrial Intelligence Center, 45
Bruch, Carl E., xi
  The Environmental Consequences of War, xi
Brundtland, Gro Harlem, ix
building partnerships, 149–52, 154–55, 160, 167, 172
Burundi, 159
Butt Report, 13, 112

Callendar, Guy, 18
Cambodia, 2

CAMPIRE. *See* Communal Areas Management Program for Indigenous Resources
carbon dioxide, 10, 18, 205
carbon emissions, 200
Carpenter, Chuck, 31–32
CBC. *See* community-based conservation
CBNRM. *See* community-based natural resources management
China, 55, 115
Chissano, Joachim, 159
Churchill, Winston S., 1, 6, 10, 17–18, 22, 113
von Clausewitz, Carl, 85
Clinton, Pres. Bill, 2
cluster munitions, ix, 5, 108, 117, 215–18
coercion, 86, 211
Colorado, 30, 34, 39
Columbus AFB, MS, 28
Combat Training Branch, Israeli Air Force, 191
Combined Chiefs of Staff, 49
Command of the Air, *The* (Douhet), 44–45
Communal Areas Management Program for Indigenous Resources (CAMPFIRE), 160
community-based conservation (CBC), 149–50, 155–56, 160–64, 168, 172–73
community-based natural resources management (CBNRM), 149, 157, 160
Comprehensive Environmental Response, Compensation, and Liability Act, 36
Congo, 136–38, 159
Congo basin, 136
conservation, 90, 94, 137, 140, 149–50, 155–58, 160–2, 164–68, 172
conservation zones, 149–50, 155–57, 161–62, 165, 168, 172
Convention on Biological Diversity, 3
Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD), 212–14
Cornhusker Army Ammunition Plant, NE, 30–31
Corps of Engineers, 25, 31, 34, 36, 38
Cottbus, Germany, 17
Coventry, UK, 1, 3, 113
Cronon, William, 39

Dambusters, 14–16, 20
Danube River, 200, 208
Daura, Iraq, 57
DCDC. *See* Development, Concepts and Doctrine Centre
Defence Select Committee of the House of Commons, UK, 216
Defense Plant Corporation, 30
defoliation, 25, 74, 76, 199, 213, 215
DeLay, Tom, 39, 211
Del Ponte, Carla, 214
Democratic Republic of the Congo, 136–37
Denver, CO, 30, 34
depleted uranium (DU), 4, 215, 219
desertification, 92, 99, 134–35, 138–40, 142
Development, Concepts and Doctrine Centre (DCDC), British Ministry of Defence, ix
  Global Strategic Trends, ix
disposal of ordnance, ix, xii
DOD. *See* US Department of Defense
DOE. *See* US Department of Energy
Dortmund-Ems Canal, Germany, 17
Douglas Aircraft Company, 29
Douhet, Giulio, 44–45, 86, 110–11
  The Command of the Air, 44–45
Dresden, Germany, 2–3, 17, 107, 119
DU. *See* depleted uranium
Dunkirk, France, 1, 11–12, 112
Dust Bowl, 26–27
DynCorp, 77

Eighth Air Force, 48–51
energy infrastructure, 43, 45–46, 52, 54–55, 58, 60–62

ENMOD. *See* Convention on the Prohibition of Military or Any Other Hostile Use of Modification Techniques
Environmental Consequences of War, The (Austin and Bruch, eds.), xi
environmentalism, 18, 193
EPA. *See* US Environmental Protection Agency
European Union, 204
Exxon Valdez, 201, 205–6

Fifteenth Air Force, 49
First Lebanon War, 192
Foreign Affairs Select Committee of the House of Commons, UK, 216
forests, 11–13, 135–37, 156
Fort Worth, TX, 27, 29–30
France, 1, 11–12, 19, 44, 110, 112, 114, 144, 214
Fray, Frank, 48
Friedrich, Jörg, 14, 16, 19

Gahr Støre, Jonas, 217
Garlasco, Marc, 127
General Motors, 29
Geneva Agreements, 1954, regarding Vietnam, 70, 77
Geneva conventions, 19, 21, 108, 202
Geneva Disarmament Conference, 1932, 109
Georgia, 28, 75
Gerber, Michele, 32
Germany, 1, 3, 9–21, 25, 46–52, 61, 109–10, 112–15, 119, 126, 199–200
Gibson, Guy, 15
Global Positioning System (GPS), 118, 123, 166
Global Strategic Trends, (DCDC), ix
global warming, 4, 18
GLTP. *See* Great Limpopo Transfrontier Park
Goebbels, Joseph, 14
Gorbachev, Mikhail, 206
Gore, Al, ix
GPS. *See* Global Positioning System
Grand Island, NE, 30–31
Great Limpopo Transfrontier Park (GLTP), 158–59
Great Plains, 25–30, 34–35, 38
Greenpeace, 116
Guernica (Picasso), 1, 3, 112
Gulf War, 43, 55, 57–61, 116, 201

Haavisto, Pekka, 207
Hafvenstein, Joel, 66, 79
Hague Convention for the Protection of Cultural Property, 197
Haiphong, Vietnam, 53–55
Halevi, Avishai, 187
Hamas, 117
Hamburg, Germany, 2–3
Hanford Nuclear Site, WA, 32
Hanoi, Vietnam, 53–54
Harris, Arthur, 9–10, 13–20, 22, 113
Hastings, NE, 34
Hastings, Tom H., xiii
Hatzor, Israel, 180–81, 191–92
Hawaii, 3, 34, 43
health, 1–2, 5–6, 27, 31, 38, 57, 87, 89–90, 94, 96, 100, 116, 124, 164–66, 192, 197, 199, 202, 207–10, 214–16, 219–20
Helmand Province, Afghanistan, 76, 79
Henk, Dan, 83, 154
Hezbollah, 117, 217
Hiroshima, Japan, 2, 4, 18, 107, 119, 199
Hitler, Adolf, 107, 112
Hon Gay, Vietnam, 53
Human Rights Watch, 117, 123, 127, 203
Hussein, Saddam, 56, 126, 201

IAF. *See* Israeli Air Force
IBC. *See* Iraq Body Count Project
ICBM. *See* intercontinental ballistic missiles
ICTY. *See* International Criminal Tribunal for the Former Yugoslavia
IDF. *See* Israeli Defense Force
IG Farben (*Interessengemeinschaft Farbenindustrie Aktien-gesellschaft*), 51
Imperial Japanese Navy, 43
industrial pollution, 208, 219

Institute of Energy and Environmental Research, 208
intercontinental ballistic missiles (ICBM), 26
Intergovernmental Panel on Climate Change, ix
International Court of Justice, 205
International Criminal Tribunal for the Former Yugoslavia (ICTY), 214
International Union for Conservation of Nature (IUCN), 137, 158
Iran, 76, 159
Iraq, 2, 4–5, 13, 43, 55–61, 72, 87, 116–18, 122, 124, 126–27, 158–59, 201, 211, 216, 220
Iraq Body Count Project (IBC), 117
Iraq War, 43, 57, 60–61
Israel, 117, 125, 177–93, 200, 216
Israeli Air Force (IAF), 117, 179–93, 200
Israeli Defense Force (IDF), 177–81, 183–88, 191–93
IUCN. *See* International Union for Conservation of Nature
Iwo Jima, Japan, 114

Japan, 2–4, 18, 25, 32, 43, 61, 107, 114–15, 119, 199–200
Jason Summer Study, 54
JCS. *See* US Joint Chiefs of Staff
JDAM. *See* Joint Direct Attack Munition
Johnson, Pres. Lyndon, 53–54
Joint Direct Attack Munition (JDAM), 118
jus ad bellum, 121–22
jus in bello, 6, 121–22, 198, 203, 205, 212, 217–18, 220
Just War, 3, 6, 108, 121-22, 198–99, 203, 205, 211–12, 217–18, 220

Kabulov, Zamir, 124
Kansas, 27, 29–30, 32–37
Kansas Army Ammunition Plant, 30
Karzai, Ahmed Wali and Hamid, 74–76
Kavango-Zambezi Transfrontier Conservation Area (KAZA), 159
KAZA. *See* Kavango-Zambezi Transfrontier Conservation Area
Kenan, Noa, 188
Kenya, 150, 15657, 160, 162–64, 166–67, 169, 171–73
Kenya Wildlife Service (KWS), 162, 164, 167
Kfar Yehoshua, Israel, 180
Kibbutz Lotan, Israel, 187
Kidon, Shai, 181
Kishon River, Israel, 180
Komer, Robert, 71
Korean War, 32, 115
Kosovo, 2, 117–20, 122, 198, 200, 202, 204–6, 210–11, 215–16, 218–20
KWS. *See* Kenya Wildlife Service
Kyoto, Japan, 3

bin Laden, Osama, 121
Lake Chad, 136
landmines, 66, 93, 108, 126–27, 216
Lapidot, Amos, 183
Laughlin AFB, TX, 28
League of Nations, 109
Lebanon, 109, 117, 189–90, 192, 200, 217, 220
Leuna, Germany, 51
Lewa Wildlife Conservancy (LWC), 163–65
Lewy, Guenter, 115–16
LIFE. *See* Living in a Finite Environment
Lindemann, Frederick, 18
livestock, 13–14, 33, 93, 99, 162, 164–65, 204–5, 216
Living in a Finite Environment (LIFE), 160
Lockheed-Martin, 30
Lod, Israel, 185
London, UK, 1, 3, 78, 112
Lone Star Army Ammunition Plant, TX, 30
Longhorn Army Ammunition Plant, TX, 30
Low Countries, 11, 46
Lowry AFB, CO, 34
Luftwaffe, 47, 112, 200

LWC. *See* Lewa Wildlife Conservancy

mala in se, 217
Mandela, Nelson, 159
Manual of Air Tactics (RAF), 13
Mao Zedong, 107
megafauna, 90, 92, 96, 165
Mekorot Company, 181
Metohija, Kosovo (former Yugoslavia), 200
Mikdash Hanamerim (Temple of the Tigers), Israel, 188
Milosevic, Slobodan, 117, 120, 199, 203–4, 211
Ministry for Protection of the Environment (MPE), UK, 177–79, 181, 186
Mississippi, 28
Mitchell, William "Billy," 44–45, 57, 86
Winged Defense, 45, 57
Mogadishu, Somalia, 117
Möhne River, Germany, 14–16, 48, 199
Mongols, 2
Moody AFB, GA, 28
morale, 1, 9–10, 13, 46–48
Mozambican navy, 96
Mozambique, 85, 96–97, 158–59, 163
MPE. *See* Ministry for Protection of the Environment, UK
"Munitions Requirements of the Army Air Forces," 47
Munk, Erika, 116

Nagasaki, Japan, 2, 4, 18, 199
Nagoya, Japan, 2
Nahalal, Israel, 180
Namib Desert, 134
Namibia, 160
Nanjing, People's Republic of China, 115
National Defense Strategy, June 2008, 152
national parks, 149, 156–57, 160
NATO, 21, 76, 79, 85, 117, 120, 124, 199–200, 202–11, 213–16, 219
navy, 110
Navy of the Republic of Poland, 59
NCA. *See* Ngorongono Conservation Area
Nebraska, 29–31, 34
Negev region, Israel, 177
Netherlands, 1, 3, 20, 112, 199
Nevatim air base, Israel, 184–85
Newall, Cyril, 46–47
"New Deal," 27
Ngare Ndare Forest Reserve, 163
Ngo Dinh Diem, 70–71, 75–76
Ngorongono Conservation Area (NCA), 161
Niger, 138, 140, 142–43
Nile River, 137
Nobel, Alfred, 6
Northern Rangeland Trust (NRT), 150–51, 163–73
Novi Sad, Serbia (Former Yugoslavia), 202, 206–8, 218
NRT. *See* Northern Rangeland Trust

Obama, Pres. Barack, 124, 217
Offutt AFB, NE, 29
oil consumption, 44, 50
oil infrastructure, 57, 59, 200–1, 210
Okavango Delta, Botswana, 136
Okinawa, Japan, 114
Oklahoma, 27–29, 34–35, 37
Oklahoma City, OK, 27, 29, 35
Operation Allied Force, 58, 117, 209, 211
Operation Desert Fox, 58, 211
Operation Desert Storm, 116, 118
Operation Iraqi Freedom, 118
Operation Linebacker, 201
Operation Ramon, 183–85, 191
Operation Ranch Hand, 70, 77
Operation Rolling Thunder, 53, 201
opium, 65–70, 72–80
Oppenheimer, Robert, 4
ordnance, 10, 30, 34, 117, 200, 202, 215, 218
Orville Wright, 6
Osaka, Japan, 2
Oslo Process, 217

Pakistan, 76, 159
Pancevo, Serbia (Former Yugoslavia), 202, 205–8, 213, 218
peace parks (PP), 150, 157–59, 168

Pearl Harbor, HI, 3, 43
Peirse, Richard, 47
Permanent Okavango River Basin Water Commission, 94
PGM. *See* precision-guided munitions
Picasso, Pablo, 1
  Guernica, 1, 3, 112
Pinyon Canyon, CO, 39
Planning Division of the Israeli General Staff, 178
Ploesti, Yugoslavia, 49–50
Poland, 1, 3, 50, 59, 110, 112
poppies, 65–70, 72–80
Portal, Charles, 11–12, 18, 47
PP. *See* peace parks
precision-guided munitions (PGM), 57, 107, 118, 120, 122

Rabin, Yitzhak, 191
RAF. *See* Royal Air Force, UK
Ramat David air base, Israel, 180–81, 191–92
Regional Environmental Center for Central and Eastern Europe, 207
Rocky Mountain Arsenal, CO, 30
Romania, 49, 200, 202
Roosevelt, Pres. Franklin, 27–28
Rotterdam, Netherlands, 3, 112
Royal Air Force, UK, 1–2, 9–13, 19, 44, 46, 48–51, 110, 112–13, 115, 180, 199–200, 216, 218
  Manual of Air Tactics, 13
Royal Australian Navy, 59
Royal Navy, 59, 110, 112
Ruhr River dams, Germany, 14, 20
Rumpf, Hans, 115
Rupert, Anton, 159
Rwanda, 137–8, 159

Sahara Desert, 136
Saigon, Vietnam, 74, 76
Schilling AFB, KS, 35–37
Schutzstaffel (SS), 15
Schwabach, Aaron, 213
Sebald, Winfried Georg, 9
Second Intifada, 179, 190
Second Lebanon War, 189–90
Serbia (former Yugoslavia), 21, 58, 117, 199, 202–8, 210–11, 213, 216, 218–19
Seventeenth Air Force, 150
Shakedi, Eliezer, 186
Shannon, David, 16
Shea, Jamie, 204
Sheppard AFB, TX, 28
Shmueli, Ram, 191
Short, Michael C., 203
Sinclair, Archibald, 49
Somalia, 117, 167
South Africa, 94–97, 136, 158–59, 161
Southern African Development Community, 94
Soviet Union, 32, 55, 65, 113, 124, 156, 200
Spaight, J. M., 109, 113
Spanish Civil War, 1, 112
Speer, Albert, 50, 112
SS. *See* Schutzstaffel
Stability Pact for South Eastern Europe, 218
storage tanks, 35, 43, 57, 204
Sudan, 138–40, 142–43
Superfund Amendments and Reauthorization Act of 1981, 36
sustainability, 83, 90, 144, 146, 152–53, 156, 158, 164–65, 168, 172–73, 200
Sutner, Bertha, 6
synthetic fuel, 200
synthetic oil, 46–47, 49–51

Taliban, 65–66, 68–70, 76–79, 124
Tan Son Nhut air base, Vietnam, 73
Tanzania, 157, 160–61, 163
Texas, 27–30
TFCA. *See* transfrontier conservation areas
Tinker AFB, OK, 29, 35, 37
Tokyo, Japan, 2–3, 107
Townshend, Charles, 13
transfrontier conservation areas (TFCA), 149, 157–58, 168
Trenchard, Hugh, 44, 86
Tulsa, OK, 27, 29
tu quoque, 205

Turkey, 57, 125, 190–91
Tweezer, Zvi, 185

U-boats, 47
Umm Qasr, Iraq, 59
UN. *See* United Nations
United Kingdom, 1–4, 9–22, 19, 44–51, 59, 76, 78, 86, 108–15, 124, 144, 177–81, 186, 199–200, 216, 218
United Nations (UN), 2, 22, 66, 85, 95, 116, 124, 126–27, 138, 151, 158, 202, 207, 214–15, 217–18
United Nations Children's Fund, 116
United Nations Environment Program, 138, 218
United Nations General Assembly, 22
United Nations University for Peace, 158
United States (US), 2, 4, 18–19, 25–39, 43, 45–55, 57–59, 61, 65, 69–80, 86–87, 97, 107–8, 110–11, 113–18, 120, 122–27, 133, 140, 142–47, 149–55, 162–63, 168–69, 171–73, 178, 185, 187, 189, 199–201, 203, 205, 209, 211, 213, 215, 217, 219
US. *See* United States
USAAF. *See* US Army Air Forces
US Africa Command (AFRICOM), 97, 133, 138, 142–47, 149–50, 153–55, 162–63, 167–69, 171–73
US Agency of International Development (USAID), 143, 154, 171
USAID. *See* US Agency of International Development
US Army Air Corps, 28, 45
US Army Air Forces (USAAF), 2, 25–26, 32–35, 48–50, 110–11, 114–15, 200
US Army General Staff, Planning Division, 178
US Army Ordnance Corps, 30
US Defense Intelligence Agency, 54
US Department of Defense (DOD), 4, 25, 31–32, 34, 36–39, 149–150, 152, 154, 162, 168–69, 171–72
US Department of Energy (DOE), 25, 32
US Environmental Protection Agency (EPA), 30–31, 34, 36–37
US Geological Survey (USGS), 140, 143
USGS. *See* US Geological Survey
US Joint Chiefs of Staff (JCS), 53–54, 211
USN. *See* US Navy
US Navy (USN), 34, 59, 201
US Pacific Fleet, 43
US Strategic Air Command, 29, 111
US War Department, 28
Uvda air base, Israel, 184, 187–88

V-1 (*Vergeltungswaffe eins*), ram-jet cruise missile, 17
V-2(*Vergeltungswaffe zwei*), ballistic missile, 17
Vance AFB, OK, 28
Vauthier, Pierre, 44
Veale, F. J. P., 18
Verne, Jules, 109
Vietnam, 2, 5, 18, 25, 31, 43, 52–55, 61, 65, 70–78, 80, 115–16, 118, 126, 199, 201, 213, 215
Vietnam War, 18, 25, 52, 61, 118, 199
Viorst, Milton, 116
Virunga National Park, Democratic Republic of the Congo, 137–38, 159

Walcheren Island, Netherlands, 20
Wallis, Barnes, 15–16, 20
Walzer, Michael, 113, 210
War Cabinet, UK, 12, 17
Warden, John, 201
Warsaw, Poland, 3, 112
Washington State, 32
water, 3–4, 10, 13–16, 18, 30–33, 35–38, 48–49, 57, 66, 89–90, 92–94, 116, 133–38, 140, 147, 156, 180–81, 184, 186, 216, 218–19
Weber, Baruch, 181
wells, 30–31, 37, 59, 199, 201
Wells, H. G., 109
Western Area Plans, 46
Wichita, KS, 27, 29
Winged Defense (Mitchell), 45, 57
World Conservation Union, 137

World Health Organization, 116
World War I, xi, 44, 86, 108, 126
World War II, x, 1–3, 10, 13, 25, 32–33, 38, 43, 46, 52, 55, 61, 86, 100, 107, 110–12, 115–16, 119, 126, 200–1
World Wildlife Fund (WWF), 96, 158–160
Wright, Orville, 6
WWF. *See* World Wildlife Fund

Yugoslavia, 4–5, 21, 49–50, 58, 117, 199–208, 210, 213–14, 216, 218–19

Zeppelin raids, xi
Zimbabwe, 158–161
Zuckerman, Solomon, 18, 21

Airpower and the Environment

The Ecological Implications of Modern Air Warfare

Air University Press Team

Chief Editor
James S. Howard

Copy Editor
Carolyn Burns

Cover Art, Book Design, and Illustrations
Susan Fair

Composition and Prepress Production
Nedra Looney

Print Preparation and Distribution
Diane Clark

Library of Congress Cataloging-in-Publication Data

Airpower and the environment : the ecological implications of modern air warfare / edited by Joel Hayward.
p. cm.
Includes bibliographical references and index.
ISBN 978-1-58566-223-4
1. Air power—Environmental aspects. 2. Air warfare—Environmental aspects. 3. Air warfare—Case studies. I. Hayward, Joel S. A.
UG630.A3845 2012
363.739'2—dc23

2012038356

Disclaimer

Opinions, conclusions, and recommendations expressed or implied within are solely those of the author and do not necessarily represent the views of Air University, the United States Air Force, the Department of Defense, or any other US government agency. Cleared for public release; distribution unlimited.

Air University Press
Air Force Research Institute
155 North Twining Street
Maxwell AFB, AL 36112-6026
http://aupress.au.af.mil

later attacks on Dresden and Hamburg by RAF and US Army Air Forces (USAAF) bombers intensified this strategy.

US military aircraft in the Pacific were employed for the same tactic, beginning with the 1942 bombing of Tokyo and other targets by the Doolittle Raiders.[2] Then in March 1945, B-29s dropped incendiary bombs on the three largest cities of Japan (Tokyo, Osaka, and Nagoya). The attacks on Tokyo killed an estimated 84,000 people, injured 41,000, and made one million people homeless.[3] The dropping of atomic weapons on Hiroshima and Nagasaki in 1945 was a continuation of this strategy using a new weapon whose blast, thermal energy, and ionizing radiation could kill close to 100,000 people and injure tens of thousands more with a single bomb.[4]

Following World War II, the use of airpower to harm people and destroy property continued. Air operations in Vietnam caused extensive casualties and physical destruction that were euphemized as "collateral damage." The bombing of Cambodia, the full extent of which was not revealed until President Clinton did so in 2000, took place from 1964 to 1975.[5] Similar damage was inflicted on Kosovo, Iraq, and Afghanistan. On 14 June 2009, the chief of the United Nations' mission to Afghanistan criticized air operations that led to the deaths of hundreds of civilians.[6]

Although airpower's capacity to cause long-lasting and possibly irreversible damage to the environment has added a new dimension, reports—some of them apparently apocryphal—of war-related environmental damage began long before the development of aircraft. A frequently cited example is from the Third Punic War (second century BC): the Romans are said to have salted the fields of Carthage after they conquered it.[7] A century later, Calgacus, a Caledonian chieftain, inspired his troops to fight by warning them that their Roman enemy used "robbery, butchery and rapine." He added, "They create a desolation and call it a peace."[8]

Closely related are the ways in which military forces attempted (long before the development of airpower) to cause indiscriminate damage to health. In 1347 Mongols attacking the walled city of Caffa in what is now the Ukraine catapulted the corpses of those who had died of the plague into the city. In North America in 1763, Lord Jeffery Amherst, commander in chief of British forces, suggested to the besieged commander of Fort Pitt that blankets in which smallpox victims had slept be given to the enemy. A delegation of Delaware

Indians visiting the fort seeking its surrender received "two blankets and a handkerchief out of the smallpox hospital."

In recent years, protecting our planet from long-lasting and possibly irreversible change has become an important issue, producing attempts to reorder priorities and practices in many sectors of human life, including the use of energy for production and transportation and the ways we act in our daily lives. A new term, *ecological damage*, describes effects that are longer lasting and more severe than environmental damage. One result of the concern about ecological damage is the protection of endangered species and the negotiation of the Convention on Biological Diversity, which has now been ratified by more than 175 countries. The convention commits ratifying countries to the protection of ecosystems, which it defines as a "dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit."[9] In other words, an ecosystem is a group of interdependent organisms which share the same habitat. Damage to ecosystems from cumulative causes, such as environmental pollution, threatens the existence not only of species defined as "endangered," but ultimately of *Homo sapiens* as well.

Environmental changes, in contrast to ecological changes, generally are changes to physical structures such as air, water, and soil, which may be reversible. Environmental damage can also refer, more broadly, to social, economic, and cultural changes. Such changes, when limited in duration and scope, can indeed be survivable or even beneficial to a species in the short run, but care must be taken that the intensity or duration of these changes does not result in irreversible damage.

The advent of airpower during the twentieth century provided a series of terrible but probably reversible examples of damage to human beings and to the environment. Examples include the Nazi bombing of Guernica, Warsaw, Rotterdam, London, and Coventry, followed by the Allied bombing of Hamburg, Dresden, and other cities in Germany. The Japanese bombing of Pearl Harbor was followed by the United States using incendiary bombs to destroy much of Kyoto and Tokyo. In my assessment, which is not universally embraced,[10] these responses were roughly proportional to the provocation and, although terribly damaging, for the most part followed the guidelines that define conduct during a just war.

The capabilities of airpower to cause long-lasting environmental and ecological damage intensified dramatically at the end of World

War II. The most striking examples are the use of nuclear weapons on Hiroshima and Nagasaki and the testing of thermonuclear weapons of far greater yield in the 1950s and following decades. These weapons, whose consequences included long-lasting, ionizing radiation, appeared to cross a threshold for destructiveness and ecological damage. Some of those who developed the weapons recognized the crossing of a moral threshold. J. Robert Oppenheimer quoted from the *Bhagavad Gita*: "I am become death, the destroyer of worlds."[11]

Other instances of environmental and ecological damage caused by airpower followed. One example is the use of depleted uranium (DU) in missiles and shells. DU is a waste product mainly from the production of enriched uranium for nuclear weapons. British and US armed forces have used it in the Middle East and in the former Yugoslavia.[12]

Another example is the use of vast quantities of petroleum products in military training and in war, which depletes nonrenewable natural resources and undoubtedly contributes to global warming. American service personnel in Afghanistan and Iraq in recent years have used about 3.5 million gallons per day. Over the course of a year that amounts to 1.3 billion gallons. For every serviceperson stationed in these theatres, two others are in training or transit, and the Department of Defense (DOD) must move millions of tons of arms, ammunition, food, fuel, and equipment every year by plane or ship. The DOD is the world's leading consumer of petroleum, and an April 2007 estimate suggests that the Pentagon might consume as much as 14 billion gallons every day, greater than the daily total consumption of Sweden or Switzerland. It is impossible to identify how much of this total is due to consumption by military aircraft, but since one F-15 using full afterburner power consumes 60,000 pounds of fuel per hour per engine, military aircraft use is surely a significant part of the total consumption.[13]

Airpower can also cause ecological damage when aircraft are used to destroy nuclear power plants, spreading plutonium-239 with a half-life of 24,100 years. Aircraft that spray herbicides such as Agent Orange may not only spread cancer-causing contaminants such as dioxin, but also cause damage to complex ecological systems such as mangroves.[14] The production of bomb craters may lead to standing pools of water that in some climatic regions are breeding grounds for mosquitoes that spread malaria and other diseases. Even limited use of nuclear weapons, some have predicted, could result in widespread

cooling, agricultural failure, famine, and infectious disease. Such uses of airpower not only cause individual instances of human and environmental damage, but may irreversibly damage ecosystems when they happen repeatedly and widely.

Another less discussed way airpower can inflict potentially irreversible and widespread environmental damage is as a weapon of terrorism. Nation-states, individuals, and groups have long used other forms of indiscriminate attack to create fear. But the use of aircraft creates what might be called an "ecological" level of fear. The "shock and awe" at the start of the attack on Iraq is one example. Others include using fuel-laden commercial aircraft in the attacks on the World Trade Center and the Pentagon or aircraft dropping napalm (jellied gasoline) in Vietnam, dropping white phosphorus in crowded urban areas in Gaza, and dropping cluster bombs. Ninety-five nations signed the Convention on Cluster Munitions in Oslo in December 2008, but the United States, which used cluster bombs in the former Yugoslavia, Afghanistan, and Iraq, has not yet signed. These attacks not only kill and maim people, but may lead to long-lasting and perhaps irreversible conditions in which people carry their distrust of other individuals and nations into their social relationships.

Unmanned drone aircraft present another way airpower can create fear, adding another element to warfare. When drone aircraft are operated directly by human beings, some element of human responsibility for consequences may be present. When controllers far from the scene of battle operate them, human responsibility for consequences may be lacking.[15]

Drones have been used in Afghanistan to target individual human beings. This practice is ethically troubling and may be counterproductive in a "war against terrorism." Not only can targets be misidentified, but by international law there must be no reasonable alternative, such as capture, to killing a targeted civilian. To warrant execution the target must be actively participating in an attack on others. The use of lethal force must be proportionate to the immediate threat. In this case, too, the use of aircraft brings a warring nation closer to the borderline of illegal and unethical activities.[16]

What can be done to keep the changes brought by the use of aircraft in war from causing irreversible damage to the environment, health, and natural resources? Other chapters in this book deal with legal responsibilities, reparations, and responsibility for repairing the reversible environmental damage. But, as in other areas of public

health, the answer must lie in prevention of adverse health consequences that cannot be effectively reversed. Prevention of the environmental and ecological consequences of war, whether caused by airpower or not, ultimately lies in preventing human conflicts from becoming armed conflicts. Indeed, some have wondered whether the damage war causes to people and to the environment is making war as an extension of foreign policy obsolete. A just war, as enumerated over the centuries and recently restated by the Roman Catholic Church, must meet the following criteria:

- the damage inflicted by an aggressor on the nation or community of nations must be lasting, grave, and certain;
- all other means of putting an end to it must have been shown to be impractical or ineffective;
- there must be serious prospects of success; and
- the use of arms must not produce evils and disorders graver than the evil to be eliminated.[17]

The power of modern warfare means of destruction, particularly through airpower, should weigh heavily in evaluating actions against the last of these criteria for a just war.

Orville Wright, commenting in 1917 on his invention, said, "When my brother and I built the first man-carrying flying machine we thought that we were introducing into the world an invention which would make further wars practically impossible."[18] The damage that airpower makes possible also led to a prediction by Winston Churchill in the House of Commons in 1933 that "Air power may either end war or end civilisation."[19]

Wright and Churchill were not the first to predict an end to war based on technological destructiveness. As Alfred Nobel wrote to Bertha von Sutner, recipient of the first Nobel Peace Prize, "Perhaps my factories will put an end to war even sooner than your Congresses; on the day when two army corps will be able to annihilate each other in a second, all civilised nations will recoil with horror and disband their troops."[20] But such technological fixes have not succeeded in preventing war. The problem is moral. To end war, military forces, in this case those who fly and support air forces, would need to refuse to conduct operations that would violate the principles of *jus in bello*

(justice in war). Perhaps books like this and others will help point the way to moral constraints on the role of these forces in war.[21]

Notes

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

1. Churchill, speech, 20 August 1940.
2. Lawson, *Thirty Seconds over Tokyo*.
3. Craven and Cate, eds., *Army Air Forces in World War II*, vol. 5: *Pacific: Matterhorn to Nagasaki June 1944 to August 1945*, 614–17.
4. Rhodes, *Making of the Atomic Bomb*, 599.
5. Owen and Kiernan, "Bombs over Cambodia."
6. Hewitt, "Place Annihilation," 257–84.
7. Susan Stevens, "Legend of the Destruction of Carthage," 39–41.
8. Tacitus, *De vita et moribus Iulii Agricolae,* as translated by William Peterson quoted in Bromwich, "Euphemism and American Violence."
9. United Nations Convention on Biological Diversity, available at http://www.cbd.int/.
10. See Grayling, *Among the Dead Cities*.
11. Bird and Sherwin, *American Prometheus*, ix.
12. Fairlie, "Depleted Uranium." [Editor's note: see Joel Hayward's chapter 11 in this volume for a different perspective on DU.]
13. Frumkin, Hess, and Vindigni, "Energy and Public Health"; and Klare, "Pentagon v. Peak Oil."
14. Grotto and Jones, "Agent Orange's Lethal Legacy."
15. "60 Drone Hits Kill 14 Al-Qaeda Men, 687 Civilians," *News* (Pakistan).
16. Mayer, "Predator War"; and Shane, "C.I.A. to Expand Use of Drones."
17. "Just War Doctrine."
18. McFarland, ed., *Papers of Wilbur and Orville Wright*, 76.
19. Churchill, debate, 14 March 1933.
20. Tagil, "Alfred Nobel's Thoughts about War and Peace."
21. See Hayward's essay in this volume, "Airpower and the Environment: Some Ecological Implications of Modern Warfare." Also see Byman, Waxman, and Larson, *Air Power as a Coercive Instrument*; Wrage, ed., *Immaculate Warfare*; Sidel, Levy, and Slutzman, "Prevention of War and Its Environmental Consequences"; Leaning, "Tracking the Four Horsemen"; and Sidel, "Impact of Military Preparedness."

dwellings, his history, and his natural environment as can possibly be achieved."[2]

This chapter asks if environmental considerations were a factor in the planning of the British strategic bombing offensive of the Second World War. It then offers some reflections on why environmental considerations were not more prominent in the extensive and unfolding debates about the purposes of that offensive.

From the relatively safe vantage point of the early twenty-first century, it is clear that in addition to injuries and deaths and the destruction caused to the neighborhoods in Germany by the British bombing, there was an environmental cost, as yet not measured. Four main areas can be isolated: (1) The burning of huge quantities of aviation fuel, the explosion of thousands of tons of ordnance, and, above all, the deliberate creation of huge fires in German cities had as one consequence the release of large quantities of carbon dioxide into the atmosphere.[3] (2) The RAF's focus on trying to destroy German oil supplies and oil production facilities released numerous other toxins into the atmosphere, the land, and the water around "oil targets." (3) The deliberate attacks on the German chemical industry, and the less-focused attacks on large and small industrial centers, inevitably caused the release of dangerous chemicals onto nearby land and into the atmosphere, rivers and lakes, and groundwater supplies. (4) There was incalculable damage to all kinds of wildlife and to wildlife habitats.

Since the 1961 publication of the four-volume official history of the British bombing offensive and the earlier publication of memoirs by key figures (most notably Winston Churchill and Arthur Harris) in the evolution of British bombing policy, historians have scrutinized the debates surrounding the development of bombing from the air since 1914 and the evolution of British policy before and during World War II.[4] A number of recent histories have examined—with varying degrees of objectivity—the wartime debates about the best use of Britain's growing bomber force in the changing circumstances of the Second World War and the heated arguments over whether aircraft were best employed attacking specific "military objectives" or in "area bombing" intended to damage German morale. Most commentators also noted the concern of politicians, airmen, and bombing campaign critics for the potential damage to Germany's architectural and cultural heritage and the destruction of churches, museums, art galleries, libraries, archives, and their contents.[5] None have explored the extent to which "environmental" considerations were a

part of the wartime debates. To explore this we need to return to the primary documents.

Britain declared war on Germany with a specific plan to attack the natural environment. The "Western Air Plans" of 1 September 1939 detailed various options open to the RAF in the event of war with Germany. One of these, Plan W. A. 11, was for "attack on forests."[6] The RAF did not immediately exercise this option, as all the armed forces were restricted to attacking only "purely military objectives in the narrowest sense of the word" to avoid provoking the Germans into starting "unrestricted air warfare."[7] Once the Germans attacked the Low Countries and France in May 1940, Britain revised this policy and, as the situation worsened in June 1940, revived its plan to attack the natural environment in Germany. By this time, many prewar assumptions about bombing had been revealed as unfounded. The war entered a critical phase with the collapse of the French Army and the evacuation of the British Expeditionary Force from Dunkirk. Pressure on the RAF's Bomber Command to help alleviate the crisis and a spell of exceptionally dry summer weather on the continent combined to provoke a directive from the deputy chief of the Air Staff to Air Marshal Charles Portal (then in charge of the Bomber Command) which included a section on "Destruction of Crops and Forests." Portal was instructed:

> The time to attack crops in Germany is within the next two or three weeks, and the new "pellet" incendiary will be available in quantity early in July. You should be prepared to distribute the "pellets" over selected areas in Germany immediately after the current moon phase and a separate directif [*sic*], forwarding a map of the suggested areas, will be sent to you in the near future.

The directive continued:

> As you are aware, there are extensive areas of coniferous forests in Germany which are believed to be extremely vulnerable to incendiarism at this time of year. Some of these are in the vicinity of important military objectives and aerodromes, where a forest fire might have valuable results in dislocating German military and industrial activities apart from the moral effect.

"Crops and forests" were one of five separate objectives specified in this directive. The aircraft industry, communications, mine-laying in German coastal waters, and oil preceded it and were given greater priority.[8] The situation was very fluid. A new 4 July 1940 directive instructed Portal that attacks on forests should be "discontinued," but

that he should still prepare to use the incendiary "pellet" against crops. On 24 July, Portal was told that

> When suitable weather conditions obtain, attacks may be resumed against forest areas in Germany in accordance with the directives forwarded to your headquarters in Air Ministry letters dated 24th and 26th June, 1940. Among the areas suggested in the attachments to those letters, it is felt that the Harz Mountains would provide a valuable focus for a concentrated attack both from the material and psychological standpoints.
>
> In this connection, I am to say that consideration has been given to the possibility of utilising the existing stocks of incendiary "pellets" in conjunction with normal bombing operations in order to take advantage of the diversions and alarms which may be caused through these potential sources of fire scattered over a wide area. It is considered that, when the weather is dry, there is a reasonable chance of a number of "pellets" starting fires on the extensive stretches of heath land and similar ground which is widespread throughout Western Germany, and thus adding to the demoralising and psychological effect of our operations. Authority is being sought for the employment of the "pellets" in this way and you will be notified immediately this is obtained.[9]

One wonders what the Air Staff imagined the "demoralising and psychological effect" of causing extensive heath and forest fires in Germany might have been. Was there a sense that the Germans were particularly sensitive to nature and proud of their landscape and, as a result, would have been particularly troubled by its destruction? We will probably never know.

Although these plans came to naught, they are, when combined with other statements made at this time, very revealing. A "Committee on Preventing Oil from Reaching Germany" was established, making its Fourth Report to the government on 4 June 1940, as the evacuation at Dunkirk came to an end. It stated:

> Oil targets are, from the Royal Air Force point of view, highly desirable objectives, particularly because they are vulnerable to air attack because attack upon them gives rise to very large secondary effects by way of fire and explosions. The majority of the chief oil plants in Germany are remote from centres of civil population. Therefore attack on oil plants is likely to cause fewer casualties among civilians than other targets.[10]

The chiefs of staff, in a report to the War Cabinet on 25 May 1940, urged bombing attacks on German oil targets.[11] Unlike the proposed attacks on forests and crops, Bomber Command from 16 May had already started night attacks on oil targets in Germany. It is clear that

in the desperate circumstances of the summer of 1940, as RAF leaders realized that existing Bomber Command forces were not able to seriously impact any of the numerous targets being attacked, the British had few scruples about creating extensive fires in German forests, on farmlands, and on heaths, nor about causing huge fires and explosions in oil plants, with "very large secondary effects." Indeed, they clearly thought this a preferable alternative to causing death or injury among the civilian population.

The broader idea of influencing people by attacking their crops and other means of sustenance was indeed well established in British aerial doctrine, although it had only previously been used on "primitive peoples" and "recalcitrant tribes" in outlying areas of the British Empire as part of what in the 1920s and 1930s was termed "Air Control." Charles Townshend documented how a 1922 Air Staff memorandum listed, under the heading "Forms of Frightfulness," methods for breaking the morale of a colonial tribe. One method was to poison the water supplies with crude oil.[12] Throughout the 1920s and 1930s, the cattle and other livestock of "recalcitrant tribes" in outlying areas of the empire, notably in Africa, were targeted in "air policing" operations—typically in preference to the actual members of the tribe.[13] As late as 1937, the RAF's "Manual of Air Tactics" contained a rationale for setting crops and forests on fire, noting that this had been used in "outlying areas as a punishment against primitive peoples."[14] Underlying these forms of attack within the broader doctrine of "Air Control" was a concern to find ways of coercing people while restricting casualties to a minimum. The same concern was transferred into emerging plans for bombing Germany in the first year of World War II.

Between the dry summer of 1940 and the appointment of Arthur Harris to lead Bomber Command in February 1942, there appears to have been no resurrection of the idea of attacking crops, forests, or heaths in Germany. These ideas never appealed to Harris, who, despite his background in the practical application of "Air Control" in India and in Iraq, was committed to "the policy of destroying industrial cities" in the fight against Germany.[15] The prolonged debate in Britain over the merits of "area bombing," which followed the presentation of the Butt Report in August 1941 and the "Area Bombing Directive" in February 1942, did not engage with environmental considerations. The debate was mainly about the most effective ways of

waging war against Germany, and to a lesser extent, the ethical legitimacy of directing attacks on working-class housing in German cities.[16]

Another prewar plan with potentially significant environmental implications was resurrected—initially against Harris's wishes—and constitutes a unique case for this study: the attack on the Ruhr dams in May 1943. In a recent book, which has attracted wide attention in Germany, Jörg Friedrich states:

> The questionable method in the battle of the Ruhr belongs to the yet barely explored genre of environmental war. . . . The researchers for the operation had encountered the question of what would happen if a lightning strike with weapons was directed against two dams in the Ruhr; in all likelihood a modern biblical flood, which would work in two ways: firstly through the tidal wave released, and secondly through the resulting shortage of water in the whole Ruhr area.[17]

Friedrich produces no evidence from British sources to support these assertions, but gives a graphic description of the flooding in the Möhne-Ruhr valley and in the Eder valley following the successful attack on the dams by Lancasters of 617 Squadron. He focuses on the civilian deaths and injuries, but also notes the drowning of livestock, and states, "the whole fish population was exterminated" in the Möhne-Ruhr valley. After describing how the two dams were rapidly repaired, he states, "The potential of the environmental attack was not plumbed any further after this." He suggests that the British maintained their focus on fire raids on cities after May 1943 because they were was more profitable to them than attacks on the environment, such as the "Dambusters Raid."[18]

Friedrich is replicating a view that was widespread in Germany in the aftermath of the Dambuster Raid. This raid appeared, to the survivors of flooded areas lying immediately below the dams, as an attempt to drown them and their livestock en masse and to cause huge environmental damage to carefully managed agricultural land. A report sent to Dr. Joseph Goebbels, who was charged with responsibility for coordinating the German response to the British bombing offensive, stressed these aspects of the "catastrophe" visited upon the people in the Möhne and Ruhr valleys. It highlighted the deaths of thousands of people and the destruction of animals of all kinds as well as houses, industrial premises, and agricultural land. Describing how people living on both sides of the Ruhr had lost everything they possessed, the report stated that the "work of a few hours made deserts of sand and shingle from land which has been fertilised and culti-

vated for years." Describing effects further down the valley, the report continued: "Agriculture and industrial facilities have been for the most part exterminated."[19]

This focus on the immediate damage caused by flooding was also present in the public opinion report prepared immediately after the Dambusters Raid by the security forces of the SS (*Schutzstaffel*). The report listed the "devastation caused by masses of water" as the main consequence of the attack and the first of the proofs understood by "wide parts of the population" that there was "a cold-blooded planning of the air war in the enemy camp."[20]

In contrast, most British policy makers and historians argue that the *primary* intention of the attacks was to cause a shortage of water in the industrial cities downstream, thus restricting armaments production. Harris said that a secondary consequence of breaching the dams would be to cause widespread flooding and consequent damage. The breach of the Möhne Dam released a flood of 130 million gallons, but the destruction caused by flooding was not, and was never expected to be, as serious as the subsequent shortage of water for industrial purposes.[21]

The argument that the dams raid was primarily intended as an attack on German industry is restated by the author of an oral history explaining the genesis of the raid: "Barnes Wallis was essentially a peace-loving man, but he felt strongly that the right way forward was to destroy the dams, and thereby the Ruhr's industrial power source."[22] Wallis explained the attack as "an engineer's way of stopping the war. . . . If we rob them of all their water supply, they couldn't produce steel and the war would come to an end."[23]

According to Guy Gibson, Wallis provided a more differentiated rationale for the attack when first explaining the mission to him:

> Between them they [the Möhne and Sorpe dams] hold back about 75% of the total water available in the Ruhr Valley. If they were both to be breached, the consequent shortage of water for both drinking and industrial purposes might be disastrous. Of course, the damage caused by floods if they were breached quickly would result in more damage to everything than has ever happened in this war.[24]

This is similar to the version presented on the National Archive website, which presents a number of official documents on the raid. Part of the introductory preamble to these reads,

> In February 1943, the Assistant Chief Designer at Vickers Armstrong, Barnes Wallis, revealed his idea for "air attacks on dams" which would deprive the German arms industry of its vital water supply and cause a "disaster of the first magnitude."[25]

Charles Webster and Noble Frankland stated in 1961, perhaps a little defensively, "The sudden catastrophe which inundated the areas lying below the two dams was local, temporary, and largely agricultural."[26] In their appraisal of the raid, Webster and Frankland put as the *last* of a list of results "a considerable area of agricultural land flooded."[27] This view is undermined by the way British propaganda after the Dambusters Raid represented the whole event. Photographs showing extensive flooding were published in Britain and in pamphlets dropped over occupied Europe, with captions celebrating the damage caused by the inundations. This was of course, far more visible as an effect of the attack than the notional damage to war production.

In 1953 Denis Richards and Hilary Saunders presented a view which was closer to that of Friedrich's, who notes how the British, in their bombing, sought to harness the power of natural forces, like fire and water. Richards and Saunders wrote:

> It had long been determined to add water as well as fire and high explosive to the list of plagues scourging the Ruhr. . . . To breach the [Möhne] dam meant the release of this water, which, gushing through the valley of the Ruhr would not only cause widespread, possibly disastrous, flooding, but would also affect electricity supplies in the most highly industrialised area possessed by the enemy.[28]

Robin Neillands presented a similar view in 2001, writing that in 1940 Barnes Wallis believed that if the dams were blown up this would "let out a tidal wave of water to swamp the surrounding countryside."[29] In the end, the British planners and executors of the raid knew that if they were successful, they would cause incalculable damage and loss of life through flooding, as well as creating a shortage of water for power and for drinking. One of the pilots involved, Flt Lt David Shannon, bluntly expressed how the combined effects of the attacks on the dams were intended: "We were to strike a blow against the Hun."[30]

There was a steady intensification of the British bombing offensive against Germany through the remainder of 1943 and into 1944. Whether measured in sorties flown or in the tonnage of bombs dropped, there was a huge increase in the destructive power of Bomber Command's attacks.[31] The diversion of Harris's force in the

spring and summer of 1944 to support the Normandy invasion and to destroy V-1 and V-2 missile launch sites brought some relief to the German population but not to the environment. The focus on German oil targets in the autumn and winter of 1944 inevitably caused great environmental damage. In the last months of the war, as the German armies conducted a dogged resistance, the bombing campaign reached a furious climax. More sorties were flown and more bombs were dropped in these final months than in the whole previous campaign.[32] Some of the most destructive raids of the war, including the notorious attack on Dresden, were carried out in this final phase of the offensive.

The British government received information about the effects of the bombing by reports and photographs regularly presented to the War Cabinet by Bomber Command. Many of these photographs showed enormous fires burning after attacks on individual targets, and others displayed great devastation to landscapes surrounding targets. The annotations to some of these photographs appear—unfortunately if not actually—to rejoice in the destruction and to celebrate a job well done, and in so doing, demonstrate a horrifying complacency. Some captions refer specifically to the environmental damage. The caption to a photograph taken after the attack on the Dortmund-Ems Canal on 21 and 22 November 1944 pointed out "the river has overflowed and flooded the surrounding countryside."[33]

The "Weekly Résumé" of the military situation presented to the War Cabinet on 15 February 1945, while noting that one million tons of bombs had been dropped on Germany and Austria since the beginning of the war, referred specifically to the attack on Dresden where "1,471 tons of H. E. [high explosives] and 1,175 tons of incendiary bombs were dropped, leaving the town well ablaze with smoke rising to 15,000 feet."[34] This echoed details in the "Summary of Operations Night 13/14 February" sent to Bomber Command Headquarters, which had stated, "smoke was reported up to 15,000 Ft and all crews report an excellent attack with fires visible for 100 miles."[35] The "Weekly Résumé" for 22 February 1945 referred to the renewed attacks on Dresden, noting, "On the 15th, 685 Fortresses . . . attacked Dresden and Cottbus, following the heavy attack on the former city on the previous day and night."[36] Harris, when asked a few days later by one of Churchill's secretaries about the effect of the raid on Dresden, replied, "Dresden? There is no such place as Dresden."[37]

Misgivings about the consequences of the bombing also grew in these final months, but those concerns—raised by both opponents and supporters of the bombing—were almost exclusively focused on the deaths and injuries of civilians and on the destruction of the man-made environment in Germany. It remains to ask why there was so little consideration given at a high level to the environmental consequences of the bombing campaign. Three strands to the answer are presented here.

First, we must bear in mind the understanding the British planners had of the environmental damage that they might be causing. It would be foolishly anachronistic to imagine that politicians and airmen in the 1930s and 1940s had anything like the appreciation they might have today of the environmental consequences of their actions. To give one example, the theory that increased levels of carbon dioxide in the atmosphere were a cause of global warming, so closely connected in the public mind today with the burning of aviation fuel, had indeed been put forward by the British scientist Guy Callendar in 1938.[38] There is no evidence whatsoever to suggest that Churchill, Harris, Portal, or even scientific advisers like Solomon "Solly" Zuckerman or Frederick Lindemann knew before 1945 that the release of carbon dioxide into the atmosphere threatened to change the earth's climate irreversibly. It was not until after the dropping of the atom bombs on Hiroshima and Nagasaki that people became aware that environmental damage on a really huge scale might transcend national boundaries. The notion that attackers might hurt themselves as much as their enemies by causing environmental damage simply did not exist before 1945.

Of course the British planners knew that individual consequences of the bombing, such as the release of oil or other contaminants into water supplies, would damage the environment, but they could reasonably assume that these consequences would be local and temporary. It is striking that even the most articulate opponents of the bombing during the war, and indeed in the half-century after the war, focused their criticism on precisely those consequences of the bombing which were discussed by the planners—the death and injury of civilians and the destruction of Germany's cultural heritage. Even that most vociferous of critics, F. J. P. Veale, made no mention of environmental considerations when he renewed his polemic against "terror bombing" in 1968.[39]

The whole idea of "ecological damage" and the discourse of "environmentalism" have emerged since the Vietnam War. It is only in the

last 20 years that scholars and diplomats have really engaged with the broader topic of war and the natural environment. A protocol was added in 1977 to the Geneva conventions of 1949 stating in part, "It is prohibited to employ methods of warfare which are intended, or may be expected, to cause widespread, long-term, and severe damage to the natural environment."[40] One will search in vain for the terms Friedrich uses in 2002—*environmental war* and *environmental attack*—in documents from before May 1945.

This shift in perceptions about warfare, and about the natural world, may be illuminated with reference to the concept of *mentalités*, an idea that has been developed largely by French and German historians. Their concerns were not merely with the temporary outlook of any given group or individual, but with deeper, underlying, sometimes inaccessible attitudes, which shape collective approaches to a given situation. Typically, they see these attitudes as formations, which develop and change very slowly over the course of decades and even centuries. In the words of German historian Klaus Hatchel,

> Such collective dispositions channel notions, attitudes, and ideas in two ways: *positively* by guiding individuals within the group in a particular direction, without there being any outright coordination or explicit agreement among them; or *negatively* by blocking out or repressing other conceivable options that would appear astonishingly self-evident to uninitiated outsiders.[41]

This approach can help us understand many aspects of the British bombing offensive planning, but it is particularly relevant to the idea of the environment, which is so markedly absent from virtually all of the extensive written records of this process. What appears obvious to us today was not necessarily so in the 1940s.

It is perhaps ironic that, among the politicians, airmen, and scientists who planned the British bombing, it was that most maligned figure, Arthur Harris, who commented most explicitly on what we would now call "environmental" consequences of their actions. In most cases—for example, when Harris commented on the "prolonged and bitter opposition" met by the RAF from bird lovers to its plans to use various places in Britain as bombing ranges—he was utterly contemptuous of these objections.[42] What is relevant is that he, and presumably others, were aware of environmental considerations. They simply did not treat them with anything like the significance we would anticipate today.

Second, there was a common assumption among the planners that if there were damaging side effects of the bombing, insofar as these were visited upon the Germans, it was a fate they richly deserved. Another remark in Harris's memoirs is illuminating in this regard. Referring to the deliberate flooding of Walcheren Island in October 1944 by bombing and breaching its seawalls, Harris reveals again that he was aware of the environmental consequences of this action:

> The flooding of the fertile soil of Walcheren, which it was believed could not be restored to its original condition within many years, was a most unfortunate necessity of war, but access to the port of Antwerp was essential for all future operations by land on the Western front. And, in any case, the wholesale destruction of property is, in my view, always justified if it is calculated to save casualties.[43]

Harris restates his concern to minimize casualties, but what is also revealing is that he comments in such specific detail about the environmental consequences of this particular action. Nowhere else in his memoir does he demonstrate anything like this; we may reasonably presume that he was not equally concerned with the destruction of the environment in Germany. His concern for the "fertile soil" of Walcheren—in the Netherlands—is not, for example, paralleled by any similar concern for the agricultural land devastated by the Dambusters Raid in May 1943. It would be a mistake, in discussing any consequence of the British bombing of Germany, not to take into consideration the feelings about Germany provoked by its own record since the very start of the war.

Third, and most important, we need to understand the nature of the war the British fought between 1939 and 1945. This is a consideration which feeds into any future debate about the environmental consequences of the deployment of airpower. The politicians and airmen—and their scientific advisers—who directed the British strategic bombing campaign believed that they were fighting for their national survival. Many had personal experience of the grim struggle between 1914 and 1918 to draw upon and knew that in Germany they faced an utterly ruthless, resourceful, and determined enemy. This straightforward sense of duty is evident in Barnes Wallis, the kindly, sensitive man who designed the most destructive weapons used by Bomber Command. It will be remembered that Wallis had recognized that, for example, destroying the Ruhr dams would cause damage to "everything" below them, not just to German industrial production. A colleague commented, "Barnes Wallis was a Victorian, and a great

'Empire' man, and the country meant an awful lot to him, so anything he could do which he thought would help the country, that's what he felt he was put upon this earth to do."[44]

Zuckerman serves as another example of an influential scientist who devoted his intellect to the perfection of weapons of war. For example, he tried to maximize the blast effect of British bombs, without apparent environmental scruples.[45]

If we are to understand the evolution of British aerial strategy, we need to take full account of the precise context in which it emerged. The British decision not to bombard "fuel and oil producing plants, refineries, and storage installations" in September 1939 was not motivated by environmental or humanitarian concern, but by a desperate hope of avoiding German aerial attacks on Britain. The turn toward area bombing and the decision to concentrate resources on the development of a huge bomber force took place against a backdrop of sustained German bombing of British cities at a time when Britain and its empire stood alone. Note that the German bombing of Britain, and indeed its conduct of war in all theaters outside Germany between 1939 and 1945, was not, for all the later trumpeting of the allegedly "green" credentials of National Socialism, in any way tempered by environmental sensitivities.[46]

Even late in the war, when Britain's bomber force had become a weapon of terrible destructive force, its planning took place against a background of sustained attack on British civilians by flying bombs and rockets and of extraordinarily difficult fighting on land in northwestern Europe. The idea that attacks on German oil or transportation targets should be called off because of potential damage to the environment would have appeared utterly ludicrous to the British planners, even in the late stages of the war.[47] Briefly consider the application of a similar concern to other aspects of the war. When the *Bismarck* left Gdynia in May 1941 bound for the North Atlantic, should the government have directed British submarines and aircraft not to attack it lest thousands of tons of fuel oil from the ship's bunkers be released to contaminate the sea?

It could be that in the circumstances of a limited war, a government, and its air force, can afford to consider the environmental implications of any proposed deployment of airpower. Few would disagree that this ought to have been a factor in the minds of NATO strategists during the aerial campaign against Serbia in 1999. Since the 1977 addition of Article 35.3 to the Geneva conventions, this is a

binding obligation for signatories to those conventions. On 5 November 2001 the United Nations General Assembly adopted Resolution 56/4 declaring 6 November annually an International Day for Prevention of the Exploitation of the Environment in War and Armed Conflict.[48] This has added international weight to the obligation to have regard for the natural environment in war. It was not a luxury that Churchill, Harris, and others responsible for the planning of British strategic bombing felt they enjoyed between 1939 and 1945.

Notes

1. A rare exception was geographer Kenneth Hewitt, who, in developing his theory of "place destruction," argued that "area bombing . . . became a form of extermination aimed at the whole spectrum of human, or more exactly, civil ecology." Hewitt, "Place Annihilation," 260.

2. Sebald, *On the Natural History of Destruction*, 19.

3. It is significant in this context that the title of a recent German study of the British bombing is titled simply (in English) *The Fire*. Friedrich, *Der Brand*.

4. Webster and Frankland, *Strategic Air Offensive against Germany*; Churchill, *Second World War*; and Harris, *Bomber Offensive*.

5. For a balanced summary, see Hastings, *Bomber Command*, 201–10, 417–25.

6. Appendix 6, "Western Air Plans 1st September 1939," in Webster and Frankland, *Strategic Air Offensive against Germany*, 99–102.

7. "Bombardment Policy," CAB/66/8/16, The National Archives (United Kingdom), Kew (hereafter TNA), which contains the instructions issued just before the start of the war.

8. "Air Vice-Marshal W. S. Douglas (deputy chief of the Air Staff) to Air Marshal Sir Charles Portal," in Webster and Frankland, *Strategic Air Offensive against Germany*, 115–17.

9. Ibid., 118–19. The wording of the directive suggests that there had already been some attacks on forests. I have found no other reference to these attacks actually taking place. The Air Ministry pamphlet *Bomber Command* provides considerable detail about attacks on the first four objectives specified in the directives of 20 June and 4 July 1940, but makes no reference to attacks on crops, forests, or heathlands in Germany. Ibid., 121–23.

10. Fourth Report of Lord Hankey's Committee on Preventing Oil from Reaching Germany Committee, 4 June 1940, TNA CAB/66/8/21.

11. Report by the Chiefs of Staff Committee, 25 May 1940, TNA CAB/66/7/48: Report by the Chiefs of Staff Committee.

12. Townshend, "Civilization and 'Frightfulness,'" 142–62.

13. Killingray, "'A Swift Agent of Government,'" 429–44. I am grateful to Neil Fleming for alerting me to this reference.

14. Webster and Frankland, *Strategic Air Offensive against Germany*, note 1.

15. Harris, *Bomber Offensive*, 88.

16. It is not the purpose of this chapter to revisit these debates. For an important example of a wartime contribution which does not consider environmental considerations, but focuses entirely on the effectiveness of bombing, see the "Memorandum by O. L. Lawrence," in Webster and Frankland, *Strategic Air Offensive against Germany*, vol. 4, 214–19.

17. Friedrich, *Der Brand*, 102. All translations from German here are my own unless otherwise indicated.

18. Ibid., 104–5.

19. "Die Katastrophe an der Möhnetalsperre und Ruhr, Bericht 2," 27 August 1943, R 55/20738, Bundesarchiv, Außenstelle, Berlin, Germany.

20. "Meldungen aus dem Reich, Nr. 385, 24 May 1943," in Boberach ed., *Meldungen aus dem Reich*, Band 13, 5277–85.

21. Harris, *Bomber Offensive*, 159.

22. Arthur, *Dambusters*, 39.

23. Ibid., 43.

24. Ibid., 57.

25. TNA, "The Idea," http://www.nationalarchives.gov.uk/dambusters/idea.htm.

26. Webster and Frankland, *Strategic Air Offensive against Germany*, vol. 2, 168.

27. Ibid., 291.

28. Richards and Saunders, *Royal Air Force 1939–1945*, vol. 2, 291–92.

29. Neillands, *Bomber War,* 229–30.

30. Arthur, *Dambusters*, 150.

31. Although it is not the subject of this chapter, we should note in passing that the daylight bombing of Germany by the American Eighth Air Force, which commenced in January 1943 and intensified thereafter, was conducted with a similar disregard for environmental consequences.

32. For a statistical overview of sorties flown and tonnage of bombs dropped, see Webster and Frankland, *Strategic Air Offensive against Germany*, vol. 4, appendices 40 and 41.

33. "Summary of Operations of Bomber Command," TNA CAB/66/59/39.

34. "Weekly Résumé (no. 285) of the Naval, Military, and Air Situation," 15 February 1945, TNA CAB/66/62/3.

35. "Summary of Operations Night 13/14 February."

36. TNA CAB/66/62/11: "Weekly Résumé (no. 286) of the Naval, Military, and Air Situation," TNA AIR 14/3080.

37. Colville, *Fringes of Power*, 562.

38. Weart, *Discovery of Global Warming*.

39. Veale, *Advance to Barbarism,* 180–85. Veale's critique was first advanced in 1948.

40. Article 35.3 of the 1977 Protocol I Additional to the Geneva conventions of 1949, in Reichberg and Syse, "Protecting the Natural Environment in Wartime."

41. Hentschel, *Mental Aftermath*, 2.

42. Harris, *Bomber Offensive*, 26–27.

43. Ibid., 237. The Walcheren operation was conducted outside of Germany, in support of Allied ground forces, and therefore lies outside the scope of this study. I refer to it here insofar as it illustrates Harris's thinking.

44. Ibid., 43, citing Norman Boorer.

45. Zuckerman, *From Apes to Warlords*. Zuckerman makes no reference to what we would now call environmental concerns in his record of his wartime service.

46. For an introduction to this topic, see "The Nature of German Environmental History."

47. Arthur Harris defended the continuing offensive in the aftermath of the raid on Dresden in characteristically forthright manner, stating, "I do not personally regard the whole of the remaining cities of Germany as worth the bones of one British grenadier." Harris to Air Marshal Sir Norman Bottomley, 29 March 1945, in Hastings, *Bomber Command*, 450–53.

48. United Nations General Assembly Resolution 56/4, also available online at http://www.un.org/Depts/dhl/resguide/r56.htm.

markable story of American industrial capacity, organization, and deployment is well known, often a chapter is omitted. The production facilities for both munitions and aircraft, as well as the training and maintenance facilities established to meet the wartime emergency, left a toxic legacy that continues to plague the communities that hosted and supported these facilities. The purpose of this chapter is to examine that legacy and explore the repercussions for modern practitioners of airpower.

The Great Plains

The American Great Plains formed an attractive locale for government and defense officials charged with expanding the USAAF's production and training infrastructure. The region boasted a variety of factors that made it ideal for wartime planners.[1] First, the Great Plains encompass the geographical center of the lower 48 states. Locations there offered the maximum distance from either coast, increasing protection from aerial attack and sabotage. Because of these geographic advantages, the Air Force would later place the majority of its Cold War–era strategic assets, including intercontinental ballistic missile (ICBM) sites, bomber bases, and even its command and control facilities in the region. Today, all of the Air Force's bomber and strategic communications aircraft and ICBM silos remain on or near the Great Plains.

