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The scars beyond bullets: Recognizing the environmental toll of war

Titilayo Aishat Otukoya *

Independent Researcher, United States of America.

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Abstract

Warfare, throughout history, has not only shaped geopolitical landscapes but has left an indelible mark on the environment. The unintended consequences of armed conflicts extend far beyond the immediate theater of war, affecting ecosystems, biodiversity, and human wellbeing. We therefore need to delve into the complex and lasting environmental impact of wars, exploring case studies, international frameworks, and mitigation strategies aimed at addressing and preventing further ecological devastation which is what this paper is about.

As conflicts continue to arise globally, understanding the environmental implications becomes crucial for sustainable development and international cooperation. This study aims to synthesize existing knowledge, analyze case studies, and propose viable solutions to minimize the environmental toll of armed conflicts. By examining historical examples and current challenges, we seek to contribute to a broader discourse on the intersection of warfare and environmental conservation. And essentially, provide a comprehensive overview of the environmental consequences of war and propose effective strategies for mitigating these impacts. By assessing case studies such as the Gulf War oil spills, Vietnam Agent Orange use, and Ukraine's agricultural land destruction, we aim to uncover patterns and lessons learned.

Additionally, we scrutinize the role of international frameworks, environmental impact assessments, and post-conflict restoration efforts in alleviating the environmental aftermath of warfare.

This paper contends that the environmental impact of war is multifaceted, persisting long after hostilities cease. By examining historical cases, current challenges, and mitigation strategies, we underscore the urgency of integrating environmental considerations into military planning and international conflict resolution efforts.

Keywords: Environmental toll; Ecosystems; Warfare; Environmental conservation; Biodiversity

1. Introduction

War; in its essence; can be broadly defined as a conflict between organized groups characterized by the use of force to achieve certain objectives. Throughout history; wars have taken various forms; each with its own dynamics and consequences. Traditional warfare involves direct confrontations between Nation-States or organized armed groups; often on defined battlefields. Unconventional warfare encompasses asymmetrical tactics; irregular forces; and guerrilla warfare; challenging conventional military strategies. Civil wars; on the other hand; involve internal conflicts within a single nation; often fueled by political; ethnic; or religious divisions.

While wars have long been associated with territorial disputes; political power; and economic interests; it is crucial to acknowledge the profound human cost that accompanies armed conflicts. The toll on human lives; both military and civilian; includes injuries; displacement; and loss of loved ones. The psychological and emotional scars borne by individuals and communities endure long after the cessation of hostilities.

* Corresponding author: Titilayo Otukoya; Email: titilayootukoya@gmail.com

In recent times; there has been a growing recognition of an additional dimension to the impact of war—the environment. Wars; particularly those involving modern weaponry and industrialized nations; have increasingly demonstrated a detrimental effect on ecosystems and the planet. From deforestation and habitat destruction to the release of pollutants and the depletion of natural resources; the environmental consequences of war extend far beyond the immediate battlefield.

As we delve into the complexities of war; it becomes imperative to consider not only the direct and visible consequences but also the often overlooked environmental repercussions. Understanding the multifaceted costs of war is essential for fostering a comprehensive approach to conflict resolution and building a sustainable future. Also; the historical context of how wars have affected the environment provides insights into recurring patterns and informs contemporary strategies.

The impact of war on the environment has a long history; marked by patterns of destruction that trace back to ancient times. According to Davis (1998); "the first fireball flung at the first enemy in prehistory probably began it all". Instances such as the biblical story of Samson burning crops and Genghis Khan's conquest of Baghdad by targeting its water supply highlight the early use of environmental destruction as a tactic in warfare.

Ancient warfare extended beyond conventional tactics; with examples of chemical warfare seen in India; the Peloponnesian War; and Constantinople. During the siege of Kaffa in the 1300s; the Mongols employed biological warfare by catapulting bodies of plague victims into the city; illustrating the far-reaching consequences on human; animal; and plant life (Lanier-Graham 1993).

As history progressed; the destructive capabilities of warfare escalated; especially with the advent of weapons of mass destruction in World War I. Trench warfare in this conflict resulted in the devastation of French farmland and countryside; rendering vast areas unsuitable for agriculture. The battle of the Somme alone left over 250;000 acres of farmland and 494;000 acres of French forest irreparably damaged. The war's toll extended to European wildlife; pushing the European buffalo; or wisent; near extinction due to the massive destruction of forests.

World War I's environmental impact was not confined to Europe; it affected the United States as well. The war effort led American farmers to overproduce; depleting the fertility of fields across the Great Plains and leaving the soil devoid of essential nutrients. This historical context emphasizes how warfare; even with primitive weaponry or advanced technologies; exerts a profound and lasting influence on the environment.

Previous research has explored the ecological consequences of conflicts such as World War II; highlighting the long-lasting impact on landscapes; biodiversity; and natural resources.

Numerous case studies have examined the environmental fallout of specific conflicts. The Gulf War oil spills stand out as a stark example of intentional environmental destruction; emphasizing the need for preventive measures and effective response mechanisms. The use of Agent Orange during the Vietnam War and the ongoing destruction of agricultural land in Ukraine further illustrate the diverse and enduring environmental impacts of armed conflicts.

Thankfully; international legal instruments; including the Hague Conventions and the Environmental Modification Convention; provide a foundation for protecting the environment during warfare. Past efforts to address the environmental impact of wars have included environmental impact assessments; rehabilitation programs; and technological innovations. Therefore; evaluating the success and challenges of these strategies contributes to refining future approaches and fostering a more sustainable balance between military activities and environmental conservation.

2. Environmental Damage from Wars

Before; during and after; war impacts the environment in very grievous ways; unleashing environmental contamination and human suffering. This environmental degradation is not a temporary inconvenience but inflicts long term health risks on both human populations and the delicate ecosystems they depend on. There are two ways war impacts the environment: directly and indirectly.

2.1. Direct Environmental damage

2.1.1. Deforestation and Habitat Destruction

Wars unleash widespread deforestation and habitat destruction due to military activities such as bombing; construction of bases; and scorched earth tactics (UNEP 2009). The immediate effect is the obliteration of vegetation; leaving behind barren landscapes. Beyond the initial destruction; fires ignited by bombings can spread uncontrollably; further decimating forests and impacting surrounding ecosystems. These actions disrupt biodiversity; lead to soil erosion; and upset the delicate ecological balance in affected regions (The Earth Institute; 2022). Military operations directly threaten diverse ecosystems; endangering countless plant and animal species. Establishing military bases often involves largescale land clearing; resulting in deforestation and habitat fragmentation. This disrupts wildlife corridors; isolates populations; and alters natural migration patterns (International Peace Bureau; 2017).

Additionally; the infrastructure development associated with bases; such as roads and airstrips; further fragment habitats and contribute to habitat loss. The loss of habitats and displacement of fauna contribute to decline in biodiversity; disrupting the delicate balance that sustains ecosystems (Journal of Environmental Management; 2023). Also; the physical upheaval caused by warfare; especially through trench digging and heavy machinery use; accelerates soil erosion. This degradation harms agricultural productivity; exacerbating the challenges faced by local populations.

2.1.2. Pollution

Wars result in extensive pollution; contaminating air; water; and soil through the deployment of explosives; ammunition; fuel spills; and the burning of vehicles and infrastructure. The ramifications extend to long-term health risks for both human populations and ecosystems. Explosives release toxic chemicals; including particulate matter; nitrogen oxides; and volatile organic compounds; choking the atmosphere and triggering respiratory problems; cardiovascular diseases; and even cancer (UNEP; 2011). Depleted uranium; a common component in ammunition; unleashes a radioactive payload; contaminating air and soil; and posing a long-term threat to human health and environmental stability (ICRC; 2019).

The resulting air pollution further impacts climate conditions. Fuel spills and the use of hazardous materials in conflict zones lead to water and soil contamination. This pollution jeopardizes the availability of clean drinking water; agricultural productivity; and overall ecosystem health.

