ENVIRONMENTAL WAR CRIMES:

How Israel's military assault has turned Gaza into a toxic wasteland, threatening human survival



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ACRONYMS

ACLED	Armed Conflict Location and Event Data Project
AI	Artificial Intelligence
AMR	Antimicrobial Resistance
ARSIWA	Articles on Responsibility of States for Internationally Wrongful Acts
AWD	Acute Watery Diarrhoea
BOD_5	Biochemical Oxygen Demand
BoP	Board of Peace
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CEOBS	Conflict and Environment Observatory
CESCR	Committee on Economic, Social and Cultural Rights
ClO_4	Perchlorate
CMWU	Coastal Municipalities Water Utility
CO_2e	Carbon Dioxide Equivalent
COD	Chemical Oxygen Demand
COPD	Chronic Obstructive Pulmonary Disease
CRC	Convention on the Rights of the Child
DNT	Dinitrotoluene
2,4-DNT	2,4-Dinitrotoluene
DU	Depleted Uranium
EA	Environmental Assessment
EQA	Environment Quality Authority
ERW	Explosive Remnants of War
EU	European Union
EWARS	Early Warning, Alert and Response System
FAO	Food and Agriculture Organization of the United Nations
FIRMS	Fire Information for Resource Management System
GDP	Gross Domestic Product
GoI	Government of Israel
GRAD	Gaza Reconstruction and Development Fund
HMX	Cyclotetramethylenetetranitramine (Octogen)
IARC	International Agency for Research on Cancer
ICESCR	International Covenant on Economic, Social and Cultural Rights
ICC	International Criminal Court
ICRC	International Committee of the Red Cross
ICJ	International Court of Justice
IDF	Israel Defense Forces
IDP	Internally Displaced Person
IDRL	International Disaster Relief and Initial Recovery Assistance
IEL	International Environmental Law
IFRC	International Federation of Red Cross and Red Crescent Societies
IHL	International Humanitarian Law
IHRL	International Human Rights Law
ILC	International Law Commission
IOM	International Organization for Migration
IPC	Integrated Food Security Phase Classification
ISF	International Stabilization Force
JDAM	Joint Direct Attack Munition

LLM	Large Language Model
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
NASA	National Aeronautics and Space Administration
NCAG	Palestinian National Committee for the Administration of Gaza
NDVI	Normalized Difference Vegetation Index
OCHA	Office for the Coordination of Humanitarian Affairs
oPt	Occupied Palestinian Territory
OSINT	Open-Source Intelligence
OSM	OpenStreetMap
PAHs	Polycyclic Aromatic Hydrocarbons
PBDEs	Polybrominated Diphenyl Ethers
PCBs	Polychlorinated Biphenyls
PCDD/F	Polychlorinated Dibenzo-p-dioxins and Dibenzofurans
PCEA	Post-Conflict Environmental Assessment
PERAC	Protection of the Environment in Relation to Armed Conflicts
PFAS	Per- and Polyfluoroalkyl Substances
POPs	Persistent Organic Pollutants
PPE	Personal Protective Equipment
RDX	Cyclotrimethylenetrinitramine
SAR	Synthetic Aperture Radar
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UAE	United Arab Emirates
UAV	Unmanned Aerial Vehicle
UAWC	Union of Agricultural Work Committees
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGA	United Nations General Assembly
UNOSAT	United Nations Satellite Centre
UNRWA	United Nations Relief and Works Agency
UNSC	United Nations Security Council
UNSCR	United Nations Security Council Resolution
US	United States
USD	United States Dollar
UXO	Unexploded Ordnance
VIIRS	Visible Infrared Imaging Radiometer Suite
VOCs	Volatile Organic Compounds
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

EXECUTIVE SUMMARY

This report examines how **Israel's military assault on Gaza, concluded by a growing number of states, UN mechanisms and other authoritative bodies to be an ongoing genocide against Palestinians in Gaza, has transformed the territory into a toxic wasteland. In this wasteland, the very conditions of civilian survival have been systematically degraded, raising grave concerns of human rights violations and breaches of international law.** Our research documents how since October 2023, Israel's military has subjected Gaza to a sustained military assault of extraordinary scale and intensity, inflicting a humanitarian and environmental catastrophe through the excessive use of explosive weapons in one of the most densely populated areas in the world. This military assault devastated the civilian population, leaving hundreds of thousands of people killed or injured, and completely obliterated civilian infrastructure. It also wreaked havoc on environmental systems, dismantling the basic conditions necessary for life. The scale, intensity and widespread nature of the destruction have fundamentally altered Gaza's environment. Hazardous contaminants have been released into the soil, water and air from munitions, destroyed buildings and infrastructure, fires, damaged industrial facilities and collapsed environmental systems. These contaminants will have profound and lasting consequences for the health of the entire population and the environmental resources upon which their lives depend.

In collaboration with the Conflict and Environment Observatory (CEOBS), this paper presents a comprehensive picture of Gaza's contamination landscape. Satellite-derived data, remote sensing analysis, and geolocated conflict incident databases are used to spatially map contamination risks across Gaza, drawing on scientific and legal literature to assess exposure pathways, potential health consequences, and the legal implications of environmental harm. It demonstrates that the evidence already available is sufficient to conclude that contamination is widespread, severe and consequential, and that the destruction and contamination of Gaza's environmental resources and systems raise serious concerns under international humanitarian law (IHL), international human rights law (IHRL) and occupation law.

While it does not establish every element of the crime of genocide, the analysis also contributes to the body of evidence relevant to the prohibition of deliberately inflicting conditions of life calculated to bring about the physical destruction of a protected group under Article II(c) of the Genocide Convention, and to the corresponding obligations of States Parties. **A full, independent, field-based post-conflict environmental assessment (PCEA) is urgently needed to ensure that Gaza's recovery and reconstruction are safe, lawful and responsible, and that steps can be taken to identify, mitigate and address contamination risks to the people of Gaza. Without sustained and unimpeded access for environmental experts, assessment teams and technical specialists, the field surveys required cannot be conducted.**

Scale and intensity

Our spatial analysis indicates that Israeli **military ground operations affected approximately 78% of Gaza's territory**. The intensity of bombardment and extensive use of explosive munitions, together with the destruction and burning of buildings, water and wastewater infrastructure,

industrial and energy facilities, agricultural land and waste-management systems, has released a complex mixture of contaminants. These include explosive residues and perchlorates, heavy metals, asbestos fibres and crystalline silica, persistent organic pollutants (POPs) and pathogens. Once released into the environment, these contaminants can move through the air, soil, surface water and groundwater. The spatial analysis identified **at least one potential contamination across more than 99% of Gaza's territory**. The population is likely to have been exposed to contaminants through multiple and interconnected pathways, including through the air people breathe, the water and food people consume, and direct contact with contaminated soil, debris and water. Analysis of the severity and diversity of contamination indicates that the **highest levels of potential overall contamination are concentrated in Gaza City, Khan Younis, Rafah, Jabalia, and the Salah al-Din Road.**

Air

Explosions and fires, together with the destruction and burning of buildings and infrastructure, have released airborne contaminants that settle onto rubble, soils and other surfaces, and are repeatedly resuspended by wind, vehicle movement and clearance of damaged buildings and debris. Our analysis indicates that the **highest concentration of air contaminants is found in Gaza City, Jabalia and the North Gaza Governorate**. Israel's military assault on Gaza has also generated substantial greenhouse gas emissions, while the scale of destruction and reconstruction is expected to create further significant emissions.

Water

Water supply systems have been devastated. Around 85% of Gaza's water infrastructure has been damaged or destroyed, reducing the **water available to the population to just 16% of pre-conflict quantities in June 2024, rising to only 39% by April 2026** following emergency repairs and humanitarian intervention. The destruction of reservoirs has stripped away the system's remaining capacity to buffer disruption, leaving **combined storage sufficient to supply Gaza's population with only 18 litres per person for a single day for all uses**. Analysis of groundwater wells tested in July 2026 indicates further degradation of water quality, with **faecal coliforms detected at nearly 10 times the proportion of wells reported in 2021**, alongside widespread groundwater mineralization. Our spatial analysis indicates that the **greatest risk of exposure through contaminated drinking water is concentrated in North Gaza, Gaza City and Deir al-Balah**, where the remaining operational wells and desalination facilities lie within areas of highly vulnerable groundwater and severe conflict-related contamination.

Environmental control

The wastewater system has collapsed, with all treatment plants destroyed and only a small proportion of pumping stations and wastewater networks still functioning, leaving raw sewage to be discharged into natural waterways and the Mediterranean Sea. This has made untreated sewage a continuous source of biological and chemical contamination. Meanwhile, the collapse of solid waste management has produced widespread accumulations of unmanaged waste, increased the dispersal of contamination and created conditions for the proliferation of disease vectors. The destruction of laboratories and monitoring infrastructure, alongside restrictions on the entry of sampling and analytical equipment, has severely constrained Gaza's capacity to

undertake the sampling, testing and monitoring required to establish the extent and nature of contamination. **The destruction of these environmental management and control systems has constrained Gaza's capacity to detect, characterize, monitor, contain and manage pollution.**

Food and soil

Gaza's food system is nearing total collapse. Extensive damage to cropland, much of which is now inaccessible because it lies within the Israeli military-controlled perimeter, has severely disrupted food production. Livestock, poultry, fishing and aquaculture production have also been devastated. The destruction of seed banks and agricultural infrastructure has further reduced the capacity for local food production. The agricultural land and food systems that remain are operating within an increasingly degraded environment. The destruction of olive groves has also disrupted agricultural practices, landscapes and intergenerational connections that form part of Palestinian cultural heritage and identity. Our analysis found that areas around **Beit Hanoun, Wadi Gaza and northeast of Khan Younis are more likely to retain and accumulate contaminants over time due to their more clay-rich soils.** Should agricultural and fishing activities resume and food production recover, the population risks ingesting food that is contaminated by conflict-related pollutants that have entered the food chain.

Health

Exposure of the civilian population to contaminated air, water, soil and food adds chemical and biological hazards to an extreme burden of conflict-related injury, displacement, malnutrition and disease. **Acute respiratory infections and acute watery diarrhoea (AWD)** place a substantial burden on the population, particularly children. The collapse of health, water and sanitation systems is also creating conditions for **antimicrobial resistance (AMR)** to emerge and spread. Over the long term, exposure to hazardous contaminants raises the risk of **chronic respiratory disease, cancer, cardiovascular disease, kidney and liver damage, neurological impairment, reproductive harm and endocrine disruption**, with pregnancy and early life exposure posing additional risks to development.

Because Gaza's health and monitoring systems have been severely degraded, much of this harm will go undetected and unattributed for years. Workers involved in debris clearance, waste management, water and sanitation repair, reconstruction and agricultural recovery face a particularly high risk of exposure, including to asbestos and crystalline silica, placing them at **risk of long-latency occupational diseases**.

Legal

Israel's obligations should be assessed first under **IHL, IHRL, occupation law and applicable international environmental law**. These frameworks protect civilians, civilian objects and the natural environment; prohibit starvation and attacks on objects indispensable to civilian survival; and require the occupying power to protect public health, essential services and natural resources. Where internationally wrongful acts are established, Israel must cease them and provide full reparations for environmental harm, including restitution, compensation and rehabilitation; guarantees of non-repetition are required where appropriate. Third states have separate duties to respect and ensure the enforcement of international humanitarian law,

prevent and avoid complicity in internationally wrongful acts, and exercise due diligence in reconstruction and recovery. The documented environmental destruction may also be relevant to individual criminal responsibility under the **Rome Statute**, including alleged war crimes, crimes against humanity and genocide, subject to the applicable legal elements and evidentiary thresholds. It may likewise inform assessment under the **Genocide Convention**, particularly the deliberate infliction of conditions of life calculated to bring about a protected group's physical destruction. The **Board of Peace** and participating actors must comply with their respective applicable obligations under international law. **Oxfam calls for reconstruction arrangements to make environmental assessment, proportionate precautionary safeguards, remediation and Palestinian-led decision-making mandatory.**

Recommendations

The scale of destruction in Gaza demands an urgent and decisive response. Recovery and reconstruction discussions are advancing in the absence of any field-level assessment of conflict-related contamination, placing the health and survival of Gaza's civilian population at risk. This report sets out a five-stage framework for safe recovery and reconstruction, in which exposure reduction begins immediately, assessment proceeds alongside urgent recovery, and the level of environmental evidence and safeguards rises as interventions become more permanent. To limit further harm to people and the environment:

- **The Government of Israel** must end its genocide in Gaza, immediately cease unlawful attacks, comply fully with the Geneva Conventions and applicable IHL, and respect all ceasefire arrangements. It must lift all restrictions on the entry of humanitarian assistance, environmental assessment teams and essential materials, including the dual-use and "special approval" regimes that block laboratory equipment, water treatment inputs, generators and spare parts. It must guarantee unimpeded access for assessment teams, permit the safe export of samples for laboratory analysis, and allow access for technical personnel and for mandated international bodies, including the Independent International Commission of Inquiry, the relevant Special Rapporteurs and the United Nations Environment Programme (UNEP).
- **The Government of Israel** must disclose the information required to enable accurate environmental assessment, including the types, quantities and impact locations of munitions used and the locations of military installations, waste sites and burn pits.
- **The Government of Israel** must make full reparations for environmental and related harm caused by its internationally wrongful acts, including restitution, compensation and the rehabilitation of the affected environment and the populations exposed to it. That obligation is owed to the Palestinian people, including affected individuals, communities and institutions, does not displace claims brought by the State of Palestine, and is not contingent on donor financing arrangements.
- **UNEP** should support the State of Palestine to undertake a full, independent, field-based PCEA of Gaza, sufficiently comprehensive to characterize contamination at scale rather than at selected hotspots, alongside the restoration of Palestinian laboratory and analytical capacity. The assessment must proceed alongside urgent humanitarian and exposure-

reduction measures rather than becoming a precondition for them. Third states must use their political, financial and technical leverage to secure and support this process, while ensuring that responsibility for the environmental damage remains with Israel.

- **Third states and the UN** must ensure that the environmental dimensions of the destruction are addressed within existing accountability mechanisms rather than treated as a separate technical process, including by supporting the Independent International Commission of Inquiry to examine the contamination of water, soil and food systems, and by cooperating fully with relevant investigations and judicial proceedings. States should establish, under a UNGA mandate, a register of damage covering environmental, health and property harm caused in Gaza since 2023, so that harm is recorded while evidence remains recoverable and claims remain possible. Accountability obligations of this kind are distinct from humanitarian donorship and are not satisfied by it. Until an appropriate forum becomes available, the UNGA should extend the mandate of the Register of Damage Caused by the Construction of the Wall in the Occupied Palestinian Territory to cover all damage caused by the unlawful occupation, including breaches of IHL, pending the creation of a register specific to Israel's assault on Gaza from 2023 to the present.
- **Third states** must also fulfil their duties of prevention and non-complicity by suspending all transfers of arms, military equipment, components and relevant dual-use items for military use to Israel, which aid or assist sustaining the continuing occupation, where an overriding risk of serious violation of IHL exists and by reviewing military, security and intelligence cooperation, in order to prevent further violations. Applicable legal duties arise under Common Article 1 and the Genocide Convention, and for its States Parties the Arms Trade Treaty, including Articles 6 and 7. States must act on the applicable prevention and transfer-prohibition thresholds; a final judicial determination is not required before preventive action.
- **Donors and financing bodies** must subject all reconstruction financing to environmental due diligence, contamination risk assessment and mandatory safeguards, without prejudice to Israel's obligation to make full reparations. Financing must not support arrangements that facilitate displacement, entrench external control, separate Gaza from the West Bank including East Jerusalem, or fragment Palestinian governance. Environmental monitoring and regulatory systems must be restored within a unified, Palestinian-led governance framework.
- **The Board of Peace, participating states and all entities operating under UN Security Council Resolution 2803 (UNSCR 2803)** must comply with their applicable obligations under international law. Reconstruction must respect Palestinian self-determination and must not reinforce Israel's unlawful occupation or diminish Israel's obligations as the occupying power. Reconstruction works must be preceded by field-based environmental assessment or, where assessment remains incomplete, by precautionary safeguards appropriate to the risks, and all reconstruction financing must carry mandatory environmental and social safeguards. The State of Palestine must hold decision-making roles over environmental standards, assessment, remediation, monitoring and spatial planning, and any regulatory functions the Board exercises must be transferred to accountable Palestinian institutions on a published and strictly time-bound plan. Claims and remedy arrangements should be grounded in Palestinian authority and rights, with Palestinian institutions and affected

communities leading their design, and claims decided independently of the actors concerned. Neither these arrangements nor reconstruction financing replace or limit Israel's obligation to make full reparations for harm caused by its violations, including harm caused before October 2023. UN-led humanitarian coordination, including the UN Relief and Works Agency's (UNRWA's) mandate, must be protected.

- **Humanitarian and development actors** must integrate contamination risks into humanitarian response, recovery and reconstruction, applying established environmental and social safeguards and contamination-aware technical approaches to reduce exposure and prevent new pathways of harm. This should include safe water treatment, dust and debris controls, food-safety monitoring, contamination-aware infrastructure rehabilitation, and appropriate occupational health and safety measures. This must be accompanied by the restoration and strengthening of Palestinian environmental, public-health, laboratory and regulatory capacity, alongside sustained long-term health and environmental monitoring.