Aside from its strategic geographic location, the region offered several other features that made it attractive for a large aerial infrastructure. First, it was, and remains today, one of the most sparsely populated areas of the country. Given the low population densities, the USAAF would not significantly endanger lives with accidents and would have little difficulty locating vast expanses for training and weapons ranges.[2] The low population densities recently had been exacerbated by a man-made ecological disaster, commonly known as the Dust Bowl. Encouraged by cheap land and liberal homesteading laws, settlers had expanded into the more arid regions and plowed up the hardy prairie grasses that kept the topsoil in place. Drought returned to the region in the early 1930s, causing crops to fail and leaving no vegetation to anchor the topsoil. When windstorms moved across the largely treeless region, the topsoil was stripped and, in some cases, transported as far away as the east coast. These storms,

known as dusters, plagued the region throughout the Great Depression and further contributed to low population densities as many residents abandoned failed farms in search of relief.[3]

The Dust Bowl and resulting depopulation of rural areas had the ironic result of facilitating the establishment of wartime production facilities across the plains. Some farmers and their families left the land and congregated in cities, looking for work or relief programs. Others remained on their farms but had become disenchanted with their prospects and were quick to embrace other opportunities when they arrived. By 1940 the plains held an underutilized population that could be quickly employed in the new armaments and aircraft production facilities. A 1942 survey found that 50 percent of the workers at Boeing-Wichita had farm backgrounds. Further, a rural upbringing often translated well into war industries work. Craig Miner, in his history of Kansas, relates the observations of the personnel director at the Boeing-Wichita factory who believed that "persons from modern farm backgrounds did especially well in aircraft manufacturing jobs. . . . Nearly all Kansas farms are highly mechanized and Kansas farmers have learned the use of power machinery as well as hand tools."[4]

Cities such as Wichita, Oklahoma City, and Fort Worth owe much of their remarkable wartime growth to a combination of these factors. Wichita's population increased from 114,634 in 1940 to 176,316 in 1944.[5] While much of the available labor was unfamiliar with modern manufacturing techniques, a technical background combined with training and relief programs initiated during Pres. Franklin Roosevelt's "New Deal" to provide the necessary expertise. As a result, production facilities in these cities and others, such as Omaha, Kansas City, and Tulsa, had little difficulty finding workers to staff aircraft production centers. Often the limiting factor was not available labor, but a shortage of housing and public utilities to shelter the new employees. In one newly constructed housing area near Wichita, untreated sewage was discharged directly into the Arkansas River, presenting a public health hazard for residents downstream.[6]

Weather was another factor that made the Great Plains region an attractive location for training bases. Portions of the area average over 300 days of sunshine per year, as the Rocky Mountains to the west wring out the moisture of east-moving storms. With a prevalence of excellent visual flying conditions, low precipitation, and brief periods of poor weather, the region remains popular for military

flight training. Even today, over half of the Air Force's undergraduate pilot training (UPT) bases are located on the plains, including the only combined Euro-NATO joint jet-fighter training facility at Sheppard AFB, Texas. Other UPT bases include Vance AFB, Oklahoma, and Laughlin AFB, Texas. Only Columbus AFB, Mississippi, and Moody AFB, Georgia are located outside the Great Plains region. Unfortunately, the scarcity of rainfall in the region often exacerbated environmental damage. Low rainfall rates resulted in comparatively few flowing rivers. Within the more than 2,000 miles between the Mexican and Canadian borders, only four major river systems—the Rio Grande, Arkansas, Platte, and Missouri—travel all the way from their source in the Rockies to the Gulf of Mexico. Much of the region west of the 100th meridian averages less than 20 inches (50 centimeters) of rain annually, making residents highly dependent upon subterranean groundwater, a source especially vulnerable to contamination. In addition, the relatively low flow rate in some of these rivers makes it difficult to adequately dilute pollutants discharged into them. All of these factors worsened environmental damage, especially the pollution of surface and groundwater.

Production Facilities

In May 1940, President Roosevelt, in response to events overseas and lobbying by Army Air Corps leaders, ordered the expansion of the aircraft industry to permit production of 50,000 planes per year.[7] Military production had totaled only 2,195 planes in 1939.[8] To achieve this incredible increase in production, owners of existing factories in Baltimore, Long Island, Buffalo, Long Beach, and Seattle had to expand their facilities. But it soon became clear that the increased capacity at existing sites would be insufficient. The War Department began to contract with manufacturers to operate new production facilities that the government would build and then lease to them. The War Department decided to locate many of these new facilities on or near the Great Plains. These new factories eventually contributed a substantial portion of many of the more common types of aircraft employed by US and Allied air forces during the war (table 1).

It is difficult to assess the environmental impact of many of these facilities. In most cases the plants ceased production after the war but were occupied by other activities under war reutilization programs.

Table 1: Aircraft types produced on the Great Plains

Type Facility	Number Produced	Percent of Total Production
Heavy Bombers		
B-24		
Consolidated–Fort Worth	2,743	
Douglas–Tulsa	964	
North American–Dallas	966	
Total	4,673	24.3 percent (4,673/19,204)
B-29		
Martin–Omaha	515	
Boeing–Wichita	1,595	
Total	2,110	54.1 percent (2,110/3,898)
Medium Bombers		
B-25		
North American–Kansas City	6,608	67.3 percent (6,608/9,816)
B-26	1,585	30.7 percent (1,585/5,157)
Martin–Omaha		
Transport Aircraft		
C-47		
Douglas–Oklahoma City	5,319	51.3 percent (5,319/10,368)
Pursuit Aircraft		
P-51		
North American–Dallas	4,552	31.0 percent (4,552/14,686)
Trainer Aircraft (All Types)		
Boeing, Beech, and Cessna–Wichita	20,628	37.0 percent (20,628/55,712)

Adapted from Irving Holley, Jr., *Buying Aircraft: Materiel Procurement for the Army Air Forces* (Washington, DC: Office of the Chief of Military History, 1964), appendix B, 576–79.

For example, the Douglas plant in Oklahoma City is currently occupied by Tinker AFB. Omaha's Martin plant became the site of Offutt AFB, home to Strategic Air Command (SAC) headquarters during the Cold War. In 1948 the US government sold the North American plant in Kansas City to General Motors to produce automobiles for their Chevrolet and Pontiac lines.

Of all the new production facilities erected on the plains, only one has remained in continuous production. The Lockheed-Martin facility near Fort Worth, known as "Air Force Plant 4," is also the only WWII-era plant to be listed on the Environmental Protection Agency's (EPA) National Priority List (NPL). The NPL, or "Superfund" list, is a collection of the most heavily contaminated sites in the country. Listing a site allows the EPA to establish and implement appropriate cleanup plans.[9] At the Fort Worth plant, aggressive programs to pump groundwater contaminated with trichloroethylene (TCE), a known carcinogen, through filtration plants have, according to the EPA, reduced the threat to 13,000 residents, including those nearby at the former Carswell AFB. However, the EPA has detected contaminants in several underground aquifers above the main aquifer used for drinking water in the area.[10] The facility produced over 2,000 B-24s during WWII and has been in continuous use since, producing B-36, B-58, F-111, and F-16 aircraft and components for F-22 aircraft types. The similarity of pollutants used during these various periods makes it difficult to determine exactly when the most serious damage occurred.

Airframe production is only one of the required steps in a successful sortie launch. The completed airframe must be fueled and armed before it is ready for a crew. While it is beyond the scope of this study to examine the significant environmental repercussions of petroleum extraction and refinement in the United States, it is sufficient to note that a large percentage of Allied petroleum resources, including 90 percent of all 100-octane aviation fuels, came from US wells and refineries, some of which were located on the southern plains. Through the Defense Plant Corporation, the US government built and leased refineries across the nation, including several in the region. By 1945 American refineries were producing 514,000 barrels a day of 100-octane aviation fuel, up from 40,000 barrels per day in 1940.[11]

The Army Ordnance Corps established and operated munitions production plants in several Great Plains states. A number of these facilities are now on the EPA's Superfund list, including the Rocky Mountain Arsenal, near Denver; the Kansas Army Ammunition Plant (AAP); Cornhusker AAP in Nebraska; and the Lone Star and Longhorn AAPs in Texas. All of these facilities opened during WWII, and several remained in operation during subsequent conflicts. All eventually left their mark on the environment.

The Cornhusker AAP, near Grand Island, Nebraska, is a classic case of the unintended consequences of wartime production methods.

Built in 1942, the facility produced 330,562 1,000-pound bombs, 20,698 2,000-pound bombs, and 1.5 million 260-pound fragmentation bombs, in addition to 11,476,545 105-millimeter artillery shells during the war.[12] The DOD inactivated the facility after the war but reactivated it during the conflicts in Korea and Vietnam before finally closing it permanently. In preparing the site for sale, the Army "did extensive clean up on the plant itself, but a trail of contaminated water outside the boundaries complicated efforts to transfer the facility."[13]

The Cornhusker AAP offers a stark reminder of the lingering costs to communities that hosted production and training facilities during WWII. Toxic chemicals from the facility were held in 56 different earthen impoundments across the 19-square-mile site, the EPA said. "Releases from the surface impoundments have contaminated approximately 500 private wells," and "polluted groundwater has migrated off the site and has been detected as far as 7 miles beyond the plant's border."[14] Perhaps encouraged by the potential sale of the site, the Army Corps of Engineers has embarked on an aggressive cleanup program, excavating and incinerating contaminated soil and extracting and pumping contaminated groundwater through a filtration system before returning it to the ground. The EPA estimates that this action has shrunk the offsite contamination plume and that it will be "below cleanup levels" in three to five years.[15]

The remediation programs came too late for one Grand Island resident. In 1978 Chuck Carpenter, a junior high school science teacher, bought a home in the Le Heights section of Grand Island. In 1982 the *Grand Island Independent* reported that the Army had detected a highly toxic explosive compound known as "RDX" in the facility's groundwater but assured residents that it would take "over a century" for the contaminants to reach the town. RDX is a unique compound used exclusively in the manufacture of military explosives, linking it definitively to the ammunition plant. Later investigations revealed that the plume of contaminants was moving at a rate of "three meters per day" and would reach the town in "just four years."[16] As early as 1980, the Army became aware of the contamination and that it was migrating across the installation boundary. The Army released no information to the public for four years, while conducting tests and collecting information. In 1984 Army officials finally acknowledged that "more than half of the 467 private wells" in sections of Grand Island, including Le Heights, had "extremely elevated levels of RDX."[17] Concerned about his family's health but unable to sell a

home that had lost two-thirds of its value, Carpenter abandoned his home and declared bankruptcy. The Army refused to provide any compensation, alleging that the chemicals were released prior to the Korean War, when dumping was "legally permissible."[18] The Army eventually agreed to pay to connect residents to a city water supply but has not addressed the collapse in property value as a result of pollutants discharged from the facility.

The Air Force's primary mission during the Cold War was not delivery of conventional munitions in case of a conflict with the Soviet Union. Air Force bombers, missiles crews, and tactical fighters sat on nuclear alert, ready to launch atomic weapons at a moment's notice. But in his analysis of environmental damage in Japan during WWII, William Tsutsui noted that "plant and animal life seem to have been relatively unaffected by the bombs." Further, "the atomic bombs—like the incendiary attacks—were tremendously and tragically destructive for one species: *Homo sapiens*. When viewed from a less anthropocentric viewpoint, however, the environmental implications of direct combat in Japan during World War II are far more ambiguous."[19] Even so, production and testing of these weapons left an enormous scar on the American landscape.

In 1992, Michele Gerber detailed the effects of radiological contamination that will linger for millennia at the Hanford Site in Washington State.[20] While this and other nuclear production facilities were operated by the DOE, the DOD was a primary customer. The damage inflicted at these sites must be included in the cost of waging aerial warfare, even in a deterrence role, during the latter half of the twentieth century.

Bombing and Gunnery Ranges

In addition to manufacturing facilities, which left behind a toxic legacy, the military impacted the environment by locating large numbers of training facilities across the plains. Kansas supported 16 different Army airfields, up from only two during the prewar period.[21] These fields were used for training, from primary flight training to processing crews for overseas movement. Four of the bases—Great Bend, Pratt, Smoky Hill, and Walker—were dedicated to training B-29 crews. The new bomber required large ranges for both gunnery and bombardment training. Fortunately for the USAAF, sparsely popu-

lated areas of western Kansas were ideally suited for this purpose. The Army established three gunnery ranges in Ellis, Ness, and Gove Counties and three bomb ranges in Trego and Graham Counties. The Gove County range covered 218,880 acres and displaced 150 farm families. Local farmers were not always happy with the compensation provided and petitioned their elected officials in an unsuccessful attempt to seek redress.[22]

In addition to the hazard from aircraft straying off the range, training exercises occasionally set prairie fires that quickly spread to neighboring ranches, threatening livestock and buildings.[23] One west Kansas resident, E. J. Montgomery, wrote his senator to complain. "The planes do not stay in their range, the bullets pass over my place and I live four miles from the range."[24] The Oakley newspaper rationalized: "It is unpleasant that many people will be temporarily ejected from their homes, especially after the struggle of the dust years to regain financial independence, but such conditions exist when a nation is at war."[25]

The fire risk and loss of productive agricultural and grazing lands may have been responsible for the adoption of an area that did not require anyone to relocate. Farmers near Great Bend petitioned the Army to use Cheyenne Bottoms, a nearby 41,000-acre wetland, as a bombing and gunnery range during the war.[26] Cheyenne Bottoms has been described as the single most important wetland for migrating waterfowl and shorebirds between the Arctic tundra and the Gulf of Mexico.[27] Fortunately, the USAAF's use appears to have had little long-term negative effect. Despite the presence of spent projectiles and shell casings, a 1984 comprehensive survey of the wetlands found no excessive levels of heavy metals. The few areas with noticeable concentrations of lead in surface water had been heavily used by waterfowl hunters for years, and the appreciably lower levels in adjacent areas closed to hunting suggest that spent lead shotgun pellets were a far likelier source of contamination.[28]

After World War II, the newly independent Air Force sought to maintain bombing and gunnery ranges in Kansas to support the bases that remained open. The Army had operated Camp Phillips, an infantry training camp, on a 42,000-acre site near Salina and the Smoky Hill Army Airfield (AAF).[29] Recognizing the site's potential as a range, the Army retained control after the war rather than returning it to the original landowners, eventually transferring Camp Phillips to the Air Force. After Smoky Hill AAF closed in the 1960s, the Kan-

sas Air National Guard assumed control of the range and operates it as the Great Plains Joint Regional Training Center.[30] The range is covered by large expanses of native prairie grasses that are carefully managed by the range operators. Spraying for invasive species and controlled burns make it one of the most intensively managed tracts of native tallgrass prairies in the state. A 2007 study found that "the size and generally good condition of this largely unfragmented tallgrass prairie makes it a valuable reservoir of biological diversity for the Great Plains."[31] While the threat for contamination from unexploded ordnance remains, the intensive management demonstrates the potential for modern air forces to be good stewards of environmental resources. Had the military not retained control of Smoky Hill after WWII, it likely would have returned to agricultural production and become significantly less useful to many species of wildlife.[32]

Ranges in other areas are not as free from environmental damage as the Smoky Hill Range. The former Lowry AFB, located southeast of Denver, served as an aircrew-training center during WWII. The USAAF operated a 100-square-mile range in Arapahoe County southeast of Denver to support aircrew training for B-17, B-24, and B-29 crews. The range remained in operation through the Korean conflict before being closed in 1962. The DOD transferred large portions of the range to the state of Colorado and private landowners, but the presence of unexploded munitions required the Army Corps of Engineers to conduct an extensive site cleanup.[33] However, the most significant environmental damage on the range occurred on a portion transferred to the city of Denver in 1965 and used as a landfill for toxic chemicals. The "Lowry Landfill" has been designated as an EPA Superfund site due to the presence of metal plating wastes, industrial solvents, and radioactive wastes.[34]

So far I have focused only on USAAF production and training facilities. The US Navy also operated a number of facilities on the Great Plains, including a naval ammunition plant at Hastings, Nebraska, and primary flight training facilities in Olathe and Hutchinson, Kansas, and Norman, Oklahoma. However, the vast majority of naval aviation training occurred in coastal and marine environments, which often contain far more sensitive ecosystems. The more recent disputes over environmental damage at naval bombing and gunnery ranges on the islands of Vieques, Puerto Rico, and Kaho'olawe, Hawaii, demonstrate that the USAAF was comparatively fortunate to have a number of inland sites available for training. Some of those

sites may have even benefited from military use. As Edmund Russell and Richard Tucker have noted, "military bases have often been de facto nature preserves. By building up small areas while leaving most of the bases open for training and maneuvers, bases have sometimes created well-guarded sanctuaries for species." Russell and Tucker do not "argue that one should create bases and bombing ranges to preserve wildlife," but they note the "complex, surprising and often ironic ways in which war and nature interact."[35]

Operational and Maintenance Bases

In comparison with production and training facilities, the permanent bases established on the Great Plains proved to be the most intrusive and environmentally damaging facilities. While most lasted only as long as the war, those that remained released substantial quantities of toxic materials into the ground. Air bases in particular may be slightly more susceptible to this type of contamination than other facilities for several reasons. First, they require large quantities of potentially toxic liquids, most notably jet fuels, to accomplish their missions. These compounds are often stored in underground storage tanks (UST) to protect them from fragmenting explosives in case of attack and to reduce vertical obstructions in the airfield environment. Aboveground storage tanks could potentially intrude into the flight paths of landing and departing aircraft and also block instrument landing signals. Unfortunately, the burial of storage tanks makes it more difficult to detect leakage and failure, exacerbating the potential for release of toxic substances into the soil and groundwater.

Two Air Force facilities on the Great Plains have had significant issues with chemical release and groundwater contamination. Smoky Hill, later Schilling AFB, near Salina, Kansas, and Tinker AFB, near Oklahoma City, have released sufficient quantities of chemicals into the ground over the years to seriously threaten the water supplies of nearby residents. The most common pollutant is TCE, a persistent chemical. When first introduced as an industrial solvent, TCE quickly gained favor among maintenance specialists for its highly effective degreasing properties. Unfortunately, TCE is persistent in the environment and is a known carcinogen.[36] Even as early as 1942, the USAAF's field service section reminded users "the toxicity of this material and of all halogenated hydrocarbons generally is well known."[37]

Schilling and Tinker discharged sufficient quantities of TCE into the ground to pollute local aquifers, threatening drinking water supplies for on- and off-base residents. While current regulations prohibit the reckless discharge of TCE and other chemicals into the environment, decades of abuse have left a toxic legacy of varying severity at both sites.

Smoky Hill AAF was established in 1942 and served as a B-29 training, processing, and staging base during WWII. It remained in service after the war and in 1957 was renamed in honor of Col David C. Schilling, a native of Leavenworth, Kansas, who was killed in an auto accident in England. As a member of the 56th Fighter Group (Zemke's Wolfpack), Schilling amassed 33 "kills" during WWII. The SAC base hosted two bomb wings composed of B-47 bombers and KC-97 tankers.[38] In 1960 an Atlas-F missile wing was also headquartered at the base, with the actual missiles located at 12 dispersed sites across central Kansas. In November 1964 Air Force officials elected to close the base, surprising local officials who scrambled to find new occupants for the facility.[39] Today, the Salina Airport Authority operates the airfield as a municipal facility, while a number of commercial and educational enterprises also occupy the site, including the Salina Area Technical School and the campus of Kansas State University at Salina.

When the base closed, local officials were absorbed with preparing the site for new occupants. The thought of potential contamination was not a major consideration, despite a provision in the deed, which apparently absolved the US government of any liability for restoration or other damages.[40] Fortunately for the city, the Comprehensive Environmental Response, Compensation, and Liability Act, passed by Congress in December 1980 and later amended by the Superfund Amendments and Reauthorization Act of 1981, required the DOD to comply with all EPA guidelines, even at sites already transferred to the private sector. In 1986 the DOD established the Formerly Used Defense Sites program and placed it under the authority of the Army Corps of Engineers to assess environmental damage and engage in remediation activities. The corps has spent $3.9 billion on the program as of 2006 and estimates that it will take a total of $18.7 billion to complete remediation at the more than 4,600 sites in the program.[41] Later estimates raise this total to as high as $35 billion.

One of the main problems in addressing the issue is the number of new sites that continue to be added to the list. This was the case when the extent of Schilling AFB's contamination was first discovered in

the early 1990s. In 1993 the corps hired a contractor to complete a site investigation. Based on the results, the corps agreed to "remove or abandon in place" 107 USTs. Even this action required the Salina Airport Authority's cooperation, as the corps dug in its heels, stating that since "non-DOD parties used petroleum products at the former Air Force Base property following DOD ownership, the Corps does not intend to clean up petroleum in soils or groundwater as a separate contaminant unless it imposes imminent and substantial risk and has been identified as the sole responsibility of DOD."[42]

Discoveries of contaminated areas outside those originally tested in 1993 resulted in the corps conducting a second site investigation in 1998. The city of Salina disputed some of the findings in the second survey, only to be told that they "had no formal role in the process."[43] The city engaged with the EPA, which conducted an "expanded site investigation" that firmly tied source areas to DOD activities. In January 2006 the corps released a study of the TCE plume extending from under the base and determined that it would not reach the city's water wells for 75 years. Four months later, the corps was forced to admit it had made a mistake in its calculations and that the plume would reach the water wells serving the town's 45,679 residents in less than 10 years.[44]

Unlike Schilling, Tinker AFB continues as an active base today, despite its status as an EPA Superfund site. Established in 1942 at a cost of over $21 million, the base employed nearly 15,000 workers and served as a repair and modification center for the B-29 bomber.[45] It remained in active service after the war as one of five air logistics centers in the Air Force. As the Cold War began, the Air Force attempted to curtail some of the worst wartime excesses and address the pollution released from its facilities. By 1950 regulations required that "military authorities in the Continental United States will cooperate with civil authorities in preventing the pollution of surface or underground waters by sewage or industrial wastes from Air Force installations and activities."[46] Yet as late as 1984, Tinker was still discharging industrial waste into storm drains. In congressional testimony, the chief of the Water Quality Division of the Oklahoma Water Resources Board noted that "when the base was built, storm drains often legally carried industrial wastes. However, this practice is no longer acceptable."[47] Unfortunately, not all lines had been rerouted to collection tanks, and hazardous waste was still being discharged directly into local creeks. By December 1990 some local wells were so

badly contaminated that the base began supplying nearby residents with bottled water until they could be connected to municipal water supplies, which took place between September 1993 and May 1994.[48]

Conclusion

It is clear that the Air Force's infrastructure has inflicted considerable environmental damage on the Great Plains. In almost every case, the US government has acknowledged its role in the contamination. Legislation passed in the early 1980s has forced the DOD to participate in cleanup efforts, even at facilities no longer under DOD control. After a slow start, the Army Corps of Engineers now spends considerable time and effort in assessment and remediation programs, both at facilities on the plains and across the country. However, the impact will linger long after final cleanup efforts are complete. In most cases, the corps will be unable to remove all the pollutants, and some cleanup efforts will cease when testing reveals concentrations have dropped below levels considered dangerous to human health. Yet, the fact remains that the Air Force inflicted serious damage on the environment.

It should be noted that the environmental philosophy that permeated the service during the earlier period was not unique. Many private industries followed equally callous disposal policies during that era, and many have not been as engaged as the DOD in remediation efforts. The Army Air Forces had a vital mission during World War II, and the increases in efficiency and time must be weighed against the millions who suffered under despotic regimes that were toppled only by force. Some might argue that the Cold War presented an equal threat. The costs must be weighed against the benefits.

Still, the Army and the Air Force colluded in activities that threatened the health of residents near their bases. The question of acceptable endangerment leads down a path toward determining which lives are most worth protecting, with a consideration of both immediate and longer-term threats and orders of magnitude. Military forces have long operated under the concept of acceptable "casualty rates" and "collateral damage" and seem to be more comfortable with the idea that some must suffer so that many survive. Today, the service's tolerance for collateral and environmental damage is well below where it was 75 years ago. For example, current Air Force hazardous

materials regulations emphasize that individuals and commanders can be held personally liable for the release of pollutants at their bases. Yet, the legacy of years of reckless discharge will linger and continue to affect relations with host communities.

Having once clamored for military facilities as engines of economic development, the public is now far more wary of their presence. A recent attempt by the Army to expand its Pinyon Canyon maneuver area on the high plains of Colorado met widespread opposition from an odd coalition of antimilitary groups and more-conservative ranchers and landowners. Efforts to expand existing military facilities are often met with suspicion by local residents, whose trust has been compromised by efforts to disguise or delay notification of previous environmental threats. The current period of financial retrenchment and a shrinking share of the defense budget magnify the billions spent to remediate previous environmental damage. Perhaps there is no truer example that an ounce of prevention equals a pound of cure. Already, there is evidence that the current operating requirements reduce DOD cleanup expenditures and make it more difficult for state and federal regulatory agencies to compel compliance.[49] All of these factors impact current and future readiness and the Air Force's ability to accomplish its mission.

In this century, aerial weapons have demonstrated the ability to inflict devastating damage on remote battlefields. Yet, as William Cronon has observed in his work on nineteenth-century Chicago, "the ecological place of production (grows) ever more remote from the economic point of consumption, making it harder and harder to keep track of the true costs and consequences of any particular product."[50]

Certainly this is true for airpower. As the sites of employment expand further from the points of production, it is easy to lose sight of the true costs of developing and employing weapons from the sky. However, in any accounting of the impact of aerial warfare on the environment, these production costs, which sometimes far exceed those resulting from the weapon employment, must be included in the final tally.

Notes

1. White, *It's Your Misfortune*, 497. He notes that factors that had initially stalled development in the American West (remoteness, aridity, and low populations) all worked in its favor to attract defense activities during the war.

2. "Hundreds Mourn Family Killed in Marine Jet Crash," *San Diego Union-Tribune*, 11 December 2008. The utility of locating air bases away from population centers was recently demonstrated by a mishap involving a Marine F/A-18 aircraft that killed a family of four near MCAS Miramar.

3. Worster, *Dust Bowl.*

4. Miner, *Kansas*, 312.

5. Ibid., 312–13.

6. Hurt, *Great Plains during World War II*, 56.

7. Simonson, *History of the American Aircraft Industry*, 119.

8. Bilstein, *Enterprise of Flight*, 77.

9. Environmental Protection Agency (EPA), "What Is Superfund?"

10. EPA, "Current Status, Air Force Plant 4."

11. Yergin, *Prize*, 365.

12. Wit, "Social and Economic Impact," 153.

13. Ibid., 162.

14. EPA, "Cornhusker Army Ammunition Plant."

15. Ibid.

16. Shulman, *Threat at Home*, 74, 77.

17. Ibid., 78.

18. Ibid., 81.

19. Tsutsui, "Landscapes in the Dark Valley," 199.

20. Gerber, *On the Home Front*.

21. "US Army and Air Force Wings over Kansas," 129–57, 334–60. The prewar fields were the post airfields at Forts Leavenworth and Riley.

22. R. A. Fouts to Sen. Arthur Capper, letters, 20 July and 30 October 1943, "Gove County Gunnery Range" folder, Box 11, Arthur Capper Papers.

23. Hurt, *Great Plains*, 276.

24. E. J. Montgomery to Sen. Arthur Capper, letter. Capper Papers.

25. Undated, unidentified newspaper clipping, "Gove County Gunnery Range" folder, Box 11, Capper Papers.

26. McMullen to Sen. Arthur Capper, telegram, 13 November 1943, "Air Bases-Hays" folder, Box 1, Capper Papers.

27. Zimmerman, *Cheyenne Bottoms*.

28. Biological Survey, "Cheyenne Bottoms," 52.

29. 184th Bomb Group, *Cultural Legacy of the Smoky Hill Air National Guard Range*.

30. "Kansas Governor Hosts Ribbon Cutting," news release.

31. Busby et al. *Natural Features Inventory,* ix.

32. Ibid., 7, 253.

33. Colorado Department of Public Health and Environment, "Former Lowry Bombing and Gunnery Range."

34. Colorado Department of Public Health and Environment, "Lowry Landfill Site."

35. Tucker and Russell, *Natural Enemy,* 11.

36. US Department of Health and Human Services, "Fact Sheet."

37. US Army Air Forces, Field Service Section, Technical Bulletin, 25 March 1942, Schilling AFB Files, Kansas Department of Health and Environment, Topeka, KS.

38. "US Army and Air Force Wings over Kansas," 348–49.

39. Olson, "Salina's Response."

40. "Quitclaim Deed for Schilling Air Force Base," 465.
41. US Army Corps of Engineers, "Formerly Used Defense Sites Program."
42. "Fact Sheet," Kansas Department of Health and Environment.
43. "Schilling Air Force Base Project," 2.
44. "2000 Census: Corps Admits Miscalculation," *Salina Journal*, 5 May 2006.
45. Hurt, *Great Plains*, 243.
46. US Air Force Regulation 91–9.
47. US House, "Review of Hazardous Waste Cleanup," 89.
48. US Department of Health and Human Services, "Public Health Assessment, Tinker."
49. One source claims that between 2001 and 2004, the DOD cut its cleanup budget by 57 percent. "Cleanup Fights Stall," *USA Today*.
50. Cronon, *Nature's Metropolis*, 340.

attacked; and what are the collateral effects, the impact on the environment, and the law of war implications.

Modern warfare is destructive and has a significant impact on a nation. It requires not only balanced military forces that are organized, trained, and equipped to defend a state's national interests, but also economic infrastructures capable of supporting those forces. Economic infrastructures provide large, vulnerable targets susceptible to various types of enemy attacks. While some targets have little value, this is not the case with energy. Petroleum-based products will remain a viable world energy source for the foreseeable future. As of 1 January 2009, known global crude oil reserves were estimated between 1,184.2 and 1,342.2 billion barrels. World oil consumption has dropped sharply since the middle of 2008 in response to the global economic downturn and higher prices.[1]

Airpower Theory and Interwar Planning

Between the two world wars, military theorists from several nations advocated what they called "strategic" bombing as the logical and obvious way to employ aircraft. To the thinkers who emerged from the Great War and believed in the future of airpower, the strategic employment of its capabilities was considered the panacea that would avoid future senseless slaughters. A number of men arrived at these conclusions more or less independently. In Great Britain, Hugh Trenchard ("father of the Royal Air Force") was less of a theorist than the others, with his ideas limited in scope. Pierre Vauthier of France was the principal protagonist in that country, and the United States had Billy Mitchell.[2]

The first theoretical "prophet" of airpower was an Italian named Giulio Douhet, who published *Command of the Air* in 1921. The book was a fully developed theory of airpower and its potential. Douhet saw the airplane as the perfect offensive weapon with none of the limitations of ground or naval power. Based on his own positive and negative experiences in World War I, he concluded that the airplane was capable of inflicting overwhelming destruction. With the proper amount of airplanes appearing over an enemy's capital and industrial centers, chaos would occur and cause the immediate collapse of the enemy's government and industrial base. The bomber would always get through, because there was no effective defense against it. Douhet

stated empathically that "the fundamental principle of aerial warfare is this: to resign oneself to endure enemy aerial offensives in order to inflict the greatest possible offensives on the enemy."[3] He pointed out that his theory of war and employment of airpower, brutally conducted but concluded quickly, was far more humane than what had occurred in the world war. His proposals were hugely influential among airpower advocates, arguing that the air arm was the most important, powerful, and invulnerable part of any military. With Douhet, airpower had its first coherent theory. Air forces would no longer be considered auxiliaries and should be a nation's primary instrument of war.

In 1922 Douhet met the like-minded American airpower theorist Billy Mitchell on a visit to Europe, and soon an excerpted translation of Douhet's *Command of the Air* began to circulate in the US Air Service. Mitchell's book *Winged Defense* was published in 1925. In it he argues that airpower had become a main force in war instead of an auxiliary to the other services and would continue to be a dominating factor. In hindsight, Mitchell was more of a propagandist than a theorist, and his ideas were more limited in scope than those of others. As a result of Douhet's proposals, air forces allocated greater resources to their bomber squadrons than to their fighters. Prewar planners, on the whole, vastly overestimated the damage bombers could do and equally underestimated the resilience of civilian populations. Given the technological advances made during the 1920s and 1930s, the possibility of unlimited war continued to expand. During this period, little practical experience existed when it came to targeting national economic infrastructure. Serious thought on the subject was not considered until the late 1930s when the US Army Air Corps Tactical School (ACTS) and the British Air Ministry began to study the utility of targeting a nation's energy infrastructure, specifically the petroleum-based sector. The ACTS laid the foundation for economic analysis and industrial targeting while advocating a strategic airpower doctrine. Believing that a nation's ability to wage war was directly related to its ability to convert raw materials into weapons, strategic bombing of a nation's industrial base or economic infrastructure became the American approach.

At the same time, the British were also busy analyzing how best to destroy an adversary with airpower.[4] After a series of studies conducted during 1936, the British Industrial Intelligence Center recognized that targeting the oil industry was key. Therefore, the British

prioritized oil industry targets along with various other target sets in a series of 13 war plans known as the Western Area Plans (WAP), published on 1 October 1937. Particularly, WAPs 5 and 6 dealt with the oil industry. The latter was the basic plan to destroy the core of German fuel production and supply: 14 synthetic oil plants and as many major oil refineries. In 1939, the British Air Ministry directed a series of studies to locate the key points within critical sectors of the German economy.[5] British leaders sought target sets containing only a few targets whose destruction would have an immediate effect on the enemy's will to resist. To qualify, a target set had to be of major importance to a nation's military, be concentrated in a few locations, have no appreciable redundant capacity in or out of the country, and be incapable of quick repair or replacement or quick dispersal without loss of production.

At the heart of US doctrine as it entered World War II was the idea that the ultimate aim in war was to destroy the morale of the people. Planners believed that this objective could best be met by destroying vital links in the industrial economic structure that was already strained by the requirements of war. This approach assumed that adequate intelligence would be available on the location of these vital links and once attacked that they would not be restored for many months. Likewise, unescorted mass bomber formations would penetrate enemy defenses and destroy assigned targets.[6] Energy infrastructure was a prime target—specifically the petroleum industry. The rise of airpower made possible unprecedented violence on population centers, factories, and economic infrastructures.

Unlimited Warfare: World War II

During the course of World War II the petroleum-based sector was the primary target in a variety of warfare. On 22 February 1940, Sir Cyril Newall, chief of the British Air Staff, agreed that the Royal Air Force (RAF) Bomber Command should attack targets in accordance with WAP 6 if Germany invaded the Low Countries. By mid April 1940, the British became convinced that German refined petroleum stocks were desperately low and that any further reduction would force Germany into a crisis situation. Five days after the German invasion of the Low Countries in May 1940, Bomber Command began flying missions against Germany's petroleum-based energy

sector in the Ruhr Valley using WAP W. A. 4(c).[7] Great Britain's air offensive strategy continued to target the petroleum-based sector throughout most of 1940. In September 1940, the overly optimistic British chiefs of staff believed that Germany's refined oil stocks might be exhausted by June 1941.

In October 1940 a significant change occurred within the Air Ministry and Bomber Command. Bomber Command's Charles Portal replaced Newall as chief of the British Air Staff, and Sir Richard Peirse, an advocate of precision bombing, replaced Portal at Bomber Command. This had a massive impact upon the future of the bombing policy. Unlike Newall, Portal had firsthand experience in Bomber Command and knew its limitations far better. His views on its use were directly translated into an Air Ministry directive. The two principal objectives were now the oil plan and destruction of enemy morale.[8] Competing target sets and a lack of suitable long-range aircraft prevented realization of campaign objectives. Competing target sets in 1941 included German U-boats, U-boat construction yards and maintenance facilities, bombers, aircraft factories, and airfields. These target sets reflected the demands of the Battle of the Atlantic with German submarines and the Battle of Britain with the Luftwaffe.

The US Army War Plans Division submitted the first of the major target studies on 11 August 1941. Entitled *Munitions Requirements of the Army Air Forces*, it was commonly referred to as Air War Plans Division-1 (AWPD-1). This plan reflected ACTS doctrine that an air force should conduct precision aerial attacks against critical targets in an enemy's national economic structure to eliminate the ability to resist. Critical to the planning introduced in AWPD-1 was the disruption of German electrical power and transportation systems, destruction of petroleum systems, and, if necessary, the undermining of morale.[9] In the case of the petroleum-based sector, AWPD-1 planners identified German synthetic oil plants as high value or essential targets. At the time, synthetic oil plants were responsible for 60 percent of the German aviation gasoline (AVGAS) production. Eighty percent of the AVGAS was produced by 27 refineries located in western and central Germany about 1,000 miles from bases in England. These 27 refineries became the primary petroleum-based-sector targets for US bombers. Two minor plans—AWPD-4, *Air Estimate of the Situation and Recommendations for the Conduct of War*, and the Plan for the Initiation of Air Force Bombardment in the British Isles—listed oil as a priority target before the next major war plan, AWPD-42,

Requirements for Air Ascendancy, 1942, set responsibilities and revised targeting priorities.[10] AWPD-42, developed in the late summer of 1942, set forth the planning requirements for the number of combat aircraft required to achieve complete air superiority in Europe combined with the results of bombing efforts to date. The plan served as the basis for US Army Air Forces (USAAF) strategic planning. AWPD-42 also established a division of labor between the USAAF and the RAF bomber forces. The US Eighth Air Force pursued a precision daylight bombing campaign against critical elements of Germany's war economy. At night the RAF would continue its area-bombing offensive in an effort to break enemy morale.

Operation Chastise was the official name given the aerial attacks on German dams in the Ruhr Valley on 16 and 17 May 1943. Prior to the war, the industrial base of Germany had been identified by the British Air Ministry as an important strategic target, and the dams in that area were considered as particular targets. Besides electrical power, the dams provided water into the canal transport system. There were three primary targets for Operation Chastise—the Möhne, Sorpe, and Eder Dams—and three alternative targets—the Lister, Ennerpe, and Diemel Dams. The Möhne and Sorpe Dams controlled about 75 percent of the water supplied to the Ruhr basin. The Eder Dam regulated the flow of the Eder River, the principal tributary of the Weser River. It also provided electrical generating stations and a pumped storage station for power load equalization.[11] The tactics to attack the dams had been carefully considered, and analysis indicated that repeated strikes with large bombs would be effective in breaching them. RAF 617 Squadron, using a specially developed "bouncing bomb", carried out the raid. Nineteen Lancaster bombers took off to attack the targets. The raid was a success, despite the loss of eight aircraft and crews; the Möhne and Eder Dams were breached, causing a catastrophic flooding of the Ruhr Valley, while the Sorpe Dam sustained only minor damage.[12] Bomber Command conducted a bomb damage assessment as soon as possible using a photographic reconnaissance Spitfire from 542 Squadron, arriving over the Ruhr just after first light. The pilot, Flying Officer Frank Fray, described the experience:

> When I was about 150 miles from the Möhne Dam I could see the industrial haze over the Ruhr area and what appeared to be a cloud to the east. On flying closer I saw that what had seemed to be cloud was the sun shining on the floodwaters. I looked down into the deep valley which had seemed so peaceful

> three days before but now it was a wide torrent. The whole valley of the river was inundated with only patches of high ground and the tops of trees and church steeples showing above the flood. I was overcome by the immensity of it.[13]

Photographs taken of the breached dams showed floodwaters sweeping through the Ruhr valley, damaging factories, houses, and power stations; railway and road bridges disappeared. The raid disrupted water and electricity supplies in a key German war munitions manufacturing area. Secretary of State for Air, Sir Archibald Sinclair, called the raid "a trenchant blow for victory."[14]

The Combined Chiefs of Staff (CCS) directed that the strategic bombardment of Germany receive top priority, with the US Eighth Air Force flying from air bases in England, the US Fifteenth Air Force flying from air bases in the Mediterranean and Italy, and the RAF Bomber Command teamed to conduct the combined bomber offensive. Refined oil products became the fifth priority target set behind Germany's aircraft industry, submarine yards, transportation networks, and electrical power. The plan specified the complete destruction of 23 of 27 synthetic oil refineries and crude oil refineries in Romania, including Ploesti; the overall goal was a 47 percent reduction in refined oil products. To achieve these goals required accurate and current strategic intelligence. The CCS direction reaffirmed that requirement in support of air targeting, and the London-based Economic Objectives Unit of the US Office of Strategic Services provided part of the solution. Political considerations prevented formal prioritizing of the list of potential targets, but the top three target sets were fighter aircraft, ball bearings, and petroleum.[15]

The Ploesti refineries were targeted, beginning with a daring and costly low-level attack in August 1943. These attacks had only limited effects; oil deliveries increased until April 1944 when the attacks were resumed by the Fifteenth Air Force.[16] The Fifteenth Air Force was directed to execute four broad air campaigns against the Axis target sets: oil capabilities, air forces, communications, and ground forces. Most critical of the oil target sets were the refineries in Ploesti, which contributed about 30 percent of the entire Axis supply of oil and gasoline. One hundred and fifty German and Romanian fighters in addition to 250 heavy antiaircraft guns defended Ploesti. The Fifteenth Air Force, with the cooperation of RAF 205 Group bombers, began a series of raids on 5 April 1944, attacking the Ploesti refineries 19 times before the campaign ended on 19 August. USAAF and RAF bombers flew 5,287 sorties and dropped 12,870 tons of bombs. Ten

dive bombers, 39 escort fighters, and 237 heavy bombers—15 from the RAF—were lost; the results were good despite the losses.[17] At the end of the campaign the refineries were reduced to only 10 percent of their normal rate of activity. The average production rate was reduced by 60 percent from April to August.

In late August 1944, the Russian occupation eliminated this source of supply; dependence on the synthetic plants became even greater. Following the Ploesti raids, the USAAF and RAF dropped 10,000 tons of bombs on three synthetic oil plants in Silesia and one in Poland. By February 1945, their combined production was reduced to 20 percent of what it had been in June 1944.[18]

The petroleum-based energy sector did not receive significant attention from the Allied planners until May 1944. Previously, only about 1 percent of all Allied bombs dropped had targeted this sector. With the reduction of German airpower, oil became the priority target in the German economy. A preliminary attack was launched on 12 May 1944, with another on 28 May; the main blow was not struck until after D-day. The Germans viewed the attacks as catastrophic. Albert Speer, the minister of armaments and war production for the Third Reich, said,

> On that day the technological war was decided. Until then we had managed to produce approximately as many weapons as the armed forces needed, in spite of their considerable losses. But with the attack of nine hundred and thirty-five daylight bombers of the American Eighth Air Force upon several fuel plants in central and eastern Germany, a new era in the air war began. It meant the end of German armaments production.[19]

Synthetic oil production declined steadily, and by July 1944 every major plant had been hit. When the attacks began, these plants produced an average of 316,000 tons per month, but production fell to 107,000 tons in June and 17,000 tons in September. Output of AVGAS from synthetic plants dropped from 175,000 tons in April to 30,000 tons in July and 5,000 tons in September. Production recovered in November and December but was a fraction of pre-attack output for the rest of the war. The Germans took steps to repair and reconstruct the refineries, but synthetic oil refineries were vast, complex structures and could not be easily dispersed. Consumption of oil exceeded production from May 1944 until the end of the war. Accumulated stocks were rapidly used up and in six months were almost exhausted. The German armed forces sharply felt the loss of oil production.[20]

Programs of dispersal and underground construction were incomplete when the war ended.

Synthetic oil refineries returned to partial production in a remarkably short time but were attacked again. The IG Farben factory at Leuna, Germany's second-largest synthetic oil plant and second-biggest chemical operation, serves as an example of repetitive targeting. Leuna was protected by a highly effective smoke screen and the heaviest antiaircraft concentration in Europe. Aircrews viewed the Farben Leuna synthetic refinery as the most dangerous and difficult mission of the air campaign. Although it was attacked on 12 May and put out of production, postwar investigation of plant records and interrogation of Farben Leuna's officials established that several thousand men restored partial operation in about 10 days. The refinery was attacked again on 28 May but resumed partial production on 3 June and reached 75 percent of capacity in early July. The refinery resumed production two days after an attack on 7 July, reaching 53 percent of capacity on 19 July. An attack on 20 July shut the plant down again but only for three days; by 27 July production was back to 35 percent of capacity. Attacks throughout July, August, and September halted production, but it resumed on 14 October. The Farben facility at Leuna reached 28 percent of capacity by 20 November. Six more attacks in November and December were largely ineffective because of adverse weather. Production increased to 15 percent of capacity in January and remained at that level until near the end of the war. From the first attack to the war's end, production at Leuna averaged 9 percent of capacity.[21]

There were 22 attacks on Leuna—20 by the Eighth Air Force and two by the RAF. Due to the urgency of keeping this plant out of production, many missions were flown in difficult bombing weather. Consequently, bombing accuracy was not high compared with other targets. On clear days, only 29 percent of the bombs landed inside Farben Leuna's gates; on radar raids the number dropped to just over 5 percent. Allied crews flew a total of 6,552 bomber sorties against the plant and dropped 18,328 tons of bombs over an entire year.[22]

Except for isolated raids, the German power grid was not a priority target set during the war. This was partly due to the belief that it was highly developed and that losses in one area could be compensated by switching power from another. This assumption proved false in a postwar investigation conducted by the US Strategic Bombing Survey.[23] The German power grid was in a precarious condition from the outset

and became more unstable as the war progressed, as confirmed by statements of a large number of German officials, confidential memoranda of the National Load Dispatcher, and secret minutes of the Central Planning Committee. The destruction of five large generating stations in Germany would have caused a loss of 8 percent of the total capacity, both public and private. Destruction of 45 plants would have caused a capacity loss of almost 40 percent, and the destruction of 95 plants would have eliminated over 50 percent of the entire generating capacity of the country. The shortage was sufficiently critical that any significant loss of output would have directly affected essential war production. Generating and distribution facilities were relatively vulnerable, and their recuperation was difficult and time consuming.[24] Postwar evidence indicates that, had the power grid—electric generating plants and substations—been made a priority target set as soon as it became within range of Allied air attacks, the destruction would have had serious effects on Germany's war production.

Energy infrastructure was a vital target during World War II, and the effort's benefit was significant. Allied airpower was able to gain and maintain air superiority as Allied armies drove across Europe, overrunning the German war machine. Ultimately, the war offered numerous lessons that are still applicable today: the need for strategic intelligence; realization that doctrine is not a synonym for targeting; recognition that centers of gravity are not necessarily subject to attack; the need to anticipate the collateral effects of air attacks; and recognition that gaining air superiority is critical. The US Air Force exited World War II with the continued belief that the strategic bombing mission was the decisive military instrument of war.[25]

Limited Warfare: Vietnam

Whereas World War II was an unlimited war, Vietnam was a limited one. Four major characteristics of limited wars include (1) what is limited for one party may be total for another, (2) they may be costly and prolonged, (3) prolonged limited wars generally enjoy much less public support than other types of war, and (4) the duration and cost of war generally increases when limitations are imposed. As warfare becomes limited, the role of the energy-based sector and its associated products must change as well.[26] In true Clausewitzian fashion, it

was political and not military objectives that drove the air campaign against North Vietnam.

Air planners and strategists sought to weaken North Vietnam's will to resist by destroying its capability to fight. As a result, they chose what they thought to be key sources of military and economic power as primary targets. In an operation code-named Rolling Thunder, they used three targeting criteria: reduce North Vietnamese assistance from external sources; destroy war resources already in North Vietnam; and harass, disrupt, and impede the movement of men and materials to Laos and South Vietnam.[27] When Operation Rolling Thunder began on 2 March 1965, a majority of the energy-sector targets were off limits due to geographical constraints imposed by Pres. Lyndon Johnson on the Joint Chiefs of Staff (JCS) and air planners. When President Johnson expanded the war in the summer of 1965, the JCS sought to increase the use of airpower.[28]

In August 1965 a revised air campaign plan was submitted that called for attacks against military installations in Haiphong and Hon Gay, the mining of ports, and raids on transportation networks north of Hanoi. The plan encompassed further attacks on airfields, air defense sites, other military facilities in Hanoi, petroleum storage areas, electrical power stations, and the remaining industrial targets in Hanoi and Haiphong. The JCS's intent in targeting the petroleum infrastructure was to reduce North Vietnam's capability to provide transportation to the general population, impact the economy, and interdict the movement of supplies and troops south.[29] Due to conflicting political objectives, such as the need to end the war quickly and to prevent Russian involvement, senior Johnson administration policy makers did not back the JCS. As a result, US aircrews attacked only 126 of the 240 proposed targets by the end of October 1965. Of the remaining 114 targets, 104 were in areas that were geographically constrained.[30]

The following month, senior US defense officials recommended an evolving five-month air campaign that would conclude with attacks on the petroleum infrastructure and the mining of Haiphong harbor. The JCS called for an immediate acceleration in scale, scope, and intensity of the bombing, beginning with airstrikes against the petroleum target sets. They assumed that if the supply of petroleum products could be eliminated, the flow of supplies, materiel, and troops would slow, or stop, causing the insurgency in South Vietnam to wither away.[31]

The fact that North Vietnam possessed no oil fields or refineries and imported 170,000 metric tons of fuel in 1965, mostly through Haiphong, supported the JCS case. The Haiphong tank farms, apparently the critical link in the system, held about 72,000 metric tons. Ninety-seven percent of North Vietnam's petroleum storage capacity could be found in 13 sites, of which four had already been destroyed. The JCS believed that destruction of the Haiphong tank farm, combined with eight other major storage areas, would cause more damage than an attack on any other single target set.[32] However, intelligence indicated that numerous small petroleum storage sites and drum storage capabilities were beginning to appear. If the energy sector were to be a suitable target, timing was critical to interdict the supply system.[33]

It was not until the winter of 1965–66 that support for airstrikes began to grow. President Johnson authorized attacks against six small petroleum storage facilities in lightly populated areas at the end of May 1966. By mid June, the president's advisors convinced him to authorize airstrikes against the remaining energy-sector targets, including the storage facilities in Hanoi and Haiphong. Resumption of the airstrikes began on 29 June 1966 and continued through August. While 70 percent of their petroleum bulk storage had been destroyed, the North Vietnamese still possessed a significant amount of reserve storage, mostly in areas that were off limits inside of North Vietnam.[34] As the summer wore on, North Vietnam continued to import petroleum products that were dispersed at small storage sites in quantities sufficient to meet wartime requirements.

According to the Defense Intelligence Agency, the invulnerability of the dispersed petroleum infrastructure meant an increased cost in munitions, fuel, and loss of aircraft and aircrew. The end of airstrikes against the petroleum infrastructure came on 30 August 1966 when the Jason Summer Study was released; 47 top US scientists stated that North Vietnam was a subsistence agricultural economy that presented a difficult, challenging, and unrewarding array of target sets to be attacked by airpower. This study estimated that only 5 percent of North Vietnam's fuel requirements were required for logistics flow to the South, suggesting the air campaign could not possibly achieve its goal.[35] By the fall of 1966, US military and civilian leaders had given up any expectation of the North Vietnamese energy infrastructure being the critical link in maintaining its military and economy. Subsequently, they shifted their attention to other industries. Six years

later, a short but intense air campaign ended US participation in this limited war.

Overall, the US attempt to destroy North Vietnam's energy infrastructure can be defined as a strategic failure. Planners had overestimated the North's dependence on the port facilities at Haiphong. After airstrikes destroyed the dock facilities, tankers simply offloaded their cargoes into waiting barges, which dispersed the petroleum products among concealed storage sites along waterways. When bulk distribution became a challenge, the North Vietnamese simply switched to drums, making distribution easier, faster, and more efficient. Simple innovation reduced their reliance upon vulnerable storage and distribution facilities.[36]

Why did air planners target the energy infrastructure—specifically, the petroleum sector—if it was not essential? The answer is simple: they were guilty of mirror imaging. What worked in World War II was expected to work in Vietnam. Even if the air planners were able to overcome mirror imaging, they lacked accurate and timely strategic intelligence to support targeting.[37] The US intelligence community was focused on the Soviet Union, basically ignoring the rest of the world. Furthermore, the air planners were unprepared for limited warfare, failed to analyze properly the enemy, and had to deal with the issue of sanctuary.

By definition, a sanctuary is a "place of refuge or protection for someone who is being chased or hunted" and is a self-imposed restraint.[38] North Vietnam enjoyed the benefits of sanctuary in China. The United States also recognized certain areas within North Vietnam as being off limits in an effort to keep hostilities from escalating into unlimited warfare. Communist forces, lines of communication, and the limited petroleum industry were able to operate in a safe environment, while the targeting and destruction of the energy-based sector became more difficult and less efficient. The only way to have eliminated or marginalized the petroleum industrial base would have been to interdict it before it arrived for end use.[39]

The Gulf War

The bombing of Iraq during the Gulf War, described at the time as an air campaign against Iraq's offensive military capabilities, was broader in its intent and target selection. During the 43-day air cam-

paign, the United States and its allies sought to achieve some of their strategic objectives by targeting the Iraqi society. The air campaign was not aimed solely at Iraq's military, but included targets that were bombed primarily to create a potential postwar leverage over the Iraqi leadership rather than to influence the course of the war itself. The planners sought to damage or destroy key infrastructure that could not be repaired or rebuilt without foreign assistance. They selected a number of targets with the expectation that bombing them would amplify the impact of international economic sanctions on the Iraqi society, compelling Saddam Hussein to withdraw Iraqi forces from Kuwait to avoid a ground campaign.

Preliminary planning for an air campaign based on 27 strategic Iraqi targets in a notional "Southwest Asia contingency" plan began five days after Iraq invaded Kuwait. Revisions added additional targets, and when the air campaign began on 17 January 1991, the list included slightly more than 400 targets concentrated in an area between the Tigris and Euphrates Rivers. Additional intelligence gathered after the war began and additional bombing capabilities expanded the target list to over 700 targets. The targets were divided into 12 sets: leadership; command, control, and communications; air defense; airfields; nuclear, biological, and chemical weapons; railroads and bridges; Scud missiles; conventional military production and storage facilities; oil facilities; electricity; naval ports; and Republican Guard forces.[40] The majority of these target sets directly linked to Iraqi offensive military capabilities, but two categories—electrical and oil facilities—had a long-term impact on the Iraqi populace.

Of the more than 700 targets on the expanded list, 28 were identified as key nodes of the electrical power grid. The United States and its allies flew 215 sorties against the electrical infrastructure using unguided bombs, cruise missiles, and laser-guided bombs. At least nine targets were transformers, each estimated to take a year to repair. Other targets included main generator halls, with an estimated five-year repair time. Between the sixth and seventh days of the air campaign, the Iraqis shut down what remained of their national electrical power grid. By the end of the war, 17 of 20 Iraqi generating plants were damaged or destroyed; 11 were determined to be total losses. Within four months of the war's end, Iraq's electrical power grid had reached only 20 to 25 percent of its prewar capacity of 9,000 to 9,500 megawatts, roughly its 1920 generating capacity before reliance on refrigeration and sewage treatment became widespread.[41]

Bombing some of the electrical facilities did reinforce other strategic goals while weakening air defenses and communications between Baghdad and its field army.

Attacks on Iraqi oil facilities resulted in a similar combination of military and civilian effects. Coalition air forces dropped an estimated 1,200 tons of explosives in 518 sorties flown against 28 oil infrastructure targets.[42] The planners intended to obtain complete cessation of refining capability without damaging or destroying most of Iraq's crude oil industrial base. They believed the lack of refined petroleum products would deprive the Iraqi military of its ability to maneuver. Among the oil facilities targeted were major storage tanks, gas and oil separators, distilling towers, and pipelines. The target set included the major K2 pipeline junction near Baiji connecting the northern Iraq oil fields, an export pipeline to Turkey, and a reversible north-south pipeline inside Iraq.[43] All three of Iraq's large, modern refineries—the 110,000 barrel-a-day Daura facility outside Baghdad, the 150,000 barrel-a-day Basrah refinery, and the 300,000 barrel-a-day Baiji facility in northern Iraq—were attacked.[44] The Daura and Basra refineries were badly damaged early in the air campaign; the Baiji refinery was not bombed until its final days.

In a potentially protracted war, destroying Iraq's ability to refine oil and produce ammunition, as well as its stockpiled reserves, made sense. At the same time, US Air Force planners sought only to damage temporarily Iraq's economic infrastructure by precisely targeting easy-to-replace elements of key facilities rather than destroying those facilities outright. These plans were thwarted by the military community's deeply ingrained standard operating procedures. Wary of underestimating Iraq, air planners inflicted massive damage on the country's economic infrastructure. The Gulf War also highlighted the unforeseen consequences of disrupting the highly interconnected critical infrastructure of a modern industrialized country. Attacks on dual-use power facilities caused cascading damage throughout the water purification and sanitation systems, exacerbating a public health crisis.[45]

The United States and its allies, using unguided bombs, cruise missiles, and precision-guided munitions, hit the targets they intended to hit: electrical facilities, oil refineries, and the sustaining distribution networks. For the US Air Force, the Gulf War demonstrated what airpower strategists and proponents had argued since Billy Mitchell published *Winged Defense* in 1925: airplanes could defeat an

enemy by flying over its defensive perimeter and directly attacking its economic, energy, and military cores. This war also showed why the indirect effects of airpower must be planned in the same level of detail as the direct ones.

In the years following the Gulf War, these lessons were rapidly incorporated into targeting policy. During the four-day Operation Desert Fox in December 1998, air planners focused strikes on command, control, and intelligence targets rather than on dual-use infrastructure. They destroyed numerous Ba'ath security, intelligence, and military targets while sparing power and telephone systems. The sole energy infrastructure target, authorized after hard bargaining by planners, was an oil refinery linked to smuggling. It was temporarily crippled in a strike that disabled the site for six months while minimizing pollution. US Army attack helicopters played an important role in the plan for Desert Fox and the deployments and contingency plans that preceded it, such as Desert Thunder in January 1998. Five months after Desert Fox, new types of munitions were used during Operation Allied Force to disable Serbian electrical networks, greatly reducing permanent damage.[46]

Iraq in 2003

The Iraqi military had been greatly reduced by early 2003. The operational problem was how to overcome quickly a static Iraqi defense to support a high-intensity ground war beginning almost simultaneously with an air campaign. In such a situation, slowly maturing attacks on Iraqi dual-use industrial infrastructure would not be particularly useful from a military point of view.[47] US leaders, policy makers, strategists, and planners recognized that targeting certain forms of economic and energy infrastructure causes more disruption to civilians than to the enemy military and reduces the risk to allied forces. Moreover, such attacks may cause collateral damage, a particularly sensitive issue given the uncertain US mandate for war. Air attacks against dual-use facilities were automatically assumed to cause collateral damage and required special authorization to be included in the target sets.

When Saddam refused to abdicate power and leave Iraq in 2003, US and coalition forces launched an attack on the morning of 20 March. US aircraft dropped several precision-guided bombs on a

bunker complex where the Iraqi president was believed to be meeting with senior staff. This was followed by a series of air and cruise missile strikes directed against government and military installations. US and coalition forces invaded Iraq from Kuwait in the south and from the sea. In southern Iraq, US forces advancing northward faced the greatest resistance from irregular groups of Ba'ath Party supporters known as Saddam's Fedayeen. British forces, deployed around the southern city of Al-Basrah, faced similar resistance from paramilitary and irregular fighters. Despite fears that Iraqi forces would engage in a scorched-earth policy, destroying bridges, dams, critical infrastructure, and setting fire to Iraq's southern oil wells, retreating Iraqi forces did little damage. In fact, large numbers of Iraqi troops simply chose not to resist the advance of coalition forces. Securing the oil infrastructure was very important to mitigate damage done at the end of the Gulf War. While retreating from Kuwait, the Iraqi army set numerous oil wells on fire in an attempt to disguise troop movements and distract coalition forces. Prior to the 2003 invasion, Iraqi forces mined some 400 oil wells around Basrah and the Al-Faw peninsula with explosives.

Coalition forces launched an air and amphibious assault on the Al-Faw peninsula on 20 March to secure the oil fields. Warships of the UK Royal Navy, Navy of the Republic of Poland, and Royal Australian Navy supported the amphibious assault. The US 15th Marine Expeditionary Unit, a special forces unit of the Republic of Poland, and the UK Royal Marines 3 Commando Brigade attacked and captured the port facilities of Umm Qasr and Az Zubayr to destroy Iraqi resistance and enable follow-on humanitarian assistance. They encountered heavy resistance by Iraqi troops. Meanwhile the British Army's 16 Air Assault Brigade secured the oil fields in southern Iraq while Polish commandos and Navy SEALs captured offshore oil platforms, preventing their destruction. Despite the rapid advance of the invasion ground forces, about 44 oil wells were destroyed and set ablaze by Iraqi explosives or by incidental fire.[48] Coalition forces quickly capped the wells and extinguished the fires, preventing the ecological damage and loss of oil production capacity that occurred at the end of the first Gulf War. The swift invasion led to collapse of the Iraqi government and its military forces in about three weeks, allowing coalition forces to seize and secure the Iraqi oil infrastructure with only limited damage.

Final Analysis and a Look to the Future

When fighting an unlimited war requiring years of combat to defeat an enemy, destroying the enemy's energy infrastructure makes sense. Such targeting may be inappropriate in a limited war against a nation where the populace is not free to alter its leadership. In either type of warfare, the energy infrastructure is targeted because the nation and its citizens heavily depend on it. Strategists and planners will continue to see the energy target sets as leveraged. From a military perspective, electricity is indispensable and impossible to stockpile. Damaging or destroying removes the supply immediately, and backup sources are neither powerful nor reliable enough to replace the lost facilities. Targeting lessons learned during previous wars are still being applied and include the need to

- ask if energy is always a primary target,
- question if only certain aircraft or platforms can attack certain targets,
- obtain effective and actionable intelligence at both the tactical and strategic levels,
- consider the potential postwar impacts or ramifications of targeting energy infrastructure,
- and prepare to plan around or address the presence of sanctuaries.

In planning for the future, one logically seeks to use past experience combined with current intelligence. This study of targeting energy infrastructure is no different. This strategy is probably recognized as useful in an unlimited war but one may question its effectiveness during a limited war.

Petroleum-based energy is not likely to be replaced by any alternative energy sources for military use in the short term. Cost will not be the limiting factor, but rather the lack of a developed industrial base to sustain the alternative energy sources. Given the varying utility of targeting energy in past conflicts, will it remain a valid target in the future? The answer is an overwhelming yes. As the Gulf War and Iraq in 2003 have demonstrated, energy will remain a critical target in future conflicts. Since time is of the essence in limited warfare, it makes sense to target selected energy infrastructure. However, leaders

and planners must not overlook the possibility of a protracted war that becomes unlimited. To meet these conditions, a flexible targeting methodology must be used to achieve immediate or long-term effects as required. That methodology would be to first strike military tactical targets for immediate effect and then strike critical elements of the energy supply chain. The sources for energy products should only be struck last, should the need arise. Retired US Army colonel Douglas A. Macgregor sums up the implications for future policy makers, commanders, strategists, and planners:

> Senior officers on the operational level are central to the drama that translates strategic goals into tactical action. They must not only constantly link the strategic and tactical levels but comprehend the actions of their opponents in a similar context. How they interpret missions and employ their forces dominates operations.[49]

When discussing warfare, most people tend to think of force on force, soldier against soldier. Employing airpower against multiple target sets that include the energy infrastructure attacks everything that allows a nation to sustain itself. Understanding historical precedents is important in the success of any future targeting strategy, including that of a nation's energy infrastructure. While a number of conflicts are available for study, World War II, Vietnam, the Gulf War, and Iraq in 2003 offer the best perspectives. In World War II, the Allies fought an unlimited war against Germany and Japan. In Vietnam, limited warfare had become the practice with the goal of avoiding unlimited warfare. Energy targeting in past wars has taught many lessons that are applicable today.

- Strategic intelligence is a must.
- Doctrine is not a synonym for targeting.
- The risk of mirror imaging is a constant threat.
- The ability to gain air superiority is critical.
- Centers of gravity are not necessarily subject to attack.
- The indirect effects of airpower must be planned in the same level of detail as the direct ones.
- A plan must be developed to attenuate sanctuaries.

The fact remains that a nation's energy sector is an extremely suitable target set today and in the future. Given current and future technological developments, it is possible to identify, target, interdict, seize,

and, when required, destroy the critical components of a nation's energy infrastructure, greatly enhancing the probability of victory.

Notes

1. US Energy Information Administration (EIA), *Short-Term Energy Outlook*.
2. Stokesbury, *Short History of Air Power*, 126.
3. Ibid., 172.
4. Wuesthoff, "Utility of Targeting," 3–4.
5. Ibid., 4.
6. McMullen, "United States Strategic Bombing," 16.
7. Wuesthoff, "Utility of Targeting," 4.
8. University of Leeds, *British Strategic Bombing*, 39.
9. Wuesthoff, "Utility of Targeting," 4–5.
10. Ibid., 5.
11. T. Jones, *617 Squadron Operational Record Book 1943–1945*, AIR 8/1238: Air Chief Marshall Charles Portal to Gen Sir Alan Brooke, letter, 27 March 1943, 11–14.
12. Ibid., AIR 27/2128, 20–21.
13. Foggo and Burke, "I Captured Proof."
14. British Broadcasting Corporation, "1943: RAF Raid Smashes German Dams."
15. Wuesthoff, "Utility of Targeting," 5–6.
16. *United States Strategic Bombing Surveys*, 21.
17. Skelly, "References to Ploesti."
18. Ibid.
19. McMullen, "United States Strategic Bombing," 26.
20. *United States Strategic Bombing Surveys*, 21–23.
21. Ibid., 22.
22. Ibid., 22–23.
23. Ibid., 33.
24. Ibid., 33–34.
25. McMullen, "United States Strategic Bombing," 41.
26. Wuesthoff, "Utility of Targeting," 11.
27. Ibid., 33–34.
28. Clodfelter, *Limits of Airpower*, 85.
29. Ibid., 88.
30. Wuesthoff, "Utility of Targeting," 12.
31. Clodfelter, *Limits of Airpower*, 90.
32. Gravel, *Pentagon Papers*, vol. 4, 60.
33. Ibid.
34. Ibid., 109.
35. Ibid., 109–20.
36. Gravel, *Pentagon Papers*, vol. 3, 111.
37. Gravel, *Pentagon Papers*, vol. 4, 109–11.
38. *American Heritage Dictionary*.
39. Wuesthoff, "Utility of Targeting," 15–16.
40. Gellman, "Allied Air War."