2.1.3. Climate Change

War-related activities contribute significantly to climate change through increased greenhouse gas emissions. The Stockholm International Peace Research Institute (SIPRI) highlights the significant carbon footprint of military activities; emphasizing emissions from fuel consumption; vehicle fleets; and the manufacturing processes of military equipment.

A study published in "Nature Climate Change" suggests that the global military sector contributes to about 1.6% of total greenhouse gas emissions. Research from the International Panel on Fissile Materials underscores the environmental consequences of nuclear weapons production; including radioactive contamination. The U.S. Department of Defense has initiated efforts to improve energy efficiency and incorporate renewable energy sources to reduce the carbon footprint of military installations (Crawford N.C 2017).

This exacerbates global climate change; impacting weather patterns and intensifying environmental challenges. Communities in war-torn areas face heightened vulnerability to climate change impacts. The environmental degradation caused by conflict amplifies the challenges posed by changing climates; creating a compounding effect on the resilience of affected populations (Goodman; 2019).

The Gulf War witnessed one of the largest environmental disasters in history due to the intentional release of oil into the Persian Gulf by Iraqi forces. Approximately 240 million gallons of crude oil were dumped; causing extensive damage to marine ecosystems; coastal habitats; and affecting wildlife. A study in the journal "Marine Pollution Bulletin" outlines the persistent ecological impacts of the Gulf War oil spills; emphasizing the prolonged recovery time for affected ecosystems Michel; J. 2013). Michel et al. (2013) conducted a study on the extent and degree of shoreline oiling after the Deepwater Horizon oil spill in the Gulf of Mexico. Although this study is not directly related to the Gulf War; it provides insights into the persistent ecological impacts of oil spills; which can be extrapolated to the Gulf War scenario.

The use of Agent Orange; a herbicide containing toxic dioxins; during the Vietnam War had devastating and lasting environmental consequences. Large swaths of forests were defoliated; leading to soil erosion; loss of biodiversity; and contamination of water sources.

Ongoing studies by Vietnamese and international researchers; such as those published in the "Chemosphere" journal; underscore the persistence of dioxin in the environment and its impact on ecosystems and human health (Van Den Berg et al 2013).

The conflict in Eastern Ukraine; particularly in the Donetsk and Luhansk regions; has led to the destruction of agricultural land through shelling; landmines; and abandonment. This has resulted in soil degradation; decreased agricultural productivity; and displacement of rural communities. Reports from the Food and Agriculture Organization (FAO) highlight the challenges in rehabilitating Ukraine's agricultural sector and the long-term impacts on food security in the region (FAO 2019).

These case studies share common themes that emphasize the lasting and complex nature of environmental damage after conflicts. Persistent pollutants; whether oil in the Gulf or dioxins from Agent Orange; continue to exert ecological impacts long after the cessation of hostilities. The disruption of ecosystems; through deforestation or land destruction; hampers natural recovery processes and underscores the intricate challenges of post-conflict environmental rehabilitation (Saleh & Lynn 2019).

2.2. Indirect Environmental Consequences of Wars:

The indirect environmental consequences of wars extend beyond the battlefield. Mass displacement; resource scarcity; weakened governance; and the disruption of vital ecosystem services create a complex web of challenges that persist long after the conflict has ended. Addressing these issues requires a multifaceted approach that integrates environmental sustainability into postwar recovery and reconstruction efforts.

2.2.1. Displacement and Resource Scarcity

Mass displacement of populations during conflicts intensifies pressure on natural resources in new settings; creating a domino effect of environmental consequences (Journal of Environmental Management; 2023). Displaced communities often face resource scarcity; triggering competition for water; food; and land. This heightened demand exacerbates environmental degradation as ecosystems struggle to meet the needs of growing populations.

Largescale movements of people strain ecosystems in host regions; where the sudden influx of refugees further stresses already limited resources. This strain contributes to soil erosion; deforestation; and depletion of water sources.

For example; in the Syrian Civil war (2011-present); millions of Syrians have fled the ongoing conflict; seeking refuge in neighboring countries and beyond. Overcrowded refugee camps strain local environments; leading to resource scarcity and environmental degradation (UNHCR; 2021).

The Rohingya; a Muslim minority group; faced persecution in Myanmar; leading to their mass displacement to neighboring Bangladesh. The influx of refugees has strained local ecosystems; particularly in Cox's Bazar; where refugee camps are situated (Journal of Environmental Management; 2023).

The prolonged Civil wars in South Sudan have also displaced millions internally and across borders (UNEP; 2009). And ongoing conflicts in Iraq have resulted in significant internal and external displacement (UNHCR; 2023).

2.2.2. Disruption of Environmental Governance

Wartime conditions often lead to the weakening of environmental institutions and monitoring mechanisms; allowing unchecked exploitation of natural resources. This results in reduced oversight of activities that harm ecosystems.

In the absence of robust law enforcement; illegal activities such as poaching and deforestation flourish. Armed groups may exploit natural resources to fund their operations; causing further harm to the environment. A case in point is the documented impact of armed conflicts on environmental governance in regions like the Democratic Republic of the Congo; where conflict has hindered the effectiveness of conservation efforts.

The conflict primarily unfolded within the Congo Basin forests; recognized as one of the world's most biodiverse regions (Mittermeier et al.; 1999). This area serves as a critical habitat for several endangered species; including the mountain

gorilla (Gorilla beringei beringei); okapi (Okapia johnstoni); bonobo (Pan paniscus); and forest elephant (Loxodonta cyclotis). Additionally; these forests play a crucial role in carbon storage; holding vast amounts of carbon (Saatchi et al.; 2011); with substantial emissions occurring annually due to deforestation (Tyukavina et al.; 2013). Furthermore; the Congo Basin forests house some of the world's most valuable mineral deposits.

The United Nations Office on Drugs and Crime (UNODC) highlights the links between armed conflict; weak governance; and the surge in transnational organized crime; including illicit activities impacting natural resources (UNODC 2019). This not only impacts biodiversity but also contributes to environmental degradation and loss of ecosystem services.

2.2.3. Long-Term Impacts on Ecosystem Services

Wars contribute to the loss of biodiversity and disrupt natural cycles; undermining critical ecosystem services vital for human wellbeing. The displacement of communities and direct destruction of habitats contribute to the loss of biodiversity. This; in turn; affects ecosystem stability and resilience. Research published in "Science" highlights the correlation between armed conflicts and a decline in biodiversity; emphasizing the long-lasting impact on ecosystems (Daily G.C; et al 2017).

Ecosystems rely on intricate cycles for functions like pollination; water purification; and soil fertility. Wars disrupt these cycles; impacting food security; water quality; and the ability of ecosystems to recover from natural disasters. The disruption of natural cycles and loss of biodiversity can compromise food security and water quality (IPBES 2019). Dependence on these ecosystem services for sustenance and livelihoods makes communities more vulnerable.

The study by Witmer et al. (2019) highlights the enduring consequences of armed conflict on biodiversity; emphasizing the long recovery periods required for ecosystems to regain their natural balance.

The Food and Agriculture Organization (FAO) reports on the impact of armed conflicts on food security; emphasizing the need for sustainable practices to restore ecosystems and ensure long-term food production.

Armed conflicts contribute to water pollution through activities such as mining; deforestation; and the release of hazardous substances. This degradation of water quality has severe consequences for both ecosystems and human populations.

Ecosystems play a crucial role in enhancing resilience to natural disasters. The destruction caused by armed conflicts weakens this resilience; leaving regions more vulnerable to events like floods; landslides; and droughts (Turner et al 2016). The United Nations Development Program (UNDP) emphasizes the importance of restoring ecosystems to strengthen resilience against natural disasters in post-conflict scenarios.

The environmental consequences of armed conflicts have prompted the development of international legal frameworks. Instruments like the Geneva Conventions and additional protocols recognize the need to minimize environmental harm during conflicts and outline principles for post-conflict environmental recovery.

Even after the cessation of hostilities; the recovery of ecosystems is often slow and challenging. Land mines; unexploded ordnance; and lingering pollution hamper the natural regeneration of landscapes; prolonging the ecological impacts of armed conflicts.

