ARAVA INSTITUTE
מכון הערבה
معهد وادي عربة

REPORT

SEPTEMBER 2025

SHARED ENVIRONMENTS, SHARED FUTURES

A Perspective on Nature-Based and Decentralized Solutions for Gaza's Recovery

Publication Notes

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JUMPSTARTING HOPE IN GAZA
عودة الأمل الى غزة

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About the Arava Institute for Environmental Studies

The Arava Institute for Environmental Studies is a leading academic and research institution in the Middle East, preparing future environmental leaders from across the region to cooperatively address shared ecological challenges. Through cross-border research, hands-on fieldwork, and a university-accredited program, the Arava Institute fosters innovative environmental solutions that build trust, promote sustainability, and model peaceful cooperation in conflict-prone areas.

The Center for Applied Environmental Diplomacy (CAED) at the the Arava Institute works to resolve critical regional environmental issues and to build trust in the region through the implementation of cross-border, locally led, decentralized and environmental initiatives. Grounded in 30 years of the Arava Institute's experience, these initiatives can be scaled and replicated to address regional challenges, build confidence in cross-border cooperation, and revive belief in negotiated political solutions.

With Sincere Appreciation

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Friends of the Arava Institute

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Glossary

COGAT	Coordinator of Government Activities in the Territories
COP	Conference of the Parties
FAO	The Food and Agriculture Organization of the United Nations
Fig.	Figure
IDP	Internally displaced person
IDF	Israeli Defense Forces
IPC	Integrated Pollution Control
JHG	Jumpstarting Hope in Gaza
kW	Kilowatt
kWh	Kilowatt per hour
MSF	Médecins Sans Frontières
NBS	Nature-based solution(s)
NGO	Non-governmental organization
OHCHR	The Office of the United Nations High Commissioner for Human Rights
UN	United Nations
UNDP	The United Nations Development Programme
UNEP	The United Nations Environment Programme
UNICEF	The United Nations Children's Fund
UNOCHA	The United Nations Office for the Coordination of Humanitarian Affairs
UNOSAT	United Nations Satellite Centre
WASH	Water, sanitation, and hygiene
WFP	World Food Programme
WHO	World Health Organization

Executive Summary & Recommendations

This report provides an update to our 2024 analysis of the environmental and humanitarian impact of the current Israel-Hamas war, which focuses on the effects in Gaza and the broader implications for the region in six key areas – energy, water, environmental hazards, health, food security, and environmental degradation. We have added to this report important information on issues of human displacement and a roadmap for a phased, sustainable recovery approach.

Due to the current Israel - Hamas war, Gaza faces an unprecedented humanitarian and environmental catastrophe, marked by widespread destruction, ongoing displacement, and a severe strain on fragile ecosystems. The existing aid distribution system is currently unfit, failing to deliver assistance consistently and safely to a population enduring alarming overcrowding and critical health challenges amidst environmental degradation. The cyclical nature of conflict and inadequate traditional reconstruction efforts has deepened these vulnerabilities, highlighting a critical nexus between environmental health, public health, and lasting peace. A hopeful future for Gaza hinges on addressing the root causes of environmental degradation and health crises, fostering Palestinian ownership, ensuring transparent funding, and implementing third-party oversight to guarantee accountability and long-term stability.

Since the spring of 2024, Damour for Community Development and the Arava Institute have tried to address some of these inadequacies through their own environmental, WASH and energy efforts under Jumpstarting Hope in Gaza (JHG). While responding to the immediate crisis with food, water, hygiene kits, and basic shelter infrastructure, JHG has created a model for a transformative recovery based on experience working in off-grid communities with decentralized technologies. Recognizing that the interim period between the end of the current fighting and full sustainable recovery in Gaza will be many years, Damour and the Arava Institute offer an alternative strategy for meeting the needs of displaced persons in Gaza by establishing sustainable self-managed communities empowered by decentralized technologies and motivated by the desire to build a peaceful future in the region.

This report advocates for a paradigm shift from conventional reconstruction to a transformative recovery rooted in nature-based and decentralized solutions. It emphasizes that sustainable recovery in Gaza requires immediate, adaptive, and long-term strategic interventions that empower local communities, prioritize ecological restoration, and establish robust governance mechanisms.

Priority Actions and Recommendations for International Donors & Governments:

We structure our recovery strategy for Gaza across three interdependent phases: **Absorptive** (immediate emergency), **Adaptive** (short to medium term), and **Transformative** (long-term strategic). A genuine and sustainable recovery for Gaza demands a long-term commitment, potentially spanning 15 years or more, akin to major post-conflict reconstruction efforts, like those following WWII. Financing for this extensive recovery must be contingent upon Palestinian ownership and transparent governance, aligning with best practices for post-conflict reconstruction funding to ensure effective, accountable, and locally-driven disbursement. This collaborative framework, involving international donors, governments, and local consortia, is essential for navigating the complexities of recovery.

Absorptive Phase (Immediate Life-Saving & Stabilization)

- Secure Unimpeded Aid Access
- Prioritize Critical WASH Provision
- Expedite Debris & Contamination Clearance
- Provide Dignified Emergency Shelter

Adaptive Phase (Systemic Resilience & Local Empowerment)

- Decentralize Core Services
- Leverage Precision Data & AI
- Empower Palestinian Leadership
- Transform Waste Ecosystems
- Catalyze Local Innovation & Enterprise
- Cultivate Urban Resilience

Transformative Phase (Long-Term Healing & Strategic Future)

- Anchor Generational Financing
- Mandate Ecological Restoration
- Integrate Eco-DRR & Climate Resilience
- Enforce Green Accountability
- Establish Joint Oversight & Governance
- Unify Health & Environment for Peace
- Underwrite Political Settlement

Introduction

Once an interconnected trading hub linking east and west, Gaza today is characterized by isolation and unprecedented destruction.[1] Prior to the events of October 7th, 2023, years of ongoing hostilities had already precipitated severe environmental degradation, transforming once thriving landscapes into ecological battlegrounds.[2] As Palestinian officials rightfully pointed out at COP29, global climate goals cannot be met without addressing the reality in Palestine, where Gaza continues to suffer from energy shortages, water contamination, and widespread destruction of infrastructure. These worsening conditions exacerbate the humanitarian crisis and highlight the urgent need of a vision for Gaza: one that reclaims its legacy as a connected, networked city in continuity with its past and hope for its future.[3]

The core premise of this report is that humanitarian and environmental crises are inextricably linked. The environment, often the first and most overlooked casualty of war, suffers widespread destruction and long-term degradation, intensifying existing humanitarian issues. In Gaza, acute shortages of vital resources are compounded by severe water scarcity, widespread soil degradation, and alarming levels of air pollution, all demanding immediate action alongside the response to the humanitarian crisis. Local authorities and civil society organizations face monumental challenges in managing waste and treating contaminated water sources. Addressing these issues requires more than just reconstruction; it necessitates adopting sustainable practices to preserve Gaza's natural capital and foster resilience for future generations.

Crucially, the environment knows no borders. Rivers flow regardless of political divides, pollution respects no checkpoints, disease spreads through multiple vectors. Ecological degradation does not discriminate and affects communities regardless of the lines drawn between them. Recognizing this fundamental interconnectedness is not merely an academic exercise; it is a call to action. Environmental cooperation can serve as a rare neutral space, a shared interest that fosters dialogue and reconciliation where political processes have become deadlocked.

This report builds upon the Arava Institute's longstanding commitment to documenting and estimating the environmental impact of the Israel-Hamas war, complementing previous

1 Ditmars, H. (2021, July 14). Review: Open Gaza: Architectures of Hope. The Markaz Review.

2 Ahmad, M., Sheikh, B. A., & Sheikh, A. A. (2022). The Environmental Fallout of the Israel–Palestine Conflict: A Deep Dive into the Ecological Impact of Ongoing Hostilities. Journal of Survey in Fisheries Sciences.

3 Noor, D. (2024, November 23). 'Protect the climate for whom?': Palestinians highlight Gaza at Cop29. The Guardian - UK.

work from Spring 2024. It offers updated data, reflections, and concrete proposals to support a more sustainable recovery. We advocate for a sustainable recovery approach, a term we embrace over green recovery to emphasize a critical perspective that includes social dimensions such as gender equality, human rights, and economic parity. Decentralized technologies and NBS offer a promising pathway toward environmental justice. Yet their successful implementation requires extensive study, robust governance models that are flexible and dynamic under continuously changing conditions, and most importantly, Palestinian-led, community-driven.[4] International support, both financial and technical, is crucial in addressing these challenges.[5]

While it remains a profound hope and privilege to envision "the day after", urgent action is needed to support the healing and re-growth of Gaza's people and ecosystems. **This report calls for an immediate and permanent ceasefire, the release of all Israeli hostages, and above all, the protection of human life and our shared natural environments.** It also outlines a practical, inclusive framework for citizen-led recovery. The Arava Institute with its dedicated partners stands ready to deploy and enact a hopeful future, recognizing that recovery is a large, complex issue that demands a holistic, collaborative, and people-driven approach to truly build a resilient and thriving Gaza.

Current situation

From March 2nd, 2025, until May 19th, no humanitarian aid and supplies entered the Gaza Strip. Following almost 2 months of a complete blockade, as of July 2025,only minimal and inadequate amounts of food and other humanitarian aid have slowly begun to flow into Gaza. The consequence is that Gaza's already critical humanitarian situation, with rapidly depleting food, fuel, medical aid, and vaccines for children, has reached unprecedented depths.[6]

4 Hassoun, A. (2025). Sustainability amid conflict: Gaza's environmental, social, and economic struggles. Journal of Environmental Management, 376, 124433.

5 WHO Centre for Environment & Health. (2025). Nature-based solutions and health (World Health Organization. Regional Office for Europe, Ed.). World Health Organization.

6 UNRWA. (2025). UNRWA Situation Report #169 on the Humanitarian Crisis in the Gaza Strip and the West Bank, including East Jerusalem (No. 169). UNRWA.

Energy

One of the most immediate and severe consequences is the fuel crisis, which is severely disrupting essential services across all sectors and is perpetuated by the large-scale destruction of generators, solar units, and alternative energy sources. Fuel reserves were thought to be at 20% in March 2025, with shortages causing the shutdown of essential infrastructure with direct, severe environmental and public health implications.[7] Inter alia, the lack of fuel leads to reduced water production, limited solid waste collection, and severely limited sewage pumping.[8] It also prevents essential transport, directly jeopardizing humanitarian operations and recovery, as well as essential services like education. It is noteworthy that most available emergency service vehicles are now out of service due to fuel depletion.[9]

In a recent study, the Norwegian Refugee Council warns against the persistent reliance on costly fossil fuel generators, particularly diesel, which remain the primary source of electricity for humanitarian operations in Gaza as of today, due to Gaza's collapsed central power grid.[10] This makes essential operations highly susceptible to import restrictions and prices, underscoring a critical need for more reliable and deployable power sources. Furthermore, since October 2023, household electricity consumption plummeted to less than 50 kWh per month, with civilians widely relying on limited, intermittent, and often unreliable alternative energy sources such as small solar home systems, car batteries, and shared generators, all of which are insufficient to meet even the most basic household needs.[11] Cooking, for instance, now outweighs all other household electricity demands, requiring significantly higher amounts of energy compared to lighting or communication devices. Apart from the prohibitive fuel costs, the considerable time and physical energy spent by households to obtain fuel represents a significant daily challenge. Thus, a holistic recovery must address both the financial and logistical barriers to energy access, with particular attention to regional variations in resource availability and infrastructure for a meaningful recovery.

7 Interview with Anonymous Palestinian Engineering expert, interviewed by Elaine Donderer, May 28, 2025.

8 United Nations Office for the Coordination of Humanitarian Affairs. (2025, April 30). Humanitarian Situation Update #284 | Gaza Strip.

9 United Nations Office for the Coordination of Humanitarian Affairs. (2025, April 30).

10 Helbig, F., Al-Kaddo, H., & Onsager, J. E. (2025). Restoring Dignity: The Urgent Need for Energy Access in Gaza – 2025 Energy Assessment for Gaza: Humanitarian Operations and Household Needs. Shelter Cluster (Palestine), NRC and NORCAP.

11 Helbig, F., Al-Kaddo, H., & Onsager, J. E. (2025).

Water

Source	Facilities	Potential Supply (м3/day)	Status April 2024	Status July 2025	Remarks
Groundwater	>300 wells across the Strip	262,000	Unknown	Over 75% of wells are damaged or inaccessible	Mostly unfit for human consumption, highly dependent on fuel availability for pumping and land accessibility
Desalination (Short-term, low-volume)	Gaza City (North)	10,000	Non-operational	Non-operational	Highly dependent on fuel availability
	Al Bassa / Deir al-Balah (Central)	2,000 (5,500 at full capacity)	Partially operational at 1,600 m^3/day (estimate)	Partially operational at 15% due to fuel shortages	
	Southern Plant	20,000	Partially operational at 1,700 m^3/day (estimate)	Partially operational at 1,500 m^3/day due to fuel shortages	
Mekorot (Israel)	Al Mintar (North)	52,000	Operational at 85% capacity or 20,400 m^3/day	Partially operational at 12,800 m^3/day	Subject to Israeli policy and interruption
	Bani Saeed (Middle)		Operational at 50% capacity or 7,200 m^3/day	Non-operational since January 2025	
	Bani Suhaila (South)		Operational at 33% capacity or 4,800 m^3/day	Partially operational at 2,000 m^3/day	
Supply from Egypt	United Arab Emirates Desalination	2,400	Operational at 83% capacity or 1,992 m^3/day	Non-operational since May 2024	Potential of future expansion
Reuse	NGEST treatment and reuse scheme	13,000	Non-operational	Non-operational	Only for agricultural purposes

Table 1: Status of water sources and infrastructure in the Gaza Strip[12]

Simultaneously, the interdependency between water access and electricity drives Gaza's water crisis to unprecedented levels. As outlined in Table 1, all previously available water sources across the Strip are only partially operational or are non-operational, with water system efficiencies plummeting from 60 to 25%.[13] A key factor in this collapse is the cessation of electricity supplies by Israeli authorities, which led to the shutdown of the last functional desalination plant, leaving no viable alternative for clean water.[14] The per capita availability of water is now as low as 8.4 liters per day per person, a sharp contrast to the

12 Based on data from United Nations Environment Programme. (2024), UNOCHA. (2025, April 8). Humanitarian Situation Update #278 | Gaza Strip [EN/AR]. Gisha (2025, April 9).Gaza Now: Current facts and figures. Retrieved May 3, 2025. Gaza Humanitarian Response Update | 25 May – 7 June 2025. Retrieved July 06, 2025, and Interview with Anonymous Palestinian Engineering expert, interviewed by Elaine Donderer, May 28, 2025.