41. Ibid.
42. Ibid.
43. Ibid.
44. EIA, *Iraq Energy Data*.
45. Knights, "Infrastructure Targeting."
46. Ibid.; and Mason, "US Army Apache Helicopters," 7.
47. Knights, "Infrastructure Targeting."
48. Dao, "Nation at War: Commandos"; Dao, "Nation at War: Navy Special Warfare Group"; Klare, "Oil War"; and "Battle for Al Faw."
49. Macgregor, "Command and Control," 32.

the country's agriculture. Then, after the Soviet defeat, the Taliban's "fundamental neglect of economic development" caused further damage.[2] The Afghan environment was also badly injured during these years. Environmental degradation is a serious problem because of Afghanistan's reliance on agriculture. About 70 percent of Afghans' foodstuff and most of the country's licit gross domestic product comes from agriculture despite having only 12 percent arable land.[3]

Environmental Problems

The two most significant environmental problems are an enormous number of landmines and a pervasive water shortage. The Soviet invaders mined orchards and fields, effectively closing fertile land to cultivation and considerably reducing the amount of arable land.[4] Author and international development consultant Joel Hafvenstein noted, "Afghanistan as a whole was one of the most heavily mined countries on earth. The United Nations guessed it would take a decade just to clear the most dangerous areas."[5] Mine removal has proceeded slowly. Many main roads are not yet cleared; rural fields are even less safe. The presence of so many landmines sharply reduces not only the amount of land available for cultivation, but also the ability of farmers to get products to market.

Lack of water also handicaps Afghanistan's licit agriculture. The Soviet war, combined with a devastating multiyear drought, wreaked havoc. Many irrigation systems destroyed during the war have not been rebuilt. Much of the land is too dry for crops such as cotton and wheat. These stresses on the soil helped start a cycle of desiccation and soil loss. Fruit trees that had not been shattered during the war died from lack of water, either because of the ruined irrigation systems or because of the drought itself. This die-off, in turn, led to erosion of the remaining soil.[6] For an economy dependent on agriculture, the extent of environmental damage from mines and lack of water has been an enormous handicap.

In the midst of these economic and environmental difficulties, one crop has flourished: the opium poppy (*Papaver somniforum*). In some ways, opium is the best of all environmental and economic crops. Being easy to grow, transport, store, and monetize makes it an attractive crop for farmers and buyers. Hafvenstein asks, not entirely rhetorically, "How do you convince a farmer to give up the perfect crop?"[7]

This question needs to be answered to eradicate or even significantly reduce the poppy trade in Afghanistan.

Poppy Cultivation

The environment of Afghanistan is very hospitable for poppies, making them relatively easy to grow and highly productive. "Afghanistan's soils, climate, and altitude have also made its poppy cultivation more productive than is cultivation in other major opium-producing regions."[8] Poppies do not require much fertile soil or irrigation, which makes them well suited for present-day Afghanistan. With so much soil off limits because of mines, and the remaining land often arid, a plant that is not particularly finicky can become very attractive.

To grow poppies, farmers need almost no initial investment. Fertilizer may improve yields, but only a supply of seeds is necessary for a poppy field. In contrast, "legal agriculture necessitates substantial prefinancing, as irrigation and fertilizer are quite costly."[9] Afghani farmers often cannot afford products such as fertilizer, even if they have access to them. Poppies do not require such luxuries and do not require much time investment. Fruit trees may require years to produce marketable crops; poppies need just several months, from spring planting to fall harvest. Given the uncertainties of life in Afghanistan, this is no small advantage.

Labor is the main constraint in poppy cultivation. Labor requirements, however, are not much of a burden. Given the lack of other jobs, there is plenty of available labor. Furthermore, because poppies are grown at home, women can contribute their labor.[10] Women are forbidden from working outside of the home under strict interpretations of Islam; poppy cultivation taps into this underused labor pool. Harvesting the resin is particularly labor-intensive. Itinerant workers score each seedpod individually, and very carefully, to extract all of the resin produced by each poppy flower. Once the resin is drawn from the poppies, it must be transported to local refineries for transformation into raw opium.

Transporting the resin is easier than transporting other agricultural products. Again, poppies show their suitability for Afghanistan. Many agricultural commodities would not survive the trip to market; poppy resin is a highly profitable exception. The transportation network in Afghanistan is badly frayed. "Eighty percent of Afghanistan's

population lives in rural communities which are only thinly connected by roads."[11] Light, packable poppy resin need not travel over the roads. If the roads are impassable, farmers and traffickers can load resin or raw opium onto all-terrain vehicles or even camels.

There are few easy ways to get legal products to market, and the surcharges levied by those controlling the roads make many crops economically unattractive. Opium, however, always has access to the market since many people have great interest in getting the resin to where it needs to go. Thus, farmers are better able to monetize their crop of opium than, for example, their almonds. Traffickers help them do this, "occasionally pick[ing] up raw opium directly from farmers, relieving them of the need to undertake an expensive trip to regional markets on a poor road system."[12]

The resin's durability is an advantage in storage as well. Raw opium requires no refrigeration, a major advantage in a country where even the capital city does not have reliable electricity. Only about 15 percent of the country has access to electricity; the percentage with 24-hour refrigeration is smaller still.[13]

Opium can be stored for many years.[14] This durability allows suppliers to manipulate perceptions of availability. Huge stockpiles of opium may be little more than legends, but given opium's durability, they are plausible.[15]

The ease of opium storage changes the economics of poppy production. This durability allows producers, or their agents, to manage carefully the amount of resin and opium coming to market to stabilize the price. This is similar to how the Organization of the Oil Exporting Countries (OPEC) manages the world oil supply. Hermann Kreutzmann, among others, believes that the Taliban's dramatic cuts in Afghan poppy cultivation in 2001, so loudly announced in the press, may be an economically rational response to a glut rather than a religiously motivated prohibition. Prices quickly rose "tenfold the following year," allowing opium dealers to make substantially more money than they would have before the ban.[16] Year-by-year trends mean little given that the supply coming to market can be carefully managed; only steady, multiyear declines might indicate that total supply is decreasing.

The ease of growing, transporting, and storing resin does not alone make opium attractive. The final and most important advantage that poppies have over other agricultural crops is that they are easy to monetize. Resin finds willing buyers; farmers benefit economically

from selling the produce from their poppy fields. Disagreements exist about whether farmers are coerced into growing poppies, but even analysts who believe that cultivation is largely imposed admit that "at the same time, it holds true that poppy is a valuable cash crop which offers about ten times higher returns than wheat crops."[17] Furthermore, poppy cultivation is not limited to farmers trying to stave off destitution. "Growing poppies is . . . not simply about survival in the face of grinding poverty, but also upward mobility."[18] Even more affluent farmers find the returns from poppies attractive.

Debt is another reason why some in Afghanistan grow poppies. The ease with which buyers can resell opium gum, the unprocessed harvest of the pods, has entrenched a sharecropping system in Afghanistan. Many farmers do not own their own land; some landlords pay well for poppy, and even forbid the growth of other crops.[19]

A cycle of indebtedness, known as the *salaam* system, traps even more farmers. They presell their poppy crops before the growing season at below-market prices, receiving money and supplies to sustain them through the growth and harvest of a new crop, which the lender takes as payment.[20] When the lender takes the crop, it can be resold at a substantial profit; there are always willing buyers. This structure has helped keep many small growers in the poppy business. Having many smaller suppliers gives purchasers a good deal more leverage; if one farmer balks at a price, plenty of others will agree to it. Many small producers mean that few poppy farmers can achieve any kind of leverage over the opium producers or exporters.

The bulk of the money does not accrue to the farmers but to the refiners and traffickers. "Narcotics trafficking is regarded by some as [*sic*] core impediment to the US mission in Afghanistan, generating what US commanders estimate to be about $100 million per year for the Taliban."[21] This approximate number does not include money going to other subversives or criminals that are not part of the Taliban.

Aerial Interdiction

The poppy economy is only one aspect of an extremely complicated foreign policy problem for the United States: how to stabilize Afghanistan under a benign central government with a limited investment of money and manpower. The revenue from opium production flows to the Taliban, other antigovernment groups, and various

criminals, all having different interests than those of the United States. Cutting off this funding source, given the limited US resources in Afghanistan, is a difficult problem. One proposal, seemingly straightforward, is to kill the poppies. Aerial eradication appears to be an attractive solution.

But one also has to consider the demands of a casualty-averse public. Aerial eradication fits this consideration. Manual eradication in rural Afghanistan is an extremely risky method for drug control. Even Afghanistan's own soldiers have met resistance. "Predictably, the Afghan government eradication teams that actually attempted to carry out their orders, rather than simply accepting bribes, have frequently met with armed resistance from peasants, even in the restricted and relatively safe areas where they have been deployed."[22] US troops would face similar, if not more acute, resistance. Should casualties result from these operations, the political fallout could handicap US efforts in Afghanistan. Awkward questions about mission creep could arise. Even if there were no US casualties, the number of adversarial interactions between US troops and Afghani civilians could increase. This increase is, presumably, something the United States would rather avoid.

Finally, aerial eradication is very easy to explain and publicize. Charts and PowerPoint slides showing the number of acres sprayed, sorties flown, and the gallons of chemical sprayed are clear, persuasive, and reassuring. Pictures of sprayed fields and dead plants seem to prove progress in the fight against the Taliban and illegal drugs.

Although aerial eradication might seem a plausible option for reducing the amount of poppy, the decision to spray herbicidal chemicals should be made cautiously. The United States has an unhappy history with aerial eradication and counterinsurgency (COIN). In early 1962, as part of Operation Ranch Hand, Pres. John F. Kennedy authorized the use of chemicals, primarily the arsenical Agent Blue, to destroy rice, manioc, and other food crops in South Vietnam.[23] The rationale for this decision, supported by South Vietnamese president Ngo Dinh Diem was that aerial eradication would prevent crops from falling into the hands of National Liberation Front soldiers. The North Vietnamese forces would thus fail in their efforts to overthrow the South Vietnam government, in part because of lack of food.

The United States brought herbicides into South Vietnam in violation of the 1954 Geneva Agreements, which partitioned Vietnam along the 17th parallel and forbade foreign intervention in the country's

war. The United States did not sign the agreement but pledged to uphold it. Since providing military equipment to either the North or the South was prohibited, the United States transported the chemicals in anonymous barrels, distinguished only by the colored bands around them. The South Vietnamese air force conducted the spraying missions, but the equipment, advisors, and chemicals were all American.

The scheme did not work. North Vietnamese soldiers and allies in the South got the food they required to wage war against the Diem government. Furthermore, the rural South Vietnamese whose lands were sprayed saw their fields die off, losing the produce from those fields. Understandably, these people resented the spray campaign.[24] The United States was unable to hide its involvement in the operation, despite concerted efforts to do so.[25] The perception that the United States was making war on Vietnamese peasants was very difficult to counteract. It also undermined the legitimacy of the South Vietnam government at a time when that government was increasingly under threat.

Aerial eradication efforts in South Vietnam and in Afghanistan have some striking similarities. A sense of control over an unfamiliar and dangerous environment may be part of the attraction of an aerial spray campaign. There are significant environmental challenges to aerial spraying in each country—each has climate and weather extremes, and both environments are very different from those found in the United States. Spraying also entails using herbicides, which are powerful chemicals. Finally, in each case, aerial spraying makes up only one piece of a complicated COIN puzzle.

The United States has a long history of attempting to control frightening new lands. The Homestead Act of 1862 is the best-known example, but historians have documented others beginning from the earliest settlements.[26] These efforts have included settlement, forced migrations, and deforestation. The themes of reclamation and cleansing pervaded discussions of the South Vietnamese landscape. "Plans call for burning over the defoliated areas where they have dried out sufficiently. This will drive out any Viet Cong still taking cover there, and will facilitate later planned reclamation of much of the area for crops."[27] National Security Council member Robert Komer was blunter than most: "After Laos, and with Berlin on the horizon, we cannot afford to go less than all-out in cleaning up South Vietnam."[28] The same is true for Afghanistan. As in South Vietnam, the environmental and logistical challenges fit within this larger narrative

of American history: taking action to civilize a wilderness. In working with an Afghan officer on an eradication campaign, a US contractor dismissed claims that it was too late in the growing season for eradication.[29]

Battling the environments in South Vietnam and Afghanistan has proved formidable because they are both so extreme and different from any found in the United States. The United States has no ecosystems like those found in South Vietnam. The US Air Force tested its spray equipment at Eglin AFB on the North Florida coast; however, the tropical plants and the extreme heat, rain, and humidity of South Vietnam are not found in Florida or anywhere else in the United States.

The punishing climate of southern Afghanistan, with blistering hot days and freezing nights, is found only in the western US deserts; this area does not share Afghanistan's challenging terrain. One senior Defense Department official observed that

> Getting into Afghanistan, which we need to do as quickly as we can possibly do it, is very difficult because . . . next to Antarctica, Afghanistan is probably the most incommodious place, from a logistics point of view, to be trying to fight a war. . . . It's landlocked and rugged, and the road network is much, much thinner than in Iraq. Fewer airports, different geography.[30]

A more prosaic difficulty with spraying in South Vietnam or Afghanistan is the climate's effects on equipment. In South Vietnam, the US Air Force was initially unprepared for the demands of triple-digit heat and torrential rains on its spraying equipment. The equipment soon malfunctioned under the strain. The climate in Afghanistan, although obviously very different, is also wearing. Extremes of heat and cold, combined with dust that works its way into all machinery, take a toll on aircraft and equipment. Furthermore, because Afghanistan is landlocked, access to fuel and spare parts is very limited.

Locating poppy fields is not difficult. They can "[stretch] as far as the eye could see: intense fuchsia blossoms in brilliant seas of green."[31] Rice paddies are an almost surreal green; they, too, are easy to spot. Precise application of herbicide, however, is considerably more difficult than just locating the fields. Temperature, wind patterns, and local ecology are only three of the factors that can determine where exactly the sprayed chemicals land.[32] In the southern United States, a region Americans understood better than South Vietnam, controlling forest growth through spraying proved almost prohibitively difficult. In

South Vietnam, the herbicides' instability became apparent even before they were loaded onto the planes. Fumes from chemicals stored at Tan Son Nhut Air Base killed surrounding vegetation, including two flame trees. Even empty barrels were unsafe; about 1 percent of the chemical remained after the contents were emptied, and this small percentage was enough to kill plants near the barrel.[33]

Perhaps the most important similarity is that, in each case, aerial eradication makes up only part of a larger COIN effort. In addition to evaluating the efficacy and practicality of aerial interdiction by itself, decision makers had to grapple with how this tactic might affect the achievement of broader goals. To complicate matters further, decisions about interdiction competed with decisions not just about other COIN tactics, but also with choices about broad COIN strategies—as well as with policy decisions in other parts of the world. A decision to use aerial herbicides is complicated, but it is only one piece of a complex problem, which in turn is embedded in challenges. This was true for the United States in South Vietnam and is also true for efforts in Afghanistan.

Within this context, aerial eradication can imply a level of US commitment that does not exist. Spraying can send misleading messages about what the United States is willing to do. The public images of spraying suggest that nothing is off limits. The starkness of sprayed rice paddies or a bare field may imply that the United States is prepared to go as far as needed in its COIN efforts. This was not the case in South Vietnam and is not the case in Afghanistan. The illusion that these chemicals signify some sort of commitment affects US allies and adversaries. One proponent of spraying wrote in the *New York Times* that US allies should "help in [an aerial eradication] effort or stand down and let us do the job."[34] Given the self-imposed limits on the US efforts in Afghanistan, this stance may lead to a role that the United States is not willing to play.

Even a relatively limited commitment may prove difficult. The ostensible goal in both countries is to change the behavior of the local populace through eradication. In South Vietnam, the goal was that rural Vietnamese would not supply the insurgents; in Afghanistan, the goal is that farmers will not grow poppies. According to some proponents, total eradication may not be needed to lead to changes in behavior. Douglas Wankel, a former Drug Enforcement Agency official who is now a private US government contractor, led an eradication campaign in Afghanistan's Uruzgan province. He notes,

> We're not able to destroy all the poppy—that's not the point. What we're trying to do is lend an element of threat and risk to the farmers' calculations, so they won't plant next year. . . . It's like robbing a bank. If people see there's more money to be had by robbing a bank than by working in one, they're going to rob it, until they learn there's a price to pay.[35]

In South Vietnam, the United States was equally confident in predictions about the effects of spraying. At a high-level conference on Vietnam on 23 July 1962,

> [Gen Paul D.] Harkins outlined for the conferees the plan developed in Saigon and explained that fields abandoned by Montagnards as they moved to strategic hamlets needed to be sprayed in order to keep those crops from falling into guerrilla hands. . . . The Secretary inquired of Ambassador Nolting as to whether crop destruction would cause negative propaganda inside South Vietnam. Nolting responded that destroying crops abandoned by Montagnards should cause no problem.[36]

Nolting was wrong. A later RAND Corporation study indicated that defoliation and crop destruction had built widespread and lasting antipathy toward the United States. As far as many rural Vietnamese were concerned, outsiders, who previously did not intervene for good or bad, were suddenly deeply involved in their day-to-day affairs, determining what and where they could farm. Not surprisingly, many resented this sudden and heavy intrusion. A RAND study noted, "The reaction to spraying operations which destroy civilian crops is almost unanimously hostile."[37] Aerial spraying did influence the local population but perhaps not always in the direction the United States preferred.

The same dynamic may hold true in Afghanistan. Rural South Vietnam and rural Afghanistan have long-standing traditions of local governance and a tenuous, if not hostile, relationship with their national government, a relationship that aerial spraying further erodes. Should spraying become widespread, many rural farmers, otherwise largely disconnected from the capital, would have their most direct contact with Kabul and Washington through the spray of a crop duster. This has already led to increased hostility toward the US and Afghan governments in sprayed areas.[38] Estrangement from the central government provides opportunities for extra-governmental forces to build influence and power. These local actors have their own agendas, which may or may not match those of the Karzai government or the United States. Many are also deeply, and very profitably, involved in the opium trade.[39]

Although the national government may be remote to rural dwellers, its survival is an important motive for aerial eradication. Internal forces threatened Diem's regime in the early 1960s and the Karzai government currently. Crops targeted for eradication fund groups that undermine the stability and the very existence of the US-backed regime. Depriving the communists and their allies of food was clearly in the interest of the Diem government if the communists conquered South Vietnam. Pres. Hamid Karzai must cope with insurgencies and opponents that receive considerable revenue from the drug trade and are working to destroy his government.

Environmental Damage

Environmental damage is another potential consequence of aerial eradication. While most officials in the early 1960s dismissed environmental safety, the issue receives a great deal more attention today. However, when discussing eradication in South Vietnam and Afghanistan, the public message is that herbicidal chemicals are perfectly safe. In the case of Vietnam, it is now quite clear that the United States sprayed poorly understood chemicals. Despite pronouncements that these agents were safe, insurance companies, environmental activists, and scientists all had questions (and reservations). As Rachel Carson warned of widespread damage from defoliants, Illinois insurance companies tightened underwriting standards for farmers who used these chemicals.[40] The academic and corporate scientific communities also had persistent concerns.[41]

In the debate over eradication in Afghanistan, the Bush administration expressed confidence that poppies could be killed with no unanticipated environmental consequences. Thomas Schweich, a senior counternarcotics official in the administration, dismissed concerns: "Drug lords use [glyphosate] in their gardens in Kabul. . . . My assistant at the time was a Georgia farmer, and he told me that his father mixed glyphosate with his hands before applying it to their orchards." Others, however, are not so sanguine. Studies indicate that various formulations of glyphosate can persist in the soil and have been linked to cell damage.[42] The impact of glyphosate on an environment as degraded as Afghanistan's can only be guessed.

The eradication dilemma in Afghanistan differs from the one in South Vietnam because the situation in Afghanistan is geometrically

more complicated. Opium interdiction is a problem affecting US policies regarding not only Afghanistan, but also Pakistan and Iran (two major transit points for Afghani opium) and Great Britain, the NATO ally responsible for counternarcotics in Afghanistan under the 2001 Bonn Agreement.[43] The phrase "fighting the Taliban" simplifies the problem to meaninglessness. The Taliban are involved in the drug trade, but to what extent has been disputed for years. In addition, other people and organizations are profiting from illegal opium; some are affiliated with the Taliban, and some are not.

Karzai's position in Afghanistan is even more compromised than was Diem's. Karzai has active political opposition; by 1961, Diem had neutralized most of his. Karzai's vulnerability may obviate his willingness to allow aerial spraying. Any negative effects may be blamed on his government, weakening it still further. Antigovernment forces, in their efforts to show the Karzai government as uncaring and a Western puppet, can use consequences that may be tangentially linked to spray campaigns. Should there be a bad harvest or another drought, opponents might plausibly argue that the United States, aided and abetted by the Afghan government, caused it.

The depth of the Karzai family's involvement in the drug trade also poses problems. There are swirling rumors about the complicity of the president's brother, Ahmed Wali Karzai, in the illegal drug trade. Another brother has substantial investments in property and car dealerships in areas rife with illegal drug activity.[44] The vast majority of Afghan poppy cultivation takes place in the southern provinces, especially Helmand, which are the base of Karzai's support. Spraying poisonous chemicals on the fields of his Pashtun countrymen may not be a high priority for Karzai.

The United States would have to be visibly and publicly responsible for spraying, unlike in Vietnam. Aerial spraying in Afghanistan would have to occur without the comforting fiction that it was an activity performed and controlled by Afghanistan's own sovereign government. In Vietnam, the United States kept its national fingerprints off of the spraying operations to the greatest extent possible. The US Embassy in Saigon, the US Information Agency, and the State Department made elaborate plans to deflect responsibility for defoliation and crop destruction onto the government of South Vietnam.[45] Even this pretence would be impossible in Afghanistan; the US role in spraying would be enormous and obvious. This would forestall charges of duplicity but make conclusions about meddling and war

making on the Afghan people quite easy to draw. One author observed that "even if a private company such as DynCorp, which has experience spraying in Colombia, carried out such an operation secretly and both the Kabul government and the international community denied any knowledge or authorization, the United States, which controls Afghanistan's air space, would inevitably receive the blame as a bully sentencing poor Afghan Muslims to starvation."[46]

Instead of evading the Geneva Agreements' restrictions, as it did in South Vietnam, the United States would have to manage its allies' prohibitions on defoliant and herbicide use to undertake an aerial eradication program in Afghanistan. This is a big disadvantage, given the importance of allied troops in Afghanistan. John Lee Anderson in *The New Yorker* observed, "The Europeans are adamantly opposed [to chemical spraying]—just look at the whole genetically-modified-crop debate in Europe. If they decided to spray over the next few months, we would need to have an information campaign on spraying, telling the Afghans they're not going to have two-headed babies, but also telling them so in Europe, in The Hague, and in Rome."[47] The United States dropped leaflets during Operation Ranch Hand, but there was still lasting public relations damage. In the case of spraying poppies, public backlash and a reduction or withdrawal of coalition troops could hamper the overall effort in Afghanistan.

A saying commonly attributed to the Taliban is, "The Americans have watches, but we have time."[48] This may describe the COIN campaign in general, but it is almost certainly true in the case of aerial eradication. In South Vietnam, spraying a rice paddy could kill the plants and reduce the insurgents' supply of rice for that season. In Afghanistan, the time horizons of a spray campaign, focused on immediate and visible results, versus those of a trafficker are very different. Killing poppies is an ambiguous achievement. Even if an entire field is eradicated, the supply-and-demand dynamics of opiates make this almost irrelevant. If the supply of resin goes down materially, then middlemen should be able to rebalance the market by processing and selling the previously stored product. If the supply of illegal drugs declines, then the dominant suppliers and dealers would pick up market share at the expense of less powerful ones, as happens in legal and illegal industries alike. The rice fields of Vietnam filled a very different economic role, one that did not generate extraordinary revenues or profits and did not attract numerous competing buyers or sellers.

To reduce poppy cultivation in the near and far term will take a multiyear effort and have steep environmental costs. Because poppies are an annual crop and their resin so easy to store, spray campaigns would have to happen every year to kill that year's crop and force existing stockpiles into the market to meet demand. The repeated application of powerful chemicals could have a serious impact on the Afghan environment, making it even more difficult to replace poppies with other crops. In the worst case, as occurred in parts of South Vietnam, the landscape becomes sterilized.[49] Under these conditions, crop substitution becomes impossible. The damage from herbicides on Afghanistan's soil, already taxed by decades of war, could be considerable. Whatever effects glyphosate or other herbicides might have on fields in the southern United States, those effects may not remain the same in such a radically different, and compromised, environment.

The role of money is the biggest difference in the cases of Afghanistan and South Vietnam. In Afghanistan, the money the crops generate finances crime and corruption throughout the Middle East and Central Asia. The targeted crops in South Vietnam were not as valuable, did not have as wide a market, and easily reached consumers. Rice required relatively little processing after harvest, and manioc required none. Communist troops could seize harvests, or even fields, and gain a food supply that did not require much further effort.

Poppies, on the other hand, do not have much value when still in the field. The real money is made and the largest benefits accrue once the resin is harvested and refined. Each step in the process adds value and generates revenue for the growers, harvesters, or refiners. The poppies are not moneymakers. These funds go, if only in part, to fund the Taliban.[50]

The amount of money generated by poppies severely distorts the Afghan economy because it makes up so much of the country's total revenue. As Rory Stewart in the *London Review of Books* described the situation: "There is almost no economic activity in the country, aside from international aid and the production of illegal narcotics."[51] To complicate matters further, a significant percentage of that international aid comes into Afghanistan to fight the illegal drug trade. Alternate sources of income would need to make up the shortfall from aid reduction as well as from poppy reduction.

Aerial eradication would affect rural citizens before it affected nongovernmental organizations. Money is why farmers grow poppies, and for some, the loss of a poppy crop might drive them more

deeply into debt.[52] Gretchen Peters, a journalist who has worked extensively to understand and document the problem, puts it bluntly: "Wide-scale spraying would play into the hands of traffickers and terrorists. If implemented, this policy would drive up opium prices, thus increasing profits for drug dealers and the Taliban, and make life even harder for already debt-ridden Afghan farmers—exactly the results the US government and NATO don't want."[53]

All of this is not to say that eradicating the poppies and damming the flow of money and illegal drugs are not worthwhile goals. However, depending on how this goal is defined, aerial eradication may not be an effective route toward achieving it. The first question that must be asked is what does *success* look like? This question has dogged US efforts in Afghanistan, and not just in the context of poppies or spraying.

If the goal is *stability*, depending on how that word is defined, poppies may help rather than hinder. A certain level of safety and predictability is necessary for economic transactions to occur, whether legal or illegal. Hafvenstein implies that poppies may not be the force for anarchy they seem to be. "Our target area was Helmand province, which was both an oasis of relative calm in the heart of the Taliban resistance and the foremost drug-producing region in the country."

Poppies provide jobs, and jobs foster stability. As a rule, farmers are active, vigorous men. Insurgents target farmers who have no crops and few job prospects. If the insurgency has a ready supply of cash, perhaps from the illegal drug trade, it becomes even more attractive to a disaffected and unemployed man. In rural Afghanistan, nonagricultural jobs are in short supply. Even in the few urban areas, jobs are limited, particularly for the majority of potential workers who are illiterate and unskilled.[54]

It is also unclear what the farmers would do with non-poppy crops. In order to monetize them, as they do poppies, they have to sell them. Other countries would need to open their markets to agricultural imports, a politically formidable goal given the power of the farm lobbies in the United States and Western Europe. Even getting agricultural crops to market within Afghanistan is a nearly insurmountable problem because of the lack of secure roads. Journeys are too dangerous and take too long to make economic sense.

Various local militias have taken root along with the poppies, promoting a sort of stability. There remains a strong bias toward local governance, but not because local leaders have political legitimacy or

local support. Rather, leaders may gain and hold their positions through the buildup of private militias, paid for through drug revenues. Furthermore, these same leaders, because of their influence, may be particularly attractive to foreign intelligence services. An informer among their ranks could prove useful enough to justify, if not blindness, some myopia toward the ongoing production and sale of illegal drugs.

Aerial eradication is an imperfect solution to a difficult problem. The hurdles that the United States encountered in the early 1960s during another eradication campaign give some indication of just how challenging an Afghanistan campaign might be. In fact, spraying the poppy fields in Afghanistan would be an even more complicated campaign than crop destruction in South Vietnam.

This is not to say that aerial spraying could not play a role in breaking the cycle of indebtedness, unemployment, and violence that has taken hold. However, considerations about the appropriateness of spraying would have to include the potential economic and environmental effects of a successful campaign, however defined. If herbicides further damage the Afghanistan environment and farmers are left with even fewer choices of how to support themselves and their families, the results for Afghanistan and the United States could be devastating.

Notes

1. Because of the complexity and opaqueness of the illegal drug trade, this chapter does not rely on statistics about drug production, pricing, or use. David MacDonald, an advisor to the United Nations, rightly warns that "certainly all official estimates and figures emanating from Afghanistan, right up to the present day and whether collected by government or international agencies, are subject to wide variation and should be treated with caution." MacDonald, *Drugs in Afghanistan*, xxii.
2. Felbab-Brown, "Afghanistan," 56.
3. Glaze, *Opium and Afghanistan*, 2.
4. Chayes, *Punishment of Virtue*, 188.
5. Hafvenstein, *Opium Season*, 47.
6. Chayes, *Punishment of Virtue*, 149–50.
7. Hafvenstein, *Opium Season*, 10.
8. Clemens, "Opium in Afghanistan," 409.
9. Aras and Toktas, "Afghanistan's Security," 46.
10. Clemens, "Opium in Afghanistan," 409.
11. Robichaud, "Buying Time in Afghanistan," 8.
12. Felbab-Brown, "Afghanistan," 57.

13. Katzman, *Afghanistan*, 4.
14. Felbab-Brown, "Afghanistan," 57.
15. Peters, *Seeds of Terror*, 237.
16. Kreutzmann, "Afghanistan and the Opium," 613. Other authors who assert this include Hafvenstein, *Opium Season*, 215; Chayes, *Punishment of Virtue*, 85; and Blanchard, *Afghanistan*, 8.
17. Kreutzmann cites the *World Drug Report 2006* (Vienna: United Nations Office on Drugs and Crime, 2006), 212. Kreutzmann, "Afghanistan and the Opium," 609.
18. Felbab-Brown, "Afghanistan," 59.
19. Blanchard, *Afghanistan*, 9.
20. Kreutzmann, "Afghanistan and the Opium," 617; and Blanchard, *Afghanistan*, 9.
21. Katzman, *Afghanistan*, 20.
22. Felbab-Brown, "Afghanistan," 62.
23. Stellman et al., "Extent and Patterns of Usage," 682.
24. Betts and Denton, *Evaluation of Chemical Crop Destruction*, xi–xii.
25. Buckingham, *Operation Ranch Hand*, 23.
26. See, for example, Cronon, *Changes in the Land*; Nye, *America as Second Creation*; and E. Morgan, *American Slavery*.
27. National Security Files, Countries—Vietnam, Box 203, Subjects—Summary of Suggested Courses of Action (1961), John F. Kennedy Presidential Library (JFKL).
28. US Department of State, *Foreign Relations of the United States*, 236.
29. Anderson, "Taliban's Opium War."
30. Mufson and Pincus, "Major Challenges for Pentagon."
31. Peters, *Seeds of Terror*, 2.
32. Burns, "Use of Aircraft for Foliar Applications," 92.
33. Buckingham, *Operation Ranch Hand,* 39; and Stellman et al., "Extent and Patterns of Usage," 685.
34. Schweich, "Is Afghanistan a Narco-State?"
35. Anderson, "Taliban's Opium War."
36. Buckingham, *Operation Ranch Hand*, 72.
37. Betts and Denton, "An Evaluation of Chemical Crop Destruction," 13.
38. Van Ham and Kamminga, "Poppies for Peace," 72.
39. Giustozzi, "War and Peace Economies," 82.
40. Carson, *Silent Spring*, 60–61; and "14th Custom Spray School."
41. For examples, see McDermid, ed., *Use of Chemicals*; and Mullison, "Volatility of Several Salts," 287.
42. Albers et al, "Influence of Organic Matter"; and Benachour and Séralini, "Glyphosate Formulations."
43. Blanchard, *Afghanistan*, 8.
44. Katzman, *Afghanistan*, 10.
45. Buckingham, *Operation Ranch Hand*, 28–29; Telegram #235, Edward Murrow to Frederick Nolting, 11 March 1963, National Security Files, Countries, Vietnam, General, 3/1/62–3/17/63, Box 197, Document 12, 1, 2, JFKL; and Telegram #497 from Rusk to Nolting, 14 November 1962, National Security Files, Countries, Vietnam, General, 11/11/62–11/25/62, Box 197, Doc 1, JFKL.
46. Felbab-Brown, "Afghanistan," 63.
47. Anderson, "Taliban's Opium War."

48. Robichaud, "Buying Time in Afghanistan," 1.
49. David Biggs (professor of Southeast Asian and environmental history, University of California, Riverside), personal communication, 11 September 2009.
50. Katzman, *Afghanistan*, 20.
51. Stewart, "Irresistible Illusion," 3.
52. Blanchard, *Afghanistan*, 9.
53. Peters, *Seeds of Terror*, 7.
54. Katzman, *Afghanistan*, 52.

functions, and (2) whether or not there are meaningful environmentally relevant roles these security establishments could effectively play. In the first decade, neither question was definitively answered by existing theory or practice.

This chapter proposes partial answers to the second question. It does not delve deeply into the topic of evolving military roles and missions. It avoids a treatment of civil-military relations and offers no conclusions as to the propriety of employing military institutions in pursuit of society's environmental ends. Instead, it identifies some roles that militaries could play if asked to do so.

Military establishments are not homogeneous in composition or in function. The assessment taken here is much more enlightening if focused on the capabilities of particular organizational actors. Hence the chapter spotlights the potential role of airpower—and the contribution that a relatively sophisticated air force could make—to environmental ends. Likewise, environmental activities do not occur in a vacuum but in particular places. Application of airpower is meaningful only if contextualized to the political realities of a natural and cultural environment. Some of the world's most trenchant environmental dilemmas—and some of the most hopeful prospects for progress on environmental issues—can be found in developing countries in southern Africa. That region is the geographic focus for this chapter, with the implication that at least some of what is true for southern Africa will apply elsewhere (with appropriate contextual adjustment).

Security Sector not Spared

Since the mid 1980s, a substantial worldwide discourse has emerged on the security implications of environmental issues.[1] Some scholars have challenged the notion that security and the environment should be linked, but those scholars represent a minority view that does not generate much current traction.[2] Rather, the world's leaders now recognize that environment plays a role in virtually all national and international efforts to promote long-term development, reduce destabilizing want, and attenuate violent conflict.[3]

Security agencies have not been exempt from this international environmental conversation. Many governments have looked to the security sector for some environmentally related activity. National intelligence organizations increasingly are asked to assess the political and

security implications of environmental trends. Police agencies and judiciaries enforce growing bodies of environmental law. Defense establishments are held to ever-stricter standards of environmental accountability, as are broader international military coalitions. Both the United Nations (UN) and the North Atlantic Treaty Organization (NATO) now publish environmental policy guidance for military operations.[4] Some governments have harnessed their militaries to environmental ends, as evident in the antipoaching operations of countries like Botswana, Brazil, and Mozambique.

What has not emerged to date is any substantial advocacy for the targeting of military establishments at wide-ranging environmental ends. No military constituency has made a strong public case for its greater involvement in environmental issues.[5] With a handful of exceptions, national governments have not assigned prominent environmental roles and missions to armed forces.[6] In fact, it is easy to anticipate the complaints of military leaders if their organizations suddenly were saddled with such responsibilities, as well as the complaints of environmental activists worried about militarizing the environment.

Yet the fact that militaries have not engaged in sophisticated environmental roles does not suggest that they are incapable of performing them. At various times in human history military establishments undertook significant shifts in function and ethos to successfully address the peculiar needs of sovereign or society. Twenty-first-century airmen would do likewise if directed. However, airpower and the environment probably do not give an initial impression of significant overlap. Making the case that they could requires a brief excursion into the nature of airpower and contemporary thinking about the environment.

Implications of Airpower

Western military scholarship still respects the dicta of nineteenth-century Prussian thinker Carl von Clausewitz, and none of his writing is more often quoted than "war is . . . a true political instrument, a continuation of political activity by other means."[7] In this line of reasoning, neither military establishments nor their capabilities are ends in themselves, but means to larger political ends. The same is true of more narrowly delimited military capabilities like airpower. No matter how that capability may be defined, a Clausewitzian paradigm

would classify it simply as one among many military capacities employed by a nation-state within a range of policy instruments available to pursue its national interests.

A standardized international definition of airpower is somewhat problematic. Each nation maintains a unique inventory of interests and parcels military roles and responsibilities rather differently. Military establishments exhibit distinctive national traditions, structures, and doctrine, so a definition is partially dependent on peculiar historical and cultural circumstances. However, a universally acceptable and minimalist definition of airpower would identify its one key feature: an ability to use the atmosphere as the peculiar medium in which a security-related end is pursued (or the atmosphere as a medium that is leveraged to apply a military capacity). Western militaries add the dimension of space to the notion of airpower, inferring a concern for missiles, satellites, and other space vehicles (and the protection from threats posed by such vehicles).[8]

The notion of airpower itself has certainly not been static, generating a continuing spate of controversies. Aerial reconnaissance of the battlefield dates back to manned balloons. But the advent of powered flight in the early twentieth century shifted the focus to the packaging and delivery of coercive power. Early airpower debates centered on emphasizing the priorities for delivering that coercion: whether priority should be given to the direct support of ground forces, defense from adversary use of the air, or attack on the adversary heartland. World War I experiences contributed to fierce controversies on these issues, propelled by men like Giulio Douhet in Italy, Hugh Trenchard in the United Kingdom, and Billy Mitchell in the United States.[9] World War II intensified the earlier obsession with delivery of coercive power—US airpower ultimately delivered the most lethal technology of that era—but also sowed the seeds of other important roles, including strategic aerial reconnaissance and the airlift of men and materiel.

These new airpower roles matured during the Cold War. Delivery of coercive power at the tactical, theater, and strategic levels remained a key concern, although airmen per se were not always in charge of this function.[10] In America, and elsewhere, airmen typically bore much of the responsibility for protecting the heartland from aerial attack, though responsibilities for air defense were scattered among ground, air, and sea services. Despite some dispersion of tactical aerial surveillance responsibilities, airmen and airpower continue to play a large and growing role in surveillance and reconnaissance. For its

part, strategic surveillance in the developed countries tends to be an airpower function shared with—and overseen by—national intelligence services. Short-range tactical air transport (emphasizing rotary-wing aircraft) is often a ground forces function, while airmen flying fixed-wing aircraft continue to dominate the longer-range airlift and continue to control strategic aerial transport, along with the logistics and communications to support it.[11]

Evolving new roles endow airpower with attributes most relevant to this discussion. During the Cold War, the worldwide scope of strategic attack, strategic lift, and strategic surveillance pushed American Airmen to develop broad, global perspectives. In the wake of the Cold War, a proliferation of international interventions in complex humanitarian emergencies around the world almost inevitably resorted to US strategic airpower. This placed demands not only on the technological and managerial prowess of US Airmen, but also upon their ability to work effectively with coalition partners, international humanitarian organizations, and host-nation civil societies.

Along with the interventions by international coalitions in complex humanitarian emergencies came an increasing emphasis on taking care of people—human populations traumatized by violence or natural disaster. Those activities included at least some concern for conflict management along with the provision of materiel for basic human needs and delivery of emergency health care. By 2010 the US Air Force had developed a well-refined and tested tactical capability to quickly install the management of such functions "on the ground" through activation and deployment of a contingency response group.

After 2001 US involvement in conflicts in Iraq and Afghanistan brought an expansion of US military roles into activities which may loosely be characterized as national reconstruction. Airmen, along with other military personnel, were heavily involved with the details of local government and civil society, assisting in providing both the physical and economic security required to rebuild the shattered lives of local communities and reestablishing the capability of security forces and the legitimacy of host-nation political authorities. America's Airmen had acquired some responsibility for managing social change within civil societies.

Meanwhile, airpower's location within the dimensions of air and space brought some interesting corollaries. By the early twenty-first century, the ability to conduct military operations within these dimensions inferred considerable technological sophistication. The

associated equipment was some of the most advanced ever produced. This equipment required intensive education for its operators as well as organizational and individual sophistication in the processes of production, fielding, and maintenance. Twenty-first century air operations demanded substantial management skill to oversee even the most routine activities.[12]

Airpower in developed nations also required a long-term focus. Technology was developed and applied in costly, long-term acquisition programs, generating sophisticated equipment which then remained in use for decades. Egregious acquisition errors inevitably squandered scarce resources and posed substantial security risks. These factors dictated a clear requirement for higher-ranking airmen to see a future with some clarity and manage the risks with some dexterity.

Military leadership, whether in airpower or any other domain of military endeavor, heavily focuses on solving problems and overcoming obstacles—typically in circumstances of adversity, ambiguity, and intercultural complexity. Such roles demand a capacity to establish coherence and order in inherently disordered surroundings, along with significant technological and management capabilities to overcome the problems. But the successful accomplishment of these roles also requires proficiency in "people skills": building teams, harmonizing efforts, and motivating diverse individuals and groups to work together towards common goals. Because of the unique technological demands and the unforgiving lethality of error, airpower demands a substantial inventory of all these skills. When brought into nonmilitary activities, the men and women in uniform who managed America's air operations in peace and war generally have proven to be competent leaders, good organizers, and effective technical experts.[13]

When it comes to airpower per se, the managerial oversight and many of the actual operations are similar to other public sector activities. For instance, the same kind of expertise and equipment required for contingency planning and military airlift is regularly applied to natural disaster response or to the surge capabilities of commercial mail carriers. Strategic air operations require robust, reliable, long-range logistics and communications capabilities which have obvious utility for rapid, long-range movement of any commodity. Air and space surveillance provides rapid warning of dangerous military adversaries but could also be used to track natural environment changes. For responsive reporting on atmospheric conditions, some air forces maintain their own weather services. In short, airpower

carries within it the seeds of many nonmilitary public and private sector functions.

Airpower's unique, inherent capabilities also make it in many cases *the* military capability most suited to extending the reach of the state and enhancing its capabilities. Particularly in circumstances where infrastructure is underdeveloped or deteriorated (an all too common characteristic of the developing world), airpower provides national leaders with otherwise unequalled options for flexible, rapid response to the remotest reaches of the state and beyond. In cases of dire national emergency, few institutions can equal a reasonably competent and well-equipped air force in supporting the symbolic and redistributive mandates of state power. The qualities required for typical roles in military management and leadership, along with the scientific and technical expertise required for effective deployment of airpower, suggest that senior airmen may be uniquely equipped among their public sector colleagues to assist in addressing a nation's environmental priorities.

Defining *Environment*, Connecting Dots

The discussion earlier noted a lack of global consensus on environmental issues. Difficulty in achieving that consensus may be due in large part to the loose conceptual boundaries of the domain itself.[14] "Environmental" issues comprise an amorphous mass of assorted topics that do not always appear closely connected or even inherently related, and the issues elide easily into other domains such as health and livelihood. Although the boundaries of the field are ambiguous, it is useful to identify several of the broader categories of environmental concerns before turning to a discussion of possible roles for airpower.

Natural resources comprise one area of environmental concern and are also subject to substantial controversy. (The resources themselves may range from minerals, to water, to flora and fauna in the natural environment, to soils, air, and other natural features.) Here, societies exhibit a variety of apprehensions. One is centered on rights to access—questions of legitimacy in exploiting the resources and the propriety of methods employed in that exploitation. This calls attention to some of the most difficult yet important roles played by political authorities—establishing societal consensus on rights of access

to natural resources, achieving transparency and accountability in administering those rights, and distributing the associated benefits so that the issues do not become politically destabilizing. A related question is how to preclude exploitation of natural resources by unauthorized actors. Another relates to conservation and sustainability—how to exploit natural resources in a responsible way that avoids, attenuates, or otherwise manages the problem of resource depletion.

An associated environmental concern is "biodiversity"—an interest in preserving and protecting the various forms of life on the planet. This is now increasingly based on a conviction that mankind is impoverished by the extinction of any form of life and by regret at the loss of potential contributions to human well-being. (A smaller but vocal ecocentric community argues for the criticality of biodiversity out of a conviction that all forms of life have an equal right to coexist with humankind.[15]) By the mid 1990s, biodiversity had become a mainstream concern within an attentive Western public sensitized to poaching of megafauna in Asia and Africa—with the very real prospect that wildlife species like the Siberian tiger and rhinoceros faced imminent extinction.[16]

Another topic overlapping "natural resources" is the natural environment's capability to sustain human health and well-being—or to threaten it. As noted earlier, overuse depletes resources. The more immediate threat is the contamination of air, soils, and water resources which compromises their use for human livelihoods—imperiling human health or menacing food chains upon which humans are dependent. African environmental threats, such as drought, flooding, typhoons, volcanic eruptions, and effluence of toxic volcanic gasses, range widely.

Some environmental problems attack human populations directly. For instance, the natural environment in tropical zones incubates diseases that can take a devastating toll on the life or health of human populations, sometimes (as with the hemorrhagic fevers of central Africa) appearing with terrifying suddenness and lethality. Such diseases can also be quickly borne by human hosts along modern transportation routes directly into the population centers of the developed world. Some environmental threats emanate from unwise economic development practices, whether these are the toxic chemicals left over from mineral extraction, waste from electricity generation plants, or soils contaminated beyond use from accumulated salts in poorly managed irrigation schemes. Many threats arise from complicated

interactions of multiple factors, such as the depletion of atmospheric ozone and the resulting dangerous increases in ultraviolet radiation on the earth's surface. Some environmental threats are stimulated by human activity; others are not.

Climate impacts many other environmental variables, and climate change has unsurprisingly become an issue of great concern as well as great controversy. In recent years the issue became entangled with global political wrangling over causality and responsibility. Greenhouse gasses, thought to be a primary cause, result mainly from the combustion of fossil fuels that powers the conveniences and industries of the world. International efforts to contain and reverse that combustion had proven relatively ineffectual until 2010, but the issue had the attention of world leaders and an attentive international public. It was nonetheless apparent that real progress on this issue would require painful and politically fraught choices, where long-term benefit demanded short and midterm sacrifice.

Even a superficial overview of these various environmental domains and issues points to complex interconnectedness. Many of the categories significantly overlap each other and also extend into other domains of human endeavor, whether economic development, subsistence, or quality of life. A satisfactory solution to virtually any single environmental dilemma requires a simultaneous resolution of problems stemming from the second- and third-order effects of that solution. Put another way, real progress in addressing environmental concerns almost inherently requires holistic "systems thinking" about all the impacted fields along with the capacity to achieve "buy-in" across affected communities of human actors. It also requires approaches that do not sacrifice the future for the political convenience of the present. Here, the unique skills and understandings of military leaders may give them an advantage as contributors to the management of a society's environmental equities. Military leaders (and particularly airmen) have a unique preparation among the professions for connecting scientific with technical expertise, people skills, and holistic long-range thinking to address problems that are partly anchored in the material universe and partly in the world of ideas and culture.

The Southern African Environmental Scene

The thought of Africa conjures up interesting and contrasting environmental stereotypes in the developed West. On one hand, the continent enjoys a quaint reputation for the richness of its fauna—particularly the spectacular megafauna. On the other hand are images of catastrophe, environmental disaster, conflict over resources, scarcity, disease, and human suffering.[17]

Perhaps two-thirds of Africa's people depend wholly or in part on subsistence agriculture. For populations whose livelihoods—and lives—are at the mercy of an unpredictable natural environment, the factors of precipitation, soils, predatory insects, and disease loom very large. African dependence on subsistence agriculture is compounded by the inadequacies of weak states that offer little safety in times of difficulty. While the ramifications of climate change are debated by scholars and policy makers in developed countries, African farmers and herders experience its effects every day, having seen precipitous declines in precipitation in some areas, more frequent droughts (with increasing severity), and decreasing predictability of weather patterns in general since the mid twentieth century.[18] The impact of climate change is compounded by (in some respects perhaps caused by) expanding human populations and human activities, such as deforestation and the overplanting or overgrazing of marginal land, leading to desertification and decreased carrying capacity of the land.[19]

Subsistence agriculture is by no means the only focus of environmental concern. For millions of residents of Africa's urban and periurban environments, access to clean air and clean water is problematic at best. Given the limitations of fresh water resources in some areas, access to any water may be a significant problem for some African urban areas in the intermediate future.[20] Rapid, uncontrolled urbanization has imposed severe challenges on city authorities, whose capacity to extend urban sanitation infrastructure into growing squatter communities is almost uniformly limited, resulting in heavy use of scarce distribution resources and the inadequate processing of waste. The continent's escalating deforestation is kindled in large part by a demand for charcoal—the only fuel affordable for cooking and heating in much of urban Africa. On winter days, African cities often are enveloped in palls of carcinogenic charcoal smog.

African conflict has its own unfortunate connections to Africa's environmental problems. Some of the continent's conflict has been stimulated or prolonged by struggles over mineral resources such as diamonds and coltan. These struggles deny environmental benefits to local societies and empower exploitative and sociopathic warlords while encouraging egregious human rights abuses. In regions of conflict, African states have difficulty maintaining control of natural resources, including precious minerals and wildlife, resulting in wanton and unsustainable exploitation.[21] African conflict typically results in flows of refugees and displaced persons, with concomitant fouling of water resources, deforestation, poaching, destruction of wildlife habitat, and epidemic human diseases. In some areas, legacies of past conflict include huge swaths of rural land seeded with chemical contaminants or landmines that continue to kill or maim humans and animals.[22]

Economic development in Africa also has not been kind to the environment.[23] The emphasis on mineral exploitation since the colonial era has left in its wake the toxic environments of environmentally unfriendly extraction and refining. An expansion of the transportation infrastructure has enabled illegal harvesting and poaching of flora and fauna in once inaccessible areas. Like livestock ranchers everywhere, African herders are not sympathetic to wildlife that competes for grazing and water, preys on their cattle, or transmits disease—and they often use modern technology to eliminate such threats, with unfortunate second- and third-order effects for the rest of the environment. The fossil fuels that generate electricity for growing populations of African consumers tend to be "dirty," contributing to high levels of unhealthy atmospheric particulates, as do mineral and petroleum refineries and other industries weakly restrained by environmental regulations. Particulates enter the air from fleets of urban vehicles whose exhaust systems go largely unregulated. The environment is further plagued by the all too frequent unfortunate accidents—such as contamination of a critically important aquifer in water-poor Botswana by nitrates leaching out of local commercial chicken farms.

Africa's ability to deal with its many environmental problems is limited. African leaders—faced with a host of urgent problems and pressures from constituents and international actors and constrained by woefully inadequate resources—are obliged to make difficult choices. Environmental issues are rarely the most immediate and

pressing of their concerns, and often are deferred in favor of more urgent priorities. In fact, African leaders and common citizens pay attention to environmental issues mainly when these significantly overlap other areas of greater concern such as human health and economic development. Then, too, African environmental concerns can be significantly at odds with those of their external partners. Africans are skeptical of the agendas of Western environmental activists who prioritize conservation and the well-being of wildlife over the well-being of people.

Although Africans face difficult environmental dilemmas, they have demonstrated a willingness and ability to find solutions, particularly in the southern region. Several southern African countries have made explicit national commitments to the environment in published policy statements. The region as a whole (in the form of the Southern African Development Community) has committed itself to commendable environmental objectives.[24] Southern African countries have demonstrated an impressive commitment to work together on environmental issues through such initiatives as the three-nation Permanent Okavango River Basin Water Commission or the ambitious Kavango Zambezi Transfrontier Conservation Area, the latter a project to tie the national park systems of five countries together in an enormous human development and environmental conservation scheme.[25] Of particular interest to this discussion is the fact that several southern African countries have assigned environmental roles to their military establishments. While there is currently no region-wide consensus on such roles, a local precedent is firmly established.

Two broad and somewhat overlapping categories define southern African public-sector environmental programs. The broadest is natural resources management, which breaks down into several divergent streams. A second category may be described as mitigation of threats to human health and well-being that emanate from the natural environment, a category that also diverges into a variety of different programs and approaches. These two broad streams are not particularly connected in public policy—either at the national level or in the region as a whole. If both categories and all their various divergent streams were effectively integrated into a synergistic, overarching environmental program, the region could probably achieve significant efficiencies, along with a better capability to partner with internal and external allies and a greater effectiveness in pursuing the particulars. Regrettably, the present situation lacks that unity of approach.[26]

The Regional Embrace of Human Security

By 2010 most southern African countries subscribed to the broad new conceptualizations of security generally categorized under the rubric of "human security."[27] The term was popularized by the UN in the early 1990s and, by the turn of the century, was thoroughly embedded in UN agencies and approaches.[28] The UN portrayed its new security model as "people-centered" (rather than state-centered); the most basic components were freedom from fear and want. The formula consisted of various constituent parts, prominently including "environmental security" that protected people from the short- and long-term ravages of nature, man-made threats in nature, and deterioration of the natural environment.

The broader definitions of security did not resonate everywhere, and some scholars challenged the human security paradigm as a whole, while others rejected the notion that the environment and security should be linked.[29] Not all the world's scholars are equally enthusiastic about the government embrace of environmental agendas. Some are naturally suspicious of any governmental interest in the environment and are worried that "securitizing environmental issues [risks] state co-option, colonization and emptying of the environmental agenda."[30] Such differences are also evident in arguments over the meaning and implications of environmental security, a construct that continues to elude a widely accepted definition.[31] Early on, African scholars supported the new "security" thinking and tended to endorse the broader definition exemplified in the UN conceptualization. As early as the 1990s, human security themes were prominent in the thinking of African officials and academics.[32] Interestingly, *environment* appeared in most of the new African definitions of security, either in terms of a human right to a healthful environment or in terms of rights by common citizens to environmental resources.[33]

Initially, the broader models of security left little room for the coercive agencies of the state and seemed to deny security-sector officials any exclusive right to define the subject. The new thinking questioned the relevance of the traditional military establishments themselves. However, a few countries bravely endeavored to adapt the broader models of security to military roles and missions. One of the most remarkable was post-apartheid South Africa. After 1994 that country made a very concerted effort to realign its military to its new national priorities and commitment to human security.[34] South

Africa's foundational document for its new military establishment articulated a whole new philosophy of national defense, capturing one of the most expansive definitions of security on record and offering a clear environmental dimension:

> National security is no longer viewed as a predominantly military and police problem. It has broadened to incorporate political, economic, social, and *environmental* matters . . . security is an all-encompassing condition in which individual citizens . . . *inhabit an environment which is not detrimental to their health and well-being* [emphasis added].[35]

The linkages in the South African white paper were not foreign to officials in other African countries. By the twenty-first century, southern Africans had established a conceptual relationship between militaries and environmental security in their region, though they were far from a full exploration of its possibilities and a long way from unanimous endorsement of the notion of employing militaries in such roles.[36] However, two southern African countries have pursued environmental security through resort to military force, Botswana and Mozambique.

By the mid 1980s, Africa's megafauna were severely threatened, particularly elephants and rhinos. Networks of well-armed criminals with links to the Persian Gulf and Far East sponsored much of the slaughter.[37] In Botswana, as in other parts of Africa, commercial poachers threatened the wildlife, along with the closely associated tourist industry, and assaulted local citizens living near the national conservancies. Botswana deployed its defense force into those conservancies in 1987, initiating a successful, long-term effort to halt egregious, commercial megafauna poaching. National park protection continues to be an important military mission for Botswana.[38]

In the mid 1990s, the southern African country of Mozambique elected to use part of its military in an environmental security role. Here, its navy was recruited into an innovative partnership sponsored by the World Wildlife Fund (WWF), an international environmental advocacy group. Within this partnership, the Mozambican navy works closely with the Ministry of Fisheries and local civil society groups to protect natural resources and enforce environmental law on the country's inland waterways.[39]

Two African countries' successful use of military force in an environmental security role does not validate that usage as a universal norm. Nor does it prove that military deployment is the best solution

to the commercial poaching problem. However, it does suggest that African security agencies can play useful environmental security-niche roles in carefully defined circumstances.

Beyond Botswana and Mozambique, in 2010 South Africa was the only southern African country with a serious military involvement in environmental security. It maintained a small environmental office within its National Defense Force headquarters and was concerned with a broad range of environmental issues, although its focus was limited almost exclusively to military installations and their immediate environs. South Africa employed its air force in routine coastal patrolling to secure its maritime resources, drawing aircraft from a Cape Town squadron and linking that to coastal law enforcement. Just as significantly, it served as a bridge to military environmental activities in other African countries, hosting consultations on environmental issues among military officials. These initiatives suggested that senior leaders in African militaries were open to possible roles in regional environmental initiatives.[40]

Since the activation of the Africa Union (AU) in 2002, Africans have engaged in productive consultations with each other to address their regional security dilemmas. These years have witnessed the initial outlines of a continent-wide security architecture conceived and created by Africans, involving a system of regional standby brigades for peace support operations and a centralized early-warning crisis tracking center.[41] This new security architecture potentially can attenuate many security-related problems, including those connected to the environment. Many of Africa's crises have profound environmental ramifications, and it is inevitable that any intervention in complex humanitarian emergencies deal with at least some environmental aspects of human security.

With the end of the Cold War, Africans engaged with external security actors, among them the United States and the EU, in fundamentally new ways. One of the novel features of these post–Cold War relationships has been a growing commitment to mutual partnerships intended to reduce instability and insecurity while promoting human rights along with sustainable human and economic development. African connections with the United States since 2007 have been troubled by the activation of a new military command—the US Africa Command—to oversee US security interests in the region. However, despite African suspicion of American intentions, the new US military entity is fundamentally oriented towards partnership, coop-

eration, and multisector/whole of government relationships.[42] The same is true of the deeper though less visible relationship emerging between the AU and the EU.[43] While environmental security has not been a strong feature of these security partnerships to date, a good potential and an excellent forum now exist.

Airpower: A Potentially Useful Contributor

The bottom-line concern here is the role that airpower could play in efforts by southern Africans to deal with their environmentally related problems and issues. The challenge now is to speculate on how all this might tie together, leading to observations on the applicability of airpower at three different levels: (1) the technical characteristics of airpower; (2) contemporary airpower roles; and (3) the unique skills of airmen.

An argument was offered earlier that airpower provides the state with unmatched capacity to extend its physical reach through rapid, agile airlift. This applies to any state priority, including reaction to environmentally related crises. Perhaps just as important is the potential of modern airpower to provide state authorities with timely all-source surveillance. Currently fielded technology allows aircraft—both manned and unmanned—to collect information from radar, video imagery, and electronic signals.

At least one southern African country—Botswana—uses airpower in combined-arms military operations against armed criminals targeting its wildlife resources. In this case, airpower provides both tactical surveillance and airlift. While these technical capabilities of airpower are applicable to environmentally related national and regional issues, their full potential has not been maximized anywhere (including southern Africa). For instance, space-based sensors could be particularly useful in providing analysts and policy makers with timely environmental information. It is not hard to envision air force analysts charged with responsibilities for collecting, analyzing, and reporting that kind of information.

Existing airpower missions hold the seeds of potential environmental roles. One of the most obvious is the airpower obsession with weather—environmental factors that impact the safety and capacity of aerial vehicles. The same military expertise that tracks weather conditions for flight could facilitate similar weather-related roles: providing warning of dangerous weather conditions, tracking longer-

range environmental trends for policy makers, and assessing impacts of weather phenomena on human safety, human livelihoods, and national infrastructure. Airpower also offers prospects for employing technology such as satellites and manned or remotely piloted aircraft to conduct scientific surveillance of the environment, ranging from measuring atmospheric particulates and ambient radiation to tracking levels of desertification and deforestation.

The contemporary connection of military airpower to human need (to address complex humanitarian emergencies) also has implications for helping human populations cope with environmental threats. For instance, air forces now routinely deliver medical care to populations traumatized by deadly epidemic disease. It is not difficult to picture air force analysts following trends in human and livestock disease (typically having climatological ramifications) and advising on quick responses to disease outbreaks. The same may be true of similar environmental threats, such as crop disease and damaging insects.

The technological characteristics of airpower offer potential environmental applications, but the most important contribution may be a purely human factor—the capabilities of airmen themselves. Given the ambiguous, interrelated, and complex nature of environmental issues, the capacity of the nation-state to address them requires analysts and planners that think scientifically, holistically, and long-range. Those managing these efforts must establish priorities and chart a clear path to identified ends. Contemporary military leaders excel at these roles. Most military education now emphasizes problem analysis and effective planning, and the military profession has a well-deserved reputation for skills in these areas.

Airmen bring both a particular depth in harnessing sophisticated technology to a wide range of requirements and a profound institutional understanding of the man-machine interface. Since airmen must understand both the science of the technology they use and the natural environment (particularly the atmosphere) in which it is used, they are uniquely suited among the military services to connect the dots between the development of environmental policy, the planning for its implementation, and at least some of the implementing programs.

A Partnership Angle

Military leaders in southern Africa and elsewhere are unlikely advocates for expanded environmentally related roles, and neither they nor the policy makers they serve are inclined to endow military establishments with primary responsibility for environmental issues in the near future. Military involvement in a society's environmental equities, if any, will probably always involve a subordinate and supporting role to other government and civil society actors. However, military personnel and military technology could make important contributions in a variety of such roles, whether in data collection and analysis, provision of logistic support to other state and civil society actors, natural disaster and health threat mitigation, or strategic and operational planning. The state should also require military organizations to model environmental stewardship and assure that military planning deliberately considers environmental factors in all operations. This is as true for airpower as for any other military engagement.

The environment is important in its own right, but it also is a logical candidate for transnational partnerships and relationship building. Many environmental problems are regional and transnational and can serve effectively as relatively benign "bridging issues" (similar to coal and transportation infrastructure in post–World War II Europe), connecting partners that are significantly at odds with each other over other concerns. This is true within southern Africa and true between southern Africans and external parties.[44] Southern Africans should be most receptive to such partnerships if the ultimate mutual objective is enhanced human security. Cooperation to mitigate environmental threats and promote health, well-being, and economic development will resonate with Africans. A narrow, exclusive focus on biodiversity (e.g., protecting wildlife) probably will not.

Southern Africans may elect to task their militaries with substantially greater environmental roles, but it is unlikely they will do so without encouragement, resourcing, and perhaps some modeling from external military partners. As discussed in the unique airpower roles, that probably would include at a minimum offers of education and training specifically targeted at environmental management, environmental analysis, and use of technology for collection of scientific information.

The relationship could conceivably involve far more. If the AU implements its ambitious vision of a robust continental security in-

frastructure, including a crisis tracking center, environmental security should take its rightful place among the other components of human security—and environmental threats could be as carefully monitored as any other menace to human well-being. This may particularly be a domain in which EU countries could offer resources and expertise. It may also be an opportunity for both developed Western countries and their African partners to think about the use of military human and technical resources to address the burgeoning environmental threats of the twenty-first century.

The time is ripe for the kinds of partnerships that could make southern Africa a showcase of international cooperation on issues of environmental security, with enormous potential benefits to Africans and to humanity as a whole. If airmen and airpower were asked to play a productive part, they could make a significant contribution.

Notes

1. Ullman, "Redefining Security," 129–53; Matthews, "Redefining Security," 162–77; Homer-Dixon, "On the Threshold," 76–116; Homer-Dixon, *Environmental Scarcity and Global Security*, 5–40; Homer-Dixon, *Environment, Scarcity and Violence*; Homer-Dixon and Blitt, *Ecoviolence*; Thakur, "United Nations and Human Security," 52; Kaplan, "Coming Anarchy," 44–77; Stoet, *Human and Global Security*; Homer-Dixon, "Debating Violent Environments," 89–96; and Brauer, *War and Nature*.

2. Dalby, "Contesting an Essential Concept," 3–32; Levy, "Is the Environment a National Security Issue?" 35–62; Kakonen, *Green Security*; Deudney, "Case against Linking Environmental Degradation," 461–76; and Deudney, "Environment and Security," 23–28. For a useful overview of contemporary approaches to environment and security, see Brown, "Environment and Peace," 3. For interesting discussions of the controversies surrounding the concept of environmental security, see Foster, "Environmental Security," 373–95; and Dalby, "Security, Modernity, Ecology," 95–134.

3. As an example, note the assertion of former UN secretary general Kofi Annan that "our efforts to defeat poverty and pursue sustainable development will be in vain if environmental degradation and natural resource depletion continue unabated," quoted in Dodds and Pippard, *Human and Environmental Security*, xvi.