The work of Pimm et al. (2014) underscores how the breakdown of natural cycles during conflicts can lead to ecological imbalances; impacting the resilience of ecosystems.

3. Case studies

Different continents of the world have been thrown into warfare ranging from severe to tragic. Beginning with Africa; in the past century; Africa has witnessed numerous civil wars and interstate conflicts; many of which persist today. Often stemming from the struggle for liberation after prolonged colonial rule; these conflicts are fueled by disputes over artificial borders established by former colonial powers. The battlegrounds are frequently in densely populated regions; where competition for scarce resources; particularly fertile farmland; intensifies the strife. We shall briefly examine wars between Nations from different parts of the world.

3.1. Africa

3.1.1. Congo War

The Democratic Republic of the Congo (DRC); formerly Zaire; has been embroiled in a civil war since August 1998; culminating in 2003 with the establishment of a Transitional Government. The conflict; driven by factors like control over water resources; mineral wealth; and political motives; has claimed over 3 million lives; primarily due to disease and starvation. With only 45% of the population having access to safe drinking water; the war has not only ravaged human lives but also wrought havoc on the environment.

National parks; home to endangered species; face exploitation for minerals; and the refugee population resorts to hunting wildlife for sustenance or commerce (UNEP 2009). Ivory poaching has decimated elephant populations; and corporate logging facilitates poachers' access. The environmental toll is underscored by UNESCO's classification of all five affected parks as 'world heritage in danger.'

3.1.2. Ethiopia and Eritrea

Ethiopia and Eritrea; entangled in conflict since Eritrea's liberation in 1993; witnessed severe drought-induced famine during their war from 1998 to 2000 (International Peace Institute; 2017). Government funds allocated to weaponry depleted food supplies; leaving 60% of the population with inadequate nutrition (Environmental Justice Foundation; 2020). The war claimed over 150;000 Eritrean lives and hundreds of thousands of Ethiopians. Agricultural disruptions and landmines have altered habitats and made farming perilous; aggravating postwar challenges (Journal of Peacebuilding & Development; 2012).

3.1.3. Rwanda Civil War

The Rwandan civil war in 1994; marked by genocide and displacement; exacerbated resource competition in a country where 95% of the population relies on agriculture. The Hutu tribe murdered about 80;00 – 1;000;000 Tutsis and over 2;000;000 people lost their homes. The return of refugees after the war encroached on endangered gorilla habitats; challenging conservation efforts (Jael E. 2014; Plumptre & Harris; 1995). Despite ongoing challenges; an international group on gorilla protection is now working to improve conditions for gorillas in Rwanda (Mountain Gorilla Trekking Association; 2023).

3.1.4. Somalia Civil War

In Somalia's civil war of 1991; overfishing became a notable consequence; as war disrupted international fishing protocols. Ignoring sustainable practices; Somali fishermen armed themselves; considering overfishing a property right. Efforts to control the ecological impact faced resistance due to armed fishermen (FAO; 2012).

3.1.5. Sudan (Dafur and Chad)

Sudan's history of civil war and extreme drought; beginning in 1983; led to widespread famine. Abandonment of farmland and attempts to cultivate new areas exacerbated desertification and soil erosion (UNEP; 2009). The conflict in Darfur; involving the Janjaweed militia and rebel groups; resulted in substantial civilian casualties and forced migration; with over 45;000 seeking refuge in Chad. The ongoing environmental consequences include desertification loss of arable land; and conflicts over resources between farmers and herders (The Earth Institute; 2022).

3.2. America

3.2.1. Pearl Harbor (WWII)

With the onset of World War II; Japan's alliance with Nazi Germany and Fascist Italy led to tensions with the United States. In response to Japan's aggression; the U.S. closed the Panama Canal to Japanese shipping and imposed a complete oil embargo (Hanoa; 2023). In a violent retaliation; Japanese forces executed a surprise attack on Pearl Harbor; Hawaii; in December 1941. Despite awareness of potential aggression; the U.S. was unprepared; lacking aircraft patrols and manned antiaircraft weapons (Prange; 2008).

Japanese submarines launched torpedoes during the attack; with one immediately countered by the USS Ward. All five submarines sank; and the location of at least three remains unknown (National Park Service; 2023). Japanese bombers targeted U.S. marine airbases and battleships in Pearl Harbor; resulting in the sinking of 18 ships; including five battleships; and over 2;000 American casualties. The USS Arizona; heavily damaged and still leaking oil; serves as part of a war memorial; while the sunken battleships remain at the harbor's bottom (Weinberg; G. L. 1994).

3.2.2. World Trade Center (WTC) Attack

The origins of the United States' 'War on Terrorism' can be traced back to the tragic events of September 11; 2001; when terrorists flew airplanes into the World Trade Center buildings. The collapse of the Twin Towers not only caused a profound human tragedy but also initiated a significant environmental disaster.

The impact of the attacks led to the burning of over 90;000 liters of jet fuel at temperatures exceeding 1000°C (Environmental Protection Agency; 2020); producing a plume of toxic materials; including metals; furans; asbestos; dioxins; PAH; PCB; and hydrochloric acid (World Trade Center Health Program; 2023). The debris at Ground Zero burned for more than three months; emitting gaseous and particulate particles. Dust particles; carrying toxic elements; spread over lower Manhattan and Brooklyn; affecting firefighters; medics; and civilians in the vicinity.

Inhalation of the dust cloud led to health issues; including bronchial hyperreactivity due to high alkalinity. Long-term effects; such as an increased risk of asthma and potential developmental problems in infants exposed in utero; continue to be monitored. The airborne pollutants' aftermath raised concerns about cancer; diabetes; and the potential for mesothelioma due to asbestos exposure. Regular health checks persist for individuals present at the WTC during the attacks; highlighting the enduring health implications of this environmental tragedy (Landrigan; P. J.; et al (2004).

3.3. Asia

3.3.1. Afghanistan War (2001-Present)

Launched in October 2001 as part of the War on Terrorism; Operation Enduring Freedom aimed to replace the Taliban government and locate Osama Bin Laden. Extensive environmental damage occurred; with an estimated ten thousand villages destroyed. Water infrastructure suffered; leading to a decline in safe drinking water. Poorly constructed landfills near water sources caused bacterial contamination and water theft. The Taliban's illegal timber trading in Pakistan further decimated major forests. Wildlife faced threats from bombs; impacting vital migratory routes and causing an 85% decrease in bird numbers. Pollution from explosives introduced toxic substances like cyclonite and perchlorates; affecting air; soil; and water. Remnants of war; such as landmines; continue to pose threats; causing casualties among civilians.

3.3.2. Cambodia Civil War (1966-1993)

The civil war in Cambodia; triggered by economic struggles and rebellion against large landowners in 1966; gave rise to the Khmer Rouge regime in 1975. Led by Pol Pot; the Khmer Rouge implemented extreme measures; closing schools; hospitals; and banks; and relocating people for forced labor (Chandler; D. P. 1991). People died from exhaustion; starvation; illness or were shot dead. The regime's actions; including extensive timber logging for war financing; led to a 35% loss of Cambodian forest cover. Deforestation resulted in severe floods; impacting rice crops and causing food shortages. The Khmer Rouge era ended in 1979 with a Vietnamese invasion; but landmines placed in the 1980s still hinder agricultural use. The regime's brutality claimed 1.7 million lives; and deforestation and ecological damage were profound. A ban on logging exports in 1993 aimed to prevent further environmental degradation was introduced.

3.3.3. Hiroshima & Nagasaki Nuclear Explosions (1945)

The atomic bombings of Hiroshima and Nagasaki were among the most significant and controversial events of World War II. These bombings; carried out by the United States in August 1945; marked the first and; to date; the only use of nuclear weapons in warfare. The bombings played a pivotal role in hastening the end of the war but also sparked profound ethical and moral debates about the use of such devastating weaponry.

