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YEMEN'S ENVIRONMENTAL CRISIS: THE FORGOTTEN FALLOUT OF AN ENDURING CONFLICT

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About the author

Sahar Mohammed is a Yemeni Researcher. She has a degree in physics and started writing with a particular focus on the environment in 2018, publishing with many local and regional platforms. She was selected for the MENA environmental journalism fellowship with Climate Tracker in 2019. Her media piece on women and water won the MENA Blue Peace Open Eye Award from KAS & Cewas organizations in 2020. Sahar was awarded ICFJ's Global Nutrition and Food Security Reporting fellowship and UN LDC5 journalism fellowship in 2022. She was also awarded a Candid Journalism Grant and two grants from ICFJ. Besides writing, Sahar is working on managing media projects as a project assistant with Intenews Yemen.

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Photo cover: Yemeni man, taking long roads for clean water, fills water drums in Abbas district of Hajjah, Yemen on March 2022. © Mohammed Al Wafi - Anadolu Agency

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Introduction

The devastating impact of an eight-year-long war in Yemen has resulted in [one of the most severe humanitarian crises](#) witnessed in the 21st century. This conflict has not only ravaged a country already plagued by poverty but has also brought about the obliteration of two decades' worth of development progress. Prior to the intensification of the conflict in March 2015, Yemen ranked 153rd out of 189 countries on the development index. However, with the prolonged conflict, development indicators have plummeted, sinking to 183rd place by 2020. As the armed conflict opposing the Saudi-led Arab coalition and the Houthis continues to escalate, its repercussions have spread across various regions, inflicting severe damage upon all sectors throughout Yemen.

The capital, Sana'a, and Saada have emerged as the epicenters of the crisis, with Taiz, Aden, and Al Hudaydah following closely behind. The extent of the devastation is staggering, with approximately [40%](#) of residential units either partially or completely destroyed. Statistics reveal that over a third of educational facilities have been reduced to ruins, while 40% of the water and sanitation sector infrastructure has been damaged. Furthermore, the health sector has sustained damage to a substantial [39%](#) of its infrastructure. The escalation of the armed conflict has also led to the internal displacement of nearly 3.65 million people, profoundly impacting their lives and the environment. This dire situation has resulted in an alarming depletion of trees, as they are excessively logged for fuel and cooking. Additionally, limited resources such as sources of water have become subject to intense competition.

The conflict has had a profound impact on the economic landscape, with GDP plummeting to less than 5%. This downturn has directly affected the standard of living, resulting in a staggering 20 million out of 30 million Yemenis experiencing food insecurity. The consequences are further manifested in the deterioration of essential services, particularly in the healthcare sector. The economic fragility and scarcity of food have had a devastating toll, accounting for an astounding 60% of the total number of casualties, which had reached 377,000 by the end of 2021. If the war persists, it is anticipated that the percentage of individuals, especially children, who will die due to indirect causes linked to the conflict will rise to 70% of total casualties by 2030.

Lastly, it is important to highlight the severe environmental degradation that Yemen is grappling with, particularly concerning water scarcity and the deterioration of mountain terraces. These terraces have served as a crucial farming

method for the mountainous lands of Yemen for countless generations, supporting the food production upon which much of the Yemeni population relies. Additionally, the area affected by desertification has expanded due to prolonged drought, exacerbated by the increasing emission of greenhouse gases resulting from population activity. The armed conflict, sweeping across different regions of Yemen, has further compounded these challenges. As is the case in any conflict zone, there are indirect repercussions on the Yemeni environment. This study aims to shed light on the most prominent of these effects and put forth recommendations that can potentially mitigate the long-term environmental consequences of the conflict.

The War's Aggravating Effect on Yemen's Water and Sanitation

Yemen grapples with a dire water crisis, relying heavily on rainwater to sustain its groundwater and surface water sources. However, rapid population growth, exceeding 3.2% annually, coupled with the expansion of economic activities, has strained the water sector's institutional capacities. Despite donor efforts to develop institutional structures and water networks prior to the war, the state's institutional capacity remains weak. Presently, public water network projects only cover 68% of the urban population in Yemen, with per capita water availability ranking as the lowest in the Arab world. In 1997, [the average per capita share stood at 131m³](#), but it gradually declined to a mere 74m³ following the onset of the conflict.