4. United Nations Department of Peacekeeping Operations, "Environmental Policy for UN Field Missions"; and NATO STANAG 7141.

5. A case has been made by others. Singh, "Role of the Military"; Henk, *Botswana Defence Force*; and Mosher et al., "Green Warriors."

6. It is important to note that some military establishments have assumed significant environmental responsibilities, perhaps best exemplified by the US Army Corps of Engineers, which historically has been heavily involved in domestic US river basin and wetland management, applying that expertise on a limited basis in contingency operations overseas. Note also that the US Army Environmental Policy Institute was created to assist Army leadership in policy formulation and implemen-

tation related to the environment. However, military involvements in environmental issues almost inevitably are limited and typically focused on one environmental domain while neither holistic nor comprehensive.

7. Clausewitz, *On War*, 87.

8. A useful discussion is offered by Lambeth, *Transformation of American Airpower*, 233–59. The publication is a RAND Corporation study, suggesting a close connection to the thinking of senior US Air Force thinkers and leaders.

9. For Douhet's ideas, see Brodie, *Strategy in the Missile Age*, 71–105. For Trenchard, see Meilinger, "Trenchard and Morale Bombing," 243–70. For Mitchell, see Clodfelter, "Molding Airpower Convictions," 79–114. For current implications, see Lambeth, *Transformation of American Airpower*, 260–96.

10. For example, attack on the adversary's heartland from the air tended to be the unique prerogative of airmen until the advent of strategic missiles. At that point, America's newly independent Air Force assumed this role without much controversy, while the Soviet Union opted to create an entirely new ground-based service (the Strategic Rocket Forces) to conduct intercontinental attack from space.

11. An interesting overview of the evolution of these airpower roles is provided by Mets, *Reflections of a Middling Cold Warrior*.

12. Organizing and supervising a space vehicle launch were epitomes of this expertise. Yet the normal air operations of flight planning and air traffic control, often taken for granted by common citizens enjoying the benefits, were no activities for amateurs.

13. In the late 1950s, the eminent Harvard political scientist Samuel Huntington made a compelling case for regarding military officership as a profession in the United States. According to the model he offered, a profession required (among other attributes) a unique expertise gained through intensive, specialized education. He argued that the professional expertise of the military officer was "the management of violence" on behalf of the state. Not surprisingly, Huntington's model became quite popular with military professionals, but by the early twenty-first century the conclusions he reached in the 1950s no longer did full justice to the expertise he had sought to describe. Had Huntington written his book in 2010 he might well have described the unique expertise of the military officer as simply "management," or even better, "leadership." Huntington, *Soldier and the State*.

14. For commentary on domain boundaries, see Homer-Dixon, "On the Threshold," 88; Sills et al., *Environmental Security*, xi; Speth, *Red Sky at Morning*, 30–33; and Henk, "Environment, the US Military," 100.

15. Henk, "Environment, the US Military," 99–100.

16. Blaike, Blaike, and Blaike, "Elephants, People, Parks and Development," 735–51; Martin, "Yemeni Rhino Horn Trade," 13–16; Martin, "Report on the Trade in Rhino Products," 13–20; Vigne and Martin, "Taiwan," 23–25; Western, "Undetected Trade in Rhino Horn," 26–28; Barbier et al., *Elephants, Economics and Ivory*; Balfour and Balfour, *Rhino*; Douglas-Hamilton and Douglas-Hamilton, *Battle for the Elephants*; Leader-Williams, *World Trade in Rhino Horn*; Bonner, *At the Hand of Man*; Ricciuti, "Elephant Wars," 14–35; Ellis, "Of Elephants and Men," 53–69; Sas-Rolfes, *Rhinos*; and du Bois, "Illegal Trade in Endangered Species," 28–41.

17. Regrettably, a half century of dramatic population growth, urbanization, and economic development, as well as the devastations of armed conflict, has severely threatened Africa's once rich wildlife. Biodiversity is far from the most significant

environmental issue in the minds of either most African citizens or their political leaders. For the issues of global economic disaster (including African implications), see Kaplan, "Coming Anarchy," 44–77; Homer-Dixon, "On the Threshold," 76–116; Homer-Dixon, *Environmental Scarcity and Global Security*; "Environmental Scarcities and Violent Conflict," 5–40; Homer-Dixon, *Environment, Scarcity and Violence*; Homer-Dixon, "Debating Violent Environments," 89–96; Homer-Dixon and Blitt, *Ecoviolence*; Bannon and Collier, *Natural Resources and Violent Conflict*; Berdal and Malone, *Greed and Grievance*; Kansteiner and Morrison, *Rising U.S. Stakes in Africa*, 88–103; and Lake et al., *More than Humanitarianism*, 28–76.

18. Ackerman, "Most Vulnerable Continent," 141–66. For the southern African region, see Tyson, "Climatic Change in Southern Africa," 241–58; Chenje and Johnson, *State of the Environment in Southern Africa*; and Tsheko, "Rainfall Reliability."

19. Burgess, "Environment and Human Security," 36–41.

20. Schwartz and Singh, *Environmental Conditions*; Godschalk, "Waging War over Water," 110–33; Klare, *Resource Wars*; and Swatuk, "Environmental Cooperation in Southern Africa," 143–45.

21. Feleke, "From Greed to Grievance," 185–99; and Smilie, Gberie, and Hazleton, *Heart of the Matter*.

22. A useful overview is provided in Austin and Brunch, *Environmental Consequences of War*. For another broad overview that touches on many of the issues, see Purkitt, *African Environmental and Human Security*.

23. For fascinating insights by an African scholar who has paid a high personal price for his courage in calling attention to these issues, see Turton, "Resource Allocation and Xenophobic Violence," 111–23.

24. Esty et al., *2005 Environmental Sustainability Index*; South African Department of Environmental Affairs and Tourism, "Overview of Integrated Environmental Management"; Republic of Botswana, *Vision 2016*, 6–7; *Southern African Development Community*; and Swatuk, "Power and Water," 210–47.

25. For an excellent overview of southern African cooperation on river basin development and conservation, see Turton, Ashton and Cloete, eds., *Transboundary Rivers*. For historical detail on the Permanent Okavango River Basin Commission, see Pinheiro, Gabaake, and Heyns, "Cooperation in the Okavango River Basin," 105–18. For a description of the Kavango-Zambezi initiative, see Henk, "Human and Environmental Security in Southern Africa."

26. For a more detailed discussion of the southern African environmental scene, see Henk, "Environment, the US Military," 98–117.

27. For a brief overview of the debate, see Matthews, "Redefining Security," 162–77; Baldwin, "Concept of Security," 5–26; Buzan, Waever, and de Wilde, *Security*; Smith, "Increasing Insecurity of Security Studies," 72–101; Zacarias, "Redefining Security," 31–52; and Cilliers, *Human Security in Africa*.

28. *Human Development Report*, 1993; and *Human Development Report*, 1994.

29. Deudney, "Case against Linking Environmental Degradation," 461–76; Deudney, "Environment and Security," 23–28; Kakonen, *Green Security*; Levy, "Is the Environment a National Security Issue?" 35–62; and Dalby, "Contesting an Essential Concept," 3–32.

30. Barnett, *Meaning of Environmental Security*, 157; and Dalby, *Environmental Security*.

31. Dalby, "Security, Modernity, Ecology," 95–134; Foster, "Environmental Security," 373–95; and Swatuk, "Environmental Security," 203–36.

32. Solomon and van Aardt, eds., *Caring Security in Africa*; Swatuk and Vale, "Why Democracy Is Not Enough," 361–89; Muloongo, Kibasomba, and Kariri, *Many Faces of Human Security*; and Hendricks, *From State Security to Human Security*.

33. Okoth, "New East African Community,"158–59. Two years before the UN endorsed "human security," the celebrated *Kampala Document* published by the African Leadership Forum (and supported by the Organization of African Unity and the United Nations) offered a definition of security very close to the later UN conceptualization. *Kampala Document*, 9. By the early twenty-first century, African scholars in seven nongovernmental research organizations across the continent had come together to form the African Human Security Initiative with a specific agenda of measuring the performance of African governments in promoting human security, insisting on accountability to human security principles (www.africanreview.org). By that point, the new African Union had agreed on a Common African Defence and Security Policy with a particularly nuanced and robust articulation of its human security foundations. See Cilliers, *Human Security in Africa*.

34. Ferreira and Henk, " 'Operationalizing' Human Security," 501–25; and R. Williams, "Defence in a Democracy," 205–23.

35. *South African White Paper*, 1.

36. African militaries in general have a relatively unsavory reputation in Africa, in many cases well deserved. This reputation undermines effective communication within African public sectors and compromises the willingness of officials outside the security sector to communicate with their military counterparts. For further discussion of these issues, see Howe, *Ambiguous Order*, 27–72.

37. Blaike, Blaike, and Blaike, "Elephants, People, Parks and Development," 735–51; Martin, "Yemeni Rhino Horn Trade"; Martin, "Report on the Trade in Rhino Products"; Vigne and Martin, "Taiwan"; Western, "Undetected Trade in Rhino Horn"; Barbier et al., *Elephants, Economics and Ivory*; Balfour and Balfour, *Rhino*; Douglas-Hamilton and Douglas-Hamilton, *Battle for the Elephants*; Leader-Williams, *World Trade in Rhino Horn*; Bonner, *At the Hand of Man*; Ricciuti, "Elephant Wars," 14–35; Ellis, "Of Elephants and Men," 53–69; Sas-Rolfes, *Rhinos*; and du Bois, "Illegal Trade in Endangered Species."

38. Henk, "Botswana Defence Force," 170–91; Henk, "Biodiversity and the Military"; and Henk, *Botswana Defense Force*.

39. "Strategic Partnership." For additional details, see http://wwf.panda.org/who_we_are/wwf_offices/mozambique/.

40. Thomas Schultheis (US European Command environmental officer, Stuttgart-Vaihingen, Germany), personal communication with author, 24 February 2005; Lt Col Brian P. Smith (US Air Force, chief of the Office of Defense Cooperation), interview by the author, 11 June 2005, Pretoria, South Africa; and Col Seakle Godschalk (director of the Environmental Office in the Headquarters, South African National Defence Force), communications with the author, 2004–2006, Pretoria, South Africa. See also Godschalk, "Protecting Our Environment," 24–27.

41. Cilliers, *African Standby Force*.

42. "Symposium," 1–99; and Ploch, *Africa Command*. For some African concerns, see Malan, "AFRICOM."

43. For illustrative detail, see *The Africa-EU Strategy Partnership*; and Toth, "Historical Duty or Pragmatic Interest?"

44. For the European analogy, see Haas, *Beyond the Nation-State*. Significantly, at a time when military-to-military relations between the United States and two countries in southern Africa were fraught by political disagreement, amicable military cooperation and communication continued over issues of the environment. Henk, "Environment, the US Military," 107–10.

improvements in intelligence gathering tools have made it easier to discriminate between military and civilian targets and to strike only those of a military nature. Moreover, this capability greatly reduces the attacker's risk. Modern air warfare reduces casualties among both the attackers and the attacked, making it an increasingly efficient, effective, and humane tool of US foreign policy. Unfortunately, ground war remains extremely deadly, and the use of weapons such as landmines and cluster munitions continues to exact a high toll on civilians. International law, ostensibly designed to limit the suffering of civilian noncombatants in war, falls short in important areas. Deadly activities and weapons—largely policy weapons such as sieges and economic sanctions—continue to kill civilians and cause untold suffering. These horrific weapons should now become our focus.

The Theory

The Law of Armed Conflict governs whether or not a war is just as well as what actions are permissible in it. Some laws have been agreed to by international treaty, as in the Geneva conventions of 1949. In the absence of codified law, nations turn to customary usage or the just war tradition that has developed over several centuries and has, seemingly, consistently stressed the immunity of noncombatants.[2]

The inauguration of balloon flight during the nineteenth century presented potentially new dangers to civilians, so in 1899 delegates from 26 nations met at The Hague to discuss limitations on the use of airships as weapons. Attendees agreed to a prohibition on the dropping of explosives from balloons to remain in effect for five years. When the stricture lapsed in 1904, an attempt was made to reinstate it. The prohibition was not renewed since only Britain and the United States supported an extension.[3] This was the only international attempt to limit air war prior to 1914. World War I saw strategic bombing conducted by all major belligerents. These attacks were highly inaccurate due to the primitive navigation and bombing equipment of the day.[4] Even so, bombing claimed only a small number of noncombatants—1,413 dead in Britain and perhaps a few thousand more scattered throughout the rest of Europe.[5]

In contrast, nearly 15 million died in the war, and this carnage had a profound impact on survivors. After the armistice the great powers began discussing disarmament, and a commission of jurists met at

The Hague in 1922–23 to draw up guidelines for regulating air warfare. Rules were drafted, but political and military leaders rejected the restrictive and impractical language. As a result, no country ratified the treaty.[6] More talks at the Geneva Disarmament Conference in 1932 also proved fruitless.[7]

As war approached in 1938, the League of Nations passed a nonbinding resolution prohibiting the intentional bombing of civilian populations, bombing of other than military objectives, and attacks that negligently imperiled the civilian population.[8] This was a meager effort, and in 1938 British jurist J. M. Spaight wrote, "The law of bombardment is very far from being clear. . . . It is indeed in a state of baffling chaos and confusion that makes it almost impossible to say what in any situation the rule really is. . . . From one point of view one might say, indeed, that there is no law at all, for air bombardment."[9]

Military commanders attempted to modify the existing rules regarding war on land and sea but were not successful. For example, armies could bombard a defended fortress even if it contained civilians—Atlanta in 1864, Paris in 1871, Alexandria in 1882, and Port Arthur in 1904. Using these precedents, Airmen later reasoned that when Allied bombers flew over German-occupied Europe and were shot at by tens of thousands of antiaircraft guns and intercepted by hundreds of enemy fighters, all of Nazi-occupied Europe was, in effect, a "defended fortress." Of greater relevance (and confusion), international law permitted navies to shell undefended fortresses and cities to destroy the military stores and facilities—Canton in 1856, Tripoli in 1911, Beirut in 1912, and German coastal raids against England in 1914 and 1916. Sailors were given wider latitude in shelling civilians because navies could not occupy a port as an army could. Aircraft, like ships, could not occupy a city, defended or otherwise, so the permissive rules of sea warfare were more applicable to air war.[10] Debates continued, but limitation attempts failed because the airplane offered an escape from the hecatomb of the world war. No one wished to return to the trenches, so military and civilian leaders were reluctant to emasculate a weapon offering relief from that nightmare.

Political and military leaders' ambivalence in addressing the legal issues regarding air warfare was also present among those devising a doctrine for employing the new weapon that offered both great hope and great uncertainties. Theorists and practitioners believed the airplane revolutionized warfare by allowing different strategies, doctrine, and organization. Novelists such as Jules Verne and H. G. Wells

imagined aerial navies raining bombs and terror on urban populations, causing panic and pressure for peace. Some early military theorists took a similar approach. Italian general Giulio Douhet described airpower's destructive potential and paradoxical peaceful intent in terms that echoed the dire predictions of the novelists:

> Who could keep all those lost, panic-stricken people from fleeing to the open countryside to escape this terror from the air? A complete breakdown of the social structure cannot but take place in a country subjected to this kind of merciless pounding from the air. The time would soon come when, to put an end to horror and suffering, the people themselves, driven by the instinct of self-preservation, would rise up and demand an end to the war—before their army and navy had time to mobilize at all![11]

Air leaders in Britain and the United States rejected such apocalyptic visions and instead argued that airpower would shorten wars and make them less bloody. They theorized that it was possible, in principle, to shoot the gun out of the enemy's hand—to disarm by disrupting the enemy's industrial war production.

The British Royal Air Force (RAF) and the US Army Air Forces (USAAF) entered World War II with doctrines stressing precision bombing of enemy industrial centers. The RAF operations manual stated that the civilian populace was not, as such, a legitimate target. Area bombing was rejected—"all air bombardment aims to hit a particular target," and in every case "the bombing crew must be given an exact target and it must be impressed upon them that it is their task to hit and cause material damage to that target."[12] In August 1939, the month before Germany invaded Poland, the chief of the Air Staff (CAS) sent a message to the head of Bomber Command stating RAF policy in clear terms: "we should not initiate air action against other than purely military objectives in the narrowest sense of the word, i.e., Navy, Army and Air Forces and establishments, and that as far as possible we should confine it to objectives on which attack will not involve loss of civil life."[13] During the campaign in France the following year, the CAS reiterated this policy in a message to RAF commanders—the intentional bombing of civilian populations was illegal; commanders should identify objectives struck in advance; attacks must be made with "reasonable care" to avoid undue loss of civilian lives; and the provisions of international law must be observed.[14] War's realities would soon put these idealistic goals to the test.

Bombing doctrine in the United States was similar. Officers at the Air Corps Tactical School at Maxwell Field, Alabama, believed that a

country's economy was complex but fragile. Key nodes within that economy—the transportation system or specific factories that manufactured crucial industrial components—were disproportionately vital to smooth operation. If this "industrial web" were disrupted, the entire system would suffer debilitating shock waves.[15] The USAAF war doctrine manual listed several potential target systems: raw materials, rail and motor transport, power plants, factories, steel mills, oil refineries, and other similar establishments. There was no mention of targeting population centers or popular will.[16] As in Britain, Douhet's city-busting theories were rejected for a focus on the industrial infrastructure that made a nation's war economy operate.

Although humane standards were important, military efficiency also played a role. An enemy country contained thousands of potential targets—things of value or of importance—but only finite numbers of bombs, planes, and crews were available. Which targets were more vital than others? Prioritization was necessary to separate the critical from the trivial, and industrial strength seemed a logical top candidate.

In addition, airpower strategists in Britain and the United States believed that the precision bombing of military targets would not only disrupt the war economy, but would cause revulsion among the populace who would then clamor for peace. In other words, an air war was so potent that it would deter war, but if war broke out, it would be over quickly, and the number of people killed would be fairly small—especially as compared to the 15 million that died in the Great War. Airpower would humanize war.[17]

Although this notion seems peculiar today, such thinking underpins the nuclear deterrence doctrine operating since the early 1950s. Nuclear war would be so awful as to be unthinkable; therefore, it will not occur (that is, as long as one is prepared to wage it). It was no coincidence that the motto of the Strategic Air Command—the custodian of US nuclear-armed bombers and missiles throughout the Cold War—was Peace Is Our Profession. The nuclear deterrent posture, backed by thousands of nuclear weapons among a number of countries, remains in place today.

The Practice

World War II proved to be far different than predicted. Airpower did not deter armed conflict as had been hoped—although neither

did land power, sea power, or the policy of appeasement. Nor did airpower ensure a short war, although it did make the war shorter—especially in the Pacific.

Germany had bombed urban centers in the Spanish Civil War (Guernica) and in the opening stages of World War II (Warsaw and Rotterdam). In 1940 it was England's turn. In the summer of 1940 Hitler gleefully predicted to Albert Speer:

> Have you ever seen a map of London? It is so densely built that one fire alone would be enough to destroy the whole city, just as it did over two hundred years ago. Göring will start fires all over London, fires everywhere, with countless incendiary bombs of an entirely new type: thousands of fires. They will unite in one huge blaze over the whole area. Göring has the right idea: high explosives don't work, but we can do it with incendiaries; we can destroy London completely. What will their firemen be able to do once it's really burning?[18]

France's fall in June 1940 left Britain alone against Germany, and the ensuing blitz against British cities left the country reeling. Tens of thousands of civilians died under German bombs, but surrender was unthinkable. Yet, Britain could not retaliate with its army—that had been thrown off the continent at Dunkirk—or with an overstretched navy fighting for its life against German submarines and land-based aircraft. The only hope of hitting back at Germany and eventually winning the war lay with Bomber Command, but operations quickly demonstrated that prewar doctrine had been unrealistic. British bombers were too small, too slow, too vulnerable, and too few. German fighters and antiaircraft guns decimated the attackers, so Bomber Command retreated to the safety of night, something for which it was neither trained nor equipped. (The Luftwaffe also suffered problems when bombing Britain in daylight, so the blitz was carried out at night.) Worse, dismal winter weather adversely affected navigation, target acquisition, and bombing accuracy. The Butt Report of 1941 revealed that only 33 percent of bombs dropped during British night attacks fell within five miles of the intended targets; strike accuracy on moonless nights was even more inaccurate.[19] Although Britain's intent was precision bombing, in practice, it became area bombing. Aircrew survival dictated night area attacks, and there was little alternative other than not to attack at all.[20] Moral constraints bowed to military necessity, and this led air leaders down a precarious path.

By early 1942 the RAF's night offensive was targeting German cities, partly out of frustration over abysmal bombing accuracy and partly in retaliation for similar attacks on British cities by the Luftwaffe. The

November 1940 German raid on Coventry had been a turning point—Prime Minister Winston Churchill then directed the RAF to aim for city centers on missions over Germany. "Our plans are to bomb, burn, and ruthlessly destroy in every way available to us the people responsible for creating this war," Churchill said.[21] Air Marshal Arthur Harris, who took over Bomber Command in February 1942, agreed with his civilian superiors about the concept of area attacks.

Philosopher Michael Walzer has examined the moral implications of area attacks.[22] Early in the war British leaders argued that a combination of reprisal, revenge, and military necessity made city bombing both necessary and acceptable. Although rejecting the motivations of reprisal or revenge—in my view far too summarily—Walzer looked closely at the rationale of military necessity. Arguing that the triumph of the Nazi state was too terrible to contemplate, he conceded that in the dark days of 1941, before the Soviet Union and the United States entered the war, Britain's future looked bleak. Britain's only hope of hurting Germany and ultimately achieving victory was through strategic bombing. Given the inaccuracy of the night strikes, it was obvious that thousands of civilians would die if such a strategy were employed. Viewing this strategy as a "supreme emergency," Walzer concluded that although distasteful, it was morally acceptable. However, he then argued that this justification evaporated when the Allies began winning the war. With the specter of defeat no longer looming, Allied armies closing in on the Reich, and bombing accuracy greatly enhanced, city busting lost its necessity and acceptability. At least that is the position of a philosopher writing several decades after the event.

At the time, ultimate victory was not obvious, and J. M. Spaight, the British jurist who had complained of air war's lack of legal guidelines, argued in 1944 that total war meant factory workers and transportation systems were "warriors," not noncombatants. An attacker was therefore "fully entitled to put them out of action." In addition, German cities were all "battle-making towns" and thus legitimate military targets.[23] A more recent study echoes this view. "The cities of Europe and their inhabitants represented not merely another target among many. They stood at the epicenter of modern warfare. They were sites of production; they delivered essential economic and demographic resources to battle." The urban populations "were more than passive victims."[24] War in practice was considerably different from war in theory, and people of intellect and integrity could disagree even on the most basic premises.

US air doctrine also evolved during the war. The USAAF's losses during daylight strikes were severe, culminating in the Schweinfurt mission of 14 October 1943, when 60 B-17s and more than 600 crewmen were lost—over 20 percent of the attacking force. Nonetheless, American air leaders clung tenaciously to their daylight precision bombing doctrine, convinced that only a daylight precision campaign made sense. An invasion of France offered no hope of success before mid 1944, and something had to be done to take the war into Germany and relieve pressure on the Soviets, who were already talking about a separate peace—the route they had taken in 1917. Britain and the United States could not allow that to happen.

The Pacific air campaign also posed problems for the USAAF. Bombing accuracy was worse than in Europe because of the greater distances involved and the unexpected 200 mile-per-hour jet stream at 35,000 feet where the B-29s generally flew. In addition, Allied intelligence concerning Japan's economy was inadequate, due to the closed nature of Japanese society.[25] Japanese industry was less centralized than in Europe—rather than located in large factories near towns, numerous small shops were spread throughout the cities. To destroy an aircraft assembly complex, the Allies had to identify and strike several dozen "cottage factories" or destroy a large section of the city, eliminating the dozens of small factories it contained. Area bombing could be done at night with less risk to the attackers, but it crumpled the idea of not targeting the population that had been US doctrine for two decades.

The war had to be won, however, and Japan was a particularly tenacious opponent—more than 20,000 Americans died at Iwo Jima and Okinawa; the Japanese defenders suffered nearly 150,000 fatalities. Moreover, on Okinawa over 160,000 civilians died—caught in the crossfire between the opposing armies.[26] One can debate the numbers of projected casualties that would have resulted in the planned Allied invasions of the home islands, but such landings would likely have cost millions of American and Japanese lives. Air attacks, culminating in the two atomic strikes, seemed an expedient alternative and no less inhumane than starvation of the civilian populace through the slowly tightening naval blockade or the vicious and bloody land campaigns already scheduled.[27]

An important issue often overlooked regarding strategic bombing attacks concerned efforts taken by defenders to thwart the bomber crews. Germany and Japan were trying to decrease the accuracy of

Allied attacks. Indeed, the RAF's move to night operations in 1940 was a result of successful German air defenses. But at night, the Germans blacked out city lights and jammed radio navigation signals designed to help the bombers pinpoint their targets. To fool the USAAF bombers in daylight, the Germans and Japanese built fake factories, camouflaged real ones, and built smoke generators to deliberately obscure targets. They launched hundreds of interceptor planes and thousands of artillery shells to shoot down the bombers. These activities greatly distracted the bomber crews, making their aim less accurate. Consequently, they often missed the intended targets and bombed something else, resulting in civilian casualties.[28] Who was responsible for this collateral damage—the crews that dropped the bombs or the defenders that deliberately worked to make those bombs hit something else, usually innocent people? Unquestionably, many noncombatants were killed in the Allied air attacks of World War II, but relative to the total number of deaths in the war, air attack—as had been predicted by prewar air theorists—was a surprisingly discriminate weapon.

Perhaps 40 million civilians died during World War II. Of those, the US Strategic Bombing Survey states that 635,000 died in Germany and Japan due to Allied air attacks.[29] The Germans and Japanese claim the number is higher. Hans Rumpf, Germany's general inspector for fire services during the war, estimates that over 600,000 died in Germany alone. He states that a further 182,000 civilians died in other European countries as a result of air attack, including 60,000 in Britain killed by German bombs, rockets, and missiles.[30] Even so, these numbers are a fraction of the total war dead. For example, over six million people died at the hands of the Japanese; however, less than 600,000 of those died via air attack. Indeed, the Japanese murdered over 100,000 Chinese at Nanjing using small arms and swords.[31] Thus, even if using the maximum of two million dead due to air attack, 95 percent of the civilians killed in World War II were claimed by genocide or traditional means of land and sea warfare; they were shot, shelled, or starved to death or succumbed to disease.

The plight of civilians subjected to air attack—at least as practiced by the West—improved after 1945. Many noncombatants died in both the Korean and Vietnam Wars, but statistics for the Korean War are unreliable.[32] Guenter Lewy, professor emeritus of political science at the University of Massachusetts, provides plausible figures for Vietnam. According to his research, around 587,000 North and South

Vietnamese civilians were killed in the fighting. Of those, the Vietcong assassinated 39,000 South Vietnamese people, and another 65,000 civilians died in US bombing operations over North Vietnam. The bulk of the Vietnamese noncombatant dead, 483,000, were killed in South Vietnam. Based on admissions to South Vietnamese hospitals between 1967 and 1970, Lewy estimates that 66.5 percent of all injuries resulted from mines, mortars, guns, or grenades. Shelling or bombing injured the other 33.5 percent. If these percentages are used for the entire war, if we assume that the number of those injured by shelling or bombing are equal (Lewy does not break this category down), and if we assume that those killed met their fates in the same percentages as did those who were wounded—and these are big ifs—then of the 587,000 Vietnamese civilians that Lewy states were killed during the war, around 146,000 (25 percent) died from air attacks. The other 75 percent, over 440,000 people, were killed by ground or naval action.[33]

The number of civilian casualties in conflicts involving the United States has dropped dramatically since Vietnam. Greenpeace estimated that 5,000 Iraqi civilians were killed by air attack in the 1991 Gulf War, but other researchers put the figure at less than 1,000.[34] Although thousands of tons of bombs were dropped on Iraqi targets during Desert Storm, damage to the civilian population was minor, which amazed Western observers. Milton Viorst wrote, "Oddly, it seemed, there was no Second World War–style urban destruction, despite the tons of explosives that had fallen. Instead, with meticulous care—one might almost call it artistry—American aircraft had taken out telecommunications facilities, transportation links, key government offices, and, most painful of all, electrical generating plants."[35] Another visitor, Erika Munk, wrote in similar terms, "We expected to find enormous unreported destruction. . . . Instead we found a city whose homes and offices were almost entirely intact, where the electricity was coming back on and the water was running. . . . I think the reason we didn't see more destruction was that it wasn't there." Munk estimated that the maximum number of civilians killed during the six-week air campaign was 3,000.[36] This is a sizeable figure, but not in comparison to the estimated one million plus Iraqis (most of them children) who, according to the United Nations Children's Fund and the World Health Organization, died as a result of UN sanctions put in place before the war but not lifted until after the second Gulf War of 2003.[37]

The next sizable conflict involving the United States was in 1995 when force was used to halt the fighting in Bosnia. According to Serbian president Slobodan Milosevic, perhaps 25 civilians died from NATO's three-week air campaign. To stop the ethnic cleansing by the Serbs in Kosovo, NATO launched Operation Allied Force in 1999. After a 78-day air campaign, Milosevic capitulated. Despite the duration and intensity of this air campaign, Human Rights Watch estimated that fewer than 500 civilians were killed.[38]

Statistics for the wars in Afghanistan and Iraq are inconsistent, running from 500 to 1,300 dead in Afghanistan through 2002, and from 3,000 to 7,000 dead for the first six months of the Iraq campaign.[39] Human Rights Watch states that "the ground war caused the vast majority of deaths," noting that ground-launched cluster bomb munitions caused 90 percent of all civilian casualties at al-Hilla.[40]

The Iraq Body Count (IBC) provides another account of civilian casualties in Iraq. This organization has determined that through 2008, about 85,000 Iraqi civilians died as a result of the war. Of these, about 9,500 were the result of air strikes (11.3 percent of the total). Significantly, not only have the numbers of civilian deaths decreased since 2005, but the percentage of deaths attributable to air attack has also decreased to 2.6. In other words, the IBC calculates that over 97 percent of the 60,922 Iraqi civilians killed since 2005 have been the victims of ground warfare.[41]

The Israelis went through a similar trend in their military operations against Hezbollah and Hamas. Prior to 2004 the ratio of noncombatants to terrorists killed was around 1:1. At that point the Israeli Air Force changed its rules of engagement, tactics, ordnance, and intelligence procedures. The ratio improved to 1:12 in 2004, 1:28 in 2005, and 1:24 in the first half of 2007. In the second half of 2007 the ratio was a remarkable 1:100. However, the Israelis note that operations in densely populated areas in southern Lebanon and Gaza, where significant Israeli ground forces were employed and which required extensive air support, once again pushed the ratio down to around 1:1.[42]

The low numbers of deaths due to airstrikes are remarkable, especially when compared to the alternatives of sanctions or a traditional land campaign. In the ambush and subsequent firefight between US Army Soldiers and Somalis in Mogadishu in October 1993, for example, 18 Americans were killed and another 82 wounded, but between 500 and 1,000 Somali civilians were gunned down in that 24-hour period.[43]

What has caused the remarkable drop in casualties in air warfare? Largely, it is a result of precision-guided munitions (PGM). Although PGMs were used in the Vietnam War, Desert Storm was the first conflict where they played a major role. There are various types of PGMs: electro-optical, infrared, cruise missiles using ground-tracking radar, and laser-guided bombs. The laser-guided bomb was the most widely heralded "new" weapon of Desert Storm. Because of cockpit videos necessary to track laser bombs, the world saw memorable film clips of bombs flying down airshafts and through bunker doors. Nonetheless, of the more than 200,000 bombs dropped during Desert Storm, fewer than 17,000, or slightly more than 7 percent, were PGMs.[44] Only a small percentage of aircraft in the US inventory were equipped to drop such weapons.

Following Desert Storm the numbers and types of PGMs increased. PGM use increased to 35 percent over Kosovo in 1999. In Afghanistan the number jumped to 56 percent, and in Operation Iraqi Freedom (OIF) 70 percent of all bombs dropped were PGMs. All US strike aircraft can now deliver these munitions.[45] The types of PGMs available have also expanded and been improved to allow greater accuracy and flexibility. The global positioning system–aided joint direct attack munition (JDAM), which can bomb through clouds or sandstorms, made its debut over Kosovo. A laser-guided JDAM, first employed in Iraq in August 2008, allows precision strike against moving targets.[46] The standard figure given for JDAM accuracy is five meters, but those who employed the weapons in OIF say accuracy was far better than advertised.[47]

Yet, PGMs are only as good as the intelligence used to guide them. If it is now possible to put a bomb through a specific window of a particular building, then it is essential to ensure that it is the correct window. Sensors have grown in number and resolution capability over the past two decades. Space-based cameras and radar can produce resolutions of a few feet. Airborne sensors have a similar performance, and spotters on the ground have sophisticated Global Positioning System (GPS) rangefinders and laser designators to accurately locate and mark potential targets.

The impact of increased PGM use has been profound. One PGM is equivalent to dozens if not hundreds of unguided bombs in the effects that it achieves—neutralizing the target. Besides lowering the risk to the attacking aircrew (fewer aircraft/sorties are needed, thus putting fewer crewmembers at risk), PGM use dramatically reduces the amount of collateral damage.

Perceptions of Air War and the Use of Force

Yet the negative reputation that airpower had been saddled with after World War II was difficult to shake. Strategic bombing brought to mind Dresden or Hiroshima.[48] Those events were certainly horrible, but it is important to remember that far more civilians died in the siege of Leningrad (over one million) than died in all of the bombing raids on Germany and Japan combined.[49]

Why did airpower get such bad press through the end of the Cold War? Several possible explanations exist. First, the psychological trauma produced by aerial destruction can be profound: it can occur with little or no warning and in a greatly compressed period of time. Land and sea warfare effects are generally felt only over the long term. The Romans destroyed Carthage as totally as the United States did Hiroshima, but it took the Roman legions several years; it took one B-29 two minutes. It was the conquest of time, not of matter, that so shocked the world.

Second, airpower is violent and graphic, whereas a blockade is seen as nonviolent and bloodless. A RAND study refers to airpower, and especially any collateral damage caused by it, as being "mediagenic." The study notes that collateral damage incidents are four times more likely to be reported on television than in the print media.[50]

Third, some view airpower as less noble than close combat and question the "morality of distance." A Marine Corps general recently commented: "There comes a point when a country puts young folks at risk because it becomes important for them to defend a certain way of life. . . . From a Marine point of view, we can't lose our honor by failing to put our own skin on the line."[51] To those of such ilk, it is only honorable to kill if there is a good chance you will be killed in return. Such thinking is, to me, astonishingly foolish. Airpower offers a far more intelligent and humane alternative.

Dramatic advances in weapons technology permitting previously impossible accuracy have been crucial to limiting collateral damage; yet a tension remains between risk to friendly forces and accuracy seeking to limit collateral damage, and sometimes this issue is misunderstood. For example, during the 1999 Kosovo air campaign allied aircraft were directed to remain above 15,000 feet to avoid enemy ground fire. Some have argued that this policy was immoral or illegal because it induced inaccurate bombing, thus increasing collateral damage and civilian casualties.[52]

In truth, a PGM is most accurate when dropped from medium to high altitude, because that allows time for the weapon to correct itself in flight. If dropped from a lower altitude, the weapon will have less kinetic energy, and its steering fins will have less time to correct the aim; the weapon will usually hit short. From the pilot's perspective, higher altitude also allows time to identify the target at sufficient distance, designate it (if laser guided), and launch the weapon. The optimum altitude to ensure accuracy is above 15,000 feet for PGMs against a fixed target.

In contrast, the optimum drop altitude to ensure accuracy for nonguided munitions is lower than for a PGM. Even so, target acquisition by the aircrew remains a limiting factor; coming in too low at 500 knots makes it nearly impossible to acquire the target, line up, and drop the bomb accurately. As a result, the best altitude for delivering unguided weapons is around 5,000 feet. However, this places the aircraft right in the thick of fire from ground defenses. Air commanders resolved this dilemma by keeping aircraft at medium altitudes but restricting the use of non-PGMs to areas where there was little or no chance there would be civilian casualties or collateral damage.

A difficulty arises when attacking mobile targets, where the key factor becomes identification. Is the column below comprised of military or civilian vehicles; if both, which are which? At medium altitudes it is difficult to make such a distinction. On 14 April 1999, near Djakovica, Kosovo, NATO pilots attacked what intelligence sources had identified as—and which indeed appeared to be—a military column. It is now known the column also contained refugees—the Serbs illegally commingled military and civilian vehicles. As a result, several dozen civilians were killed in the airstrikes.[53] Could this accident have been avoided if the aircraft had flown at a lower altitude? Perhaps. Indeed, NATO then changed the rules, allowing aircraft in certain circumstances to fly lower to ensure target identification. There is a tradeoff in such instances: if flying lower increases the risk to aircrews, at what point does the risk of misidentifying a target override the risk of losing a plane and its crew? If incurring friendly losses meant the shattering of the alliance, was that preferable to Milosevic continuing his atrocities unchecked?

The drive to limit civilian casualties and collateral damage has generated great scrutiny among military planners. Since the air campaign in Kosovo, a special software program has been used, appropriately termed "Bugsplat," which predicts the amount of damage that

could occur for a given airstrike. Planners examine a computer-generated map of the target area that contains details regarding the size, construction materials, and function of surrounding buildings. Planners can specify the type of bomb used, warhead size, attack path, fuse setting, and other factors for a specific target. The computer program then estimates how much damage, if any, would occur to nearby buildings if a munition hit on target or if it missed. Based on the results, planners can then modify the size of the warhead, weapon type, attack path, and other variables to drive the anticipated damage results lower.[54] In some cases, the target might be avoided altogether if Bugsplat indicates that significant collateral damage would occur.

Even so, mobile targets pose special problems. Because of their nature, aircrews have less time to determine their identity. For example, if a suspected Scud missile launcher is seen headed for a tunnel, the pilot must quickly decide to either hit it—and risk that it is actually a civilian fuel truck—or hold up, allowing the vehicle to escape. If it is a Scud, it could reemerge an hour later, after the aircraft is gone, and launch, perhaps against civilian targets. Finding the means to accelerate the decision making for hitting mobile/fleeting targets to enhance military effectiveness, while still assuring the protection of civilians, will not be an easy task.

The Challenges Ahead

Jus ad bellum and *jus in bello* are different but related concepts: the first refers to reasons for going to war, and the second relates to actions during the war itself. There is a separation between these concepts because military actions in war should not be judged according to the validity of the reasons politicians chose to prosecute the war. Combatants may not exceed the law just to remove a particularly nasty opponent. This is not the case in Islamic law where a just cause allows "any means to further that cause."[55] Indeed, Osama bin Laden argued that since the United States is evil and makes war on Muslims, all Americans are likewise guilty and deserve to die—making no distinction between military and civilians.[56]

Regardless, for a variety of reasons, the separation between *jus in bello* and *jus ad bellum* is breaking down. Internationally sanctioned interventions are more prevalent, being justified as humanitarian. In

some cases, like Kosovo and Afghanistan, the West partly justified intervention to prevent genocide and other war crimes committed in civil wars (thereby setting controversial precedents). Since intervention was justified in moral terms (*jus in bello*), the application of force had to be above reproach (*jus ad bellum*). The world expected much higher standards of conduct from coalition forces in Kosovo, Afghanistan, and Iraq than were required of those they were fighting.

Part of the problem is that military planners are tied to an archaic, Clausewitzian view of war that emphasizes the destruction of the enemy's armed forces.[57] Targeting is therefore considered legal because it is applied to military forces and those things that support them.[58] For example, a factory making military equipment is a legitimate military target. A factory making women's dresses might be attacked because it is owned by the enemy dictator's brother and striking it increases pressure on the dictator to make peace. Many lawyers would argue that striking that target would be illegal since the target was not "military" per se. Such a view stems from an outdated view of warfare. Airpower makes coercive strategies increasingly possible—with less loss of life and damage to both sides. The law must catch up to airpower's increasingly effective coercive capacity.[59]

Another dilemma concerns the requirement that military commanders protect the lives of their own forces and not put them at undue risk, while simultaneously limiting noncombatant casualties and property damage. Deliberate commingling military targets with civilians has aggravated this dilemma. Examples include placing surface-to-air missile sites on or near hospitals and schools, installing a military communications center in the basement of Baghdad's al-Rashid Hotel, or simply using civilian refugees as shields, as the Serbs did in a military encampment in the woods near Korisa, and as the "Fedayeen" did south of Baghdad.[60]

Those activities were illegal, but what response is appropriate? Allowing these practices to go unpunished is rewarding bad behavior, but is there an alternative to turning the other cheek, especially when the price for doing so could be increased military casualties?

This is a contentious issue that centers on an interpretation of the rules of discrimination and proportionality. Tactically, the United States generally responds by using more PGMs, more accurate PGMs, nonlethal weapons, and restrictive rules of engagement. Examples include coalition aircraft at times using concrete-filled bombs to limit collateral damage and certain types of military targets, like bridges,

being struck only at night to minimize the possibility of injury to civilians. But what if these efforts at mitigation are insufficient?

Targeting lies at the heart of this. Some targets are considered "preplanned" while others are not. The problem of "pop-up" or fleeting targets has already been noted: what if a target presents itself and there is little time to analyze it? Then what if the enemy ground forces are attacking friendly troops? This situation, termed "troops in contact," has proved an especially thorny problem. Ordinarily, preplanned targets are thoroughly vetted in advance of an airstrike to ensure that intelligence has identified the correct target and that collateral damage will be held to a minimum—the Bugsplat process noted above. The degree of collateral damage expected determines the necessary level of authority—the air commander, the theater commander, or even the president—required to authorize the airstrike. In a troops-in-contact situation, this process is bypassed. Forces under attack on the ground often call in airstrikes to assist them. The strike location provided might be GPS coordinates or might just be a rough description of a building the enemy is firing from. Pilots then do their best to identify the enemy location and deploy their weapons to effectively strike that location. It is in this situation where most mistakes occur.

Human Rights Watch completed a study of collateral damage incidents in Afghanistan and determined that the vast majority of cases where air-delivered weapons caused civilian casualties were troops-in-contact situations. The statistics are compelling. Of 35 airstrikes involving collateral damage during 2006 and 2007, only two were preplanned strikes. Over 95 percent those airstrikes involved troops in contact—instances when the rigorous safeguards taken to avoid collateral damage were necessarily bypassed.[61] Out of 5,342 airstrikes flown by coalition air forces that dropped "major munitions" during 2006 and 2007, a mere 0.66 percent of that total caused collateral damage.[62] Yes, any mistake is deplorable, but that is still a remarkably small number.

It should thus not come as a surprise when the US death toll in Afghanistan began building toward a new high in 2009 that an Army spokesman stated bluntly, "It is what we expected. We anticipated that with forces going in, increased number of troops, increased engagement, you are going to have increased casualties."[63] The solution to lowering casualties, on both sides, seems apparent: avoid putting in ground forces.

The priceless ruins of ancient Babylon have suffered grievously at American hands. The US Army actually turned these ruins into a military base, Camp Alpha, causing "major damage" according to the United Nations Educational, Scientific, and Cultural Organization. The report of the UN's cultural agency stated that "foreign troops and contractors bulldozed hilltops and then covered them with gravel to serve as parking lots. . . . They drove heavy vehicles over the fragile paving of once-sacred highways." When fortifying this new base, the Soldiers "built barriers and embankments . . . pulverizing ancient pottery and bricks that were engraved with cuneiform characters." Among the structures suffering most was the famed Ishtar Gate; the damage will be extremely difficult if not impossible to repair.[64]

It is of more than passing interest that the former Russian Federation ambassador to Afghanistan, Zamir Kabulov, believes that the United States has repeated all the major mistakes that the Soviet Union made after invading Afghanistan nearly 30 years ago. He stated, "After we changed the regime, we should have handed over and said goodbye. But we didn't. And the Americans haven't either." Kabulov is especially critical of President Obama's plan to send in more ground troops—the same strategy that backfired on Moscow: "The more foreign troops you have roaming the country, the more the irritative allergy toward them is going to be provoked." The Taliban seem to agree with that assessment, as they stated in an interview conducted by a British reporter. The subsequent article's title says it all: "The More Troops They Send, The More Targets We Have."[65] This is a depressing prophecy.

It is alarming, but should not be surprising, that recent polls show that Afghanis blame the United States and NATO more than the Taliban for their country's travails: only 47 percent have a favorable opinion of the United States, and 25 percent actually hold that attacks on US/NATO forces are justified.[66]

Such animosity appears to be mutual. A US Army report on the mental health of Soldiers and Marines serving in Iraq contained some remarkable findings. When asked, 62 percent of Marines and 53 percent of Soldiers responded that they felt noncombatants need not be treated with dignity and respect. Worse, 60 percent of all Marines surveyed and 45 percent of all Soldiers stated that they would not report a unit member that they saw killing an innocent noncombatant. These are astounding findings, reported by the military itself, which cast an ominous cloud on ground operations.[67]

Aircraft were first used in war in 1911 when Italy fought the Ottoman Empire in Libya. When an Italian aircraft bombed Turkish infantry positions, the Turks claimed, falsely, that it had struck a hospital and killed several civilians.[68] It would seem that the propaganda value of collateral damage caused by air attack, both real and imagined, was recognized nearly as quickly as the importance of bombing itself. Given the seriousness of collateral damage incidents, it is surprising that the US military has not been more proactive in investigating incidents and then releasing findings. When asked about this, one high-ranking military public affairs officer responded that such activities "were not command essential."[69] This is shortsighted. The military's access to numerous sensors, videos, pilot reports, and reports from personnel on the ground means that no one is better able to determine the facts.[70] If this responsibility is abdicated, then someone else will fill the information vacuum with reports, probably inaccurate and fragmentary, that will be accepted as true. The Israelis have formed special teams that accompany all ground units into action with the mission to conduct "operational verification." Armed with video cameras and tape recorders, they "document the story in real time" to counteract the tales spread by terrorists.[71]

The "war on terror" highlights many of the challenges noted above. Terrorists often use illegal methods and weapons to achieve their goals; yet they are often shielded from the consequences of their illegal acts. Terrorists often operate in urban areas, deliberately commingling with civilians and occupying protected structures such as mosques and schools. They are well aware that the United States and other Western countries will be loath to strike—which they would be legally entitled to do—for fear of collateral damage and international censure. Terrorists are capable of blending into the civilian populace, making it extremely difficult to track them, much less strike them.[72] These are all formidable challenges for any type of military force to address, including airpower.

Conclusions

We must confront what one could cynically call "the myth of noncombatant immunity." The noble attempts to reduce the suffering of noncombatants during war only paste a fig leaf on the problem. In reality, civilians have always suffered the most in war. This was never

truer than in the twentieth century, when estimates of those who died in war ranged as high as 175 million, the majority of whom were noncombatants. Worse, the number of civilians dying in war as a percentage of total deaths has increased dramatically over the past century. These statistics indicate that the principle of noncombatant immunity is at best a goal we have tried unsuccessfully to achieve, but at worst a myth that hides the truth. Innocent people have always suffered the most in war, especially in the traditional forms of land and sea warfare. Throughout the past century, indiscriminate killers included unrestricted submarine warfare, landmines, blockades, sanctions, sieges, artillery barrages, starvation, and genocide—as well as some bombing operations in World War II, Korea, and Vietnam.

Centuries of evidence show that blockades, sanctions, and sieges have a percolating effect: they start killing at the bottom levels of society and slowly work their way upwards. Over one million civilians died at Leningrad during World War II, while more than 20,000 civilians died at Sarajevo in 1993; yet sieges are still legal under international law.[73] Regarding blockades, the more than 800,000 German civilians who died as a result of the Allied starvation blockade in World War I were not soldiers, politicians, or even factory workers.[74] Instead, the first to die were the old, the young, and the sick. Eventually, and only very slowly, did the effects reach the upper levels of society. Such odious results also were the norm in Iraq during the 1990s as a result of sanctions imposed by the UN to pressure Saddam Hussein, sanctions that killed over one million civilians; it was not Saddam Hussein and his generals who went to bed without their supper.

The sanctions imposed on Haiti between 1991 and 1993 in an attempt to push out the military junta in power were similarly egregious. During those two years the Haitian economy was devastated: unemployment soared to 70 percent, inflation doubled, GDP dropped 15 percent, and 1,000 children died each month as a direct result of the legally levied sanctions.[75] Small wonder that two observers wrote a critical and cynical article on the matter titled "Sanctions of Mass Destruction."[76]

Some have argued that such suffering is the fault of the country's leaders, who refuse to give in or who hoard food and medicine for themselves—and not the responsibility of those who impose these deadly sanctions. History shows, however, that countries usually react to attacks in war by accepting casualties to achieve their objectives, and they will protect whatever allows them to continue the

fight. They will sacrifice the weakest segments of society so that the strong can fight on. Nations at war for their survival (or at least the survival of their leaders) cannot afford to take a "women and children to the lifeboats first" stance. Thus, dozens of cases over several centuries demonstrate what should have been anticipated after the US and UN leaders imposed sanctions on Iraq and Haiti. It is disingenuous to claim afterwards that they did not know the gun was loaded. In truth, blockades and sanctions are deliberately genocidal policies that must be outlawed.

It is time to return to the basics. If the intent of international law is to limit civilian deaths in war, then we should look at the past century to see what methods of war and which weapons have been most destructive and move for legislation to limit them. The arithmetic is clear. The biggest killers have been blockades, sanctions, sieges, landmines, artillery, small arms, genocide, starvation, and despotic rulers who murdered their own people to consolidate power. These are the areas that the law should examine, rather than concern itself with putting further restrictions on airpower, which has proven to be, as Marc Garlasco from Human Rights Watch has stated, "probably the most discriminate weapon that exists."[77] To continue to put additional restrictions on what targets can be attacked from the air, with what weapons, and in what manner, makes little sense. It may reduce the number of civilians killed in war by a hundred people here or there, but it will ignore the hundreds of thousands who die in traditional forms of war. Focusing on airpower, as if it were the real problem, is akin to rearranging the deck chairs on the *Titanic*.

It must be our goal and the main focus of the law to employ weapons and strategies that limit collateral damage and civilian casualties. Clearly, the events of the past two decades have revealed the stark contrast between the discriminate and precise nature of air warfare—especially as conducted by the United States and its allies—and that of land warfare. But even more to the point, the appalling slaughter of one million Iraqi civilians as the consequence of UN-imposed sanctions must become the primary focus of the legal community. There is a gaping hole here that must be filled; yet it is barely even acknowledged. War is indeed hell. People suffer in war, innocent people, and this is precisely why countries try to avoid war and why they decide to end it. The challenge is to fight only when it is necessary and then to exercise forbearance in war, while also achieving the stated political objectives. Airpower now offers the greatest possibility of achieving

these diverse goals, which means international law must turn its focus to the far more prevalent and deadly threats.

Notes

1. Elliot, *Twentieth Century Book of the Dead*, 154, 161. According to Elliot, "demographic violence" is when government forces fire on protestors.

2. For historical background on the just war tradition, see James Turner, *Just War Tradition*. For an update, see his *Morality and Contemporary Warfare*. It is an ironic paradox that at the same time international efforts to put legal restrictions on war have increased over the past century, so have the number of noncombatants killed.

3. Royse, *Aerial Bombardment*; and Watt, "Restraints on War," 57–65.

4. Kennett, *First Air War*; and Fredette, *Sky on Fire*.

5. Royse, *Aerial Bombardment*, 181. Of note, 10 times as many British noncombatants were killed on ships attacked by German submarines or that struck German mines than were killed by German air raids (13,333 and 1,620 dead, respectively). Micheal Clodfelter, *Warfare and Armed Conflicts*, 427.

6. Wyman, "First Rules of Air Warfare"; Brune, "Effort to Regulate," 183–85; and P. Williams, "Legitimate Targets in Aerial Bombardment," 574–76.

7. For an overview of the attempt to put limits on war, and especially airpower, see Meilinger, "Clipping the Bomber's Wings," 306–30.

8. Leroy, "Limitations on Air Warfare," 27. For the text of the resolution, see Schindler and Toman, *Laws of Armed Conflict*, 221–22.

9. Spaight, "Chaotic State of the International Law," 25. Spaight had been a British delegate to The Hague Commission of Jurists in 1922–23.

10. For a discussion of the attempt to shoehorn air operations into laws designed for war on land and at sea, see Parks, "Air War"; and Spaight, *Air Power and the Cities*. Of interest, more than three decades after World War II, the US Air Force published a manual on the legal aspects of air warfare in which it defined cities located behind enemy lines as "defended fortresses." US Air Force Pamphlet 110–31, *International Law*.

11. Douhet, *Command of the Air,* 58. The book was written in 1921 and revised in 1927, but the first English translation did not appear until 1942.

12. Royal Air Force, *War Manual*, I/10. This reasoning was the same as that espoused by Prime Minister Neville Chamberlain before the House of Commons in June 1938. Meyer, "Tearing Down the Façade," 152.

13. Air Chief Marshall Newell to Air Chief Marshall Ludlow-Hewitt, message, 23 August 1939, The National Archives, Kew, UK (TNA): AIR 75/8.

14. Chief of the Air Service to all Air Officers Commanding, message, 4 June 1940, TNA: AIR 8/283.

15. For the best overviews of US air doctrine prior to World War II, see McFarland, *America's Pursuit of Precision Bombing*; and Biddle, *Rhetoric and Reality in Air Warfare*. For typical examples of Air Corps Tactical School (ACTS) lectures on the subject of strategic bombing of an industrial web, see "ACTS: Bombardment Text" and "ACTS: Bombardment Aviation."

16. US Army Field Manual 1-5, *Employment of Aviation*, 36.

17. Ader, *Military Aviation*, 27.

18. Sebald, *On the Natural History of Destruction*, 103–4. At the time, Albert Speer was Hitler's chief architect; later he would become the minister of armaments production. Reichsmarschall Herman Göring commanded the Luftwaffe.

19. Webster and Frankland, *Strategic Air Offensive against Germany*, vol. 4, 205–13. Due to improvements in radar/radio navigation and bombing aids, accuracy improved throughout the war. By the end of 1944, more than 80 percent of RAF bombs were falling within three miles of the aim point. US Strategic Bombing Survey (USSBS), "Description of RAF Bombing."

20. Britain attempted a starvation blockade of Germany, like it had imposed in World War I, but Hitler had overrun so much of Europe that the blockade had only a minor effect. Nevertheless, there were local shortages and hardship, especially in Greece, where starvation threatened the populace with "decimation" in 1942. Medlicott, *European Blockade*, vol. 2, 272. See also Beaumont, "Starving for Democracy," 57–82.

21. Webster and Frankland, *Strategic Air Offensive against Germany*, vol. 2, 215; and Batchelder, *Irreversible Decision*, 175.

22. Walzer, *Just and Unjust Wars*, 253–63. A similar argument is made in Cohen, *Arms and Judgment*, 129–44.

23. Spaight, *Bombing Vindicated*, 76–77, 112.

24. Funck and Chickering, *Endangered Cities*, 5.

25. Craven and Cate, *Army Air Forces in World War II*, vol. 5, 3–175, 507–756.

26. Feifer, *Tennozan*, 533.

27. For projected Allied casualty figures, see Giangreco, "Casualty Projections," 521–82. For the Japanese decision to surrender, see Asada, "Shock of the Atomic Bomb," 477–512. The invasion of Kyushu, set for 1 November 1945, envisioned 767,000 Allied troops, and that of Honshu, planned for February 1946, projected the use of more than one million Allied troops. There were at least three million armed Japanese defenders throughout the home islands. On average, the United States suffered 35 percent casualties when attacking Japanese positions throughout the war (about 30 percent of which were deaths); Japanese losses were far higher: 95 percent dead (very few Japanese surrendered or were captured). Thus, if these averages would have held true for the projected invasions of the home islands, the Allies could have expected around 180,000 dead, while the Japanese would have lost nearly three million military dead. Civilian deaths (based on the Okinawa campaign) would have been horrendous.

28. Note that the same was true for the Germans. British air defenses forced them to attack at night, and British defenses also included blackouts and electronic warfare to baffle German bombers. See R. V. Jones, *Wizard War*.

29. *United States Strategic Bombing Surveys*, 36, 92.

30. Rumpf, *Bombing of Germany*, 164–65. He gives no sources for his estimates. M. Clodfelter, *Warfare and Armed Conflicts*, 490, 526–27, 543–44, gives lower estimates.

31. Rummell, *Death by Government*, 4, 148, 152; and Katsuichi, *Nanjing Massacre*, xiii.

32. M. Clodfelter, *Warfare and Armed Conflicts*, 234. He states that 129,000 South Korean civilians were murdered by the communists, with another 115,000 killed in the fighting (the cause of death is not given). In addition, up to one million civilians died in the North, most due to famine and disease. Close to one million combatants also died during the war.

33. Lewy, *America in Vietnam*, 442–51. The math: 587,000 – 39,000 (Vietcong murders) = 548,000; 548,000 – 65,000 (bombing of North) = 483,000; 483,000 x 16.75 percent

(percentage of civilians presumed killed by air in South) = 80,902; 80,902 + 65,000 = 145,902 total dead to air attacks; 145,902 ÷ 587,000 = 24.8 percent.

34. Arkin, Durrant, and Cherni, *On Impact*, 46; and Heidenrich, "Gulf War," 108–25. Arkin, Durrant, and Cherni also note on page 15 that at least 50,000 Kurds and Shiites were killed by Saddam in the abortive uprisings of summer 1991.

35. Viorst, "Report from Baghdad," 58.

36. Munk, "New Face of Techno-War," 583.

37. United Nations Children's Fund, "Child and Maternal Mortality," 10; and Garfield, "Morbidity and Mortality."

38. Owen, *Deliberate Force*, 161. For Kosovo, see Human Rights Watch, *Civilian Deaths*, 5.

39. The Project on Defense Alternatives (PDA) estimates that between 1,000 and 1,300 civilians died in Afghanistan as a result of air attack. Conetta *Strange Victory*, 6. Perhaps 3,750 civilians died in Iraq. Conetta, "Disappearing the Dead," 1, 3. The Iraq Body Count (IBC) organization gives the higher figures. IBC, "Dossier of Civilian Casualties."

40. Human Rights Watch, *Off Target*, 13.

41. The IBC website contains a number of studies dealing with Iraqi civilian deaths. For the early period see IBC, "Dossier of Civilian Casualties." The IBC continues to update its figures at www.iraqbodycount.org. The highest casualty figures are given by a Johns Hopkins University study; its estimates are more than six times greater than other agencies. Even so, the percentage of deaths it cites as caused by air attacks through 2006 (13 percent) is similar to the percentage provided by the IBC. Burnham et al., "Human Cost of the War." This study has been severely criticised due to its methodology; see "Author of Shocking Iraq Study," 1. A recent study gives a slightly smaller number for total deaths, but the percentage of civilians killed by air attack remains the same. Hicks et al., "Weapons That Kill Civilians."

42. These statistics were provided to the author in July 2009 by Lt Col Roni Amir of the Israeli Air Force.

43. Bowden, *Black Hawk Down*, 333.

44. Cordesman, " 'Instant Lessons' of the Iraq War," 88.

45. Ibid.

46. Schanz, "Focused Lethality."

47. Wall and Barrie, "US, UK Eye Upgrades." The article gives an average accuracy figure of 2.4 meters for the JDAM.

48. Carlino, "Moral Limits," 15–29; and Crane, "Sky High."

49. Glantz, *Battle of Leningrad*, 543, 547. The primary causes of civilian deaths in Leningrad were starvation, artillery fire, and small arms fire.

50. Larson and Savych, *Misfortunes of War*, 2–3.

51. "Panel Touts Robots' Future," *Virginian-Pilot*.

52. Former president Jimmy Carter termed Operation Allied Force "excessively brutal." See *Washington Post*, 27 May 1999, A-33; and novelist Norman Mailer said it was "obscene." See *Washington Times*, 24 May 1999, A-27.

53. Human Rights Watch, *NATO Deaths*, 9–10.

54. Graham, "Military Turns to Software." The name derives from the color-coded products that depict splotches where different degrees of damage are likely to occur upon weapon impact.

55. Rauert, "Influence of Just War," 75.

56. Laden "Letter to the American People."

57. Clausewitz, *On War*, 258. The book contains several statements such as, "permit us to make the following unequivocal statement: 1. Destruction of the enemy forces is the overriding principle of war, and, so far as positive action is concerned, the principal way to achieve our object."

58. For an interesting discussion of targeting civilian leaders, see Lotrionte, "When to Target Leaders."

59. For an excellent discussion, see Meyer, "Tearing Down the Façade," 152.

60. Human Rights Watch, *NATO Deaths*, 19–22. For a detailed account, see Central Intelligence Agency, *Putting Noncombatants at Risk*.

61. Human Rights Watch, " 'Troops in Contact,' " 2–5.

62. Air Forces Central Combined Air and Space Operations Center, "2004–2008 Combined Forces Air Component Commander." These statistics include only those on which "major munitions" were dropped. This term does not include sorties that expended 20 or 30 millimeter cannon fire or rockets. Obviously, if those sorties were included (the number is unknown), then the percentage that caused collateral damage would be even lower.

63. King and Barnes, "Deadly Afghan Day Signals," 12. In mid 2009, new procedures were instituted that restricted ground troops from calling in air strikes, and this lowered collateral damage. See "Air Strike Rules," 11.

64. Bakri, "Babylon's Ancient Wonder."

65. Abdul-Ahad, "More Troops They Send."

66. Cohen and Agiesta, "Poll of Afghans Shows Drop." The British Parliament's report on Afghanistan also refers to the "cultural insensitivity" of US troops and the "scandal-ridden matter of treatment of detainees." See United Kingdom Parliament, "Eighth Report," sect. 2, para. 28 and 30.

67. Office of the Surgeon, "Mental Health Advisory Team," 35–37. Curiously, these questions were not asked in the Army's follow-up report released in March 2008. It is because of these disturbing facts that the Army has formed a Center of Excellence for the Professional Military Ethic at West Point in a belated attempt to heighten moral, ethical, and legal standards among Soldiers. It does not appear the Marine Corps has taken a similar step.

68. Boyne, *Influence of Air Power*, 8.

69. For example, see "5,558 Iraqis Killed since Occupation," *Dallas Morning News*. In 2004 a two-star admiral in charge of US Central Command public affairs used these words in speaking to me.

70. It took over four months for US Central Command (CENTCOM) to release its findings regarding the 8 April 2003 firing of a US tank round into the Palestine Hotel, killing two journalists and wounding several others. It is difficult to understand why this report could not have been completed and released within days of the shooting. Human Rights Watch has called for the military to establish an agency to investigate quickly all incidents of alleged collateral damage and then report their findings to the world. See Human Right Watch, "Troops in Contact," 8.

71. Dunlap, "Lawfare," 36–37.

72. The magnitude of this problem is increasing as women and children are now being used in suicide attacks. "Insurgents Using Teens," *Chicago Tribune*; and S. Carter, "Taliban Buying Children."

73. M. Waxman, "Siegecraft and Surrender," 402.

74. Bell, *History of the Blockade*, 672. Bell states that 762,736 German civilians starved to death during the war due to the Allied blockade, and another 66,466 died of tuberculosis and other lung diseases caused by the lack of fat, oils, and milk in their diets (the absence of which were also due to the blockade).

75. D. Waxman, "Sanctions," 40.

76. Mueller and Mueller, "Sanctions of Mass Destruction."

77. Dunlap, "Lawfare," 36.

government agencies, can bring the knowledge, expertise, and resources needed to make Africa more stable and secure by making its environment more stable and secure.

Environmental Degradation and Conflict in Africa

Environmental degradation in Africa can be explored from several perspectives. To analyze this issue comprehensively, we can dissect it into five major subheadings: land, water, climate, plants and animals, and people.[4] Each topic can be viewed as to how degradation is or is not affecting it. Some background information about Africa and environmental degradation there should also help illuminate key challenges.

At present, the rich and diverse African biodiversity is threatened by a confluence of climate change, habitat destruction, poaching, and surging populations.[5] Rapidly increasing populations are modifying land-use patterns, demanding more clean water, and stressing animal and plant communities throughout Africa. All these environmental changes are occurring across an ecologically diverse continent populated by equally diverse people.

Africa is the second largest and second most populous continent behind Asia. It contains a vast variety of natural resources including approximately 30 percent of all of the earth's minerals.[6] Forty percent of the world's gold, 60 percent of the cobalt, and 90 percent of the planet's platinum are found in Africa.[7] The continent is also home of the Nile, the longest river in the world; the Sahara, the biggest desert in the world; the Namib, the oldest desert; and the shortest continental coastline.