Israel's military assault on Gaza has caused extraordinary suffering and environmental destruction. The states, institutions and organizations concerned must act on these recommendations without delay to prevent further harm and enable safe recovery and rehabilitation.



A flattened neighbourhood where a lone building frame stands in the rubble. Northern Gaza Strip, 20 January 2025.
Photo: Alef Multimedia/Oxfam

CONFLICT CONTAMINATION IN GAZA: WHAT ARE WE TALKING ABOUT?

Israel's military assault in Gaza has released toxic contaminants that move through the environment, threatening the health of current and future generations.



Addressing contamination is a legal obligation and essential for the safe, dignified and sustainable recovery of Gaza.

Contamination in Gaza is widespread, persistent and multi-layered. Without comprehensive environmental assessment, remediation and long-term monitoring, **recovery and reconstruction risk entrenching harm and undermining the right to health for generations to come.**

Note: This figure summarises potential contamination pathways and health concerns identified in this report. It does not constitute a quantitative risk ranking.

1. INTRODUCTION

Following the atrocities by Palestinian armed groups on 7 October 2023, Israel has subjected Gaza to a sustained and highly destructive military assault, amounting to genocide against the population.[1] This has devastated civilian infrastructure, environmental systems, and the basic conditions necessary for life. By October 2026, Israeli forces had killed more than 74,000 Palestinians and wounded over 175,000,[2] while thousands remain unaccounted for under the rubble. Satellite-based damage assessments by the United Nations Satellite Centre (UNOSAT) indicate that by 11 October 2025, over 80% of all structures across Gaza had been damaged or destroyed, including homes, hospitals, schools and critical public infrastructure.[3] Water and sanitation systems have been extensively degraded, with over 85% of infrastructure damaged or rendered inoperable.[4] Agricultural systems have been similarly devastated, with the majority of arable land affected and tree crops almost entirely destroyed.[5] The destruction of markets and supply chains has further disrupted access to food, deepening the dependency of people living in Gaza on external aid.[6] This has been part of a policy of deliberate deprivation of aid and the use of starvation as a weapon of war.[7] This kind of collective punishment is prohibited.[i]

The humanitarian crisis is compounded by an environmental catastrophe that is inseparable from the conduct of Israel's military campaign. Widespread destruction, debris accumulation, and the extensive use of explosive weapons across one of the world's most densely populated territories have introduced hazardous contaminants into soil, water and air on a massive scale. These are not peripheral consequences of conflict, nor were they the inevitable result of asymmetric urban operations.[8] They are the direct and foreseeable result of choices made in the conduct of Israel's military assault and application of force, leading to the widespread and systematic destruction of Gaza's civilian infrastructure.[9, 10] Heavy metals, explosive residues, asbestos, dioxins, polycyclic aromatic hydrocarbons (PAHs) and biological contaminants are now embedded across environmental systems that Gaza's civilian population depends on for survival. These contaminants will persist for years, in some cases decades.

The scale of this environmental destruction demands an urgent and decisive response. At present, recovery and reconstruction discussions are advancing in the absence of a field-level post-conflict environmental assessment (PCEA)[ii] of conflict-related contamination, placing the health and survival of Gaza's civilian population at risk.

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i 'To the extent that the purpose of the blockade is retribution, the blanket denial of services essential for water access in response to the acts of armed groups may constitute collective punishment of the civilian population.' UNHRC. (12 June 2024). *Report of the Independent International Commission of Inquiry on the Occupied Palestinian Territory, including East Jerusalem, and Israel*. UN Doc: A/HRC/56/26, para. 52. Retrieved from: https://undocs.org/A/HRC/56/26. For an analysis of the issues involved, see: The Geneva Academy of International Humanitarian Law and Human Rights. (2019). *The Water Crisis in War and Under Occupation*. Retrieved from: https://archives.geneva-academy.ch/joomlatools-files/docman-files/IHL%20Spot%20Report%20-%20Water%20Crisis%20in%20War%20and%20Under%20Occupation.pdf

ii A Post-Conflict Environmental Assessment (PCEA) is a systematic process for identifying, characterizing and evaluating actual and potential environmental impacts arising from conflict, including effects on human health and natural resources. In the context of Gaza, a full field-based PCEA would involve on-site investigation and environmental sampling to identify and characterize contamination in soil, water, air and debris; assess contaminant pathways, distribution, persistence and potential exposure; and determine the measures required to manage risks, remediate environmental damage and inform safe recovery and reconstruction.

The scale of this environmental destruction demands an urgent and decisive response.

1.1 Reconstruction without environmental assessment

Existing remote assessments, including those conducted by the UNEP, have documented widespread environmental degradation in Gaza.[11] However, they cannot establish site-specific contamination levels without a field investigation. This is consequential because the failure to identify and manage contamination would potentially embed these public health hazards into rebuilt environments, undermining food and water safety, and exposing workers and communities to toxic materials, while creating legal and financial liabilities for the actors involved in recovery. These risks reinforce growing international recognition that reconstruction in conflict-affected settings must be rights-based, informed by evidence, and supported by independent technical assessments capable of identifying, containing and managing environmental hazards before rebuilding begins.[12, 13]

The absence of a full, independent, field-based PCEA is a direct consequence of Israel's continued refusal of independent access to Gaza. Without sustained and unimpeded access for environmental experts, assessment teams and technical specialists, the field surveys required cannot be conducted. As a result, contamination cannot be fully characterized, monitored or mitigated, while civilians continue to be exposed to hazards which cannot be thoroughly examined.

A comprehensive, independent, field-level PCEA is essential to the safe recovery of Gaza and to fulfilling duties to protect health and the environment.

1.2 Gaza and comparable contexts

There is sufficient evidence from Gaza and other conflict settings to conclude that military activity of this scale and intensity results in complex, widespread and persistent environmental contamination. This contamination directly affects the environmental systems upon which civilian survival depends, including water resources and food production. The weapons deployed span aerial bombs, heavy artillery, tank munitions, guided missiles, white phosphorus, and armoured vehicles and buildings packed with explosives and remotely detonated. Each of these weapons represents a distinct contamination source releasing hazardous substances into soils, groundwater, surface water and the built environment.

UNEP estimates that Israel's military operations have generated 61 million tonnes of debris, about **29 tonnes of debris for every person in Gaza,** much of it containing pulverized building materials, asbestos and other hazardous substances.[14] These materials will not remain contained; they will be dispersed through environmental media across densely populated areas, increasing the likelihood of human exposure through direct contact, dust inhalation and the ingestion of contaminated water and food.[15] The estimated debris in Gaza[16] is approximately

eight times the 7.65 million tonnes estimated in Mosul, Iraq following the 2017 conflict,[17] and approximately three times the 20.3 million tonnes generated in Aleppo and Homs combined during the Syrian conflict.[18]

Additionally, Israel's systematic destruction of Gaza's civilian infrastructure, including its water, wastewater and solid waste systems, fuel storage, electrical networks, and industrial and medical facilities, has created a second and equally consequential contamination layer. Each destroyed sector adds another hazardous contamination profile to Gaza's environment, including petroleum hydrocarbons and polychlorinated biphenyls (PCBs) from ruptured fuel depots and destroyed electrical transformers; pathogens and antimicrobial-resistant (AMR) bacteria from collapsed wastewater systems; and dioxins and furans from fires.

Comparable PCEAs reinforce these concerns. Following the 2006 conflict in Lebanon, UNEP found heavy metals in soils from all sampled locations, petroleum contamination at bombed fuel facilities and petrol stations, and localized chemical contamination near industrial sites.[19] Studies from Iraq documented elevated concentrations of heavy metals in soils and human biological samples, alongside reported congenital birth defects, suggesting an association between conflict-related environmental contamination and adverse health outcomes.[20] In north-west Syria, a region-wide survey of 66 sites following more than a decade of conflict found elevated concentrations of potentially toxic elements in soils, with cadmium, arsenic and cobalt levels particularly elevated in areas that had experienced intense conflict-related impacts.[21] In Ukraine, field studies have identified heavy metal residues associated with munition detonations, including arsenic, barium, copper, iron, lead and zinc in soils at battlefield and unexploded-ordnance destruction sites.[22] UNEP's assessment following the 2008–09 hostilities in Gaza documented hazardous substances in conflict debris, including asbestos,[23] while its 2024 preliminary assessment identified a range of environmental hazards, including unexploded ordnance, asbestos and other hazardous substances, raising concerns about the contamination of soil and groundwater by chemicals and heavy metals.[24]

Given the scale and extent of destruction in Gaza, it is reasonable to expect widespread contamination, with growing exposure risks.

1.3 Scope, analytical approach and principal findings

This paper addresses the critical gap in understanding the environmental consequences of Israel's military assault in Gaza. It examines the potential scale, distribution and implications of conflict-related contamination across the territory, drawing on remote sensing and satellite-derived damage data, secondary scientific and technical literature, comparative evidence from other conflict settings, and legal analysis.

This analysis does not replace a field-based PCEA, and is constrained by the absence of field investigations, systematic environmental sampling, and unrestricted access to affected areas. Instead, it brings together available evidence despite access restrictions and demonstrates that the available evidence is already sufficient to identify serious and foreseeable contamination risks requiring urgent assessment and response. Although many findings are supported by the convergence of multiple independent lines of evidence, including

remote sensing, engineering assessments, humanitarian data, comparative post-conflict studies and established scientific understanding of contaminant behaviour, the precise extent, concentration and distribution of many contaminants can only be confirmed through an independent field-based PCEA. Nonetheless, the report reaches three principal conclusions:

1. Despite the absence of a full, independent, field-based PCEA, there is already sufficient evidence to conclude that environmental destruction is extensive, and contamination is widespread, severe and consequential.
2. Environmental contamination in Gaza directly undermines the conditions necessary for civilian survival, engaging clear obligations under IHL, IHRL and occupation law. Failure to address the contamination must be assessed against each actor's applicable obligations.
3. A comprehensive, independent, field-based PCEA must guide safe and responsible recovery alongside immediate measures to reduce exposure to contamination in Gaza.

The absence of independent field-based evidence is a direct consequence of Israel's continued restrictions on independent access to Gaza. This should not be a reason to delay, defer, or diminish the urgent response that the available evidence already demands.

This report employs a multi-layered analytical approach integrating environmental science, spatial analysis and legal analysis to assess the scale, distribution and implications of conflict-related contamination in Gaza. Secondary scientific and technical literature, including peer-reviewed research, PCEAs from comparable settings, humanitarian reporting and UN agency data, provided the evidentiary foundation for identifying contaminant types, environmental pathways, exposure mechanisms and associated human health and ecological risks. This research was complemented by a legal analysis drawing on IHL, IHRL and occupation law to assess the legal implications of environmental degradation during armed conflict.

Spatial analysis formed the core analytical framework underpinning this assessment. Open-source conflict incident databases were used to identify and geolocate pollution-generating events, including airstrikes, artillery impacts, military operations and damage to civilian infrastructure.[iii] These data points were integrated with satellite-derived damage assessments and remote-sensing products, including Sentinel-1 radar imagery, VIIRS fire detection data and vegetation indices, to identify the distribution of damaged infrastructure, debris, agricultural losses, fire activity and other environmental hazards. The multiple datasets were then analysed collectively to identify areas where conflict-related contamination is most likely to occur, estimate the diversity and severity of contamination across Gaza, and assess potential exposure pathways affecting water resources, food systems, livelihoods and human health. The resulting maps, spatial analyses and quantitative findings presented throughout this paper are derived from this integrated analytical framework. A detailed description of the methodology,

iii Open-source conflict incident data was drawn from the Armed Conflict Location and Event Data Project (ACLED), Airwars and GeoConfirmed. These datasets were used to identify and geolocate conflict-related incidents with the potential to generate environmental contamination and were analysed alongside satellite imagery, remote-sensing products and other geospatial datasets.

underlying datasets, analytical assumptions, sectoral weightings and limitations is provided in **Annex 1**.

2. MAPPING MUNITIONS USE AND CONTAMINATION RISK IN GAZA

The scale and intensity of Israel's military assault on Gaza have created conditions in which environmental contamination is extensive and widespread. Available evidence indicates that tens of thousands of strikes have occurred in one of the most densely populated environments in the world.[25] Each strike represents a potential point source of contamination, introducing hazardous materials into soils, groundwater, surface water and the built environment. Patterns of bombardment, infrastructure destruction and debris accumulation create spatially and temporally differentiated contamination risks, with some areas likely to face significantly higher exposure levels than others.

The scale and intensity of Israel's military assault on Gaza have created conditions in which environmental contamination is extensive and widespread.

To understand and manage these risks, it is essential to move beyond generalized assessments and identify where contamination is most likely to occur, how it spreads through the environment and who is most exposed.

2.1 The scale and types of munitions used

Israel's military assault has involved the deployment of explosive weapons at an extraordinary scale and intensity. In the first five days of the assault alone, the Israeli Air Force dropped approximately 6,000 bombs – around 4,000 tonnes of munitions – at a sustained rate of roughly one bomb every minute per day.[26] By early 2026, the UN reports that more than 200,000 tonnes of explosives had been dropped on Gaza in almost two years, describing the volume of ordnance deployed as unprecedented and estimating its total energy as equivalent to approximately 13 Hiroshima-sized nuclear bombs.[27]

The weapons used in the assault span a wide spectrum of explosive yield and contaminant profiles. The UN has documented the use of large-payload aerial bombs, including US-manufactured Mark 80 series bombs, alongside unguided munitions, artillery, multiple-launch rocket systems and tank-fired high-explosive shells in densely populated areas.[28] Other investigations have further documented specific systems, including JDAM-guided variants, BLU-109 bunker-buster penetrators and GBU-39 precision glide bombs.[29, 30, 31] Naval bombardment of Gaza's coastal areas has also been documented,[32] as has the use of white phosphorus, an incendiary chemical that ignites spontaneously on contact with air, representing a distinct

contamination source.[33, 34] Heavy 155mm artillery shells have also been widely used, alongside tank-fired munitions from Merkava battle tanks, guided missiles and munitions launched from unmanned aerial vehicles (UAVs).[35, 36, 37, 38]

As an indication of scale, Israel had purchased more than 14,000 MK-84 2,000lb bombs from the United States (US) by June 2024,[39] with a further shipment reported in February 2025.[40] The scale of heavy aerial bombardment is further evidenced by the identification of almost 600 large blast craters across Gaza by late 2023.[41]

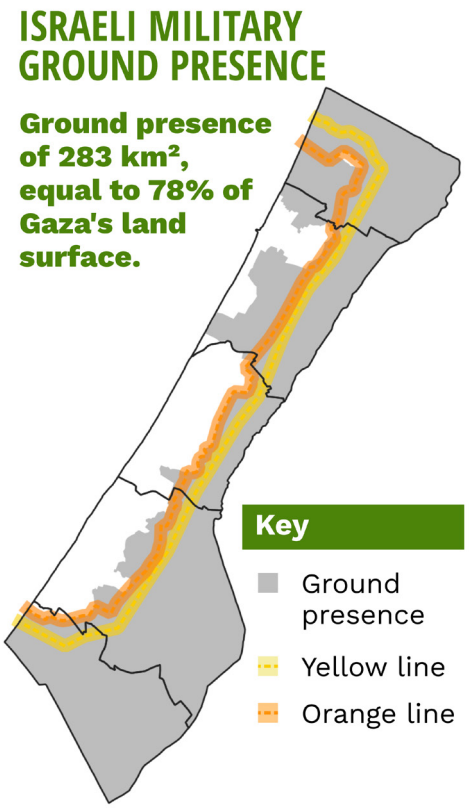
A notable and particularly destructive feature of Israel's ground offensive has been the widespread use of decommissioned armoured personnel carriers packed with one to three tonnes of explosives, remotely detonated to demolish structures.[42, 43] These function as large mobile charges, generating intense and localized contamination. Armoured bulldozers and attached explosive charges have similarly been deployed to demolish civilian buildings.[44]

A detailed breakdown of munition types and their characteristics is provided in **Annex 2**.

Ground operations have left a separate but significant contamination footprint. Damaged and abandoned military vehicles, heavy equipment, batteries, fuels, lubricants, hydraulic fluids, electronics, spent casings and field waste are concentrated along ground operation routes, military corridors, staging areas, buffer zones and former positions. Ground military activity has directly affected approximately 283km^2, representing 78% of Gaza's total land area of 365km^2.[iv] As a result, contamination risks associated with military operations cannot be treated as localized phenomena and must be understood as affecting much of Gaza's environmental and civilian landscape.

Additionally, a significant proportion of munitions will have failed to detonate on impact, leaving unexploded ordnance (UXO) and explosive remnants of war (ERW) embedded within rubble, soil, damaged infrastructure and agricultural land.[45, 46] Beyond their immediate blast hazard, these residual explosives represent a longer-term pollution source as

Figure 1: The estimated extent of Israeli ground military operations across the Gaza Strip



Source: Yellow and orange lines digitised from an Applied Research Institute of Jerusalem map via Reuters, 30 April 2026; previous control area: @Stinky (OSINT investigator), X.

iv The extent of military activity is estimated as the area between the orange line and the border with Israel, plus the area west of the orange line where there have been Israeli ground operations.

corroding casings continue to leach energetic compounds and metals into surrounding soils and groundwater over time.