Throughout the conflict, the warring parties in Yemen have used various weapons, with cities such as Taiz, Sana'a, Aden, and Al Hudaydah witnessing airstrikes led by the Arab coalition that directly impacted water and sanitation networks. Negligence and the suspension of funding have also contributed to the failure of water and sanitation institutions. Over the years of the conflict, the water infrastructure has suffered [105 incidents](#): 96 of them resulting from airstrikes and the rest from ground-based shelling by conflict forces. Approximately 10% of water facilities have been completely destroyed, such as the Al Hudaydah desalination plant, while

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around 38% have been adversely affected, including sewage stations, pumps, cisterns, and water tanks. The governorates of Taiz and Al Hudaydah in southern Yemen are among the hardest-hit areas, with [60%](#) of water and sanitation assets being adversely impacted.

At present, a significant number of Yemenis lack access to clean water through water networks or established institutions, including those in major cities. Water shortages and disruptions in many neighborhoods and households have become commonplace. For instance, in Aden both the quantity and quality of water have been affected, with water pumping from the city reduced to a mere 8 hours per day in 2018, [compared to the pre-war duration of 22 hours](#). The lack of funding has virtually halted water laboratory operations. In Taiz, southern Yemen, the conflict has led to the blockade of key water outlets and Houthi militia control over the water basin that supplies the city, resulting in severe water scarcity.

Taiz has long suffered from water scarcity even prior to the war, with residents receiving water in their homes only once every 22 days. The situation further deteriorated amid [fierce battles and blockades](#) during the conflict, leading to near-complete disruption of the water institution due to extensive damage to infrastructure and transportation networks.

To compensate for the water shortage, the private sector has resorted to haphazard practices, such as unregulated well digging. Within the city, the number of wells reached 70, but most of them have dried up, leaving only 22 functioning wells. Many families have turned to unsafe alternatives, such as purchasing water from mobile tanks, which poses a financial burden given the economic fragility and interrupted salaries. The quality of this water is, moreover, often compromised. Some families rely on free water from reservoirs supported by philanthropists or water sector organizations or collect and store rainwater during the rainy season.

Storing water in contaminated or exposed plastic containers has negatively impacted water quality, resulting in a surge of water-related diseases and epidemics, particularly dengue fever and malaria, in various regions of Yemen.

Aerial bombardments also targeted the water treatment unit in Sana'a, which was already suffering from equipment deterioration due to poor maintenance, negligence, inadequate funding, and mismanagement. This led to the disruption of water pumping and treatment, and given the [high levels of nitrates and iron](#) in the well water in Sana'a and other cities, this interruption poses significant health risks to consumers.

Private sector-owned water, sold to citizens, has also faced challenges, as water sample tests revealed an excessive concentration of dissolved solids.

Moreover, groundwater reserves have experienced significant depletion due to unregulated digging and poor monitoring. Both ground and surface waters have been subject to pollution from plastic waste and sewage water in several areas, particularly in mountainous regions.

Sewage treatment units have been severely impacted by the armed conflict and the lack of oil derivatives. In Taiz, approximately 31.2 million cubic meters of untreated wastewater are [used by farmers for irrigation](#), contaminating crops such as vegetables and qat. The untreated wastewater contains heavy metals, including zinc, arsenic, and barium, at levels that exceed internationally permissible limits, which further exacerbates the health crisis by increasing the spread of parasitic worms, bacteria, and other harmful diseases.

The deterioration of sanitation services, coupled with the difficulty of accessing clean water, has significantly compromised the overall health of the population. Shortly after the conflict erupted in late 2016, an unprecedented cholera epidemic began to spread caused by the *Vibrio cholera* bacterium in contaminated food and water. By mid-2017, [cholera claimed a life every hour](#), with over 500,000 people infected. By the end of 2019, the epidemic had left more than two million Yemenis infected, with a death toll of 13,750. Cholera outbreaks are closely associated with conflict in any region. For instance, cholera had previously spread across four Yemeni governorates following the outbreak of civil war against armed groups in 2011.

Conflict Zones Grapple with Solid Waste and Garbage

The conflict has had a direct impact on the management of solid waste in most cities in Yemen. The country already experienced challenges in waste removal and management, and the situation has significantly worsened after the war.