Land

Environmental degradation of land results from processes that reduce the capacity of the land to produce sustenance or resources. These can include desertification, deforestation, soil erosion, salinization, and other natural and anthropogenic processes. Comprehensive review of public information and peer-reviewed reports indicates that Africans in 32 countries consider land degradation a preeminent environmental challenge.[8]

The geography of Africa is quite interesting and diverse. African land is mostly arid (60 percent), and most of the land (65 percent) is degraded either naturally or anthropogenically. Thirty-one percent of

African pasture lands and 19 percent of forests are degraded in some form or another—while only 10 percent of all African land is considered prime farmland and another 25 percent is rated as having low to moderate potential for sustainable agriculture. While 20 percent of Africa's overall land area is forested, an average of 40,000 square kilometers (0.6 per cent) are deforested every year. The areas that are vulnerable to desertification and home to over 20 million Africans are expanding, increasing pressure on land natural resources. In 1950, the hypothetical individual share of the land could be calculated at 13.5 hectares/person; in 2005 it had dropped to 3.2 hectares/person and is predicted to be 1.5 hectares/person in 2050.[9] Land degradation is obviously increasing, although restoration efforts have been successful in a few areas with reforestation, soil enhancement, and erosion control programs.

Water

Water is another environmental resource that is often the focus of intense competition and conflict. "Changes in water quality and quantity—in freshwater environments (lakes and rivers) and in coastal and marine environments—rank among the most challenging environmental and social issues that Africa currently faces." Water pollution and water scarcity were specifically identified in several African states as critical environmental issues.[10] Land and water conditions are affected by ongoing changes in Africa's varied and unique climate zones. The recent and rapid increases in global average temperatures are driving a variety of transformations to Africa's climate, increasing environmental degradation. Rainfall patterns and growing seasons are changing, sea levels are rising, water stress is spreading, ecosystems are being transformed, and disease vector ranges are being altered.[11]

Africa is the second driest continent after Australia; therefore, 75 percent of Africans rely upon groundwater as their major source of drinking water. Water resources are unevenly distributed in Africa with some areas having abundance while other areas suffer from scarcity. Scientists estimate that more than 300 million of Africa's almost one billion people face water scarcity and stress challenges. Africa contains approximately 3,930 cubic kilometers of renewable water resources, representing less than nine percent of the global total, while per capita consumption of water is 31 cubic meters per year for its

almost a billion people.[12] Scientists estimate that an additional 250 million Africans will face water scarcity challenges as a result of global climate change.[13] Pressures on water resources are clearly increasing. For example, Lake Chad in northern Africa has been shrinking as a result of climate change and increasing agricultural demand.[14] In other areas, cooperation and water management processes are preserving vital watersheds. The Okavango Delta presents a spectacular case of how coordinated wetland management is preserving the world's largest inland delta.[15]

Climate

Not only is Africa the second driest continent, it is also the world's hottest. It has six climatic zones: tropical wet, tropical summer rainfall, semiarid, arid, highland, and Mediterranean. Some of these zones contain spectacular biodiversity. The Fynbos region in the Cape Province of South Africa, for example, has the highest rate of general endemism in the world. The seasonal and diurnal variation in some of Africa's climatic zones is amazing. For instance, the temperature variation seasonally in the Democratic Republic of the Congo is only 1.4°C, while temperature swings between the coldest and hottest month in the Sahara Desert can exceed 20°C. One interesting fact is that Africa is the lightning center of the planet and has more lightning flashes per square kilometer that anywhere else.[16] Africa's variation in climate also enables enormous continental biodiversity.

Plants and Animals

Africa's plants and animals are varied, plentiful in some regions and endangered in others. The world's largest bird (ostrich) and largest land mammal (African elephant) both reside in Africa. Large populations of mammals, such as wildebeests and zebras, migrate across African savannahs by the thousands. Additionally, 98 percent of Madagascar's land mammals, 92 percent of its reptiles, 68 percent of its plants, and 41 percent of its bird species are found only on this island. The Congo basin contains the second largest area of intact rain forests after the Amazon basin. The rich African biodiversity includes eight of the world's 34 biodiversity hotspots. Nevertheless, African biodiversity is declining steadily, as more than 120 plant species have become extinct and another 1,771 are threatened with extinction.[17]

The critical factor in reversing the decline of biodiversity and environmental degradation in general involves human activities.

People

Africa is home to 965 million people and is considered by many to be the birthplace of mankind. It is the second most populous continent, with a population density of 32.6 people per square kilometer. The population is unevenly distributed, with some areas—for example in the Sahara—with very few permanent towns or villages, while areas such as the Nile River Delta are extremely densely populated. In 2005, over 60 percent of Africans still lived in rural areas, but the number moving to urban areas is rapidly increasing. While approximately 57 percent of all Africans are still employed in agricultural activities, urban growth in Africa is the highest in the world. Africa's overall population growth rate of 2.32 percent annually (almost double the 1.24 percent global rate) is the highest in the world, and 20 of the 30 fastest growing countries are African states.[18] This places enormous pressure on agriculture to feed the growing populations, which in turn places even more pressure on natural habitats and environmental resources.

Wars on the African continent have also had serious and lasting effects on the natural environment and on Africa's human populations. For example,

> The social dislocation caused by war is a further cause of environmental damage. Floods of refugees in particular can threaten natural resources such as water and forests. The Rwandan conflict and the events that it triggered in the Democratic Republic of the Congo (DRC, ex-Zaire) became a major cause of deforestation in central Africa. One casualty was Africa's first national park, the Virunga National Park, on the border between the DRC and Rwanda. The World Conservation Union [International Union for Conservation of Nature] (IUCN) reported that in six months, the Rwandan refugees and Hutu soldiers from camps around the town of Goma in the DRC had deforested some 300 square kilometers of Virunga National Park in their search for food and wood. At the height of the crisis, the IUCN estimated that some 850,000 refugees were living within or close to the park and took between 410 and 770 tons of forest products out of the park daily. In the confusion, Zairian soldiers were raiding the park for timber to sell to refugees and relief organizations. Similar destruction became a feature of civil and cross-border conflicts across much of Africa in the 1990s.[19]

Roving bands of guerrilla and other unconventional forces can do great harm to natural resources and entire ecosystems when they live off the land or plunder resources to buy arms and food. The recent

conflict in Rwanda resulted in the mass slaughter of the mountain gorillas in the Virunga National Park. The widespread loss of centralized or sovereign control over natural resources throughout Africa as a byproduct of civil war or violent conflict continues to lead to extensive environmental degradation.

Reactions of state and regional governmental organizations to growing environmental degradation vary throughout Africa. Some countries have been unable to find the means to reduce conflict while others have adapted and mitigated environmental degradation, thereby reducing conflict and insecurity. Two contrasting cases where state reactions to environmental degradation challenges were dissimilar and consequent stability and security outcomes were also vastly different, the Sudan and Niger, are discussed below. Examination of these two cases can yield potential lessons for AFRICOM leaders that may help efforts to increase their capacity to enhance Africa's stability and security in the future.

Case Studies: Degradation and Conflict

The relationship between conflict and environmental degradation in Africa is often complex and multicausal. Case studies of environmental degradation in the Sudan and Niger—analyzed within the five domains of land, water, climate, plants and animals, and people—reveal some of the specific pressures and challenges, which can then become focal points for AFRICOM efforts to help Africans help themselves.

Sudan

A case study of the Sudan by the United Nations Environment Program (UNEP) identified environmental degradation as a major factor contributing to violent conflict. Years of ethnic conflict; population displacement; weak, corrupt, and biased governance; uncontrolled exploitation of natural resources; and little or no investment in sustainable development significantly contributed to instability and insecurity as well.[20] In the Darfur region of Sudan, years of drought exacerbated by desertification and population growth led nomadic pastoralists to move herds of cattle and goats into land occupied primarily by subsistence farmers. A vicious conflict ensued, with as many as 450,000 people killed by fighting and disease and approximately 2.4 million people displaced from their homes.[21]

The UNEP's analysis indicates a very strong link between land degradation, desertification, and conflict in Darfur. Northern Darfur—where exponential population growth and related environmental stress have created the conditions for conflicts to be triggered and sustained by political, tribal, or ethnic differences—can be considered a tragic example of the social breakdown that can result from ecological collapse. Long-term peace in the region will not be possible unless these underlying and closely linked environmental and livelihood issues are resolved.[22]

Environmental issues have been and continue to be contributing causes of conflict. Competition over oil and gas reserves, Nile waters and timber, as well as land use issues related to agricultural land are important causative factors in the instigation and perpetuation of conflict in Sudan. Confrontations over rangeland and rain-fed agricultural land in the drier parts of the country are a particularly striking manifestation of the connection between natural resource scarcity and violent conflict. In all cases, however, environmental

factors are intertwined with a range of other social, political, and economic issues.[23]

Land degradation, competition for scarce water supplies, changing precipitation patterns contributing to drought and desertification, widespread destruction of forested ecosystems by refugees, and large, uncontrolled population movements all contributed to instability and insecurity in this troubled region. While Sudan presents a clear example of environmental degradation intertwined in a circular relationship with violent conflict, Niger offers an opposing case study where environmental degradation initiated innovative, proactive processes that improved ecological conditions and contributed to enhanced security and stability.

Niger

During the 1970s, Niger was in the grip of an enormous drought. The Sahel region, already characterized as an arid region of variable rainfall and low-fertility soils, is home to most of Niger's people. Threats of desertification and land degradation forced the rural farmers in this enormous dry land to change their relationships with the land and with each other. Systematic ecosystem management processes designed to restore environmental conditions and agricultural productivity were adopted throughout the region. Specifically, farmers adopted simple, low-cost environmental management techniques that enabled natural regeneration of trees and shrubs. The techniques, collectively known as farmer-managed natural regeneration (FMNR), involved uncomplicated forest, soil, and water conservation programs.[24] The results have been spectacular. US Geological Service (USGS) scientists compared aerial photographs from the 1970s to photos taken in 2005 and were astonished by the widespread environmental transformations. Over five million hectares of land in Niger now show regeneration of vegetation.

Today, agricultural parklands replace the windswept fields of the 1970s. On-farm tree densities have increased ten- to twentyfold. Village sizes have also dramatically increased in the area, generally by a factor of three—a direct indicator of rural population growth. The changes were equally surprising on the rocky slopes and plateaus east of Tahoua, almost totally denuded in 1975. A patchwork of terraces and rock bunds constructed to stem soil erosion, trap precious rainfall, and create micro catchments for planting and nurturing trees

now extends throughout the region. Trees now occur on most plateaus, and farmers have taken advantage of the new environment to plant fields of millet and sorghum between the ribbons of trees. Windbreaks of mature trees crisscross the wide Maggia Valley and its tributaries. Many of the valleys now have dikes and low dams to create ephemeral lakes. As their waters recede in the dry season, farmers plant vegetables. A vibrant dry season market gardening economy has developed. Large tracts of valley lands are now green with produce, including onions, lettuce, tomatoes, sweet potatoes, and peppers. Many interviews with villagers at all sites confirm that there has been notable environmental improvement since the 1970s. Farmers point to the increase in woody cover, the diversity of high-value trees, and the rehabilitation of the productive capacity of tens of thousands of hectares of degraded land. The projects of the 1970s and 1980s demonstrated what could be done, giving villagers options. Since then, there has been a huge spread effect, particularly in farmer-managed natural regeneration—a significant change in the way farmers maintain their fields, allowing high-value trees to grow in their fields.[25]

Changes in ecosystem management have improved the environment across all five domains in Niger. Degradation of the land is been markedly reduced, erosion decreased, fertility enhanced, and agricultural productivity dramatically improved. Even though rainfall levels are still below historic levels before the 1970s drought, farmers have learned to capture scarce rainfall, and groundwater levels have risen in some areas. Niger has been experiencing many of the climatic changes that affect the Sudan, and yet its farmers are adapting to the changing conditions without the violence and instability seen in the Sudan. In addition, the biodiversity of the area has been greatly increased by expansive terracing and planting of trees. Scientists assert, "Farmers have reacted proactively to the large-scale land degradation that occurred during the droughts of the 1970s and 1980s, and have begun protecting their resources on a massive scale, encouraging natural regeneration, rebuilding their soils, and harvesting scarce rainfall." Even though the population of Niger has doubled since the 1970s, Niger's rural farmers have decentralized control over natural resources, increased land/food security, and empowered local people to care for their own resources.[26] Importantly, for other "Sahelian countries facing the triple challenges of population growth, desertification, and climate change, FMNR also offers a cheap and effective model to improve farm productivity and reclaim precious land from the dunes." Conflict still occurs over property rights and access to natural resources but large-scale violence and population displacements have not been a consequence of environmental degradation and change in Niger.[27]

The dramatic differences in how people in the Sudan and Niger reacted to environmental degradation and change illustrate the need for more study into the intricate relationships between environmental degradation and conflict. The lessons learned from these two disparate outcomes also offer opportunities for AFRICOM to learn from the processes and measures applied successfully and unsuccessfully and provide focused, proactive, constructive assistance to Africans as they learn to help themselves.

Overall Recommendations

AFRICOM has the potential to contribute significantly to stability and security in Africa. By building positive relationships with African

militaries and governments, AFRICOM personnel can build Africa's capacity to adapt to and mitigate environmental change. The following recommendations are offered for AFRICOM consideration.

1. **"Help Africans operationalize their knowledge of the relationships between the environment and security—Prepare and provide training/education material on environmental security."**[28]

Exemplified by the Sudan and Niger, environmental degradation is a threat to the environmental and national security of all African states. Degradation contributes to conflict, both violent and nonviolent, across Africa. AFRICOM can employ focused environmental security curricula to help increase the awareness of individual African states and select regions to the impending challenges to their stability and security created by continued environmental degradation.

AFRICOM should work toward establishing centers of excellence that address environmental security issues. These centers could prepare environmental security training and education curricula that investigate and provide responses to local, state, and regional linkages between environmental degradation and conflict.[29]

2. **"Share environmental information/data with African states in an easily accessible manner."**[30]

African states on the whole lack access to up-to-date, advanced, and comprehensive environmental information/data. When simple, scientifically based ecosystem management processes were implemented in Niger, stability and security increased. In the Sudan, where these processes and other good governance procedures were not applied, violence and instability erupted. Without accurate and current environmental information, African states cannot make informed security decisions for the future.

AFRICOM can either provide environmental information directly to selected states or assist in the creation of environmental information databases that are transparent, easily used, and accessible to as many citizens as possible. Additional environmental information can be obtained from "after action reports" from various agencies (Department of State, USAID, World Food Program, Peace Corp, etc.) to see how they support environmental activities in Africa. Reports from the USGS have been crucial in determining what went right in Niger. Information also can be acquired from contractors and from

allies such as Italy, the United Kingdom, and France who provide environmental support in Africa.[31]

3. **"Assist African militaries to facilitate, inculcate, and disseminate an African environmental ethic—focused on mission, community, and environment—understanding ecosystem services and causal relationships."[32]**

US military forces are currently struggling to develop a comprehensive environmental ethic that extends to contingency and peacekeeping operations.[33] Progress includes the US Army's environmental sustainability ethic of "mission, community, and environment," which could provide a template upon which African states and AFRICOM can begin a dialogue with military professionals on the relationships between ecosystem services, environmental security, and conflict.[34] An African environmental ethic can prevent degradation and augment security. Perhaps African Contingency Operations Training and Assistance funds could be used to initiate the process of instilling an environmental ethic in interested African militaries.[35]

4. **"Expand the use of state partnership programs (SPP) and US National Guard personnel to train African militaries for natural disaster and environmental mitigation responses."[36]**

Many SPP personnel and US National Guard units are experts at responding to natural and environmental disasters. African militaries can benefit from this expertise through training on how to respond to environmental disasters like floods, droughts, and disease pandemics. SPP personnel and US Guardsmen also understand the importance of environmental mitigation procedures and could share their extensive knowledge with African military professionals with AFRICOM assistance.

5. **"Help African militaries purchase and utilize available environmental monitoring and early warning devices."[37]**

Many African states lack a proactive solution to the natural and environmental disasters that often weaken and disable state security. AFRICOM professionals can assist acquisition of early warning and natural disaster monitoring devices by selected African militaries. If African militaries, and in particular air forces, can increase their monitoring and response capabilities to natural and environmental disasters, they will enhance their security competencies, public image, and professionalism.

One concept to consider is "fractional ownership," where African states or regional organizations can lease expensive environmental monitoring equipment. Fractional ownership or leasing "could be a concept explored by US Foreign Military Sales" and/or international corporations and the overall process "could foster growth of real African regional capability" to respond to environmental crises and disasters even if the process started bilaterally or unilaterally.[38]

6. "Assist African environmental security specialists to train others."[39]

Establishing a core cadre of African environmental security specialists will have multiple benefits. These specialists can create targeted programs that address African environmental security challenges and responses and help professionalize African militaries. AFRICOM can provide training, expertise, and a curriculum that will make this effort possible.

7. "Assist Africans to mitigate environmental degradation by migrants and refugees."[40]

Environmental refugees and migrants fleeing environmental degradation and conflict challenge every African state's limited security and economic resources. Mass movements of displaced individuals and families place a huge burden on the refugee camps and on the local environment. AFRICOM can help African militaries locate refugee camps in sustainable locations, construct camps that reduce environmental and security challenges, and proactively prevent environmental degradation from happening in the first place.

8. "Inform African militaries of US environmental security expertise and capabilities."[41]

A specialized segment of US military and governmental professionals have extensive expertise in environmental security, degradation, and mitigation issues. The in-depth and practical knowledge of these professionals can be used to reduce environmental degradation and conflict in Africa. AFRICOM should provide African military leaders with information on these capabilities and opportunities for US environmental security professionals to share their proficiencies with their African counterparts.

One method to share information could involve building "social networks" between AFRICOM staff members, African environmentalists, African environmental security experts, and other agencies, components, and even nongovernmental environmental agencies.

An environmental security social network could enhance sustainable environmental practices and processes and augment stability and security operations. In addition, personal handheld communication devices could improve communications reliability, speed, and access in all of Africa without an expensive supporting land infrastructure. Social networks and personal handheld devices would be invaluable as tools for strategic environmental security communications.[42] Nevertheless, local environmental knowledge should not be discounted; simple word-of-mouth, low-tech communication can be very effective, and inclusion of often marginalized groups (women and young men) should be a focal point of all communication and environmental security strategies.[43]

9. **"AFRICOM should concentrate on those environmental security projects that provide visible results measured against realistic milestones."**

AFRICOM must hold engagement partners accountable and continually move those partners toward becoming self-sufficient contributors.[44] Various studies have shown that when individuals and groups become accountable and responsible for managing environmental assets and have the capacity to manage ecosystems effectively, then cooperation, ownership and stewardship values, and sustainability of the resources increase visibly.[45]

10. **"Assist Africans in building aviation capacity or air domain development (ADD)."**[46]

AFRICOM can help African states build ADD, which will enhance air safety, expand trade, promote security/stability, and improve surveillance, control, and protection of natural resources by developing civil-military partnerships between AFRICOM aviation organizations and African states. ADD will enable African states to overcome transportation infrastructure limitations that plague many states throughout the continent.[47]

Conclusions

AFRICOM can become a positive, proactive force on the African continent helping Africans help themselves. US military forces, environmental organizations, and government agencies have enormous expertise and knowledge on environmental change and the challenges

and opportunities it can create. AFRICOM must help Africans build environmental, economic, and social capital to ensure stability and security. The processes AFRICOM supports should ensure Africans are provided with expert, current, and relevant environmental management information; gain secure and equitable control over their natural resources; and are empowered to make community-based decisions concerning these resources. The frameworks and institutions that enable the supporting processes all have working antecedents in the United States and other developed states, and AFRICOM can assist process adaption by Africans for Africans.[48] Information, expertise, secure resource ownership, frameworks, and institutions can give Africans the tools to protect the land, water, climate, biodiversity, and people from further environmental degradation and the added devastation of linked violent conflict. The goals of these efforts are to help Africans reduce environmental degradation, protect and sustain natural resources, and mitigate conflict over the environment. AFRICOM's charge is to become a strategic, operational, and tactical enabler.

Notes

1. See United Nations Environment Program (UNEP), *GEO-4*; *2008 Living Planet Report*; and Millennium Ecosystem Assessment, *Ecosystem and Human Well-Being*.
2. UNEP, *Africa*, 57.
3. Ward, *United States Africa Command*, 11.
4. UNEP, *Africa*, chap. 1, PowerPoint presentation, slide 5.
5. Ibid, xi.
6. Ibid., chap. 1: PowerPoint slide 4.
7. Ibid., x.
8. Ibid., 19, xii.
9. Ibid., xi, 19, 13.
10. Ibid., 20, xii.
11. Ibid., 14; and Boko, "Africa," 435.
12. Ibid., xi, 6.
13. Boko et al., "Africa," 435.
14. UNEP, *Africa*, 52–55.
15. Henk, *Botswana Defense Force*.
16. UNEP, *Africa*, 9, 11, 8, 29.
17. Ibid., 220, 23.
18. Ibid., 14, x, 13.
19. Pearce, "From Viet Nam to Rwanda.
20. UNEP, *Sudan*, 6.
21. UNEP, *Africa*, 60.

22. UNEP, *Sudan*, 7.
23. Ibid., 6.
24. *World Resources Report,* 143–45.
25. UNEP, *Africa*, 16–17; and Tappan, "RE: Extent of Natural Regeneration."
26. UNEP, *Africa*, 17.
27. *World Resources Report,* 155, 157.
28. Burgess, ed., *Air Force Symposium 2009*, 8.
29. Ibid., 6.
30. Ibid., 8.
31. Ibid., 4.
32. Ibid., 8.
33. Mosher et al., *Green Warriors.*
34. Schoomaker and Brownlee, *Army Strategy for the Environment*, 2.
35. Burgess, *Air Force Symposium 2009*, 5.
36. Ibid., 8.
37. Ibid.
38. Ibid., 31–32.
39. Ibid., 8.
40. Ibid.
41. Ibid., 9.
42. Ibid., 28–29.
43. *World Resources Report,* 156.
44. Burgess, *Air Force Symposium 2009*, 5.
45. *World Resources Report*.
46. Peltier and Thomas, "Air Domain Development in Africa."
47. Ibid., 111.
48. Ibid., 111–57.

to build partnerships that could significantly increase the influence of US African Command (AFRICOM), the newest combatant command within the DOD.

A 2009 AFRICOM/Air University symposium featured a track on environmental security, which identified ways AFRICOM could engage in partnering for lasting and meaningful influence. One workshop featured discussion of conservation zones, such as TFCAs and peace parks (PP).[1] The workshop proposed several initiatives and roles where AFRICOM, and specifically the US Air Force (USAF), could promote environmental security in Africa.

This chapter offers analysis of the mutual benefits to US national security interests, African governments, and marginalized populations accruing from promotion of environmental security by building partnerships. Utilizing airpower as an engagement capacity, partnership building can aid in the development and sustainment of conservation zones in Africa.

- This chapter proposes that promoting environmental security is both an end in itself and a critical component of human security. As such it will aid in legitimizing nation-states and ultimately promote stability in Africa. Application of the concept of "conservation zones" can be effective in promoting environmental and human security.
- It proposes that US foreign policy should include environmental security programs as means for building partnerships for stability in foreign nation-states. AFRICOM, and specifically the Seventeenth Air Force, can play a vital role in the success of environmental security programs.
- It defines the various types of conservation zones in Africa and explores three primary benefits—sustainment of biodiversity, an engine for economic development, and a means of conflict management—that can result from successful conservation zones. One specific type of conservation zone, CBC programs, offers unique partnership opportunities to address human and environmental security at a local community level. Effective partnership building should not just be at national levels.
- It offers a specific case study of a successful CBC program, the Northern Rangeland Trust (NRT) in Kenya, with a brief illustration of how AFRICOM could engage an array of aviation and

USAF resources to benefit the development and sustainment of the NRT, thereby promoting lasting and effective partnerships with local and ultimately national governments.

Use of the NRT as a partnership-building model would also provide an example of how such engagements would occur and identify elements, like education and training in cross-cultural competence, necessary for success.

Human (and Environmental) Security: The New Security Strategy

Stability in Africa and elsewhere requires human security; the guarantee of human rights is necessary for lasting sovereign governments. The concept of human security was established by the United Nations (UN) beginning in the 1990s.[2] The notion of human security has been redefined to mean that state security requires the safety of individuals and the well-being of local communities rather than national military power.[3] "This kind of security redirected attention away from the nation-state and toward individuals and local communities. In addition to protection from physical violence, it offered safety from chronic threats like hunger, disease, severe economic deprivation, or political repression."[4]

Crucial to human security is environmental security—protecting people from the short- and long-term ravages of nature, deterioration of the natural environment, and man-made threats to the environment, while guaranteeing access to and preserving natural resources. The concept of environmental security has grown beyond the concern of species and habitat protection to a concern for survivability of the planet. Developing and sustaining environmental security in Africa offers military and nonmilitary organizations an opportunity to engage in mutually beneficial partnerships with African partner nations and their local populations, thereby promoting stability and ultimately benefiting US national security.

Building Partnerships

Arguably, the most important military component of the struggle against violent extremists is not the fighting we do

> *ourselves, but how well we help prepare our partners to defend and govern themselves.*
>
> —*National Defense Strategy*, June 2008

A government's legitimacy requires an ability to provide human security. Building partnerships has become an important instrument of the DOD and US foreign policy in promoting stability in partner nations. It is defined as "Airmen interacting with international airmen and other relevant actors to develop, guide, and sustain relationships for mutual benefit and security."[5]

The USAF is developing partnership-building doctrine predicated on the continued and increasing importance of establishing and sustaining partnerships that will evolve into long-term alliances. Partnership building includes the following concepts important to the USAF:

1. Security assistance can encompass a variety of interactions ranging from passing conversations to formalized agreements. Partnership-building activities include humanitarian assistance, medical readiness exchanges, exchange programs with military members and civilians in professional military education and topical education/training in specific areas (civil engineering, environmental management, technological schools, etc.), and the more traditional military-to-military programs such as collaboration in exercises and weapons programs.

2. Actors involved in partnership building include those from local to international authorities and nongovernmental organizations (NGO). Partnerships develop across a spectrum of methods and relationships. Collaboration and strong, vital relationships are the currency involved.

3. Successful partnerships are built on courses of action and resources that can bring immediate and longer-term benefits. The focus of the partnership is its sustainability over the long term. However, the most successful partnerships see a gradual drawdown in US resources and involvement.

4. Aviation and airpower can promote the prosperity of all nations, especially those that work toward human security. Some policy makers might recognize that aviation can provide a wide range of benefits, but few fully comprehend airpower as a strategic

investment in national and human security. It can catalyze legitimacy, project national sovereignty, and accelerate internal stability and regional security. Airpower can also be an engine for economic, technological, and intellectual development, generating infrastructure essential to the internal and external strength of a nation. Connecting aviation to local leaders/communities could promote the development and sustainment of human security and result in successful partnership building.[6]

Environmental Security and Conflict

We live in a world of ongoing conflict, rapidly increasing population, and dwindling resources. Recently, the effect of kinetic operations has become increasingly relevant. Current US military strategy and doctrine have recognized environmental security concerns in tactical and operational planning and policies.[7] It is understood, however, that military stability operations—that is, kinetic operations, including conflict and postconflict operations, staged domestically and from foreign bases—impact the environment greatly. Understanding the ecological footprint of conflict and postconflict operations to human/environmental security and managing this footprint to minimize the effect on the natural resources and human populations are necessary for the success of postconflict physical, social, and cultural reconstruction and long-term sustainability. Along these lines, environmental security "best practices" for military operations outside the continental United States (CONUS) have developed from the environmental programs found at all military installations inside CONUS, including a suite of processes (environmental baseline surveys, environmental impact statements, etc.).

AFRICOM, Partnership Building, and Environmental Security

This chapter argues that militaries can also be engaged to promote and sustain environmental security in many areas of the developing world, or in areas that are caught in the pincers of human and/or environmental crises, in addition to being deployed into conflict situations. Militaries offer unique command and support structures that include capabilities, technologies, and a "military culture" that can

develop and sustain environmental security in the entire continent of Africa as well as conflict areas such as the Middle East, Southwest and Southeast Asia, South America, and elsewhere. Providing resources to nations and local communities needing environmental security support in terms of mutual benefits and cooperation can minimize perceptions of militarization or military colonialism.

The standing up of AFRICOM represents a departure from traditional forms of US military engagement, growing from a desire to create a combatant command that could engineer a "whole of government approach" for positive influence by engaging in collaborative relationships with partner nations and other organizations across the African continent.

> USAFRICOM better enables the Department of Defense to work with other elements of the U.S. government and others to achieve a more stable environment where political and economic growth can take place. USAFRICOM is committed to supporting U.S. government objectives through the delivery and sustainment of effective security cooperation programs that assist African nations build their security capacity to enable them to better provide for their own defense.[8]

The leadership of ARFICOM includes representation from the Department of State (DOS), the DOD, the US Agency of International Development (USAID), and other government agencies involved in Africa. AFRICOM also seeks to engage humanitarian organizations involved in Africa issues and common concerns.

This paradigm shift in US military-civilian relations reflects the changing face of foreign relations in an increasingly "globalized" twenty-first century. The end result of US involvement in a continent as diverse as Africa, and with many countries still struggling from the aftermath of colonialism, points toward reconstruction and stability operations as primary concerns for US foreign policy and a potential DOD opportunity in building partnerships with African nations. Dr. Dan Henk observed that historic patterns of foreign policy initiatives in African environmental security indicate that interagency dysfunction and stove piping would exist in stability operations projects undertaken within the traditional combatant command approach.[9] AFRICOM exists as a means of harnessing the efforts and strengths of several agencies to engage in a range of programs—including military-to-military, military-to-civilian, and civilian-to-civilian—to promote a "stable and secure" African environment and to promote human security.

A host of African, non-African governmental, and nongovernmental organizations and funding will be necessary to develop and sustain environmental security programs in local, regional, and international partnerships. Both non-African and African militaries can and will need to play critical roles in providing support. In Africa, where most nation-states are in their infancy and human security is constrained by a host of factors—little or no infrastructure, ethnic conflict, and environmental crises, both man-made and natural, resulting in natural resource loss, disease, and famine—the notion of "security" cannot be tied to the traditional concept of defending national integrity but should reflect a more human-centric perspective. Historically, militaries in Africa supported dictatorships and juntas whose social, cultural, and economic policies undermined human/environmental security. Many African countries have resisted or at least approached AFRICOM with trepidation due to this history. In the past, colonial powers protected Africa from the Africans. Resources flowed out—diamonds, minerals, oil—even Africans, up to the nineteenth century—and many of those resources still continue to leave, with benefits accruing only to a tiny percentage of Africans. With independence rolling across the continent in the mid-to-late twentieth century and new governments unable to govern effectively, human life and natural resources were and are victims of civil wars, terrorism, and cross-border conflicts. In many parts of Africa, the militaries have contributed to destabilizing countries and to genocide, ethnic cleansing, and marginalization of ethnic and cultural groups not in power. This perception of militaries, past and present, has led to the concept of "militarization" and has initially stained the efforts of AFRICOM. Dealing with the perception of militarization and thus abating resistance to stability operations will be the burden of organizations such as AFRICOM.

AFRICOM, and thereby the USAF, can bring to bear unique capabilities and technologies through building partnerships, particularly in the development and sustainment of national and international conservation zones, TFCAs, PPs, and CBC programs. The conservation zone can be understood in terms of three primary benefits: sustainment of biodiversity, development and sustainment of economic development, and a vehicle for conflict management and resolution.[10] There are several types of conservation zones, including TFCAs, PPs, and CBC programs. Each offers opportunities for developing and sustaining partnerships with Africans.

The CBC programs offer opportunities for developing lasting partnerships with African communities that can promote the development of human security beyond what national government organizations can provide.[11] One CBC program in northern Kenya suggests how the USAF through partnership building can develop and promote sustained partnerships at the level of local communities—considered critical in promoting stability in developing and conflict-prone nation-states.

Conservation Zones

The environment, as we have discussed, is a critical component to guaranteeing human security for Africans. The development and implementation of conservation zones that incorporate local communities and governmental organizations in managing land for multiple purposes can promote stability. The development of ecological areas/conservation zones to promote sustainability and stability has a long history. The birth of national parks and forests in the United States is just one example of such use. More recently, the use of conservation zones in Africa and other areas, such as North/South Korea, the Middle East, Southeast Asia, and nations in and around the former Soviet Union, has been promoted as a means of conflict resolution.

Conservation zones are based on three general benefits or pillars of sustainability:

1. sustainability of biodiversity through conservation [conservation and management of natural resources, including water (hydroelectric) and land resources such as forests and wildlife] and preservation of the "commons" to reduce conflict over depletion of resources; [12]

2. management and sustainability of economic development both locally and regionally through the engines of ecotourism and community-based land use programs; and

3. sustainability of regional peace and stability through conflict resolution to include bilateral and multilateral relations between nations.[13]

Conservation zones refer to ecologically protected areas whose boundaries and land use have been agreed upon by local, national,

and/or consortia of national governments and NGOs. At the local community level, conservation zones can create governance that is often far more influential and beneficial to local populations than national governments, especially where the national government lacks a strong presence in areas more rural and distant from the government centers.

There are three basic types of conservation zones in Africa. The first, transnational, has borders established by national governments and maintained by a consortium of governments. These not only engage indigenous and local populations, but also depend on successful international cooperation to create, sustain, and protect natural and human resources in and around the conservation areas. A second type includes areas within national borders (e.g., wildlife refuges and national parks). The third type engages local populations in establishing and managing natural resources areas for sustaining wildlife and promoting local economic development. Community-based natural resources management (CBNRM) programs in southern Africa, originating in the 1980s and piloted in Kenya, Tanzania, and other countries, exemplify these.[14] Rural communities that live in nontenable or marginal agricultural lands in and around wildlife- or game-rich habitats or migratory routes are empowered to manage the natural resources for economical benefit through ecotourism. Management of these community-based areas creates local governance that often becomes the de facto decision maker in community issues and a tie to the national government.

Environmental stress rarely respects national boundaries, and it may be beneficial for countries and regions to cooperate to alleviate similar or mutual problems.[15] Concentrating on environmental peacekeeping instead of environmental problems and environmental security entails interactions that can be building blocks for future cooperation.[16] Protected areas—transfrontier protected areas, transboundary protected areas, or transfrontier conservation areas (TFCA) that straddle national or regional boundaries—are often called peace parks.[17] Peace parks are found primarily in past conflict, postconflict, or potential conflict regions.

Generally, TFCAs are ecological "protected areas" developed between nation-states sharing a political boundary. There is usually some regular communication and information sharing between TFCA partners. TFCAs may or may not have contiguous boundaries and/or contain human use land areas.[18] The development of TFCAs

in Africa has been especially successful in facilitating the resolution of territorial conflict and promotion of environmental sustainability. TFCAs have also become "important symbols and outright manifestations of the peace process."[19] For conservationists, TFCAs are an enforceable means for protecting biodiversity. For national militaries, they become an area without human population encroachment. Recently, however, TFCAs have become refuge areas or staging platforms for rebels. TFCAs also represent economic development for local indigenous groups or privately sponsored ecotourism companies. They offer pharmaceutical companies or NGOs interested in preserving agricultural biodiversity a genetic "warehouse" of potential natural resources or information.

Ecotourism is an engine that can drive both funding and livelihoods for those who live in and around the TFCA.[20] TFCAs such as the Great Limpopo Transfrontier Park (GLTP) that straddles the boundaries of Mozambique, South Africa, and Zimbabwe offer places to live within and adjacent to park boundaries

Peace parks date from 1932 and the development of the Waterton-Glacier International Peace Park on the border between the United States and Canada.[21] Organizations such as the World Commission on Protected Areas of the International Union for Conservation of Nature (IUCN), the World Wildlife Fund (WWF), and the United Nations University for Peace have worked in some way to further the concept of promoting peace through building peace parks. According to the IUCN, a PP must promote a "clear biodiversity objective, a clear peace objective and cooperation between two countries or subnational jurisdiction." The UN University for Peace defines PPs as protected areas where "there is a significant conflictive past."[22] Others have defined "Parks for Peace" as "transboundary protected areas that are formally dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and to the promotion of peace and cooperation."[23] Clearly, PPs focus on sustaining peaceful relations between nations, promoting environmental sustainability, and preserving access to natural resources.

Peace parks provide a collaborative alternate solution to barricaded borders, thereby mitigating tensions. They have been used successfully in regional areas either prone to conflict or in a postconflict condition, such as the border between Kuwait and Iraq.[24] The Korean demilitarized zone is a nature corridor untouched for 50 years and an opportunity for engagement in collaborative efforts to maintain habitats

and reintroduce species, promote novel cooperation in international relations, and symbolize peace.[25] The Siachen Glacier region has been and continues to be a region of conflict between India and Pakistan; "combat over a barren, uninhabited nether world of questionable strategic value is a forbidding symbol of their lingering irreconcilability."[26] A "Transboundary Peace Park," to be bilaterally managed by both India and Pakistan, has been proposed that could end the ongoing "low-intensity border war between the two nations."[27] A frontier peace park in the Mesopotamian marshlands between Iran and Iraq is in the preliminary stages. The goal is to bring Shia and Sunni together and to restore sensitive marshlands necessary for biodiversity and agriculture damaged by decades of conflict.[28] The boundary land between Afghanistan and Pakistan also has been proposed for a series of TFCAs.[29]

The development of TFCAs featured peace parks in early 1990s Africa.[30] Peace parks came into being through discussions of common interests, first between South African WWF president Anton Rupert and Mozambique's president Joachim Chissano in 1990, with later support of the newly elected South African president, Nelson Mandela. The Peace Parks Foundation was established in 1997. The foundation was a collaboration of the governments of Mozambique, Zimbabwe, and South Africa and NGOs such as the WWF of South Africa and the World Bank.

There are several successful peace parks in southern Africa, including the GLTP, Kibira National Park, Virunga National Park, and the Volcanoes National Park, which make up the Great Lakes TFCAs of Burundi, Democratic Republic of Congo, and Rwanda. The ambitious Kavango–Zambezi (KAZA) Transfrontier Peace Parks Initiative includes five African countries—South Africa, Botswana, Mozambique, Zimbabwe, and Angola.[31] The KAZA has remained in the planning stage for several years due to the political instability of some members leading to internal conflict. The implementation of such an initiative only underscores the potential benefits of TFCAs to nations and their neighbors. While analysis is ongoing, organizations such as the Peace Parks Foundation in South Africa continue to promote peace parks, leaving the potential for engagement in partnership building open.[32]

Community-Based Conservation Programs—A Unique Opportunity for Building Partnerships

Community-based conservation programs represent a new conservation ethic in Africa as elsewhere in the last two decades.[33] The colonial conservation ethic, "protectionist (fortress) conservation," was state-controlled, "top-down" management and has given way to a management approach based on "inclusive, participatory, community-based endeavors."[34] Initially labeled as CBNRM projects when first developed in Africa in the 1980s, programs were established in countries under different acronyms but with the common goals of community participation leading to natural resources management, recovery and sustainment of at-risk wildlife, and community development. In Namibia, the CBNRM program was labeled "LIFE" (Living in a Finite Environment), and in Zimbabwe it was labeled "CAMPFIRE" (the Communal Areas Management Program for Indigenous Resources).[35] Today these programs are found in many African countries and are subject to growing pains specific to local, national, and international governments. Also, the national and international NGOs that represent powerful and competing interests may or may not promote conflict resolution, attenuation, and management.

Top-down approaches of national and state governments in the development and sustainment of national parks now create difficulty in adapting to the community-based conservation ethic and translation of that ethic into successful community development and sustainment of local natural resources to the benefit of community residents.[36] The heart of making CBC programs successful requires allying the twin goals of conservation (including biodiversity) and economic development (socioeconomic benefits to local communities). Likewise, these goals must be reconciled with those of all stakeholders. Efforts of NGOs such as the WWF and The Nature Conservancy can promote conservation through limited land use that marginalizes the benefits to the local communities.[37]

Other difficulties lie in articulation between the efforts and management of government organizations and the participation of the local communities. This is apparent in the operation of national parks and refuge areas where the needs of indigenous peoples are not considered. Lately, national governments in countries such as Kenya and Tanzania have promoted the development of conservation areas that

have incorporated those indigenous traditional land users in the management and sustainment of parks.

The Ngorongono Conservation Area (NCA) in Tanzania offers indigenous populations residence within and adjacent to park boundaries. Even though limiting their traditional subsistence strategies—for example, pastoralism for the Masai—the NCA park development and sustainment can offer employment, experience, and training/education.[38] Yet there is also evidence that the Masai culture and specifically its relationship to wildlife have dramatically been altered, and the local indigenous cultures and life ways—herding and grazing cattle—fragmented. Even though local Masai have been included in park management in some capacities, they are not active or meaningful participants. In addition, Masai ecological knowledge, including "geographical understanding of the landscape . . . to ecological knowledge and resource management process" honed over centuries of local subsistence, is not taken into consideration in the discourse shaped by the hegemony of Western conservation approaches. This local knowledge is based on a continuing ecological repository of orally compiled observation and interaction with natural resources that lies beyond the "science" of conservation and must be integrated into CBC to be an effective program.[39]

In Tanzania, as elsewhere (South Africa, Malawi, Uganda, Zimbabwe, and outside of Africa), there is a problematic dialogue between the more "official" entities of government, NGOs and donor agencies/organizations that represent the power brokers, and the local communities themselves. Oftentimes there is a lack of adequate representation to establish or reconcile an effective management that considers both goals of conservation and economic development. An effective CBC program requires that the resource brokers consider "how to reshape their own institution and agendas to really *fit* communities—with their diverse needs, knowledge, and complex social and ecological structures—into conservation" (emphasis in the original).[40]

The Western notion of "community" may also bias the application of CBC. Western notions of geopolitical boundaries, such as villages, applied to seasonal transhumance subsistence, mobile agricultural, or food forager cultures (these strategies are most likely those practiced by indigenous populations in and around CBC lands) constrain the consideration of conservation approaches and limit the application of natural resources for economic development. Conservation zones offer a multitude of engagement points that could be utilized in

developing partnerships through promotion of human and environmental security. At the same time, AFRICOM, other DOD, or DOS efforts to frame the activity and the relationships in terms of promoting sustainable African success in conservation zones must apply caution to partnership activity.

Contemporary CBC Programs: Land Trusts and the Kenya Land Conservation Trust

In 2005, the Kenyan government incorporated the Kenya Land Conservation Trust (KLCT). The trust encompasses CBC programs that "extend beyond protected areas" and the acquisition of critical pieces of land integral to national conservation efforts.[41] Protected areas in Kenya account for only 8 percent of its land. This leaves large parcels of wildlife habitat outside the protection of governmental agencies such as the Kenya Wildlife Service (KWS) and the Ministry of Lands and Housing when it comes to protecting against "incompatible" land use practices "emanating from population increases . . . and the consequent conversion of land for agriculture, subdivision, settlements and livestock loss" and potential use by criminal or terrorist organizations.[42] Leaders from national and local private sectors, civil society, and landowners join a diverse trust board featuring African Wildlife Foundation (AWF), KWS, and the Ministry of Lands and Housing. This provides a venue for "active" participation in communities where the KLCT will be operating. Various mechanisms are used to ensure conservation, to include land purchases, easements, leases, and management agreements.

Besides facilitating the KLCT, the AWF has initiated the African Heartlands Program that emphasizes conservation of African wildlife through protection of "large, cohesive conservation landscapes."[43] As indicated above, many of the critical ecological "corridors" that help sustain wildlife through migratory routes as well as necessary tracts of habitat are not under protection afforded by national governmental agencies. Local communities or even state agents without means to protect or sustain conservation of natural resources falling within individual or community boundaries or designated land tenures mostly own these corridors. The development of land trusts has brought private lands under conservation and facilitated development of natural resources management plans that promote synchroni-

zation of multiple land uses that benefit both biodiversity and human livelihood. The African Heartlands Programs as of 2005 had initiated CBC programs to benefit communities in Mozambique, Tanzania, and Botswana.

CBC programs offer a unique partnership-building opportunity at community levels to address environmental and, in general, human security at the ground level. The partnerships are developed in a complex coalition that would include national government agencies; the more grounded the community, the more viable the relationship between community and national government. Strengthening this frequently tenuous relationship between government and communities in many African nations promotes stability.

Another example of a CBC program in Kenya is the Northern Rangeland Trust (NRT). The NRT was prompted by support from the Lewa Conservancy, a private land trust in northern Kenya. The success of the NRT suggests a potential model of CBC that could be exported to other areas of Africa, and AFRICOM could be a means to assist in the development and sustainment of these programs.

Lewa Wildlife Conservancy and Northern Rangeland Trust

A Case Study

Arguably one of the most successful CBC programs in Kenya, perhaps on the continent, is the partnership between the nonprofit Lewa Wildlife Conservancy (LWC), a 62,000-acre former privately owned cattle ranch, and the Northern Rangeland Trust, a collection of local communities north of the conservancy that have designated communal land for wildlife preservation. The former owners of Lewa Downs, now the LWC, primarily herded cattle until 1983 but also operated a successful wildlife "ecotourist" program fueled by the now-endangered black rhino and Grévy's zebra, as well as elephant, lion, leopard, and African buffalo. With the black rhino approaching extinction due to poaching in the early 1980s, the owners set aside and fenced part of the ranch as a rhino sanctuary. A decade later the sanctuary was expanded and converted to a general wildlife sanctuary to include the entire ranch and adjoining Ngare Ndare Forest Reserve.

The LWC has also addressed social and health issues within local communities as well as those adjacent to its boundaries. It has created a very efficient wildlife "security" force that cooperates with the Kenya Wildlife Service and features a variety of security technologies to maintain an effective deterrent to poaching. Occasionally, the LWC security partners with the KWS and community conservation programs in antipoaching missions.

The northern rangelands contain a precarious environmental situation; "the long-term conservation of wildlife in Kenya's northern rangelands is inextricably linked to the fate of the local pastoralist communities."[44] The LWC has taken an active role in northern Kenya, fostering a conservation and wildlife preservation ethic to combat the negative effects of human intervention from overgrazing and livestock, poaching, and ethnic violence. There is a connection between the conservation of wildlife and preservation of biodiversity in northern Kenya with the development of the local pastoralist communities. CBC initiatives in Kenya, as elsewhere in Africa, rest on the development of wildlife and habitat, with ecotourism as a driver of economic development. The efforts and resources supplied by governments and NGOs are crucial to these initiatives. The drive for economic sustainability often overshadows the absolute need to involve the local community at every step of the developmental process. The evolution of the NRT is an example of a CBC initiative that weaves into its expression the critical piece of community governance and management.

Land ownership is a defining attribute of the NRT and supports the notion of conservancy independence. Ownership empowers communities to make informed decisions that relate to community needs. However, the majority of Kenya's CBC initiatives tend to focus on generating economic benefits for the community through ecotourism. The real needs—to establish a solid foundation for local governance and sustainability of that initiative—come second. As a result, community participation from the outset is largely passive and tends to become overly dependent on long-term support from the government and NGOs. The NRT has approached development with goals customized to each conservancy and based on the needs of local communities. This approach promotes a solid and accountable foundation for investment from a variety of sources into the conservancies and cultivates independence from the specific interests of each of the organizations. Investment is applied to directly support conservation *and* to community institutions that may indirectly support

conservation and the development of the community. In others words, success of the conservancy fosters community development.

In 2004, LWC personnel collaborated with national and local governments and conservation groups to establish the NRT. The main problems and their solutions in development of the NRT followed the three pillars of conservation zones discussed earlier: sustainability of biodiversity, economic development, and conflict resolution. The NRT encompasses 1.5 million acres and is home to "approximately 60,000 pastoralists of different ethnic origin including Samburu, Rendille, Laikipiak Maasai and Meru."[45] The trust stretches across a large swath of traditional African megafauna habitat, yet each of the trust's conservancies contains a unique constellation of animal and plant species that require specific conservation and local economic development.

Goals of the NRT are to

- ensure the conservation, management, and sustainable use of the natural resources within the trust area;
- promote and develop tourism and all other environmentally sustainable income-generating projects within the trust area;
- promote culture, education, and sports of the residents of the trust area;
- promote better health of the residents of the trust area through the provision of better health services and facilities;
- alleviate poverty of the inhabitants of the trust area through improved social services, provision of employment, and establishment of community-based enterprises; and
- promote and support trusts, corporations, NGOs, and other charitable organizations with similar objects to those of the trust.[46]

The NRT has organized around a governance structure that relies on representation of individual conservancies through a democratically elected council of elders and a board of trustees with a set tenure of service. An executive director coordinates trust operations by funneling decisions through the community development department, the research and monitoring department, the livestock and rangelands manager, and the business and enterprise manager. Individual conservancies allocate almost 50 percent of their ecotourism income toward an annual operating budget, with the remainder going to

community institutions and services for community development (e.g., education, social services, health care, etc.).[47]

Individual conservancies follow a similar administrative structure, with the traditional community leadership empowering a community conservancy board that directs operations through the four departments similar to those mentioned above. Conflict resolution teams reconcile resource use when grazing and other disputes arise. The teams consist of respected elders led by a retired chief who "maintain peace through mediation, dialogue and advice." Team members receive formal training in an array of conflict resolution techniques as well.[48]

The northern rangelands are unique in Kenya, perhaps in all of Africa. There are no physical boundaries or fencing that would impede the natural movement of wildlife. The NRT acts to secure this area through individual conservancies that work locally in concert with other conservancies to maintain wildlife and a broader ecological mosaic strategy that guarantees the necessary wildlife migration through the rangelands.

The success of the individual conservancies depends on effective management of the NRT and external support from a variety of organizations. This also depends on effective ecological monitoring and a sound security program that support the wildlife, habitat, and communities. Tools necessary for ecological monitoring and a viable security program include "radio communications equipment, a direct communication channel, weapons (dependent on government policy), uniforms, binoculars, GPS units, camping equipment for mobile security teams, computer and office resources, airstrips, and other infrastructure."[49]

A sound ecological strategy can rely on the resources of the conservancy managers, governmental organizations, and nonprofit ecological conservation organizations for evaluation of the ecological management program to provide flexibility in adapting to changing conditions and to coordinate management strategies with developmental potential. Inherent in the NRT and its individual conservancies is a community "participation" monitoring program that combines both quantitative ecological monitoring and localized participatory qualitative monitoring. This prioritizes species monitoring, promotion of trust and individual conservancy collected data, and initial analysis by NRT technicians. Satellite remote sensing and aerial survey data complement the conservancy-collected data.[50] Monitoring programs consist of ground and aerial monitoring and

surveys of wildlife species, habitat vegetation, rangeland conditions, and game bird species to promote sustainable management practices. This straightforward approach provides communities with information for critical decision making on conservation and development activities.

The northern Kenyan rangelands have struggled with the effects of political instability in neighboring Somalia and Ethiopia in the form of terrorism. The Kenyan government and local communities have resolved some of the human insecurity; however, activities such as poaching continue to plague the ecological security and success of the NRT itself. The trust engages a security network that spans the entire range, including an active, well-trained, and well-resourced security team. The operations of the security program are also closely allied with organizations such as the KWS and Kenyan police. For security operations that require additional support, resources such as aerial reconnaissance, dogs, and armed forces are available from the Lewa Conservancy.

The NRT and AFRICOM/USAF: A Model for Building Successful Partnerships

Air and space capabilities can aid in meeting human security needs through effective governance, promoting national and local security, and meeting the sociocultural needs of the people. The modern standards that ensure safe and effective air and space operations require infrastructure development that benefits both civil and military use. Aiding the development of air and space capabilities can include a range of activities that includes military-to-military, military-to-civilian, and civilian-to-civilian contacts. Activities could include civil (human security) operations through civil aviation training, humanitarian response activities, promotion of medical assistance in rural and marginalized communities, assistance in building the necessary infrastructure to support both civil and military aviation, development of training exchange programs for personnel in both civil and military aviation, peacekeeping, and other activities. USAF partnership building could involve robust application of air and space assistance in the development and sustainment of aviation capability to both partner nation governments and local communities.

AFRICOM could provide support in seven specific areas to TFCAs and peace parks to promote partnership building. These areas directly support environmental security in those conservation areas developed and supported primarily by governmental and NGO agencies:

1. Provide environmental security education/training and regional cooperation training to African militaries.
2. Assist African governments and militaries in creating security for TFCA (e.g. the Botswana Defense Force).[51]
3. Assist with knowledge sharing related to piracy, poaching, trafficking, terrorism, and other illicit transboundary activities.
4. Assist with knowledge sharing to identify and maintain areas suitable for designation as a TFCA.
5. Facilitate the TFCA programs with the assistance of DOD environmental and natural resource managers.
6. Assist Africans in environmental remediation programs to mitigate and return natural environments to sustainability following human impact such as post-demining environmental mitigation.
7. Provide cross-cultural education/training programs to all involved stakeholders. Develop program assessment measures to include short- and long-term ethnographic studies to ensure that development and sustainment of conservation zones is both effective and sensitive to the local peoples and culture in and around the conservation zones.[52]

The NRT offers opportunities where AFRICOM could apply support to localized and community-based conservation programs. AFRICOM support would allow individual communities/conservancies to be primary stewards of the ecological and human security. As has been argued, environmental security can promote human security for those far from the effective reach of their national government. The NRT conducts partnership-building activities at low levels of security assistance or civil-military operations, and standard interagency coordination at the country–team level should be adequate. This does not minimize the effectiveness of such activity. The populations affected may not be large or sophisticated in the means of economic development, but the vast area in the NRT and the need to guarantee "ownership" of that land as a barrier/buffer to the violence

from bordering nation-states and organized criminal activities such as poaching are critical for human security in Kenya. For this security to be realized, the local populations need to be fully engaged in control of the land and be able to make a living off the land.

Aviation and USAF Support

Aviation and aviation support infrastructure are key to many of the operations, development of the NRT, and the individual conservancy programs. Northern Kenya, like so many other rural areas on the continent, lacks the infrastructure of basic local roads as well as national or international highways. Aviation becomes a necessary means of travel and transport connecting local communities, such as the community conservancies of the NRT, and also connecting them to services from national agencies and organizations. There are several areas where AFRICOM/USAF could provide assistance.

Security Assistance

Aerial support would be critical for developing and maintaining an effective security program for wildlife, residents, and visitors. Aviation enables reconnaissance for identifying poachers and other criminal and terrorist activities. The Lewa Conservancy has developed this capability, and aerial reconnaissance support over the vast area of the NRT would be very beneficial. Transport of security forces can be done more effectively and rapidly through aviation resources. Providing equipment such as light aircraft, maintenance programs and parts, and training for security forces to develop and maintain human and technological resources would also be beneficial. Local security forces could benefit from programs along the lines of International Military Education and Training through DOD professional military education programs across the services and, for aviation, through Air University.

Ecological Management

Ecological monitoring programs would also benefit from an increased use of aviation and space. Aerial surveys of wildlife (specifically the migration routes), of grassland usage, and of the maintenance of livestock-free zones are essential to sustaining viable

populations. Since the NRT's ecological monitoring is done through the local conservancies, land "truthing" wildlife populations requires coverage on foot. Aviation can provide transportation to and from monitoring areas. The use of satellite remote sensing can provide survey data across the entire NRT that will complement monitoring at an individual conservancy level.

Economic Development

Aviation would promote economic development of the NRT and individual conservancies through wildlife-based enterprises that would include transportation of tourists and resources to and from wildlife areas and transport into facilities that support tourism.

Humanitarian and Emergency Care

Localized humanitarian crises as well as emergency care and medical response capability can also benefit from aviation resources. Transport of medical personnel and supplies and patients would be more effective with aviation.

Technology and Research Transfer

The USAF, through its environmental management programs and adherence to sound stewardship principles and application of innovative science, can also provide cutting-edge technology to apply to trust and individual conservancy programs. Providing educational opportunities/internships to NRT and conservancy employees through exchange programs with environmental management programs and/or partnership programs with academic programs would be useful to sustaining the success of conservancies.

Conditions for Success

There is ample opportunity for partnership building to assist local communities in stabilizing their own human security needs, which ultimately will allow the solidification of a sovereign government to meet and sustain human security over the long term. For environmental security based and directed at local communities' partnership programs to be successful, certain conditions need to be met. These include cultural awareness of the African people and education/

training of US/DOD personnel in cross-cultural competence.[53] Cross-cultural competence would facilitate mapping the necessary relationships to engage a pilot project like the NRT; identifying the human, technological, and material resources that might be useful to the NRT; and producing the "lessons learned" for future projects similar to the NRT.

Cross-Cultural Competence

Implicit in developing and sustaining partnerships with African nations and the many ethnic and tribal groups that make up the cultural landscape of the continent is successful cross-cultural interactions. The USAF promotes cross-cultural competence as an applied suite of knowledge, skills, and attitudes that prepare Airmen to operate successfully in culturally complex situations without an extensive regional or culturally specific experience and linguistic competency.[54] Knowledge of the foundational concepts and domains of culture and enhancing behaviors such as cultural relativism will promote and sustain communicating, relating, and negotiating skills necessary to work across cultural barriers.

Mapping the Relationships

AFRICOM continues to define its scope and nature of operations on the African continent as well as develop an internal "rhythm" for its three components, DOS, DOD, and USAID, to work together to build partnerships. Identifying and mapping the necessary organizations/agencies critical for success of an NRT partnership are necessary prior to the planning phase of such an endeavor. Initially, those departments within AFRICOM that would play a role in planning and implementation would need to coordinate their efforts through the ambassador and the country team. The country team would initiate the outreach necessary to Kenyan governmental organizations and agencies responsible for contacting local community/conservancy officials to query on initial in-country visits that would begin to explore the potential for applying human and other resources to the NRT. Clearly, the sensitivity of the role of AFRICOM in supporting such projects would best be facilitated by a coordinated effort worked through the country team.

Modeling CBC Programs

CBC programs like the NRT offer a means for developing and sustaining human security in large areas with relatively low population density. Community conservation programs promote stewardship by local communities with a dual benefit of promoting biodiversity and a sustainable local economy in areas that are usually marginal in both agricultural value and economic development. In the case of the NRT, the benefits accrued by individual conservancies are magnified by the relationships each has with the larger trust and with the Lewa Conservancy. More land, especially more contiguous land, is brought under community control, while human and material resources needed by individual conservancies can be pooled to minimize cost. AFRICOM could then play a pivotal role in helping identify and develop CBC programs in other areas of Kenya and the rest of the continent.

Further Study

The complexity of agencies and organizations that would be instrumental in brokering a successful program of assistance to the NRT is indeed a labyrinth and must be mapped to find the most effective pathway. This study has established the foundation for considering an approach to partnership building through the need for environmental security in Africa. It has examined conservation zones as a possible avenue toward partnership building, specifically a recently established CBC program that might afford a pilot study of engaging AFRICOM. Further research and analysis should be accomplished to ascertain the value of whether this type of partnership in Africa can be successful and mutually beneficial. A study directed at the feasibility of a project like the NRT as a model for building partnerships through similar environmental security/sustainability projects in other regions of Africa would be beneficial and should consider the following goals:

1. identify stakeholders for establishing the viability of such projects;
2. conduct capability needs assessment to identify the potential human, technological, and material resources that the DOD and AFRICOM could provide that would benefit the NRT and other CBCs; and

3. initiate/participate in preliminary discussions with US governmental agencies and NGOs that would play important roles in the success of such projects (e.g., Kenyan Wildlife Services, Kenyan Land Trust officials, Lewa Conservancy, and the NRT board).

Conclusion

Promoting African stability through development and eventual sustainability of human security by Africans is a necessary condition for successful promotion of US foreign interests. Environmental security efforts such as CBC programs offer positive and viable partnership building opportunities for AFRICOM. Using the NRT as a feasibility model and/or pilot program should be explored to include further research on the types of human and technological resources that would benefit it with an eye on developing sustainability by the local conservancies and building initial relationships between AFRICOM and country teams and with those Kenyan local and national officials and other necessary personnel. Such a model or pilot would also provide its own case study of how such engagement would occur and identify conditions such as education and training in cross-cultural competence that would be necessary.

Notes

1. Burgess, *Air Force Symposium 2009*.

2. Initially, human security was defined in the United Nations Development Program, *Human Development Report 1993*, 2; and later in 2003, United Nations Commission on Human Security, *Human Security Now*.

3. United Nations Commission on Human Security, *Human Security Now*, 1.

4. Ferreira and Henk, "'Operationalizing' Human Security," 1. See also Sands, "Letters to AFRICOM No. 3," 27–40; and United Nations Development Program, *Human Development Report 1994*. The latter states on page 22,

> The concept of security has far too long been interpreted narrowly: as security of territory from external aggression, or as protection of national interests in foreign policy or as global security from the threat of a nuclear holocaust. It has been related more to nation-states than to people. Forgotten were the legitimate concerns of ordinary people. . . . For many of them, security symbolized protection from the threat of disease, hunger, unemployment, crime, social conflict, political repression and environmental hazards.

5. Adapted from the March 2009 LeMay Center Building Partnerships (BP) Symposium, 6–8 January 2010, session 1. This definition acts under the premise that "Airmen" are active duty, reserves, civilians, etc. (see Air Force Doctrine Document [AFDD] 1). The reference to Airmen in the definition supposes that they are performing aviation-related activities.

6. Adapted from draft AFDD 3-20, *Building Partnerships*.

7. Mosher et al., *Green Warriors*.

8. United States Africa Command, "About U.S. Africa Command."

9. Henk, "Environment, the US Military," 98–117.

10. Sands, "Letters to AFRICOM No. 3," 27.

11. Ibid., 30.

12. Hardin's notion of the "tragedy of the commons" describes how multiple stakeholders can negatively impact a shared ecology if their self interest overrides shared management and efforts toward sustainability. Hardin, "Tragedy of the Commons."

13. Sands, "Letters to AFRICOM No. 3," 31.

14. Henk, "Environment, the US Military."

15. Brock, "Peace through Parks."

16. See Conca and Dabelko, *Environmental Peacekeeping*.

17. The many definitions of the "protected" zone or areas that cross some formal or political boundary are in reality very closely allied in concept. See Hsiao, "Peace Parks."

18. *Southern African Development Community Protocol on Wildlife Conservation*, 2. See also Sandwich et al., *Transboundary Protected Area*.

19. Weed, "Central America's Peace Parks," 177.

20. Timothy, "Cross-Border Partnership."

21. Ramutsindela, "Scaling Peace and Peacemakers"; and Ali, "Introduction."

22. Hsiao, "Peace Parks," 1.

23. Sandwich et al., *Transboundary Protected Area.* See also Ali, "Introduction."

24. Alsdirawi and Faraj, "Establishing a Transboundary Peace Park."

25. Healy, "Korean Demilitarized Zone"; and Kim, "Preserving Korea's Demilitarized Corridor."

26. Kemkar, "Environmental Peacemaking," 3.

27. Ibid., 23.

28. Stevens, "Iraq and Iran in Ecological Perspectives."

29. Fuller, "Linking Afghanistan with Its Neighbors."

30. Brock, "Peace through Parks."

31. Henk, "Human and Environmental Security."

32. Peace Parks Foundation, http://www.peaceparks.org/Home.htm.

33. Bajracharya, Furley, and Newton, "Impacts of Community-Based Conservation"; Hulme and Murphree, "Communities, Wildlife, and the 'New Conservation' in Africa"; and Hulme and Murphree, eds., *African Wildlife and Livelihoods.*

34. Goldman, "Partitioned Nature," 1.

35. Henk, "Environment, the US Military," 108–9; and Metcalfe, "Campfire."

36. Goldman, "Partitioned Nature"; Campbell and Vainio-Mattila, "Participatory Development and Community-Based Conservation"; and Balint and Mashinya, "Decline of a Model Community-Based Conservation Project."