13 Interview with Anonymous Palestinian Engineering expert, interviewed by Elaine Donderer, May 28, 2025.

14 Middle East Monitor. (2025, March 12). MSF condemns Israel's 'use of aid as a tool of war.' Retrieved May 7, 2025.

WHO's emergency minimum requirement of 15 liters.[15] The water insecurity experienced by 93% of households compels more than a third of all Gazans to purchase water from private vendors with no oversight, imposing a significant financial burden and forcing a reduction in overall consumption.[16] Such measures severely compromise hygiene practices, including the essential cleaning of water containers. Alarmingly, recent assessments reveal that 41% of these containers were visibly dirty, highlighting profound water quality and public health concerns.[17] Water quality issues not only concern Gazans, but jeopardize the health and viability of the surrounding ecosystem, including transboundary water bodies, such as the ancient groundwater aquifer that is shared by Egypt, Israel, and Palestine.

Environmental Hazards: Waste, Pollution & Specialized Contamination

The breakdown of sanitation infrastructure presents a severe and immediate environmental catastrophe. Since October 2023, all wastewater treatment plants have ceased operations due to extensive damage, and only a handful of sewage pumping stations remain partially functional; essential facilities, such as Gaza City's 7B station, are beyond emergency repair.[18] This widespread systemic failure has forced the diversion of raw sewage into makeshift lagoons, including those at Sheikh Radwan and Al Saftawi, which now face constant overflow risks, directly exposing tens of thousands of people to raw sewage.

	Outside Shelters	Makeshift Sites	Non-UNWRA Shelters	Gaza	Deir al-Balah	Khan Younis	Overall
Flooding / Stagnant Water	52%	44%	49%	53%	51%	41%	46%
Piles of Solid Wastes	63%	34%	61%	67%	44%	35%	42%
Human Excreta or Traces	8%	18%	21%	11%	27%	13%	17%
Dead Animals	23%	14%	20%	35%	22%	8%	16%
Rodents or Other Pests	88%	79%	70%	81%	74%	81%	78%
Black Sludge or Sewage	50%	23%	20%	39%	39%	14%	26%
UXOs or Mines	5%	3%	0%	2%	4%	2%	3%

Table 2: Proportion of Gazan Households Reporting Public Health Threat within 10 Meters of Shelter/Home, 2025 [19]

15 Interview with Anonymous Palestinian Engineering expert, interviewed by Elaine Donderer, May 28, 2025.

16 United Nations Office for the Coordination of Humanitarian Affairs. (2025, July 02).

17 WASH Cluster State of Palestine. (2025). Joint WASH Assessment Round 4. UNICEF. [Internal Report]

18 United Nations Office for the Coordination of Humanitarian Affairs. (2025, July 02).

19 WASH Cluster State of Palestine. (2025).

Figure 1: RAFAH, GAZA – APRIL 26: Palestinians who take refuge and live in tents due to ongoing Israeli attacks in Gaza, also face the risk of epidemics due to uncollected garbage and accumulated sewage water in Rafah, Gaza on April 26, 2024. (Photo by Jehad Alshrafi/Anadolu via Getty Images)

	Outside Shelters	Makeshift Sites	Non-UNWRA Shelters	Gaza	Deir al Balah	Khan Younis	Overall
Containement Collapse	13%	22%	1%	16%	17%	19%	17%
Flooding	35%	47%	50%	46%	48%	45%	46%
Overflowin	42%	38%	52%	49%	42%	38%	41%

Table 3: Proportion of Gazan Households Reporting Sewage Released Within 10 Meters of Shelter/Home, 2025 [20]

Moreover, the highly porous soil characteristic of much of the Gaza Strip, while sometimes reducing immediate surface water pooling after spills, alarmingly facilitates the rapid infiltration of sewage into the crucial underlying groundwater (Fig.1).[21] This poses a significant public health hazard, as pathogens and chemical pollutants from the sewage can contaminate the aquifer, threatening anyone relying on untreated well water.[22] Further deterioration of this vital groundwater source from sustained sewage infiltration will severely compound health risks, making the provision of safe water an even more daunting challenge. Beyond

20 WASH Cluster State of Palestine. (2025).

21 United Nations Environment Programme. (2024). Environmental impact of the conflict in Gaza: Preliminary assessment of environmental impacts. Nairobi: United Nations Environment Programme.

22 United Nations Environment Programme. (2024).

the aquifer, direct environmental threats are evident around dwellings, with a staggering 46% of households reporting incidents of sewage or excreta release within 10 meters of their shelters, tents, or homes due to flooding, 41% due to overflow, and 17% from facility

Beyond the immediate issue of raw sewage, Gaza faces an escalating and interconnected threat from uncontrolled waste accumulation and the collapse of specialized waste management systems.

containment collapse (Table 2-3).[23] These frequent occurrences, particularly prevalent in makeshift sites where, according to UNICEF, 22% of populations report containment collapses from self-built latrines, underscore the extreme vulnerability of Gaza's sanitation system and the urgent need for decentralized infrastructure.

Beyond the immediate issue of raw sewage, Gaza faces an escalating and interconnected threat from uncontrolled waste accumulation and the collapse of specialized waste management systems. The proliferation of informal dumpsites, combined with mounting volumes of hazardous medical waste within healthcare facilities, significantly amplifies health risks for the entire population and creates an acute potential for widespread disease outbreaks.[24] This is further compounded by contamination from vast quantities of war debris, unexploded ordnance, and weaponry residue, along with pervasive air pollution resulting from the informal open burning of solid waste.[25] It is important to note that comprehensive information and assessment regarding other potential chemical, biological, or radiological hazards from conflict-related activities remains extremely limited, hindering a full understanding of the scale of contamination.

The breakdown of waste management structures is particularly alarming, since hazardous materials are indiscriminately mixed with general waste. This poses a grave risk of infectious disease outbreaks, including viral hepatitis, as dangerous chemical substances,

23 WASH Cluster State of Palestine. (2025).

24 United Nations Environment Programme. (2024).

25 United Nations Environment Programme. (2024).

contaminants, and sharp instruments accumulate untreated in hospitals, clinics, and primary healthcare centers.[26] The specialized process of sorting, treating, and safely burying this hazardous waste in main landfills has become impossible due to widespread destruction of medical waste collection vehicles and treatment plants, coupled with a severe shortage of essential sterilization supplies and detergents in healthcare facilities. While dedicated teams, in cooperation with international medical organizations and health authorities, have managed to collect and securely treat approximately ten tons of medical waste monthly, this effort is dwarfed by the overwhelming scale of the problem. After October 7th, the actual quantity of accumulated medical waste exceeded 25 tons monthly, while only 4-6% were collected and treated, indicating that most hazardous medical waste is not properly managed.[27] This uncontrolled biohazard threatens to overwhelm an already collapsed healthcare system and accelerates environmental degradation.

Health

The correlation between inadequate sanitation and waste management facilities and public health threats is evident. Poorly managed sanitation facilities contribute to the contamination of living environments, increasing the risk of waterborne diseases and other health issues. The damage to wastewater treatment facilities and sewage networks further exacerbates

Against this backdrop of environmental contamination, Gaza's already vulnerable population faces a healthcare system in ruins.

these risks, as untreated sewage can spread pathogens and pollutants. Additionally, the functionality and hygiene issues with communal toilets create further barriers to safe sanitation practices, leading to compromised hygiene and increased health risks, particularly for vulnerable populations.[28] This in turn exacerbates protection and health issues, notably

26 Palestinian Centre for Human Rights (2025, April 15). Systematic Environmental Warfare: Israel Renders Gaza Uninhabitable Through Waste Crisis. Retrieved May 3, 2025,

27 Palestinian Centre for Human Rights. (2025, April 15).

28 United Nations Office for the Coordination of Humanitarian Affairs. (2025, July 02).

for women. A Global Protection Cluster report highlighted that displaced women consistently express profound fears for their personal safety and that of their families due to the lack of privacy, secure latrines, and safe bathing spaces.[29]

Additionally, airborne particulate pollution, laden with hazardous compounds from crushed building materials and debris, is posing an insidious and direct threat. This contaminated dust and air pollution is inhaled directly, increasing the risk of respiratory and cardiovascular distress and long-term conditions like cancer, particularly among children and those in densely populated temporary shelters.[30] Pollution infiltrates soil and water bodies, eventually leaching into groundwater and potentially contaminating food supply through absorption by crops.[31] More exact on-the-ground data has yet to be collected.[32]

Figure 2: Emergency room in a Gaza hospital. Photo credit: World Health Organization; License: CC BY-NC-SA 3.0 IGO.

Against this backdrop of environmental contamination, Gaza's already vulnerable population faces a healthcare system in ruins. By June 2025, only 18 of Gaza's 36 hospitals were partially operational, with 18 entirely out of service, and ten out of 16 field hospitals

29 Gender Based Violence Area of Responsibility, & United Nations Population Fund. (2025). Gender-Based Violence (GBV) snapshot: Gaza, December 2024 - March 2025. ReliefWeb.

30 Pathak, G., Nichter, M., Hardon, A., Moyer, E., Latkar, A, Simbaya, J. et al. (2023). Plastic pollution and the open burning of plastic wastes. Global Environmental Change 80(24).

31 United Nations Environment Programme. (2024). & Velis, C. A. and Cook, E. (2021). Mismanagement of Plastic Waste through Open Burning with Emphasis on the Global South: A Systematic Review of Risks to Occupational and Public Health. Environmental Science & Technology 55(11), 7186–7207.

32 United Nations Office for the Coordination of Humanitarian Affairs. (2025, July 02). Reported impact snapshot | Gaza Strip (2 July 2025). Retrieved July 06, 2025

being functional.[33] This systemic collapse has profoundly impacted routine health services, notably for children, with over one million minors in need of mental health and psycho-social support.[34] UNICEF has reported that routine childhood vaccinations are no longer accessible, and a crucial fourth round of the polio vaccination campaign, intended for over 600,000 children in early April, remains suspended due to ongoing displacement orders, movement restrictions, and depletion of vaccine stocks.[35] Furthermore, service delivery at 13 routine immunization points has been interrupted.[36] Médecins du Monde issued an urgent warning on April 22, stating that without immediate intervention, Gaza's children face a "communicable disease resurgence, endangering the lives of thousands."[37] Children also constitute most patients suffering from severe burns due to hostilities, often with limited options for care or adequate pain management.[38] Generally, an estimated 350,00 civilians in Gaza suffer from chronic non-communicable diseases like cancer, heart disease, dialysis patients, diabetes, and stroke, and are not receiving sufficient healthcare.[39]

Threats such as communicable diseases extend beyond Gaza's borders. Although no polio cases have been reported since that of a child in August 2024, the most recent environmental samples from January 2025 continue to confirm the presence of the poliovirus strain in Deir al Balah and Khan Younis.[40] While pre-conflict polio vaccination rates in Gaza were commendably high (98-99%), infants and young children who have not yet received vaccinations are now at extreme risk due to the absence of medical services and lack of humanitarian access to many areas.[41] Identifying early polio symptoms is exceptionally difficult amidst war conditions and the deteriorating health of those in refugee camps. This situation poses a severe threat not only to Gaza's population but also to young children and other vulnerable residents in neighboring Israel. As public health experts have warned, the highly contagious virus can spread through contaminated transboundary water sources, making a cooperative international response imperative to prevent a regional epidemic.[42]

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33 United Nations Office for the Coordination of Humanitarian Affairs. (2025, July 02). Reported impact snapshot | Gaza Strip (2 July 2025). Retrieved July 06, 2025

34 United Nations Office for the Coordination of Humanitarian Affairs. (2025, July 02).

35 United Nations Office for the Coordination of Humanitarian Affairs. (2025, April 30).

36 United Nations Office for the Coordination of Humanitarian Affairs. (2025, April 30).

37 Médecins du Monde. (2025, April 22). Urgent Call to Protect Children's Health in Gaza. ReliefWeb.

38 United Nations Office for the Coordination of Humanitarian Affairs. (2025, April 30).

39 Communication with Anonymous Palestinian Health expert, interviewed by Elaine Donderer, June 16, 2025.

40 Fletcher, E.R. (2025, February 19). Third Polio Vaccination Campaign Planned for Gaza Next Week. Health Policy Watch. Retrieved July 07, 2025

41 Communication with Anonymous Palestinian Health expert, interviewed by Elaine Donderer, June 16, 2025.

42 United Nations Office for the Coordination of Humanitarian Affairs. (2025, April 30).

Lessons from past global conflicts in regions like Yemen, Syria, and Iraq demonstrate that preventing further spread relies heavily on high pre conflict vaccination rates, trust in vaccine providers, and consistent access to healthcare facilities.[43]

The overall loss of life is staggering. Between October 7, 2023, and April 30, 2025, the Ministry of Health in Gaza under the Hamas regime reported at least 52,400 people killed and 118,014 injured[44], with recent estimates climbing much higher.[45] A significant number of war-wounded will require years of rehabilitation, facing heightened risks of infections, amputations, and permanent disability.[46] Physicians note that even after successful surgeries, infections are rampant due to the lack of appropriate sanitation, hygiene, and antibiotics, leading to unnecessary deaths.[47] The profound psychological trauma from violence, loss of loved ones and homes, harsh living conditions, and repeated displacements represents an enormous and pressing mental health burden that may persist for decades. According to estimates published in The Lancet, the war could lead to a conservative 186,000 excess deaths in Gaza, with 148,000 of these being indirect fatalities resulting from healthcare system collapse, malnutrition, and disease outbreaks.[48] These grim figures underscore that even with a ceasefire, the journey to rehabilitation will impact generations. **Recovery requires an end to the war.** In addition to the obvious humanitarian reasons for the people of Gaza and the Israeli hostages, a ceasefire will enable efforts to improve the water, sanitation, and hygienic conditions and to enhance food security, rebuild adequate shelter, and rehabilitate Gaza's health system by restoring hospitals' capacities.