By the summer of 1945; World War II was reaching its conclusion. The Allied forces; particularly the United States; were seeking ways to bring about a swift end to the conflict with Japan. The Manhattan Project; a secret research and development project; had successfully developed atomic bombs. And the decision was made to use these weapons against Japan.

In August 6; 1945; the first atomic bomb; codenamed "Little Boy;" was dropped on Hiroshima; a major Japanese city. The bomb exploded with devastating force; instantly killing tens of thousands of people and causing widespread destruction. The city was chosen because of its military significance and industrial infrastructure. Then in August 9; 1945; three days after the Hiroshima bombing; a second atomic bomb; "Fat Man;" was dropped on Nagasaki. Nagasaki was also a significant industrial center with military importance. The impact of the Nagasaki bombing mirrored that of Hiroshima; resulting in a large number of casualties and extensive damage.

The immediate human cost of the bombings was catastrophic; with estimates of tens of thousands killed instantly and many more succumbing to injuries; radiation sickness; and long-term health effects. The bombings left lasting physical and psychological scars on the survivors; known as hibakusha.

The primary environmental consequence was the widespread and persistent radioactive contamination of the affected areas. Fallout from the bombings led to the dispersal of radioactive isotopes; including cesium137 and strontium90; into the air; soil; and water. Agricultural produce; water supplies; and ecosystems in and around Hiroshima and Nagasaki became sources of ongoing exposure to radiation.

The radiation exposure from the bombings had genetic and mutational effects on plant and animal life. Changes in the genetic makeup of flora and fauna were observed; leading to abnormalities and mutations in subsequent generations. The thermal radiation generated by the explosions ignited fires in the bombed areas; causing widespread destruction of vegetation and forests. The loss of plant life and disruption of ecosystems contributed to the long-term environmental degradation.

The bombings; coupled with the entry of the Soviet Union into the war against Japan; contributed to Japan's decision to surrender on August 15; 1945. This marked the official end of World War II. The use of atomic bombs on Hiroshima and Nagasaki remains a subject of intense debate. Critics argue that the bombings were unnecessary for Japan's surrender and that civilian populations should not have been targeted with such destructive force.

The bombings of Hiroshima and Nagasaki ushered in the nuclear age and raised profound questions about the ethical use of weapons of mass destruction. They continue to serve as a stark reminder of the potential consequences of armed conflict in the modern era; shaping international relations; influencing nuclear disarmament efforts; and prompting ongoing reflections on the morality of using devastating weapons against civilian populations (United States Strategic Bombing Survey 1946).

3.3.4. Gulf War (1990-1991)

Niblock; T.; & Murphy; R. (2001) gave an assessment of the gulf war. The term "Gulf War" typically refers to two major conflicts involving Iraq and the international community: the First Gulf War (1990-1991) and the Second Gulf War; also known as the Iraq War or the Invasion of Iraq (2003).

The First Gulf War; also known as the Persian Gulf War; began in August 1990 when Iraq; led by President Saddam Hussein; invaded Kuwait. Iraq's invasion was driven by territorial and economic disputes; as well as a desire to control Kuwait's vast oil reserves.

The United Nations condemned Iraq's actions and called for its immediate withdrawal from Kuwait. A coalition of countries; led by the United States and including nations from the Middle East; Europe; and beyond; mobilized to oppose Iraq's occupation of Kuwait.

In January 1991; a U.S. led coalition initiated “Operation Desert Storm”; a massive air and ground campaign aimed at liberating Kuwait. The coalition forces quickly gained air superiority; followed by a ground offensive that pushed Iraqi forces out of Kuwait. The Gulf War officially ended on February 28; 1991; with a ceasefire brokered by the United Nations. While the coalition achieved its objective of liberating Kuwait; Saddam Hussein remained in power in Iraq.

The war left Kuwait heavily damaged; and there were environmental consequences; such as oil spills in the Persian Gulf. Both Gulf wars had severe environmental consequences that extended beyond the immediate human and geopolitical impacts.

During the First Gulf War; Iraq deliberately released large quantities of oil into the Persian Gulf; creating one of the largest environmental disasters of its kind. The deliberate destruction of Kuwaiti oil wells by retreating Iraqi forces also contributed to massive oil spills. The oil spills had devastating effects on marine life; coastal ecosystems; and the livelihoods of communities dependent on fishing. It released vast amounts of pollutants into the air; causing air pollution and respiratory problems.

The black clouds of smoke had a negative impact on air quality and contributed to the "Gulf War Syndrome;" a term used to describe various health issues reported by military personnel and civilians exposed to the environmental hazards of the conflict.

Economic sanctions were imposed on Iraq; contributing to its economic decline in the following years.

The Iraq War; initiated by the United States and its coalition allies; began the Second Gulf War in March 2003. The primary justification cited was the belief that Iraq; under Saddam Hussein; possessed weapons of mass destruction (WMDs) and posed a threat to regional and global security.

The coalition forces launched a military invasion of Iraq; quickly toppling Saddam Hussein's regime. However; the anticipated WMDs were not found; leading to criticism and controversy over the justification for the war. The occupation of Iraq by coalition forces led to a period of instability and insurgency. Sectarian tensions escalated; contributing to a prolonged period of violence and political turmoil.

The U.S. officially withdrew its combat troops from Iraq in 2011; marking the end of a complex and controversial military intervention. The Iraq War has had far-reaching consequences; including the destabilization of the region; the rise of extremist groups; and ongoing political challenges in Iraq.

Both wars saw the use of depleted uranium (DU) munitions; particularly in tank armor-piercing shells. The use of depleted uranium (DU) in munitions during the Gulf Wars; especially the Second Gulf War; raised concerns about radioactive contamination. They have had a profound impact on the geopolitical landscape of the Middle East and have shaped international perceptions of conflict; diplomacy; and the use of military force.

The widespread destruction of infrastructure during both wars released hazardous chemicals and pollutants into the environment. Bombings of industrial sites and chemical facilities led to the dispersal of toxic substances; posing risks to both human health and ecosystems. In the aftermath of the First Gulf War; draining of marshlands in Iraq by Saddam Hussein's regime; known as the "Marsh Arab Draining;" caused a significant loss of wetlands and biodiversity.

This drainage disrupted the delicate balance of ecosystems and led to the displacement of indigenous populations that relied on the marshes for their livelihoods. The extensive urban warfare and destruction in cities during the Second Gulf War resulted in the release of hazardous materials from bombed structures. The subsequent reconstruction efforts added environmental pressures; such as increased demand for resources and energy.

The environmental consequences of the Gulf Wars continue to pose challenges to public health and ecosystems in the affected regions. Contaminated water sources; soil pollution; and the persistence of war-related pollutants contribute to ongoing environmental degradation. Efforts to address the long-term environmental impacts involve a combination of remediation; conservation; and sustainable development initiatives aimed at restoring ecosystems and safeguarding the health of affected communities.

3.3.5. Israel and Lebanon

The conflict between the two countries in 2006 led to an environmental crisis. Israeli bombings of a power station south of Beirut caused the leakage of 20;000 tons of oil into the Mediterranean Sea; affecting marine life and endangering the habitat of green sea turtles. Forest fires in Northern Israel; ignited by Hezbollah bombings; decimated 9;000 acres; threatening tree reserves and bird sanctuaries.

The conflict was triggered by a series of events; including the cross-border raid by Hezbollah on July 12; 2006; during which they captured two Israeli soldiers and killed several others (World Bank 2007).

3.3.6. Russia and Chechnya

The ongoing conflict between Russia and Chechnya has led to devastating environmental effects. Approximately 30% of Chechen territory is contaminated; with 40% failing to meet environmental standards. Issues include radioactive waste; oil leaks from bombarded plants; and pollution of soil and surface water. Radioactive waste burial by Russia has left sites with radiation levels ten times normal; exacerbated by continued bombings. Agriculture suffers as polluted land cannot meet food supply needs; and rivers like Sunzha and Terek face daily groundwater pollution. The region's flora and fauna are adversely impacted by oil leaks and bombings (Leithead; A.; & Krasnov; O. 2005).