2.2 The contamination profiles of munitions and environmental exposure pathways

The intensive use of explosive weapons in Gaza's densely populated setting has generated a complex and multi-layered contamination profile, resulting from both the composition of munitions and their interaction with urban infrastructure and the environment. Evidence from PCEAs shows that these contaminants are not limited to isolated impact sites but can become widely dispersed across soils, groundwater, surface water, sediments and the land surface, creating multiple and overlapping risks of human exposure across widespread geographies and timescales.[47, 48]

Contaminants associated with munitions and the destruction of the built environment are environmentally persistent and in many cases pose risks to human and environmental health at very low concentrations. These can be broadly grouped into:[49, 50, 51, 52, 53]

- **Inorganic contaminants:** including perchlorate (ClO_4^-) and heavy metals [lead (Pb), antimony (Sb), copper (Cu), tungsten (W) and zinc (Zn)].
- **Explosives and energetic residues:** including trinitrotoluene (TNT), 2,4-dinitrotoluene (2,4-DNT), cyclotrimethylenetrinitramine (RDX), and octogen (HMX).
- **Combustion-related and persistent organic pollutants (POPs):** including polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F), polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs).
- **Debris-associated contaminants:** including asbestos fibres, lead-based paints, insulation materials, plastics and industrial chemicals.

A detailed overview of contaminant types and properties is provided in **Annex 3.**

Beyond munitions, Israel's systematic destruction of civilian infrastructure has created a second, territory-wide layer of environmental contamination. Each sector of destroyed infrastructure carries its own contamination profile, while the collapse of environmental management systems amplifies the movement and persistence of contaminants across Gaza. **Table 1** provides an overview of the primary contamination classes released by sector. The consequences of this destruction for Gaza's water, food systems, livelihoods and human health are examined in Chapters 3 to 7.

Table 1: Civilian infrastructure destruction and primary contaminants by sector

Sector	Infrastructure destroyed	Potential contaminant class
Wastewater	Treatment plants, pumping stations and sewer networks.	Pathogens, AMR bacteria, nutrients and pharmaceuticals.
Fuel and energy	Fuel depots, petrol stations, transformers and electrical networks.	Petroleum hydrocarbons, PCBs and PAHs.

Sector	Infrastructure destroyed	Potential contaminant class
Industrial and commercial	Factories, workshops, warehouses and cold stores.	VOCs, heavy metals, solvents and refrigerants.
Medical	Hospitals, clinics, pharmacies and ambulances.	Infectious waste, pharmaceuticals, cytotoxins and AMR bacteria.
Solid waste	Sanitary landfills, collection vehicles and dump sites.	Leachate, combustion products, PFAS and pathogens.
Agricultural and agrochemical	Cropland, greenhouses and agrochemical storage.	Pesticides, fertilizers, livestock waste and AMR bacteria.
Residential	Housing, refugee camp structures and built fabric.	Asbestos, crystalline silica, lead and flame retardants.

Once released, these contaminants can reach the civilian population through four principal exposure pathways, each examined in detail in **Annex 4:**

- Inhalation of contaminated dust, smoke and airborne particulate matter.
- Ingestion of polluted water from degraded groundwater and surface-water sources.
- Consumption of contaminated crops, livestock products and fish.
- Direct skin contact with contaminated soils and debris.

These pathways do not operate independently. Contaminants transfer continuously across air, soil, water and biological systems, creating cumulative exposures that underpin both immediate and long-term impacts across health, water and food security, livelihoods and environmental recovery.[54, 55] Evidence from PCEAs in Iraq and Lebanon confirms that contaminants associated with military activity can disperse through soil, water and air.[56, 57] Many of these contaminants remain in the environment for years and decades, creating pathways for human exposure through inhalation, ingestion and direct contact. In Iraq, studies identified elevated concentrations of heavy metals in soils and in human biological samples, highlighting potential exposure through dust and environmental contact.[58] In Lebanon, following the 2006 bombing of the Jiyeh power plant, research documented PAHs from the resulting oil spill in marine organisms, demonstrating the transfer of contaminants from a conflict-related release into the marine food system.[59] In heavily damaged cities such as Aleppo, the destruction of buildings generated fine particulate matter containing hazardous materials, posing significant risks for returning populations and debris removal workers.[60] In Gaza, the intensity of bombardment, the scale of generated debris, the density of the civilian population, and the total collapse of environmental management systems combined make exposure risks systemic, continuous and likely to persist long after active hostilities cease.



Stacks of munitions and casings lying among rubble (left); close-up of munition casings marked "USA/DOD" (right). Khan Younis, southern Gaza Strip, 8 April 2024. Photo: Alef Multimedia/Oxfam

3. THE SCALE OF CONFLICT-DRIVEN CONTAMINATION

Gaza's civilian population is living within a contamination crisis that spans the entire Gaza Strip. Israel's military assault has pulverized buildings, torched warehouses, ruptured fuel depots, destroyed hospitals and overwhelmed waste sites, releasing hazardous pollutants into the air, debris, soil and environmental systems on which civilian survival depends. These contaminants are dispersed through densely populated urban areas, transported through air and water systems, embedded within debris and damaged infrastructure; contact with them is increasingly unavoidable for civilians living across Gaza.

This extensive and widespread contamination risks is a highly consequential and enduring outcome of Israel's military assault in Gaza. Understanding its full scale is essential for accountability and environmental remediation, as well as safe and responsible recovery and reconstruction.

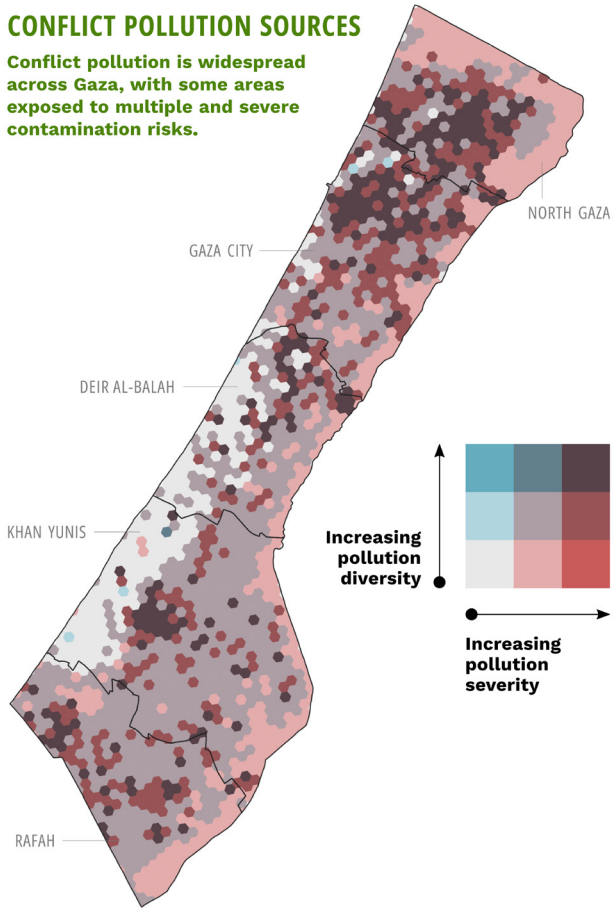
3.1 Territory-wide contamination

Spatial analysis integrating multiple conflict-related pollution sources, including military activity, satellite-derived damage assessments, and the locations of damaged civilian infrastructure, industrial facilities, wastewater systems, fuel and energy infrastructure, solid waste sites and agricultural areas, identified indicators of at least one potential contamination source across **more than 99% of Gaza's area**.[v] Figure 2 illustrates the estimated distribution, diversity and severity of conflict pollution across the territory, while Figure 3 further highlights the extensive overlap between destruction to the built environment; damage to agricultural areas; and the indicative distribution of Israeli military operations.

The spatial analysis indicates that the **highest expected diversity and severity of conflict-related contamination is found in Gaza City, Khan Younis, Rafah, Jabalia, and along the Salah al-Din Road**, corresponding closely with the areas subjected to the most sustained bombardment, ground military operations, infrastructure destruction and debris accumulation. However, contamination is not limited to areas directly targeted during military operations (**Figure 2** and **Figure 3**), as pollutants generated by conflict-related activities can be dispersed through environmental systems and transported across the territory. Even comparatively less directly targeted areas, such as the coastal zone between Al Mawasi and Az-Zawaideh, are not insulated from contamination. Pollutants can spread through air movement and water flows, and are further dispersed by the collapse of environmental management systems. This is particularly significant in areas such as Al Mawasi, where large numbers of displaced populations have been concentrated despite limited environmental infrastructure and services.[61]

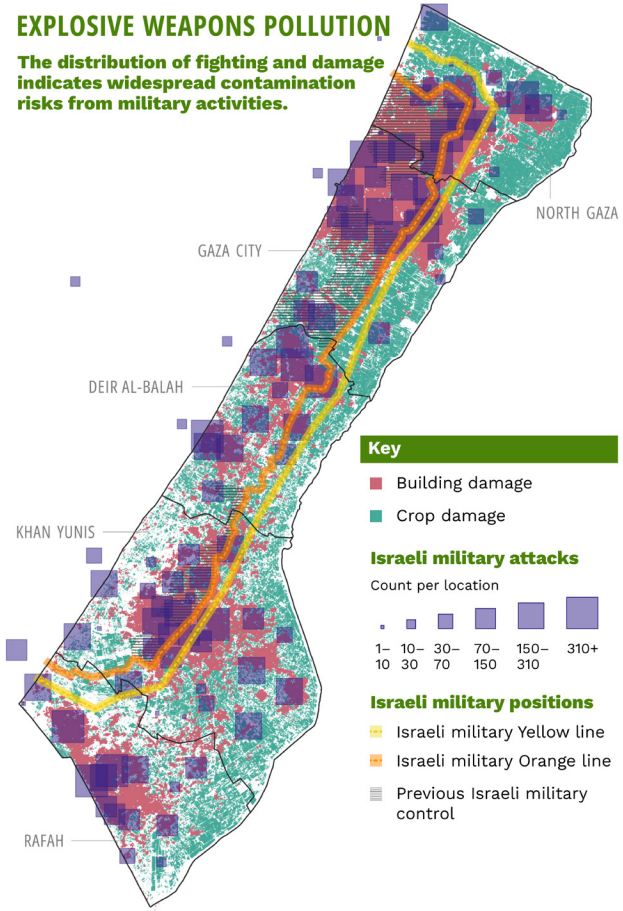
v The analytical approach, including the data sources, spatial assumptions and sectoral weightings underpinning this assessment, is described in Annex 1. A summary is also provided in Section 1.3.

Figure 2: The estimated distribution, diversity and severity of conflict-driven contamination across Gaza



Note: Contamination proxy calculated from damage mapping, incident detection and particular signatures of harm for each contamination sector; results are qualitative.

Figure 3: Damage to the built environment and agricultural areas in Gaza, with indicative distribution of Israeli military operations



Source: Yellow and orange lines digitised from an Applied Research Institute of Jerusalem map via Reuters, 30 April 2026; previous control area: @Stinky (OSINT investigator), X. Building damage: radar damage proxy, Scher and Van Der Hoek (2026). Agricultural damage: Yin et al. (2025). Event count data derived from ACLED, filtered for 'Battles' and 'Explosions/Remote violence' event types with 'Military forces of Israel' as 'actor1', 7 October 2023 – 21 April 2025.

3.2 Fires, explosions and toxic air exposure

Israel's military assault has caused severe and sustained air pollution across Gaza. Repeated bombardment, large-scale fires, demolition activities, debris accumulation, fuel combustion and the collapse of waste management systems have generated both acute and chronic inhalational exposure risks across densely populated civilian areas. These activities have released complex mixtures of hazardous pollutants into the air, including particulate matter, heavy metals, volatile organic compounds (VOCs), combustion by-products, and persistent organic pollutants (POPs) such as dioxins and furans which are associated with incomplete combustion processes.[62]

Satellite fire-detection data identified 1,273 fire hotspots across Gaza between 7 October 2023 and 31 December 2025, with sustained fire activity recorded throughout the conflict period.[vi] These figures likely underestimate the true scale of burning as they do not fully capture fires occurring within forced displacement areas, damaged neighbourhoods, temporary waste sites or informal fuel production activities. Table 2 provides examples of large-scale fires to illustrate the diversity of materials burnt.

Table 2: Examples of large-scale fires in Gaza

Date	Latitude	Longitude	Name
12/12/2023	31.529	34.522	Mansoor Printing
23/10/2023	31.502	34.487	Al-Madina Soda Plant
16/11/2023	31.499	34.431	ASY Desalination Plant
24/11/2023	31.474	34.435	Industrial area including Yafal Aluminium Works Company
01/12/2023	31.343	34.323	Al-Huda Pharmacy
06/04/2024	31.482	34.451	Unidentified industrial building
14/06/2024	31.535	34.510	Indonesian Hospital
03/08/2025	31.532	34.458	Food warehouse

Alongside fires, the systematic demolition of Gaza's built environment has generated intense releases of contaminated dust and hazardous particulate matter. Israel's use of armoured bulldozers, explosive charges attached to buildings and explosive-laden vehicles to collapse structures[63] has produced demolition events releasing silica-rich concrete dust, asbestos fibres, heavy metals and combustion residues. Demolition and debris clearance involving these hazardous materials would ordinarily require dust suppression, physical containment and exclusion zones to prevent contaminants from spreading and to protect workers and the public through appropriate personal protective equipment (PPE).[64] In Gaza, these protective measures cannot be implemented at the necessary scale because of continued Israeli military operations and restrictions on the movement of people, materials and equipment, leaving civilians continuously exposed to hazardous dust and other airborne contaminants.

vi Active fire detections were obtained from NASA FIRMS using the VIIRS 375m product from the NOAA-20 (JPSS-1/J1) sensor. The VIIRS active fire algorithm follows the methodology described by Schroeder et al. (2014). See: W. Schroeder, P. Oliva, L. Giglio and I. A. Csiszar. (2014). 'The New VIIRS 375 m active fire detection data product: Algorithm description and initial assessment'. Remote Sensing of Environment, 143, pp. 85–96. Retrieved from: https://doi.org/10.1016/j.rse.2013.12.008. Analysis undertaken by CEOBS. The 1,273 detections represent fire hotspots rather than distinct fire events, and no adjustment was made for repeated detection of the same fire.

UNEP estimates that Israel's military operations have generated more than 61 million tonnes of debris across Gaza, of which 2.91 million tonnes are associated with industrial and potentially contaminated sites.[65] This debris does not remain static. Wind movement, ongoing bombardment, rubble clearance, salvage activities, vehicle movement and the daily movement of civilians continuously resuspend contaminated dust into the atmosphere, creating an unavoidable exposure pathway that extends far beyond any individual attack. **Figure 4** illustrates the widespread inhalational risks associated with resuspended contaminated dust, particularly across heavily damaged urban centres including Gaza City, Jabalia and Khan Younis.

The collapse of fuel supplies, electricity systems and municipal services has exacerbated chronic air pollution across Gaza. Fuel shortages have severely constrained humanitarian and municipal operations, affecting the ability of actors to transport water, collect and manage waste, and the transport of essential goods.[66] It has also driven the widespread burning of waste and the increased use of wood, cardboard, plastics, nylon, mixed waste and other readily available combustible materials for cooking and heating, particularly within overcrowded displacement sites and informal shelters.[67] Landfill and dump-site fires have added further persistent emission sources. For example, a fire at a temporary landfill in the Ard Firas area of Gaza City in May 2026 required both municipal and humanitarian actors to bring it under control,[68, 69] highlighting the environmental and public health risks associated with the growing reliance on temporary waste disposal sites.

The destruction of energy infrastructure has introduced a separate and serious contamination pathway. Israel's military assault has destroyed 2,105 electricity distribution transformers across Gaza, alongside 3,780km of electrical networks and cables. Older transformers may contain polychlorinated biphenyls (PCBs), a confirmed human carcinogen, which could be released if such equipment is damaged.[70] The destruction of fuel depots and petrol stations can similarly release potential sources of petroleum hydrocarbons and combustion residues into the environment.

Respiratory health concerns are increasingly being reported among Gaza's population. Humanitarian medical teams have reported an increased incidence of acute respiratory infections and asthma among Gaza's population.[71, 72] Clinicians and researchers have identified a distinct respiratory illness pattern, associated with the toxic air conditions generated by Israel's military assault, which they have termed 'siege pollution exposure respiratory syndrome'; this is particularly concerning for children given their physiological vulnerability and higher relative inhalation rates.[73, 74, 75] While this term does not establish a clinical diagnosis, the combination of prolonged exposure to airborne pollutants, overcrowding, displacement and disrupted health services raises significant risks for both acute and longer-term respiratory health.