Food Security

A cessation of hostilities is paramount not only for saving lives but also for restoring the fundamental building blocks of human sustenance. Gaza is currently gripped by a food security emergency of catastrophic proportions. Between September and October 2024, the entire territory was categorized at IPC Phase 4 (Emergency) for food insecurity.[49] During this

43 United Nations Office for the Coordination of Humanitarian Affairs. (2025, April 30).

44 United Nations Office for the Coordination of Humanitarian Affairs. (2025, April 30).

45 Hasson, N. (2025, June 26). 100,000 Dead: What We Know About Gaza's True Death Toll. Ha'aretz.

46 Bég, S. (2025, January 24). Gaza: At long last, a temporary ceasefire. Doctors Without Borders / Médecins Sans Frontières (MSF). Retrieved May 3, 2025

47 Communication with Anonymous Palestinian Health expert, interviewed by Elaine Donderer, June 16, 2025.

48 Bég, S. (2025, January 24).

49 United Nations (2024, October 17). Gaza Strip: Acute Food Insecurity and Acute Malnutrition - IPC Special Snapshot - September 2024 - April 2025 - Question of Palestine. Retrieved December 16, 2024

period, an estimated 1.84 million people in the Gaza Strip faced severe levels of acute food insecurity, including approximately 133,000 enduring famine-like conditions (IPC Phase 5) and 664,000 in acute emergency (IPC Phase 4). The situation deteriorated further into the period of November 2024 to April 2025, when nearly 2 million individuals, over 90 percent of the population, were classified as experiencing Crisis (IPC Phase 3) or worse.[50]

Within this grim assessment, 345,000 people (16 percent) were in Catastrophe (IPC Phase 5), and 876,000 (41 percent) faced Emergency (IPC Phase 4) conditions, with particularly severe acute food insecurity noted in Rafah and the northern governorates.[51] Malnutrition rates have surged to ten times their pre-conflict levels, pushing the humanitarian situation to a "breaking point," a concern underscored by the WFP's late April report of depleted food stocks.[52]

Although COGAT, the Israeli Defense Ministry body responsible for civilian affairs in the Palestinian territories, and others, dispute the IPC estimates for Gaza[53], it remains evident that the widespread obliteration of Gaza's food production capacity fundamentally undermines its ability in supporting its population. Furthermore, an analysis of satellite imagery from the Sentinel-2 satellite by UNOSAT, spanning March 2018 to March 2025, reveals a stark transformation of agricultural landscapes. Approximately 80% of all croplands in Gaza had been either damaged or destroyed by March 2025.[54] Intensive military activities, such as the movement of heavy machinery, compacts, erodes, and depletes fertile topsoil, making it difficult for vegetation to grow. This extensive devastation of fertile land is of serious detriment to the region's ability to feed itself.

In addition, Gaza's fishing sector, traditionally a vital source of both livelihood and crucial nutrition, has been securitized. Fishermen confront immense dangers at sea, compounded by severe access restrictions, insufficient equipment, and pervasive threats to life. Driven by the deepening food crisis, many are compelled to embark on perilous fishing trips despite the acute risks of becoming a target of military action. Reports from April documented multiple instances where fishing vessels were struck or came under fire near the shore,

50 United Nations (2024, October 17).

51 United Nations (2024, October 17).

52 United Nations Office for the Coordination of Humanitarian Affairs. (2025, April 30).

53 Staff, T., & Reuters. (2024, March 30). "Multiple factual flaws": Israel contests UN-backed report on imminent famine in Gaza. Times of Israel.

54 UNOSAT. (2025, January 30). Damage to Cropland Overview Map.

leading to casualties among fishermen.[55] Aid organizations and local fishermen confirm that Israeli security measures in Gaza's coastal waters have rendered fishing activities virtually impossible since the onset of the conflict. Nezar Ayyash, president of the Gaza fishermen's association, reported that at least 120 fishermen have lost their lives during the hostilities. He describes a desperate scene where hungry fishermen are forced to fish perilously close to the coast, "risking their lives, but they have no other option. The army have been shooting everyone going to the sea".[56] The Israeli military has not disputed these reports, asserting that "this maritime zone is considered a combat area".[57] By July, the UN Special Rapporteur on the Right to Food conveyed that an estimated 93% of the combined agriculture, forestry, and fishing sectors can be considered destroyed.[58]

This wholesale destruction of agricultural land and the effective incapacitation of the fishing industry do not merely compound the immediate humanitarian crisis but affect Gaza's environmental capacity to sustain its inhabitants. **The extensive harm to croplands, the ruin of agricultural infrastructure, and the contamination of land and water resources will inevitably lead to severe and prolonged environmental degradation, impacting soil fertility, water availability, and biodiversity, all indispensable elements for future food security.**

55 United Nations Office for the Coordination of Humanitarian Affairs. (2025, April 30).

56 Stack, L., & Bashir, A. B. (2024, November 1). As Famine Stalks Gaza, Farmers Lament Their Many Losses. The New York Times.

57 Stack, L., & Bashir, A. B. (2024, November 1).

58 Shaban, A. A., & McAllister, G. (2024). Resilience, Reciprocity and Recovery in Gaza: Drawing Lessons from Women-led Agribusinesses Amidst Conflict and Crisis. Gaza Urban and Peri-Urban Agriculture Platform (GUPAP).

Displacement

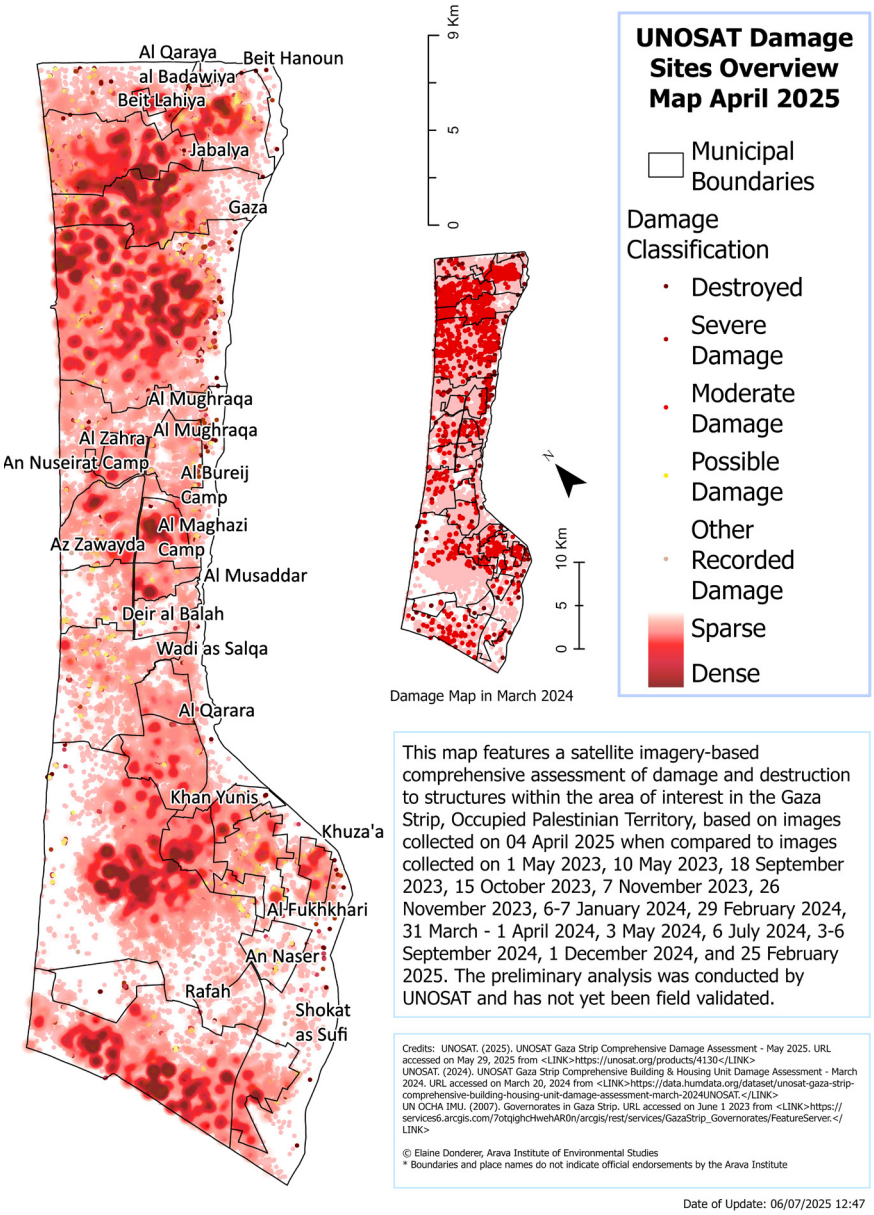

Figure 3: UNOSAT Status of Damage Counts and Sites across the Gaza Strip as of April 2025 [59]

The scale of destruction in Gaza has generated ongoing waves of displacement, fundamentally reshaping the Strip's physical and human landscape. Satellite imagery analysis by UNOSAT reveals the extent of the structural damage by December 2024, identifying 60,368 structures as destroyed, 20,050 severely damaged, 56,292 moderately damaged, and an additional 34,102 possibly damaged, totaling 170,812 affected structures (Fig. 3).[60] This accounts for approximately 69% of Gaza's total infrastructure, encompassing an estimated 245,123

59 UNOSAT. (2025, May 07). Gaza Strip Comprehensive Damage Assessment.

60 UNOSAT. (2025, May 07).

damaged housing units, including over 2000 destroyed educational facilities and 62% of the total road network.[61] The governorates of North Gaza and Rafah have borne the brunt of this escalation, showing the most significant increase in damage since September 2024.[62] Notably, the reduced frequency of UNOSAT's regular damage assessment publications raises concerns about the impacts of sensational news coverage as opposed to comprehensive data allowing for accountability.

The human consequence is a population in constant motion, repeatedly seeking safety that remains elusive. UNOCHA reports that vast areas of Gaza have become uninhabitable or designated displacement zones: 100% of Rafah, 84% of North Gaza, 78% of Gaza City, 51% of Khan Younis, and 41% of Deir al Balah. The UN estimates that approximately 420,000 people have been displaced yet again since the ceasefire breakdown.[63] Overall, humanitarian consortia estimate that 423,547 individuals have been displaced from their homes at least once since the onset of the war.[64]

Indeed, nearly the entire population of Gaza has been displaced multiple times, often under shelling and aerial bombardments. Many of the most vulnerable households find themselves unable to relocate or secure safe shelter. The vast majority live in temporary, makeshift camps, enduring an alarming population density reported to near 40,000 people per square kilometer.[65] This extreme overcrowding in temporary settlements not only creates severe humanitarian challenges but also places immense strain on limited resources and fragile local ecosystems, contributing to environmental degradation.

The Israeli army continues to issue evacuation orders for expansive areas of the Strip, forcing residents who had only recently returned to their homes, or what remained of them, into yet another cycle of displacement. According to an assessment by the UN Site Management Cluster, over 390,000 people have been displaced since hostilities resumed on March 18, 2025. Recent orders include two areas in Gaza City on April 3, and parts of Deir al-Balah on April 6, the latter impacting 12 IDP sites housing 8,000 people, a hospital, and health centers,

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61 United Nations Office for the Coordination of Humanitarian Affairs. (2025, July 02).

62 UNOSAT. (2024, December 13). Gaza Strip Comprehensive Damage Assessment. https://unosat.org/products/4047

63 Agency for Technical Cooperation and Development, CCCM Cluster, Danish Refugee Council, UN High Commissioner for Refugees, & UN Relief and Works Agency for Palestine Refugees in the Near East. (2025, April 29). Population Movement Monitoring Flash Update (April 22 – 29, 2025 – Update 12).

64 Agency for Technical Cooperation and Development, CCCM Cluster, Danish Refugee Council, UN High Commissioner for Refugees, & UN Relief and Works Agency for Palestine Refugees in the Near East. (2025, April 29).

65 United Nations (2024, October 17).

with two field hospitals nearby.[66] Moreover, reports persist of attacks on tents sheltering internally displaced persons across the Gaza Strip. Between March 18 and April 27, OHCHR documented 259 attacks on residential buildings and 99 on IDP tents. Most of these strikes resulted in fatalities, including women and children. Alarmingly, 40 of the reported attacks on IDP tents occurred in the Al Mawasi area in Khan Younis, a zone repeatedly designated by the Israeli army as a refuge for civilians.[67]

In recent months, the conditions surrounding aid distribution have become an increasingly critical concern. Haaretz, an Israeli news outlet, reports that Israeli soldiers have testified to the deliberate firing at unarmed Palestinians near American aid distribution sites over the past month, including those managed by the American Gaza Humanitarian Foundation.[68] In an official statement, IDF state that the reports are under examination but strongly reject accusations of deliberately instructing soldiers to shoot at civilians, asserting that such directives are prohibited, and that they are working to facilitate aid distribution and secure routes to prevent aid from reaching Hamas.[69] The IDF also noted ongoing efforts to improve operational response and minimize friction, including reorganizing areas with new fencing, signage, and additional routes. Either way, the current system does not guarantee the protection of civilians and the establishment of a genuinely dignified, just, and consistently safe system for humanitarian aid access. **The persistent threat of interpersonal and military violence at aid points not only exacerbates the humanitarian catastrophe but also erodes trust and undermines the fundamental principles of humanitarian assistance.** Ensuring that aid reaches civilians safely and without risk to life is non-negotiable for any legitimate and effective response to the crisis.

