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**A Sustainable Restoration Plan for Gaza**



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## A Sustainable Restoration Plan for Gaza

 <sup>1\*</sup> Alon Tal, <sup>2</sup> Galit Cohen

<sup>1</sup> Freeman-Spogli Institute for International Studies, Stanford University

<sup>2</sup> Israel Institute for National Security Studies, Tel Aviv

<https://orcid.org/0009-0009-7661-4096>

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### Abstract

**Purpose:** Since the outbreak of the Gaza war, innumerable discussions for resolving the conflict have emerged considering governance, security, equity and feasibility. Any discussion involving the aftermath of the fighting in this embattled area must also include a focus on sustainability. The article highlights the primary environmental challenges associated with post-war ecological restoration.

**Methodology:** This article represents an historical analysis, reporting the results of a desk study, based on academic sources, reports of international agencies, civil society and government data.

**Findings:** In recent decades, Gaza's environment increasingly reflects the adverse impacts of mounting demographic density, resource exploitation, poor management and significant contamination. Degraded ground water quality, sewage contamination of coastal waters and debris from inadequate solid waste infrastructure, traditionally, have been the primary environmental hazards. The ongoing military conflict has only exacerbated these acute problems, adding additional risks from airborne particles from the massive damage sustained by local buildings, especially when structures contain asbestos.

**Unique Contribution to Theory, Practice and Policy:** The article offers a brief historic review of Gaza's natural resources, the drivers of the acute environmental degradation and priority action items for a sustainable strategy for Gaza and its residents' future.

**Keywords:** *Gaza, Environment, War, Water Quality, Sustainability*

## Introduction

After the dust finally settles and the sides have buried their dead, not only will the Palestinian and the Israeli people remain, but so will a wounded environment. It bears the mark of prolonged and particularly intensive battles. During the first three months of the war alone, Israel reportedly dropped some 45,000 bombs causing extensive damage (Alfonsi, 2024). Discussions of the “day after” arrangement are critical as the sides along with the international community -- seek a way forward. In these efforts, expediting the renewal of basic environmental infrastructure and removing the most pressing environmental hazards will be critical if rebuilding efforts are to provide Gaza residents a reasonable quality of life. In this article, we offer a historical analysis, based on a desk study, relying on myriad academic sources, reports by international agencies, civil society analyses and governmental data. The authors also rely on decades of personal experience as environmental experts and managers in formulating recommendations for what an ecological restoration plan for Gaza should contain.

With 2.1 million people living on 365 square kilometres (an area twice the size of Washington, DC), notwithstanding common claims, prior to the 2023 War, Gaza was not yet the most crowded place on earth. (City states like Singapore and Hong Kong are far more congested.) (CIA Factbook 2024). But high local birth rates and demographic trends suggest that it will not take long for Gaza to surpass such high-density locations. The crowded conditions for many years served to exacerbate mounting environmental hazards and adverse health impacts. Overcrowding will continue to complicate clean-up and restoration efforts.

The transition from a relatively remote, rural district during the first half of the twentieth century to a dense conurbation occurred relatively quickly: A 1946 report submitted by the British Government reported roughly 50,000 residents in the Gaza district (Anglo-American Committee of Inquiry, 1946). These numbers grew dramatically after the Palestinian migration during the 1948 war. By 1967, when Egyptian rule over the Gaza Strip ended, there were roughly 400,000 people living there; during the subsequent 57 years, population increased by 500 percent (Reuters, 2023). The associated environmental consequences were enormous.

What had once been a relatively fertile agrarian region became a highly urbanized, metropolitan space. (Even the apparently inflated official claim of “25,000 Gazan agricultural holders” (Palestinian Central Bureau of Statistics (PCBS), 2023) today suggests that less than 2% of the local population makes a living from agriculture.) Water was the first natural resource to reflect the dramatic demographic transition. Lacking any real streams or lakes, historically, Gazans relied on wells that pumped from the shallow underlying aquifer. As population expanded, so did extraction.

Already in the 1950s and '60s, over pumping of groundwater during the Egyptian occupation resulted in massive salinization, as salty water from a lower-lying, saline aquifer inundated wells. In addition, profligate exploitation in the western part of Gaza, seawater intrusion produced steady dramatic increases in water salinity (United Nations, 2012). Nitrate contamination also spiralled

upward due to excessive use of fertilizers by local farmers, along with the percolation of sewage from cesspools, solid waste leachate and unregulated industrial discharges (Weinthal, 2005).