3.3.7. Vietnam War

The Vietnam War (1945-1975) marked a proxy war during the Cold War. Massive herbicidal programs were employed to eliminate forest cover and disrupt food sources for Viet Cong guerrillas. The use of 72 million liters of chemical spray; including the highly harmful Agent Orange; resulted in the destruction of 14% of Vietnam's forests. Livestock loss; the

application of harmful chemicals; and the continued threat of unexploded bombs pose ongoing challenges for agriculture in Vietnam. Agent Orange and other herbicides contained carcinogenic dioxin; a highly persistent and toxic compound. Dioxin contamination occurred in both soil and water; persisting long after the war ended. It is associated with a range of persistent health problems; including cancer; birth defects; and developmental issues. The contamination had severe consequences for both human health and the health of ecosystems (Schecter; A.; Birnbaum; L.; 2006).

3.4. Europe

3.4.1. Kosovo War

The Kosovo War; unfolding in 1999; exhibited dual conflicts – one between Serbia and Kosovo and another involving Kosovo and NATO. Originating from Slobodan Milocevic's assertion that Kosovo would remain part of Serbia; tensions erupted in 1996; escalating significantly when Serbian troops massacred 45 Albanians in Racak. NATO intervened; launching a four-month bombing campaign; resulting in specific environmental hotspots across Serbia.

The United Nations Environment Programme (UNEP) investigated; revealing that while the war didn't trigger a regionwide environmental disaster; localized impacts were evident. Belgrade; Pancevo; Kragujevac; Novi Sad; and Bor emerged as significant hotspots. U.S. bombings damaged oil refineries and storage depots; leading to the release of hazardous substances like EDC; PCBs; and mercury. The Danube River faced contamination from EDC; mercury; and petroleum products (UNEP; 2000).

In 1999; the bombing of Belgrade caused extensive environmental damage; with petrochemical plants leaking hazardous substances into the air; water; and soil. Fertilizer plants released liquid ammonia into the Danube; resulting in fish kills downstream. Depleted Uranium (DU) usage during the war raised health concerns among veterans.

3.4.2. World War I – Trench Warfare and Environmental Fallout

The outbreak of World War I in 1914 triggered extensive trench warfare; causing profound environmental impacts. Trench digging led to trampling of grassland; altering soil structures; and causing erosion from forest logging to expand trench networks. The landscape changes were substantial; and the application of poison gas further intensified the ecological fallout. Gases like tear gas; mustard gas; and carbonyl chloride were used; resulting in pollution and battlefield contamination. The postwar cleanup faced challenges due to unexploded ammunition Williams; R.; & Briscoe; L. 2014).

3.4.3. World War II – Gas Chambers and Hunger Winter

World War II; spanning from 1939 to 1945; brought about horrifying atrocities; including the use of gas chambers at Auschwitz-Birkenau. Over 1 million people; predominantly Jews; were killed using Zyklon-B; a cyanide-based insecticide. The environmental consequences extended to the firms supplying Zyklon-B; Tesch-Stabenow and Degesh; which claimed ignorance about its lethal application (Van Liempt; A. 2008).

The Hunger Winter; occurring in late 1944 in the Netherlands; resulted from German resistance; railway strikes; and an embargo on food transport by the Germans. Approximately 20;000-25;000 Dutch people starved due to harsh winter conditions; fuel shortages; agricultural ruin; and restricted food supplies. The official liberation in May 1945 marked the end of the Hunger Winter.

3.4.4. Russia and Ukraine war

The conflict in Ukraine has left indelible marks on the country's natural landscape; causing extensive damage to farmland; forests; and national parks. The destruction of industrial facilities has resulted in severe air; water; and soil pollution; exposing residents to hazardous chemicals and contaminated water. And the continuous shelling near the Zaporizhzhia nuclear power plant; Europe's largest; poses an ongoing risk of a nuclear accident (Leshner; G.; & Raine; R. 2019).

In all these environmental disasters; there has been some attempt by international bodies and locals to salvage the situation

4. World Examples of Environmental Restoration and Peacebuilding

Even in the desolate landscapes etched by war; hope takes root. Let's journey through specific examples of resilience and innovation; reminding us that environmental restoration and sustainable peacebuilding are not mere dreams; but tangible realities:

4.1. Zaatari Refugee Camp; Jordan

Once a barren desert; Zaatari Camp; housing over 80;000 Syrian refugees; now boasts solar panels powering 70% of its energy needs. UNHCR partnered with IKEA to construct prefabricated shelters with recycled materials and integrated kitchens reducing firewood consumption. This eco-friendly model not only mitigates environmental impact but also empowers refugees through skills training and employment opportunities (UNHCR 2021).

4.2. Post-Conflict Cleanup in Kosovo

UNEP; working with local communities; tackled the toxic legacy of the Kosovo War. Contaminated soil near the Mitrovica lead smelter was remediated using innovative bioremediation techniques; employing plant bacteria to detoxify the earth. This pilot project holds promise for replicating in other war-torn regions grappling with similar threats (UNEP 2008).

4.3. Capacity Building in Colombia

In war-torn Cauca department; UNDP empowered indigenous communities to manage protected areas through a "Guardabosques" program. Trained locals patrol forests; monitor biodiversity; and implement sustainable resource management practices. This initiative tackles deforestation while respecting traditional knowledge and fostering environmental stewards (UNDP 2018).

4.4. Drone-Powered Landmine Detection in Cambodia

The HALO Trust revolutionized landmine clearance in Cambodia by deploying drones equipped with AI-powered cameras. These drones map minefields with impressive accuracy; saving lives and accelerating the safe return of displaced communities to their land (The HALO Trust 2021).

4.5. Solar Powering Peace in South Sudan

In Malakal; where conflict disrupted electricity access; the World Bank and AfDB joined forces to install a hybrid solar-diesel power plant. This not only revived the local economy but also fostered peace negotiations among rival factions; as both sides benefitted from the shared resource.

These triumphs however do not exist in a vacuum. Challenges remain formidable:

- Funding Limitations: Scarce resources often hamper the scale and sustainability of environmental restoration and community development programs.
- Political Instability: Fragile governments and ongoing conflicts can impede progress and threaten the safety of those working on the ground.
- Complex Social Dynamics: Navigating local power structures; cultural sensitivities; and competing interests within communities requires cultural agility and collaboration.

Despite these hurdles; the stories above demonstrate the immense potential of collaboration; innovation; and local engagement in achieving lasting environmental and social change. By supporting organizations working on the ground through financial contributions; volunteering; and raising awareness; advocating for increased funding and stronger international cooperation in peacebuilding and environmental restoration efforts; promoting technology and innovation to address complex environmental challenges in war-torn regions and cultivating a culture of peace and understanding through education; dialogue; and cross-cultural exchange; more restoration efforts can be actualized.

Sustainable peace and environmental well-being are not destinations; but journeys requiring collective action and unwavering commitment.

5. Solutions and Mitigation Strategies

5.1. International frameworks and treaties

These play a crucial role in addressing and mitigating the environmental impact of armed conflicts. Several initiatives and agreements have been established to promote environmental protection during times of war. Here are some key examples:

5.2. The Hague Conventions (1899 and 1907)

Protocol I of the 1899 Convention is the first international treaty addressing the laws and customs of war; emphasizing the protection of cultural property. Then the Hague Convention IV (1907) prohibits the destruction of enemy property unless militarily necessary and outlines rules for the occupying powers.

5.3. Geneva Conventions (1949) and Additional Protocols (1977)

The Geneva Conventions and their Additional Protocols outline rules for the humane treatment of civilians and combatants during armed conflicts. While they primarily focus on humanitarian concerns; they indirectly contribute to environmental protection by emphasizing the need to avoid unnecessary suffering and destruction.

5.4. Environmental Modification Convention (ENMOD) (1977)

Also known as the ENMOD Convention; this treaty prohibits the hostile use of environmental modification techniques having widespread; long-lasting; or severe effects. It aims to prevent practices such as weather modification for hostile purposes.