Before the war, the government had approved a national strategy and an investment plan for solid waste management, aiming to improve waste collection and treatment, establish data collection systems, and upgrade waste disposal sites. The plan was valued at [US\\$270 million](#), with coordination between relevant actors and institutions such as the local authority and the Cleaning and Improvement Fund under the Ministry of Local Affairs. However, the outbreak of the Arab Spring in 2010 and the subsequent armed conflict in 2015 hindered the plan's implementation. Even before the war, institutions were affected by the focus on emergency relief and humanitarian aid, rather than long-term development

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interventions. The fuel crisis and interruptions in workers' salaries further impacted waste collection, causing delays in some areas. The lack of equipment and vehicles for waste collection was already a problem, with only 65% of waste being collected in cities and 5% in rural areas. During the conflict, 45% of these vehicles were looted or destroyed, and the influx of internally displaced people added pressure on some cities. The total damage to the solid waste sector in Yemen exceeded US\$7 million in more than 16 cities.

Approximately 60% of household waste is not collected, leading to piles of waste accumulating on streets and in valleys, as seen in Al Mahrah. Heavy rains worsen the situation, washing away the waste and obstructing water flow, resulting in flooding and damage to nearby farms and homes.

The existing official waste collection sites were already problematic, with only 21 landfills, of which only six were under supervision. Most waste is not buried in landfills, which poses environmental and health risks, including the emission of greenhouse gasses and the possibility of landslides. Moreover, the seepage resulting from waste infiltrates through the soil layers and eventually contaminates the groundwater reservoirs that serve as the primary source of water in Yemen, particularly during the rainy seasons.

Unburied waste creates a health crisis, providing a breeding ground for disease vectors like malaria and dengue fever, as well as stray animals such as dogs. The risk of spreading diseases including rabies has increased, with reported injuries reaching 9,000 and 50 deaths in just seven months in 2019. In conflict-affected areas like Taiz, additional challenges arise, leading to the establishment of alternative landfills near residential areas. In response to the circumstances created by the siege imposed by the Houthi forces, there was a need to relocate the waste dump. Sharaab Junction, located west of the city and under Houthi control, became one of the chosen sites for this purpose. The resulting landfill in this area is now a mound that once served as a family park until it was ravaged by air raids. Today, it has been repurposed into an alternative waste dump to meet the demands of the besieged city of Taiz.

The accumulation of waste in landfills, particularly medical waste, poses a significant health hazard and becomes a nightmarish scenario as fires spontaneously erupt due to the high internal temperatures within the massive piles of waste containing chemicals from various medical sources. In some cases, residents resort to harmful practices like deliberately burning waste heaps to reduce their volume, resulting in fumes that may contain heavy metals such as mercury. These fumes can inflict damage on the nervous system and lead to kidney infections in the long term, particularly affecting newborns.

Inadequate management of waste dumps is closely linked to health risks, including asthma, allergies, skin irritations, and gastrointestinal diseases among nearby communities. Furthermore, workers involved in waste collection lack even the most basic form of protection, and in many cases, there is a complete absence of protective measures or medical insurance for them. As a result, they are susceptible to various diseases arising from their work.

Medical waste and its toxic chemicals present a grave health threat across most regions of Yemen. Shockingly, only 56% of health facilities possess private incinerators, of which 22% are broken or unused due to factors like location, poor maintenance, and a lack of essential resources like oil derivatives. In Sana'a, medical waste used to be separated and burned in a dedicated incinerator, which was destroyed in an explosion in 2015. Consequently, the waste has been disposed of in the Azraqueen landfill, where it mixes with the rest of the waste without any sorting or burial. This situation poses a health risk, including the potential for infections like cancer and other immune disorders if toxic chemicals seep into underground water sources.

The conflict has also had a detrimental impact on the waste recycling process, which predominantly relies on scavengers who collect scrap and plastic materials from landfills and streets. However, due to factors such as power outages, the exorbitant price of oil derivatives, difficulties in accessing conflict-affected areas, and challenges in exporting materials outside Yemen, only two out of five recycling factories continue to operate, and at a limited capacity.

The Devastating Impact of Landmines and Explosives

Since the outbreak of political tensions and conflicts in the early 1960s, mine planting has become widespread in central regions in Yemen. After the country ratified the Ottawa Convention – which prohibits the manufacture, import, and laying of mines and explosive devices – Yemen became the first Arab country to eliminate anti-personnel mines, successfully destroying its stockpile. However, the escalation of political unrest in 2011 and the armed conflict in 2015 led to the indiscriminate planting of various mines in 17 governorates, often without military necessity.