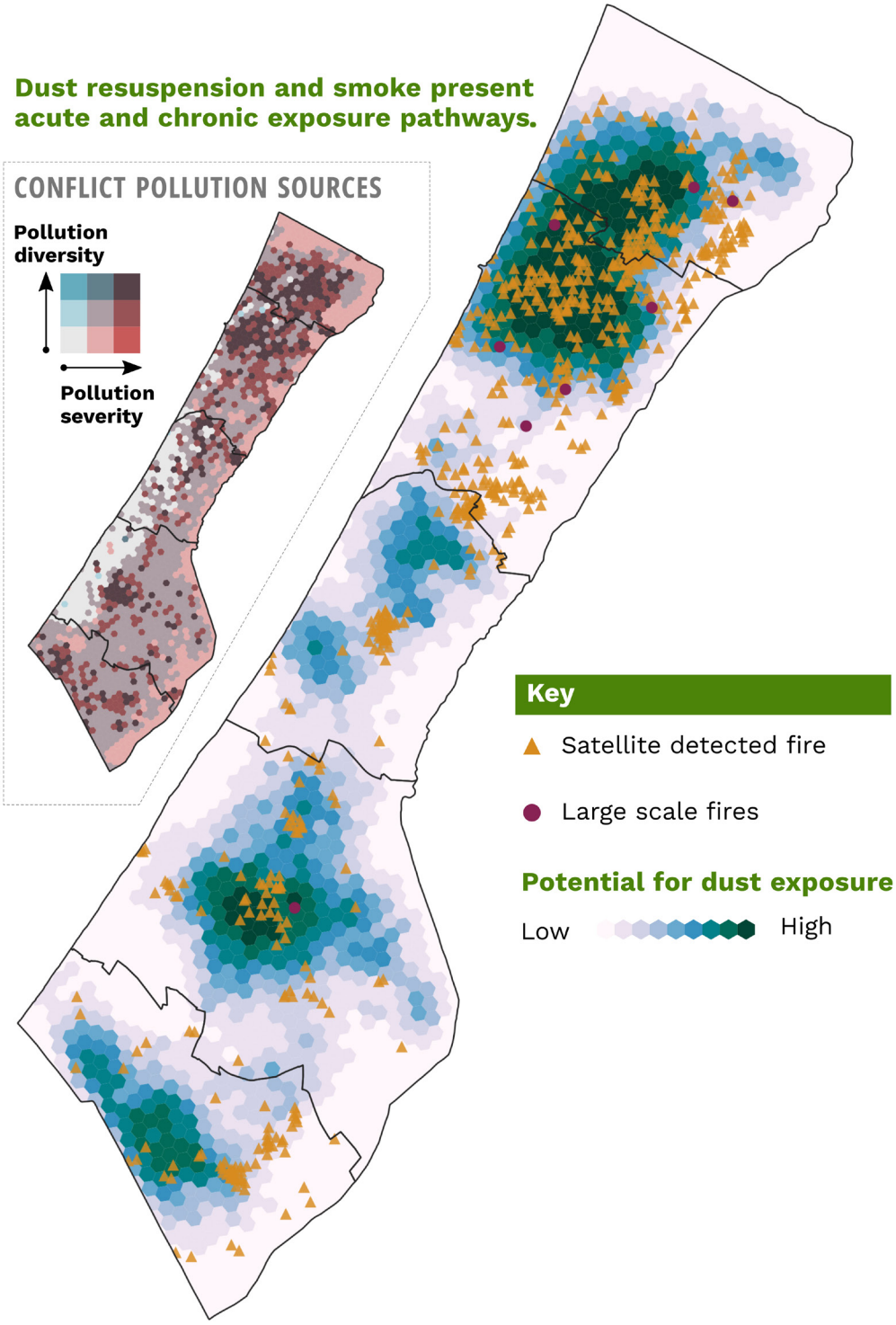
The effects of conflict-related air pollution are not necessarily confined to the territory in which pollutants are generated. Evidence from previous conflicts demonstrates that pollutants released during military operations can be transported across national borders. During the 1999 Kosovo conflict, air strikes on industrial facilities in Serbia released hazardous pollutants, including persistent organic pollutants.[76] Elevated concentrations of these pollutants were subsequently detected in northern Greece, with atmospheric trajectory analysis linking the pollution episodes to industrial sites destroyed in Serbia. The study also modelled the transport

of pollutant plumes towards Bulgaria, Romania, Ukraine, Moldova and the Black Sea.[77] More recently, analysis of the 2022 war in Ukraine using satellite observations and atmospheric modelling found that smoke-containing air masses from conflict-related fires in the Chornobyl region were transported across national borders into Romania, Serbia, Kosovo and Albania, while higher-altitude air masses reached Poland and the Baltic region.[78, 79] UNEP's assessment of Gaza has likewise recognized the potential for transboundary environmental consequences.[80] However, systematic air-quality monitoring and field sampling have not been possible at the scale required to establish whether, and to what extent, pollutants generated in Gaza have crossed its borders.



Hazy sun over massive mounds of rubbish. Central Gaza Strip, 29 June 2025. Photo: Alef Multimedia/Oxfam

Figure 4: Exposure pathway: air. Inhalational risks from resuspended contaminated dust across Gaza.



Note: Dust risk proxy calculated from damage mapping, prevailing wind conditions and surface openness. Source: Fire locations from MODIS and VIIRS via NASA FIRMS, 7 August 2023 – 31 December 2025.

3.3 Conflict-related greenhouse gas emissions

Israel's military assault in Gaza has also generated a substantial greenhouse gas emissions burden. These emissions arise from military operations and the destruction of infrastructure, debris management and reconstruction. A 2026 study estimated that direct emissions from open conflict had exceeded 1.3 million tonnes of carbon dioxide equivalent (CO_2e) by January 2025, rising to 33.2 million tonnes CO_2e when including emissions associated with pre-conflict military infrastructure and post-conflict reconstruction.[81] The largest share is associated with reconstruction, estimated at 31.4 million tonnes CO_2e or approximately 95% of the total 33.2 million tonnes CO_2e estimated across the wider conflict cycle.

The management of the conflict-related debris will also generate additional emissions. A separate study in 2025 estimated that transporting the 36.8 million tonnes of building debris generated during the first 14 months of the conflict would require more than 2.1 million truckloads and 29.5 million kilometres of travel, generating approximately 65,642 tonnes CO_2e before accounting for emissions from crushing and processing the material.[82] The latest UN estimate puts the total volume of rubble across Gaza at 61 million tonnes, indicating that emissions associated with debris clearance and processing are likely to be substantially higher.[83]

The scale of these emissions is particularly significant when considered against Palestine's pre-conflict emissions base. The Palestinian Central Bureau of Statistics estimated total greenhouse gas emissions for the occupied Palestinian territory (oPt) at 6.48 million tonnes CO_2e in 2022 and 5.57 million tonnes in 2023.[84] The estimated 33.2 million tonnes CO_2e across the wider conflict cycle is approximately equivalent to Palestine's total national emissions over almost six years at the 2023 level. It is also equivalent to Jordan's total annual emissions in 2024 or to the annual emissions of approximately 7.6 million petrol cars.[85] The climate burden of the conflict therefore extends well beyond the emissions generated during military operations, with a substantial additional burden associated with the destruction and rebuilding of Gaza's built environment.

3.4 The collapse of environmental management systems

Gaza's contamination crisis is driven by the extensive use of explosive weapons, the widespread destruction of buildings and civilian infrastructure, and the resulting generation of debris and release of hazardous contaminants. Indirect civilian harm – including foreseeable disruption to water, sanitation, healthcare and other essential services – must be considered when assessing an attack. An attack on civilian infrastructure is prohibited where it is directed against a civilian object, while an attack on a military objective is unlawful if incidental civilian harm is excessive in relation to the military advantage anticipated.[vii] These impacts have been compounded by the destruction and collapse of the environmental management systems

vii Protocol Additional to the Geneva Conventions of 12 August 1949 and relating to the Protection of Victims of International Armed Conflicts (Protocol I), adopted 8 June 1977, arts. 48, 51(4)–(5)(b), 52(1), and 57(2)(a)(iii), 1125 U.N.T.S. 3. Retrieved from: https://ihl-databases.icrc.org/en/ihl-treaties/api-1977; International Committee of the Red Cross. (2005). *Customary International Humanitarian Law*, vol. I: rules 7, 14 and 15. Cambridge: Cambridge University Press. Retrieved from: https://ihl-databases.icrc.org/en/customary-ihl/v1.

that once contained, treated and reduced environmental hazards. Israel's military assault had destroyed all six of Gaza's wastewater treatment plants by April 2024,[86] rendering them non-operational, while as of April 2026, only 19% of sewage pumping stations remain functional and approximately 30% of the wastewater network retains some operational capacity.[87] This has resulted in the uncontrolled discharge of approximately 40,000m^3 of raw sewage per day into the Mediterranean Sea, with a further estimated 15,000m^3 per day lost from the wastewater collection system through cesspits and other leakage pathways, creating a significant source of groundwater contamination.[viii]

Wastewater quality measurements from six principal wastewater pumping stations in Gaza City provide an indication of the pollution levels entering the environment following the collapse of wastewater treatment. As shown in **Table 3**, representative wastewater characteristics substantially exceed Palestinian maximum limits for treated wastewater discharged to the sea and groundwater recharge by infiltration, including total suspended solids (TSS), biochemical oxygen demand (BOD_5) and orthophosphate, demonstrating the severity of pollution following the collapse of wastewater treatment. These measurements characterize wastewater within the wastewater system and do not, on their own, establish the extent of contamination in Gaza's drinking-water sources, which requires separate sampling and analysis of groundwater and drinking water.

Table 3: Representative wastewater characteristics compared with Palestinian discharge standards[88]

Parameter	Representative value	Palestinian maximum limit – sea discharge ≥500m offshore	Exceedance	Palestinian maximum limit – groundwater recharge by infiltration	Exceedance
pH	7.59	6.0–9.0	—	6.0–9.0	—
Total TSS	831mg/L	60mg/L	13.9 ×	50mg/L	16.6 ×
Total BOD_5	1,011mg/L	60mg/L	16.9 ×	40mg/L	25.3 ×
Total COD	2,041mg/L	200mg/L	10.2 ×	150mg/L	13.6 ×
Orthophosphate (PO_4-P)	16.2mg/L	5mg/L	3.2 ×	15mg/L	1.1 ×

Source: Oxfam/Palestine Environmental Friends (PEF), unpublished wastewater sampling data, April 2026. The results are indicative of wastewater characteristics based on samples collected on 13 and 20 April 2026 from Al Bagara PS5, Samer PS6, Zaiton PS7B, Beach Camp PS3, Montada PS1 and Fawaida PS9.

Solid waste collection capacity has also largely collapsed, with collection vehicles reduced from 261 to just 48. While both principal sanitary landfills remain inaccessible, at least 56 temporary dump sites have been established across Gaza, although only 11 currently remain accessible and operational.[89, 90] These temporary dump sites largely lack engineered environmental protection measures including liners and leachate collection or containment systems, creating ongoing risks of soil and groundwater contamination. The accumulation of unmanaged waste

viii Analysis of pumping station flow measurements and operational records; clarification provided regarding estimated wastewater discharge and system losses with the Gaza Coastal Municipalities Water Utility, April 2026.

has consequently driven the widespread proliferation of rodents, flies, cockroaches and other disease vectors. By April 2026, an estimated 1.45 million people were living in areas affected by rodent and pest infestations, while accumulating waste, untreated sewage and overcrowded living conditions contributed to increasing cases of skin infections, ectoparasitic infestations and other communicable diseases.[91] The collapse of dedicated medical waste management systems has compounded these risks, with medical waste often mixed with general refuse, exposing waste workers, waste pickers and nearby communities to infectious materials.[92]

Environmental monitoring and regulatory capacity in Gaza have also largely collapsed. The destruction of laboratories, damage to monitoring infrastructure, and restrictions on the entry of sampling and analytical equipment have simultaneously eliminated Gaza's capacity to detect, characterize and manage environmental contamination.[93] The absence of comprehensive monitoring obscures the scale, distribution and evolution of environmental risks across water, soil, air and food systems, while severely constraining evidence-based remediation, regulatory oversight and recovery planning.

The collapse of wastewater treatment, solid waste management and environmental monitoring has transformed environmental management systems from mechanisms that once limited pollution into drivers of its accumulation and spread. Untreated sewage, unmanaged waste and the inability to detect or respond to contamination now compound pollutants released through bombardment and infrastructure destruction. This is creating cumulative environmental impacts across water resources, agricultural systems and food production. Israel's destruction of these systems prolongs and compounds environmental harm beyond individual attacks. The following chapters examine these consequences in relation to water, food systems, livelihoods and human health.

Gaza's contamination crisis is territorial in scale, multi-source in origin and systemic in character. It is the cumulative result of Israel's systematic destruction of buildings, infrastructure and the environmental management systems that once contained pollution and protected public health. As a consequence, water, food, air and soil systems have all been compromised.

4. WATER RESOURCES AND WATER SECURITY

Water lies at the centre of Gaza's environmental crisis. It is both a fundamental human right[94] and a critical natural resource upon which public health, food security, ecosystem function and reconstruction depend. The consequences of the destruction and contamination of Gaza's water systems extend far beyond access to drinking water, affecting environmental sustainability and human wellbeing.

Long before October 2023, Gaza faced an extreme water crisis. The territory is almost entirely dependent on the Coastal Aquifer, which historically supplied 81% of the total water available

to the population.[95, ix] Decades of over-extraction had already driven widespread salinization and seawater intrusion, compounded by the progressive reduction of natural groundwater recharge as urbanization expanded impervious surfaces and reduced infiltration rates.[96] Contamination from untreated wastewater, agricultural runoff (including fertilizers and pesticides), uncontrolled solid waste disposal, and seawater intrusion associated with aquifer over-abstraction had left 97% of the aquifer chemically polluted even prior to October 2023.[97, 98] Pre-conflict groundwater vulnerability assessments identified coastal areas, where the water table is shallowest, as particularly susceptible to contaminant infiltration.[99, 100, 101]

Israel's unlawful occupation, near-total blockade and longstanding control over water resources, infrastructure development and investment created the conditions that drove the progressive deterioration of Gaza's water resources.[102, 103] Arbitrary restrictions on infrastructure development, wastewater treatment, and the entry of essential equipment and materials significantly constrained the ability of Palestinian institutions to address aquifer depletion, reduce contamination and protect water resources.

As a result, Gaza entered October 2023 with severely limited capacity to manage further environmental degradation, leaving its already fragile environmental systems highly vulnerable to the scale and intensity of Israel's military assault and the widespread and persistent contamination that followed. The extensive use of explosive weapons, combined with the widespread and systematic destruction of water, wastewater, and solid waste management systems, as well as industrial and urban infrastructure, introduced multiple new contamination pathways through which pollutants are entering groundwater, coastal waters, soils, and water distribution systems. Post-conflict modelling suggests that without timely remediation, continued contamination and groundwater degradation could significantly reduce the aquifer's long-term recovery potential.[104]

4.1 System collapse: the destruction of water and wastewater infrastructure

Israel's sustained military bombardment has devastated Gaza's water and wastewater systems. UNOSAT estimates that over 85% of WASH infrastructure has been damaged or destroyed, affecting wells, pumping stations, desalination plants and treatment facilities.[105] Physical destruction has been compounded by sustained restrictions on access, fuel, electricity, spare parts, treatment chemicals and repair materials, preventing the operation and rehabilitation of surviving infrastructure and transforming physical damage into the prolonged systemic collapse of water service delivery.

This deterioration is reflected in the progressive collapse of Gaza's water availability as shown in **Table 4**. Prior to October 2023, approximately 334,000m^3 of water per day was available from groundwater abstraction, desalination facilities, and imports through the Mekorot pipelines. By June 2024, total water availability had collapsed to just 54,747m^3 per day, representing

ix Groundwater accounted for 81% of the total available water in Gaza, while 3% was supplied by the three seawater desalination plants along the coastline, 3% from municipal desalination plants, and approximately 12% was imported from Israel via three Mekorot lines.

an 84% reduction from pre-conflict levels. This translated into an average household water supply of only 4.74 litres per capita per day (l/c/d), far below the quantity required to meet even basic survival needs.[106] Although emergency repairs, humanitarian interventions and the partial restoration of water infrastructure increased total water availability to approximately 130,000m^3/day by April 2026, this remained 61% below pre-conflict levels, while average household water availability remained at only 23.48 l/c/d—less than half of the World Health Organization's (WHO's) minimum recommended level of 50 l/c/d required to meet essential domestic needs.[107, 108]

Table 4: The evolution of total water availability in Gaza by source, including humanitarian-supported supply, in April 2026[109]

Water source	Pre-October 2023 (m^3/day)	June 2024 (m^3/day)	April 2026 (m^3/day)
Internal production: wells and desalination water supply	278,907	40,810	96,844
Mekorot supply from Israel	55,200	12,168	28,795
UAE desalination plant supply from Egypt	–	1,769	4,676
Total water available	334,107	54,747	130,315
Reduction from pre-conflict period (%)	–	84%	61%

Source: Oxfam analysis of CMWU water production and supply data.

The partial recovery masks the continued degradation of Gaza's core water infrastructure. Municipal groundwater wells, historically the backbone of Gaza's water supply, have been particularly affected. Of the 346 municipal wells that existed before October 2023, only 161 remained operational by April 2026.[110] Desalination capacity has also been severely constrained. Only 39 of 139 municipal brackish water desalination plants and two of the three seawater desalination plants were operational by April 2026.[111]

Israel's destruction of water reservoirs across Gaza has eliminated one of the few remaining buffers against supply disruption. Of the 61 reservoirs that existed prior to October 2023, only nine remained operational by April 2026, reducing total storage capacity from 143,800m^3 to just 38,600m^3,[x] sufficient to supply Gaza's 2.1 million people[112] for only a single day with 18 litres per capita.

Table 5: The operational status of Gaza's water infrastructure in April 2026[113]

Infrastructure type	Total assets before October 2023	Operational in April 2026	% Non-operational
Municipal water wells	346	161	53.50%
Water reservoirs	61	9	85.20%
Municipal brackish water desalination plants	139	39	71.90%
Seawater desalination plants	3	2	33.30%

x Analysis of data on water resources and water production rates provided by the Gaza Coastal Municipalities Water Utility in April 2026.