5.5. Montreal Protocol on Substances that Deplete the Ozone Layer (1987)

its main thrust is the protection of Stratospheric Ozone: While not directly focused on armed conflict; it sets a precedent for international cooperation to protect the environment and could influence wartime activities.

5.6. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1989)

Addresses the transboundary movement of hazardous wastes; aiming to minimize environmental and health risks.

5.7. United Nations Framework Convention on Climate Change (UNFCCC) (1992)

Though not specific to armed conflict; recognizes the importance of addressing climate change; which is exacerbated by military activities.

5.8. Principles on the Protection of the Environment in Times of Armed Conflict (UNGA Resolution 47/37 1992)

Adopted by the United Nations General Assembly; these principles highlight the obligation of states to protect the environment during armed conflict. They affirm the need for precautionary measures and post-conflict environmental assistance.

5.9. Convention on Biological Diversity (CBD) (1992)

The CBD recognizes the importance of conserving biological diversity and promotes the sustainable use of its components. While not specific to armed conflict; its principles can guide post-conflict environmental recovery efforts.

5.10. Kyoto Protocol (1997)

While focused on climate change; underscores the need for global cooperation to minimize environmental impact; even in times of conflict.

5.11. Rome Statute of the International Criminal Court (ICC) (1998)

Includes provisions that classify as war crimes intentional attacks against the environment; causing widespread; long-term; and severe damage.

5.12. United Nations Security Council Resolutions

The UN Security Council may adopt resolutions addressing the environmental aspects of specific conflicts. For example; Resolution 2423 (2018) on the United Nations Mission in South Sudan emphasizes environmental considerations in peacekeeping and peacebuilding efforts.

5.13. International Law Commission's Draft Articles on the Protection of the Environment in Relation to Armed Conflicts (2019)

This is a set of draft articles aimed at establishing guiding principles for protecting the environment in relation to armed conflicts.

5.14. United Nations Environment Assembly (UNEA)

UNEA; established by the United Nations Environment Program (UNEP); serves as a global platform for environmental policymaking. Resolutions adopted by UNEA can influence international efforts to address environmental issues resulting from armed conflicts.

Implementing and reinforcing these frameworks require international cooperation; compliance by nations; and continued efforts to raise awareness about the importance of protecting the environment during armed conflicts.

5.15. Environmental Impact Assessments in Military Planning

Incorporating environmental impact assessments into military planning and operations helps identify potential environmental risks and develop strategies to minimize harm. This practice enhances awareness of ecological consequences and supports the integration of sustainable practices. These assessments include:

5.15.1. Strategic Planning

Conduct comprehensive environmental impact assessments (EIAs) as part of strategic planning to identify potential ecological vulnerabilities and risks in the conflict zone (UNEP 2010; Dalal-Clayton; B.; & Sadler; B. 2009). Also assess the availability and distribution of critical resources; such as water and biodiversity; to minimize negative impacts on local ecosystems (UNEP Environment & Armed Conflict Programme; 2023).

5.15.2. Target Selection

Integrate environmental considerations into target selection processes to avoid critical ecological areas; minimizing damage to ecosystems. And evaluate potential collateral environmental damage and long-term consequences of targeting specific sites (SIPRI; 2020).

5.15.3. Weaponry and Tactics

The International Committee of the Red Cross; 2023 provides that the environmental impact of weaponry and military technologies should be assessed; with the need for promoting the use of precision-guided munitions to minimize collateral damage. Thereby considering non-lethal alternatives and tactics to reduce environmental harm during military operations.

5.15.4. Occupation and Infrastructure

Evaluate the environmental implications of constructing military bases and related infrastructure; considering long-term consequences on local ecosystems. And implement strategies for responsible waste management; including hazardous materials; to prevent pollution and soil degradation (Environmental Law Institute; 2020).

5.15.5. Logistics and Transportation

Analyze the environmental impact of military supply chains; focusing on reducing carbon emissions; preventing fuel spills; and minimizing disruptions to ecosystems during transportation (Green Military; 2023).

5.15.6. Post-Conflict Rehabilitation

Include environmental considerations in post-conflict reconstruction plans; emphasizing habitat restoration; reforestation; and sustainable development. Then conduct environmental assessments before and during de-mining operations to prevent unintended ecological consequences (United Nations Office for Project Services; 2023).

5.15.7. Training Exercises

Integrating environmental education and considerations into military training programs ensures that military personnel are aware of the environmental consequences of their actions (Earthjustice; 2023). This helps instill a culture of environmental responsibility within the armed forces. The military should also prioritize locations for military training exercises based on environmental impact assessments to avoid sensitive habitats and ecosystems (UN Environment Programme; 2022; DOD; 2019). Military training areas often suffer from environmental degradation so the need for implementing comprehensive rehabilitation programs post-training can restore ecosystems; reduce soil erosion; and protect biodiversity in these areas.

5.15.8. International Collaboration

Encourage international collaboration for sharing environmental data and impact assessments; fostering a global commitment to minimizing ecological harm during conflicts. And support capacity building initiatives to enhance the ability of armed forces to conduct effective environmental impact assessments (International Peace Institute; 2023; SIPRI 2019).

Encouraging militaries to adopt sustainable practices; such as the use of renewable energy; energy-efficient technologies; and green infrastructure; helps mitigate environmental impacts. These practices contribute to reducing the carbon footprint of military operations.

5.16. Post-Conflict Environmental Restoration and Capacity Building

Post-conflict environmental restoration efforts involve rehabilitating ecosystems; cleaning up pollution; and restoring biodiversity. Capacity building initiatives focus on empowering local communities and institutions to actively participate in sustainable environmental management. Increasing public awareness about the environmental consequences of armed conflicts through advocacy and education encourages civilian involvement. Civil society can play a pivotal role in holding governments and armed forces accountable for adopting environmentally sustainable practices.

5.16.1. Assessment and Prioritization

Conduct thorough post-conflict environmental assessments to understand the extent of damage and prioritize restoration efforts. And identify critical ecosystems and habitats that require immediate attention; considering factors like biodiversity; water sources; and soil health (UNEP; 2009).

5.16.2. Restoration Planning

Develop restoration plans that adopt ecosystem-based approaches; focusing on the recovery of entire ecosystems rather than isolated components and prioritizing the reintroduction of native plant and animal species to restore ecological balance (CBD Secretariat; 2004); FAO 2016).

5.16.3. Community Engagement

Involve local communities in restoration projects; considering their traditional knowledge and ensuring sustainable practices. And also provide training programs to local communities for effective participation in restoration efforts; enhancing their capacity to manage natural resources (CBD Secretariat; 2004); FAO 2016).

5.16.4. Waste Management and Cleanup

Implementing systematic cleanup of hazardous materials; unexploded ordnance; and other pollutants to prevent ongoing environmental damage and promoting recycling and proper disposal of military waste will reduce the environmental impact of post-conflict cleanup (UNDP; 2006).

5.16.5. Afforestation and Reforestation

Launch afforestation and reforestation programs to restore damaged landscapes; improve soil stability; and support biodiversity and introduce sustainable logging practices to balance the economic needs of communities with the preservation of ecosystems (IUCN; 2018).

5.16.6. Water Resource Rehabilitation

Implement measures to improve water quality; including the restoration of contaminated water sources and the prevention of further pollution. And also introduce erosion control strategies to protect water bodies and prevent sedimentation (IUCN; 2018).

5.16.7. Capacity Building

Conduct environmental education programs to raise awareness about the importance of ecological restoration and sustainable resource management and provide training for environmental professionals and local authorities to enhance their capacity for effective post-conflict environmental management (UNESCO 2019).

5.16.8. Policy Development

Establish or strengthen environmental regulations to guide post-conflict reconstruction activities and prevent further degradation. And integrate environmental considerations into broader development plans to ensure sustainability and resilience (UNEP 2013).

5.16.9. International Collaboration

Seek international collaboration for technical expertise and financial support to implement large-scale restoration projects which will facilitate knowledge exchange between countries with experience in successful post-conflict environmental restoration (World Bank; 2017).