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As of January 2023, there were [5,892 deployed](#) anti-personnel mines and a further 134, 632 anti-tank mines. There are 225,738 units of unexploded ordnance, while the number of other explosive devices reached 7,632. These numbers continue to rise as the conflict in Yemen persists. It is estimated that the country would need eight years to complete mine clearance even if sufficient resources and mine-laying maps were available.

The impact of mines has resulted in [injuries and damages](#) to 3,286 civilians, including 723 children, causing health issues and deformities. Additionally, 2,562 civilians have lost their lives. Among the affected areas, Taiz has the highest number of casualties and health-affected individuals, with a rate of 22%.

The damage caused by mines extends beyond human losses. The agricultural sector has been severely affected, with 334 farms completely destroyed and the loss of approximately 2,185 livestock.

Mines have [irreversible impacts](#) on the ecosystem, deteriorating the internal structure of the soil, reducing productivity, and increasing vulnerability to erosion. For example, in Vietnam, mine contamination led to a 50% decrease in rice crop productivity, while Afghanistan witnessed the destruction of a quarter of its forests. Similarly, in Cambodia, approximately 35% of the vegetation cover has been destroyed after two decades of war. The environmental consequences of mines in Yemen require further investigation through comprehensive studies.

Furthermore, mines have been planted in coastal and marine areas, particularly around the FSO Safer vessel moored in the Red Sea, threatening its unique biodiversity. This poses a significant risk to marine organisms, mangrove forests, coral reefs, and environmentally sensitive coastal areas, as some of these areas serve as military barracks and are surrounded by mines.

Planted mines are susceptible to corrosion and contain toxic substances such as TNT and other hazardous compounds. These substances can leak into the surrounding soil or water. Over time, these compounds break down and dissolve, posing a severe risk if they enter the human body even in small amounts.

The Toll of Oil Pollution

Oil pollution resulting from exploration operations, drilling, extraction, or leakage from pipes and tanks is considered one of the most hazardous pollutants that impact the environment and human health. Oil production began in the [early 1980s](#) in several areas of southern Yemen, and Marib witnessed various forms of pollution, including soil pollution from waste dumping and air pollution from intentional gas flaring. The situation further deteriorated after the 2015 war, and the soil in the region between Marib and Shabwa in southern Yemen now contains hazardous compounds like volatile petroleum hydrocarbons and toxic metals such as chromium and lead, which can cause cancer.

The Harib area in Marib is [heavily polluted](#) at all levels. Soil pollution reached 74.5%, followed by air pollution at 11.8%. These pollutants have had a negative impact on the health of the residents in the region, leading to the widespread prevalence of various diseases. For instance, cancer affects 64% of residents with medical issues, chest, and respiratory diseases affect 17.6% of sick individuals, and kidney diseases affect 9.8%. Among the individuals residing within a 30-to-50-mile radius of the FSO Safer in Yemen, brain cancer affected 64.7% of the population; breast cancer affected 15.8%; bowel cancer, 10.5%; and leukemia affects 10.5%.

In Hadhramout, [toxic waste](#) production has become a pressing issue since most of the oil fields are in the plateau region, which also serves as the water source for the valleys, and waste disposal does not adhere to environmental standards. The waste is [injected](#) into underground formations close to fresh drinking water aquifers in the city of Mukalla. This is exacerbated by administrative corruption and the fragility of oversight authorities even before the war.

Oil waste contains toxic heavy metals such as zinc, copper, barium, and cadmium, which contaminate water and soil, leading to health problems among the population. Over 15 years, Hadhramout has witnessed a significant increase in the number of cancer cases. While there were 323 reported cases in 2004, the number doubled to 1,133 in 2014. Additionally, various other diseases related to the digestive and respiratory systems, as well as the kidneys and liver, have been observed.

Recommendations for Reducing Environmental Degradation in Yemen

Yemen stands as one of the world's poorest nations, facing challenges not only in terms of living standards but also in the availability of vital resources like water, which serves as the foundation of life and is under constant threat of depletion. The ongoing war has further aggravated the living conditions of the population, leading to widespread poverty, food insecurity, and the destruction of critical infrastructure and institutions. Moreover, it has accelerated the already severe deterioration of the environment, which is already strained due to rapid population growth and the excessive demands placed on limited resources, particularly water.