Environmental Degradation

The scale of destruction in Gaza manifests as profound and widespread environmental degradation. While civilians have yet to experience safety, the level of building destruction has generated an unprecedented debris situation. The sheer volume of rubble, its widespread geographic distribution, and the rapid rate at which it continues to accumulate are unparalleled (Fig. 3). This debris is heavily contaminated with unexploded ordnance and weaponry

66 Gisha (2025, April 9).

67 OHCHR. (2025, April 29). Türk calls on world to prevent total humanitarian catastrophe in Gaza.

68 Hasson, N., Kubovich, Y., & Peleg, B. (2025, June 27). 'It's a Killing Field': IDF Soldiers Ordered to Shoot Deliberately at Unarmed Gazans Waiting for Humanitarian Aid. Haaretz. Retrieved July 06, 2025

69 Israeli Defense Forces (2025, June 27). IDF Response Regarding Allegations of Deliberate IDF Fire Toward Gazan Civilians Waiting for Humanitarian Aid. Retrieved July 06, 2025 from

residues, posing extreme hazards.[70] Moreover, the presence of asbestos from damaged structures, particularly within former refugee camps, adds additional environmental and health risks to the cleanup efforts.

The ongoing hostilities have directly impacted the very ecosystems essential for life, with consequences that disregard political borders. One example is compromised air quality due to the release of toxic particulates and gases. These pollutants significantly impair crop health and yield, as prolonged exposure stresses plants and reduces productivity. This atmospheric contamination is part of a broader assault on agricultural capacity. Bombardment directly renders large tracts of vital agricultural land unusable, scarred by unexploded ordnance and craters, leading to an immediate and substantial loss of food production. The destruction of

The destruction of green spaces has further contributed to widespread habitat loss, directly threatening the survival of numerous plant and animal species essential to the region's ecological balance.

crops and livestock, coupled with farmers' inability to tend their fields, results in a dramatic decline in local food supply.[71] Furthermore, the intensity of bombings, particularly in 2023, have not only harmed biodiversity and disrupted ecosystems but effectively diminished their capacity to provide essential services like pollination, natural water purification, and maintaining soil fertility. This directly translates to reduced agricultural productivity and overall ecological instability, exacerbating humanitarian challenges.[72]

The destruction of green spaces has further contributed to widespread habitat loss, directly threatening the survival of numerous plant and animal species essential to the region's ecological balance. For instance, Gaza's documented animal diversity, including 29 reptile species like various snakes, lizards, and turtles, is now under immense pressure due to the degradation of their habitat, conservation sites, and zoos.[73] Disruptions also extend to global

70 United Nations Environment Programme. (2024).

71 Al-Muhannadi, K., & Buheji, M. (2023). Mitigating Risks of Environmental Impacts on Gaza - Review of Precautions & Solutions post (2023 War). International Journal of Advanced Research in Engineering and Technology, 14(7), 15–47.

72 Al-Muhannadi, K., & Buheji, M. (2023).

73 Abd Rabou, Abdel Fattah. (2024). On the Palestinian Reptilian Fauna Caged and/or Kept Stuffed at Zoos of the Gaza Strip. Open Journal of Ecology. 14. 950-980.

bird migration routes and other crucial wildlife habitats, highlighting the interconnectedness of ecosystems on a planetary scale. **The increasing threats to biodiversity feed a dangerous feedback loop in which the natural environmental diversity and its inherent capacity to absorb shocks, such as floods and droughts, diminishes accordingly. This escalating vulnerability further strains communities already struggling with the profound consequences of war.**

Satellite imagery taken since the January 19 ceasefire offers a stark visual testament to this ecological devastation. It reveals that an estimated 80 percent of Gaza's trees have been lost. Beyond this immediate loss of green cover, vital wetlands, sand dunes, and coastal waters have all suffered extensive damage. Even Wadi Gaza, the territory's only significant perennial river, has endured severe degradation. UNEP warns that the widespread stripping of trees, shrubs, and crops has inflicted such severe damage on the soil of this once fertile and biodiverse territory that it now faces desertification.[74]

These localized environmental catastrophes carry transboundary implications, underscoring that pollution has no borders. The continued contamination of water bodies like Wadi Gaza and the Mediterranean coastline poses risks far beyond Gaza's shores, with principal currents in the Levantine Sea traveling northward of Gaza, along Israeli, Lebanese, and Turkish shores, transporting surface waters from Gaza also along the coastlines of Cyprus.

Figure 4: Surface circulation in the Mediterranean Sea [75]

74 Pearce, F. (2025, February 6). As War Halts, the Environmental Devastation in Gaza Runs Deep. Yale Environment 360.

75 https://www.dreamstime.com/surface-flow-map-mediterranean-sea-surface-flow-map-mediterranean-sea-image155645318

Environmental disruptions also extend to global bird migration routes and crucial wildlife habitats, highlighting the interconnectedness of ecosystems on a planetary scale (Fig. 5).[76] Israel-Palestine constitutes a crucial pitstop for over 500 million migratory birds annually. Some scientists point out that large birds are at risk of death as their size, speed, and travel direction may be misinterpreted as UAVs and met with interception missiles from Israel.[77] Moreover, destruction of agricultural land and wildfires related to the war reduce food availability for birds, such as barn owls, negatively affecting ecological balance.[78] Hence, war threatens biodiversity and animal habitats, with marine, terrestrial and avian life being no exception.

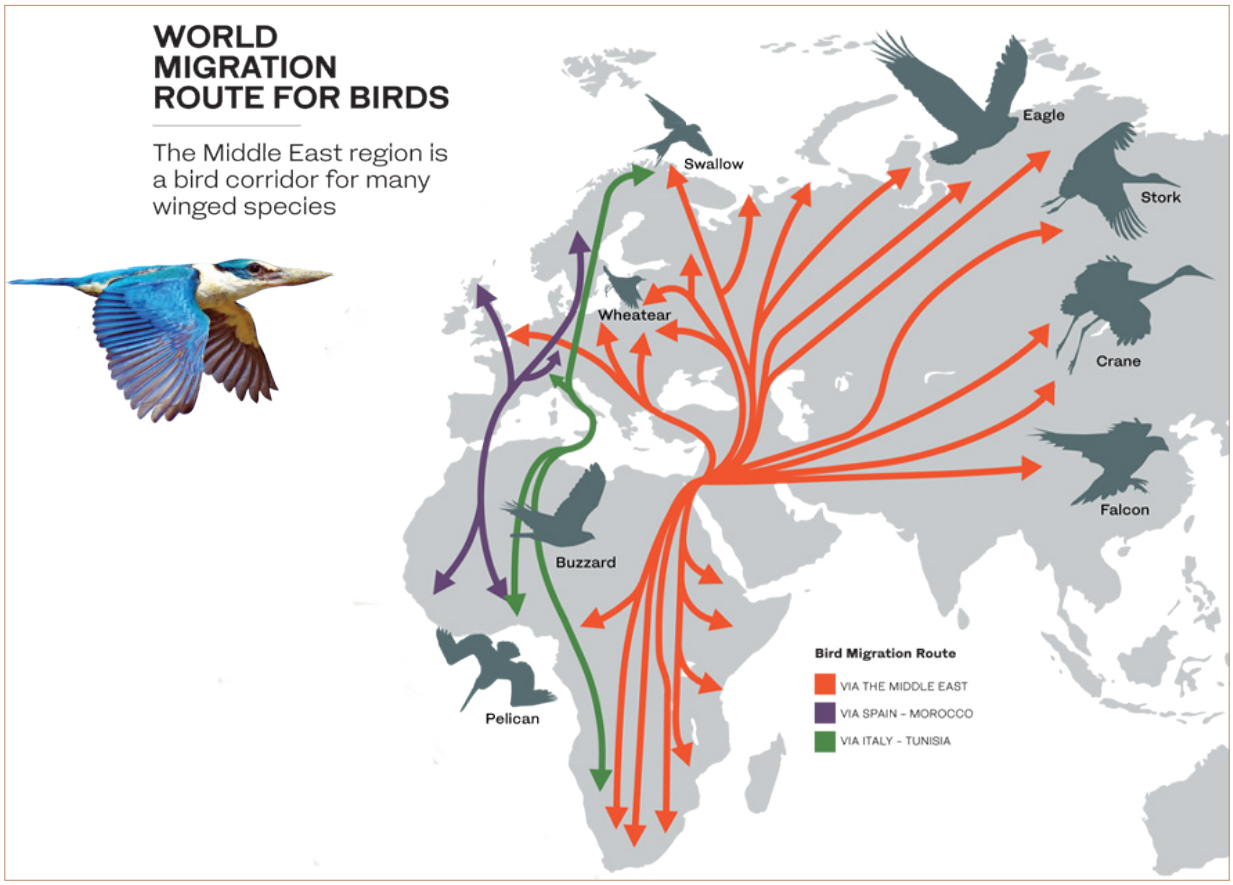

Figure 5: Dominant bird migration routes from Europe and Asia to Africa and vice versa [79]

The cumulative environmental damage, from contaminated air and water to degraded soil and lost biodiversity, already affects health, livelihoods, and ecological stability across

76 Dardona, A. W., & Khalaf-von Jaffa, N. A. B. (2014). Studying Aquatic Birds in the area between the Gaza Fishermen Port and Wadi Gaza Estuary, Gaza Strip, Palestine. Gazelle: The Palestinian Biological Bulletin, 124, 22-39.

77 Coreth, M., Leshem, Y., & Roulin, A. (2022). Birds as Bridges between Religions and People. In Religion and Nature Conservation (pp. 225-236). Routledge.

78 Rozman, G., Izhaki, I., Roulin, A., & Charter, M. (2021). Movement ecology, breeding, diet, and roosting behavior of barn owls (Tyto alba) in a transboundary conflict region. Regional Environmental Change, 21(1), 26.

79 Bell, J. (2019, May 12). What Saudi Arabia, neighbors are doing to protect bird migratory routes in the Middle East. Arab News.

a wider region. The profound ecological damage, intrinsically linked to the humanitarian catastrophe, underscores the urgent need for a comprehensive response that looks beyond immediate relief to address long-term recovery. It is a stark reminder that **true rehabilitation must encompass not just people and infrastructure, but the very environment that sustains them. This necessitates a shift from managing crises to proactively challenging conditions of vulnerability.**

A phased recovery model

The immense challenges facing Gaza demand a strategic and compassionate approach, one that moves beyond immediate crisis management toward building lasting stability and well-being. Our proposed framework for this journey envisions a phased progression, focusing on evolving capacities and conditions that allow communities not just to cope, but to truly thrive. This model helps us understand how interventions can evolve, from addressing urgent needs to fostering profound, systemic change.

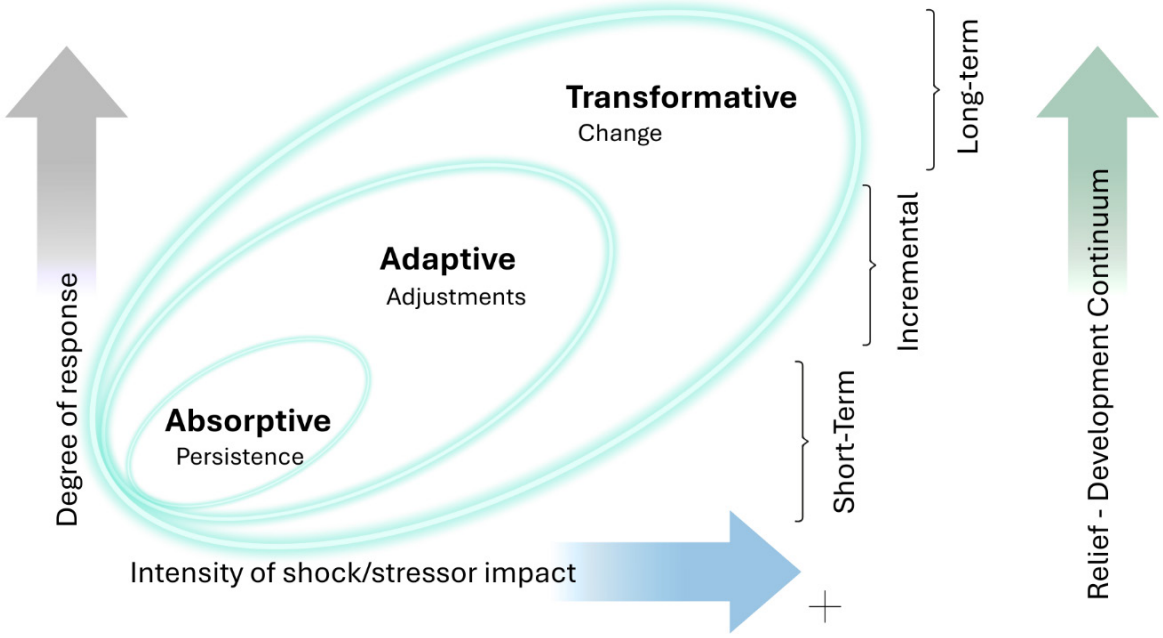

Figure 6: A phased recovery model based on absorptive, adaptive, and transformative capacities[80]

Figure 6 illustrates the dynamic progression in which immediate relief efforts, focused on sustaining essential conditions, gradually transition and integrate with longer-term development initiatives that aim for transformative change.[81] This integrated approach,

80 Adapted with permission from Béné, C., Headey, D., Haddad, L., & von Grebmer, K. (2016). Is resilience a useful concept in the context of food security and nutrition programmes? Some conceptual and practical considerations. Food Security, 8(1), 123–138.