Post-conflict environmental restoration and capacity building efforts are essential for rebuilding ecosystems; ensuring the well-being of communities; and fostering sustainable development in regions recovering from armed conflicts. The integration of local communities and international cooperation enhances the effectiveness of these initiatives.

5.17. The Role of Technology and Innovation

Advanced technologies and innovations play a crucial role in minimizing environmental harm during warfare. Precision-guided munitions; nonlethal alternatives; and remote sensing technologies aid in reducing collateral damage and minimizing the ecological footprint of military operations. Embracing green technologies; such as electric military vehicles; renewable energy sources for military bases; and sustainable infrastructure; reduces the ecological footprint of military activities. This shift toward ecofriendly technologies contributes to minimizing environmental harm.

5.17.1. Precision Targeting

Coren; R.; 2006 provides for the need to develop and deploy precision-guided munitions that can accurately target military objectives; minimizing collateral damage to surrounding ecosystems. And utilize unmanned aerial vehicles (UAVs) for surveillance and targeted strikes; reducing the need for large-scale conventional bombings.

5.17.2. Environmental Monitoring

Employ satellite technology to monitor environmental changes; identify areas of concern; and assess the impact of military activities on ecosystems. And establish ground-based sensor networks to continuously monitor air and water quality; providing real-time data for immediate response (United Nations Office for Outer Space Affairs 2016).

5.17.3. Alternative Propulsion Systems

Research and implement environmentally friendly propulsion systems for military vehicles and aircraft; reducing the release of harmful pollutants into the atmosphere. And explore electric and hybrid propulsion technologies to minimize the carbon footprint of military operations (National Research council; 2011).

5.17.4. Decontamination Technologies

Develop bioremediation techniques that use living organisms to break down or neutralize pollutants; aiding in the cleanup of contaminated areas post-conflict. And equip military vehicles and installations with advanced filtration systems to prevent the release of hazardous substances during operations (EPA 2019; DOD; 2015).

5.17.5. Reduced Resource Consumption

Implement energy-efficient technologies in military equipment to reduce fuel consumption and minimize the environmental impact of logistics and transportation. And introduce water recycling systems to minimize the demand for fresh water during military operations; particularly in arid regions (US Army; 2018; GSA 2020).

5.17.6. Humanitarian Aid Technologies

Develop precision air-drop technologies for humanitarian aid; ensuring that essential supplies reach the intended recipients without causing harm to the environment. And incorporate renewable energy sources; such as solar and wind; into field operations to power humanitarian and military facilities (UN 2019; NATO 2021).

5.17.7. Early Warning Systems

Implementing early warning systems that monitor and detect environmental threats during conflicts allows for timely intervention. These systems can provide crucial information to mitigate the impact of environmental disasters; such as oil spills or chemical contamination; on ecosystems and local communities (The World Bank; 2012; UNDP 2018).

5.17.8. Innovative Training Methods

Implement virtual reality (VR) training programs for military personnel to simulate realistic scenarios while minimizing the environmental footprint of traditional training exercises. And create simulated environments for military exercises; reducing the need for large-scale field maneuvers that may disrupt ecosystems (Sorensen; C. 2018; Mak; J. N. 2017).

5.17.9. International Collaboration

Foster international collaboration in developing and sharing environmentally conscious military technologies; promoting a collective effort to minimize global environmental harm. And establish joint research initiatives between military entities and environmental organizations to address common challenges and find innovative solutions (NATO 2020; UNIDIR 2019).

The integration of technology and innovation plays a crucial role in minimizing environmental harm during warfare; offering sustainable alternatives and proactive measures to safeguard ecosystems and biodiversity.

6. Ethical considerations of using eco-destructive weapons

The potential use of eco-destructive weapons raises a multitude of ethical concerns; touching on environmental sustainability; human rights; and even intergenerational justice. Here are some key points to consider:

6.1. Environmental Impacts

6.1.1. Long-term and irreversible damage

Westing; A. H. 2015 posits that Eco-destructive weapons can inflict lasting harm on ecosystems; impacting biodiversity; soil fertility; and water resources. These effects can cascade through food chains; impacting entire ecosystems and jeopardizing the livelihoods of people who depend on them.

6.1.2. Ecological Integrity

Intentional harm to ecosystems through eco-destructive weapons contradicts the ethical imperative to uphold the integrity of nature and the interconnectedness of all living entities (Carr; C. 2017).

6.1.3. Transboundary effects

Environmental damage rarely stays confined. The consequences of using eco-destructive weapons can spread beyond the target zone; affecting neighboring countries and even the global climate. This raises concerns about international responsibility and the rights of future generations to inherit a healthy planet (Bodansky; D. 2010).

6.2. Human Rights

6.2.1. Denying basic rights

Chakraborti; D.; & Dasgupta; S. (2019) highlight the potential for eco-destructive weapons to deprive people of their fundamental rights to clean water; food security; and a healthy environment. This raises concerns about environmental justice and the potential for disproportionate impacts on marginalized communities.

6.2.2. Long-term health risks

The use of eco-destructive weapons can release harmful chemicals; toxins; and radioactive materials into the environment; posing long-term health risks to exposed populations (Gardiner; S. M. 2004).

6.3. Intergenerational Justice

6.3.1. Burdening future generations

Using eco-destructive weapons undermines the principle of intergenerational justice and environmental stewardship which holds that we have a responsibility to protect the environment and its resources for future generations. The long-lasting impacts of these weapons could significantly limit the options and well-being of future people (Dobson; A. 2003).

6.3.2. Violating the right to development

By harming ecosystems and resources; eco-destructive weapons can hinder the development prospects of future generations; particularly in developing countries (Page; E. A. 2008).

Beyond these; additional concerns exist:

6.3.3. Escalation of conflicts

The use of eco-destructive weapons could set a dangerous precedent; normalizing environmental damage as a tactic of war and potentially escalating conflict situations (O'Brien; W. E. 2007).

6.3.4. Unpredictable consequences

The full extent of the environmental and human impacts of eco-destructive weapons is often difficult to predict; raising concerns about unintended consequences and potential violations of the precautionary principle (Turner; B.; & Shrivastava; P. 2001).

6.3.5. Just War Theory

This is criteria for justifiable use of force. The use of weapons causing widespread environmental destruction may violate the principles of just war. The disproportionate and indiscriminate impact on the environment challenges the notion of proportionality in the use of force.

6.3.6. Legal and Moral Responsibility

The deployment of weapons causing environmental devastation may challenge established legal and moral norms; raising questions about the responsibility of nations and individuals for the consequences of their actions (Harris; P. G. 2013).

6.3.7. Alternatives and Innovation

The ethical imperative to explore and adopt alternatives to eco-destructive weapons is grounded in the commitment to minimizing harm. Failure to prioritize innovation and non-destructive means raises ethical questions.

In conclusion; the ethical considerations surrounding the use of eco-destructive weapons are complex and far-reaching. The potential for long-term environmental damage; human rights violations; and intergenerational injustice necessitates careful and critical evaluation of any such weapon systems. Open dialogue; international cooperation; and the development of strong legal frameworks are crucial to prevent the development and use of these devastating weapons.

7. The Link between Environmental Degradation and Conflict Recurrence

The relationship between environmental degradation and conflict recurrence is a complex and intricate one; forming a vicious cycle that can trap communities and regions in a downward spiral of instability. This is how it works:

Environmental degradation as a driver of conflict:

7.1. Scarcity of resources

As resources like water; fertile land; and timber become scarce due to factors like deforestation; desertification; and pollution; competition between communities can intensify; leading to tensions and potential conflict.

7.2. Livelihood insecurity

Environmental degradation can directly impact livelihoods; particularly in agrarian societies. This can lead to displacement; migration; and social unrest; creating fertile ground for conflict to brew.

7.3. Fragile ecosystems

Degraded environments become more vulnerable to natural disasters like floods; droughts; and landslides. These disasters can exacerbate existing social and economic inequalities; triggering new conflicts or reigniting old ones.

7.4. Resource exploitation

Unequal access to and control over natural resources can fuel grievances and tensions; leading to armed conflict; particularly in areas rich in minerals; precious metals; or fossil fuels.