As set out in **Section 3.4**, the destruction of Gaza's wastewater treatment plants[114] and the collapse of most of its sewage pumping and network capacity[115] mean that raw sewage continues to be discharged into the Mediterranean Sea and lost through cesspits and other leakage pathways, creating additional pathways for the contamination of soil and groundwater.[116, xi] Wadi Gaza represents the single largest sewage outfall, with an estimated discharge of approximately 13,000m^3/day.[xii] Sewage accumulates in low-lying areas and flows through surface watercourses,[117] becoming a defining feature of Gaza's devastated urban environment, dispersing industrial pollutants, toxic debris and military-derived contaminants across the wider environment. Untreated wastewater entering the Mediterranean Sea is also contributing to coastal pollution and exposing marine ecosystems and fisheries to contamination (see **Section 5.3**).

The destruction of Gaza's wastewater systems by Israel's military* assault *has compounded the water crisis by transforming sanitation infrastructure from a system designed to contain contamination into one that actively disperses it.

Even among functioning facilities, production remains substantially below potential capacity because of shortages of fuel, electricity, membranes, chemicals and maintenance materials. The partial increase in total water availability since 2024 therefore reflects the restoration of parts of a severely degraded system rather than recovery of its pre-conflict capacity. This deepens Gaza's dependence on externally controlled water and energy inputs, reinforcing Israel's practice of hydro-hegemony through both physical destruction and control over access to water and energy. Although essential water and sanitation operations require a minimum of 70,000 litres of fuel per day, only 25% of this requirement was made available during May and June 2025.[118] Fuel constraints have continued to disrupt WASH operations in 2026, with recent UN reports documenting shortages affecting water production, trucking and wastewater services.[119]

The destruction of water and wastewater infrastructure in Gaza should also be understood in the context of the documented direct Israeli attacks on water infrastructure as a method of warfare,[120] with consequences extending beyond the immediate loss of essential civilian services to the environmental conditions necessary to sustain life.

4.2 The contamination of water resources and exposure risks

Israel's systematic destruction of Gaza's water and sanitation infrastructure, and its widespread destruction of urban infrastructure, wastewater systems, solid waste management systems, industrial facilities and agricultural lands have introduced large quantities of hazardous contaminants into the environment, while simultaneously dismantling the systems required

xi Analysis of pumping station flow measurements and operational records; clarification provided regarding estimated wastewater discharge and system losses with the Gaza Coastal Municipalities Water Utility, April 2026.

xii Ibid.

to contain, monitor or treat them.[121] As discussed in **Section 3**, the systematic destruction of environmental monitoring systems has severely constrained Gaza's capacity to assess water quality. Damage to laboratories, shortages of analytical equipment and restrictions on the entry of laboratory materials, together with the loss of qualified personnel and the destruction and inaccessibility of groundwater monitoring wells, have severely reduced routine surveillance of drinking water quality.[122, 123] Consequently, the contamination documented in this section should be regarded as indicative rather than exhaustive, with significant uncertainty remaining over the full extent of chemical and microbiological contamination across Gaza's water resources.

The limitations in monitoring are particularly significant for groundwater, given the vulnerability of Gaza's Coastal Aquifer to contamination from pollutants at or near the surface, particularly in northern Gaza around Gaza City, where the aquifer is particularly shallow, and the coastal areas, where it is shallow and the overlying material is relatively porous.[124, 125, 126] These hydrogeological characteristics allow contaminants to infiltrate more readily into groundwater. Vulnerability is further affected by changes to the land surface caused by bombardment, cratering, tunnelling and earthworks, which can alter groundwater recharge and the movement of water and contaminants through the subsurface.[127, 128]

Against this background, the pathways through which conflict-related contaminants can reach Gaza's water resources are multiple and interconnected. **Figure 5** illustrates the principal exposure pathways through which contaminants are mobilized into Gaza's water systems and reach the civilian population. These pathways include the infiltration of contaminants from debris and destroyed infrastructure into groundwater; sewage overflow and wastewater infiltration; surface runoff transporting pollutants through urban areas and agricultural land; and the redistribution of contaminants through flooding and damaged drainage networks and natural waterways. The figure also highlights how areas of high levels of conflict-related contamination overlap with zones of high to extreme groundwater vulnerability and concentrations of active wells and desalination facilities, many of which draw water from relatively shallow aquifers.

As shown in **Figure 5**, the spatial overlap is particularly important in North Gaza and Gaza City governorates, where heavy bombardment, debris accumulation and conflict-related contamination overlap with extensive inundation (flood) zones and concentrations of active wells and water desalination facilities. These conditions increase the likelihood that flooding, sewage overflow and surface runoff mobilize pollutants into groundwater systems and surrounding water infrastructure. Risks are also particularly acute in Deir al-Balah, one of Gaza's most important operational water production areas, where large concentrations of active municipal wells and some of the highest-producing desalination facilities are located above highly vulnerable groundwater systems and exposed to substantial conflict-related contamination.

Against this spatial and hydrogeological context, the 2026 Ministry of Health water-quality testing provides field-based evidence of conditions within these vulnerable groundwater systems. As shown in **Table 6**, the testing of 79 groundwater wells found faecal coliforms (FC)

in 19% of wells, compared with 2% of groundwater wells reported as contaminated in 2021,[xiii] indicating a significant increase in microbiological contamination.[129] The analysis also found widespread mineralization of Gaza's groundwater, with Total Dissolved Solids (TDS) exceeding 1,000mg/L in 77.2% of wells and Electrical Conductivity (EC) exceeding 2,500µS/cm in 78.5% of wells.[130] A study of 115 municipal groundwater wells sampled in October 2022 reported mean TDS of 3,261mg/L and mean EC of 5,202µS/cm,[131] with the 2026 results remaining of the same order of magnitude at >3,770 mg/L and >6,019 µS/cm respectively. The findings therefore indicate that severe groundwater mineralisation remains widespread, alongside a marked increase in microbiological contamination in the wells tested.

The geographical distribution of these findings is particularly significant. Elevated TDS was detected in 96.7% of wells in Gaza City and EC in 100%, while both TDS and EC exceeded the respective thresholds in 100% of wells in Deir al-Balah. Faecal coliforms were also detected in 20% of wells in both Gaza City and Deir al-Balah, and in 25% of wells in North Gaza. This distribution closely corresponds with the areas identified through the spatial analysis as particularly vulnerable to groundwater contamination and where groundwater vulnerability, active water sources and conflict-related contamination pressures overlap. The convergence of the field-based water-quality findings and the spatial analysis therefore identifies North Gaza, Gaza City and Deir al-Balah as priority areas for systematic groundwater monitoring and further investigation of potential contamination pathways.

Table 6: Water quality results from 79 groundwater wells tested in July 2026, by area

Area	Total sites tested	Faecal coliform >0 (CFU/100 mL)	FC mean/ highest (CFU/100 mL)	TDS >1,000 mg/L	TDS mean/ highest (mg/L)	EC >2,500 µS/cm	EC mean/ highest (µS/ cm)
North Gaza	12	25.0%	>8.6 / >100	25.0%	934 / 1,860	25.0%	1,505 / 3,000
Gaza City	30	20.0%	2.5 / 50	96.7%	>4,153 / >12,400	100%	>7,103 / >20,000
Deir al-Balah*	25	20.0%	0.7 / 13	100%	5,795 / >13,000	100%	8,700 / >19,500
Khan Younis	12	8.3%	0.25 / 3	33.3%	1,428 / 3,500	33.3%	2,236 / 5,500
Total	79	19.0%	>2.5 / >100	77.2%	>3,770 / >12,400	78.5%	>6,019 / >20,000

* Deir al-Balah includes the 11 wells tested in Nuseirat. Water-quality testing results for Nuseirat wells revealed the following: FC detected in 18.2% of wells (mean 0.18CFU/100mL, maximum 1CFU/100mL); 100% exceeded 1,000mg/L TDS (mean 3,733mg/L, maximum 8,432mg/L); and 100% exceeded 2,500µS/cm EC (mean 6,015µS/cm, maximum 13,600µS/cm).

xiii Analysis of Ministry of Health water-quality test data for 85 sites, of which 79 are groundwater wells. The sampling was conducted in July 2026, and was tested for faecal coliforms (FC), total dissolved solids (TDS) and electric conductivity (EC). Samples were collected from the source before treatment; the presence of a chlorination system at a site therefore does not affect interpretation of the microbiological results. These results are from a one-off assessment rather than a systematic groundwater monitoring programme and should therefore be interpreted as timestamping, indicative of conditions in the wells sampled, rather than as representative of groundwater quality across Gaza as a whole.

The field evidence also reinforces the importance of understanding how conflict-related contaminants may enter and move through these vulnerable groundwater systems. Residues from explosive munitions, including heavy metals and explosive by-products, are deposited onto soils and urban surfaces and can leach into the aquifer through infiltration,[132, 133] particularly where land integrity has been disrupted by bombardment.[134] Craters created by explosive weapons may accelerate the downward migration of contaminants by acting as preferential flow pathways, while compacted soils and damaged natural waterways alter natural recharge processes and increase flooding and surface runoff.[135, 136] The high TDS levels identified in the 2026 groundwater testing further underscore the importance of this pathway. While TDS cannot identify individual contaminants or establish a conflict-related source, elevated TDS levels indicate a groundwater system with a high dissolved load in which mobile, water-soluble contaminants warrant particular attention. These include perchlorate, which is highly soluble and mobile in groundwater,[137] as well as munitions constituents such as RDX, HMX, TNT and DNTs, which can enter and migrate through groundwater following their release, depending on their physicochemical properties.[138] Targeted laboratory analysis is therefore required to establish whether these contaminants are present; at what concentrations; their subsequent risks; and mitigation measures.

The collapse of wastewater infrastructure further introduces untreated sewage, pathogens, nitrates and AMR bacteria into groundwater and surrounding environments.[139, 140, 141] The absence of coliforms, however, does not rule out the presence of other harmful pathogens. In areas such as Al Mawasi, where the absence of functioning wastewater systems has increased reliance on cesspits and soak pits, the shallow and relatively permeable hydrogeological conditions may increase infiltration of wastewater-derived contaminants into surrounding soils and groundwater.[142]

The collapse of solid waste management systems has also created a direct contamination pathway into water resources. By May 2025, at least 56 temporary dump sites had emerged across Gaza,[143] many located within 100 metres of surface watercourses,[xiv] significantly increasing the risks of pollutant leaching and the bacterial contamination of nearby water resources. As of March 2026, only 11 temporary dump sites remain active.[144] The broader collapse of solid waste management systems, and its consequences for Gaza's environmental conditions, is examined in **Section 3.**

The convergence of contaminated areas, vulnerable groundwater and active water-production infrastructure creates credible and potentially persistent pathways for contaminants to enter water supplies used for drinking, cooking and other domestic purposes. However, without systematic post-conflict water-quality monitoring, the extent of actual contamination and human exposure cannot yet be established. These conditions make the independent assessment and monitoring of priority areas particularly urgent.

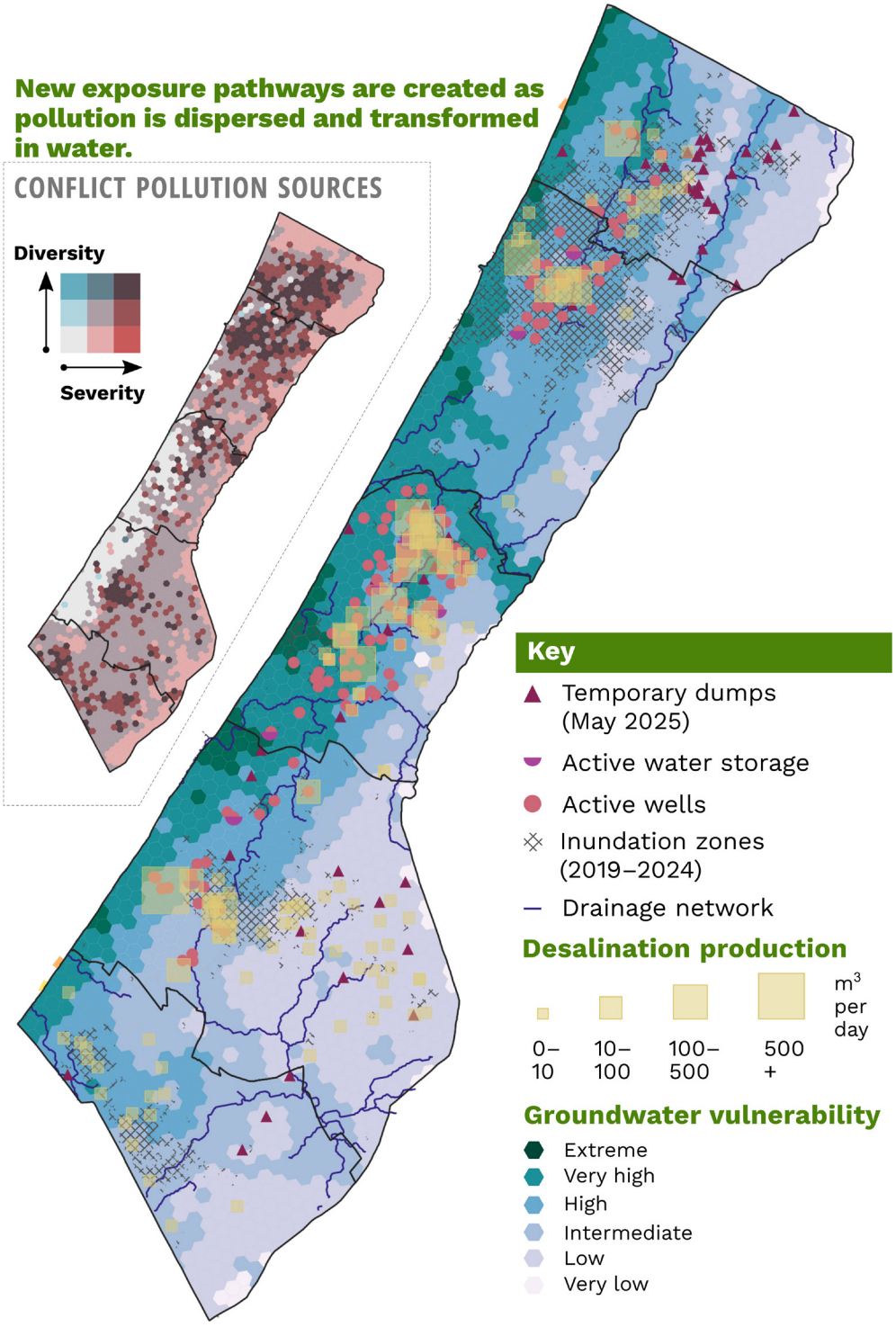
xiv Debris and solid waste polygons within 100m of water bodies were of this contaminant type; calculated based on a 100m buffer of the OSM waterways layer.

North Gaza, Gaza City and Deir al-Balah emerge as priority areas where conflict-related pollution, groundwater vulnerability and active water sources overlap, creating heightened risks of contamination and potential human exposure through water used for drinking, cooking and other domestic purposes. This potentially continuous exposure could have consequences far beyond immediate humanitarian needs, threatening Gaza's water resources, food systems, public health and environmental recovery.



A stagnant pool of water reflecting destroyed buildings. Sheikh Radwan, Gaza City, 18 October 2025. Photo: Alef Multimedia/Oxfam

Figure 5: Exposure pathway: water. Groundwater vulnerability to pollution and the distribution of water production across Gaza.



Source: Well and desalination data: CMWU, April 2026. Groundwater vulnerability digitised from Baalousha (2010). Dump site locations: UNDP. Inundation and drainage data: IOM.

5. FOOD SYSTEMS AND FOOD SECURITY

Prior to October 2023, Gaza's food system, despite being constrained by land availability, water scarcity and access restrictions, was characterized by intensive production systems. Agricultural land covered approximately 40% of the Gaza Strip, with high-value crop cultivation including vegetables, citrus fruit, olives and greenhouse-based horticulture, which contributed to sustaining local food availability and livelihoods.[145] The use of greenhouses and irrigated agriculture enabled year-round production of crops. Local agricultural production supplied approximately 95% of fresh-vegetable consumption, highlighting the critical role of horticulture and market-oriented vegetable production in Gaza's food system.[146] Livestock and fisheries also contributed to local food availability, providing a source of animal protein and nutrient diversity. Despite this productive capacity, the food system remained structurally vulnerable, with approximately 62% of households already food insecure, and a large proportion of the population dependent on humanitarian aid to meet basic dietary needs.[147]

Israel's military assault has resulted in the widespread destruction of agricultural production systems, assets and infrastructure. At the same time, the collapse of water systems (**Chapter 4**), the destruction of markets (**Chapter 6**), and restrictions on movement and access have simultaneously disrupted food supply, reduced food availability, further increased dependence on external aid and reduced dietary diversity. Food insecurity in Gaza is currently driven by a lack of access, compounded by reduced food availability, the collapse of production systems, declining dietary diversity and the degradation of the environmental conditions required for safe food production. These impacts are reflected in the latest IPC Acute Food Insecurity analysis (July 2026), which estimated that 1.2 million people (59% of the population) in Gaza were experiencing 'crisis' or worse levels of food insecurity (IPC Phase 3 or above).[148] Israel's systematic destruction and degradation of food production systems, the very infrastructure upon which civilian survival depends, engages clear obligations and prohibitions under IHL, including the prohibition of starvation of the civilian population, the protection of objects indispensable to civilian survival, and the obligation to allow and facilitate humanitarian assistance.[149, xv]

5.1 Agricultural impacts and soil contamination

Agricultural systems in Gaza have undergone near-total collapse as a result of sustained Israeli military bombardment, environmental contamination, land degradation and severe access restrictions. By late 2025, satellite-based assessments indicate that over 87% of cropland had been damaged, with destruction affecting crops, greenhouses and irrigation infrastructure,[150] effectively collapsing local food production systems.[151] This was compounded by extensive damage to agricultural wells and irrigation systems.[152, 153] In 2026, the Food and Agriculture Organization of the United Nations (FAO) estimates that under current constraints 1,000 farmers

xv The analogous rule in the ICRC Customary IHL Study is Rule 54 – Attacks against Objects Indispensable to the Survival of the Civilian Population, which should be read together with Rule 53 – Starvation as a Method of Warfare. International Committee of the Red Cross. (2026). Customary International Humanitarian Law Database. Retrieved from: https://ihl-databases.icrc.org/en/customary-ihl

can produce around 5,000 tonnes of fresh vegetables, enough to feed nearly 95,000 people for one year, compared with approximately 12,800 tonnes under conditions of full and unrestricted access to agricultural inputs and equipment, enough to feed around 165,000 people for one year.[154]

The extent and scale of destruction to Gaza's agricultural land by the cumulative effects of blast damage and bombardment, deliberate burning, mechanical destruction through earthworks and bulldozing by Israeli military vehicles, and sustained access denial, is extreme. As illustrated in **Figure 3**, satellite analysis identified widespread explosive weapon impacts, including almost 600 craters from MK-84 2,000lb bombs during the first six weeks of the assault.[155] Approximately 40% of these craters were located on agricultural land, illustrating the extent to which farmland was directly affected. Beyond destroying agricultural land, Israel's assault has transformed Gaza's food production systems into pathways for the accumulation and transfer of conflict-related contaminants.