81 Béné, C., Cornelius, A., & Howland, F. (2018). Bridging Humanitarian Responses and Long-Term Development through Transformative Changes—Some Initial Reflections from the World Bank's Adaptive Social Protection Program in the Sahel. Sustainability, 10(6), 1697.

often referred to as the humanitarian-development continuum, recognizes that immediate needs and deeply rooted vulnerabilities are interconnected. It emphasizes the need to create synergies between short-term assistance and long-term development actions, acknowledging that humanitarian crises and ecosystems are often intertwined. This framework, while a simplified representation, powerfully demonstrates how organizations can align their immediate interventions with dynamic visions for societal change.

At the initial stage, recovery efforts concentrate on sustaining essential conditions. This involves immediate humanitarian interventions designed to provide life-saving assistance, helping populations absorb the direct impact of a crisis and restore basic functioning. Historically, these efforts have focused on enabling communities to "bounce back" after extreme events, ensuring immediate survival and stability.[82] As conditions stabilize, the focus shifts to adapting and adjusting to new realities. This phase involves interventions aimed at helping communities make necessary adjustments and foster new capacities in the face of ongoing challenges. Programs that address climate-related shocks and stressors, for instance, typically fall within this adaptive stage, enabling populations to modify practices and systems to better navigate persistent difficulties.[83] The long-term objective, however, is laying the groundwork for transformative change. This goes beyond simply repairing what was lost or adjusting to current conditions. It involves fundamental shifts in the underlying systems and power dynamics that contribute to vulnerability, aiming for a more just, equitable, and sustainable future. This highest level of recovery empowers communities to reshape their environment and societal structures, rather than merely reacting to them.

For Gaza, any path forward must prioritize Palestinian-led and enacted initiatives. This principle ensures that solutions are culturally appropriate, context-specific, and genuinely empower local communities, fostering true ownership and sustainable outcomes. It is recommended that proclaimed solutions integrate decentralized, nature-based approaches and circular economy principles to realize local ownership. Emphasizing decentralized solutions is paramount because they directly empower local communities, fostering self-reliance from the ground up. This approach enables the practical implementation of circular economic models and significantly reduces dependence on politically volatile national governments, creating a more resilient and stable foundation for recovery. Adopting decentralized, circular economy models focused on resource efficiency, waste reduction, and closed-loop systems,

82 Béné, C., Cornelius, A., & Howland, F. (2018).

83 Béné, C., Cornelius, A., & Howland, F. (2018).

can drastically improve resource management and promote long-term economic viability.[84] NBS, such as artificial wetlands, urban green spaces, or coastal ecosystems, can additionally reduce environmental risks while enhancing biodiversity and vital ecosystem services (Table 4).[85] These solutions not only mitigate risks like flooding, erosion, and heat, but also provide crucial co-benefits like clean water, food production, tourism, and recreation.[86]

#	Type of Solution	Description	Relevant Recovery Phases(s)
1	Dignity Packs	Backpacks with essential hygiene products to help maintain a level of personal cleanliness and dignity, which is critical in reducing the spread of disease and improving the overall health and well-being of displaced people(s).	Absorptive
2	Hot Meals	Daily meals for displaced people(s) sourced from local producers or aid trucks.	Absorptive
3	Water Storage Tanks	Water storage tanks are crucial in humanitarian operations for providing a reliable and sustainable water supply to affected populations. They are used to store water collected from various sources, including springs, water treatment systems, or rainwater harvesting, ensuring a backup supply in case of disruptions. These tanks are designed to be durable, scalable, and easily deployable, making them suitable for various environments and needs.	Absorptive, Adaptive
4	Solar Power Units	Energy generated from solar power can help to reduce the cost of electricity, contribute to a resilient electrical grid, create jobs and spur economic growth, generate back-up power for nighttime and outages when paired with storage, and operate at similar efficiency on both small and large scales.	Absorptive, Adaptive, Transformative
5	Urban Farming	"Urban farming" is the utilization of available space for food production, through the investment of available resources and unused areas in cities. These unused areas can involve spaces such as empty land between buildings, as well as rooftops of residential buildings, hospitals, schools and roadsides.	Absorptive, Adaptive, Transformative
6	Watergen Units	Energy-efficient mobile Atmospheric Water Generator that doesn't require any infrastructure besides an electrical socket and works absolutely independently from existing piping and produces potable water.	Absorptive, Adaptive, Transformative
7	Laguna Systems	Off-grid biofiltration wastewater treatment systems offering cost-effective and environmentally friendly non-potable water.	Absorptive, Adaptive, Transformative
8	Water Desalination Units	Portable desalination units or devices designed to produce fresh water from saltwater or brackish water, typically using methods like reverse osmosis or distillation. These unconventional water sources can be a vital diversifier in water-scarce areas.	Absorptive, Adaptive, Transformative
9	Home Biogas	Low-cost small biogas digester suitable for different IDP camp sizes. An innovative system that treats organic waste on-site by converting it into renewable energy used for cooking or heating.	Absorptive, Adaptive, Transformative
10	GreenCake	Environmentally friendly building blocks at high-quality, and a lower cost than cement. The bricks are made out of ash and rubble from the demolished houses in Gaza.	Adaptive, Transformative
11	Citizen Science	Participatory data collection and validation through remote citizen science programs accessible to Gazans, while building local capacity for processing and usage.	Adaptive, Transformative

84 Mattour, N., & Kamoun-Chouk, S. (2025). Circular Economy Challenges and Opportunities amidst Sustainable Development and Perpetual Crises: A Reflection from the Learning Lens of Palestinian Universities. Circular Economy and Sustainability, 5(1), 699–717.

85 van Zanten, B., Gutierrez Goizueta, G., Brander, L., Gonzalez Reguero, B., Griffin, R., Kapur Macleod, K., Alves, A., Midgley, A., Diego Herrera, L., & Jongman, B. (2023). Assessing the Benefits and Costs of Nature-Based Solutions for Climate Resilience: A Guideline for Project Developers. World Bank.

86 van Zanten, B., Gutierrez Goizueta, G., Brander, L., Gonzalez Reguero, B., Griffin, R., Kapur Macleod, K., Alves, A., Midgley, A., Diego Herrera, L., & Jongman, B. (2023).

#	Type of Solution	Description	Relevant Recovery Phases(s)
12	Early Warning Systems based on Ecological Indicators	Monitoring changes in ecosystems and biodiversity to provide early warnings for environmental hazards, allowing for timely preparedness and response.	Adaptive, Transformative
13	Agroforestry	Integrating trees and shrubs into farming systems can improve soil health, enhance biodiversity, provide shade and windbreaks, and offer additional sources of food, fodder, and fuel, contributing to food security and resilience.	Transformative
14	Permaculture and Regenerative Agriculture	Create small-scale sustainable and self-sufficient agricultural systems that mimic natural ecosystems, improving soil fertility, conserving water, and enhancing biodiversity while producing food.	Transformative
15	Native Seed Banks and Nurseries	Establish local nurseries that specialize in propagating native Palestinian plant species, particularly those known for their drought tolerance, resilience to saline conditions, and ability to stabilize soil. Seed banks will preserve genetic diversity for future restoration and climate-resilient agriculture.	Transformative
16	Artificial Reefs from Recycled Debris	Carefully clean and repurpose inert war debris (like concrete rubble) to create artificial reefs in designated areas offshore. These structures provide habitat and shelter for marine life, promoting biodiversity and enhancing fish stocks over time while reducing coastal erosion and flood risks. An economic benefit is the promotion of the fishing sector.	Transformative
17	Bio Remediation using Native Plants and Fungi	Identify and cultivate native Palestinian plant species and fungi known for their ability to absorb and break down specific pollutants like heavy metals and other toxins (phyto-remediation and myco-remediation).	Transformative
18	Stormwater Harvesting and Drainage	Incorporating green infrastructure like permeable pavements, rain gardens, and bioswales in urban reconstruction to help manage stormwater runoff, reduce flooding, improve water quality, and create green spaces.	Transformative
19	Aquifer Recharge & Restoration Zones	Identification of viable recharge zones and degraded areas requiring restoration to formulate strategic recommendations for integrated aquifer restoration for reduced salinity and pollutants in transboundary water resources.	Transformative
20	Green Corridors and Stepping Stones	Networks of vegetated areas connecting larger green spaces to support wildlife, pollinators and protect migratory routes of birds while providing urban cooling.	Transformative

Table 4: Overview of potential solutions by recovery phase

The "Jumpstarting Hope in Gaza" (JHG) initiative exemplifies how these principles can be put into practice. JHG's collaborative network, spearheaded by the Arava Institute and Damour for Community development, includes including Movement on the Ground, and SmartAID, alongside sub-partners like Duke University, Peres Center for Peace, and Gigawatt Impact, working together to deploy modular, off-grid systems.[87] These include advanced small-scale reverse osmosis water desalination systems, atmospheric water generators, on-site wastewater treatment, solar and hybrid micro-grids, and adaptable camp infrastructure, all supported by social enterprises.[88] These vital services have potential to provide self-reliance in drinking water, energy, and sanitation directly within communities. The modular nature of JHG's approach allows for rapid scaling through locally governed infrastructure models and

87 Baggio, G., Adamowski, J., Hyde, V. J., & Qadir, M. (2024). Small-scale desalination and atmospheric water provisioning systems in water-scarce vulnerable communities: status and perspectives. International Journal of Water Resources Development, 40(4), 686–717.

88 Salah, W. A., Abuhelwa, M., & Bashir, M. JK. (2021). The key role of sustainable renewable energy technologies in facing shortage of energy supplies in Palestine: Current practice and future potential. Journal of Cleaner Production, 293, 125348.

strategic private sector partnerships, ensuring swift expansion and replication of successful installations across Gaza. This adaptability makes it a compelling blueprint for addressing humanitarian crises and building sustainable futures in the region.

Absorptive phase

Absorptive Phase (Immediate Life-Saving & Stabilization)

• **Secure Unimpeded Aid Access:** Mandate and enforce consistently safe, unhindered, and dignified humanitarian aid entry and distribution. The current system is unfit; lives depend on immediate, reliable access.

• **Prioritize Critical WASH Provision:** Rapidly fund and deliver essential hygiene kits and potable water systems, mitigating immediate health crises at their source and preventing further disease outbreaks.

• **Expedite Debris & Contamination Clearance:** Allocate immediate, dedicated resources for systematic removal of rubble and unexploded ordnance, essential for safety, access, and enabling early recovery.

• **Provide Dignified Emergency Shelter:** Ensure swift provision of temporary housing and essential services in secure areas, preventing

Despite the ongoing destruction, Gazans demonstrate a remarkable spirit of sumud[89] actively engaged in a continuous process of recovery. This crucial first phase focuses on sustaining essential conditions, providing urgent humanitarian support, and laying the groundwork for future stability. Much of this immediate action is spearheaded by local actors and community-based organizations, who are on the front lines of the disaster, as access to Gaza remains restricted and hostile.

In response to the conditions described in the previous section, community aid organizations like Damour for Community Development and its partners are actively providing critical immediate relief. Their work includes the distribution of essential dignity packs and hot

89 Meaning steadfastness or perseverance in Arabic.

meals, alongside the urgent provision of shelter. A significant achievement to date is the successful establishment of four community-managed shelters across southern Gaza, which up until the ceasefire in January 2025 offered refuge and vital services to over 12,000 displaced individuals. These shelters were designed to provide more dignified and stable options than rudimentary tents, which are highly vulnerable to extreme weather. Today, JHG supports Damour in the management of the Mesk & Layan Shelter, located in the Khan Younis governate, in south al-Mawasi, housing 4,000 displaced people and supporting 8,000 civilians in surrounding areas.

The facilities include communal kitchens that serve both camp residents and neighboring communities. The shelter acts as a local hub for food, and WASH provisions, with a recent water well and pump installed on site. Additionally, expanding the availability of clean and affordable cooking fuels, increasing access to appliances, and introducing alternative energy and storage solutions could ease burdens on affected populations, reducing time demands, improving household welfare, and curbing harmful practices like resorting to scavenging for fuel.[90] This shelter is currently identified as a top priority for urgent water infrastructure development, with our teams currently identifying adequate spots for a small scall reverse osmosis desalination system.

The continued efforts by local consortia provide displaced residents with access to crucial WASH and energy services by applying sustainable approaches. For instance, a 100-family camp only requires approximately 26.5 kW of solar power to meet basic electricity needs. The JHG consortium is actively planning to scale this modular shelter model to additional sites, including in North Gaza, to expand refuge and support for internally displaced people while major reconstruction remains a distant prospect. This work not only addresses immediate humanitarian needs but also seeks to create more stable shelter options for a population where women and children represent the predominant demographic. Diplomatic efforts focused on the environment are also crucial to guarantee dignified shelter locations and facilitate access to basic services.

A key aspect of sustaining essential conditions in balance with the surrounding ecosystem also includes fostering self-reliant governance within the temporary camps. This includes establishing robust communication channels and effective community management structures. Empowering residents with ownership over the management of their immediate

90 Helbig, F., Al-Kaddo, H., & Onsager, J. E. (2025). Restoring Dignity: The Urgent Need for Energy Access in Gaza – 2025 Energy Assessment for Gaza: Humanitarian Operations and Household Needs. Shelter Cluster (Palestine), NRC and NORCAP.

living environments is vital for ensuring responsiveness, maintaining order, and promoting collective well-being amidst chaos. However, as the situation changes rapidly, the flow of families in and out of the camps continues, and stability remains elusive.

Figure 7: Food distribution in al-Mawasi by the Jumpstart Hope in Gaza Initiative.
Photo credit: Damour for Community Development.

Amidst a rise in malnutrition and hunger, immediate efforts focus on ensuring basic sustenance through the distribution of hot meals from locally sourced produce (Fig.7). This critical response is often driven by the profound solidarity within communities, exemplified by the establishment of community kitchens in shelters for displaced people.[91] These collective care initiatives not only provide essential nourishment but also embody the ethics of mutual support engrained in Palestinian culture. Prior to the recent escalation, the Gaza Strip had already seen remarkable achievements in urban agricultural enterprises, which demonstrated significant adaptation and productivity.[92] These projects, including organic agricultural units supported by organizations like the MA'AN Center, proved capable of producing comparable

91 "Urban Farming"... a Safe source of Food and a Lifeline for Hundreds of Families in Gaza. (2019, May 1).