By 2018, 97% of wells monitored in Gaza did not meet World Health Organization standards (Rinat, 2018). Already in 2010 local hydrologists called (unsuccessfully) for a moratorium on pumping in order to allow the aquifer to refill and dilute the high pollution concentrations (Abu-Mayla, 2010). Much like Israeli water management strategy a decade earlier, Gazan leadership turned to the sea to address its acute drinking water crisis (Manama, 2022): Prior to the October 7<sup>th</sup> Hamas attack, the UN reported that 90% of Gazans received their drinking water from a series of 154 desalination plants, most of which were small, privately operated and unlicensed (UNEP, 2020). Notwithstanding the ongoing enmity and periodic rounds of violence, Israel continued to export as much 10% of Gaza's local water supply through three separate pipes, with the aquifer continuing to supply farmers and other consumers with tainted well water (Wilson, 2023). In other words, even prior to the massive environmental degradation caused by the recent warfare, Gaza's water resources were almost completely compromised.

For many years, Gaza residents had no sanitation infrastructure at all, beyond basic cesspools and septic tanks. Copious amounts of sewage flowed freely into the Mediterranean Sea (estimates of 100,000 m<sup>3</sup> / day) creating a local sanitation risk and a hazard to marine life (Heller, 2014). When pollution concentrations and currents were particularly high, the Israeli desalination plant in Ashkelaon, lying a mere ten miles to the north, periodically was forced to cease operations (Associated Press, 2016).

After two decades of planning, in 2021 a major sewage treatment plant became operational in northern Gaza collecting the wastes of about one million local residents (World Bank, 2018). The quality of the adjacent Mediterranean waters showed immediate improvement. Six other wastewater plants supplemented this facility, reducing the daily raw sewage discharge to only about 40,000 cubic meters (UNEP, 2020). Unreliable energy supply and a variety of maintenance challenges, however, meant that treatment was highly intermittent (Barhoum, 2021).

### **War and Environmental Destruction**

During the fighting in Gaza between October 2023 and April 2024, beyond the danger of being caught in the crossfire, the people of Gaza were subjected to a range of acute environmental insults. These included food insecurity, exposure to extreme weather due to loss of housing, lack of shelter and acute water scarcity. Under such crowded conditions, in the absence of minimal sanitation services, the risk of disease outbreak remains elevated (Damien, 2023).

Months of intense, urban fighting left Gazan environmental infrastructure devastated. For instance, 57% of WASH facilities are estimated to be damaged or destroyed including the desalination plants in the northern and central regions of Gaza (United Nations, 2024). An additional 162 wells and one of the three Israeli pipelines were damaged during the fighting and ceased to operate. (Over the course of the war, in addition to the 20,000 trucks delivering humanitarian aid, Israel coordinated the repair work on three pumps at the UNICEF desalination plant in Deir-Albalah

which provided water for roughly approximately 50,000 residents (Sharon, 2023). Nonetheless, the estimated 3 to 7 liters of water, per-person-per-day, which has been reportedly available for most of the Gazan population, is but a tiny fraction of the UN recommended, 50-liter-daily-per-capita supply. As in the past, the lack of infrastructure in a dense urban environment will increasingly be manifested in high levels of chlorophyll, gastrointestinal parasites and other organic contaminants in Gaza's Mediterranean waters (Price, 2024). In a word, the present *humanitarian* catastrophe is directly linked to the ongoing *environmental* disaster.

Looking forward, it appears as if Gaza residents will need to start, almost from the “square one”, in reestablishing local environmental infrastructure. According to different estimates, between 20 and 60% of total urban infrastructure has been damaged or destroyed (World Bank, 2024).

The kind of rebuilding required is reminiscent of post-World War II efforts in Germany and Japan (Dower, 1999; Shibata, 2005). Because of the health risk associated with contaminated Gazan water supplies, priority should be given to repairing the desalination facilities and reestablishing treatment plants for the 100,000 cubic meters of wastewater which will increasingly contaminate sea and land now that residents have begun to return to their homes.

Generally, solid waste management has never been particularly advanced in the region– nor in Gaza in particular. (Egypt and Israel only recycle between 20-25% of their trash.) As a result of the war, it is estimated that five out of Gaza's six municipal solid waste management facilities sustained substantial damage. Garbage is being deposited in makeshift locations, with winter rains leaching a range of contaminants into the groundwater. With the general chaos, there are additional concerns about the effect of emission of harmful gasses and particulates into the atmosphere by the burning of solid waste in open fires (UNDP, 2024). For six months, massive amounts of explosives and other chemicals of war have been steadily released into the local soil and air, creating sundry potential public health risks.

### **A Sustainable Restoration Strategy for Gaza**

Trend is not destiny. Gaza is need of a fundamental ecological makeover. Basic environmental services urgently need to be reestablished and should constitute the single top priority in Gazan reconstruction efforts. It is important that any environmental restoration strategy avoids decades of dereliction and provide Gaza's beleaguered residents with a sustainable future. Already initial activities to restore a modicum of environmental services to Gaza have begun. For instance, On December 2023, a new desalination plant alongside Rafah was established by the UAE. It produces 4.5 million liters of clean water a day, supplying hundreds of thousands of residents with potable water (el Tahar,2023). Soon thereafter, Israel established an additional water pipeline to deliver water from its grid to Gaza. In March 2024, five water pumping facilities were refueled, supplying water to over 200,000 residents in northern Gaza (Times of Israel, 2024).