The destruction of agricultural systems represents a loss of cultural heritage and the historical relationship between Palestinian communities and the land. Olive cultivation has deep cultural and historical significance in Palestine. UNESCO recognizes traditional olive-growing landscapes as expressions of centuries of Palestinian agricultural practice and human interaction with the environment, and identifies olive trees as deeply symbolic features of the Palestinian landscape that are representative of Palestinian identity.[156, 157] In Gaza, this cultural and agricultural heritage has been severely affected by the destruction of olive groves. By October 2024, OCHA reported that more than one million olive trees had been uprooted.[158]

Due to the ongoing genocide, only 3% of total cropland is accessible and undamaged. Since the last olive harvest in October 2025, the amount of accessible and undamaged cropland has declined from 601 hectares to just 448 hectares, reflecting a further deterioration in access to agricultural land since the so-called ceasefire.[159] This decline is a result of restrictions on access imposed by the Israeli military, including the establishment of the "Yellow Line", which has created Israeli military-controlled areas extending into Palestinian agricultural land and further constrained farmers' ability to access and cultivate their fields. As of June 2026, access-restricted areas take up 65 per cent of the Gaza Strip, most of them off limits to residents.[160]

Across the oPt, UN reporting has also documented the deliberate uprooting, burning and destruction of Palestinian olive trees by Israeli forces and settlers.[161] The loss of olive trees therefore extends beyond the immediate loss of agricultural production and livelihoods, disrupting landscapes, practices and intergenerational connections that form part of Palestinian cultural heritage and identity.

The destruction of Gaza's seed conservation infrastructure compounds these losses. The Al-Qarara Baladi seed bank in Gaza was destroyed during the assault, while the Union of Agricultural Work Committees (UAWC) seed multiplication unit in the occupied West Bank was also destroyed on 31 July 2025.[162] These facilities held significant stocks of locally adapted Palestinian seed varieties, with 33 varieties conserved at Al-Qarara, while crops at the UAWC facility represented approximately 80% of the seed stock intended for distribution to hundreds of farmers for the following planting season. Their destruction represents a significant loss

of locally adapted genetic resources and reduces the diversity of seeds available for future cultivation. It also constrains the range and resilience of crops that can be re-established during agricultural recovery.

Restricted access to agricultural land presents an additional major constraint. At present, Gaza's arable land is mostly inaccessible due to its location within the Israeli military-controlled perimeter (see **Figure 3** – yellow line), placing significant areas beyond Palestinian access and cultivation.[163] The presence of UXOs further restricts safe access to farmland, delays recultivation and increases risks to farmers attempting to resume production.[164] Since October 2023, 580 UXO accidents have been recorded across Gaza, resulting in 274 deaths and 1,134 injuries.[165]

Israel's military assault has exposed agricultural lands to extensive environmental contamination. Explosive munitions, debris from destroyed infrastructure, and disrupted wastewater systems introduce hazardous substances into soils, including heavy metals and combustion by-products, which can persist and affect soil quality and productivity for decades.[166] These contaminants can accumulate in soils and groundwater, be taken up by crops through irrigation and enter the food chain. In Gaza, soil sampling following Israel's 2014 military offensive on Gaza found concentrations of copper, manganese and lead in soils from bomb craters that were 31, 114 and 12 times higher, respectively, than in control soils, while lead concentrations in edible parts of several crops exceeded normal ranges and reached toxic levels in onion bulbs.[167, 168] Exposure to contaminants such as lead can cause serious neurological, developmental, cardiovascular and kidney effects (see **Chapter 7**).[169]

This confirms that conflict-related contamination can occur in Gaza's soils, while the distribution and persistence of munition residues can vary substantially across adjacent areas and at different soil depths, depending on local conditions and the properties and transformation of individual contaminants.[xvi, 170, 171] Military contamination of soils with metals from munitions can persist for decades.[172] Recent soil sampling in southern Lebanon, comparing heavy metal concentrations in 2001 and 2025, found hotspot concentrations of antimony and other metals released from munitions reaching up to 500 times historical averages in some locations, with statistically significant increases also recorded for lead, copper and zinc.[173] In Iraq, analysis of the impact of sustained armed conflict on agriculture found that crop yields remained suppressed long after the end of conflict.[174]

Beyond munition residues, Gaza's soils are exposed to additional contamination from the destruction of agrochemical storage sites. Gaza's principal agrochemical storage facility, the Khudair Warehouse, was destroyed in 2021, releasing pollutants into the surrounding environment.[175] While it is unclear whether the rebuilt structure continued to store agrochemicals, both the site and surrounding land have since sustained heavy damage, likely resuspending legacy contamination. The widespread destruction of agricultural infrastructure, including more than 7,200 damaged greenhouses identified by remote mapping,[176] has also

xvi The primary vector for the dispersion of pollutants through the soil profile is by the infiltration of surface waters. Therefore, the aqueous solubility of explosive compounds is an important factor. On the battlefield, this can vary widely from that of the pure compound due to the use of binders and stabilizing products in explosive manufacture. Another significant factor is the transformation of these products by exposure to sunlight, chemical reduction and biological degradation, which can produce compounds that are even more toxic than the original explosives.

contributed to the release of stored agrochemicals including fertilizers, herbicides and pesticides. Additionally, the release of heavy metals from destroyed and degraded solar panels has been shown to pollute soils, especially when buried.[177] Analysis suggests that approximately 6km^2 of agricultural soils may have been directly exposed to contamination from hazardous industrial materials and photovoltaic installations.[178]

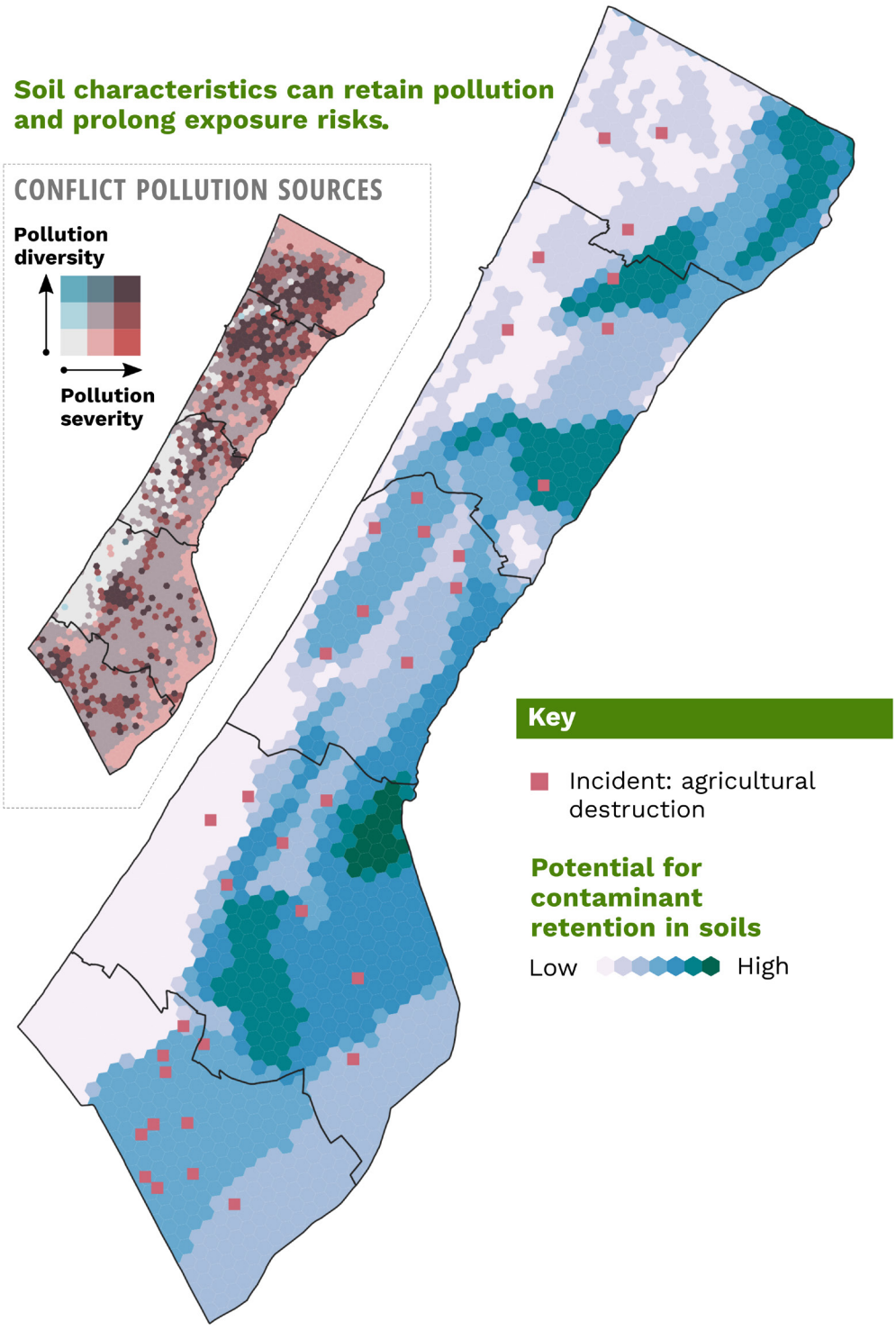
The discharge of untreated sewage onto land and into water systems introduces additional biological and chemical contaminants, which can be transported through irrigation or flooding into agricultural soils. These contaminants are mobilized through erosion, runoff and infiltration, reducing soil fertility and posing risks of uptake into crops and exposure to livestock through contaminated fodder and water.[179]

Soil texture plays an important role in determining how contaminants spread and how much contamination stays retained within it. Much of Gaza's soil is sandy, especially along the coastline, which allows pollutants to infiltrate down into deeper soil layers and groundwater, rather than remaining near the surface. However, areas around Beit Hanoun, Wadi Gaza and northeast of Khan Younis contain higher clay content soils, where pollutants are more likely to accumulate and persist over time.[180, 181] **Figure 6** highlights areas where the risks of long-term soil contamination and direct human exposure through contact with contaminated soil and agricultural systems are likely to be highest. The areas northeast of Gaza City and around Wadi Gaza are of greatest concern.

Military operations will also have altered the physical and biological properties of affected soils in ways that worsen contamination risks. Heavy military vehicles compact soils and reduce their ecological functioning,[182] while bomb craters destroy vegetation and disrupt soil structure, drainage patterns and water movement.[183, 184] The effects of these processes, already observed following Israel's previous military assaults in Gaza in 2014 and 2021,[185] are now occurring at a vastly greater scale. Contaminated soils and waters in conflict are also associated with increased rates of antimicrobial resistance, where pollutants, disrupted health systems and antibiotic use combine to create conditions that accelerate resistance. This is a pattern already documented in Gaza prior to October 2023 that is likely to have significantly worsened since.[186, 187]

Food security in Gaza must be understood as a crisis of food availability driven by the destruction and degradation of food production systems. This has been compounded by Israel's use of starvation and the denial of humanitarian assistance, in addition to the challenges of food safety, dietary quality and long-term public health, whose full consequences will extend across years and generations.

Figure 6: Exposure pathway: soil. The spatial distribution of soils with high potential to retain contaminants and conflict-linked agricultural damage incidents.



Source: Soil pollution retention proxy derived from soil maps from Ravikovitch (1969) and Shomar et al. (2010). Incident data: unified incident dataset from this study, including ACLED, GeoConfirmed and Airwars data.

5.2 Animal production systems

Israel's military conduct in Gaza has also devastated animal production systems. Roughly 95% of cattle have been lost, along with significant reductions in sheep and goat populations, while poultry production has almost entirely collapsed.[188] The destruction of animal shelters, feed supplies and veterinary services has worsened these losses.[189] The destruction of livestock systems represents the breakdown of nutrient cycles, livelihoods and local food system resilience.

For the livestock that have survived, contamination exposure mirrors that of the human population. Animals are exposed through contaminated water, contact with polluted soils and debris, and, where locally produced forage is used, through contaminated feed sources. These contaminants may accumulate in animal tissues and re-enter the human food chain through meat, milk and other animal products. However, the collapse of Gaza's livestock populations has substantially reduced the immediate contribution of locally produced animal-source foods to the food supply. At the same time, shortages of feed, water and veterinary services continue to increase livestock mortality and disease risks.[190] As livestock production is gradually rebuilt, contaminated land, water and locally produced feed could become increasingly important exposure pathways, particularly when animals and animal products re-enter local food systems.

5.3 Fisheries and marine food sources

Fisheries, which previously contributed to local food supply and dietary diversity, are now almost entirely disrupted because of Israel's sustained military assault and access restrictions. Before Israel's military assault, Gaza's fisheries produced approximately 4,660 tonnes of fish annually, with a further 750 tonnes from aquaculture.[191] The sector supported around 110,000 people, including 4,200 registered fishers and boat owners.[192] Attacks on coastal infrastructure have destroyed fishing vessels, port facilities and aquaculture installations, while access to the sea has been severely restricted, preventing most fishing activity.[193] The average daily catch between October 2023 and April 2024 fell to just 7.3% of 2022 levels, a 92.7% reduction, leaving fish largely unavailable as a local source of protein and other essential nutrients.[194]

The destruction and collapse of Gaza's wastewater collection and treatment systems have resulted in the widespread discharge of raw untreated sewage into the marine environment, adding to pre-existing wastewater pollution and contributing to the degradation of Gaza's coastal ecosystems.[195] The collapse of treatment capacity, damage to sewage networks and increased reliance on cesspits have also increased the contamination of the coastal environment and Coastal Aquifer.