92 Shaban, A. A., & McAllister, G. (2024).

yields to conventional farming, often with superior quality and environmental safety. Such initiatives provided participants with vital training, guidance, water reservoirs, and essential inputs like seeds, seedlings, and compost, with some even evolving into income-generating projects.[93]

Although local initiatives and past successes highlight potential, the immediate need remains overwhelming. Notably, JHG successfully distributed 60,000 hot meals, 3,000 food parcels, and 600 tins of infant formula during the aid blockade that took place since March 2nd, 2025, aiming to enhance nutritional diversity and food availability for approximately 20,000 people. This immediate provision of food, alongside the continued support for local, self-sustaining efforts, is crucial to address the escalating hunger crisis and leverage Gaza's inherent capacity for local food production, even under extreme duress.

The fundamental link between water access and food security underscores the urgency of the repair, maintenance, and ultimately upgrade of pre-existing water infrastructure. Immediate efforts, however, focus on alternative water distribution and enhancing storage capacity at both community and household levels to mitigate the impact of disrupted supply chains. Innovative solutions are ready to be deployed, for instance, Watergen atmospheric potable water systems delivering vital drinking water, provided by JHG, which can function in key areas such as field hospitals.[94] Further immediate interventions involve the deployment of decentralized water systems, including water storage tanks, desalination units, and wastewater treatment systems, powered by solar energy from regional enterprises.[95] These integrated systems are designed for robust, long-term operation in crisis settings and can help mitigate pathogens in wastewater systems.[96]

However, significant challenges persist in ensuring accessible water, particularly at displacement sites (Fig.8). Pumping water from aquifers is largely unavailable due to fuel shortages, and transporting water to shelters from existing sources proves prohibitively expensive. Digging new, deeper wells for low-salinity water is often impractical due to extreme costs and the difficulty of reaching depths below 20 meters. To overcome this, technical teams on the ground have suggested a pragmatic approach: treating water from

93 "Urban Farming"... a Safe source of Food and a Lifeline for Hundreds of Families in Gaza. (2019, May 1).

94 Özcan, G., Çelebi, N. G., & Arpacıoğlu, Ü. (2022). Portable irrigation system producing water from air for sustainable living:"ECO-WATER-GEN". Journal of Architectural Sciences and Applications, 7(2), 501-510.

95 Pachaiappan, R., Cornejo-Ponce, L., Rajendran, R., Manavalan, K., Femilaa Rajan, V., & Awad, F. (2022). A review on biofiltration techniques: recent advancements in the removal of volatile organic compounds and heavy metals in the treatment of polluted water. Bioengineered, 13(4), 8432–8477.

96 Interview with Anonymous Israeli Project Manager, interviewed by Elaine Donderer, May 31, 2025.

other available regional sites and then transporting it to shelters, where it can be stored in communal water tanks. This immediate strategy is crucial for sustaining basic water access while major infrastructure remains under repair.

Regarding waste and pollution, the immediate imperative is to manage contamination risks.[97] As previously mentioned, the war in Gaza severely exacerbates air pollution through waste incineration, military vehicle emissions, and the pulverization of materials from bombings, all of which demonstrably impact public health, contributing to respiratory and other illnesses. Additionally, within temporary displacement sites, a particularly acute challenge is the disposal of sewage. Currently, waste from toilets and showers is often directed into makeshift cesspits dug directly into the sand. These shallow pits, lacking proper sulfur-resistant lining, pose a major health hazard, failing to insulate waste from the surrounding environment.[98] Hence, the risks of emergent pathogens are tangible, as observed by medical professionals in various shelters. In the words of the WHO Director-General: "Disease and war are old friends. But the opposite is also true: health and peace go hand-in-hand. And in this increasingly divided and divisive world, health can be a bridge to peace. There is no health without peace, and there is no peace without health."[99] While the WHO continues extensive vaccination campaigns, disease samples persist, and other environmental health threats, rooted in systemic infrastructure collapse, remain entirely unaddressed.[100] To get to the root of this profound challenge, urgent and substantial investment in decentralized water and wastewater treatment facilities is essential. Addressing immediate contamination and pollution risks is a paramount priority for health and environmental protection, offering a tangible pathway to stability. Funding can enable immediate, localized solutions to manage sewage and provide clean water, safeguarding public health and breaking the cycle of contamination-driven disease outbreaks. Such investment is fundamental to addressing all dimensions of health, both environmental and human, while safeguarding both physical well-being and the critical psychological dimensions of living in dignity and safety.

Notably, the pervasive trauma and relentless stress of the war can constitute an additional hindrance to recovery, as stress-related illnesses and mental health disorders increase the burden on Gaza's already decimated healthcare system. Addressing the psychological dimensions of the war immediately is as critical as providing physical first aid. Early

97 United Nations Environment Programme. (2024).

98 United Nations Environment Programme. (2024).

99 WHO (2025, June 22). WHO Director-General's keynote speech at the 116th Rotary International Convention – 22 June 2025. Retrieved July 06, 2025

100 Fletcher, E.R. (2025, February 19).

Figure 8: 12 October 2023, Palestinian Territories, Gaza City: Palestinians fill containers with drinking water from a water distribution vehicle, amid the water crisis caused by the Israeli siege on the Gaza Strip, on the sixth day of the continues fighting between Israel and Hamas. Photo: Mohammed Talatene/dpa (Photo by Mohammed Talatene/picture alliance via Getty Images)

intervention programs focusing on conditions like Acute Stress Reaction and Disorder are essential.[101] This includes launching initiatives for Psychological First Aid and implementing "Train the Trainer" programs, leveraging online resources and digital services where possible to ensure immediate and widespread access to support.[102] These measures are vital for easing the strain on facilities and staff. As Gisela Silva Gonzàlez, MSF Mental Health Activity Manager in Gaza, notes, medical workers tend to continue their work despite their own emotional distress and constant worries about their families' safety.[103] This environment intensifies work-related stress, making every patient's case a potential emotional trigger. MSF's mental health staff are observing severe symptoms in medical professionals, including anxiety, insomnia, depression, intrusive thoughts, emotional avoidance, and nightmares.[104] While MSF is working to provide urgent mental health care to these frontline workers, significantly more support is needed. Direct support to the healthcare system also involves the deployment of prefabricated mobile clinics equipped with essential medical beds and

101 Bryant, R. A., Friedman, M. J., Spiegel, D., Ursano, R., & Strain, J. (2011). A review of acute stress disorder in DSM-5. Focus, 9(3), 335-350.

102 Akoury-Dirani, L., Sahakian, T. S., Hassan, F. Y., Hajjar, R. V., & Asmar, K. E. (2015). Psychological first aid training for Lebanese field workers in the emergency context of the Syrian refugees in Lebanon. Psychological Trauma: Theory, Research, Practice, and Policy, 7(6), 533.

103 MSF. (2024, April 26). Gaza's healthcare workers grapple with the mental health impact of an unyielding war.

104 MSF. (2024, April 26).

emergency kits, and the training of healthcare workers.[105] Moreover, implementing accessible telemedicine systems could help improve access to urgent medical care and reduce the risk of disease outbreaks.

These immediate efforts across the areas of shelter, food, water, waste, and health are not isolated; they must operate in tandem. Laying this foundational groundwork of sustaining essential conditions is a crucial first step that stabilizes communities, safeguards basic well-being, and creates the necessary environment for the successful implementation of more comprehensive adaptive strategies.

Adaptive phase

Adaptive Phase (Systemic Resilience & Local Empowerment)

• **Decentralize Core Services:** Strategically invest in localized water, wastewater, and renewable energy systems to address chronic public health crises and critical infrastructure bottlenecks, fostering self-sufficiency.

• **Leverage Precision Data & AI:** Fund and deploy advanced data verification, remote monitoring, and early warning systems to optimize aid delivery, enable adaptive planning, and anticipate evolving needs.

• **Empower Palestinian Leadership:** Channel significant support directly through, and strengthen the capacity of, local Palestinian consortia and independent technocratic bodies, ensuring their central role and ultimate ownership of recovery efforts.

• **Transform Waste Ecosystems:** Invest in integrated solid waste management systems, fostering community engagement and resource recovery to build healthier environments and local circularity.

• **Catalyze Local Innovation & Enterprise:** Allocate substantial funding and technical assistance to cultivate and scale local businesses and innovative solutions, recognizing them as essential engines for economic revitalization and sustainable livelihoods.

• Cultivate Urban Resilience: Mandate significant investment in urban and regenerative farming initiatives to drastically enhance local food security, promote sustainable resource use, and strengthen community vitality within

105 Communication with Anonymous Palestinian Health expert, interviewed by Elaine Donderer, June 16, 2025.

Following the efforts to sustain essential conditions, Gaza transitions into an adaptive phase of recovery. In this period, communities gradually move away from reliance on humanitarian aid towards renewed self-sufficiency. Rather than a distinct, time-bound stage, this is a complex and evolving process that begins even as immediate humanitarian responses are underway, and continues long after, laying the groundwork for a more stable and sustainable future. It involves strategically adjusting and developing new capabilities to navigate persistent challenges and changing circumstances. A key focus of adaptation is the installation of more robust and long-term infrastructure. The JHG coalition is at the forefront of this effort, committed to establishing secure, off-grid shelters. These shelters plan to integrate advanced off-grid WASH and energy technologies, promoting both sustainability and independence.[106] Complementary solutions range from building blocks from recycled debris by GreenCake to Home Biogas. These innovative systems are not merely immediate solutions; they represent a commitment to self-determination for the people of Gaza.

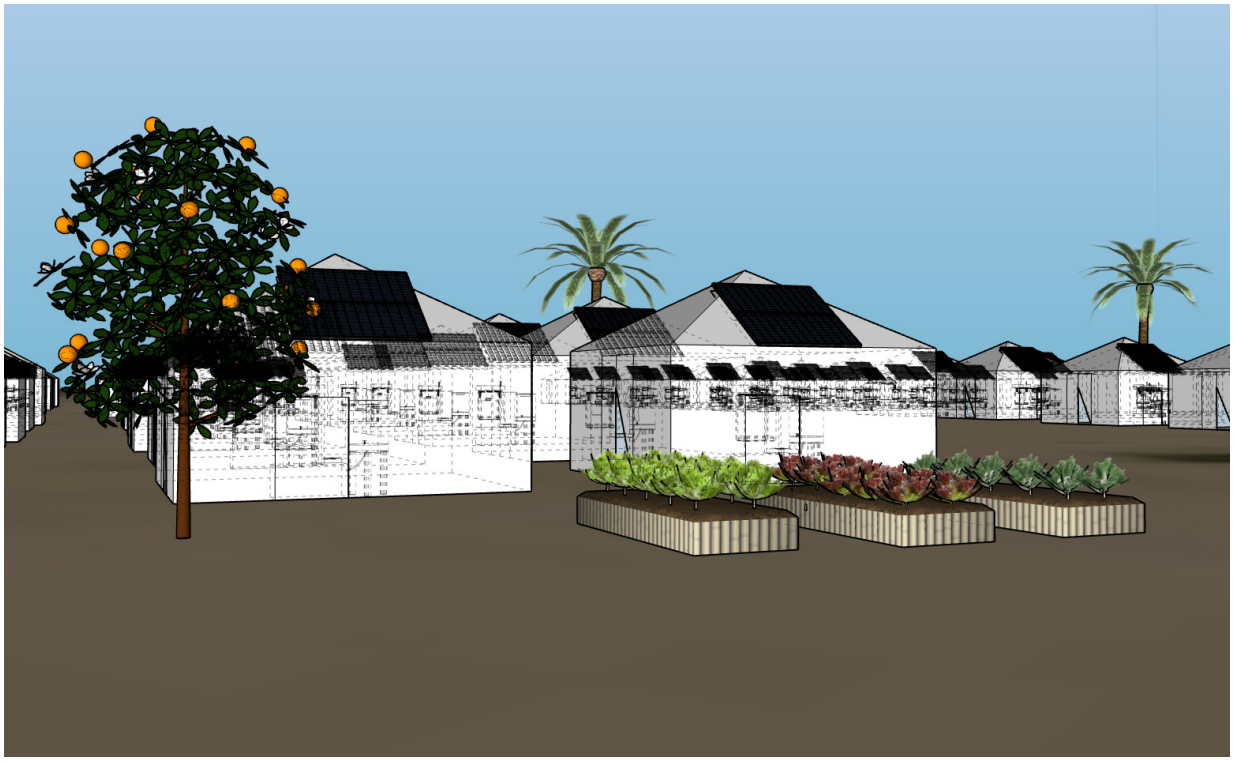

Figure 9: Green Shelters rendering

As experience has shown, central to reducing reliance on external resources is the establishment of decentralized systems, such as solar power grids and other renewable energy sources.[107] These solutions are vital for decreasing dependence on costly and

106 Hassoun, A. (2025).

107 Interview with Anonymous Israeli Project Manager, interviewed by Elaine Donderer, May 31, 2025.

difficult-to-obtain diesel for generators, offering a more stable and environmentally sound power supply. Promoting integrated water-energy-food nexus approaches further enhances resource efficiency and overall sustainability by recognizing the interconnectedness of these vital sectors.[108] Effective water governance in this adaptive phase involves transforming a challenge into an opportunity. Gaza's unique hydrology, particularly its susceptibility to flash floods, presents a dual intervention potential: mitigating the immediate threat of floods and simultaneously recharging the vital Coastal Aquifer.[109] This integrated approach not only addresses urgent humanitarian concerns but also strengthens long-term water management capabilities and has the potential to support economic stability for both Gaza and neighboring regions.

Key adaptive strategies for water include but are not limited to:

- **Early Warning Systems:** Implementing three-day forecasts for temperature and precipitation, coupled with mobile alerts for rainfall exceeding flood thresholds based on historical and citizen data. This proactive measure aims to protect lives and infrastructure.