To address this critical situation, decisive measures must be taken, including:

General Policy Recommendations:

- Prioritize the cessation of the war and focus on achieving security and peace throughout the country.
- Conduct a comprehensive assessment of the environmental impact of the war and its remnants on the ecosystem.
- Develop a comprehensive national strategy to rebuild and improve Yemen's post-war economy.
- Embrace sustainable environmental practices and promote equitable distribution of natural resources.
- Utilize existing pre-war visions and strategies, particularly in water management, food security, agriculture, and solid waste recycling.
- Allocate resources (estimated at US\$20 to US\$25 billion dollars) for reconstruction efforts and restoring what has been destroyed during the war to normalize the economic and social conditions.
- Strengthen governmental environmental institutions by providing long-term strategies and adequate financial and technical support to foster environmental peace.
- Integrate environmental management into the processes of reconciliation and peacebuilding.
- Utilize development aid to enhance data collection tools and capacity building in environmental conservation.

Recommendations for the Water, Sanitation, and Energy Authorities:

- Promote the use of alternative energy sources for daily activities, such as providing access to domestic gas for cooking, to reduce reliance on wood and vegetation as fuel.
- Encourage agricultural producers, particularly those growing qat, to diversify their crops, enhancing food security, reducing water depletion caused by qat cultivation, minimizing the use of toxic fertilizers, and decreasing the need for imports.
- Support environmental mediation initiatives that facilitate dialogue among various stakeholders in communities facing water scarcity, promoting sustainable water resource management.
- Treat wastewater and utilize it for irrigation purposes, reducing water demand and ensuring efficient use of resources.
- Expand and maintain water and sanitation infrastructure to serve a larger portion of the population, ensuring access to clean water while preventing pollution and environmental degradation.

Recommendations for Dealing with Mines:

- Advocate for all parties involved to provide mine maps and prioritize the removal and proper disposal of mines.
- Increase support for mine-clearance programs.
- Enhance efforts to protect civilians by establishing clear boundaries and mapping high-risk areas with prominent warning signs, helping to prevent accidental injuries and casualties.
- Strengthen legal frameworks by criminalizing the planting of mines and the use of explosive materials.

Recommendations for Waste Management:

- Reconstruct, operate, and expand waste disposal sites, while carefully considering their location to ensure they are away from residential areas and water resources.
- Implement proper segregation of hazardous waste, particularly medical waste, from other types of waste, and dispose of it using scientifically proven methods.
- Invest in the reconstruction of waste recycling plants and provide incentives, such as soft loans or grants, to encourage individuals and organizations interested in this field. Explore the potential for utilizing waste treatment for energy production.
- Establish medical and hazardous waste disposal units in major cities to ensure safe and specialized handling of such waste.
- Regularly maintain and restore waste management facilities to ensure their optimal functionality.

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Recommendations for Oil Pollution:

- Enforce strict laws and regulations to minimize oil pollution and ensure that extraction companies adhere to safe waste disposal practices.
- Reduce gas emissions by imposing fees on producers and promote the utilization of gas for energy production rather than burning it at oil production sites.
- Explore opportunities to utilize oil-contaminated water in the Hadhramout regions, applying advanced techniques and scientific methods for recycling and using it in agriculture and livestock projects.
- Impose fines on individuals or entities that violate environmental pollution regulations and hold them accountable for their actions.
- Establish mechanisms to compensate individuals affected by environmental pollution caused by oil extraction and other mining activities.

Conclusion

Preserving the environment and maintaining ecological balance are essential for ensuring a safe and stable life for the people of Yemen. Unfortunately, the environment in Yemen has faced numerous threats and risks, stemming from the impacts of war, conflicts over resources, and the unsustainable economic practices that have led to its degradation. Despite previous efforts to develop strategies and plans for environmental preservation, these threats and risks persist, and are further exacerbated by ongoing war, mismanagement, and inadequate funding. It is crucial that we put an immediate end to the war and prioritize environmental rehabilitation as an integral part of peace-making initiatives. This approach is necessary to halt the loss of both human lives and valuable natural resources.

About the Arab Reform Initiative

The Arab Reform Initiative is an independent Arab think tank working with expert partners in the Middle East and North Africa and beyond to articulate a home-grown agenda for democratic change and social justice. It conducts research and policy analysis and provides a platform for inspirational voices based on the principles of diversity, impartiality, and gender equality.



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