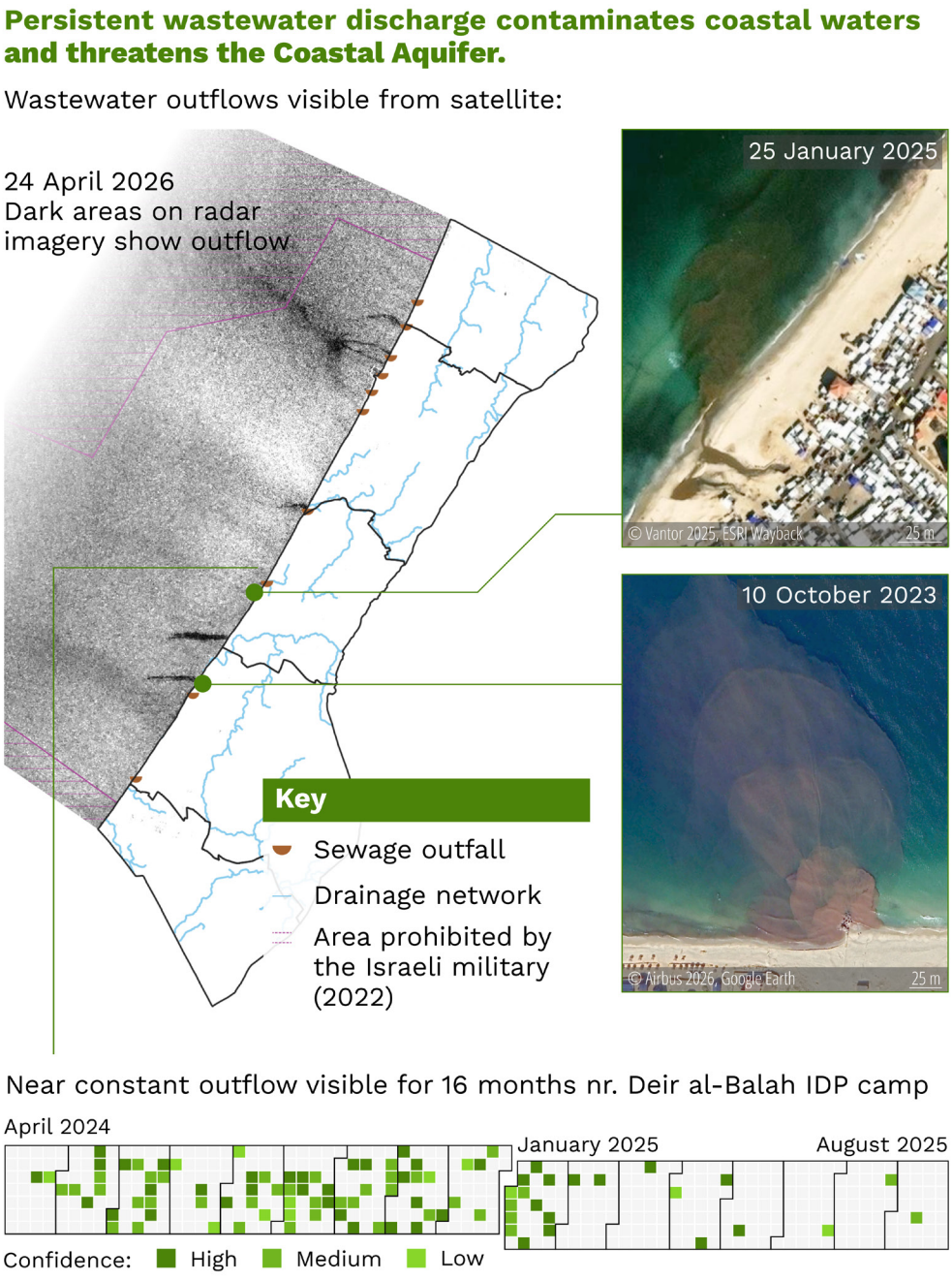
Figure 7 illustrates the sustained nature of this contamination pathway. Satellite imagery identified several active wastewater outfalls along Gaza's coastline, including one adjacent to the Deir al-Balah camp for internally displaced people (IDP) that remained visibly active for at least 16 consecutive months, from April 2024 to August 2025. Environmental assessments indicate that marine ecosystems have been contaminated by sewage, solid waste and munitions, with contaminants potentially entering the marine food chain and posing risks to human health through seafood consumption.[196] Although the collapse of Gaza's fisheries has

substantially reduced immediate exposure through locally caught seafood, this pathway will become increasingly important as fishing and aquaculture recover and contaminated marine resources re-enter local food systems.



A donkey cart and people wade through a street flooded with wastewater. Deir Al-Balah, central Gaza Strip, 6 July 2024.
Photo: Alef Multimedia/Oxfam

Figure 7: **Exposure pathway: wastewater discharge to coast waters and marine environment. Sustained wastewater discharge from an outfall adjacent to the Deir al-Balah IDP camp, April 2024–August 2025.**[xvii]



Source: Outfall locations: Gaza CMWU. Main image: Copernicus Sentinel-1 surface roughness visualization. Top inset image: ESRI World Imagery © Esri, Maxar, Earthstar Geographics and the GIS User Community. Bottom inset: © Airbus 2026, Google Earth.

xvii These observations were derived from multiple remote-sensing sources, primarily PlanetScope satellite imagery. Active discharge was detected, on average, once every seven days between 17 April 2024 and 15 August 2025.

6. LIVELIHOODS AND ECONOMIC SYSTEMS

Prior to October 2023, livelihoods in Gaza were already highly constrained by decades of unlawful occupation, blockade and recurrent cycles of conflict that had systematically suppressed economic development and restricted access to markets, capital and productive resources.[197] Despite these structural constraints, a semi-functional economic fabric persisted, sustained through small-scale private enterprise, informal labour, public sector employment and agriculture-linked livelihoods. However, this system was fragile. Unemployment in Gaza exceeded 45% and a large proportion of households were dependent on humanitarian assistance to meet basic needs.[198] Israel's military assault has collapsed this already fragile economic system, while simultaneously transforming the physical landscape in which people attempt to survive and rebuild into a pervasive source of toxic exposure.

Gaza's economy has now contracted by more than 80%, while unemployment has risen to approximately 80% of the labour force.[199, 200] However, the economic crisis cannot be understood through conventional economic indicators alone. The disruption of markets, the destruction of productive assets and the collapse of environmental management systems have converged to create conditions in which economic survival itself has become a vector of toxic exposure.

Israel's destruction of Gaza's economy must therefore be understood as the elimination of livelihoods, and the systematic creation of conditions in which livelihood, recovery, reconstruction and survival itself risk exposing civilians to hazardous environmental contamination.

6.1 Loss of productive assets and economic disruption

Israel's military assault has destroyed Gaza's economic infrastructure at a scale that has precipitated an unprecedented economic collapse. By the end of 2024, Palestinian GDP had fallen back to its 2010 level and GDP per capita had returned to its 2003 level, erasing 22 years of development progress.[201] Gaza's GDP alone contracted by 83% in 2024, falling to US$362m, while GDP per capita fell to US$161.[202] The Rapid Damage and Needs Assessment (RDNA) of April 2026, jointly conducted by the World Bank, the European Union and the United Nations, estimates that by October 2025 the assault had caused US$35.2bn in direct damage to physical infrastructure and a further US$22.7bn in economic losses, bringing combined damage and losses to US$57.9bn.[203] Recovery and reconstruction needs are estimated at approximately US$71.4bn over the coming decade, including US$26.3bn required in the first 18 months.[204] This is seven times, in real terms, the combined cost of reconstruction after every major Israeli military offensive on Gaza over the past two decades.[205] Within the productive economy, 92% of assessed establishments in the commerce and industry sector had sustained damage, including 72% that were completely destroyed.[206] Construction activity has largely ceased, manufacturing output – including food processing, textiles and other small-scale industrial production – has been severely disrupted, and markets have been destroyed, disrupting the wider economic systems through which goods, services and livelihoods are sustained.[207]

The agricultural and fisheries sectors, which prior to October 2023 sustained rural and coastal livelihoods and contributed significantly to Gaza's food security, have been similarly devastated. As discussed in Sections **5.1** and **5.3**, the widespread destruction of farmland, irrigation systems, fishing infrastructure and coastal facilities, combined with severe access restrictions, contamination risks, unexploded ordnance and the discharge of untreated sewage into marine environments, has rendered large parts of Gaza's productive landscape unsafe, inaccessible or unable to function. The destruction of these sectors has resulted in direct economic losses, while disrupting the value chains that support production, marketing and livelihoods, and undermining local economic self-sufficiency.

The environmental damage associated with this destruction will also shape the conditions under which economic recovery takes place. For many civilians, restoring livelihoods will require working amid contaminated debris, damaged infrastructure, polluted land and unexploded ordnance, making environmental assessment and remediation integral to safe and sustainable economic recovery. The Oxfam-MAS-Paltrade report "Building the Gaza Strip Anew" (July 2026) outlines an economic strategy for sovereignty covering trade, investment, and enterprise recovery, including the need for inclusive employment, care-sensitive recovery and disability-accessible economic participation.[208]

The destruction of Gaza's productive economy has made environmental exposure a condition of economic recovery. For many civilians, earning a living now requires working amid contaminated debris, damaged infrastructure, polluted land and unexploded ordnance.

6.2 Labour exposure and reconstruction risks

The collapse of Gaza's economy has forced a fundamental shift towards survival-based labour. With limited access to formal employment, civilians are increasingly engaged in activities such as debris removal, informal construction and materials salvage. These activities are undertaken by household members repairing and recovering their homes as well as individuals engaged in paid work.[209, 210] Although essential for survival and early reconstruction, this work is frequently carried out without PPE, adequate awareness of environmental hazards, or appropriate occupational health and safety measures, directly exposing people to conflict-related environmental contamination.[211]

Debris generated by the destruction of buildings and infrastructure in Gaza, estimated at 61 million tonnes,[212] contains hazardous materials, including heavy metals, asbestos, explosive residues, crystalline silica, industrial chemicals and fine particulate matter.[213] People and workers handling, transporting and processing this debris are repeatedly exposed to these materials through inhalation, ingestion and direct contact, often over prolonged periods and with no knowledge of contamination levels or means of managing risk.[214] Labour exposure risks are compounded by the presence of unexploded ordnance within rubble and damaged structures, while the informal reuse of crushed debris in reconstruction, road filling and temporary shelters risks redistributing contaminated materials directly into rebuilt

environments. The scale of debris clearance alone, estimated to require more than 2.1 million dump-truck loads, travelling the equivalent of 736 times the Earth's circumference,[215] means that exposure to contaminated dust and hazardous materials is likely to continue for years, if not decades. Evidence from demolition and post-disaster contexts demonstrates that debris handling significantly elevates exposure to hazardous particulates and fibres, and can result in long-term health impacts, particularly where dust suppression, containment and protective measures are absent.[216, 217, 218, 219]

Farmers and agricultural labourers attempting to resume food production face comparable occupational risks. Agricultural lands across Gaza are increasingly affected by residues from munitions, heavy metals, wastewater infiltration, debris contamination and unexploded ordnance, exposing workers to hazardous materials through direct contact with contaminated soils, dust inhalation and irrigation water. These conditions also risk reintroducing contaminants into food systems and local markets as agricultural production resumes.

Occupational exposure risks are concentrated in the same areas that have experienced the highest levels of destruction and debris accumulation, including Gaza City, Jabalia, Khan Younis and the Salah al-Din Road; these are the same areas where informal reconstruction, salvage work and survival labour are most concentrated. As demonstrated in **Figure 2** and **Figure 3**, and discussed in **Chapter 3**, these same areas also exhibit the highest levels of contamination diversity and severity. Economic necessity is therefore driving civilians directly into some of the most hazardous contamination environments in Gaza.

The collapse of Gaza's economy has transformed survival-based labour into a major pathway of environmental exposure. Civilians rebuilding homes, clearing debris and salvaging materials now face prolonged exposure to hazardous contaminants.

7. HUMAN HEALTH: RISKS AND LONG-TERM IMPACTS

The widespread environmental contamination resulting from Israel's military assault in Gaza creates health risks that extend far beyond immediate physical and mental trauma. In Gaza, the destruction of urban infrastructure, the dispersal of munitions residues, the collapse of water and sanitation systems, and the accumulation of contaminated debris have created multiple and overlapping exposure pathways through which civilians are continuously exposed to hazardous substances. These include heavy metals, fine particulate matter, asbestos, polycyclic aromatic hydrocarbons (PAHs), dioxins, perchlorates, explosive residues, white phosphorus and other toxic combustion by-products released from both munitions and infrastructure destruction.[220, 221] Prolonged displacement and overcrowded temporary shelters further increase these exposures, as limited access to safe water, sanitation, waste management and electricity forces civilians to live and carry out routine activities in

environments where contact with contaminated water, sewage, waste, smoke and debris is difficult to avoid.

Gaza's civilian population is exposed to multiple hazards at the same time, including chemical and physical hazards, psychosocial stress, displacement, social fragmentation and chronic uncertainty. These exposures interact, affecting stress responses, immune function, endocrine systems and other biological processes; they also contribute to both immediate and longer-term health effects.[222, 223] In Gaza, these exposures are compounded by individual vulnerabilities such as age, gender, nutritional status and pre-existing health conditions. For displaced populations living for prolonged periods in overcrowded shelters, limited access to safe water, sanitation, waste management and electricity can further increase exposure to environmental hazards through routine activities such as water collection, food preparation and waste disposal. These activities may involve repeated contact with contaminated water, sewage, waste, smoke and debris. Evidence from Gaza and other conflict settings indicates that such cumulative exposures can contribute to immediate illness and to long-term chronic disease, reproductive and developmental harm, and intergenerational health impacts, particularly where exposure occurs alongside malnutrition, displacement and the collapse of healthcare systems.[224, 225]

The collapse of Gaza's health infrastructure, including laboratories, toxicology services, cancer registries and disease surveillance systems, as well as water and sanitation services within healthcare facilities, has severely compromised both the capacity to detect contamination-related illness and basic infection prevention and control. Contamination-related illness may therefore go undetected and unattributed for years.[226] This invisibility is in itself a consequence of Israel's systematic destruction of Gaza's public health systems. In the absence of field epidemiological and biomonitoring data, the health risks assessed in this chapter are therefore based on the contamination pathways identified throughout this report and the established scientific evidence on their health effects.

7.1 Immediate and acute health risks

Israel's military assault has generated conditions for acute and sustained toxic exposure across Gaza's civilian population. Repeated bombardment and the debris generated have released large volumes of fine particulate matter and hazardous dust, including silica, asbestos, heavy metals, and combustion by-products, into densely populated urban environments.[227, 228] People across Gaza are exposed continuously through inhalation, ingestion and dermal contact. Airborne pollutants can cause acute respiratory irritation and inflammation, asthma exacerbation and lung injury.[229] The health burden is already substantial, with more than 1.9 million cumulative cases of acute respiratory infections recorded during January and February 2026, accounting for 68% of diagnosed infectious diseases reported through the Early Warning, Alert and Response System (EWARS surveillance system).[230] Humanitarian medical teams have reported an increasing incidence of these conditions across Gaza's population,[231, 232] while clinicians and researchers have raised concerns about the cumulative respiratory burden associated with conflict-generated air pollution in Gaza, including among children.[233, 234, 235] However, opportunities for prevention and treatment are severely constrained by the destruction and

disruption of health services, limited access to medicines and respiratory care, and the conditions of displacement.

At the same time, Israel's destruction of water and wastewater systems has exposed populations to microbial and chemical contaminants through unsafe drinking water and environmental contact. The health consequences are already evident: around 81,000 cases of acute watery diarrhoea were recorded during January and February 2026, including more than 36,000 among children under five. This followed more than 496,000 cases during 2025, demonstrating the persistence of a substantial disease burden into 2026.[236] Antimicrobial resistance is an additional concern, with multidrug-resistant bacteria identified in Gaza healthcare settings, including resistant *Pseudomonas* in water at primary healthcare centres, while disrupted WASH and infection prevention and control can facilitate their spread.[237, 238] The collapse of water and sanitation systems has also created conditions for the re-emergence of poliovirus. Circulating vaccine-derived poliovirus type 2 (cVDPV2) was detected in Gaza wastewater in 2024, followed by a confirmed paralytic case in a child: the first reported polio case in Gaza in 25 years.[239]

The near-total collapse of Gaza's healthcare systems means that acute health risks associated with environmental contamination that might otherwise be mitigated or managed are more likely to progress to severe morbidity or death.

7.2 Chronic disease and long-term toxicological burden

The long-term health consequences of Israel's military assault will extend far beyond the period of active hostilities. Many contaminants released during conflict persist in environmental media and accumulate in the human body over time, creating a substantial long-term burden of chronic disease – the full scale of which will only become visible years or decades after exposure.[240]

Israel's large-scale destruction of residential buildings across Gaza has released asbestos fibres and crystalline silica at scale, which are associated with mesothelioma, lung cancer, asbestosis and silicosis, with disease typically emerging decades after initial exposure.[241, 242] The bombardment and burning of industrial sites, fuel depots, waste facilities and urban infrastructure have generated PAHs, dioxins and combustion by-products whose exposure is associated with increased cancer risk and long-term organ toxicity.[243, 244] The destruction of more than 2,000 electrical transformers across Gaza[245] may have released polychlorinated biphenyls (PCBs), confirmed human carcinogens linked to melanoma and non-Hodgkin lymphoma, into surrounding soils and urban areas.[246]

Heavy metals including lead, mercury and cadmium – deposited through munitions fragmentation and infrastructure destruction – accumulate in the body and are associated with renal, neurological, cardiovascular and developmental toxicity.[247] Prolonged exposure to fine particulate matter, which is generated continuously through bombardment, demolition, debris disturbance and open burning, is associated with chronic respiratory disease, cardiovascular

disease and premature mortality; global evidence identifies air pollution as one of the leading environmental determinants of non-communicable disease burden.[248, 249]

Exposure to contaminants released through Israel's use of explosive munitions, fires and the destruction of infrastructure may result in endocrine and metabolic disruption with long-term consequences. Perchlorates from propellant systems interfere with thyroid hormone production and may impair metabolic regulation and neurological development, while dioxins act as endocrine disruptors linked to reproductive, immune and developmental harm.[250, 251]

Conflict-related contamination will leave a health burden in Gaza that continues to accumulate long after active hostilities cease, while the destruction of health and environmental monitoring systems limits the ability to detect and respond to its effects.

7.3 Maternal, neonatal and child health risks

Pregnant women, newborns and children face disproportionately severe risks from conflict-related environmental contamination due to heightened physiological vulnerability and critical developmental periods. In Gaza, these risks are compounded by concurrent malnutrition, repeated displacement, psychological trauma and the collapse of maternal and neonatal healthcare services.[252, 253, 254]

Exposure to fine particulate matter and environmental contaminants during pregnancy is associated with increased risks of adverse birth outcomes, including preterm birth, low birth weight and stillbirth.[255] Evidence from conflict-affected settings demonstrates that these risks are further amplified where toxic exposure occurs alongside food insecurity, maternal stress and the disruption of antenatal care.[256] In Gaza, deteriorating maternal and neonatal outcomes have already been documented under these combined conditions.[257]

Evidence from Iraq and earlier Israeli military offensives on Gaza raises further concerns regarding congenital anomalies and developmental disorders associated with maternal exposure to conflict-related contaminants. After the Iraq War, studies from Fallujah showed a sharp increase in congenital anomalies, including cardiac malformations linked to military activity, with heavy metal exposure identified as a plausible cause.[258] In Gaza, elevated heavy metal burdens have been documented in mothers and newborns exposed to military activity, suggesting the in-utero transfer of conflict-related contaminants.[259]

Children are particularly vulnerable to contaminated dust and soil due to their higher inhalation rates, hand-to-mouth behaviours, and greater absorption of toxicants relative to body weight. Lead exposure, for which no safe threshold exists, is associated with reduced cognitive function, behavioural disorders and irreversible neurodevelopmental harm even at low concentrations.[260] In Gaza, where lead is deposited across residential environments through munitions fragmentation and the destruction of lead-containing building materials, children's exposure is likely continuous and unavoidable under current conditions.