- **Targeted Humanitarian Operations:** Developing prioritized lists of zones for new shelters or recommendations for flood and hazard mitigation in existing shelters. These are informed by feasibility and damage assessments, incorporating vital input from participatory mapping initiatives to ensure community needs are met.

- **Capacity Building and Innovation:** Fostering the development of tools and methodologies specifically tailored to address Gaza's complex hydrological challenges. This includes introducing improved data collection and validation methods, particularly crucial for war-affected areas. The aim is to shield both humanitarian workers and civilians from further harm, setting a precedent for similar initiatives in other vulnerable regions.

Understanding how environmental hazards impact different locations, social groups, and infrastructure requires robust data. Disaster-related statistics, disaggregated by sex, age,

108 Interview with Anonymous Israeli Project Manager, interviewed by Elaine Donderer, May 31, 2025.

109 Abd-Elaty, I., Abd-Elhamid, H. F., & Qahman, K. (2020). Coastal aquifer protection from saltwater intrusion using abstraction of brackish water and recharge of treated wastewater: case study of the Gaza aquifer. Journal of Hydrologic Engineering, 25(7), 05020012.

and disability, are essential. Such granular data reveals patterns of exposure and vulnerability, enabling informed decisions across all sectors, including investments in accessible and adaptable infrastructure, environmental conservation, social protection, and systems for food, energy, and water security.

Building self-sufficiency in the face of ongoing challenges and environmental pressures is particularly relevant for resilient food systems. Respondents in a study by the Gaza Urban and Peri-Urban Agriculture Platform highlight several critical areas of support. Financial assistance or credit was identified as the most crucial need by 70% of respondents, closely followed byaccess to water and irrigation infrastructure (65%), and support for market access (50%).[110] Significantly, 45% of respondents emphasized the importance of accessible training in sustainable agricultural practices, such as agroecology and urban farming, as effective means to adapt to challenges, with 80% of respondents regarding such training as highly beneficial.[111] In transitioning from emergency response to rehabilitation and healing, organizations like the FAO are already procuring essential supplies. These include greenhouse plastic sheets, vital vaccines, energy blocks, and plastic sheds for animals, all critical for restoring food production, safeguarding livestock, and re-establishing livelihoods.[112] The FAO is also poised to reactivate field projects previously on hold due to military activities, which are projected to inject approximately $20 million into the local economy.[113] This investment aims to directly support the rehabilitation efforts of farmers, livestock herders, and fishermen and women, fostering self-reliant agri-food systems across Gaza.

Moving beyond immediate crisis response, a robust, forward-looking economic framework is essential, one designed to withstand future disturbances, whether in times of peace or conflict. This framework should focus on understanding and optimizing how Gaza's environmental and social systems respond to ongoing stresses, including war, resource depletion, and infrastructure damage, with implementation beginning even before comprehensive rebuilding commences.[114] Lessons from initiatives like those of the Arava Institute underscore the power of lasting commitment and dedicated individual engagement in formulating and implementing such strategies. The sustained duration of such cross-border peace network programs has fostered vital trust and accountability among partners,

110 Shaban, A. A., & McAllister, G. (2024).

111 Shaban, A. A., & McAllister, G. (2024).

112 Rigillo, N. (2025, January 28). Gaza: Immediate action must combine emergency relief with the restoration of local food production. Retrieved May 3, 2025

113 Rigillo, N. (2025, January 28).

114 Al-Muhannadi, K., & Buheji, M. (2023).

highlighting the importance of sustained local empowerment and collaborative efforts to bridge funding gaps, such as those left by USAID withdrawals.[115]

However, the complex security and governance landscape continues to necessitate highly innovative methods for assessing and mitigating environmental hazards. Identifying and addressing contamination risks early is paramount, especially given the unpredictable operating environment. Fortunately, Gaza possesses significant internal capabilities, such as its higher education institutions, scientific laboratories, and active civil society organizations collectively holding irreplaceable knowledge about the local ecosystem.[116] Protecting and valuing local expertise will be fundamental as efforts commence to restore Gaza's natural resources and degraded environments.

Ensuring the enduring success of recovery initiatives hinges on embedding long-term sustainability directly into project design. This involves a deliberate transfer of ownership and management responsibilities to local partners and community-based committees. Throughout a project's lifecycle, comprehensive training programs are crucial, equipping local technicians and management teams with the skills needed to independently maintain and operate decentralized water, sanitation, and energy systems.[117] Establishing viable financial models, which might include modest service fees or strategic public-private collaborations, is also essential for these solutions to remain economically viable over time.[118] Such an approach enables communities to gradually shift from reliance on external support to autonomous management of vital infrastructure and services.

At a broader governance level, a critical re-evaluation of the policy frameworks guiding recovery efforts is underway. The Palestinian Authority, for instance, is actively reviewing diverse international and regional reconstruction plans to develop a favorable policy framework for implementation.[119] It is noteworthy that recovery efforts should ultimately be shaped and driven by the needs and aspirations of the local population, not pre-determined solely by external entities. While approaches continue to evolve, a key consideration involves fostering decentralization in oversight, particularly given the geographical separation

115 Interview with Anonymous Israeli Project Manager, interviewed by Elaine Donderer, May 31, 2025.

116 United Nations Environment Programme. (2024).

117 Interview with Anonymous Israeli Project Manager, interviewed by Elaine Donderer, May 31, 2025.

118 Interview with Anonymous Engineering Palestinian expert, interviewed by Elaine Donderer, May 28, 2025.

119 Interview with Anonymous Engineering Palestinian expert, interviewed by Elaine Donderer, May 28, 2025.

between the West Bank and Gaza.[120] This calls for the creation of a dedicated, efficient, and accountable body to manage the day-to-day administration and implementation of projects within the Gaza Strip. To ensure both credibility and facilitate funding flows, such a body could operate under a local consortium's overall guidance while collaborating with a neutral international party, such as the World Bank Reconstruction Fund, the European Union, or the European Investment Bank, to provide transparency and accountability for disbursements and project execution. We envision this blend of local leadership and international cooperation as a key to effective and sustainable recovery.

Nevertheless, a successful strategy is fundamentally reliant on rigorous, evidence-based decision-making. This necessitates prioritizing the collection and dissemination of information from diverse and independent sources, with a strong emphasis on local data ownership and recognition of local contributions. A critical area for improved data collection concerns the presence and impact of toxic remnants of war. Gathering detailed information on the types and precise geographic locations of contaminants, as well as reports on past harm and assessments of future risks, is paramount for effectively responding to victims' needs.[121] Currently, the scarcity of comprehensive data, particularly on any toxic or radiological substances, represents a significant barrier to providing adequate assistance. Therefore, a priority must be to increase data collection on specific pollutants, toxins, and pathogens found in Gaza's water, soil, and air.[122] Despite growing international attention to the environmental consequences of armed conflict, a clear framework for addressing the needs of those affected by resulting pollution has largely been absent. The established concept of victim assistance, a widely accepted component of humanitarian disarmament law, may offer a promising model to bridge this gap.[123]

Yet, the inherent challenges in measuring the full extent and permanent impacts of environmental damage in Gaza are undeniable. Pollution from military activities, for instance, often goes unmonitored due to the absence of active monitoring systems within the Strip, and results from neighboring countries like Egypt or Israel are not routinely shared.[124] Furthermore, environmental degradation is likely to continue and accumulate amidst ongoing military actions and the persistent siege, in the absence of any functional pollution

120 Interview with Anonymous Israeli Project Manager, interviewed by Elaine Donderer, May 31, 2025.

121 Docherty, B., Griechen, M., Levine-Spound, D., Marshall, S., & Rafferty, J. (2020). Confronting Conflict Pollution: Principles for Assisting Victims of Toxic Remnants of War. Harvard Law School International Human Rights Clinic and Conflict and Environment Observatory.

122 Communication with Anonymous Civil, Architectural, and Environmental Engineering expert, interviewed by Elaine Donderer, June 22, 2025.

123 Docherty, B., Griechen, M., Levine-Spound, D., Marshall, S., & Rafferty, J. (2020).

124 Al-Muhannadi, K., & Buheji, M. (2023).

monitoring stations or systems on the ground.[125] Recognizing these constraints, a necessary step is a field-based assessment process either when access is granted, or through remote citizen science data collection. The data would enable a more accurate determination of the extent and type of environmental degradation, facilitating the identification of appropriate remediation options through consultation with relevant local stakeholders. Such a science- and evidence-based approach is crucial for formulating truly effective and sustainable recommendations. Data for recovery must be actionable and widely accessible, bridging silos of remotely sensed and on-ground information, to accurately model pathways for recovery. Thereby, consortia may build digital infrastructure to act as a decision-support system, capable of assessing risks and rapidly adapting to changing conditions.[126]

Transformative phase

Transformative Phase (Long-Term Healing & Strategic Future)

• **Anchor Generational Financing:** Establish and firmly commit to a multi-decade financing strategy for comprehensive, systemic recovery, ensuring sustained, flexible funding directly tied to transparent progress and robust local absorption capacities, transcending short-term political cycles.

• **Mandate Ecological Restoration:** Champion and fund large-scale NBS as the bedrock of environmental recovery and resilient infrastructure, including constructed wetlands for wastewater, regenerative agriculture, and comprehensive ecosystem rehabilitation.

• **Integrate Eco-DRR & Climate Resilience:** Fundamentally embed Ecosystem-based Disaster Risk Reduction and climate mitigation strategies into all recovery planning and implementation, leveraging natural systems to future-proof against environmental hazards.

• **Enforce Green Accountability:** Establish and empower independent, robust accountability mechanisms to rigorously prevent greenwashing and ensure all

125 Al-Muhannadi, K., & Buheji, M. (2023).

126 Etherton, B. A., Choudhury, R. A., Alcalá Briseño, R. I., Mouafo-Tchinda, R. A., Plex Sulá, A. I., Choudhury, M., Adhikari, A., Lei, S. L., Kraisitudomsook, N., Buritica, J. R., Cerbaro, V. A., Ogero, K.,Cox, C. M., Walsh, S. P., Andrade-Piedra, J. L., Omondi, B. A., Navarrete, I., McEwan, M. A., & Garrett, K. A. (2024). Disaster Plant Pathology: Smart Solutions for Threats to Global Plant Health from Natural and Human-Driven Disasters. Phytopathology, 114(5), 855–868.

environmental recovery projects deliver verifiable, measurable ecological and social benefits.

• **Establish Joint Oversight & Governance:** Mandate an internationally supervised trust fund with a clear, non-negotiable mandate for transparent financial management and independent oversight, operating in direct partnership with, and ceding executive authority to, empowered Palestinian-led administrative bodies.

• **Unify Health & Environment for Peace:** Direct substantial, integrated funding towards environmental health and public health infrastructure (especially decentralized solutions), explicitly recognizing these investments as the foundational pillars of long-term stability and a just peace.

• **Underwrite Political Settlement:** Insist that all recovery efforts are meticulously embedded within a clear, internationally supported political framework that unconditionally guarantees Palestinian self-determination and systematically prevents future cycles of war and destruction.

Sustainable recovery culminates in the transformative phase, where communities regain rights and opportunities for a future of building back better. This stage moves beyond simply restoring what was lost or adapting to new realities. **It is about enacting systemic changes to address root vulnerabilities and foster lasting sustainability.**

For one, the overwhelming scale of debris, coupled with Gaza's spatial constraints and pre-existing scarcity of raw construction materials, makes a circularity-based approach to reconstruction not just beneficial, but essential.[127] Prior to October 7th, Gaza's estimated 28 million tons of quarry reserves were already overexploited, making reliance on new raw materials unsustainable.[128] Therefore, the extensive recycling of construction and demolition waste is indispensable for any future reconstruction effort.[129] One sustainable pathway includes the utilization of recycled materials, exemplified by initiatives like EcoBricks, turning vast quantities of rubble into new building components. This innovative process conserves natural resources, dramatically reduces waste, lowers greenhouse gas emissions, and

127 Naik, T. R., & Moriconi, G. (2005, October). Environmental-friendly durable concrete made with recycled materials for sustainable concrete construction. In International Symposium on Sustainable Development of Cement, Concrete and Concrete Structures, Toronto, Ontario, October (Vol. 5, No. 7).

128 United Nations Environment Programme. (2024).

129 United Nations Environment Programme. (2024).

creates new local markets and income opportunities within the recycling industry.[130] Beyond environmental gains, recycled materials can also enhance building performance, offering improved thermal insulation, acoustic properties, and indoor air quality.[131] However, large-scale rubble recycling would require significant preprocessing and clearing of hazardous components from the material.

The holistic vision for recovery is restoring ecosystems and infrastructure with sound environmental practices. This means designing new spaces with natural cooling, robust flood protection, efficient energy systems, and comprehensive climate adaptation integrated into every facet of rebuilding. Crucially, a truly sustainable transformation demands inclusive approaches, actively ensuring the full participation of youth, women, and the disabled. **Broad involvement is vital not only for equitable decision-making but also for delivering essential psychosocial benefits, making resident contributions integral to a genuinely resilient and forward-looking Gaza.**

Another key area is water system restoration. This requires precise identification and rigorous protection of vulnerable groundwater recharge zones, coupled with dedicated efforts for aquifer restoration. Such actions are fundamental for integrated transboundary water management, guaranteeing flood mitigation amidst long-term water security. A prime example of such transformative environmental ambition is the potential revival of the Wadi Gaza Master Plan. Developed in 2019 by Hydro Nova for UNDP, this comprehensive plan aimed to restore the Wadi Gaza, transforming it into a vibrant area for conservation, recreation, and economic growth .[132]

Envisioned as a five-year package, the "Wadi Gaza Natural Park and Greenway" encompassed ecosystem rehabilitation, park and recreation facility construction, solid waste management, institutional and legal frameworks, flood management, and flora and fauna conservation.[133] It would constitute an important step toward rebuilding local bird and plant populations and restoring the Wadi's natural ecological functions. Critically, the plan also sought to integrate urban development, design flood protection, and pollution control measures, such as constructed wetlands and innovative bio-saline agriculture utilizing treated wastewater, to build long-term environmental robustness.[134]

130 Naik, T. R., & Moriconi, G. (2005, October).

131 United Nations Environment Programme. (2024).

132 Hydro Nova. (2019). Wadi Gaza Master Plan.

133 Hydro Nova. (2019).

134 Hydro Nova. (2019).

While such ambitious plans offer a blueprint for extensive ecological revival, it is crucial that such conservation efforts are designed with profound human involvement. Establishing protected areas must avoid inadvertently creating new barriers or restricting the movement and livelihoods of local populations, a concern echoed by experiences in other parts of Palestine, like the West Bank where nature reserves have sometimes constrained farmers' access to land.[135] True environmental protection in Gaza's context requires a collaborative approach that integrates human needs and local participation, ensuring that critical ecosystems are safeguarded with communities, not from them. This ensures that ecological restoration genuinely serves the long-term well-being of Gaza's inhabitants and fosters sustainable coexistence.