37. Benjaminsen, Kepe, and Bråthen, "Between Global Interests and Local Needs."

38. McCabe, Perkin, and Schofield, "Can Conservation and Development Be Coupled among Pastoral People?"
39. Goldman, "Partitioned Nature," 856.
40. Ibid.
41. "Kenya Land Conservation Trust Formed."
42. Ibid.
43. Gichohi, "From the Desk of the Vice President for Programme."
44. Northern Rangeland Trust, http://www.nrt-kenya.org.
45. Ibid.
46. Ibid.
47. Ibid.
48. Ibid.
49. Ibid.
50. Ibid.
51. See Henk, "Environment, the US Military."
52. Sands, "Letters to AFRICOM No. 3."
53. Cross-cultural competence (3C) can be defined as "the ability to adapt effectively in cross-cultural environments." Sands, "Cultural Relativism," 13. The DOD has identified 3C as a necessary enabler for mission success in culturally complex environments such as deployments. In today's changing military engagements, as represented by counterinsurgency, counterterrorism, and building partnerships, and specific to the engagements proposed to aid in environmental security, 3C would be a critical set of knowledge, skills, and abilities to develop and engage. Services across the DOD are instituting education and training programs in 3C, and 3C is and will be advanced to civilians within the DOD.
54. Air Force Culture and Language Center, http://www.culture.af.edu.

area of the state of Israel—30 percent of state lands are used for military exercises, 4 percent are military installations, 1 percent comprise defense system installations, and security restrictions are imposed on 12 percent. Restrictions such as limiting the height of construction or fixing a flight path prevent full land use.[1] The MPE and the IDF began to institutionalize the links between them in 1997. At the ministry, the deputy director of supervision and public relations is in charge of liaison with the IDF. In the IDF, the environmental section in the General Staff's Planning Division, established in 1997, is in charge of coordinating all IDF activities with the MPE. As an indication of the importance the ministry assigns to its link with the IDF, it financed the position of head of the environmental section until 2002.

The IDF began to give greater attention to environmental issues in the 1990s. In December 1996, the Planning Division established a steering committee to coordinate the IDF's environmental activities. The deputy head of the Planning Division established the scope of the committee's activities in November 1997, determining that the membership of the committee would represent the services, the territorial commands, and other entities. The head of the Strategic Planning Branch in the Planning Division serves as committee chair, outlining the policy of the IDF in this matter, instructing military commands with regard to long-term planning, following up on application of the decisions, and initiating and promoting projects.

The Planning Division set up five secondary committees in 1998 that are subordinate to the steering committee: oils and fuel, waste and recycling, hazardous materials, commands, and procedures. Significant progress began in February 1999 when the vice chief of staff officially approved the document outlining the environmental policy of the IDF, detailing the objectives, and providing the operational means to attain them. It begins:

> The IDF is aware of the potential environmental effects of its ongoing activities, and undertakes to act on the matter from a national standpoint, and according to the directions developing in the field of quality of the environment in Israel. Out of concern for quality of the environment that is a component of the quality of life in Israel, the IDF has decided that environmental aspects will constitute an integral part in the totality of considerations on military action, and *on condition* (emphasis in original) that they do not harm the operational ability of the IDF to fulfill security demands; the IDF will initiate activity to increase awareness of the values of environmental protection among officers and soldiers, while creating a change in the current image of the army in this sphere; it is important to convey this message to the commanders, to

> furnish them with relevant knowledge and to awaken in them the desire and commitment to act to protect the environment that is the quality of our life; within the IDF's work program a planned integration of environmental considerations will be carried out in order to avoid harming the environment in IDF installations and to reduce their harmful effect on the environment in Israel, out of a commitment and persistent effort to observe all the laws and regulations with regard to environmental protection that apply to the IDF.[2]

These policies were not put into practice, and disputes arose between the IDF and the MEP. The ministry frequently complained to military authorities about the lack of information about possible sources of pollution. In general, the IDF did not act methodically to pass on information about various pollutants that were discovered in its facilities that could have a real effect on the environment.[3] Due to this lack of information from the IDF, the MPE was forced to locate hazards in military bases from sampling and observation posts outside the bases or from citizens' reports. Its ability to test in the bases is restricted. Even after MPE inspectors received permission to carry out inspections, the military frequently refused them entry to the bases.[4]

The partial realization of IDF environmental policy is reflected in the corps' annual project schedule. The policy required that each service and command be required to prepare an annual project schedule concerning protection of the environment that would determine how it would advance the environmental objectives of the IDF. As of March 2004 the IAF had an "environmental master plan" for the years 2001 to 2005. This was in contrast to the other services that did not formulate a perennial master plan. The IAF planned to allocate approximately 6.5 million new Israeli shekels (NIS) in 2001. In practice, the service spent only 4.4 million NIS (75 percent) that year. In 2002 the service planned to allocate 5.30 million shekels but spent only 2.67 million (50 percent).[5] The main reason for the underallocation in practice was large cuts in the Israeli defense budget that began in 2000. These cuts were necessitated by the economic crisis that affected Israel due to the Second Intifada (that started in December 2000) and the world hi-tech crisis in the year 2000.

Among the IDF services, there is special importance regarding protection of the environment in the IAF, for better or worse, due to the potential scope of its effects. The IAF affects the environment in three ways. First, the physical infrastructure of the service has significant environmental implications. One reason is that, due to the small scale of Israel, most of the bases are located near large concentrations

of population. In the event of war, IAF bases would be primary targets of the enemy. Therefore, there is a danger that civilian communities close to the bases would suffer significant environmental damage.

Second, IAF activity in the national airspace has environmental implications. The small area of the state of Israel and the plethora of aerial threats against it imbue the IAF with considerable influence on the policy determining use of Israeli airspace. This policy, particularly the fixing of military and civilian flight paths, has significant environmental implications. Third, the Israel Defense Forces is a "people's army" and not a professional force. Accordingly, it carries out an extensive array of educational activities intended to enrich the world of its soldiers as citizens in a democratic state. For well over a decade, the IAF has been carrying out courses about the environment as part of its educational activities. This has a great potential for influencing the attitudes of the soldiers and officers regarding quality of the environment.

As noted, the present study focuses on the first aspect—the effect of the physical infrastructure of the IAF on the environment in Israel. This topic is of special interest because most of the primary bases in northern or central Israel were built during the British Mandate period and used by the British Royal Air Force. As a result, they suffer from antiquated infrastructure that does not comply with modern standards. Two of the air force bases, Ramat David in northern Israel and Hatzor in the center of the country, were discovered to be main sources of surface and underground water pollution. The Hatzor base had been a major pollution source for many years. In 1983 a leak of 20,000 cubic meters of jet fuel caused pollution measuring 300 meters long, 2,000 meters wide, and 90 centimeters deep in the Coastal Aquifer, one of the three main water sources in Israel. The Ramat David, the central base in the north, has documented repeated fuel leaks since 1974. These leaks were caused by overfilling underground fuel tanks, bad maintenance of the fuel pipes, flooding of the fuel tanks on rainy days, spilling of surplus jet fuel from planes to the ground, cleaning of planes with jet fuel and flushing the waste to the ground, leaks from the fuel lines, spillage from fuel tanks, and flushing of the surplus fuel into absorbing pits.[6] These leaks caused pollution in the Kishon River and its streams and also in reservoirs in the settlements of Nahalal and Kfar Yehoshua.[7]

The cases of pollution led to talks between the IAF, the IDF, the Defense Ministry, the Water Commission (the regulatory authority

of the water system in Israel), and the Mekorot Company (a government-owned company holding the monopoly on developing the water system in Israel). The discussions dealt with ways of solving the pollution in the Coastal Aquifer caused by the Hatzor base. The prolonged discussions led to conclusions that there had not been proper treatment of the jet fuel tanks and installations, both in Hatzor and in Ramat David. In both bases corrosion was found in the underground pipes used to transport huge quantities of jet fuel. Accordingly, the corrosion was the main source of the many leaks. The IAF was aware for many years that the solution to the problem was installation of cathodic protectors on the jet fuel tanks to help prevent corrosion. However, in practice they were installed only after 2003.[8]

The slowness of the IAF and the IDF to treat the sources of pollution caused anger among governmental supervisory and law-enforcing elements in charge of environmental quality. In 2006, Baruch Weber, head of the Polluted Industrial Areas and Land Department in the MPE, stated, "The IDF needs to map the pollution, fix priorities and begin to deal with the matter. We held discussions and talks with various elements in the armed forces, and I regret to say that no real progress has been made, not at a satisfactory pace." Weber also claimed that the IDF made it difficult for the MPE to enforce the law. "We know about problems in a number of bases, but when our inspectors want to check what is going on in other bases, they don't succeed in passing the guard at the gate." He claims that the IDF used out-of-date equipment and control systems when more-modern equipment could have prevented this pollution. He says, "The problem in the IDF is chiefly awareness. A soldier that spills fuel is not aware that the fuel seeps into and reaches springs."[9]

These claims were correct, partially, with regard to the IAF. It preferred to avoid investing in local solutions that would have prevented some of the pollution. Instead it invested in building new alternative infrastructure based on lasting development principles. The head of the quality control branch at the IAF staff in 2006, Lt Col Shai Kidon, claimed, "In the past they used to spill the oil into the channels in the area of the Hatzor base and it seeped into the earth and reached underground water." At that time the question of pollution was not dealt with in the force as it is nowadays. During recent years the base has been approved by the Standards Institution of Israel, and today there are no cases of environmental pollution. The matter of treating the

damage that was caused earlier is being examined at present by Mekorot and the Defense Ministry.[10]

Transferring the hub of the service's activity to the new bases in the Negev included the potential for solving several main problems involving the environment. First, the infrastructure that the service established in the Negev was built from the start in accordance with progressive standards. Unlike the antiquated infrastructure at bases in the north and center of the country, the new infrastructure was built with an awareness of the need to avoid pollution. Second, although the Negev constitutes 60 percent of the area of the state of Israel, only about 10 percent of the country's population lives there. The air force bases in the Negev, unlike those in the north and center of the country, mostly are not located near civilian population centers. Accordingly, they enjoy a greater freedom of action since they do not disturb the civilian population with noise.[11] Third, the redeployment of the IAF in the Negev has the potential in the long term to remove some of the restrictions on airspace in the north and center of the country. In addition, reduction of IAF activity in these areas reduces, in itself, environmental damage.

Deployment of the Israeli Air Force in the Negev after Withdrawal from the Sinai

Israel's victory in the 1967 war dramatically expanded its airspace area. These areas, specifically the Sinai Peninsula, opened up training areas for the Israeli Air Force. The force hurried to use this opportunity, preparing to use Egyptian airfields abandoned during the war and setting up air control units.[12] After the 1973 war, the IAF even built modern bases in Sinai. The peace agreement signed between Israel and Egypt in 1979 mandated that Israel remove all civilian and military presence in the Sinai Peninsula by April 1982. The treaty not only ended the dispute between Israel and Egypt, but also this idyll of open flying spaces. The IAF recognized that it would have to return and train in the limited airspace of Israel, within the 1967 borders. Pressure on Israeli airspace also was expected to be greater than before the war of 1967 because the lessons of the 1973 war pointed to the need to expand the IAF.

The IAF began to plan its redeployment within Israel immediately upon the signing of the peace agreement. One of the first decisions

was to build a high-quality infrastructure that would serve the force for many years to come. The service avoided as much as possible using temporary buildings. The redeployment was called the Ramon Operation, after the Ramon Crater in the Negev, and was carried out in two stages. Operation Ramon A included the evacuation of IDF forces from Sinai, transferring the area to the Egyptians, and redeployment of the IDF within Israel. Operation Ramon B included the redeployment of IDF forces in the Negev and in Judea and Samaria. This was carried on over a number of years and ended in the mid 1980s.[13] The main issues that the service dealt with concerning Operation Ramon are reflected in the words of the IAF's tenth commander, Gen Amos Lapidot (December 1982 to September 1987):

> Today we fly, more or less, within the Green Line and a little over Judea and Samaria. This is a very narrow area, making exercises difficult and causing congestion in air activity, and as a result there occur exceptions to flight safety rules, exceptions likely to cause an increase in the number of accidents. To a certain extent disturbance of the civilian population increases; for example, sonic booms over residential areas. In this respect the return of the Sinai Peninsula was for the IAF the loss of an ideal training ground. . . . I regard the withdrawal and contraction with the confines of the Green Line as one of the most difficult challenges, for the reasons I have stated. The second challenge is the resettlement and redeployment in new bases and the third challenge—the absorption of sophisticated and modern equipment.[14]

The focus of the IAF's redeployment was, as stated earlier, in the Negev, which served as the principal reserve land of the state of Israel. As such, it was the only area where one could build the extensive infrastructure of new airfields. Even before the start of the Ramon Operation, the IAF had many units in the Negev. However the Ramon Operation was expected to increase the military presence there significantly. It was feared that the dramatic growth in the scope of military activity would adversely affect the fabric of civilian life in the Negev. The Israeli government prepared in advance to deal with the matter. The Ministry of Defense initiated a number of interministerial committees to coordinate the redeployment of the IDF in the Negev. The IDF and government ministries decided that the military project would be a tool for the advancement of civilian development of the region. Atypically, civilian regional planning objectives of various government ministries were integrated into military programs. However, it is possible that the main environmental effect of the Ramon program was that it fixed, irreversibly, the military and civilian

allocations of land use in the Negev. Most of the area assigned to the IDF was used as training grounds and not for building infrastructure.[15]

The main involvement of the IAF in Operation Ramon was in Ramon B. In this operation the IAF managed a giant construction project that included the establishment of three new airfields: Ramon, Uvda, and Nevatim. The Ramon and Uvda bases had been established by the United States and were already operative during the withdrawal from the Sinai Peninsula in March 1982. The Nevatim base was built by the Israeli defense system. The IAF also enjoyed the allocation of training areas in the Negev. It received live-fire training ranges in areas of the western Hanegev Mountain and in the northern Arava.[16] The IAF was also involved in another aspect of the redeployment at the borders of the Green Line. The redeployment in the Negev obligated the closing of airspace to civilian aircraft and a revision of civilian flight paths. The IAF cooperated with the Ministry of Transport and Road Safety and the Civil Aviation Authority in the revision of Israeli airspace.[17]

Redeployment of the IAF in the Negev from the Year 2000

In the 1990s the IDF and the IAF were under growing pressure to transfer army camps from the center of the country to the periphery. This pressure stemmed partially from the desire of civilian elements to use the land that the IDF would vacate for civilian purposes. However, it also reflected a growing awareness of the pollution caused by military bases to the soil and underground water, decreasing toleration of noise nuisance, and lastly, air pollution caused by the activity of the IAF. To a lesser extent was the fear of damage to the population concentration in the center of the country in the event of ground-to-ground missile attacks against the military bases in the region.[18] With the passing of time, this pressure partially bore fruit when the defense system agreed to vacate some of its bases. Most of the units involved were slated to move to the Negev. The IDF prepared plans for redeployment under the name "The IDF Goes South." The IAF part in the plan was called "IAF to the South." These plans were integrated into the civilian development plan for the Negev—Negev 2015. The main points of the plan, which set a strategic vision for the development of

the Negev for the years 2005 to 2016, were approved by the Israeli government on 20 November 2005.

The transfer of thousands of families of career officers to the Negev due to the military redeployment was a central component of the plan. Moving families of IDF officers, belonging to the upper-middle class in Israel, to the Negev was perceived as beneficial to economic activity and physical development there.[19] Together with its contribution to the promotion of civilian development objectives, the IDF regarded the IDF Goes South as a chance to create a military center of gravity in the south of the country—a new center of gravity that would improve the operational capabilities of the IDF should its bases in the center of the country be attacked.[20]

The IDF Goes South plan was different in a number of aspects from Operation Ramon, in which the IDF set up expansive new infrastructures. In IAF to the South, the IAF focused on extending the existing military infrastructure. Almost no new bases were established. Each one of the services established a special administration to plan the redeployment in the Negev. Similar to the military-civilian cooperation in Operation Ramon, the planning process took into account the possible effects on the way of life, infrastructure, and economic life of the citizens in the Negev. The IAF administration was the first to implement plans for redeployment. The first step was the closure of the base in Lod, in the center of the country, and the transfer of its units to the southern base at Nevatim. The IDF invested a huge amount of money, in Israeli terms, in extending the infrastructure at Nevatim: approximately 1.6 billion NIS (350 million US dollars).

According to Col Zvi Tweezer, head of the administration of IAF Goes South,

> The Lod base is very old fashioned, having been built bit by bit over the years, and from the standpoint of infrastructure that we built in Nevatim, there is no doubt that we have made a great improvement over what the unit has been used to till now. The change begins with a long, state-of-the-art, runway, progresses to upgraded parking slots for planes plus advanced communications infrastructure, ending with an extensive improved defense cover that will be built in the base.[21]

The construction work in Nevatim began in June 2004. The units from the Lod base, the main base for the IAF's transport squadron, transferred to Nevatim in August 2009.[22]

The extension plan of the infrastructure at the Nevatim base paid special attention to quality of the environment. Among other things,

a power station powered by natural gas will be built in the base with a production capacity that exceeds the anticipated needs of the base. The surplus electricity created is intended to serve also the nearby civilian settlements. Similar to many IDF bases, the base had internal sewerage prone to leakage. The IAF administration planned to connect the base to the regional sewage treatment facility to reduce the risks of polluting soil and underground water.[23]

The increased emphasis on environmental considerations in the IAF plans reflected a greater change in the service's perception of the subject. The service began to understand that environmental damage has negative implications in operational, economic, and even social terms. Toward the end of the first decade of the twenty-first century, the IAF invested a great deal in its contacts with the MPE, answering a call from the ministry to the IDF to increase cooperation between them. The ministry demanded that the IDF, as the largest consumer of resources in Israel, help by reducing its harmful effects on the environment. Among other matters, the ministry called for improved coordination in allotting money from the defense budget to protect nature and to reconcile the goals of the ministry with military development plans. According to a senior source in the ministry,

> We have a solution for each environmental problem that arises and we would be happy to deal with it. The complexity is caused when there is a lack of reporting of damage. The amount of requests from commanders nowadays is greater than in the past but still not enough. Reporting straight after an incident has occurred enables reduction of damage, even when it is a question of water or ground pollution.

In his view the greatest stumbling block when working with the IDF is the lack of budget coordination. "There is readiness on behalf of the commanders responsible for projects in the field. Allocation of resources for that purpose is more complicated."[24]

A meeting took place between then-commander of the IAF, Brig Gen Eliezer Shakedi and the then-director of the MPE Shai Avital in December 2007 that turned out to be a historic milestone. Also attending the meeting were personnel of the MPE, IAF base commanders from the south, and relevant officers from IAF headquarters. The top echelons of the IAF proposed strengthening its activity in the environmental field and pointed out several possibilities, such as recycling of sewerage and solid waste, reusing drain water, creating solar electricity, building drain water systems for irrigation, and

implementing green building, environmental education, and the transition from diesel fuel to natural gas, among others.[25]

The increasing cooperation between the MEP and the IAF led to positive results in the southern IAF bases. For example, in the Ramon base in 2007, one of the officers was put in charge of treating the environmental damage. On his initiative the base began to recycle the waste it created extensively. The command of the base actively helped and set up a site designated for sorting the waste. It also issued a directive ordering the soldiers to evacuate the waste in the base to the sorting site and set up a recycling goal of 80 percent of the base's waste. The recycling was expected to yield financial profit, since the recycling companies began to buy the sorted waste. According to the Ramon base commander, Col Avishai Halevi,

> Those that serve in the base do not perceive recycling to be a burden, but as a small investment that contributes to the protection of the environment, and which also helps us to make a profit that helps us to improve the welfare of the soldiers. In almost every place on the base there is a Green corner where waste for recycling is sorted and oils drained. We understand that we have the obligation to the soil, and we have to find new ways to recycle and not to return harmful substances.[26]

The focus of environmental considerations in planning the redeployment of the IAF in the Negev was reflected in educational activities in the service's bases in the south. From its inception the IDF considered itself, as the people's army, obligated to investing in the promotion of the education of its personnel, and traditionally, these programs dealt with love of the land and the history of the Jewish people and of the state of Israel. During the 1990s, these educational programs began to deal also with environmental topics.[27] This was especially prominent in the southern IAF bases where educational programs were developed that were meant to raise the awareness and broaden the knowledge of soldiers regarding quality of the environment.

The IAF base at Uvda developed a range of programs demonstrating the potential in educating conscripted soldiers (aged 18–21) to promote awareness of the environment in Israeli society. It was decided in 2006 to establish an ecological park integrating mud buildings in the base. In the park sitting areas, a *tabun* (clay oven) for baking, environmental benches, and statues were designed and all constructed from mud and recycled materials. The park was built under the leadership of six women from the families in the base, who had learned to build from mud in Kibbutz Lotan. The kibbutz residents

are experts in ecological subjects and run projects on the matter. In the words of Tahal Biran, the project's coordinator at the time and resident of the military families' neighborhood, "We have for a long time been looking for a project connected to the environment. In the kibbutz we took a course on building from mud, and right now we are applying what we learnt in a first attempt to build the ecological park." She argues that the clay earth and the weather of the Negev enable the creation of mud buildings in a particularly efficient manner. According to her, the project succeeded to enlist all the families living in the neighborhood during 2006. "The children in school and the families provide the domestic waste, and thus help the environmental sculpture." After the end of the first stage, the soldiers at the base took responsibility for the project.[28] Another educational initiative that crystallized at the base in 2007 was the "Sabbath of Values." Each weekend, military and civilian rabbis alternately gave lessons on Judaism, Zionism, love of one's country, and protection of the environment.[29]

As part of the effort of the IDF and the IAF to aid civilian authorities in the Negev, a program was formulated called "Sites and Values." The program was developed at the initiative of the Educational and Youth Corps and the *Beit Morasha* of Jerusalem (literally, "Home of Tradition"), a civilian educational center. Within the framework of Sites and Values, soldiers at the base adopted the cover sands in the eastern Uvda valley. The cover sands are chalk sand dunes constituting the habitat of rare plants and many species of animals. The soldiers helped the inspectors of the Israel Nature and Parks Authority southern district to maintain the site. Likewise, the base planned workshops on values at the site. In the words of the then-education officer of the base, 2nd Lt Noa Kenan, "We regarded the cover sands as a source for acquiring values for the soldiers of the base. The adaptation of animals to the desert environment and the aridness is impressive, and it is comparable to values such as the adaptation of the fighter to his/her environment and to self-discipline." According to her, the site will be used for instilling love of homeland and the importance of settling the Negev and for the creation of a link between those serving at the base and the environment in which they live. The base command also planned to help maintain and protect a nearby archaeological site called *Mikdash Hanamerim* (Temple of the Tigers). In the temple, 16 illustrations of tigers were found, made from small tablets of local limestone. This rare find, which is estimated to be

thousands of years old, was not protected against all-terrain vehicles. The base command, in cooperation with inspectors and ecologists from the southern district in the Israel Nature and Parks Authority, intends to fence the site.[30]

Operational Implications of Environmental Considerations on IAF Activity

The growing awareness in the IAF of environmental considerations also had implications on its operations. These implications found expression in several areas.

Damage to the Civilian Environment in the Event of Attacks on Bases

In most of Israel's wars there were hardly ever attacks on IAF bases within the 1967 borders. The environmental damage likely to be caused in the event of ground-to-ground missiles being fired at IAF bases was exposed during the Second Lebanon War (July–August 2006). During this war thousands of rockets were fired at northern Israel, including at several main IAF bases. One of those hit was the northern aerial control unit located on Mt. Meron. The unit is situated in the heart of a nature reserve that constitutes a natural habitat of rich vegetation and many animals. Rockets falling in the reserve ignited blazes that destroyed many thousands of square meters (or *dunams*, which are the area of 1,000 square meters) of natural forest. After the war ended, during the months of August and September 2006, several *dunams* of natural forest were felled next to the base to minimize potential damage in a future war. Although this was likely to harm the animals and plants existing in the nature reserve, the Israel Nature and Parks Authority deemed it a necessary step. Guy Cohen then Israel Nature and Parks Authority inspector in charge of the Mt. Meron Reserve said, "During the war we visited the base several times because we wanted to comprehend the extent of the base's responsibility and also to minimize the damage that such a felling would cause to nature, and to us, who protect it." The IAF hired a contractor that carried out the work of thinning the trees. All in all, about ten *dunams* of natural forest were felled inside the base and up to a distance of 15 meters from the base fence.[31]

Increase in Restrictions on Exercises

At the end of the twentieth century and the beginning of the twenty-first, the IAF was required to prepare for action on a wide range of missions. It played a crucial part in the military action in the Second Intifada, 2000–2005, and in the Second Lebanon War. In these conflicts the IAF was required to operate in urban environments densely populated with civilians. Simultaneously, it prepared for the possibility that it would be required to act against countries far away from Israel and even for the event of a conventional war. However, the IAF is being increasingly restricted in its ability to train. The proximity of the bases to civilian population centers in the north and the middle of the country created severe noise disturbances. In several cases the IAF decided to limit the hours of activity in the bases.[32] In other cases, certain training contours, such as low-level flights, led to angry complaints from civilians. As a result, it is possible that its ability to train in an optimal way was harmed.[33]

Development of Simulators and Cooperation with Foreign Air Forces

The lack of training areas led the IAF to invest in two kinds of partial solutions. The first was the development of advanced simulators.[34] The investment was expressed both in the systems themselves, meant to be as realistic as possible, and in the training of the simulator operators.[35] The simulators enabled IAF pilots to train on contours they were forbidden to fly because of safety and environmental protection restrictions. The IAF aspired to develop systems that would enable communication between different simulators. This capability, when achieved, would enable joint training in the simulator for combat, helicopter, and transport pilots.

The second partial solution was creating cooperation with foreign air forces, beginning in the 1990s. One of the main aims was to attain the opportunity to train in foreign countries. Thus, the IAF could train, for the first time since the withdrawal from Sinai, in vast spaces. As opposed to Sinai, where it was only possible to train under desert conditions, IAF squadrons began to train overseas in varying environments.[36] Together with training in recognized international exercises such as Red Flag in the United States or Maple Flag in Canada, the IAF trained in states such as Italy and Turkey.[37] The cooperation between the Israeli and Turkish air forces was especially fruitful.

In the words of Brig Gen Ram Shmueli, who played a central part in his capacity as head of the Combat Training Branch at IAF Headquarters, "In my first job as Head of Branch for Combat Training I managed to lead the IAF to one of the most important strategic connections—cooperation with the Turkish Air Force. When I began my post I made it my mission to bring about combined exercises with a foreign air force. Not that I had an inkling of how to do this but I felt that this was important." At that time, then-Prime Minister Yitzhak Rabin decided to establish diplomatic ties with Turkey, and Shmueli notes,

> Suddenly the opportunity we had been looking for arose. At the highest echelons it was decided to send a group from the General Staff to the Turkish Air Force to build a foundation of cooperation. As Head of the Branch for Combat Training I was chosen to be head of the delegation sent to Ankara. . . . The first talks were characterized by suspicion and tension on both sides. Both we and the Turks did not know what the other side thought and what exactly the aim of this idea was. Little by little, meeting after meeting, the chilly atmosphere thawed.[38]

The cooperation between the Israeli and Turkish air forces was quite close and included joint exercises in both countries. Over the years it expanded to multinational exercises with additional air forces. The cooperation ran into difficulties in October 2009 after the Anatolian Eagle exercise was cancelled. The planned American, Turkish, and Israeli air force combined exercise was cancelled by the Turkish government.[39] The incident illustrated the growing security importance that Israel attributes to cooperation between the IDF and foreign armed forces and the resulting dependence created on foreign states.

Conclusions

Since the 1990s, the IAF has shown increasing sensitivity to the effects of its bases and their activities on the environment in Israel. This is part of a growing awareness by the IDF of its influence on environmental quality as Israel's largest consumer of resources. The present study found that the IAF devoted considerable attention to environmental topics in two spheres: physical infrastructure and education. The IAF is aware of the environmental implications of its physical infrastructure due to pollution damage resulting from the antiquated infrastructure in the Ramat David and Hatzor bases. As early as the Ramon Operation in the 1980s, the IAF recognized the

advantages of a high-standard, permanent infrastructure. Nevertheless, at that time the main attention was devoted to financial gains resulting from ignoring this need. The planners of the IAF Goes South project paid a lot of attention to environmental issues. The IAF made a conscious decision to avoid as much as possible the renovation of its out-of-date infrastructure in its bases in the north and center of the country. Instead, projects were integrated that were intended to minimize damage to the environment and to bring about a reduction in the consumption of energy in the redeployment to the southern bases. The growing recognition by the IAF of the implications of its activities on the environment constitutes a large part of the changes in the civil-military relations in Israel. In the past, Israeli society revered the IDF as the realization of Zionist values. After the debacle of the 1973 war and, even more strongly, since the 1982 Lebanon War, Israeli society began to show growing criticism toward the IDF.[40] This criticism enabled the formation of pressure groups that demanded the IDF change its policies on specific matters.[41]

The IDF succeeded over the years in adopting policies intended to reduce possible criticism. For example, in the 1980s and 1990s, parents who had lost their sons in training accidents criticized IDF safety procedures and methods of inquiry into training accidents.[42] As a result, the IDF improved safety procedures in exercises and succeeded in dramatically reducing the number of accidents. The military even took care to publish these facts in the media to avoid future criticism. The attention that the IAF directed at environmental issues in the project IAF Goes South is similar to the IDF's policy in other areas with a high public profile. The IAF probably would not have given attention to environmental issues had the Israeli public not shown increasing awareness of the economic, social, and health damage stemming from environmental pollution.

Proof of the IAF's utilitarian attitude toward handling the environmental damage it caused was expressed by the negligible financial allocation to the issue. As previously mentioned, the IAF did not even use its entire meager environmental budget allotment in the years 2001–2002. It even refused to extensively treat the damage caused by fuel leaks in the bases at Ramat David and Hatzor. Officially, the IAF declared that the out-of-date infrastructure in the bases would be renovated within the framework of a multiyear plan. The practical significance of this declaration was that many years would pass

before the rehabilitation of the antiquated infrastructure that continued to be a possible source of pollution.

The second field in which the IAF acted extensively to promote environmentalism was that of education. It initiated a range of creative activities to promote awareness of quality of the environment in its soldiers and officers. It is possible that the principal influence of the IAF's operations will be in this field. Since the beginning of the decade, many thousands of enlisted soldiers who have been exposed to these activities have been released from the IAF. If the educational programs were effective, these young people internalized the need to become aware of environmental issues and have been instructed how to contribute to environmental protection. The traditional educational elements in the IDF and in the IAF derived, as pointed out previously, from the IDF being a "people's army." The essence of the activity was in promoting those values regarded as having a national consensus. The changes in civil-military relations and the widening schisms within Israeli society resulted in some educational activities in the IDF becoming controversial. From this angle, environmental issues that are a "consensus" in Israeli society helped educating elements in the IAF prove that they could contribute to developing the manpower of the service and its image.

It seems that the IAF did not clearly recognize the connection, indirect but significant, between growing Israeli environmentalism and the growing restrictions on its operational activity within the state of Israel until recently. This may be the main reason for the lack of consideration of the environmental implications of IAF operations. Because the Israeli Air Force has been fighting constantly since its establishment, its organizational culture inclines toward consideration of force employment at the expense of force generation. Accordingly, the role of environmental considerations is limited if they are not included in the planning and execution of operations. This approach contradicts the growing attention of the international community to environmental considerations in attacking infrastructure targets such as fuel tanks or power stations.

In spite of the reservations mentioned, the very fact that environmental considerations had a practical effect on the largest IAF infrastructure project in decades is a significant innovation. The activity of the service in this field is demonstration of a possible contribution of armed forces to improving the quality of life and development of the whole of society.

Notes

1. Israel State Comptroller, "Treatment of the Ministry of Defense," 78.
2. Ibid., 88–89.
3. Ibid., 80–82.
4. Ibid., 83.
5. Ibid., 89–90.
6. Oren and Regev, *Land in Khaki*, 426.
7. Ibid.
8. Ibid.
9. Weiss and Salome, "Ministry of the Environment Claims."
10. Ibid.
11. Despite the sparse population in the Negev, during extensive activity such as annual exercises, the residents of the Negev complain about the noise of the planes. See Buchbut, "Training for Long Runs."
12. Habakuk, "First Sixty Years," 69.
13. Oren and Regev, *Land in Khaki,* 102–3.
14. Lapidot, "Special Interview," 6–9.
15. Oren and Regev, *Land in Khaki,* 104–5.
16. Ibid., 105–9.
17. Ibid.
18. Ibid., 168.
19. Ibid., 187.
20. Ibid., 181.
21. Arden, "Conquering the Negev," 6.
22. Oren and Regev, *Land in Khaki,* 186.
23. Arden, "Conquering the Negev," 6.
24. Karni, "In the Ministry for Protection of the Environment," 9.
25. "IAF Will Promote Environmental Issues."
26. Wolff, "Soldiers Recycle," 15.
27. Israel State Comptroller, "Treatment of the Ministry of Defence," 93–94.
28. "Uvda Base: Deep in the Mud," 16.
29. Wolff, "Uvda Base," 17.
30. Karni and Avior, "Uvda Base," 18.
31. Karni, "After the Fighting," 18; and Karni, "Animal, Plant and Vegetable," 13.
32. Ashkenazi, "Grounded due to Ceramics Class," 28.
33. Ibid.
34. On the importance of simulators in the IAF, see Pfeffer, "Under Simulated Fire"; and Yehoshua, "New in the Air Force."
35. Concerning the simulator systems, see Sharon, "New," 9–11. Electronic version available at http://www.iaf.org.il/454-18564-HE/IAF.aspx. For the training of simulator operators, see Pfeffer, "Under Simulated Fire."
36. The IAF utilised exercises in foreign countries for training long-range squadrons. The growing threats against the state of Israel from distant countries such as Iran magnified the importance of the IAF's ability to operate at long range. See Shuval, "Italian Job." The IAF does not normally practice for long-range flights in simulators. See Pfeffer, "Under Simulated Fire."

37. The IAF participated in Red Flag in 1988 as an observer. In 1998 the IAF renewed its participation as an observer and even participated later on. See Peled-Fleischer, "Israeli Pilots Took Part," 8–12; and Shuval, "Italian Job." Shuval claims that cooperation between the Israeli and Italian air forces began in 1999 and that they include periodic joint exercises.

38. Rosenberg, "Man, Earth and the Heavens." Electronic version available at http://www.iaf.org.il/1102-18386-he/IAF.aspx.

39. At the time of writing, no one knows for certain why it was cancelled. In Turkey they claimed that the exercise was cancelled due to the negative Turkish public opinion toward Israel as a result of the IDF activity in the "Cast Lead" operation in Gaza at the beginning of 2009, or due to the anger of the Turkish defense system about a problematic arms deal with Israel. For example, see Eichner, "Turkey Soothes."

40. Concerning changes in civil-military relations in Israel, see in particular Cohen, *Israel and its Army*.

41. In fact, the activities of feminist pressure groups led to the integration of women in the flying course of the IAF during the 1990s. Cohen, *Israel and its Army*, 76.

42. Peri, "Civil-Military Relations in Israel in Crisis."

Moreover, the West's ethical framework for understanding armed conflict, "just war," forms a sizeable chunk of its warrior code. Within this code, warfare is a regrettable activity directed against the culpable, undertaken only when a better state of peace is the likely outcome and if the good accomplished outweighs the harm done. Deeply embedded within just war are concepts of proportionality and discrimination. In terms of *jus in bello* (the criteria for fighting wars "cleanly"), proportionality means that military forces must not undertake any actions in which the incidental harm would be excessive in relation to the likely military benefit. Throughout my own career of teaching military officers, I have ordinarily summarized this concept by encouraging them never to use more force or to cause more damage than is necessary to guarantee the attainment of just military goals. Similarly, discrimination means that military forces may only wage war on combatants and military objects and must act purposely and painstakingly to ensure that civilians suffer no more harm than military necessity demands. It is thus eminently logical that, as Western warriors are framing their use of force in terms of minimizing suffering while doing good—all the while protecting the innocent, including those on the other side—they should understand the importance of minimizing harm to the very environment and habitat that sustain the innocent. It is equally reasonable that, as the purpose of military activity is a better state of peace, it would be incongruous to inflict damage upon the innocents within the opposing state, and possibly within neighboring states, that lasts well beyond the end of conflict and complicates the restoration of harmony.

Lastly, I strongly disagree with those ecologists who assert that we need to take an absolutist stance against all military activities that result in any ecological harm. Our just war criteria are adequate as a guide for military planners and practitioners. Both proportionality and discrimination involve careful calculations that render some regrettable harm acceptable when balanced against the greater good being achieved. I accept this line of reasoning and argue, not for absolutist prohibitions, but for the inclusion of ecological protection in all military planning and for it to be weighed expertly, along with the likely need for postwar remediation activities, among the factors that will ultimately determine the justifiability of military actions.

This chapter draws on the Kosovo conflict as its central case analysis to give readers something recent upon which to reflect that does not involve the emotionally charged "war on terror." (Equally powerful

examples of environmental harm caused by airpower and other forms of military force can also be found during that so-called war.) The chapter is not intended as the last word on the subject of the real and potential ecological ramifications of modern airpower but merely as a first word. It aims to demonstrate some complexities within the closely intertwined relationship between defense and security priorities, international humanitarian law, the Western just war framework, and environmental ethics. It offers several observations and asks a set of questions in the hope that readers will feel prompted to seek their own answers. It is my belief that air forces should engage these issues proactively, addressing them on their own terms with judgment and at a realistic tempo before public pressure and special interest groups might compel defense ministries to make sweeping changes, some of them possibly rushed and unhelpful.

Since ancient times armies have often consciously used the natural environment as a weapon against opponents. They have poisoned wells, salted fields, burned crops, and done other ecologically harmful things. In 1945, for example, German officers who feared an Allied attack intentionally flooded 20,000 hectares of agricultural land in the Netherlands, leaving it unusable for crops until the Dutch finally reclaimed the land four months later after a massive rehabilitation program. I began thinking about the ecological implications of modern air warfare when, as an undergraduate, I studied the environmental damage caused by the RAF bombing of the Möhne and Edersee dams in May 1943 and the USAF atomic bombing of Hiroshima and Nagasaki in August 1945. I was surprised most of all to learn the full extent of the American defoliation program during the Vietnam War, which represented a watershed in the relationship between warfare and the environment. Between 1962 and 1971, US aircraft sprayed 3,640 square kilometers of South Vietnam's croplands, deep vegetation, and jungles with 55,000 metric tons of herbicides and defoliants to destroy the plant-based ecosystem for the purpose of disrupting agricultural food production and destroying plant cover for the Vietcong.[2] Its effects were dreadful for Vietnam's ecosystems and, most infamously, for human health.

My thinking about the relationship between warfare and the environment began to focus in March 1999 when NATO airpower began wrecking Yugoslavian (especially Serbian) infrastructure in a well-intended but poorly conceived attempt to coerce Slobodan Milosevic's government into protecting and granting more freedom to the beleaguered

Albanian ethnic majority of Kosovo and Metohija. I felt disappointed that, even in our era of effects-based operations and precision-strike capabilities, NATO chose to wreck almost all major oil refineries, petrochemical installations, and fertilizer works, as well as their tankage areas. NATO thereby spilled harmful oil and toxic chemicals into the soil, aquifers, and waterways—including into the Danube River, the crucial economic artery of several uninvolved nations—and created carcinogenic, mutagenic, toxic, and perilous airborne pollution. These acts were widely publicized and highly controversial. Like many concerned observers, I wondered why, in a war fought for humanitarian purposes, with a highly commendable, almost obsessive desire to ensure the totally accurate placement of ordnance to minimize immediate civilian deaths, NATO nonetheless seemed reckless with Yugoslavia's natural environment.

I began researching this particular issue in July 2006 after feeling equally disquieted when Israeli Air Force airstrikes created a dreadful six-mile-wide and 100-mile-long oil slick along the Lebanese coast by striking an oil storage depot at the Jiyeh power plant, about 19 miles south of Beirut, flooding 15,000 tons of oil into the Mediterranean and causing the worst-ever oil spill in that sea. A further 25,000 tons burned for 27 days, reportedly "spewing a toxic cloud into the air and causing a rain of toxic oil downwind."[3]

Targeting oil infrastructure from the air is not new. During the Second World War, for instance, both Allied and Axis air forces considered oil production, refinement, storage, and transportation facilities, and systems as integral to their enemies' viability and survivability. Even the Luftwaffe, which was designed and utilized primarily for battlefield interdiction and attack, bombed Caucasian oilfields in 1942 in an angry attempt to punish the Soviet Union.[4] During the last three months of the Pacific War, the USAAF conducted a weighty campaign aimed at destroying Japan's oil infrastructure.[5] The greatest counter-oil campaigns occurred during 1943 and 1944, when the USAAF struck the Romanian oilfields and refineries that supplied a large portion of Germany's oil and both the RAF and the USAAF wrecked synthetic fuel plants across Germany.[6]

The targeting of oil sharply divided senior Allied air commanders, but only because some of them passionately argued against its purported strategic effectiveness and not because anyone felt gravely worried about the natural environment.[7] Decades before scientists began expounding concerns about "acid rain," "sustainability," "carbon

emissions," and the "greenhouse effect," and during a war in which neither side worried much about the suffering of enemy populations, these great campaigns caused levels of local environmental harm that were not analyzed in any of the major postwar bombing surveys and which would be unacceptable in any of today's limited wars.[8]

I would not dream of casting stones at our valiant forebears. It would be wrong to impose the widespread ecological values of today onto previous generations. Moreover, we cannot attribute responsibility for large-scale oil pollution during the Second World War solely to air forces. For example, navies, equally unaware of the long-term harm likely to occur, targeted and sank not only fuel-laden warships, but also each other's merchant ships, including oil tankers. Indeed, the combined gross registered tonnage of the oil tankers sunk was 1,235,097, with a total oil-carrying capacity of as much as 17,171,183 barrels or 2,592,380 tons.[9] That is the equivalent of one *Exxon Valdez*–size spill occurring every month of World War II.

Petroleum, oil, and lubricants (often simplified as "POL") infrastructure remained a primary target set for airpower planners throughout the Cold War and following decades and featured prominently, for example, in the USAF and USN Rolling Thunder and Linebacker bombing campaigns against North Vietnam.[10] In 1988 the most celebrated airpower thinker of recent times, John Warden III, maintained that the "petroleum chain . . . still remains a potentially key target simply because a modern military machine cannot function without fuel."[11] Indeed, Warden argued that, along with electricity, oil was a major center of gravity (one of his five "rings") and that carefully focused attacks on the oil chain would denude the enemy of energy. Warden's ideas influenced the Gulf War of 1991, during which coalition air forces wrecked Iraqi oil storage and distribution installations—but not all long-term export infrastructure—as part of a campaign aimed at paralyzing Saddam Hussein's state and forces.[12] (The Iraqis created far more devastating environmental harm when they detonated more than 700 Kuwaiti oil wells, igniting over 600 of them, and discharged more than six million barrels of crude oil directly into the Persian Gulf. Happily for airpower advocates I must note that precision airstrikes by USAF F-111Fs against pumping stations and manifolds actually stemmed that horrific flow.[13]

Warden and other air strategists of his generation did not analyze (and to be fair probably gave no thought to) the key problem with destroying or damaging oil infrastructure as opposed to merely

disrupting distribution. They ignored the fact that liquid hydrocarbons and the chemicals utilized in their refinement are potentially extremely damaging to ecosystems. The explosive or incendiary force of ordnance either burns the petroleum upwards, creating potentially deadly air pollution which may cause dreadful health problems in the short term (but thankfully seldom causes lingering harm after the pollution dissipates), or spills it into the ground, with the potential for long-lasting and calamitous contamination of soils, aquifers, and waterways. The *Commentary on the 1977 Additional Protocols to the Geneva Conventions* states, "As regards the destruction and setting alight of refineries and petroleum storage facilities, it is hardly necessary to stress the grave danger that may ensue for the civilian population."[14]

NATO's 1999 attacks on Yugoslavian refineries and petrochemical and fertilizer installations at Pančevo, Novi Sad, and elsewhere created such demonstrable environmental pollution—with the wreckage, spills, fires, and billowing clouds being captured on the camcorder of local inhabitants as well as more expertly by journalists—that when the Serbian government accused NATO of creating an environmental catastrophe, it was not a lone voice. Even the relevant watchdog agencies within the United Nations and other reputable and nonpartisan interstate bodies expressed strong concerns about the attacks. Neither they nor Western media could brush aside the Serbian governmental allegations (which exaggeratedly described the violence as "ecocide") as merely unverifiable and unwarranted anti-NATO propaganda.[15] With many scores of thousands of Serbians evacuating towns and villages to flee clouds of toxic chemicals, with slicks in the Danube, and with smoke plumes moving eastward over Romania, Bulgaria, Moldova, Ukraine, and the Black Sea,[16] it was impossible to deny that, even if only in the short term, the attacks had an adverse and widely dispersed environmental impact.[17]

NATO argued emphatically that the 100 or so industrial facilities it bombed throughout Serbia were "dual-usage" installations and thus legitimate targets according to sections of the 1977 Additional Protocol I to the 1949 Geneva conventions. For example, NATO described the Pančevo refinery and works, the largest petrochemical complex in the Balkans,[18] as a "strategic target" that "provided oil and other elements to support the Yugoslav Army. By cutting off these supplies [NATO] denied crucial material to the Serbian forces fighting in Kosovo."[19] Although civilian facilities are ordinarily strictly off limits, Article 52(2) does indeed permit attacks on those facilities

"which by their very nature, location, purpose, or use make an effective contribution to military action and whose total or partial destruction, capture or neutralization, in the circumstances ruling at the time, offers a definite military advantage."

The moral "double-effect" principle embedded within *jus in bello* also permits the targeting of dual-usage infrastructure and makes allowance for incidental civilian deaths if those deaths are *unavoidable*. Yet, it permits this targeting only if it is *solely* intended to affect the capability of the opponent's armed forces. If NATO's intent was also to demoralize the Serbian population to generate additional pressure for the Milosevic regime to capitulate, then the double-effect principle no longer justifies these actions.[20]

Unfortunately, this seems to have been the case. Even if one chooses to argue that oil refineries were providing fuel for military operations as well as for civilian consumption, and were thus reasonable dual-usage targets, it is harder to make an equally strong case for pharmaceutical factories, car factories, and even fertilizer plants.[21] The view that NATO wanted to put pressure on Milosevic through squeezing and scaring his people by wrecking things around and among them gains support from the US military's own reported admission to Human Rights Watch that NATO destroyed some targets that were not legitimately "dual-usage" and did so because they were "symbolic" and "psychologically lucrative."[22] Human Rights Watch found that such actions were "done more for psychological harassment of the civilian population than for direct military effect." This conclusion is reinforced by an ironic source: the NATO joint air component commander, Lt Gen Michael C. Short. "If you wake up in the morning," he told the *Globe and Mail* on 26 May 1999, "and you have no power to your house and no gas to your stove and the bridge you take to work is down and will be lying in the Danube for the next 20 years, I think you begin to ask, 'Hey, Slobo[dan], what's this all about? How much more of this do we have to withstand?' "[23] Perhaps with a boast, he later said that he had wanted the Serbian leadership "to wake up to a city that was smoking."[24] He even admitted that he had warned Serbian air force commanders, "The speed and the violence and the lethality and the destruction that is going to occur is beyond anything that you can imagine. . . . If you force me to go to war against you, Belgrade will never look that way again—never in your lifetime, or your children's lifetime. Belgrade and your country will be destroyed if you force me to go to war."[25]

Even ignoring this unusual ethical position, NATO failed to explain convincingly why its remarkably precise and thus potentially highly discriminate air force needed to destroy the storage tanks, thus burning or spilling staggering quantities of liquid hydrocarbons and chemicals, rather than less harmfully targeting the adjacent but separate refinery installations, or, far better still, precisely hitting the more discrete river port, road, and rail nodes to stop loading, transportation, and distribution of the oil and chemicals.[26] NATO did publicly explain on 3 May 1999 that it had damaged Serbia's main electricity stations and thus robbed the Serbian population of 70 percent of its electricity. Spokesman Jamie Shea even publicly stated that Milosevic would thus know that NATO "has its fingers on the light switch. . . . We can turn the power off whenever we need to and whenever we want to."[27] Yet NATO's information campaign included no real effort to explain why it was setting ablaze and flooding oil and chemicals in refineries and storage facilities instead of merely "switching off" those installations by accurately targeting their internal and external sources of electricity. Aircraft did target and destroy local transformers at the sites, interrupting their functionality, so it is less clear why NATO still chose to inflict such heavy and dangerous damage to the plants, oil, and chemical tanks. Further, NATO did not explain why, after a European Union total oil embargo of Yugoslavia came into effect on 30 April 1999[28]—NATO's chief spokesman claimed on that date, "the tap is being turned off all across Europe,"[29]—it continued to burn and spill huge quantities of oil and chemicals right up until the conflict's last days.

During the war NATO responded to accusations of grave environmental harm in a very strange fashion. Aware that the world rightly felt horror at the expulsion and panicked flight of 850,000 Kosovars, NATO exaggerated the physical harm being done to their abandoned dwellings by the Serbian army and by Serb paramilitaries. It maintained at one point that there were then "200 burning villages, town and cities" across Kosovo.[30] After presenting exaggeration, it then relativized the environmental harm being committed by both NATO and the ethnic cleansers.

> We see a lot of smoke, the smoke is coming from all of these burning villages in Kosovo and if you're talking about environmental damage, I think the "scorched earth" policy applied to Kosovo, the destruction of livestock, the destruction of rivers and roads and communication routes, the destruction of the agriculture, the slaughtering of a large percentage of the cattle and the

> livestock, is going to be much more significant in the long term and incidentally require a lot more money to fix than the repair of some oil refineries.[31]

This tu quoque defense ("You can't criticize us for our wrongdoing because you're doing it too!") was disingenuous at best and dishonest at worst. Some Serbian regular army units and paramilitary groups did atrocious, murderous things in Kosovo, but they did not apply a "scorched earth" policy to the province, let alone cause or threaten a long-term environmental catastrophe involving the destruction of permanent natural features and resources. And the complaints leveled against NATO related to the imperilment of human life and widespread and potentially enduring damage to fragile ecosystems, not to the cost of repairing oil refineries.

NATO's inadequate explanations and attempts at justifications did little to assuage concerns all over the world about its *jus in bello* proportionality. Even worse, NATO's actions and media ops failures resulted in accusations—and even formal charges presented at the International Court of Justice—of willful and criminal contravention of Articles 35(3) and 55(1) of the Additional Protocol I explicit prohibition against "widespread, long-term and severe damage to the natural environment." Unlike other provisions of the same protocol, no exception can be made for "military necessity."[32]

Convincing critics that the level of wreckage remained proportionate was always going to be far more difficult for NATO than justifying the inclusion of the installations in its target sets. People believe what they see, and in 1999 they saw colossal destruction. I use the word *colossal* here with no hyperbole. It may surprise some readers to learn that in total, NATO burned far more oil and dangerous chemicals into the air or spilled far more into the Serbian soils, aquifers, and waterways in its 1999 air war than the 10.8 million gallons (257,000 barrels or 38,800 tons) of crude oil that the *Exxon Valdez* had spilled following its highly controversial grounding off the Alaskan coast in 1989.[33]

At Pančevo alone, NATO air attacks caused the release of 80,000 tons of oil and oil products,[34] most of which burned wildly from ruptured tanks, poisoning the air only 12 miles from Belgrade's 1.5 million inhabitants with deadly substances including sulphur dioxide, nitrogen dioxide, carbon monoxide, polyaromatic hydrocarbons, and lead. The Pančevo raids also spilled over 2,000 tons of toxic dichloroethane into soils and groundwater, burned around 250 tons of vinyl

chloride monomer (which would have produced toxic dioxins and hydrochloric acid), and flooded around 250 tons of liquid ammonia and eight tons of metallic mercury, some of which entered a canal leading straight into the Danube.[35] Desperately weighing the lesser and greater of two evils, the site managers themselves released the liquid ammonia, knowing that a direct hit on stored ammonia had the potential to kill large numbers of people.[36] Another 73,000 tons of crude oil and oil products burned or seeped into the groundwater in the northern city of Novi Sad.[37] Elsewhere throughout Serbia (and Kosovo itself), heavy metals, sulfur dioxide, ammonia, and other caustics escaped from burning industrial facilities into the air, soil, groundwater, and rivers, causing large-scale evacuations and leaving many experts convinced that the impact of the toxic releases would reach—as they did—far beyond Yugoslavia's borders.[38]

This is not to suggest that the long-term ecological consequences of the destruction at Pančevo and other sites exceeded those of the infamous *Exxon Valdez* spillage. The latter occurred in a highly fragile ecosystem in an area along the Alaskan coast so remote that cleanup proved tragically slow, difficult, and incomplete. Little of the spilled oil could be burned. While the unburned oil produced airborne toxins, burning would have reduced the destruction of flora and fauna caused by the concentrated surface "slick." This evaporated and decomposed far more slowly in the low temperatures than it would have under similar circumstances in a more temperate climate.[39]

One cannot deny, on the other hand, that the environmental contamination at and around NATO's Serbian industrial targets was, at least in the short term, so obviously severe that it greatly reduced NATO's positive press from being extremely successful at minimizing civilian deaths caused *directly* by bombing.[40] Moreover, the environmental destruction alienated many influential observers, including former Soviet president Mikhail Gorbachev and others, who had agreed with NATO's aims of ending ethnic violence and caused very unhelpful domestic controversy in NATO nations.[41]

Serbia employed a clever media strategy to draw the world's attention to the level of its environmental suffering. They were aware that no objective scientific teams were in country who could verify or challenge its claims during the conflict and that NATO would have few options for countering its information (or *mis*information) strategy.[42] This is something important for military planners nowadays to ponder. If their campaigns or missions cause even what *appears* to be

large-scale ecological damage, their political leaders will find it difficult to mount a credible defense against charges of catastrophic harm. Garnering and maintaining popular support for wars of choice that involve no direct threats to sovereignty or key interests are not easy, even within apparently reasonable contexts. But in this era of widespread public concern for the environment, politicians will find it easier to maintain support for their actions if they do not seem to be doing harm while claiming to be doing good.

In response to continued reports of widespread environmental harm, the Regional Environmental Center for Central and Eastern Europe, assisted by a variety of specialist-contracted experts, undertook the very first objective study of environmental conditions in Serbia.[43] It reported that, while thankfully there was "no evidence of a large-scale ecological catastrophe . . . the environment in the whole territory of Yugoslavia was affected as a result of the military conflict." It also found that pollution was "very severe in the vicinity of targeted industrial complexes . . . and many valuable ecosystems were disturbed."[44] It considered it too early to offer evidence-based opinions about the long-term effects, but warned that the environmental damage that had occurred or that might in the future included threats to ecosystems (especially river systems) and human health caused by exposure to toxic or carcinogenic substances.

At almost the same time, the very concerned UN Environment Program took the unprecedented step of hastily forming a Balkans task force to assess the environmental consequences of NATO's air campaign. This was the first time that the UN had ever integrated environmental issues as a central part of a postconflict humanitarian effort. Led by former Finnish environment minister Pekka Haavisto, the task force visited the wrecked refineries and industrial complexes in the weeks immediately after the cessation of violence and released its findings four months later. It detected four major ecological "hot spots" of grave concern that needed urgent attention (Pančevo, Kragujevac, Novi Sad, and Bor), but added that permanent degradation of soils and waterways seemed unlikely. The UN team recognized that some of the environmental pollution apparently predated the NATO strikes, while some of it resulted from them. The task force nonetheless added that urgent attention would be needed, irrespective of the cause, "if further damage to human health and the environment is to be avoided."[45]

The task force's report was not accepted by all scientists and interested bodies. Many considered it a "political" report supporting a predetermined conclusion and relying on hasty and imperfect research and an inadequate methodology.[46] Better studies, the critics asserted, contradicted the task force's findings. They pointed to a parallel short-term study by the World Wide Fund for Nature that highlighted the broader transboundary and ecosystem implications of the discharged toxic chemicals and offered the less-positive summation that "toxic contamination in Yugoslavia is spreading."[47] The politically neutral Swiss-based FOCUS team of humanitarians and scientists that spent several months in 1999 assessing postwar damage throughout Serbia also offered this somber assessment: "Destruction of many potentially dangerous objects on FRY [Federal Republic of Yugoslavia] territory caused the threat of ecological catastrophe."[48] Likewise, focusing especially on Novi Sad, two Belgrade scientists identified "catastrophic pollution."[49] They reported that, although airborne pollution was "extreme but short-lived," the pollution of the soil and surface and groundwater was long term. "The pollution in these zones," they asserted, "especially in the Danube river basin, is a hazard for the further degradation of the environment, and a risk for the human health."[50] Similarly, and perhaps most notably, the US-based Institute of Energy and Environmental Research (IEER) expressed serious concerns in its 2002 assessment.[51] Particularly at Pančevo, chemical releases occurred "which pose potentially long-term threats to the local population and local environment."[52] The IEER noted that, while it was impossible to be precise or to predict future circumstances with certainty because of a lack of available prewar baselines, persistent toxins, carcinogens, and other pollutants entering the ecosystems looked likely to have long-term negative consequences, including for human health. The IEER was very careful to apportion responsibility fairly and even criticized Serbia for its prewar record of industrial pollution at some sites. It nonetheless reserved its strongest criticism for NATO for its inclusion of some of the petrochemical infrastructural targets and the excessive level of their physical destruction, reporting, "persuasive evidence indicates that humanitarian law may have been violated in the NATO bombing campaign, notably with respect to the bombing of Pancevo."[53] The IEER went so far as to recommend:

> The entire issue of bombing civilian facilities to accomplish military objectives needs to become the subject of a rigorous public inquiry. Such an inquiry should include consideration of immediate and/or environmental and health damage that could be inflicted on the country or in neighboring countries sharing ecosystems with the countries at war.[54]

Given that NATO undoubtedly intended Operation Allied Force as a positive humanitarian intervention—with the ending of ethnic violence as the primary objective—even on balance, such environmental degradation and explicit criticisms of it can only be considered ultimately counterproductive. It weakens moral positions. Ethicist Alex J. Bellamy argues that humanitarian interventions place additional burdens of justice upon political leaders and military commanders more than many other expressions of warfare. He notes that planners must pay particular attention to the selection of targets involving civilian objects and that "in humanitarian interventions, failure to exhibit due care casts serious doubt on the legitimacy of the operation as a whole."[55]

Just as any physician is morally obliged to cause no harm while seeking to remedy a patient's malady, or at least to minimize all possible harm created by the treatment, responsible government institutions need to balance their security priorities and moral considerations with other influential factors, which nowadays include environmental ethical considerations. It is not beyond reason to foresee a near future in which ecologists will sit alongside lawyers in campaign planning staffs and air targeting cells to offer advice or direction on the potential harm likely to be caused in specific missions. Their expertise in helping air planners to minimize harm to the very people they are trying to support should be welcomed, not feared. The moral shift away from old-fashioned concepts of collective responsibility, in which populations are punished or permitted to suffer harm because of the actions of their governments, as well as the strengthening of international legal protections of civilians, greatly increases the onus upon air planners to minimize every form of so-called collateral damage.

I disagree with some ethicists and lawyers who argue that, because of the likely release of "dangerous forces," attacks on oil and petrochemical installations should be prohibited in the same ways that dams, dykes, and nuclear generators are protected under the provisions of Article 56 of the Additional Protocol I. Because meticulously planned and very precise attacks on oil targets need not cause "severe

losses among the civilian population," as defined by Article 56, I cannot accept the position that air planners must *never* target oil or petrochemical installations. When balancing competing priorities, particularly when a patient's life is threatened, even the most compassionate of physicians may judge it necessary to dispense a treatment—chemotherapy, for example—that will kill peripheral healthy cells even as it targets the source of the threat to life. Of course, no doctor would prescribe these terrible treatments unless the patient's illness was grave. Likewise, continuing with this analogy, the implementation of any significant environmentally risky or destructive measures should only be contemplated in military contexts involving tremendous need, such as tipping-point moments in struggles of national survival. Ethicist Michael Walzer argues that during such "supreme emergencies," a fear exists beyond the ordinary fearfulness of war, caused by dangers beyond the ordinary dangers of war (he means the imminence of defeat and enslavement),[56] and that such fear and danger may well require extreme measures that override ethical norms and may even contravene law.[57]

NATO made a reasonable case in 1999 that the world community should not tolerate Serbian maltreatment of Kosovars. It represented a grave affront to Western core values. Yet the scale of ethnic violence, while sufficiently distressing to merit efforts to end it, did not constitute enough of a grievance—let alone anything close to a "supreme emergency"—to warrant the scale of violence by NATO to inadvertently pose serious health risks to both Serbian and Kosovar civilian populations and thereby cause much short-term and some long-term harm to the environment and its ecosystems of the Balkans.

Even without the gravity of the disputed issues of legality and morality, NATO's destruction of Yugoslavian oil infrastructure did not even accord with sound military strategizing. Planners who target an enemy's cardinal energy systems must know that, with the exception of electricity, which can be quickly interrupted, it will take a relatively long time for the desired effects of a counter-oil campaign to kick in. Destroying petrochemical installations, refineries, and storage facilities will inevitably reduce the enemy's ability to operate its armed forces effectively, but it will not do so swiftly, much less immediately, especially if the enemy armed forces are (as Yugoslavia's were) adaptable, lying low, and not engaged in significant fuel-consuming movements or maneuvers. Destroying enough oil infrastructure to paralyze armed forces will necessitate a massive and focused attack, or a

lengthy and constant series of attacks. Even after 78 days of increasingly powerful attacks, NATO had only destroyed around 40 percent of Serbia's military fuel stocks.[58] While a counter-oil strategy might superficially seem eminently sensible for campaigns predicted to be protracted—and my view is that any such campaigns should be undertaken only with tremendous care, proportionality, precision, and thought for the future—it is not an especially useful modus operandi for brief coercive strikes, particularly those with humanitarian goals.

We should not forget that the NATO planners intended Operation Allied Force to be a short and sharp *coercive* mission along the lines of Operation Desert Fox against Iraq in December 1998. Indeed, Pentagon spokesman Kenneth Bacon announced on the eve of the first strikes on Serbia, "We have plans for a swift and severe air campaign."[59] Likewise, Secretary of State Madeleine Albright herself stated on 24 March 1999, "I don't see this as a long-term operation. I think it is achievable within a relatively short period of time."[60] The fact that Operation Allied Force lasted 78 days cannot disguise the fact that it was intended to coerce Milosevic into changing his mind on the violence in Kosovo within two or three days. As Tom DeLay, the US House majority whip, commented one-third of the way through the campaign, "the Secretary of State, the Secretary of Defense, and the Chairman of the Joint Chiefs of Staff told us that this was no big deal, that we were going to bomb for a couple of days, 48 hours, and then stop bombing, and Milosevic would come to the table."[61] Permanent destruction of oil refinement and storage facilities and other chemical works was thus at odds with the original rationale of the mission and makes little sense unless one attributes to NATO air planners a recognition sometime in April—as I do—that their coercive strategy had failed and that the campaign had changed from coercion, to denial, and then to punishment.[62]

Moreover, astute and politically smart strategists and planners might want to reflect on the likelihood that in today's ecologically aware world, massive or sustained attacks on petrochemical installations—especially on their tank farms, which will cause sizeable poisonous spills and huge toxic fires—will generate politically destabilizing arguments about proportionality, and thus the operation's justice. Refuting public allegations over proportionality is not something a military wants to find itself doing. It will have few objective and easily understandable criteria upon which to build a defense. The just war concept of proportionality pertaining to noncombatants is complex

and not helpfully defined in international humanitarian law. The legal explanation of proportionality is codified in Articles 51.5(b) and 57.2(a) (iii) of the Additional Protocol I, which states that it is prohibited for the military to engage in any action "which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated."[63] A breach nowadays constitutes a war crime under the Statute of the International Criminal Court.[64] Unhelpful ambiguity exists on how anyone can objectively determine when an attack crosses the threshold and becomes "excessive" (it is a comparative concept, not a measurable absolute concept) and how anyone can compare and evaluate such dissimilar values as civilian harm and military gain. Yet the consensus view and the *jus in bello* norm is that when waging war on combatants and military objects, military forces must act painstakingly, deliberately, and carefully to ensure that civilians suffer no more harm than military necessity demands. Suggesting that the drafters of the Additional Protocol I also meant ensuring that the quality and habitability of the environment are not degraded would be hyperbolic. The environmental movement was far less motivated, powerful, and ubiquitous in 1977 than it is now. Yet, it is not unreasonable to foresee that (as I believe and recommend) a strengthening of both ethical and legal definitions will come to include these concepts.[65]

Tightening legislation is necessary. Opponents of any attacks that purportedly cause environmental harm and who desire to see prosecutions made against the perpetrators are currently not helped by the ambiguity of the wording in the Additional Protocol I, which prohibits "widespread, long-term and severe damage to the natural environment," regardless of the military objective.[66] The problem with this prohibition, of course, is that currently it is almost impossible to measure that sort of damage in specific and objective terms. Moreover, the adjectives "widespread, long-term and severe" are joined by the conjunction *and*, implying a cumulative triple standard that must be fulfilled. In other words, even an attack on a petrochemical plant that caused widespread and horrific ecological harm might fail to meet this standard unless critics could demonstrate that its effects could also be measured in years, if not decades.[67]

Some critics of environmental degradation caused by air attacks have attempted to reduce this timescale by drawing upon the 1977 Convention on the Prohibition of Military or Any Other Hostile Use

of the Environmental Modification Techniques (ENMOD), written as a consequence of widespread criticism of the disastrous US defoliation program in Vietnam. The ENMOD was promulgated in 1978 and was ratified by the United States in 1980.[68] The ENMOD bans "military or any other hostile use of environmental modification techniques having *widespread, long lasting or severe* effects as a means of destruction, damage or injury to any other State Party" (emphasis added).[69] The Conference of the Committee on Disarmament defined these terms for the purpose of the ENMOD treaty in an Understanding Regarding the Convention:

a) "Widespread": encompassing an area on the scale of several hundred square kilometers;

b) "Long-lasting": lasting for a period of months, or approximately a season; or

c) "Severe": involving serious or significant disruption or harm to human life, natural and economic resources or other assets.[70]

Interestingly, the three criteria mentioned in the ENMOD are joined by the conjunction *or*, rather than the *and* of the Additional Protocol I, meaning that it may not be necessary to fulfill a cumulative standard. Moreover, the Committee on Disarmament's explanation that *long-lasting* might mean "a period of months, or approximately a season," seems to suggest a more readily defined and reasonable threshold that would make prosecutions for environmental harm during wartime more likely. Indeed, if these criteria were applied to NATO's targeting selection process, the worst of the aforementioned attacks on petrochemical installations in Serbia, especially the destruction of Pančevo, might have been prohibited. Aaron Schwabach, an American law professor who has written extensively on the NATO campaign, concluded that it seemed "likely" that the damage at Pančevo would meet "at least one of these requirements."[71] Unfortunately for critics of NATO's war, the ENMOD prohibitions do not automatically include all attacks leading to environmental harm, but only those activities undertaken deliberately to manipulate the environment's natural processes (e.g., by changing weather patterns or by widespread defoliation). Even more unhelpful for those who seek to minimize environmental harm during wartime, the Committee on Disarmament's definition was not intended as a definition of the Additional Protocol I (in addition to the ENMOD), and

it is not even formally incorporated into the terms of the ENMOD. In other words, the definition actually serves to confuse matters, not to clarify them.