While far from adequate, these initial efforts to restore basic services suggest that if designed correctly, the Gazan reconstruction should actually lead to an improvement in the poor environmental conditions that characterized life there prior to the war (EU, 2024). For instance,

the municipal water piping systems were prone to substantial leaks, inefficiencies, and frequent breakdown which made prevailing scarcity even more severe. As part of the environmental makeover, they must be replaced, a step which will reduce massive leakages that have existed for decades in the fresh water supply system.

### **Conclusions**

After many years, it is time to heed the calls by Gazan and international hydrology experts for a moratorium on pumping in most of the aquifer underlying Gaza so that natural replenishment can bring pollutant concentrations down to a reasonable level. This means that desalination plants will need to be expanded. In particular, the new southern facility near Rafah should be expanded to service the enormous influx of war refugees who are likely to remain in the southern edge of Gaza for the foreseeable future. (Baba, 2023) Like many of the latest plants in the area, this facility should be a BAT facility, with World Bank or blended funding. As wastewater treatment plants are repaired and upgraded, they should include infrastructure to supply treated effluents to augment supply for reasonably priced irrigation of Gaza's 45,000 acres of farmland (Vos, 2024). (Based on average Israeli irrigation levels, if Gazan farmers fully irrigated their lands, it would require less than 100,000 acre-feet or roughly. 120,000,00 cubic meters).

Drainage infrastructure has long been inadequate in Gaza. Given projections for extreme weather events in Gazan cities – which can be expected in a region defined as a “climate hot spot” - urban reconstruction needs to include much improved municipal storm water systems. Shading in public spaces through a massive tree planting campaign should be part of the reconstruction program for public spaces.

Of course cleaning up the enormous amount of demolition debris from the many buildings that are not salvageable constitutes a formidable task. The risk of airborne particles, especially if any of the structures contain asbestos, is significant (Limb, 2024). Gaza's construction wastes is largely recyclable: after being crushed up in shredding facilities it–can then be used as construction aggregate for repaving roads and rebuilding homes. During the initial stages of demolition cleanup, there are additional health risks associated with extricating the corpses, still buried (Goodman,2024).

Ever since in the inception of modern warfare, military training and actual combat leaves behind a toxic legacy of soil contamination, characterized by high concentrations of explosives, metalloids, metals, radionuclides and in some cases herbicides (European soils still contain high levels of copper and lead from battles fought during World War I.) (Tucker, 2004). Soil experts have taken to identifying the phenomenon of “bomburbation, that reflect the long-term effects of explosions on the ground, with detonation of rockets and artillery shells leaving residual zinc, chromium, nickel and cadmium. In the case of Gaza, the extensive, scattered and often subterranean weapons production facilities that flourished in Gaza for the past decade undoubtedly contributed to such pollution. Future demilitarization of Gaza would not only contribute to a political settlement, but provide environmental benefits as well.

The initial step in addressing this soil contamination and safety hazard needs to involve the collection of munitions (as well as as unexploded bombs which on average are 10% of those dropped). An important preliminary step involves soil monitoring to prioritize the most severely polluted brownfields. Typically soil decontamination activities in war zones require incineration, although there are voices for alternative – and less expensive -- biological remediation techniques such as mycomediation. This technology relies on fungi to degrade or isolate soil contaminants. Ultimately, post-conflict soil decontamination is a long, costly and sisyphian process which will take years.

### **Conclusions**

Estimates have begun to emerge for the costs of Gaza's future cleanup and reconstruction (Aljazeera, 2024; Reuters, 2024). One assessment made by the EU, World Bank and United Nations projects that the cost associated with establishing WASH and environmental infrastructures in Gaza is by no means insignificant, but still only around 5% of the total 20 billion dollar total price of rebuilding after the war. (EU, 2024). It should be at the top of the restoration list.

### **Recommendations**

The war in Gaza revealed an extraordinary infrastructure that was developed during the past decade. Sadly, it was an infrastructure designed to provide a subterranean killing machine. The time has come for it to be replaced by state-of-the art, environmental infrastructure that can provide the Gazan people with clean water, solid waste recycling, sanitation, sustainable transportation and the kind of drainage and shading required for adaptation in a climate hotspot. If there are any lessons to be learned from the war in Gaza it is that no matter which side wins the battle, the environment comes out a loser. The next chapter in this region's long environmental history could be different.

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