> "for true and lasting transformation, environmental restoration must be explicitly embedded within future peace agreements and all post-war reconstruction endeavors."

Notably, for true and lasting transformation, environmental restoration must be explicitly embedded within future peace agreements and all post-war reconstruction endeavors. Gaza stands to benefit from international climate mitigation activities, including those funded by the 2016 Paris Agreement, particularly as it navigates the critical phase of environmental rebuilding and sustainable development.[136] Moreover, there is a compelling vision to reconnect Gaza with the global market, reimagining it as a strategic hub within a larger regional economic ecosystem, potentially linking with initiatives such as the proposed Middle East Economic Corridor. [137]

Within this expansive vision, the restoration of coastal wetlands and artificial reef structures may present a powerful nature-based solution.[138] These ecosystems can significantly mitigate flood risk by reducing the impact of storm surges and extreme weather while offering diverse

135 Interview with Anonymous Palestinian Engineering expert, interviewed by Elaine Donderer, May 28, 2025.

136 van der Hoeven, L. (2025, April 17). The Axis of Loss in Gaza: The Environmental Losses During Humanitarian Warfare. Opinio Juris. Retrieved May 3, 2025

137 Interview with Anonymous Palestinian Engineering expert, interviewed by Elaine Donderer, May 28, 2025.

138 Lew, N. H. (2023). Building Artificial Reefs from Recycled Construction Materials: A Feasibility Study. Construction Management.

co-benefits, including an increase in fish biomass and boosted revenues from fishing.[139] Another highly ambitious concept involves the strategic reuse of the immense volume of rubble for artificial land expansion into the Mediterranean Sea. Given the monumental task of managing this debris, consortia are conceptualizing designs for creating new land areas. This endeavor requires extensive sorting and pre-processing of materials, utilizing specialized containment structures like geocontainers, often coated to mitigate the leaching of potential contaminants into the marine environment.[140] The intent is to develop new islands or land extensions that could host specific infrastructure, such as desalination or hydropower plants, while meticulously adhering to biodiversity and marine conservation objectives to preserve the quality of life both within and around the sea. Inspired by successful precedents in places like the Maldives, Singapore, Dubai, and the Netherlands, such projects could create a significant maritime and aviation industry hub for regional purposes, potentially connecting with Gulf States and Southern Europe, akin to Dubai's role today in Southeast Asia.[141] However, this bold vision, while sparking hope for a future day after, and signaling a new era of proactive rebuilding, must prioritize benefits for Gaza's population—through job creation, tourism, and energy access—and not merely serve regional interests.

Despite unimaginable pressures, Gaza's food system displayed a remarkable capacity to absorb shocks, taking considerably longer to collapse than anticipated. This endurance offers a profound policy lesson: genuine food security is fortified not by specialization, but through increased diversification, localization, and robust social organization of food production and distribution. For the future, two contrasting visions for agriculture are emerging. One, often termed 'climate-smart agriculture,' risks entrenching a capital-intensive, high-tech, and externally dependent model, raising concerns about deepening corporate control and potentially creating new forms of reliance on multinational corporations akin to colonial modernity.[142] In contrast, local agricultural NGOs and experts are strongly advocating for agroecology, a transformative approach that is reparative, knowledge-intensive, diversified, and profoundly people-centered. This vision champions technology sovereignty, prioritizing place-based solutions rooted in diverse local knowledges and innovations, co-designed directly with farmers, and focusing on resilient polycultures.[143] At the core of this sovereign food system, as local organizations suggest, lies the preservation and distribution of open-

139 van Zanten, B., Gutierrez Goizueta, G., Brander, L., Gonzalez Reguero, B., Griffin, R., Kapur Macleod, K., Alves, A., Midgley, A., Diego Herrera, L., & Jongman, B. (2023).

140 Interview with Anonymous Palestinian Engineering expert, interviewed by Elaine Donderer, May 28, 2025.

141 Interview with Anonymous Palestinian Engineering expert, interviewed by Elaine Donderer, May 28, 2025.

142 Shaban, A. A., & McAllister, G. (2024).

143 Shaban, A. A., & McAllister, G. (2024).

pollinated baladi seeds (local, heirloom seeds).[144] These native varieties, adapted over generations to local conditions, can thrive with minimal industrial inputs and water. Policies are critically needed to support their propagation through community-led seed libraries and agroecological practices, thereby multiplying genetically diverse, pest- and drought-resistant, and nutrient-dense varieties to build a truly self-reliant and equitable food future for Gaza.[145]

However, international focus tends to prioritize Gaza's formal economy, which critically risks rendering invisible the vital contributions of residents, especially their pivotal role in food and nutritional security. This overlooks crucial parallel economies, including solidarity, sharing, circular, so-called sumud economies, which have been indispensable to Gaza's survival.[146] A truly transformative approach must actively recognize and empower these informal yet powerful systems, ensuring that, for instance, women, despite carrying immense care burdens, are not overlooked in reconstruction, particularly concerning land access and security of tenure, where municipal records are destroyed. Initiatives are urgently needed, such as those exploring digital archiving and dispute mechanisms, to verify and preserve land rights.

A holistic recovery project must strategically address environmental risks, including comprehensive crisis response plans for clearing unexploded ordnance, repairing soil, decontaminating water, rehabilitating infrastructure, and establishing strategic input stocks.[147] Implementing green building standards, promoting energy-efficient technologies, and incorporating green spaces within urban areas will significantly reduce the environmental impact of development.[148] The recovery strategy should integrate Palestinian agricultural principles of fruit gardens, urban farming, renewable energy, and circular economy innovations, promoting greater energy autonomy, food sovereignty, and reduced dependency on external actors.[149] To succeed, these strategies must also confront risks such as land grabbing, exploitation of offsetting schemes by third parties, lack of free, prior, and informed consent in data collection procedures, greenwashing, militarized conservation, and persistent failures to facilitate justice.[150]

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144 Shaban, A. A., & McAllister, G. (2024).

145 Meneley, A. (2020). Hope in the ruins: Seeds, plants, and possibilities of regeneration. Environment and Planning E: Nature and Space, 4(1), 158–172.

146 Shaban, A. A., & McAllister, G. (2024).

147 Shaban, A. A., & McAllister, G. (2024).

148 Wolters, E., & Schellens, M. (2024). Nature in Action for Peace: Challenges and Opportunities to Address Environmental Dimensions of. PAX.

149 United Nations Country Team, & Humanitarian Country Team. (2024).

150 Wolters, E., & Schellens, M. (2024).

While the range of possibilities is great, from agroforestry, and green corridors to artificial reefs, and bioremediation through fungi or plants[151], we think of our friends in Gaza, who, amidst grand plans, colonial maps, ancient trade routes and utopian dreams, are carving out their own architectures of hope, every single day. Lessons from cross-border dialogues, like those engaged in by the Arava Institute, underscore how fostering intercultural structures and dialogue can significantly reduce conflict drivers, improve social cohesion, remediate pollution, and enhance resource governance for sustainable peace. Hence, any NBS must center on the concept of justice, ensuring they actively contribute to progressive, anti-racist, and social-ecologically sustainable communities, reinforced by strengthening the legal capacities of local communities regarding nature conservation, resource use, and land tenure. These comprehensive, just, and locally-driven strategies, coupled with ambitious visions for sustainable urban design and new economic hubs that genuinely benefit all Gazans, represent an overdue paradigm shift towards a day of lasting peace and prosperity.

Conclusion & Future Outlook

With the de facto occupation of much of the Gaza Strip by Israeli and Hamas military, hope is an increasingly scarce commodity. History offers a stark warning: many may remain in displacement camps for generations if basic services and rights to Palestinian populations are not guaranteed, even under a new administration. This humanitarian crisis is simply untenable, and offers no viable pathway for peace or stability, regardless of any future political arrangements.[152] **A fundamental prerequisite for any progress is an immediate, unconditional, and sustained ceasefire that includes releasing all of the hostages remaining in Gaza.** Without establishing a solid political agreement with accountability mechanisms among all relevant parties, facilitated by an international body like the European Union, we risk perpetuating a vicious cycle of instability. Any plan for Gaza will inevitably fail without robust political security measures and a commitment to implementation that genuinely satisfies both Israeli and Palestinian authorities and populations, fostering prosperity and peace for the entire region. **Prioritizing the preservation of life is paramount.** This necessitates emergency programs designed to enable essential services, such as water, electricity, and food, for the displaced population in the crucial first years.[153] For this, unimpeded and safe

151 Vaksmaa, A., Guerrero-Cruz, S., Ghosh, P., Zeghal, E., Hernando-Morales, V., & Niemann, H. (2023). Role of fungi in bioremediation of emerging pollutants. Frontiers in Marine Science, 10, 1070905.

152 Interview with Anonymous Israeli Project Manager, interviewed by Elaine Donderer, May 31, 2025.

153 Lakshmi, S. (2025, February 22). Strategic Sustainable Development as a Tool for Conflict Resolution in Post-War Regions. JK Policy Institute.

entry of sufficient humanitarian supplies is non-negotiable; supply chain barriers, including security on routes within the Strip and storage capacities, must be minimized, and civilians must have unobstructed access to assistance. Most importantly, **the war must end to allow for recuperation and healing.**

Gaza's future can be an ecological and dignified one. Some proclaim it as an opportunity to rewrite the story and create a regional model for ecological peace-facilitation and sustainable recovery.[154] This conviction, however, also stems from the understanding that the health of ecosystems is inextricably linked to human well-being. Any environmental or peace-oriented initiative must originate from perspectives and mechanisms that hold legitimacy among communities. This requires meaningful community participation in design and implementation, building local institutional capacities, and leveraging spontaneous recovery initiatives. Any political solution should bridge the West Bank and Gaza, reinforcing connectivity by, for example, sourcing materials and expertise from the West Bank, and allowing families to reunite.[155]

Beyond immediate relief, true recovery hinges on empowering Gazans to build their own future by promoting private sector and citizen participation.[156] This aligns with a broader vision to foster social cohesion by promoting inclusive, community-driven development. Experience shows that the use of education is essential in healing societal rifts, building shared visions, and addressing past injustices through truth and reconciliation efforts.[157] The lessons from initiatives like those of the Arava Institute underscore the power of dialogue and transboundary structures to foster participation, reduce conflict drivers, clean conflict pollution, and improve resource governance for sustainable peace. As Palestinian activist Amira Mohammed powerfully articulated in her speech at the Mayors Peace Conference in Paris: "We are not heroes, we are not villains, and we are not victims. We are mothers, we are fathers, we are daughters, we are doctors, we are lawyers, we are writers, and we are poets. We are humans, (...) so do not turn us into symbols of suffering or a lesson in resilience. We are people with needs, with futures, and a right to thrive."[158] Her statement highlights that recovery must enable thriving cultures, not just survival, honoring the inherent dignity and agency of the people of Gaza.

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154 Interview with Anonymous Palestinian Engineering expert, interviewed by Elaine Donderer, May 28, 2025.

155 United Nations Country Team, & Humanitarian Country Team. (2024). Early Recovery Approach and Action Plan for Gaza [Living document]. (2025, June 02).

156 United Nations Country Team, & Humanitarian Country Team. (2024).

157 Lakshmi, S. (2025, February 22).

158 Guerrières de la Paix (2025, May 19). Amira Mohamed & Ibrahim Abu Ahmad, à la conférence internationale « Les villes au défi de la Paix » [Video]. YouTube. Retrieved June 30, 2025, from

While this report focuses primarily on the environmental and humanitarian consequences of the Israel-Hamas war from October 7th to June 2025, it also emphasizes broader implications of transboundary environmental degradation. In Israel, for instance, past hostilities have not only cost human lives, but also destroyed 1,200 hectares of forest, 6,600 hectares of nature reserves, and 7,000 hectares of grazing lands, significantly harming biodiversity, and carbon storage.[159] Hostilities between Israel and Hezbollah have triggered widespread wildfires that further destroyed vital carbon sinks in Israel and Lebanon. Meanwhile, the emissions generated by military operations worldwide contribute significantly to global greenhouse gas levels.

This interconnectedness demonstrates how there is truly no winning in war, and the damage inflicted demands a collective, regional approach to recovery that acknowledges our shared ecological fate. To address this monumental challenge, transparent and accountable governance is crucial, necessitating the realization of the different roles of third-party actors. Organizations such as the European Union, European Investment Bank, or World Bank Reconstruction Fund, can help ensure fair disbursements and effective program implementation, while bridging the massive funding gaps currently evident.[160] **The Arava Institute actively seeks partnerships to support these critical relief and long-term sustainability efforts, recognizing that public support is decisive. Together, we must ensure that Gaza's people receive the support they deserve—not only to survive, but to live with dignity, justice, and hope for the future.**

159 Goldammer, J. G. (2013). Vegetation Fires and Global Change: Challenges for Concerted International Action. A White Paper directed to the United Nations and International Organizations . In Beyond Climate Change: Wildland Fires and Human Security in Cultural Landscapes in Transition – Examples from Temperate-Boreal Eurasia (pp. 285–311). Kessel.

160 Interview with Anonymous Palestinian Engineering expert, interviewed by Elaine Donderer, May 28, 2025.

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