Given this lack of clarity over timescales, making a compelling legal case that a state has committed excessive harm to the environment is always going to be highly problematic immediately after the cessation of any hostilities, at least without new laws or a strengthening of existing laws. Compounding this problem is the fact that demonstrable—as opposed to merely threatened or even likely—human health problems (e.g., unusual cancers) or damage to ecosystems may take years to appear. Also, within contexts in which little baseline public health and environmental information exists, such damage may never be readily measurable, let alone placed within an objective and provable analysis of causation. The emotions surrounding warfare, with inevitable finger pointing from both sides, also make this type of analysis particularly problematic.

This was precisely the problem that Yugoslavia and various NGOs faced when they tried to bring a case against NATO before the International Criminal Tribunal for the Former Yugoslavia (ICTY). To the dismay of many international legal experts and human rights groups, who accused her of accepting unbalanced evidence in favor of NATO,[72] Carla Del Ponte, the ICTY prosecutor, informed the UN Security Council on 2 June 2000 that she had decided not to open a criminal investigation into any aspects of NATO's 1999 air campaign.[73] She specified that although NATO undoubtedly made mistakes, she felt "satisfied that there was no deliberate targeting of civilians or unlawful military targets by NATO during the campaign." More importantly for the purposes of this study, while accepting a finding that NATO had caused "some" damage to the environment, Del Ponte rejected assertions that the tribunal should prosecute NATO for causing excessive ecological harm. The main problem was not that the United States and France had never ratified the Additional Protocols of 1977. (This was of course true. The United States has still not ratified them, and France only did in November 2001.) Rather, Del Ponte accepted a review committee's finding that the "imprecise" phrasing in the Additional Protocol I meant that it was extremely difficult to determine when any attacks during any wars had caused environmental harm exceeding the protocol's threshold, especially as "long-term" would (despite the ENMOD-related advice) need to be "measured in years rather than months." The committee

noted that, while it had "led to criticisms by ecologists," the vagueness of the standard meant that, "on the basis of information currently in its possession, the environmental damage caused during the NATO bombing campaign does not meet the Additional Protocol I threshold."[74] The issue of intent also created a problem:

> The requisite *mens rea* [measure of intent] on the part of a commander would be actual or constructive knowledge as to the grave environmental effects of a military attack; a standard which would be difficult to establish for the purposes of prosecution and which may provide an insufficient basis to prosecute military commanders inflicting environmental harm in the (mistaken) belief that such conduct was warranted by military necessity.[75]

The current vagueness of international humanitarian law is also a problem for critics of air forces that use ordnance that the public considers extremely ecologically harmful, such as white phosphorus bombs, cluster munitions, and depleted uranium (DU) rounds. All three of these ordnance types have undeniably effective military roles when used only against enemy combatants. Yet, for different reasons, each one causes such highly controversial unintended secondary effects that many people consider *any* use to be reckless. Most environmentalists condemn them all as environmentally harmful. I also tend not to like their usage, especially in close proximity to civilians, but that is mainly because I recognize that the use of any contentious weapons will create destabilizing controversy and add to unwanted propaganda battles. Moreover, I am not convinced that an adequate scientific consensus exists to allow me to argue with certainty, for example, that even the 30,000 DU shells fired at 112 locations in and around Kosovo by USAF A-10s caused (or will cause) serious and long-term environmental harm and that DU-contaminated areas should be treated with anything more than the "precautionary approach" recommended by the UN's environmental watchdog organization.[76] Science may in time demonstrably undermine the UN's position, and I am mindful that the defoliation of Vietnam by Agent Orange and other defoliants has caused severe human health and environmental harm despite early US beliefs that no long-term harm to humans would occur.[77]

Cluster bombs are different from white phosphorus and depleted uranium shells in that they produce no secondary toxins that can cause chemical actions on life processes that might kill or harm humans, animals, or other living things. Yet they have a worse and more clearly proven influence on the natural environment. Cluster bombs'

primary harm comes when widely spread and highly volatile unexploded submunitions cause the death and maiming of innocent people after—sometimes *long* after—the cessation of hostilities. Ninety-eight percent of the 11,044 recorded and verified casualties of cluster munitions in recent wars have been civilians.[78] In terms of the environment, cluster munitions have a very deleterious effect. Hundreds of thousands of fearful farmers in modern warzones avoid tilling submunition-contaminated fields, irrigating contaminated groves or orchards, and raising livestock on contaminated grasslands. This has a seriously negative impact on local economies and on ecosystems. Cluster munitions also cause health and hygiene problems by creating malnutrition and denying safe access to water. In these ways they cause foreseen but unintended harm similar to, although individually far more lethal than, antipersonnel landmines. During NATO's war on Serbia, USAF and RAF (and a small number of Dutch) aircraft dropped a confirmed minimum of 1,254 cluster bombs in Kosovo (531 by the RAF, which mainly targeted fielded forces and their weapons).[79] They scattered no fewer than 234,123 submunitions.[80] With a failure rate calculated at 7.8 percent, this means that NATO left 18,261 unexploded submunitions in or on the ground in Kosovo, none of them having self-destruct fuses. Thankfully, nearly all have now been located and cleared,[81] although 2,500 remain in Serbia proper,[82] and Kosovo's litter of USAF and RAF cluster submunitions has caused 152 postwar civilian casualties.[83]

Within the first year after the war's end, elements within the British government were unhappy with the RAF's heavy use of cluster munitions. On 23 May 2000, a report of the Foreign Affairs Select Committee of the House of Commons concluded: "We recommend that the UK Government consider carefully the experience of the use of cluster bombs in the Kosovo campaign to determine in future conflicts whether they are weapons which pose so great a risk to civilians that they fall foul of the 1977 Protocol and should not be used in areas where civilians live."[84] Likewise, on 23 October 2000, a report of the Defence Select Committee of the House of Commons concluded that "our major contribution to the bombing campaign was in the form of unguided cluster bombs—a contribution of limited military value and questionable legitimacy."[85] It is therefore unfortunate that the RAF used them again (although nowhere as prolifically as the British Army) in Iraq in 2003, alongside the USAF, which had also used them in Afghanistan in and after 2001. Israel's air force, but especially

its army, likewise used staggering quantities of cluster munitions in its 2006 campaign against Hezbollah insurgents and terrorists, leaving one million unexploded submunitions across southern Lebanon.[86] The unintended death and maiming rates of civilians in all three campaigns have been high and regretted and have seemed to undo some of the good that the various air forces and armies were trying hard to achieve.

A widespread Western consensus has quickly emerged that cluster munitions violate the *jus in bello* principles of proportionality and discrimination so grievously that they must be classed as weapons *mala in se*, which means "bad in themselves," irrespective of any legal prohibitions. The logic framing this consensus is consistent with both international humanitarian law and just war principles. It argues that, because military forces nowadays can reasonably determine from objective analyses of recent conflicts that almost all cluster-bomb victims will be civilians who will suffer death, maiming, and environmental harm for many years after their initial use for military purposes, their harm cannot reasonably be balanced against any good achieved.

Modern wars have included many things *mala in se*, such as rape, torture, ethnic cleansing, and chemical and biological weapons. Cluster munitions are the most recent addition to this category. In February 2007, 46 national representatives met in Oslo to endorse a call by Norwegian foreign minister Jonas Gahr Støre to conclude a new legally binding instrument that will prohibit the production, stockpiling, transfer, and use of cluster munitions and to provide adequate resources to assist survivors and clear contaminated areas. Subsequent International Oslo Process meetings occurred in Peru (May 2007), Austria (December 2007), New Zealand (February 2008), and Ireland (May 2008). In Dublin, 107 countries adopted the treaty text, and they opened a signature process in Oslo on 3 December 2008. The convention will enter into force six months after 30 states have submitted their instruments of ratification to the secretary general of the United Nations. Four states have now done so. The United States has neither signed nor ratified the convention, although in March 2009 President Obama took a highly commendable first step by permanently banning the US sale of all cluster munitions except those (which is a tiny amount) that leave behind less than 1 percent of their submunitions as duds.[87] The United Kingdom has gone even further. It responded to the emerging *mala in se* consensus on cluster munitions

responsibly and decisively by banning them in three stages: first, on 20 March 2007, by withdrawing all of the RAF's 3,650 RBL755 "dumb" cluster bombs and their 536,550 submunitions as well as the British army's 43,200 multiple-launch M26 rockets and their 27,820,800 submunitions; second, in May 2008, by withdrawing the remaining army cluster munitions which had (inadequate) self-destruct fuses; and third, in December 2008, by signing the convention outlawing all cluster ordnance.[88]

Even if we accept a *jus in bello* argument that in any particular conflict a belligerent may foresee but not intentionally cause some environmental harm, we should also accept the *jus post bellum* argument that after the end of hostilities and the restoration of what we hope will be a better state of peace, the restoration of the quality of life of the affected innocents should occur as fully as swiftly as possible. As the UN explains, this is not only a moral obligation; it is a practical part of peacemaking and nowadays extends to the human habitat and even beyond. "Environmental conditions—from the air that people breathe and the water they drink, to the ecosystems that support forestry, farming and fishing—have a crucial influence on the success of efforts to rebuild shattered communities and livelihoods. Only by ensuring environmental security can the wider goals of postconflict reconstruction and human development be sustained."[89] In the case of the Kosovo conflict the infrastructural damage was substantial and the environment harm severe in places. Swift remediation was crucial.

The United Nations Environment Program (UNEP) took the unprecedented step of assuming responsibility for postwar remediation, concluding that "it was evident that, not only had people been through untold pain and suffering, but that the environment had suffered as well."[90] It therefore immediately undertook to create a strategy to unite concerned nations in a program to clean up the worst pollution and contamination to minimize long-term risks to Serbs, Kosovars, and others. Its own 1999 task force, which had identified the four heavily polluted "hot spots" around Pančevo, Kragujevac, Novi Sad, and Bor, served as the basis of its feasibility study to define the exact scientific and financial requirements for urgent cleanup projects at those and maybe other locations. In March 2000, cleanup measures for the four worst hot spots featured prominently as priority projects at the funding conference organized under the auspices of the Stability Pact for South Eastern Europe. By the late summer of 2000, following positive initial responses from many governments

and pledges from several European countries to support additional activities, the UNEP commenced a major environmental cleanup project at conflict-caused contamination sites in Serbia (including Kosovo). Over the next four years the UNEP mitigation and remediation project helped to secure fresh drinking water, remediated contaminated soil and groundwater, removed and treated scores of tons of extremely hazardous chemicals and waste, rehabilitated wastewater treatment capacities, installed environmental monitoring stations, and strengthened national and local environmental management capacities.

Donor countries had pledged a total of $20 million, but several reneged altogether or reduced their contributions. The UNEP had to make do with $12 million and could not do everything it had wanted.[91] Its efforts nonetheless made a highly positive difference. After four years of intense industrial site, soil, and groundwater remediation work at the worst sites, the UNEP announced in May 2004 that, while the cleanup programs had only addressed the most urgent issues, they had made such substantial progress with them that the ecological hot spots no longer warranted that label and that the programs could be turned over to the Serbian government.[92] There was, and still is, much work left to Serbia to do before anyone can reasonably conclude that all environmental damage has been entirely negated.

It has now been 10 years since NATO airpower destroyed Serbian refineries and petrochemical installations and five since the UNEP ended its partial environmental cleanup campaign. Yet, Serbia is still deeply troubled by NATO's ostensible disregard of ecological responsibility. Unusually higher cancer rates, for instance, are still attributed to the effects of NATO's bombing campaign and even to its use of depleted uranium.[93] Establishing the verity of such claims is beyond my professional expertise and might not even be possible for an oncologist or a public health expert because of a lack of both baseline evidence and objective, thorough studies and because of Serbia's continuing poor record of industrial pollution.[94]

Conclusions

This study has demonstrated that modern airpower has unequalled capacity for destructiveness within the human habitat and interrelated ecosystems of an opponent's state. Traditional target sets *still*

include a lot of industrial plants and infrastructure that contain highly toxic and carcinogenic chemicals which can, if discharged through attacks, cause severe damage to the natural environment and its flora and fauna, not to mention human health. Any such environmental harm nowadays has far greater potential for causing destabilizing controversy within the environmentally aware public than ever before. Existing international humanitarian law is not yet adequate to discourage protagonists during the heat of war from attacking some things that perhaps should only be targeted under unique circumstances, with extraordinary care, and after weighing potentially wider implications. Existing conventions should be strengthened or new laws created. Yet, the *jus in bello* concepts of proportionality and discrimination embedded within our just war code already *are*—or would be if more widely understood—an eminently reasonable basis for constraining the injudicious use of force against objects that have the potential for environmental harm. Western warriors already conceptualize their use of violence in terms of minimizing suffering while doing good, all the while protecting the innocent, including the opponent's. It is a short and easy step of logic that they should understand the importance of minimizing harm to the habitat of the innocent. It is equally logical that, as the purpose of armed violence should always be a better state of peace, warriors will want to avoid inflicting damage upon the innocents within the opposing state, and possibly within the wider region, that might last well beyond the end of conflict and therefore complicate the restoration of lasting peace. One of the lessons we should learn from the Kosovo conflict—indeed, from Afghanistan, Iraq, and Lebanon as well—is that most military commanders and planners are not adequately familiar with the key environmental sciences and are therefore not best placed to foresee all *unwanted* consequence as they plan operations and missions to achieve *wanted* effects. The inclusion of ecologists alongside lawyers in campaign planning staffs and air targeting cells to offer advice or direction on the potential harm likely to be caused in specific missions will at least partially strengthen the way that environmental factors can be "brought in from the cold." Their expertise in helping planners to minimize harm to the very people they are trying to support should be welcomed, not considered intrusive.

Notes

1. *Hague Convention for the Protection of Cultural Property*, Art. 1(a).
2. Leaning, "War and the Environment," 278.
3. Steiner, "After the Bombs." See also United Nations Environment Program, *Lebanon Post-Conflict Environmental Assessment*, especially 42–46; Carassava, "U.N. Pledges $64 Million"; Black, "Environmental 'Crisis' in Lebanon"; and Milstein, "Lebanon Oil Spill."
4. See Hayward, "Too Little, Too Late."
5. *United States Strategic Bombing Survey (Pacific War), Crude Oil Production and Refining*.
6. For Germany's reliance on oil and the wartime consequence of this dependence, see Hayward, "Hitler's Quest for Oil." See also Pearton, *Oil and the Romanian State*; and Stout, *Fortress Ploesti*.
7. Buckley, *Air Power in the Age of Total War*, 163; and Jacobs, "British Strategic Air Offensive," 147, 150, 167.
8. Austin and Bruch, eds., *Environmental Consequences of War*, 120.
9. Stephens, *Vulnerability of Total Petroleum Systems*, 42–44.
10. Mark Clodfelter, *Limits of Air Power*; and Frankum, *Like Rolling Thunder*.
11. Warden, *Air Campaign*, 39.
12. Davis, *On Target*; and Keaney, "Surveying Gulf War Airpower."
13. Hallion, *Storm over Iraq*, 231.
14. Sandoz et al., eds., *Commentary on the Additional Protocols*, 669.
15. This colorful phrase even made it into mainstream publications. See, for example, Joksimovich, "Militarism and Ecology."
16. Vukmirovic et al., "Regional Air Pollution," 741.
17. Gopal and Deller, *Precision Bombing, Widespread Harm*, 25; United Nations Environment Program and United Nations Center for Human Settlements (Habitat), *The Kosovo Conflict*, 32; and Carter and Turnock, eds., *Environmental Problems of East Central Europe*, 403.
18. Booth, "NATO Bombs Left a Toxic Slough."
19. Hedges, "Serbian Town Bombed by NATO."
20. Reichberg and Syse, "Protecting the Natural Environment," 463; and Ceulemans, "NATO Intervention in the Kosovo Crisis." Also see Meyer, "Tearing down the Façade," 172–73, 176–77, 181.
21. Gopal and Deller, *Precision Bombing, Widespread Harm*, 76.
22. Meyer, "Tearing down the Façade," 100; and "*Un cahier spécial sur le Kosovo*."
23. Short also said, "At some point, you make the transition from applauding Serb machismo . . . to thinking what your country is going to look like if this continues." Drozdiak, "Commander of Air War Says Kosovo Victory Near."
24. Tirpak, "Washington Watch."
25. Public Broadcasting Service, "War in Europe."
26. Austin and Bruch, eds., *Environmental Consequences of War*, 652.
27. NATO Briefing, 3 May 1999. Shea's speech can be found in Shea and Jertz, "Press Conference."
28. Cortright and López, eds., *Smart Sanctions*, 95.
29. Shea and Marani, "Press Conference," 30 April 1999.

30. Shea and Marani, "Press Conference," 19 April 1999.

31. Shea and Marani, "Press Conference," 30 April 1999.

32. Austin and Bruch, eds., *Environmental Consequences of War*, 651; and *Operational Law Handbook 2000*, 17–18.

33. Figures published on the website of the *Exxon Valdez* Oil Spill Trustee Council, "Oil Spill Facts."

34. United Nations Environment Program and United Nations Center for Human Settlements (Habitat), *Kosovo Conflict*, 31, 34.

35. *Assessment of the Environmental Impact*, esp. § 4.1.1 and 4.1.2; Popovska and Sopova, "Pollution of the Balkans"; Carter and Turnock, *Environmental Problems of East Central Europe*, 403; and Austin and Bruch, eds., *Environmental Consequences,* 649.

36. Gopal and Deller, *Precision Bombing, Widespread Harm*, 32, 33; United Nations Environment Program and United Nations Center for Human Settlements (Habitat), *Kosovo Conflict*, 34.

37. United Nations Environment Program and United Nations Center for Human Settlements (Habitat), *Kosovo Conflict*, 47.

38. Ibid.; and C. Morgan, "Collateral Damage."

39. An excellent early study of pollution caused by warfare in arctic regions can be found in Stockholm International Peace Research Institute, *Warfare in a Fragile World*, 114–25, 151.

40. According to the International Criminal Tribunal's *Final Report to the Prosecutor,* NATO's campaign killed 495 civilians and wounded a further 820. See § V(53).

41. For an example of Gorbachev's concerns, see Gorbachev, "Poison in the Air." A trawl of the Internet will produce hundreds of archived mainstream media reports of the ecological damage caused by NATO's campaign.

42. Bacevich and Cohen, eds., *War over Kosovo*, 15.

43. *Assessment of the Environmental Impact*.

44. Ibid., "Executive Summary."

45. United Nations Environment Program and United Nations Center for Human Settlements (Habitat), *Kosovo Conflict*, 9, 11.

46. See C. Morgan, "Collateral Damage." In her 2000 paper, the late Dr. Janet M. Eaton, a Canadian biologist and activist, typified these critics, noting that the task force, "although composed of many expert scientists from around the world, was very limited in duration, lacked breadth and scope, failed to have within its mandate assessment of the impact on human health and lacked the cooperation of NATO authorities to either locate or assess the impact of depleted uranium weapons in spite of widespread concern and warnings about the ecological and health implications." Eaton, "Ecological and Health Consequences."

47. World Wide Fund for Nature, "Danube Carpathian Program."

48. *FOCUS Assessment Mission*.

49. Martinovic-Vitanovic and Kalafatic, "Consequences of War."

50. Ibid.

51. Gopal and Deller, *Precision Bombing, Widespread Harm*.

52. Ibid., 85.

53. Ibid., 86.

54. Ibid., 13.

55. Bellamy, *Just Wars*, 213.

56. See Orend, "Is There a Supreme Emergency Exemption?"

57. Walzer, *Just and Unjust Wars*, 251–62.

58. Bacevich and Cohen, *War over Kosovo*, 24.

59. See Hayward, "NATO's War in the Balkans," 2.

60. Ibid.

61. Ibid., 3. See also Daalder and O'Hanlan, *Winning Ugly*, 91–93, 209; and Henriksen, *NATO's Gamble*, 5, 199.

62. Observing the conflict as it unfolded, I noticed a dramatic change of operational intensity and tempo in the fourth week of April 1999, coinciding with the NATO Summit in Washington. See Hayward, "NATO's War in the Balkans," 10. Eminent British defense commentator John Keegan saw the same shift, noting that NATO began to "visit a true blitz on the Serb homeland." Keegan, "Please Mr Blair."

63. *Protocol Additional to the Geneva Conventions*, Art. 51 (5)(b) and Art. 57 (2)(b).

64. United Nations, *Statute of the International Criminal Court*, Art. 8(2)(b)(iv). The statute modifies "excessive" with the adjective "clearly" and "military advantage" with "overall," thereby emphasizing both the need for clarity and the importance of avoiding assessments of individual attacks in total isolation.

65. Rodin, "Ethics of Asymmetric War," 162.

66. Austin and Bruch, eds., *Environmental Consequences of War*, 651.

67. International Criminal Tribunal, *Final Report to the Prosecutor,* § I (15); and Austin and Bruch, eds., *Environmental Consequences of War*, 652.

68. See Dieterich, " 'Law of War' and Ecology," 137–60.

69. *Convention on the Prohibition*, Art. I.

70. Quoted in Gopal and Deller, *Precision Bombing, Widespread Harm*, 75.

71. Schwabach, "Environmental Damage," 129.

72. For example, see Benvenuti, "ICTY Prosecutor"; Ronzitti, "Is the *Non Liquet* of the Final Report?"; and "Amnesty International's Initial Comments."

73. International Criminal Tribunal, *Final Report to the Prosecutor.*

74. Ibid., § 4 (A)(17).

75. Ibid., § 4 (A)(23).

76. United Nations Environment Program, *Depleted Uranium in Kosovo*; and United Nations Environment Program, *Depleted Uranium in Serbia and Montenegro*.

77. Cf. "Defoliating Viet Nam."

78. *Fatal Footprint*, 41.

79. Secretary of State for Defence Geoff Hoon, House of Commons Hansard Written Answers for 19 January 2000; Minister of State for the Armed Forces Adam Ingram, House of Commons Hansard Written Answers for 16 November 2001; *Cluster Munitions in Kosovo*, 9, 10; and Norton-Taylor, "US Deploys Controversial Weapon."

80. *Cluster Munitions in Kosovo*, 9. See the very close NATO figures quoted by the International Committee of the Red Cross in *Cluster Bombs and Landmines in Kosovo*, 6.

81. *Cluster Munitions in Kosovo*, 43.

82. "2,500 NATO Cluster Bombs"; and Fawkes, "Scars of NATO Bombing."

83. *Cluster Munitions in Kosovo*, 46.

84. House of Commons, Foreign Affairs Select Committee, Fourth Report.

85. House of Commons, Defence Select Committee, Fourteenth Report.

86. Secretary of State for International Development Hillary Benn, House of Commons Hansard Written Answers for 18 December 2006; and *Fatal Footprint*, 35.

87. "Obama Takes US Closer to Cluster Bomb Ban."
88. Hewson, "Cluster Weapons Ban Leaves Gap in UK Inventory"; and Norton-Taylor, Walker, and agencies, "Cluster Bomb Treaty."
89. *From Conflict to Sustainable Development*, 7.
90. Ibid., 6.
91. Marković, "Serbia."
92. United Nations Environment Program, Press Release, 7 May 2004.
93. Cf. Zimonjic, "BALKANS: Fallout of Bombing."
94. Cf. "Serbs Call for Restrictions on Noxious Factory Emissions."

IDF	Israeli Defense Forces
IEER	Institute of Energy and Environmental Research
IUNC	International Union of Conservation of Nature
JCS	Joint Chiefs of Staff
JDAM	joint direct attack munition
KAZA	Kavango–Zambezi
KLCT	Kenya Land Conservation Trust
km	kilometer
KWS	Kenya Wildlife Service
LIFE	Project Living in a Finite Environment
LWC	Lewa Wildlife Conservancy
MPE	(Israeli) Ministry for Protection of the Environment
NATO	North Atlantic Treaty Organization
NCA	Ngorongono Conservation Area
NGO	nongovernmental organization
NIS	new Israeli shekels
NPL	National Priority List
NRT	Northern Rangeland Trust
OIF	Operation Iraqi Freedom
OPEC	Organization of the Oil Exporting Countries
PDA	Project on Defense Alternatives
PGM	precision-guided munitions
POL	petroleum, oil, and lubricants
PP	peace parks
RAF	Royal Air Force
SAC	Strategic Air Command
SPP	state partnership programs
SS	*Schutzstaffel*
TCE	trichloroethylene
TFCA	transfrontier conservation areas
TNA	The National Archives, Kew, UK
UN	United Nations
UNEP	UN Environment Programme
UPT	Undergraduate Pilot Training
USAAF	United States Army Air Forces
USAF	US Air Force
USAID	US Agency of International Development

USGS	US Geological Service
USSBS	US Strategic Bombing Survey
UST	underground storage tank
WAP	Western Area Plan
WWF	World Wildlife Fund
WWII	World War II

Bibliography

"14th Custom Spray School: Flame Cultivation, Face Flies among Topics at Illinois Conference." *Agricultural Chemicals* 17, no. 3 (March 1962): 68–72.

"60 Drone Hits Kill 14 Al-Qaeda Men, 687 Civilians," *The News* (Pakistan), 10 April 2009. http://www.thenews.com.pk/TodaysPrintDetail.aspx?ID=21440&Cat=13&dt=4/10/2009.

184th Bomb Group, Kansas National Guard, Pamphlet. *The Cultural Legacy of the Smoky Hill Air National Guard Range*. Undated. Kansas Collection. Spencer Memorial Library, University of Kansas.

2008 Living Planet Report. World Wildlife Fund. http://assets.panda.org/downloads/living_planet_report_2008.pdf.

"2,500 NATO Cluster Bombs Still Out There." *B29 News*, 11 March 2009.

"5,558 Iraqis Killed since Occupation." *Dallas Morning News*, 24 May 2004.

Abdul-Ahad, Ghaith. "Inside the Taliban, the More Troops They Send, the More Targets We Have." *The Guardian*, 15 August 2009. http://www.guardian.co.uk/world/2009/aug/15/fighting-taliban-in-afghainsten-war.

Ackerman, John T. "The Most Vulnerable Continent: Africa and Global Climate Change." In *African Environmental and Human Security in the 21st Century*, edited by Helen Purkitt, 141–66. New York: Cambria Press, 2009.

"ACTS [Air Corps Tactical School]: Bombardment Aviation," 1 January 1938. File 168.7001–28. Air Force Historical Research Agency (AFHRA), Maxwell AFB, AL.

"ACTS: Bombardment Text," 1 October 1933. File 248.101–9. AFHRA, Maxwell AFB, AL.

Ader, Clément. *Military Aviation*. Maxwell AFB, AL: Air University Press, 2003.

The Africa-EU Strategy Partnership: A Joint Africa-EU Strategy. Africa-EU Summit, Lisbon, Portugal, 8–9 December 2007. http://www.fanrpan.org/documents/d00454/Africa-EU_strategy.pdf.

Air Force Culture and Language Center. http://www.culture.af.edu.

Air Force Doctrine Document (AFDD) 3-20. *Building Partnerships*, draft, undated.

Air Forces Central [AFCENT] Combined Air and Space Operations Center. "2004–2008 Combined Forces Air Component Commander Air Power Statistics." AFCENT Public Affairs, 31 December 2008.

Air Ministry [United Kingdom]. Pamphlet. *Bomber Command: The Air Ministry Account of Bomber Command's Offensive against the Axis, September 1939–July 1941*. London: Her Majesty's Stationary Office (HMSO), 1941.

"Air Strike Rules Seen Cutting Civilian Deaths." *Washington Times*, 6 August 2009.

Albers, Christian N., Gary T. Banta, Poul Erik Hansen, and Ole S. Jacobsen. "The Influence of Organic Matter on Sorption and Fate of Glyphosate in Soil—Comparing Different Soils and Humic Substances." *Environmental Pollution* 157, no. 10 (October 2009): 2865–70.

Ali, Saleem. "Introduction: A Natural Connection between Ecology and Peace." In *Peace Parks: Conservation and Conflict Resolution*, edited by Saleem Ali, 69–82. Cambridge, MA: MIT Press, 2007.

Alsdirawi, Fozia, and Muna Faraj. "Establishing a Transboundary Peace Park in the Demilitarized Zone (DMZ) on the Kuwait/Iraq Borders." *Parks* 14, no. 1 (2004): 48–55.

The American Heritage Dictionary of the English Language. New York: American Heritage, 1971.

"Amnesty International's Initial Comments on the Review by the International Criminal Tribunal for the Former Yugoslavia of NATO's Operation Allied Force." http://www.essex.ac.uk/armedcon/story_id/000135.htm.

Anderson, Jon Lee. "The Taliban's Opium War: Letter from Afghanistan." *The New Yorker* 83, no. 19 (9 July 2007). http://www.newyorker.com/reporting/2007/07/09/070709fa_fact_anderson.

Aras, Bulent, and Sule Toktas. "Afghanistan's Security: Political Process, State-Building and Narcotics." *Middle East Policy* 15, no. 2 (Summer 2008): 42–48.

Arden, Elad. "Conquering the Negev." *Bemahane*, 21 December 2007 [Hebrew].

Arkin, William, Damian Durrant, and Marianne Cherni. *On Impact: Modern Warfare and the Environment: A Case Study of the Gulf War*. London: Greenpeace International, May 1991.

Arthur Capper Papers. Kansas State Historical Society, Topeka, KS.

Arthur, Max. *Dambusters: A Landmark Oral History*. London: Virgin Books, 2008.

Asada, Sadao. "The Shock of the Atomic Bomb and Japan's Decision to Surrender: A Reconsideration." *Pacific Historical Review* 67 (November 1998): 477–512.

Ashkenazi, Avi. "Grounded due to Ceramics Class." *Yediot Aharonot*, 27 July 2005 [Hebrew].

Assessment of the Environmental Impact of Military Activities during the Yugoslavia Conflict: Preliminary Findings. Szentendre, Hungary: Regional Environmental Center for Central and Eastern Europe, 1999.

Austin, Jay E., and Carl E. Bruch, eds. *The Environmental Consequences of War: Legal, Economic, and Scientific Perspectives*. Cambridge: Cambridge University Press, 2000.

"Author of Shocking Iraq Study Accused of Bad Ethics." *Houston Chronicle*, 5 February 2009.

Bacevich, Andrew J., and Eliot A. Cohen, eds. *War over Kosovo: Politics and Strategy in a Global Age*. New York: Columbia University Press, 2001.

Bajracharya, Siddhartha, Peter Furley, and Adrian Newton. "Impacts of Community-Based Conservation on Local Communities in the Annapurna Conservation Area, Nepal." *Biodiversity and Conservation* 15, no. 8 (July 2006): 2765–86.

Bakri, Nada. "Babylon's Ancient Wonder, Lying in Ruins." *Washington Post*, 29 July 2009, C1.

Baldwin, David. "The Concept of Security." *Review of International Studies* 23, no. 1 (1997): 5–26.

Balfour, Daryl, and Sharna Balfour. *Rhino: The Story of the Rhinoceros and a Plea for Its Conservation*. Cape Town, South Africa: Struik Publishers, 1991.

Balint, Peter, and Judith Mashinya. "The Decline of a Model Community-Based Conservation Project: Governance, Capacity, and Devolution in Mahenye, Zimbabwe." *Geoforum* 37, no. 5 (September 2006): 805–15.

Bannon, Ian, and Paul Collier, eds. *Natural Resources and Violent Conflict: Options and Actions*. Washington, DC: The World Bank, 2003.

Barbier, Edward B., Joanne C. Burgess, Timothy M. Swanson, and David W. Pearce. *Elephants, Economics and Ivory*. London: Earthscan, 1990.

Barnett, John. *The Meaning of Environmental Security: Ecological Politics and Policy in the New Security Era*. London: Zed Books, 2001.

Batchelder, Robert C. *The Irreversible Decision, 1939–1950*. Cambridge, MA: Houghton Mifflin, 1962.

"The Battle for Al Faw." *Return to the Gulf, Operation Telic, March–May 2003*. http://www.britains-smallwars.com/gulf2/AlFaw.html.

Beaumont, Joan. "Starving for Democracy: Britain's Blockade of and Relief for Occupied Europe, 1939–1945." *War and Society* 8 (October 1990): 57–82.

Bell, A. C. *A History of the Blockade of Germany, 1914–1918*. London: HMSO, 1937.

Bellamy, Alex J. *Just Wars: From Cicero to Iraq*. Cambridge, UK: Polity Press, 2006.

Benachour, Nora, and Gilles-Eric Séralini. "Glyphosate Formulations Induce Apoptosis and Necrosis in Human Umbilical, Embryonic, and Placental Cells." *Chemical Research in Toxicology* 22, no. 1 (2009): 97–105.

Benjaminsen, Tor, Thembela Kepe, and Stine Bråthen. "Between Global Interests and Local Needs: Conservation and Land Reform in Namaqualand, South Africa." *Africa: The Journal of the International African Institute* 78, no. 2 (2008): 223–244.

Benvenuti, Paolo. "The ICTY [International Criminal Tribunal for the Former Yugoslavia] Prosecutor and the Review of the NATO Bombing Campaign against the Federal Republic of Yugoslavia." *European Journal of International Law* 12, no. 3 (2001): 503–29.

Berdal, Mats, and David Malone, eds. *Greed and Grievance: Economic Agendas in Civil Wars*. Boulder, CO: Lynne Rienner Publishers, 2000.

Betts, Russell, and Frank Denton. *An Evaluation of Chemical Crop Destruction in Vietnam*. Santa Monica, CA: RAND Corp., 1967.

Biddle, Tami Davis. *Rhetoric and Reality in Air Warfare: The Evolution of British and American Ideas about Strategic Bombing, 1914–1945*. Princeton, NJ: Princeton University Press, 2004.

Bilstein, Roger E. *The Enterprise of Flight: The American Aviation and Aerospace Industry*. Washington, DC: Smithsonian Scholarly Press, 2001.

Bird, Kai, and Martin J. Sherwin. *American Prometheus: The Triumph and Tragedy of J. Robert Oppenheimer*. New York: Vintage Books, 2006.

Black, Richard. "Environmental 'Crisis' in Lebanon." *BBC News*, 31 July 2006.

Blaike, Abel, Nick Blaike, and Piers Blaike. "Elephants, People, Parks and Development: The Case of the Luangwa Valley, Zambia." *Environmental Management* 10 (1986): 735–51.

Blanchard, Christopher M. *Afghanistan: Narcotics and US Policy*. Washington, DC: Congressional Research Service, 2009.

Boberach, Heinz, ed. *Meldungen aus dem Reich: Die geheimen Lageberichte des Sicherheitsdienstes der SS 1938–1945* [*Messages from the Reich: The Secret Management Reports of the Security Service of the SS*], vol. 13. Herrsching, Germany: Manfred Pawlak Publishing Company, 1984.

du Bois, Kathleen E. "The Illegal Trade in Endangered Species." *African Security Review* 6, no. 1 (1997). http://www.iss.co.za.

Boko, Martin, I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo, and P. Yanda. "Africa." In *Climate Change 2007: Impacts, Adaptation and Vulnerability: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* edited by M. L. Parry, O.F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson, 433–67. Cambridge: Cambridge University Press, 2007.

Bonner, Raymond. *At the Hand of Man: Peril and Hope for Africa's Wildlife*. New York: Alfred A. Knopf, 1993.

Booth, William. "NATO Bombs Left a Toxic Slough." *Washington Post*, 21 July 1999.

Bowden, Mark. *Black Hawk Down: A Story of Modern War*. New York: Atlantic Monthly Press, 1999.

Boyne, Walter J. *The Influence of Air Power upon History*. Gretna, LA: Pelican Publishing Co., 2003.

Brauer, Jurgen. *War and Nature: The Environmental Consequences of War in a Global World*. Lanham, MD: AltaMira Press, 2009.

British Broadcasting Corporation. "1943: RAF Raid Smashes German Dams." *On This Day, 1950–2005, 17 May*. http://news.bbc.co.uk/onthisday/hi/dates/stories/may/17/newsid_3623000/3623223.stm.

Brock, Lothar. "Peace through Parks: The Environment on the Peace Research Agenda," *Journal of Peace Research* 28, no. 4 (November 1991): 407–23.

Brodie, Bernard. *Strategy in the Missile Age*. Princeton, NJ: Princeton University Press, 1965.

Brown, Oli. "Environment and Peace: Steady Progress since 1972." Contribution to the International Conference on Environment, Peace and Dialogue among Civilizations, Tehran, Iran, 9–10 May 2005. http://www.iisd.org/pdf/2005/security_env_peace_iran.pdf.

Brune, Lester H. "An Effort to Regulate Aerial Bombing: The Hague Commission of Jurists, 1922–1923." *Aerospace Historian* 29 (September 1982): 183–95.

Buchbut, Amir. "Training for Long Runs." *Maariv*, 22 May 2009 [Hebrew].

Buckingham, William A. *Operation Ranch Hand: The Air Force and Herbicides in Southeast Asia, 1961–1971*. Washington, DC: Office of Air Force History, 1982.

Buckley, John. *Air Power in the Age of Total War*. London: University College of London Press, 1999.

Bundesarchiv [Federal Archive], Außenstelle [Foreign Office], Berlin, Germany.

Burgess, Stephen F., ed. *Air Force Symposium 2009: US Africa Command (AFRICOM)—31 March–2 April 2009*. Final Report. Maxwell AFB, AL: Air University, 2009.

———. "Environment and Human Security in the Horn of Africa." *Journal of Human Security* 4, no. 2 (2008): 36–41.

Burnham, Gilbert, Shannon Doocy, Elizabeth Dzeng, Riyadh Lafta, and Les Roberts. "The Human Cost of the War in Iraq: A Mortality Study, 2002–2006." Baltimore, MD: Bloomburg School of Public Health, Johns Hopkins University, 2006.

Burns, Paul Y. "Use of Aircraft for Foliar Applications of Herbicides in Southern Forests." In *The Use of Chemicals in Southern Forests*, edited by Robert W. McDermid, 92. Baton Rouge: Louisiana State University Press, 1961.

Busby, William H., J. M. Delisle, C. C. Freeman, K. Kindscher, H. Loring, D. E. Nimz, and C. J. Schmidt. *A Natural Features Inventory of the Smoky Hill ANG* [Air National Guard] *Range, Kansas*. Open-file Report 137. Lawrence: Kansas Biological Survey, September 2007.

Buzan, Barry, Ole Waever, and Jaap de Wilde. *Security: A New Framework for Analysis*. Boulder, CO: Lynne Rienner Publishers, 1998.

Byman, Daniel L., Matthew C. Waxman, and Eric Larson. *Air Power as a Coercive Instrument*. Santa Monica, CA: RAND Corp., 1999.

Campbell, Lisa, and Arja Vainio-Mattila. "Participatory Development and Community-Based Conservation: Opportunities Missed for Lessons Learned." *Human Ecology* 31, no. 3 (September 2003): 417–37.

Carassava, Anthee. "U.N. Pledges $64 Million for Cleanup of Oil Spill off Lebanon." *New York Times*, 18 August 2006.

Carlino, Michael A. "The Moral Limits of Strategic Attack." *Parameters* 32 (Spring 2002): 5–29.

Carson, Rachel. *Silent Spring*. 40th anniv. ed. New York: Mariner Books, 2002.

Carter, F. W., and David Turnock, eds. *Environmental Problems of East Central Europe*. London: Routledge, 2002.

Carter, Sara A. "Taliban Buying Children to Serve as Suicide Bombers." *Washington Times*, 1 July 2009.

Central Intelligence Agency. *Putting Noncombatants at Risk: Saddam's Use of 'Human Shields.'"* Washington, DC: Central Intelligence Agency, January 2003.

Ceulemans, Carl. "The NATO Intervention in the Kosovo Crisis: March–June 1999." In *Moral Constraints on War: Principles and Cases*, edited by Bruno Coppieters and Nick Fotion, 205–28. Lanham, MD: Lexington Books, 2002.

Chayes, Sarah. *The Punishment of Virtue: Inside Afghanistan after the Taliban*. New York: Penguin Books, 2007.

Chenje, Munyaradze, and Phyllis Johnson, eds. *State of the Environment in Southern Africa*. Harare, Zimbabwe, and Maseru, Lesotho: Southern African Research and Documentation Centre/Southern African Development Community/World Conservation Union, 1994.

Churchill, Winston. Debate. House of Commons, London, 14 March 1933. Hansard Digitisation Project. http://hansard.millbanksystems.com/people/mr-winston-churchill/1933.

———. *The Second World War*. 6 vols. London: Cassell and Co., 1948–1954.

———. Speech. House of Commons, London, 20 August 1940. Hansard Digitisation Project. http://hansard.millbanksystems.com/people/mr-winston-churchill/1940.

Cilliers, Jakkie. "The African Standby Force: An Update on Progress." Occasional Paper 160. Pretoria, South Africa: Institute for Security Studies (ISS), March 2008.

———. *Human Security in Africa: A Conceptual Framework for Review*. Monograph for the African Human Security Initiative, 2004. http://www.africanreview.org.

Clausewitz, Carl von. *On War.* Edited and translated by Michael Howard and Peter Paret. Princeton, NJ: Princeton University Press, 1976.

"Cleanup Fights Stall New Uses for Old Bases." *USA Today*, 14 October 2004.

Clemens, Jeffrey. "Opium in Afghanistan: Prospects for the Success of Source Country Drug Control Policies." *Journal of Law and Economics* 51, no. 3 (August 2008): 407–32.

Clodfelter, Mark. "Molding Airpower Convictions: Development and Legacy of William Mitchell's Strategic Thought." In *The Paths of Heaven*, edited by Phillip S. Meilinger, 79–114. Maxwell AFB, AL: Air University Press, 1997.

———. *The Limits of Airpower*. New York: Free Press, 1989.

Clodfelter, Micheal. *Warfare and Armed Conflicts: A Statistical Reference to Casualty and Other Figures, 1500–2000*. Jefferson, NC: McFarland & Company, 2002.

Cluster Bombs and Landmines in Kosovo: Explosive Remnants of War. Geneva: International Committee of the Red Cross, 2000.

Cluster Munitions in Kosovo: Analysis of Use, Contamination and Casualties. London: Land Mine Action, 2007.

Cohen, Jon, and Jennifer Agiesta. "Poll of Afghans Shows Drop in Support for U.S. Mission." *Washington Post*, 10 February 2009.

Cohen, Sheldon M. *Arms and Judgment: Law, Morality, and the Conduct of War in the Twentieth Century*. Boulder, CO: Westview Press, 1989.

Cohen, Stuart A. *Israel and Its Army: From Cohesion to Confusion*. London and New York: Routledge, 2008.

Colorado Department of Public Health and Environment. "Former Lowry Bombing and Gunnery Range." http://www.cdphe.state.co.us/hm/flbgr.htm.

———. "Lowry Landfill Site." http://www.cdphe.state.co.us/hm/flbgr.htm.

Colville, John. *The Fringes of Power: 10 Downing Street Diaries 1939–1955*. New York and London: W. W. Norton & Co., 1985.

Conca, Ken, and Geoffrey Dabelko. *Environmental Peacekeeping*. Washington, DC: Woodrow Wilson Center Press, 2002.

Conetta, Carl. "Disappearing the Dead: Iraq, Afghanistan, and the Idea of a 'New Warfare,'" Research Monograph No. 9. Cambridge, MA: Commonwealth Institute Project on Defense Alternatives (PDA), 18 February 2004.

———. *Strange Victory: A Critical Appraisal of Operation Enduring Freedom and the Afghanistan War.* Cambridge, MA: Commonwealth Institute PDA, 2002.

Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques. http://fletcher.tufts.edu/multi/texts/BH700.txt.

Cordesman, Anthony M. "The 'Instant Lessons' of the Iraq War." Report. Washington, DC: Center for Strategic and International Studies, April 2003.

Cortright, David, and George A. López, eds. *Smart Sanctions: Targeting Economic Statecraft*. Lanham, MD: Rowman & Littlefield Publishers, 2002.

Crane, Conrad C. "Sky High: Illusions of Airpower." *National Interest* 65 (Fall 2001): 116–22.

Craven, Wesley F., and James L. Cate, eds. *The Army Air Forces in World War II*. Vol. 5, *The Pacific: Matterhorn to Nagasaki, June 1944 to August 1945*. 1952. New imprint, Washington, DC: Office of Air Force History, 1983.

Cronon, William. *Changes in the Land: Indians, Colonists and the Ecology of New England*. Rev. ed., New York: Hill and Wang, 2003.

———. *Nature's Metropolis: Chicago and the Great* West. New York: W. W. Norton & Co., 1991.

Daalder, Ivo H., and Michael E. O'Hanlan. *Winning Ugly: NATO's War to Save Kosovo*. Washington, DC: The Brookings Institution, 2000.

Dalby, Simon. "Contesting an Essential Concept: Reading the Dilemmas in Contemporary Security Discourse." In *Critical Security Studies*, edited by Keith Krause and Michael C. Williams, 3–32. London: University College Press, 1997.

———. *Environmental Security*. Minneapolis: University of Minnesota Press, 2002.

———. "Security, Modernity, Ecology: The Dilemmas of Post-Cold War Security Discourse." *Alternatives* 17, no. 1 (1992): 95–134.

Dao, James. "A Nation at War: The Commandos, Navy Seals Easily Seize 2 Oil Wells." *New York Times*, 22 March 2003.

———. "A Nation at War: Navy Special Warfare Group, Cat and Mouse on Iraq's Crucial Waterways." *New York Times*, 24 March 2003.

David, Ahikam Moshe. "Beit Shean's Residents to the IAF [Israeli Air Force]: 'Quiet,'" *Yediot Aharonot*, 14 August 2009 [Hebrew].

Davis, Richard G. *On Target: Organizing and Executing the Strategic Air Campaign against Iraq*. Washington, DC: US Air Force History and Museums Program, 2002.

"Defoliating Viet Nam." *Time*, 23 February 1968. http://www.time.com/time/magazine/article/0,9171,837961,00.html.

Deudney, Daniel. "The Case against Linking Environmental Degradation and National Security." *Millennium* 19, no. 3 (1990): 461–76.

———. "Environment and Security: Muddled Thinking." *Bulletin of the Atomic Scientists* 47, no. 3 (April 1991): 23–28.

Dieterich Jr., Michael D. " 'Law of War' and Ecology: A Proposal for a Workable Approach to Protecting the Environment through the Law of War," *Military Law Review*, no. 136 (1992): 137–60.

Dodds, Felix, and Tim Pippard, eds. *Human and Environmental Security: An Agenda for Change*. London: Earthscan, 2005.

Douglas-Hamilton, Iain, and Oria Douglas-Hamilton. *Battle for the Elephants*. New York: Viking Press, 1992.

Douhet, Giulio. *The Command of the Air*. Translated by Dino Ferrari. New York: Coward-McCann Inc., 1942.

Drozdiak, William. "Commander Of Air War Says Kosovo Victory Near; Belgrade Seen Giving In within Two Months." *Washington Post*, 24 May 1999, 1.

du Bois, Kathleen E. "The Illegal Trade in Endangered Species." *African Security Review* 6, no. 1 (1997). http://www.iss.co.za.

Dunlap, Jr., Charles J. "Lawfare: A Decisive Element of 21st-Century Conflicts?" *Joint Force Quarterly* 54 (3rd Quarter 2009): 34–39.

Eaton, Janet. "Ecological and Health Consequences of the NATO Bombings of Pancevo and other Petrochemical and Chemical Industrial Complexes." International Action Center. http://www.iacenter.org/warcrime/jeaton.htm.

Eichner, Itamar. "Turkey Soothes: Don't Jump to Conclusions due to the Postponement of the Exercise." *Yediot Aharonot*, 13 October 2009 [Hebrew].

Elliot, Gil. *The Twentieth Century Book of the Dead*. New York: Scribner's, 1977.

Ellis, Stephen. "Of Elephants and Men: Politics and Nature Conservation in South Africa." *Journal of Southern African Studies* 20, no. 1 (1994): 53–69.

Environmental Protection Agency. "Cornhusker Army Ammunition Plant." http://www.epa.gov/region7/cleanup/npl_files/ne2213820234.pdf.

———. "Current Status, Air Force Plant 4," 30 December 2008. http://www.epa.gov/earth1r6/6sf/pdffiles/0603610.pdf.

———. "What Is Superfund?" http://www.epa.gov/superfund/about.htm.

"Environmental Scarcities and Violent Conflict: Evidence from Cases." *International Security* 19, no. 1 (1994): 5–40.

Esty, Daniel C., Marc Levy, Tanja Srebotnjak, and Alexander de Sherbinen. *2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship*. New Haven, CT: Yale Center for Environmental Law and Policy, 2005.

Exxon Valdez Oil Spill Trustee Council. "Oil Spill Facts." http://www.evostc.state.ak.us/facts/qanda.cfm.

"Fact Sheet," 8 November 2005. Correspondence Box. Schilling AFB File. Kansas Department of Health and Environment (KDHE), Topeka, KS.

Fairlie, Ian. "Depleted Uranium: Properties, Military Use and Health Risks." *Medicine, Conflict and Survival* 25, no. 1 (January–March 2009): 41–64.

Fatal Footprint: The Global Human Impact of Cluster Munitions. Brussels: Handicap International, 2006.

Fawkes, Helen. "Scars of NATO Bombing Still Pain Serbs." *BBC News*, 24 March 2009.

Feifer, George. *Tennozan: The Battle of Okinawa and the Atomic Bomb*. New York: Ticknor and Fields, 1992.

Felbab-Brown, Vanda. "Afghanistan: When Counternarcotics Undermines Counterterrorism." W*ashington Quarterly* 28, no. 4 (Autumn 2005): 55–72.

Feleke, Elisabeth. "From Greed to Grievance: Natural Resources and Conflict in Africa." In *African Environmental and Human Security in the 21st Century*, edited by Helen E. Purkitt, 185–200. Amherst, NY: Cambria Press, 2009.

Ferreira, Realize, and Dan Henk. "'Operationalizing' Human Security in South Africa." *Armed Forces and Society* 35, no. 3 (April 2009): 501–25.

FOCUS Assessment Mission 2 to the Federal Republic of Yugoslavia: Ecology, 18 July to 13 August 1999. Bern: FOCUS: Greece-Russia-Switzerland-Austria Humanitarian Relief Operation Planning and Coordination Unit, 1999.

Foggo, Daniel, and Michael Burke. "I Captured Proof of Dambusters' Raid." *Sunday Telegraph*, 1 January 2001.

Foster, Gregory D. "Environmental Security: The Search for Strategic Legitimacy." *Armed Forces and Society* 27, no. 3 (Spring 2001): 373–95.

Fredette, Raymond. *The Sky on Fire: The First Battle of Britain, 1917–1918*. New York: Holt, Rinehart, and Winston, 1966.

Friedrich, Jörg. *Der Brand: Deutschland im Bombenkrieg 1940–1945* [*The Fire: Germany in the Bombing 1940–1945*]. Munich, Germany: Propyläen Publishing, 2002.

From Conflict to Sustainable Development: Assessment and Clean-Up in Serbia and Montenegro. Geneva: United Nations Environment Program, 2004.

Frumkin, Howard, Jeremy Hess, and Stephen Vindigni. "Energy and Public Health: The Challenge of Peak Petroleum." *Public Health Reports* 124, no. 1 (January–February 2009): 5–19.

Frankum, Ronald Bruce. *Like Rolling Thunder: The Air War in Vietnam, 1964–1975*. Lanham, MD: Rowman & Littlefield Publishers, Inc., 2005.

Fuller, Stephan. "Linking Afghanistan with Its Neighbors through Peace Parks: Challenges and Prospects." In *Peace Parks: Conservation and Conflict Resolution*, edited by Saleem Ali, 291–312. Cambridge, MA: MIT Press, 2007.

Funck, Marcus, and Roger Chickering. *Endangered Cities: Military Power and Urban Societies in the Era of the World Wars*. Boston: Brill Academic Publishers, 2004.

Garfield, Richard. *Morbidity and Mortality among Iraqi Children from 1990 through 1998: Assessing the Impact of the Gulf War and Economic Sanctions*. Campaign against Sanctions on Iraq, July 1999. http://www.casi.org.uk/info/garfield/dr-garfield.html.

Gellman, Barton. "Allied Air War Struck Broadly in Iraq: Officials Acknowledge Strategy Went beyond Purely Military Targets." *Washington Post*, 23 June 1991.

Gerber, Michele Stenehjem. *On the Home Front: The Cold War Legacy of the Hanford Nuclear Site*. Lincoln: University of Nebraska Press, 1992.

Giangreco, D. M. "Casualty Projections for the U.S. Invasions of Japan, 1945–1946: Planning and Policy Implications." *Journal of Military History* 61 (July 1997): 521–82.

Gichohi, Helen. "From the Desk of the Vice President for Programme: No Wildlife Conservation without Land Conservation." *African Heartland News*, September–December, 2005. http://www.awf.org/documents/AHN_September-December2005.pdf.

Giustozzi, Antonio. "War and Peace Economies of Afghanistan's Strongmen." *International Peacekeeping* 14, no. 1 (January 2007): 75–89.

Glantz, David M. *The Battle of Leningrad, 1941–1944*. Lawrence: University Press of Kansas, 2002.

Glaze, John A. *Opium and Afghanistan: Reassessing U.S. Counternarcotics Strategy*. Carlisle Barracks, PA: Strategic Studies Institute, US Army War College, 2007.

Godschalk, Seakle K. B. "Protecting Our Environment for a Quarter Century." *SA* [South Africa] *Soldier* 9, no. 10 (2002): 24–27.

———. "Waging War over Water in Africa." *Forum* 4 (2000): 110–33.

Goldman, Mara. "Partitioned Nature, Privileged Knowledge: Community-Based Conservation in Tanzania." *Development and Change* 34, no. 5, 833–62.

Gopal, Sriram, and Nicole Deller, *Precision Bombing, Widespread Harm*: *Two Case Studies of the Bombings of Industrial Facilities at Pancevo and Kragujevac during Operation Allied Force, Yugoslavia 1999*. Tacoma Park, MD: Institute for Energy and Environmental Research, 2002.

Gorbachev, Mikhail S. "Poison in the Air: The Environmental Cost of the Kosovo Conflict Must Be Exposed." *The Guardian*, 18 June 1999.

Graham, Bradley. "Military Turns to Software to Cut Civilian Casualties." *Washington Post*, 21 February 2003, A18.

Gravel, Mike. *The Pentagon Papers: The Defense Department History of United States Decisionmaking in Vietnam*. 4 vols. Boston: Beacon Press, 1971.

Grayling, Anthony. *Among the Dead Cities: The History and Moral Legacy of the WWII Bombing of Civilians in Germany and Japan*. New York: Walker & Company, 2006.

Grotto, Jason, and Tim Jones. "Agent Orange's Lethal Legacy: For U.S., A Record of Neglect: Poisonous Defoliants Still Exact a Toll in U.S., Vietnam." *Chicago Tribune*, 4 December 2009. http://www.chicagotribune.com/health/agentorange/chi-agent-orange1-dec04,0,1766354.story.

Haas, Ernst B. *Beyond the Nation-State*. Stanford, CA: Stanford University Press, 1964.

Habakuk, Moti. "The First Sixty Years: Part Two." *Air Force Journal* 180 (2008): 69 [Hebrew].

Hafvenstein, Joel. *Opium Season: A Year on the Afghan Frontier*. Guilford, CT: Lyons Press, 2007.

The Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict, 14 May 1954. http://portal.unesco.org/en/ev.php-URL_ID=13637&URL_DO=DO_TOPIC&URL_SECTION=201.html.

Hallion, Richard. *Storm over Iraq: Air Power and the Gulf War*. Washington, DC: Smithsonian Scholarly Press, 1992.

Hardin, G. "The Tragedy of the Commons." *Science*, New Series 162, no. 3859 (13 December 1968): 1243–48.

Harris, Arthur. *Bomber Offensive*. London: William Collins, Sons and Co. Ltd., 1947.

Hastings, Max. *Bomber Command*. Reprint, London: Pan Macmillan, Ltd., 1981.

Hayward, Joel. "Hitler's Quest for Oil: The Impact of Economic Considerations on Military Strategy 1941–42." *The Journal of Strategic Studies* 18, no. 4 (December 1995): 94–135.

———. "NATO's War in the Balkans: A Preliminary Analysis." *New Zealand Army Journal*, No. 21 (July 1999), 1–17.

———. "Too Little, Too Late: An Analysis of Hitler's Failure in August 1942 to Damage Soviet Oil Production." *The Journal of Military History* 64, no. 3 (July 2000): 769–94.

Healy, Hall. "Korean Demilitarized Zone Peace and Nature Park." *International Journal on World Peace* 24, no. 4 (December 2007): 61–83.

Hedges, Chris. "Serbian Town Bombed by NATO Fears Effects of Toxic Chemicals." *New York Times*, 14 July 1999.

Heidenrich, John G. "The Gulf War: How Many Iraqis Died?" *Foreign Policy* 90 (Spring 1993): 108–25.

Hendricks, Cheryl, ed. *From State Security to Human Security in Southern Africa: Policy Research and Capacity Building Challenges*. ISS Monograph no. 122. Pretoria, South Africa: ISS, 2006.

Henk, Dan. "Biodiversity and the Military in Botswana." *Armed Forces and Society* 32, no. 1 (January 2006): 273–91.

———. *The Botswana Defense Force and the Struggle for an African Environment*. New York: Palgrave Macmillan, 2007.

———. "The Botswana Defence Force and the War against Poachers in Southern Africa." *Small Wars and Insurgencies* 16, no. 2 (June 2005): 170–91.

———. "The Environment, the US Military and Southern Africa." *Parameters* 34, no. 2 (Summer 2006): 98–117.

———. "Human and Environmental Security in Southern Africa: The Kavango-Zambezi (KAZA) Transfrontier Conservation Area Project." In *African Environmental and Human Security in the 21st Century*, edited by Helen Purkitt, 213–36. New York: Cambria Press, 2009.

Henriksen, Dag. *NATO's Gamble: Combining Diplomacy and Airpower in the Kosovo Crisis 1998–1999*. Annapolis, MD: Naval Institute Press, 2007.

Hentschel, Klaus. *The Mental Aftermath: The Mentality of German Physicists 1945–1949*. New York: Oxford University Press, 2007.

Hewitt, Kenneth. "Place Annihilation: Area Bombing and the Fate of Urban Places." *Annals of the Association of American Geographers* 73, no. 2 (June 1983): 257–84.

Hewson, Robert. "Cluster Weapons Ban Leaves Gap in UK Inventory." *Jane's Defense Weekly*, 10 April 2007.

Hicks, Madelyn Hsiao-Rei, Hamit Dardagan, Gabriela Guerrero Serdán, Peter M. Bagnall, John A. Sloboda, and Michael Spagat. "The Weapons That Kill Civilians: Deaths of Children and Noncombatants in Iraq, 2003–2008." *New England Journal of Medicine* 360, 16 April 2009.

Homer-Dixon, Thomas. "Debating Violent Environments." Environmental Change and Security Project Report 9. Washington, DC: Woodrow Wilson Institute, 2003.

———. *The Environment, Scarcity and Violence*. Princeton, NJ: Princeton University Press, 1999.

———. *Environmental Scarcity and Global Security*. New York: Foreign Policy Association, 1993.

———. "On the Threshold: Environmental Changes as Causes of Acute Conflict." *International Security* 16, no. 2 (1991): 76–116.

Homer-Dixon, Thomas, and Jessica Blitt, eds. *Ecoviolence: Links among Environment, Population and Security*. Lanham, MD: Rowan and Littlefield, 1998.

House of Commons. Defence Select Committee. Fourteenth Report, 23 October 2000, at para. 305. http://www.parliament.the-stationery-office.co.uk/pa/cm199900/cmselect/cmdfence/347/34722.htm#a64.

———. Foreign Affairs Select Committee. Fourth Report, 23 May 2000, at para. 151. http://www.publications.parliament.uk/pa/cm199900/cmselect/cmfaff/28/2814.htm#a44.

Howe, Herbert M. *Ambiguous Order: Military Forces in African States*. Boulder, CO: Lynne Rienner Publishers, 2001.

Hsiao, Elaine. "Peace Parks: A Natural Alternative." *University for Peace: Peace and Conflict Monitor*. http://www.monitor.upeace.org/archive.cfm?id_article=456.

Hulme, David, and Marshall Murphree. "Communities, Wildlife, and the 'New Conservation' in Africa." *Journal of International Development* 11 (1999): 277–85.

Hulme, David, and Marshall Murphree, eds. *African Wildlife and Livelihoods: The Promise and Performance of Community Conservation*. Portsmouth, NH: Heinemann Publishing, 2001.

Human Development Report, 1993. New York: United Nations Development Program, 1993. http://www.undp.org/hdro/93.htm.

Human Development Report, 1994. New York: United Nations Development Program, 1994. http://www.undp.org/hdro/94.htm.

Human Rights Watch. *Civilian Deaths in the NATO Air Campaign*. New York: Human Rights Watch, February 2000.

———. *NATO Deaths*. New York: Human Rights Watch, 2000.

———. *Off Target: The Conduct of the War and Civilian Casualties in Iraq*. New York: Human Rights Watch, 2003.

———. *'Troops in Contact': Airstrikes and Civilian Deaths in Afghanistan*. New York: Human Rights Watch, September 2008.

"Hundreds Mourn Family Killed in Marine Jet Crash." *San Diego Union-Tribune*, 11 December 2008.

Huntington, Samuel P. *The Soldier and the State: The Theory and Politics of Civil-Military Relations*. Cambridge, MA: Harvard University Press, 1957.

Hurt, R. Douglas. *The Great Plains during World War II*. Lincoln: University of Nebraska Press, 2008.

"The IAF Will Promote Environmental Issues." *Channel 7*, 5 December 2007 [Hebrew].

"Insurgents Using Teens in Attacks." *Chicago Tribune*, 7 June 2009.

International Criminal Tribunal for the former Yugoslavia. *Final Report to the Prosecutor by the Committee Established to Review the NATO Bombing Campaign against the Federal Republic of Yugoslavia*. http://www.icty.org/sid/10052.

Iraq Body Count. "A Dossier of Civilian Casualties, 2003–2005." http://reports.iraqbodycount.org/a_dossier_of_civilian_casualties_2003–2005.pdf.