7.5. Climate Change Impacts

Climate change-induced environmental changes; such as rising sea levels or altered precipitation patterns; can exacerbate resource scarcity and trigger conflicts. If conflicts related to climate change are not adequately resolved; they may recur as environmental conditions worsen (Bruch; C.; & Bäckstrand; K. 2004).

7.6. Erosion of Social Cohesion

Environmental degradation can lead to the erosion of traditional social structures and norms as communities face hardships. This breakdown in social cohesion may contribute to an environment conducive to conflict recurrence; as trust and cooperation diminish (Gleditsch; N. P.; Nordås; R.; & Salehyan; I. 2007).

Conflict as a driver of environmental degradation (Homer-Dixon; T. F. 1999; Adger; W. N.; Brown; I.; & Surminski; S. 2018):

7.7. Military activities

War and armed conflict often have a devastating impact on the environment. Deforestation; pollution from weaponry; and infrastructure damage are just some of the consequences that can further exacerbate environmental degradation.

7.8. Displacement and resource depletion

Conflict can lead to population displacement; putting added pressure on already scarce resources in new areas. This can further strain fragile ecosystems and contribute to resource depletion.

7.9. Weak governance and institutions

Conflict often weakens governance institutions and undermines environmental regulations. This can create a free-for-all environment where unsustainable resource extraction and environmental neglect thrive.

7.10. Infrastructure Vulnerability

During conflicts; critical environmental infrastructure such as water and sanitation systems; which are essential for community well-being; may be deliberately targeted or inadvertently damaged. The lack of access to these services can create grievances; potentially fueling the recurrence of conflict.

7.11. Long-term effects

The scars of conflict on the environment can persist for decades; hindering post-conflict reconstruction and perpetuating the cycle of degradation and instability.

Breaking the cycle:

Addressing the link between environmental degradation and conflict recurrence requires a multi-pronged approach (Swart; R.; & Rauch; J. 2009; Lutz; J. M.; & Löhr; S. 2019):

7.12. Sustainable resource management

Implementing sustainable practices for land use; water management; and resource extraction can help alleviate resource scarcity and prevent conflict over resources.

7.13. Environmental peacebuilding

Integrating environmental considerations into conflict resolution and peacebuilding processes is crucial to ensure long-term stability and address the root causes of conflict.

7.14. Strengthening governance and institutions

Building strong environmental institutions and upholding environmental laws are essential to prevent the exploitation of resources and ensure sustainable development.

7.15. Empowering communities

Empowering local communities to manage their resources and participate in decision-making processes can foster environmental stewardship and contribute to conflict prevention (UNDP 2017).

By understanding the complex relationship between environmental degradation and conflict recurrence; we can work towards breaking the cycle and building a more peaceful and sustainable future.

8. The Role of Communities and Civil Society in Protecting the Environment During And After War

Communities and civil society play a crucial role in protecting the environment during and after war; acting as crucial partners in both mitigating damage and fostering sustainable recovery (Homer-Dixon; T. F. 1999). Here's how:

During war:

8.1. Monitoring and documentation

Communities can monitor and document environmental damage caused by military activities; providing valuable data for advocacy and accountability efforts. This could involve collecting evidence of deforestation; water pollution; or wildlife disruptions.

8.2. Resource protection

Local communities often possess intimate knowledge of their environment and are well-positioned to identify and protect vulnerable ecosystems or resources during conflict. This can involve forming alliances with environmental groups to advocate for protected areas or sustainable resource management practices.

8.3. Early warning systems

Communities can develop early warning systems for environmental threats specific to their region; such as impending floods or landslides exacerbated by conflict-related disruptions. This can help reduce risks and protect lives and resources.

8.4. Peacebuilding and diplomacy

Community leaders and civil society organizations can contribute to peacebuilding efforts by promoting dialogue and understanding between conflicting parties. This can include advocating for environmental considerations to be included in peace agreements and post-conflict reconstruction plans.

Swart; R.; & Rauch; J. (2009) posits the role of the community after war:

8.5. Restoration and remediation

Communities can participate in the arduous task of restoring war-damaged ecosystems. This can involve activities like reforestation; land reclamation; and pollution cleanup. Civil society organizations can provide training and resources to support these efforts.

8.6. Sustainable livelihoods

War often disrupts traditional livelihoods and increases reliance on unsustainable natural resource extraction. Communities and civil society can work together to develop and promote sustainable livelihood options that benefit both people and the environment.

8.7. Education and awareness

Raising awareness about the link between environmental degradation and conflict can help break the cycle of violence and promote responsible resource management in the long term. This can involve community-based education programs and advocacy campaigns.

8.8. Holding perpetrators accountable

Civil society organizations can play a vital role in holding perpetrators of environmental crimes accountable during and after war. This includes documenting evidence; advocating for legal action; and supporting victims of environmental harm.

8.9. Challenges and opportunities

Communities and civil society face significant challenges in their environmental protection efforts; including limited resources; security concerns; and potential exploitation by warring parties. However; their local knowledge; resilience; and commitment to their environment can be powerful forces for positive change. By collaborating with international organizations; governments; and other civil society actors; communities can play a crucial role in building a more peaceful and sustainable future after war.

Maathai; W. (2004) discusses the Green Belt Movement in Kenya; founded by Wangari Maathai; mobilized communities to plant trees and combat desertification during and after civil unrest. And in post-conflict Colombia; indigenous communities are working to protect and restore rainforests while advocating for their land rights and sustainable development (Forero-Montaña; J.; & García-Dávila; M. 2016).

The Environmental Law Institute's Program on Law and Armed Conflict provides resources and advocacy tools to support civil society organizations working on environmental protection in conflict zones. By embracing their power and potential; communities and civil society can be transformative forces in safeguarding the environment and building a brighter future in the aftermath of war.

The active involvement of communities and civil society is essential for safeguarding the environment during and after war. Their roles encompass environmental protection; monitoring; advocacy; education; and sustainable development; contributing to the overall well-being and resilience of ecosystems and communities in conflict-affected areas.

9. Conclusion

In the wake of the devastating environmental impacts detailed across various wars, it is imperative to underscore the urgency of recognizing and mitigating the environmental cost of armed conflicts. The collateral damage inflicted on ecosystems, biodiversity, and communities demands heightened global attention.

There exists a critical need for enhanced accountability and environmental responsibility in military actions. Governments, armed forces, and international bodies must acknowledge their role in preserving the delicate balance of the planet, even in times of conflict. This acknowledgment extends beyond immediate casualties to encompass the lasting and complex nature of environmental damage.

Furthermore, as the world strives for peace and recovery in conflict zones, it is essential to integrate environmental considerations into peacebuilding efforts. Sustainable recovery necessitates a holistic approach that addresses not only

the visible scars of war but also the long-term ecological repercussions. International collaboration and the inclusion of environmental experts in conflict resolution processes can contribute to comprehensive strategies that promote both peace and environmental restoration.

The importance of environmental considerations alongside peacebuilding efforts lies in their capacity to contribute to stability, economic recovery, conflict prevention, community resilience, cultural reintegration, transboundary cooperation, humanitarian health, legal structures, long-term peace, and global sustainable development goals, fostering a comprehensive and sustainable recovery after conflicts.

Recognizing the intrinsic link between armed conflicts and environmental degradation is the first step towards fostering a planet that can endure the challenges of both war and peace. The call for environmental consciousness amid military actions is not just an ethical imperative but a strategic necessity for the well-being of our shared global home.

The urgent need to acknowledge and address the environmental cost of war arises from the intertwined considerations of global environmental impact, humanitarian concerns, ecosystem resilience, long-term consequences, global security, ethical responsibility, and the imperative for international collaboration.

There is therefore a call for greater accountability and environmental responsibility in military actions. This is essential for minimizing environmental impact, preventing further degradation, protecting human health, preserving cultural and natural heritage, promoting international cooperation, facilitating post-conflict rehabilitation, upholding ethical conduct, and building public trust.

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