Israel State Comptroller. "The Treatment of the Ministry of Defense and Israel Defense Forces in the Issue of Protection of the Environment in the IDF," *Annual Report 55A*. Jerusalem: Governmental Printing House, 2004, [Hebrew].Jacobs, W. A. "The British Strategic Air Offensive against Germany in World War II." In *Case Studies in Strategic Bombardment*, edited by R. Cargill Hall, 91–182. Washington, DC: US Air Force History and Museums Program, 1998.

Joksimovich, Vojin. "Militarism and Ecology: NATO Ecocide in Serbia." *Mediterranean Quarterly* 11, no. 4 (2000): 140–60.

Jones, R. V. *The Wizard War: British Scientific Intelligence, 1939–1945* (New York: Coward, McCann, and Geoghegan, 1978).

Jones, Tobin, ed. *617 Squadron Operational Record Book 1943–1945*. Bicester, UK: Binx Publishing, 2002.

"Just War Doctrine." *Catholic Answers*. http://www.catholic.com/library/Just_War_Doctrine_1.asp.

Kakonen, Jyrki, ed. *Green Security or Militarized Environment*. Aldershot, UK: Dartmouth Publishing Co., Ltd., 1994.

The Kampala Document: Towards a Conference on Security, Stability, Development and Cooperation. New York: African Leadership Forum, 1992.

Kansas Biological Survey. *Cheyenne Bottoms: An Environmental Assessment*. Lawrence: University Press of Kansas, 1987.

"Kansas Governor Hosts Ribbon Cutting for Great Plains Joint Regional Training Center." News Release. The Adjutant General, Kansas National Guard, 28 March 2008. http://www.kansas.gov/ksadjutantgeneral/News%20Releases/2008/08-033.htm.

Kansteiner III, Walter H., and J. Stephen Morrison. *Rising U.S. Stakes in Africa: Seven Proposals to Strengthen U.S.–Africa Policy*. Washington, DC: Center for Strategic and International Studies, 2004.

Kaplan, Robert. "The Coming Anarchy." *Atlantic Monthly* (February 1994): 44–77.

Karni, Maya. "After the Fighting, 10 Dunams of Natural Forest in the Area of Mt. Meron Will Be Thinned Out." *Bemahane*, 15 September 2006 [Hebrew].

———. "Animal, Plant and Vegetable." *Bemahane*, 1 September 2006 [Hebrew].

———. "In the Ministry for Protection of the Environment They Call to the IDF: 'Report More to Us about Environmental Damage in the Bases'." *Bemahane*, March 2007 [Hebrew].

Karni, Maya, and Yishai Avior. "Uvda Base: Adopting the Negev Dunes." *Bemahane*, 29 December 2006 [Hebrew].

Katsuichi, Honda. *The Nanjing Massacre*. New York: M. E. Sharp, Inc. 1999.

Katzman, Kenneth. *Afghanistan: Post-Taliban Governance, Security, and U.S. Policy*. Washington, DC: Congressional Research Service, 2009.

Keaney, Thomas A. "Surveying Gulf War Airpower." *Joint Force Quarterly*, Autumn 1993, 25–36.

Keegan, John. "Please Mr. Blair, Never Take Such a Risk Again." *Daily Telegraph*, 6 June 1999.

Kemkar, Neal. "Environmental Peacemaking: Ending Conflict between India and Pakistan on the Siachen Glacier through the Creation of a Transboundary Peace Park." *Stanford Environmental Law Journal* 25, no. 1 (2005): 1–56.

Kennett, Lee. *The First Air War, 1914–1918*. New York: Free Press, 1991.

"The Kenya Land Conservation Trust Formed." *African Heartland News*, September–December 2005. http://www.awf.org/documents/AHN_September-December2005.pdf.

Killingray, David. "'A Swift Agent of Government': Air Power in British Colonial Africa, 1916–1939." *Journal of African History* 25, no. 4 (1984): 429–44.

Kim, Ke Chung. "Preserving Korea's Demilitarized Corridor for Conservation: A Green Approach to Conflict Resolution." In *Peace Parks: Conservation and Conflict Resolution*, edited by Saleem Ali, 239–60. Cambridge, MA: MIT Press, 2007.

King, Laura, and Julian E. Barnes. "Deadly Afghan Day Signals More Ahead." *Chicago Tribune*, 7 July 2009.

Klare, Michael T. "Oil Wars." *TomDistpatch.com*, 9 October 2004. http://www.tomdispatch.com/post/1888/.

———. "The Pentagon v. Peak Oil: How Wars of the Future May Be Fought Just to Run the Machines That Fight Them." *TomDispatch.com*, 14 June 2007. http://www.tomdispatch.com/post/174810/.

———. *Resource Wars: The New Landscape of Global Conflict*. New York: Henry Holt, 2001.

Knights, Michael. "Infrastructure Targeting and Postwar Iraq." *Policy Watch* no. 725 (14 March 2003). http://www.washingtoninstitute.org/templateC05.php?CID=1603.

Kreutzmann, Herman. "Afghanistan and the Opium World Market: Poppy Production and Trade." *Iranian Studies* 40, no. 65 (December 2007): 605–21.

bin Laden, Osama. "Letter to the American People." Transmitted after 11 September 2001. http://www.globalsecurity.org/security/library/report/2002/021120-ubl.htm.

Lake, Anthony, Christine Todd Whitman, Princeton N. Lyman, and J. Stephen Morrison. *More than Humanitarianism: A Strategic U.S. Approach to Africa*. Independent Task Force Report no. 56. New York: Council on Foreign Relations, 2006.

Lambeth, Benjamin S. *The Transformation of American Airpower*. New York: Cornell University Press, 2000.

Lapidot, Aharon. "Special Interview with the Commander of the Israeli Air Force, General Amos Lapidot." *Air Force Journal*, 132 (1983) [Hebrew].

Larson, Eric V., and Bogdan Savych. *Misfortunes of War: Press and Public Reactions to Civilian Deaths in Wartime*. Santa Monica, CA: RAND Corp., 2007.

Lawson, Ted W. *Thirty Seconds over Tokyo*. Washington, DC: Potomac Books, 2002.

Leader-Williams, Nigel. *The World Trade in Rhino Horn: A Review*. Species in Danger Series. Cambridge, UK: TRAFFIC International, 1992.

Leaning, Jennifer. "Tracking the Four Horsemen: The Public Health Approach to the Impact of War and War-Induced Environmental Destruction in the Twentieth Century." In *The Environmental Consequences of War: Legal, Economic, and Scientific Perspectives*, edited by Jay E. Austin and Carl E. Bruch, 384–401. Cambridge: Cambridge University Press, 2000.

———. "War and the Environment." In *Life Support: The Environment and Human Health*, edited by Michael McCally, 273–84. Cambridge, MA: MIT Press, 2002.

Leroy, Howard S. "Limitations on Air Warfare." *Air Law Review* 12 (January 1941): 27.

Levy, Marc A. "Is the Environment a National Security Issue?" *International Security*, Fall 1995, 35–62.

Lewy, Guenter. *America in Vietnam*. New York: Oxford University Press, 1978.

Lotrionte, Catherine. "When to Target Leaders." *Washington Quarterly* 26 (Summer 2003): 73–86.

MacDonald, David. *Drugs in Afghanistan: Opium, Outlaws, and Scorpion Tales* (New York: Pluto Press, 2007).

Macgregor, Douglas A. "Command and Control for Joint Strategic Actions." *Joint Force Quarterly*, no. 20 (Autumn/Winter 1998–99): 25–33.

Malan, Mark. "AFRICOM: A Wolf in Sheep's Clothing?" Testimony to the [US] Senate Foreign Relations Committee/African Subcommittee on African Affairs. 110th Cong., 1st sess., 1 August 2007.

Marković, Sasa. "Serbia: Airing Grievances." *Transitions*, 28 September 2004.

Martin, Esmond Bradley. "The Report on the Trade in Rhino Products." *Pachyderm* 11 (January–June 1989): 13–20.

———. "The Yemeni Rhino Horn Trade." *Pachyderm* 8 (January–June 1987): 13–16.

Martinovic-Vitanovic, Vesna, and V. Kalafatic. "Consequences of War Destruction of Oil Refinery-Novi Sad (Yugoslavia) on the Danube and Its Biota." *Journal of Environmental Protection and Ecology* 3, no. 2 (2002): 370–376.

Mason, Brad. "US Army Apache Helicopters and US Air Force Expeditionary Forces: Implications for Future Military Operations." Occasional Paper no. 22. Maxwell AFB, AL: USAF Center for Strategy and Technology, Air War College, June 2001. http://www.au.af.mil/au/awc/awcgate/cst/csat22.pdf.

Matthews, Jessica Tuchman. "Redefining Security." *Foreign Affairs* 68, no. 2 (Spring 1989): 162–77.

Mayer, Jane. "The Predator War: What Are the Risks of the C.I.A.'s Covert Drone Program?" *The New Yorker*, 26 October 2009, 36–45.

McCabe, J. Terrence, Scott Perkin, and Claire Schofield. "Can Conservation and Development Be Coupled among Pastoral People? An Examination of the Maasai of the Ngorongoro Conservation Area, Tanzania." *Human Organization* 51, no. 4 (1992): 353–66.

McDermid, Robert W., ed. *The Use of Chemicals in Southern Forests*. Baton Rouge: Louisiana State University, Forestry Symposium, 1960.

McFarland, Marvin W., ed. *The Papers of Wilbur and Orville Wright*. New York: McGraw-Hill, 2001.

McFarland, Stephen L. *America's Pursuit of Precision Bombing, 1910–1945*. Washington, DC: Smithsonian Books, 1995.

McMullen, John K. "The United States Strategic Bombing Survey and Air Force Doctrine." Master's thesis, School of Advanced Airpower Studies, Air University, Maxwell AFB, AL, 1 June 2001. www.au.af.mil/au/awc/awcgate/saas/mcmullen.pdf.

Medlicott, William Norton. *The European Blockade*. 2 vols. London: HMSO, 1952.

Meilinger, Phillip S. "Clipping the Bomber's Wings: The Geneva Disarmament Conference and the Royal Air Force, 1932–34." *War and History* 6 (July 1999): 306–30.

———. "Trenchard and Morale Bombing: The Evolution of the Royal Air Force before World War II." *The Journal of Military History*, April 1996, 243–70.

Metcalfe, Simon. "Campfire: Zimbabwe's Communal Areas Management Program for Indigenous Resources." Paper prepared for the Liz Claiborne and Art Ortenberg Foundation Workshop on Community-Based Conservation. http://www.resourceafrica.org/documents/1993/1993_campfire_BG.PDF.

Mets, David R. *Reflections of a Middling Cold Warrior: Should the Army Air Corps Be Resurrected?* Maxwell AFB, AL: Air University Press, December 2009.

Meyer, Jeanne M. "Tearing Down the Façade: A Critical Look at the Current Law on Targeting the Will of the Enemy and Air Force Doctrine." *Air Force Law Review* 51 (2001): 143–82.

Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being: Synthesis*. http://www.maweb.org/en/Synthesis.aspx.

Milstein, Mati. "Lebanon Oil Spill Makes Animals Casualties of War." *National Geographic News*, 31 July 2006.

Miner, Craig. *Kansas: The History of the Sunflower State, 1854–2000*. Lawrence: University Press of Kansas, 2002.

Minister of State for the Armed Forces Adam Ingram. House of Commons Hansard Written Answers for 16 November 2001. http://www.publications.parliament.uk/pa/cm200102/cmhansrd/vo011116/text/11116w17.htm#11116w17.html_spnew3.

Morgan, Claude V. Z. "Collateral Damage of the Environmental Kind." *Mother Jones*, 6 September 2000.

Morgan, Edmund. *American Slavery, American Freedom*. New York: W. W. Norton and Company, 2003.

Mosher, David E., Beth E. Lachman, Michael D. Greenberg, Tiffany Nichols, Brian Rosen, and Henry H. Willis. "Green Warriors: Army Environmental Considerations for Contingency Operations from Planning through Post-Conflict." RAND Report. Santa Monica: CA: RAND Arroyo Center, 2008.

Mueller, John, and Karl Mueller. "Sanctions of Mass Destruction." *Foreign Affairs* 78 (May/June 1999): 43–53.

Mufson, Steven, and Walter Pincus. "Major Challenges for Pentagon in Getting Fuel to U.S. Troops in Afghanistan." *Washington Post,* 15 December 2009.

Mullison, Wendell R. "The Volatility of Several Salts and Esters of 2,4-D As Determined by the Response of Tomato, Bean, and Cotton Plants." *American Society for Horticultural Science* 53 (1949): 287.

Muloongo, Keith, Roger Kibasomba, and Jemima Njeri Kariri. *The Many Faces of Human Security: Case Studies of Seven Countries in Southern Africa*. Pretoria, South Africa: ISS, 2005.

Munk, Erika. "The New Face of Techno-War." *The Nation*, 6 May 1991, 583.

NATO Standardization Agreement (STANAG) 7141, *Joint NATO Doctrine for Environmental Protection during NATO-led Activities,* 5th Edition, 20 Feb 2008.

"The Nature of German Environmental History." *German History* 27, no. 1 (January 2009): 113–30.

Neillands, Robin. *The Bomber War: The Allied Offensive against Nazi Germany*. Woodstock, NY: Overlook Press, 2001.

Northern Rangland Trust. http://www.nrt-kenya.org.

Norton-Taylor, Richard. "US Deploys Controversial Weapon." *The Guardian*, 12 October 2001.

Norton-Taylor, Richard, Peter Walker, and agencies. "Cluster Bomb Treaty: Signing of Ban on Production Begins." *The Guardian*, 3 December 2008.

Nye, David E. *America as Second Creation: Technology and Narratives of New Beginnings*. Cambridge, MA: MIT Press, 2004.

"Obama Takes US Closer to Cluster Bomb Ban." *The Guardian*, 13 March 2009.

Office of the Surgeon, Multinational Force-Iraq, and Office of the Surgeon General, US Army Medical Command. "Mental Health Advisory Team (MHAT) IV, Operation Iraqi Freedom 05-07." Full Report, 17 November 2006.

Okoth, P. Godfrey. "The New East African Community: A Defense and Security Organ as the Missing Link." In *Africa at the Crossroads: Between Regionalism and Globalization*, edited by John Mukum Mbaku and Suresh Saxena, 147–62. Westport, CN: Praeger Publishers, 2004.

Olson, Norris D. "Salina's Response to the Closing of Schilling Air Force Base." Master's thesis, University of Kansas, 1968.

Operational Law Handbook 2000. Charlottesville, VA: Judge Advocate General's School, US Army, 2000.

Oren, Amiram, and Rafi Regev. *A Land in Khaki: The Geographic Dimension of Defense in Israel*. Jerusalem: Carmel, 2008 [Hebrew].

Orend, Brian. "Is There a Supreme Emergency Exemption?" In *Just War Theory: A Reappraisal*, edited by Mark Evans, 134–53. Edinburgh: Edinburgh University Press, 2005.

Owen, Robert C., ed. *Deliberate Force: A Case Study in Effective Air Campaigning*. Maxwell AFB, AL: Air University Press, 2000.

Owen, Taylor, and Ben Kiernan. "Bombs over Cambodia." *Walrus*, October 2006, 62–69.

"Panel Touts Robots' Future Combat Role." *Virginian-Pilot*, 28 January 2009.

Parks, W. Hays. "Air War and the Law of War." *Air Force Law Review* 32 (January 1990): 1–226.

Pearce, Fred. "From Viet Nam to Rwanda: War's Chain Reaction." *The UNESCO Courier: Planet,* May 2000. http://www.unesco.org/courier/2000_05/uk/planet.htm.

Pearton, Maurice. *Oil and the Romanian State 1895–1948*. Oxford: Oxford University Press, 1971.

Peled-Fleischer, Mical. "Israeli Pilots Took Part in Exercise of USAF." *Air Force Journal*, 119 (1998) [Hebrew].

Peltier, Jean-Philippe N., and Meer Thomas. "Air Domain Development in Africa: A Reasonable Proposition." *Air & Space Power Journal*, Summer 2009, 111–13.

Peri, Yoram. "Civil-Military Relations in Israel in Crisis." In *Military, State and Society in Israel*, edited by Daniel Mamam, Eyal Ben-Ari, and Zeev Rosenhek, 114–15. New Brunswick, NJ, and London: Transaction Publishers, 2001.

Peters, Gretchen. *Seeds of Terror: How Heroin Is Bankrolling the Taliban and Al Qaeda*. New York: Thomas Dunne Books, 2009.

Pfeffer, Anshell. "Under Simulated Fire." *Ha'aretz*, 10 April 2009 [Hebrew].

Pinheiro, Isidro, Gabaake Gabaake, and Piet Heyns. "Cooperation in the Okavango River Basin: The OKACOM [Okavango River Basin Water Commission] Perspective." In *Transboundary Rivers, Sovereignty and Development* edited by Anthony Turton, Peter Ashton, and Eugene Cloete, 105–18. Pretoria, South Africa: African Water Issues Research Unit, University of Pretoria, 2003.

Ploch, Lauren. *Africa Command: US Strategic Interests and the Role of the US Military in Africa*. Washington, DC: Congressional Research Service, 10 March 2008.

Popovska, Nevena, and Jasmina Sopova. "The Pollution of the Balkans." *UNESCO Courier*, May 2000.

Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I). http://www.icrc.org/ihl.nsf/INTRO/470.

Public Broadcasting Service. "War in Europe: NATO's 1999 War against Serbia over Kosovo, Interview of Gen Michael C. Short." *Frontline*, n. d. http://www.pbs.org/wgbh/pages/frontline/shows/kosovo/interviews/short.html.

Purkitt, Helen, ed. *African Environmental and Human Security in the 21st Century*. Amherst, NY: Cambria Press, 2009.

"Quitclaim Deed for Schilling Air Force Base." Saline County Deed Book 267, 9 September 1966. Schilling AFB Files. KDHE, Topeka, KS.

Ramutsindela, Maano. "Scaling Peace and Peacemakers in Transboundary Parks: Understanding Glocalization." In *Peace Parks: Conservation and Conflict Resolution*, edited by Saleem Ali, 1–22. Cambridge, MA: MIT Press, 2007.

Rauert, Tyler. "The Influence of Just War Perspectives: Implications for U.S. Central Command." *Joint Force Quarterly* 50 (Fall 2008): 73–78.

Reichberg, Gregory, and Henrik Syse. "Protecting the Natural Environment in Wartime: Ethical Considerations from the Just War Tradition." *Journal of Peace Research* 37, no. 4 (2000): 449–68.

Republic of Botswana. *Vision 2016: Towards Prosperity for All*. Gaborone, Botswana: Government Printing Office, 1997.

Rhodes, Richard. *The Making of the Atomic Bomb*. New York: Simon & Schuster, Inc., 1986.

Ricciuti, Edward. "The Elephant Wars." *Wildlife Conservation* 96, no. 2 (1993): 14–35.

Richards, Denis, and Hilary Saunders. *Royal Air Force 1939–1945*. Vol. 2. 1953. Reprint. London: HMSO, 1974.

Robichaud, Carl. "Buying Time in Afghanistan." *World Policy Journal* 24, no. 2 (Summer 2007): 1–10.

Rodin, David. "The Ethics of Asymmetric War." In *The Ethics of War: Shared Problems in Different Traditions*, edited by Richard Sorabji and David Rodin, 153–68. Aldershot: Ashgate Publishing Ltd., 2006.

Ronzitti, Natalino. "Is the *Non Liquet* of the Final Report by the Committee Established to Review the NATO Bombing Campaign against the Federal Republic of Yugoslavia Acceptable?" *International Review of the Red Cross* no. 840 (2000): 1017–28.

Rosenberg, Ran. "Man, Earth and the Heavens." *Air Force Journal* 151 (2003) [Hebrew].

Royal Air Force. Air Publication (AP) 1300. *War Manual*, February 1940.

Royse, M. W. *Aerial Bombardment and the International Regulation of Warfare*. New York: Harold Vinal Publisher Ltd., 1928.

Rummell, R. J. *Death by Government*. New Brunswick, NJ: Transaction, 1995.

Rumpf, Hans. *The Bombing of Germany*. New York: Holt, Rinehart and Winston, 1963.

Sandoz, Yves, Philippe Eberlin, Hans-Peter Gasser, and Claude F. Wenger, eds. *Commentary on the Additional Protocols of 8 June 1977 to the Geneva Conventions of 12 August 1949*. Geneva: International Committee of the Red Cross, 1987.

Sands, Robert. "Cultural Relativism and the Convergence of Ethnography and 3C [cross-cultural competence]." *Military Intelligence Professional Bulletin*, PB-34-12-1 (January/March 2012): 13–19.

———. "Letters to AFRICOM No. 3: Transfrontier Conservation Areas and AFRICOM: Conflict Resolution and Environmental Sustainability." *Air & Space Power Journal: Africa and Francophonie* 2, no. 11 (Summer 2010): 27–40.

Sandwich, Trevor, Clare Shine, Lawrence Hamilton, and David Sheppard. *Transboundary Protected Area for Peace and Co-operation*. http://www.iucn.org/about/union/commissions/wcpa/wcpa_puball/wcpa_pubsubject/wcpa_transboundarypub/?2176/Transboundary-Protected-Areas-for-Peace-and-Cooperation.

Sas-Rolfes, Michael. *Rhinos: Conservation, Economics and Trade-Offs*. London: Institute of Economic Affairs, 1995.

Schanz, Marc V. "Focused Lethality: USAF Seeks Weapons with Less Boom but More Precision and Flexibility." *Air Force Magazine* 91, no. 12 (December 2008): 36–39.

"The Schilling Air Force Base Project: Executive Summary," Document C5-085-03013-5, Schilling AFB Files, KDHE, Topeka, KS.

Schindler, Dietrich, and Jiri Toman. *The Laws of Armed Conflict: A Collection of Conventions, Resolutions and Other Documents*. Dordrecht, Netherlands: Martinus Nijhoff Publishers, 1988.

Schoomaker, Peter J., and R. L. Brownlee. *The Army Strategy for the Environment: Sustain the Mission, Secure the Future*. Arlington, VA: Army Environmental Policy Institute, November 2005.

Schwabach, Aaron. "Environmental Damage Resulting from the NATO Military Action against Yugoslavia." *Columbia Journal of Environmental Law* 25 (2000).

Schwartz, Daniel, and Ashbindu Singh. *Environmental Conditions, Resources and Conflicts*. New York: United Nations Environmental Program, 1999.

Schweich, Thomas. "Is Afghanistan a Narco-State?" *New York Times*, 27 July 2008.

Sebald, W. G. *On the Natural History of Destruction*. Translated by Anthea Bell. New York: Random House, Inc., 2003.

———. *On the Natural History of Destruction*. 1999. Reprint. London: Penguin, 2004.

Secretary of State for Defence Geoff Hoon. House of Commons Hansard Written Answers for 19 January 2000. http://www.publications.parliament.uk/pa/cm199900/cmhansrd/vo000119/text/00119w16.htm#00119w16.html_spnew6.

Secretary of State for International Development Hillary Benn. House of Commons Hansard Written Answers for 18 December 2006. http://www.publications.parliament.uk/pa/cm200607/cmhansrd/cm061218/text/61218w0005.htm#06121816000225.

Serbian-American Alliance of New England. http://www.sane-boston.org/recentcrisesn.html.

"Serbs Call for Restrictions on Noxious Factory Emissions, Residents of Industrial Zone near Belgrade Stage Second Demonstration." *Associated Press*, 20 November 2006. http://ngo.ro/pipermail/mediu_ngo.ro/2006-November/007156.html.

Shane, Scott. "C.I.A. to Expand Use of Drones in Pakistan." *New York Times*, 3 December 2009. http://www.nytimes.com/2009/12/04/world/asia/04drones.html.

Sharon, Hila. "New: The F-16A/B Simulator Will Show Pilots Views Unique to Israel." *IAF Journal* 117 (1997) [Hebrew].

Shea, Jamie, and Giuseppe Marani, "Press Conference." *NATO's Role in Kosovo,* 19 April 1999. http://www.nato.int/cps/en/natolive/opinions_27602.htm.www.nato.int/kosovo/press/990430a.htm.

———. "Press Conference." *NATO's Role in Kosovo,* 30 April 1999. http://www.nato.int/kosovo/press/990430a.htm.

Shea, Jamie, and Walter Jertz. "Press Conference." *NATO's Role in Kosovo*, 3 May 1999. http://www.nato.int/Kosovo/press/p990503b.htm.

Shulman, Seth. *Threat at Home: Confronting the Toxic Legacy of the U.S. Military*. Boston: Beacon Press, 1992.

Shuval, Lilach. "The Italian Job." *Israel Today*, 19 October 2009 [Hebrew].

Sidel, Victor W. "The Impact of Military Preparedness and Militarism on Health and the Environment." In *The Environmental Consequences of War: Legal, Economic, and Scientific Perspectives*, edited by Jay E. Austin and Carl E. Bruch, 426–43. Cambridge: Cambridge University Press, 2000.

Sidel, Victor W., Barry S. Levy, and Jonathan E. Slutzman. "Prevention of War and Its Environmental Consequences." In *Environmental Consequences of War and Aftermath*, edited by Tarek A. Kassim and Damià Barceló, 21–40. Berlin: Springer-Verlag, 2009.

Sills, Joe B., Jerome C. Glenn, Theodore J. Gordon, and Renat Perelet. *Environmental Security: United Nations Doctrine for Managing Environmental Issues in Military Actions*. Vol. 1. Atlanta, GA: Army Environmental Policy Institute, July 2002.

Simonson, Gene Roger, ed. *History of the American Aircraft Industry: An Anthology*. Cambridge, MA: MIT Press, 1968.

Singh, Joseph G. "Role of the Military and Military Technology in Environmental Protection and Nature Conservation." Paper presented at the Hague Conference on Environment, Security and Sustainable Development. The Hague, Netherlands, 12 May 2004. http://www.envirosecurity.org/conference/presentations/session8/ESSD_Session_8_Joseph_G_Singh.pdf.

Skelly, Patrick G. "References to Ploesti, Rumania from the USAAF WWII [United States Army Air Forces World War II] Chronology, 12 June 1942 to 17 October 1944." *Military History Network*, *milhist .net*. http://www.milhist.net/usaaf/ploesti.html.

Smilie, Ian, Lansana Gberie, and Ralph Hazleton. *The Heart of the Matter: Sierra Leone, Diamonds and Human Security*. Ottawa: Partnership Africa Canada, 2000.

Smith, Steve. "The Increasing Insecurity of Security Studies: Conceptualizing Security in the Last Twenty Years." *Contemporary Security Policy* 20, no. 3 (1999): 72–101.

Solomon, Hussein, and Maxi van Aardt, eds. *Caring Security in Africa*. ISS Monograph no. 20. Pretoria, South Africa: ISS, 1998.

South African Department of Environmental Affairs and Tourism. "Overview of Integrated Environmental Management." Information Series O. Pretoria, South Africa: Department of Environmental Affairs and Tourism, 2004.

The Southern African Development Community Protocol on Shared Watercourse Systems. Gaborone, Botswana: Southern African Development Community, 1995.

The Southern African Development Community Protocol on Wildlife Conservation and Law Enforcement. Gaborone, Botswana: Southern African Development Community, 1999.

South African White Paper on Defence, 1996. Pretoria, South Africa: Department of Defense, 1998.

Spaight, James Molony. *Air Power and the Cities*. London: Longmans, Green, and Co., 1930.

———. *Bombing Vindicated*. London: Geoffrey Bles, 1944.

———. "The Chaotic State of the International Law Governing Bombardment." *Royal Air Force Quarterly* 9 (January 1938): 1–42.

Speth, James G. *Red Sky at Morning: America and the Crisis of the Global Environment*. New Haven, CT: Yale University Press, 2004.

Stearn, E., and A. Stearn. "Smallpox Immunization of the Amerindian," *Bulletin of the History of Medicine* 13, no. 601, 1943.

Steiner, Richard. "After the Bombs, Environmental Calamity." *Seattle Post-Intelligencer*, 10 September 2006.

Stellman, Jeanne Mager, Steven D. Stellman, Richard Christian, Tracy Weber, and Carrie Tomasallo. "The Extent and Patterns of Usage of Agent Orange and Other Herbicides in Vietnam." *Nature* 422 (17 April 2003): 681–87.

Stephens, M. M. *Vulnerability of Total Petroleum Systems*. Washington, DC: US Department of the Interior, Office of Oil and Gas, 1973.

Stevens, Michelle. "Iraq and Iran in Ecological Perspectives: The Mesopotamia Marshes and the Hawizeh-Azim Peace Park." In *Peace Parks: Conservation and Conflict Resolution* edited by Saleem Ali, 313–32. Cambridge, MA: MIT Press, 2007.

Stevens, Susan T. "A Legend of the Destruction of Carthage," *Classical Philology*, 83 no. 1 (1988): 39–41.

Stewart, Rory. "The Irresistible Illusion." *London Review of Books* 31, no. 13 (9 July 2009): 3–6.

Stockholm International Peace Research Institute. *Warfare in a Fragile World: Military Impact on the Human Environment*. London: Taylor & Francis Group, Inc., 1980.

Stoet, Peter. *Human and Global Security: An Explanation of Terms*. Toronto: University of Toronto Press, 1999.

Stokesbury, James L. *A Short History of Air Power*. New York: William Morrow and Company, 1986.

Stout, Jay A. *Fortress Ploesti: The Campaign to Destroy Hitler's Oil Supply*. Drexel Hill, PA: Casemate Publishers, 2003.

"A Strategic Partnership: Ministry of Defense (*Marinha de Guerra* [Navy]) and WWF [World Wildlife Fund]-Mozambique." Presentation. *Republic de Mozambique*, *Ministerio de Defensa* EASWIO [East Africa and Southwest Indian Ocean] Maritime Security Conference, Antananarivo, Madagascar, July 2006.

Swatuk, Larry. "Environmental Cooperation in Southern Africa." In *Environmental Peacemaking*, edited by Ken Conca and Geoffrey Dabelko, 143–45. Washington, DC: Woodrow Wilson Center Press, 2002.

———. "Environmental Security." In *Advances in the Study of International Environmental Politics*, edited by Michele Betsill, Kathryn Hochstetler, and Dimitris Stevis, 203–36. New York: Palgrave Publishers Ltd., 2006.

———. "Power and Water: The Coming Order in Southern Africa." In *The New Regionalism and the Future of Security and Development*, edited by Björn Hettne, András Inotai, and Osvaldo Sunkel, 210–47. London: Palgrave Publishers Ltd., 2001.

Swatuk, Larry A., and Peter Vale. "Why Democracy Is Not Enough: Southern Africa and Human Security in the Twenty-First Century." *Alternatives* 24, no. 3 (1999): 361–89.

"Symposium: The Troubled Rise of AFRICOM." *Contemporary Security Policy* 30, no. 1 (April 2009): 1–99.

Tacitus. *Agricola*. In "Euphemism and American Violence," by David Bromwich, *New York Review of Books*, 3 April 2008. http://www.nybooks.com/articles/archives/2008/apr/03/euphemism-and-american-violence/.

Tagil, Sven. "Alfred Nobel's Thoughts about War and Peace." *Nobelprize.org*, 20 November 1998. http://nobelprize.org/alfred_nobel/biographical/articles/tagil/index.html.

Tappan, Gray. "RE: Extent of Natural Regeneration in Niger." Frame-Community.http://www.frameweb.org/ev_en.php?ID=52653_20&ID2=DO_DISCUSSIONPOST_LIST.

Thakur, Ramesh. "The United Nations and Human Security." *Canadian Foreign Policy* 7, no. 1 (1999): 51–59.

Timothy, Dallen. "Cross-Border Partnership in Tourism Resource Management: International Parks along the US-Canada Border." *Journal of Sustainable Tourism* 7 (September 1999): 182–205.

Tirpak, John A. "Washington Watch: Short's View of the Air Campaign." *Air Force* 82, no. 9 (September 1999): 43.

Toth, Norbert. "Historical Duty or Pragmatic Interest? Notes on EU and AU [African Union] Security Issues." *African Security Review* 16, no. 3 (September 2007): 112–16.

Townshend, Charles. "Civilization and 'Frightfulness': Air Control in the Middle East between the Wars." In *Warfare, Diplomacy, and Politics: Essays, in Honour of A. J. P. Taylor*, edited by Chris Wrigley, 142–62. London: Hamish Hamilton, Ltd., 1986.

Tsheko, Rejoice. "Rainfall Reliability, Drought and Flood Vulnerability in Botswana." *Water SA* 29, no. 4 (July 2003): 23. http://www.wrc.org.za.

Tsutsui, William. "Landscapes in the Dark Valley: Toward an Environmental History of Wartime Japan." In *Natural Enemy, Natural Ally: Toward an Environmental History of War*, edited by Richard P. Tucker and Edmund Russell. Corvallis: Oregon State University Press, 2004.

Tucker, Richard P., and Edmund Russell, eds. *Natural Enemy, Natural Ally*. Corvallis: Oregon State University Press, 2004.

Turner, James. *Just War Tradition and the Restraint of War*. Princeton, NJ: Princeton University Press, 1981.

———. *Morality and Contemporary Warfare*. New Haven, CT: Yale University Press, 1999.

Turner, Stansfield. *Caging the Genies: A Workable Solution for Nuclear, Chemical, and Biological Weapons*. Jackson, CO: Westview Press, 1999.

Turton, Anthony. "Resource Allocation and Xenophobic Violence in South Africa." In *African Environmental and Human Security in the 21st Century*, edited by Helen Purkitt, 111–23. New York: Cambria Press, 2009.

Turton, Anthony, Peter Ashton, and Eugene Cloete, eds. *Transboundary Rivers, Sovereignty and Development*. Pretoria, South Africa: African Water Issues Research Unit, University of Pretoria, 2003.

Tyson, P. D. "Climatic Change in Southern Africa: Past and Present Conditions and Possible Future Scenarios." *Climatic Change* 18 no. 2–3 (April 1991): 241–58.

Ullman, Richard H. "Redefining Security." *International Security* 8, no. 1 (1983): 129–53.

"*Un cahier spécial sur le Kosovo*: New figures on Civilian Deaths in Kosovo War." *Le Monde diplomatique*, 8 February 2000. http://www.monde-diplomatique.fr/cahier/kosovo/hrw022000-en.

United Kingdom Parliament. "Eighth Report: Global Security: Afghanistan and Pakistan." Foreign Affairs Committee, July 2009. http://www.publications.parliament.uk/pa/cm200809/cmselect/cmfaff/302/30202.htm.

United Nations. *Statute of the International Criminal Court*, 17 July 1998. http://untreaty.un.org/cod/icc/statute/romefra.htm.

United Nations Children's Fund (UNICEF). "Child and Maternal Mortality Survey." 1999 Preliminary Report. Baghdad: UNICEF, July 1999.

United Nations Commission on Human Security. *Human Security Now: Protecting and Empowering People*. New York: United Nations Commission on Human Security, 2003.

United Nations Convention on Biological Diversity. http://www.cbd.int/.

United Nations Department of Peacekeeping Operations/Department of Field Support. "Environmental Policy for UN Field Missions," June 2009.

United Nations Development Program. *Human Development Report 1993: People's Participation*. http://hdr.undp.org/en/reports/global/hdr1993/.

———. *Human Development Report 1994: New Dimensions of Human Security*. http://hdr.undp.org/en/reports/global/hdr1994/.

United Nations Environment Program. *Africa: Atlas of Our Changing Environment*. New York: Division of Early Warning and Assessment, United Nations Environment Program, 2008.

———. *Depleted Uranium in Kosovo: Post-Conflict Environmental Assessment*. Geneva: United Nations Environment Program, 2001.

———. *Depleted Uranium in Serbia and Montenegro: Post-Conflict Environmental Assessment in the Federal Republic of Yugoslavia*. Geneva: United Nations Environment Program, 2002.

———. *GEO-4, Global Environment Outlook: Environment for Development*. http://www.unep.org/geo/GEO4/report/GEO-4_Report_Full_en.pdf.

———. *Lebanon Post-Conflict Environmental Assessment*. New York: United Nations Environment Program, 2007.

———. Press Release, 7 May 2004. http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=397&ArticleID=4479&l=en.

———. *Sudan: Post-Conflict Environmental Assessment*. http://postconflict.unep.ch/publications/UNEP_Sudan.pdf.

United Nations Environment Program and United Nations Center for Human Settlements (Habitat). *The Kosovo Conflict: Consequences for the Environment and Human Settlements*. New York: United Nations, 1999.

United Nations General Assembly Resolution 56/4. *Observance of the International Day for Preventing the Exploitation of the Environment in War and Armed Conflict*. 13 November 2001.

United States Africa Command. "About U.S. Africa Command." http://www.africom.mil/AboutAFRICOM.asp.

United States Strategic Bombing Survey. "Description of RAF Bombing." Study no. 64A, January 1947, Exhibit H.

United States Strategic Bombing Survey, Overall Report (European War). Washington, DC: Government Printing Office, 30 September 1945.

United States Strategic Bombing Survey (Pacific War), Crude Oil Production and Refining. Washington, DC: Government Printing Office, 1946.

United States Strategic Bombing Surveys (European War) (Pacific War). Maxwell AFB, AL: Air University Press, 1987.

University of Leeds. *The British Strategic Bombing of Germany: What Factors Affected the Decision To Embark on a Policy of Area Bombing?* http://www.leeds.ac.uk/history/studentlife/e-journal/Henry_Alex.pdf.

US Air Force Pamphlet (AFPAM) 110–31. *International Law: The Conduct of Armed Conflict and Air Operations*, 19 November 1976, V/7–13.

US Air Force Regulation 91–9. *Environmental Program in Foreign Countries*, 27 October 1950.

"US Army and Air Force Wings over Kansas." Part 1. *Kansas Historical Quarterly* 25 (Summer 1959): 129–57.

———. Part 2. *Kansas Historical Quarterly* 25 (Autumn 1959): 334–60.

US Army Air Forces, Field Service Section. Technical Bulletin, 25 March 1942. Schilling AFB Files. KDHE, Topeka, KS.

US Army Corps of Engineers. "Formerly Used Defense Sites Program." https://eko.usace.army.mil/usacecop/pub/ecop/what_we_do/fuds/.

US Army Field Manual (FM) 1-5. *Employment of Aviation of the Army*, April 1940.

US Department of Health and Human Services. "Fact Sheet." Agency for Toxic Substances and Disease Registry. http://www.atsdr.cdc.gov/tfacts19.pdf.

———. "Public Health Assessment, Tinker." http://www.atsdr.cdc.gov/HAC/PHA/tinker/tafb_p2.html.

US Department of State. *The Foreign Relations of the United States, 1961–1963*. Vol. 1, *Vietnam, 1961*. Washington, DC: Government Printing Office, 1988.

US Energy Information Administration (EIA). *Iraq Energy Data, Statistics and Analysis—Oil*. Washington, DC: EIA, June 2009. http://www.eia.doe.gov/emeu/cabs/Iraq/Oil.html.

———. *Short-Term Energy Outlook*. Washington, DC: EIA, 11 August 2009. http://www.eia.doe.gov/emeu/steo/pub/contents.html.

US House. *Review of Hazardous Waste Cleanup and Disposal Efforts at Tinker Air Force Base*. House Committee on Government Operations. 98th Cong., 2nd sess., 13 December 1984.

"Uvda Base: Deep in the Mud." *Bemahane*, 15 December 2006 [Hebrew].

Van Ham, Peter, and Jorrit Kamminga. "Poppies for Peace, Reforming Afghanistan's Opium Industry." *Washington Quarterly* 30, no. 1 (Winter 2006–2007): 69–81.

Veale, F. J. P. *Advance to Barbarism: The Development of Total Warfare from Serajevo to Hiroshima*. London: Mitre Press, 1968.

Vigne, Lucy, and Esmond Bradley Martin. "Taiwan: The Greatest Threat to Africa's Rhinos." *Pachyderm* 11 (January–June 1989): 23–25.

Viorst, Milton. "Report from Baghdad." *New Yorker*, 24 June 1991, 58.

Vukmirovic, Z., L. Lazic, I. Tosic, and M. Unkasevic. "Regional Air Pollution Originating from Oil-Refinery Fires under War Conditions." In *Air Pollution Modeling and Its Application XIV*, edited by Sven-Erik Gryning and Francis A. Schiermeier, 741–43. New York: Springer Publishing, 2001.

Wall, Robert, and Douglas Barrie. "US, UK Eye Upgrades to Newest Weapons." *Aviation Week and Space Technology*, 26 April 2004, 26.

Walzer, Michael. *Just and Unjust Wars*. New York: Basic Books, 1977.

Ward, William E. *United States Africa Command: 2009 Posture Statement*. Statement of General William E. Ward, US Army, Commander, United States Africa Command, before the Senate Armed Services Committee and the House Armed Services Committee, 17–18 March 2009. Kelley Barracks, Stuttgart, Germany: US Africa Command Public Affairs Office, 2009.

Warden, III, John A. *The Air Campaign: Planning for Combat*. Lincoln, NE: toExcel Press, 2000.

Watt, Donald C. "Restraints on War in the Air before 1945." In *Restraints on War*, edited by Michael Howard, 57–65. London: Oxford University Press, 1979.

Waxman, David E. "Sanctions: The Invisible Hand of Statecraft." *Strategic Review* (Winter 1998): 39–45.

Waxman, Matthew C. "Siegecraft and Surrender: The Law and Strategy of Cities as Targets." *Virginia Journal of International Law* 39 (Winter 1999): 354–434.

Weart, Spencer. *The Discovery of Global Warming: Revised and Expanded Edition*. Cambridge, MA: Harvard University Press, 2008.

Webster, Charles, and Noble Frankland. *Strategic Air Offensive against Germany 1939–1945*. 4 vols. London: HMSO, 1961.

Weed, Timothy. "Central America's Peace Parks and Regional Conflict Resolution." *International Environmental Affairs* 6, no. 2 (Spring 1994): 175–90.

Weiss, Ayal, and Yael Salome. "The Ministry of the Environment Claims: 'The IDF Pollutes the Ground in Some Bases.'" *Bemahaneh*, 6 January 2006 [Hebrew].

Western, David. "The Undetected Trade in Rhino Horn." *Pachyderm* 11 (January–June 1989): 26–28.

White, Richard. *It's Your Misfortune and None of My Own*. Norman: University of Oklahoma Press, 1993.

Williams, Paul W. "Legitimate Targets in Aerial Bombardment." *American Journal of International Law* 23 (July 1929): 570–81.

Williams, Rocky. "Defence in a Democracy: The South African Defence Review and the Redefinition of the Parameters of the National Defence Debate." In *Ourselves to Know: Civil-Military Relations and Defence Transformation in Southern Africa*, edited by Rocky Williams, Gavin Cawthra, and Diane Abrahams, 205–23. Pretoria, South Africa: ISS, 2003.

Wit, Tracy Lyn. "The Social and Economic Impact of World War II Munitions Manufacture on Grand Island Nebraska." *Nebraska History* 71 (Fall 1990): 151–63.

Wolff, Pinchas. "The Soldiers Recycle—and Earn Money." *Bemahane*, 9 March 2007 [Hebrew].

———. "Uvda Base: Learning Judaism on 'Shabbat of Values.'" *Bemahane*, 4 May 2007 [Hebrew].

World Resources Report 2008: Roots of Resilience—Growing the Wealth of the Poor. Washington, DC: World Resources Institute, 2008.

World Wide Fund for Nature. "Danube Carpathian Program, 1999." http://www.panda.org/crisis/background.html.

Worster, Donald. *Dust Bowl: The Southern Plains in the 1930s*. Oxford: Oxford University Press, 1982.

Wrage, Stephen D., ed. *Immaculate Warfare: Participants Reflect on the Air Campaigns over Kosovo, Afghanistan and Iraq*. Westport, CT: Praeger Publishers, 2003.

Wuesthoff, Scott E. "The Utility of Targeting the Petroleum-Based Sector of a Nation's Economic Infrastructure." Master's thesis, School of Advanced Aerospace Studies. Maxwell AFB, AL: Air University Press, 1994. http://aupress.maxwell.af.mil/digital/pdf/paper/t_wuesthoff_utility_of.pdf.

Wyman, Richard H. "The First Rules of Air Warfare." *Air University Review* 35, no. 3 (March–April 1984): 94–102. http://www.airpower.au.af.mil/airchronicles/aureview/1984/mar-apr/wyman.html.

Yehoshua, Yossi. "New in the Air Force: A Simulator for Helicopters." *Yediot Aharonot*, 23 May 2005 [Hebrew].

Yergin, Daniel. *The Prize: The Epic Quest for Oil, Money and Power*. New York: Free Press, 1993.

Zacarias, Agostinho. "Redefining Security." In *From Cape to Congo: Southern Africa's Evolving Security Challenges*, edited by Mwesiga Baregu and Christopher Lansberg, 31–52. Boulder, CO: Lynne Rienner Publishers, 2003.

Zimmerman, John. *Cheyenne Bottoms, Wetland in Jeopardy*. Lawrence: University Press of Kansas, 1990.

Zimonjic, Vesna Peric. "BALKANS: Fallout of Bombing 'Continues to Kill.'" *Inter Press Service*, 18 March 2009. http://www.ipsnews.net/news.asp?idnews=46176.

Zuckerman, Solly. *From Apes to Warlords: The Autobiography of Solly Zuckerman*. London: Hamish Hamilton, Ltd., 1971.

CAMPIRE. *See* Communal Areas Management Program for Indigenous Resources
carbon dioxide, 10, 18, 205
carbon emissions, 200
Carpenter, Chuck, 31–32
CBC. *See* community-based conservation
CBNRM. *See* community-based natural resources management
China, 55, 115
Chissano, Joachim, 159
Churchill, Winston S., 1, 6, 10, 17–18, 22, 113
von Clausewitz, Carl, 85
Clinton, Pres. Bill, 2
cluster munitions, ix, 5, 108, 117, 215–18
coercion, 86, 211
Colorado, 30, 34, 39
Columbus AFB, MS, 28
Combat Training Branch, Israeli Air Force, 191
Combined Chiefs of Staff, 49
Command of the Air, *The* (Douhet), 44–45
Communal Areas Management Program for Indigenous Resources (CAMPFIRE), 160
community-based conservation (CBC), 149–50, 155–56, 160–64, 168, 172–73
community-based natural resources management (CBNRM), 149, 157, 160
Comprehensive Environmental Response, Compensation, and Liability Act, 36
Congo, 136–38, 159
Congo basin, 136
conservation, 90, 94, 137, 140, 149–50, 155–58, 160–2, 164–68, 172
conservation zones, 149–50, 155–57, 161–62, 165, 168, 172
Convention on Biological Diversity, 3
Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD), 212–14
Cornhusker Army Ammunition Plant, NE, 30–31
Corps of Engineers, 25, 31, 34, 36, 38
Cottbus, Germany, 17
Coventry, UK, 1, 3, 113
Cronon, William, 39

Dambusters, 14–16, 20
Danube River, 200, 208
Daura, Iraq, 57
DCDC. *See* Development, Concepts and Doctrine Centre
Defence Select Committee of the House of Commons, UK, 216
Defense Plant Corporation, 30
defoliation, 25, 74, 76, 199, 213, 215
DeLay, Tom, 39, 211
Del Ponte, Carla, 214
Democratic Republic of the Congo, 136–37
Denver, CO, 30, 34
depleted uranium (DU), 4, 215, 219
desertification, 92, 99, 134–35, 138–40, 142
Development, Concepts and Doctrine Centre (DCDC), British Ministry of Defence, ix
  Global Strategic Trends, ix
disposal of ordnance, ix, xii
DOD. *See* US Department of Defense
DOE. *See* US Department of Energy
Dortmund-Ems Canal, Germany, 17
Douglas Aircraft Company, 29
Douhet, Giulio, 44–45, 86, 110–11
  The Command of the Air, 44–45
Dresden, Germany, 2–3, 17, 107, 119
DU. *See* depleted uranium
Dunkirk, France, 1, 11–12, 112
Dust Bowl, 26–27
DynCorp, 77

Eighth Air Force, 48–51
energy infrastructure, 43, 45–46, 52, 54–55, 58, 60–62

ENMOD. *See* Convention on the Prohibition of Military or Any Other Hostile Use of Modification Techniques
Environmental Consequences of War, The (Austin and Bruch, eds.), xi
environmentalism, 18, 193
EPA. *See* US Environmental Protection Agency
European Union, 204
Exxon Valdez, 201, 205–6

Fifteenth Air Force, 49
First Lebanon War, 192
Foreign Affairs Select Committee of the House of Commons, UK, 216
forests, 11–13, 135–37, 156
Fort Worth, TX, 27, 29–30
France, 1, 11–12, 19, 44, 110, 112, 114, 144, 214
Fray, Frank, 48
Friedrich, Jörg, 14, 16, 19

Gahr Støre, Jonas, 217
Garlasco, Marc, 127
General Motors, 29
Geneva Agreements, 1954, regarding Vietnam, 70, 77
Geneva conventions, 19, 21, 108, 202
Geneva Disarmament Conference, 1932, 109
Georgia, 28, 75
Gerber, Michele, 32
Germany, 1, 3, 9–21, 25, 46–52, 61, 109–10, 112–15, 119, 126, 199–200
Gibson, Guy, 15
Global Positioning System (GPS), 118, 123, 166
Global Strategic Trends, (DCDC), ix
global warming, 4, 18
GLTP. *See* Great Limpopo Transfrontier Park
Goebbels, Joseph, 14
Gorbachev, Mikhail, 206
Gore, Al, ix
GPS. *See* Global Positioning System
Grand Island, NE, 30–31
Great Limpopo Transfrontier Park (GLTP), 158–59
Great Plains, 25–30, 34–35, 38
Greenpeace, 116
Guernica (Picasso), 1, 3, 112
Gulf War, 43, 55, 57–61, 116, 201

Haavisto, Pekka, 207
Hafvenstein, Joel, 66, 79
Hague Convention for the Protection of Cultural Property, 197
Haiphong, Vietnam, 53–55
Halevi, Avishai, 187
Hamas, 117
Hamburg, Germany, 2–3
Hanford Nuclear Site, WA, 32
Hanoi, Vietnam, 53–54
Harris, Arthur, 9–10, 13–20, 22, 113
Hastings, NE, 34
Hastings, Tom H., xiii
Hatzor, Israel, 180–81, 191–92
Hawaii, 3, 34, 43
health, 1–2, 5–6, 27, 31, 38, 57, 87, 89–90, 94, 96, 100, 116, 124, 164–66, 192, 197, 199, 202, 207–10, 214–16, 219–20
Helmand Province, Afghanistan, 76, 79
Henk, Dan, 83, 154
Hezbollah, 117, 217
Hiroshima, Japan, 2, 4, 18, 107, 119, 199
Hitler, Adolf, 107, 112
Hon Gay, Vietnam, 53
Human Rights Watch, 117, 123, 127, 203
Hussein, Saddam, 56, 126, 201

IAF. *See* Israeli Air Force
IBC. *See* Iraq Body Count Project
ICBM. *See* intercontinental ballistic missiles
ICTY. *See* International Criminal Tribunal for the Former Yugoslavia
IDF. *See* Israeli Defense Force
IG Farben (*Interessengemeinschaft Farbenindustrie Aktien-gesellschaft*), 51
Imperial Japanese Navy, 43
industrial pollution, 208, 219

Institute of Energy and Environmental Research, 208
intercontinental ballistic missiles (ICBM), 26
Intergovernmental Panel on Climate Change, ix
International Court of Justice, 205
International Criminal Tribunal for the Former Yugoslavia (ICTY), 214
International Union for Conservation of Nature (IUCN), 137, 158
Iran, 76, 159
Iraq, 2, 4–5, 13, 43, 55–61, 72, 87, 116–18, 122, 124, 126–27, 158–59, 201, 211, 216, 220
Iraq Body Count Project (IBC), 117
Iraq War, 43, 57, 60–61
Israel, 117, 125, 177–93, 200, 216
Israeli Air Force (IAF), 117, 179–93, 200
Israeli Defense Force (IDF), 177–81, 183–88, 191–93
IUCN. *See* International Union for Conservation of Nature
Iwo Jima, Japan, 114

Japan, 2–4, 18, 25, 32, 43, 61, 107, 114–15, 119, 199–200
Jason Summer Study, 54
JCS. *See* US Joint Chiefs of Staff
JDAM. *See* Joint Direct Attack Munition
Johnson, Pres. Lyndon, 53–54
Joint Direct Attack Munition (JDAM), 118
jus ad bellum, 121–22
jus in bello, 6, 121–22, 198, 203, 205, 212, 217–18, 220
Just War, 3, 6, 108, 121-22, 198–99, 203, 205, 211–12, 217–18, 220

Kabulov, Zamir, 124
Kansas, 27, 29–30, 32–37
Kansas Army Ammunition Plant, 30
Karzai, Ahmed Wali and Hamid, 74–76
Kavango-Zambezi Transfrontier Conservation Area (KAZA), 159
KAZA. *See* Kavango-Zambezi Transfrontier Conservation Area
Kenan, Noa, 188
Kenya, 150, 15657, 160, 162–64, 166–67, 169, 171–73
Kenya Wildlife Service (KWS), 162, 164, 167
Kfar Yehoshua, Israel, 180
Kibbutz Lotan, Israel, 187
Kidon, Shai, 181
Kishon River, Israel, 180
Komer, Robert, 71
Korean War, 32, 115
Kosovo, 2, 117–20, 122, 198, 200, 202, 204–6, 210–11, 215–16, 218–20
KWS. *See* Kenya Wildlife Service
Kyoto, Japan, 3

bin Laden, Osama, 121
Lake Chad, 136
landmines, 66, 93, 108, 126–27, 216
Lapidot, Amos, 183
Laughlin AFB, TX, 28
League of Nations, 109
Lebanon, 109, 117, 189–90, 192, 200, 217, 220
Leuna, Germany, 51
Lewa Wildlife Conservancy (LWC), 163–65
Lewy, Guenter, 115–16
LIFE. *See* Living in a Finite Environment
Lindemann, Frederick, 18
livestock, 13–14, 33, 93, 99, 162, 164–65, 204–5, 216
Living in a Finite Environment (LIFE), 160
Lockheed-Martin, 30
Lod, Israel, 185
London, UK, 1, 3, 78, 112
Lone Star Army Ammunition Plant, TX, 30
Longhorn Army Ammunition Plant, TX, 30
Low Countries, 11, 46
Lowry AFB, CO, 34
Luftwaffe, 47, 112, 200

LWC. *See* Lewa Wildlife Conservancy

mala in se, 217
Mandela, Nelson, 159
Manual of Air Tactics (RAF), 13
Mao Zedong, 107
megafauna, 90, 92, 96, 165
Mekorot Company, 181
Metohija, Kosovo (former Yugoslavia), 200
Mikdash Hanamerim (Temple of the Tigers), Israel, 188
Milosevic, Slobodan, 117, 120, 199, 203–4, 211
Ministry for Protection of the Environment (MPE), UK, 177–79, 181, 186
Mississippi, 28
Mitchell, William "Billy," 44–45, 57, 86
Winged Defense, 45, 57
Mogadishu, Somalia, 117
Möhne River, Germany, 14–16, 48, 199
Mongols, 2
Moody AFB, GA, 28
morale, 1, 9–10, 13, 46–48
Mozambican navy, 96
Mozambique, 85, 96–97, 158–59, 163
MPE. *See* Ministry for Protection of the Environment, UK
"Munitions Requirements of the Army Air Forces," 47
Munk, Erika, 116

Nagasaki, Japan, 2, 4, 18, 199
Nagoya, Japan, 2
Nahalal, Israel, 180
Namib Desert, 134
Namibia, 160
Nanjing, People's Republic of China, 115
National Defense Strategy, June 2008, 152
national parks, 149, 156–57, 160
NATO, 21, 76, 79, 85, 117, 120, 124, 199–200, 202–11, 213–16, 219
navy, 110
Navy of the Republic of Poland, 59
NCA. *See* Ngorongono Conservation Area
Nebraska, 29–31, 34
Negev region, Israel, 177
Netherlands, 1, 3, 20, 112, 199
Nevatim air base, Israel, 184–85
Newall, Cyril, 46–47
"New Deal," 27
Ngare Ndare Forest Reserve, 163
Ngo Dinh Diem, 70–71, 75–76
Ngorongono Conservation Area (NCA), 161
Niger, 138, 140, 142–43
Nile River, 137
Nobel, Alfred, 6
Northern Rangeland Trust (NRT), 150–51, 163–73
Novi Sad, Serbia (Former Yugoslavia), 202, 206–8, 218
NRT. *See* Northern Rangeland Trust

Obama, Pres. Barack, 124, 217
Offutt AFB, NE, 29
oil consumption, 44, 50
oil infrastructure, 57, 59, 200–1, 210
Okavango Delta, Botswana, 136
Okinawa, Japan, 114
Oklahoma, 27–29, 34–35, 37
Oklahoma City, OK, 27, 29, 35
Operation Allied Force, 58, 117, 209, 211
Operation Desert Fox, 58, 211
Operation Desert Storm, 116, 118
Operation Iraqi Freedom, 118
Operation Linebacker, 201
Operation Ramon, 183–85, 191
Operation Ranch Hand, 70, 77
Operation Rolling Thunder, 53, 201
opium, 65–70, 72–80
Oppenheimer, Robert, 4
ordnance, 10, 30, 34, 117, 200, 202, 215, 218
Orville Wright, 6
Osaka, Japan, 2
Oslo Process, 217

Pakistan, 76, 159
Pancevo, Serbia (Former Yugoslavia), 202, 205–8, 213, 218
peace parks (PP), 150, 157–59, 168

Pearl Harbor, HI, 3, 43
Peirse, Richard, 47
Permanent Okavango River Basin Water Commission, 94
PGM. *See* precision-guided munitions
Picasso, Pablo, 1
  Guernica, 1, 3, 112
Pinyon Canyon, CO, 39
Planning Division of the Israeli General Staff, 178
Ploesti, Yugoslavia, 49–50
Poland, 1, 3, 50, 59, 110, 112
poppies, 65–70, 72–80
Portal, Charles, 11–12, 18, 47
PP. *See* peace parks
precision-guided munitions (PGM), 57, 107, 118, 120, 122

Rabin, Yitzhak, 191
RAF. *See* Royal Air Force, UK
Ramat David air base, Israel, 180–81, 191–92
Regional Environmental Center for Central and Eastern Europe, 207
Rocky Mountain Arsenal, CO, 30
Romania, 49, 200, 202
Roosevelt, Pres. Franklin, 27–28
Rotterdam, Netherlands, 3, 112
Royal Air Force, UK, 1–2, 9–13, 19, 44, 46, 48–51, 110, 112–13, 115, 180, 199–200, 216, 218
  Manual of Air Tactics, 13
Royal Australian Navy, 59
Royal Navy, 59, 110, 112
Ruhr River dams, Germany, 14, 20
Rumpf, Hans, 115
Rupert, Anton, 159
Rwanda, 137–8, 159

Sahara Desert, 136
Saigon, Vietnam, 74, 76
Schilling AFB, KS, 35–37
Schutzstaffel (SS), 15
Schwabach, Aaron, 213
Sebald, Winfried Georg, 9
Second Intifada, 179, 190
Second Lebanon War, 189–90
Serbia (former Yugoslavia), 21, 58, 117, 199, 202–8, 210–11, 213, 216, 218–19
Seventeenth Air Force, 150
Shakedi, Eliezer, 186
Shannon, David, 16
Shea, Jamie, 204
Sheppard AFB, TX, 28
Shmueli, Ram, 191
Short, Michael C., 203
Sinclair, Archibald, 49
Somalia, 117, 167
South Africa, 94–97, 136, 158–59, 161
Southern African Development Community, 94
Soviet Union, 32, 55, 65, 113, 124, 156, 200
Spaight, J. M., 109, 113
Spanish Civil War, 1, 112
Speer, Albert, 50, 112
SS. *See* Schutzstaffel
Stability Pact for South Eastern Europe, 218
storage tanks, 35, 43, 57, 204
Sudan, 138–40, 142–43
Superfund Amendments and Reauthorization Act of 1981, 36
sustainability, 83, 90, 144, 146, 152–53, 156, 158, 164–65, 168, 172–73, 200
Sutner, Bertha, 6
synthetic fuel, 200
synthetic oil, 46–47, 49–51

Taliban, 65–66, 68–70, 76–79, 124
Tan Son Nhut air base, Vietnam, 73
Tanzania, 157, 160–61, 163
Texas, 27–30
TFCA. *See* transfrontier conservation areas
Tinker AFB, OK, 29, 35, 37
Tokyo, Japan, 2–3, 107
Townshend, Charles, 13
transfrontier conservation areas (TFCA), 149, 157–58, 168
Trenchard, Hugh, 44, 86
Tulsa, OK, 27, 29
tu quoque, 205

Turkey, 57, 125, 190–91
Tweezer, Zvi, 185

U-boats, 47
Umm Qasr, Iraq, 59
UN. *See* United Nations
United Kingdom, 1–4, 9–22, 19, 44–51, 59, 76, 78, 86, 108–15, 124, 144, 177–81, 186, 199–200, 216, 218
United Nations (UN), 2, 22, 66, 85, 95, 116, 124, 126–27, 138, 151, 158, 202, 207, 214–15, 217–18
United Nations Children's Fund, 116
United Nations Environment Program, 138, 218
United Nations General Assembly, 22
United Nations University for Peace, 158
United States (US), 2, 4, 18–19, 25–39, 43, 45–55, 57–59, 61, 65, 69–80, 86–87, 97, 107–8, 110–11, 113–18, 120, 122–27, 133, 140, 142–47, 149–55, 162–63, 168–69, 171–73, 178, 185, 187, 189, 199–201, 203, 205, 209, 211, 213, 215, 217, 219
US. *See* United States
USAAF. *See* US Army Air Forces
US Africa Command (AFRICOM), 97, 133, 138, 142–47, 149–50, 153–55, 162–63, 167–69, 171–73
US Agency of International Development (USAID), 143, 154, 171
USAID. *See* US Agency of International Development
US Army Air Corps, 28, 45
US Army Air Forces (USAAF), 2, 25–26, 32–35, 48–50, 110–11, 114–15, 200
US Army General Staff, Planning Division, 178
US Army Ordnance Corps, 30
US Defense Intelligence Agency, 54
US Department of Defense (DOD), 4, 25, 31–32, 34, 36–39, 149–150, 152, 154, 162, 168–69, 171–72
US Department of Energy (DOE), 25, 32
US Environmental Protection Agency (EPA), 30–31, 34, 36–37
US Geological Survey (USGS), 140, 143
USGS. *See* US Geological Survey
US Joint Chiefs of Staff (JCS), 53–54, 211
USN. *See* US Navy
US Navy (USN), 34, 59, 201
US Pacific Fleet, 43
US Strategic Air Command, 29, 111
US War Department, 28
Uvda air base, Israel, 184, 187–88

V-1 (*Vergeltungswaffe eins*), ram-jet cruise missile, 17
V-2(*Vergeltungswaffe zwei*), ballistic missile, 17
Vance AFB, OK, 28
Vauthier, Pierre, 44
Veale, F. J. P., 18
Verne, Jules, 109
Vietnam, 2, 5, 18, 25, 31, 43, 52–55, 61, 65, 70–78, 80, 115–16, 118, 126, 199, 201, 213, 215
Vietnam War, 18, 25, 52, 61, 118, 199
Viorst, Milton, 116
Virunga National Park, Democratic Republic of the Congo, 137–38, 159

Walcheren Island, Netherlands, 20
Wallis, Barnes, 15–16, 20
Walzer, Michael, 113, 210
War Cabinet, UK, 12, 17
Warden, John, 201
Warsaw, Poland, 3, 112
Washington State, 32
water, 3–4, 10, 13–16, 18, 30–33, 35–38, 48–49, 57, 66, 89–90, 92–94, 116, 133–38, 140, 147, 156, 180–81, 184, 186, 216, 218–19
Weber, Baruch, 181
wells, 30–31, 37, 59, 199, 201
Wells, H. G., 109
Western Area Plans, 46
Wichita, KS, 27, 29
Winged Defense (Mitchell), 45, 57
World Conservation Union, 137

World Health Organization, 116
World War I, xi, 44, 86, 108, 126
World War II, x, 1–3, 10, 13, 25, 32–33, 38, 43, 46, 52, 55, 61, 86, 100, 107, 110–12, 115–16, 119, 126, 200–1
World Wildlife Fund (WWF), 96, 158–160
Wright, Orville, 6
WWF. *See* World Wildlife Fund

Yugoslavia, 4–5, 21, 49–50, 58, 117, 199–208, 210, 213–14, 216, 218–19

Zeppelin raids, xi
Zimbabwe, 158–161
Zuckerman, Solomon, 18, 21