In Gaza, exposure conditions pose a direct and immediate threat to maternal and child health; they are likely to cause lasting harm to children's health and development.

7.4 Occupational and reconstruction exposure risks

Individuals engaged in debris clearance, salvage, reconstruction, water and sanitation repair works, and agricultural recovery are likely to face some of the highest exposure levels to conflict-related contaminants of any group within Gaza's population. These workers operate in environments characterized by concentrated dust, unstable debris, damaged infrastructure and unexploded ordnance, often with limited protective equipment or formal safety protocols. Debris generated by the destruction of Gaza's built environment contains a complex mixture of hazardous materials, including asbestos, crystalline silica, heavy metals, explosive residues and combustion residues, creating exposure risks through inhalation, ingestion and direct contact.[261, 262, 263, 264, 265] The scale of debris clearance alone is estimated to require more than 2.1 million dump-truck loads, an operation that, even under optimal conditions, would span years and expose successive cohorts of workers to hazardous materials throughout.[266]

These risks are particularly acute for reconstruction workers who may repeatedly handle, transport and process contaminated materials over prolonged periods. Such exposure can increase the risk of chronic respiratory disease, fibrotic lung conditions and long-latency occupational illnesses including asbestosis and silicosis.[267] The prolonged nature of debris clearance means that occupational exposure will not be confined to the initial emergency phase but may continue throughout reconstruction. Water utility workers face additional occupational hazards during emergency repairs and sewage management, including contact with raw sewage and contaminated water, and exposure to hazardous gases such as hydrogen sulphide. These exposures are associated with risks including infectious disease, respiratory illness, irritation and acute toxic exposure, with repeated exposure potentially increasing longer-term respiratory risks.[268, 269]

Farmers and agricultural labourers attempting to resume food production will face a different set of occupational risks. Returning to agricultural production requires workers to enter environments where contamination and unexploded ordnance may remain present, making routine activities such as cultivation, irrigation and harvesting potential exposure events. These risks are compounded where agricultural land is brought back into production before contamination has been adequately assessed or remediated. Workers may therefore face not only direct occupational exposure but also the possibility of transferring contaminants through produce, irrigation systems and local markets as agricultural activity resumes, linking occupational exposure to the food-chain risks discussed in **Chapter 5**.

Occupational exposure to conflict-related contaminants is likely to become one of Gaza's most significant long-term public health risks as large-scale debris clearance, reconstruction and agricultural recovery proceed.

8. THE LEGAL, POLITICAL AND FINANCIAL RISKS OF INACTION

Israel's military assault in Gaza has resulted in widescale environmental damage that, alongside humanitarian and ecological risks, creates significant legal and financial liabilities. This damage has fundamentally degraded the environmental conditions necessary for civilian survival by severely undermining systems indispensable to life, thereby engaging and giving rise to potential breaches of legal obligations under IHL, IHRL, international environmental law (IEL), occupation law and the law of state responsibility.

These obligations differ according to the role and legal status of the actor concerned. Israel, as the occupying power and a party to the conflict, is bound by the applicable rules of IHL, including those governing distinction, proportionality, precautions and the protection of the natural environment. The obligations of third states, the Board of Peace and other actors depend on their legal status, conduct and control. Relevant duties include the customary duty not to aid or assist internationally wrongful acts, duties of non-recognition and cooperation in response to serious breaches of peremptory norms, the obligation to respect and ensure respect for the Geneva Conventions,[270] and treaty-specific duties of international cooperation and assistance.

The environmental harm caused by Israel's military assault is continuous, compounding and structurally produced with foreseeable consequences. As Professor Ralph Wilde's legal opinion explains, the legality of Israel's continued presence and the legality of its conduct are distinct questions.[271] The duty to end the unlawful occupation remains central to recovery, reconstruction and reparation. Risks cannot be understood through a lens of isolated acts of damage. As Wilde argues, legal analysis in the oPt cannot be confined to a conduct regulatory framework, which assesses individual acts in isolation, but must also engage a presence legality framework, which evaluates the legality of Israel's continued presence itself. In this reading, Israel's conduct should be assessed within a broader legal context shaped by its patterns of control, restriction and deprivation across the oPt. According to Wilde, Israel's destruction of environmental infrastructure, including through its military operations, should therefore be understood as part of a cumulative and systemic process that progressively degrades the conditions necessary for civilian survival.[272]

Within this framework, the environmental harm caused by Israel's military assault in Gaza is continuous, compounding and structurally produced, with foreseeable consequences. These documented risks put those planning recovery on notice. Where environmental risks are foreseeable, there is a responsibility for all those working under the aegis of the Board of Peace in Gaza to assess, monitor and communicate them. Failure to do so constitutes a breach of due diligence and may give rise to claims of negligence and failure of duty of care. These risks extend beyond Israel's conduct of hostilities with liability under IHL[xviii] to the private-law liability

xviii The use of wide-area explosive weapons and the deliberate targeting of Objects Indispensable to Civilian Survival bring to the fore the notion of reverberating effects under the proportionality principle. The indirect or reverberating effects of attacks can be more easily foreseen when critical civilian infrastructure has already suffered extensive harm. For example, if the health facilities of a town have been heavily impacted by the conduct of hostilities, a party to the conflict could reasonably

of those engaged in reconstruction, particularly where they operate in conditions of known or predictable environmental contamination.

8.1 The right to health and environmental protection

The scale and nature of environmental destruction in Gaza caused by Israel's military assault directly engages the right to the highest attainable standard of physical and mental health, as well as the increasingly recognized right to a clean, healthy and sustainable environment. Under Article 12 of the International Covenant on Economic, Social and Cultural Rights (ICESCR), States Parties are required to ensure 'the improvement of all aspects of environmental and industrial hygiene', including safe drinking water, sanitation and the environmental conditions necessary for health.[273, 274] These rights define the minimum environmental conditions required for civilian survival. Israel is a party to the ICESCR. The 2022 ILC Draft Principles on Protection of the Environment in Relation to Armed Conflicts provide a cross-temporal framework for preventing, mitigating and remediating conflict-related environmental harm. Their preamble recognizes the importance of the environment for livelihoods, food and water security, cultural life and the enjoyment of human rights. They do not, however, themselves formulate or affirm a distinct right to a clean, healthy and sustainable environment; that proposition is supported separately by the Human Rights Council and United Nations General Assembly (UNGA) resolutions cited in the following text.[275, xix]

In Gaza, these determinants have been systematically dismantled. The destruction of water and sanitation systems, the collapse of waste management, and the dispersal of hazardous contaminants across soil, air and water have destroyed the environmental foundations of health. This legal framing is reinforced by the recognition of a human right to a clean, healthy and sustainable environment by both the Human Rights Council[276] and the UNGA.[277] As such, this right helps to specify what Article 12 of the ICESCR requires and provides a concrete lens through which environmental destruction translates directly into violations of rights to health, water, food, housing and – ultimately – life.

The destruction of water and sanitation systems, the collapse of waste management, and the dispersal of hazardous contaminants across soil, air and water have destroyed the environmental foundations of health.

foresee the effects that an attack against a military target located close to the only functioning hospital in the area would have on the provision of healthcare. See: The IHL Centre. (2025). *The Stockholm Manual*. Retrieved from: https://admin.diakonia.se/app/uploads/sites/2/2025/09/IHL_SMM-2026-V9.pdf

xix The 2022 *ILC Draft Principles* provide a consolidated analytical framework for environmental protection before, during and after armed conflict. They are not a treaty and do not have a uniform legal status. Their individual provisions must be assessed by reference to their wording, commentary and underlying sources: some reflect or restate applicable international-law obligations, while others are framed as recommendations for progressive development or best practice.

The dismantlement of these rights and obligations reflects the progressive and systematic erosion of the conditions necessary for life with dignity. They are of immediate effect, including guarantees of non-discrimination and minimum essential levels of health, water and sanitation, and cannot be deferred or suspended in contexts of conflict or occupation.[xx]

The implications are particularly severe for children. Under the Convention on the Rights of the Child (CRC), states must address environmental risks that threaten survival and development, including exposure to pollution and unsafe water.[278, 279, 280] In Gaza, the exposure of children to toxic contaminants is continuous and cumulative, compounding the harms resulting from malnutrition, trauma and lack of access to care.

The mounting environmental risks and degradation raise acute concerns about violations of children's rights to life, survival and development, and to the highest attainable standard of health.

International human rights bodies have increasingly affirmed the link between environmental destruction in the oPt and violations of fundamental rights, specifically in relation to Israel's conduct as the occupying power. They have emphasized that the deliberate deprivation of water and the destruction of environmental systems can amount to unlawful collective punishment and may constitute cruel, inhuman or degrading treatment.[281, 282, 283, 284] In July 2025, UN experts condemned Israel's use of 'thirst as a weapon' in Gaza, underlining that the denial and destruction of water infrastructure are incompatible with IHRL and humanitarian principles.[285]

These obligations are reinforced under conditions of occupation. As the occupying power, Israel bears primary responsibility for ensuring, to the fullest extent of the means available to it, public health and hygiene in Gaza, including the provision of preventive measures necessary to combat the spread of disease and to secure medical and hospital establishments and services.[xxi] As

xx This duty primarily derives from the ICESCR, reinforced by several other agreements, including:
International Covenant on Economic, Social and Cultural Rights (ICESCR) Articles 2(1), 2(2), 3 and 12;
Universal Declaration of Human Rights (UDHR) Articles 1, 2 and 25(1);
International Covenant on Civil and Political Rights (ICCPR) Article 26;
International Convention on the Elimination of All Forms of Racial Discrimination (CERD) Article 5(e)(iv);
Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) Articles 11(1)(f), 12 and 14(2)(b);
Convention on the Rights of the Child (CRC) Article 24;
Convention on the Rights of Persons with Disabilities (CRPD) Article 25;
International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families (ICMW) Article 28.

xxi Treaty rules (belligerent occupation). These duties derive from several sources of international law, including:
1907 Hague Regulations respecting the Laws and Customs of War on Land, Articles 43, 55 and 56 (administration of the territory; care of institutions devoted to religion, charity, education and hospitals).
1949 Geneva Convention IV relative to the Protection of Civilian Persons in Time of War:
Article 16 (protection of the wounded and sick);
Article 18 (protection and functioning of civilian hospitals);
Article 55 (duty to ensure food and medical supplies of the population);
Article 56 (duty 'to the fullest extent of the means available to it', to ensure and maintain medical and hospital establishments and services, public health and hygiene in occupied territory);
Article 59 (relief actions if the population is inadequately supplied).

Wilde further explains,[286] the applicable legal framework in the oPt draws not only on IHRL, but also on occupation law, IEL, and the right of the Palestinian people to self-determination, all of which apply in situations of armed conflict and occupation. In this context, environmental protection is an integral component of the duty to maintain public health, preserve the capital of the territory, and protect natural resources from degradation, over-exploitation and pollution.

These obligations do not fall on Israel alone. Israel's duties arise as the occupying power and party to the conflict,[xxii] whereas the Board of Peace and other third parties are bound by the distinct and narrower duties of international cooperation and non-assistance described below. Under Article 2(1) of the International Covenant on Economic, Social and Cultural Rights (ICESCR), States Parties must take steps, individually and through international assistance and cooperation, to achieve progressively the full realization of Covenant rights, including in contexts of severe resource deprivation. Article 12 encompasses the underlying determinants of health, including safe water, sanitation and healthy environmental conditions. These obligations bind States Parties directly,[xxiii] including participating, funding or operational states when they act through international arrangements for Gaza's recovery and reconstruction.

The Board of Peace, a temporary and transitional structure, is not, simply by virtue of its Security Council mandate, itself a State Party to ICESCR. Nevertheless, its powers are derivative of UNSCR 2803[287] and must be exercised consistently with the UN Charter, the terms of that resolution, and applicable international law. In particular, the Board's reconstruction and service-delivery functions should be carried out in a manner that respects and promotes the rights of Palestinians, including their right to self-determination, and that does not undermine applicable human-rights or humanitarian-law protections. UNSCR 2803's framework also assigns a central role to the Palestinian National Committee for the Administration of Gaza (NCAG), a temporary and transitional Palestinian technocratic body responsible for civilian administration and intended to oversee stabilisation, recovery and reconstruction.[xxiv]

1977 Additional Protocol I to the Geneva Conventions (if and in so far as applicable):

Articles 10–11 (protection of medical units and transports, medical duties);

Articles 14–15 (protection of medical units and transports, protection of civilian medical services).

Customary international humanitarian law – Customary rules on occupation and health (as identified in ICRC Customary IHL Study):

Rule 55: Parties to the conflict must allow and facilitate rapid and unimpeded passage of humanitarian relief, including medical supplies;

Rule 56: The occupying power has the duty to ensure, to the fullest extent of the means available, food and medical supplies of the population;

Related rules on the protection of medical personnel, units and transports (rules 25 and 28).

xxii This includes the duty not to destroy dams, dykes and energy sources. See the IHL rule prohibiting the targeting of dams, dykes and energy stations: ICRC. International Humanitarian Law Databases. Retrieved from: https://ihl-databases.icrc.org/en/ihl-treaties/api-1977/article-56; and Customary IHL Rule 42: 'Works and installations containing dangerous forces', retrieved from: https://ihl-databases.icrc.org/en/customary-ihl/v1/rule42

xxiii This obligation is derived from CESCR. (2000). *General Comment No. 14,* para. 39 (read in conjunction with paras. 33–37 and 38), interpreting Article 12 together with Article 2(1). Framed in general international law terms, that negative duty can be aligned with the customary rule on aid or assistance in the commission of an internationally wrongful act, as codified in Article 16 of the ILC's *Articles on Responsibility of States for Internationally Wrongful Acts* (ARSIWA), which prohibits a state from knowingly aiding or assisting another state in the commission of an internationally wrongful act.

xxiv For details of the establishment of the Board of Peace, see: UN. (15 May 2026). The Question of Palestine. *Implementation of UN Security Council Resolution 2803: Report of the Board of Peace through the Office of the High Representative for Gaza* (S/2026/418). Retrieved from: https://www.un.org/unispal/document/implementation-of-united-nations-security-council-resolution-2803-2025-report-of-the-board-of-peace-through-the-office-of-the-high-representative-for-gaza-s-2026-418/

The relevant duty is not confined to the provision of positive assistance. States must also refrain from conduct that directly or indirectly interferes with the enjoyment of the right to health. In the reconstruction context, this requires appropriate environmental and health risk assessment, remediation where necessary, and the restoration of safe water, sanitation and health systems. Where a participating state knowingly aids or assists another actor's internationally wrongful conduct, Article 16 of the International Law Commission's *Articles on State Responsibility* may also be engaged, subject to its specific requirements of knowledge and a wrongful principal act.[288] CESCR *General Comment No. 14* supports the relevance of these concerns by treating safe water, sanitation, environmental conditions and protection from unlawful pollution and conflict-related restrictions on healthcare as integral to the right to health.[xxv]

8.2 Obligations under international humanitarian law

IHL contains obligations intended to govern the environmental conduct of militaries during conflicts. Its core principles – distinction, proportionality and precautions – require that parties distinguish between civilians and combatants, avoid excessive harm relative to anticipated military advantage, and take all feasible measures to minimize harm to civilian life and infrastructure.[xxvi]

These obligations bind Israel and any other party to the conflict.[xxvii] The 2022 *PERAC Principles*[289] offer a comprehensive cross-temporal framework, applying before, during and after armed conflict, including occupation. They restate or build upon applicable rules in some areas and recommend further measures in others. During conflict, Principle 14 requires the law of armed conflict – including distinction, proportionality and precautions – to be applied to the environment with a view to its protection; other principles address occupation, access to information, assessments and remedial measures.[290] The PERAC Principles that apply during conflict map closely on to IHL obligations.

The natural environment is not legally neutral under IHL. As described by the ICRC, it is civilian in character and therefore protected unless and until it becomes a lawful military objective.[291,] [xxviii] Principle 13(3) of the PERAC Principles provides that no part of the environment may be attacked unless it has become a military objective. Read alongside the applicable rules of IHL

xxv For the ICESCR text, see: UN. (16 December 1966). *International Covenant on Economic, Social and Cultural Rights*. Retrieved from: https://www.ohchr.org/en/instruments-mechanisms/instruments/international-covenant-economic-social-and-cultural-rights

xxvi These rules are codified in:

Additional Protocol I. (8 June 1977). *Protocol Additional to the Geneva Conventions of 12 August 1949, relating to the Protection of Victims of International Armed Conflicts*. Retrieved from: https://ihl-databases.icrc.org/en/ihl-treaties/api-1977

International Committee of the Red Cross. (2026). *Customary International Humanitarian Law Database*. Retrieved from: https://ihl-databases.icrc.org/en/customary-ihl

xxvii Although current IHL prohibits certain attacks on water infrastructure – specifically when water is indispensable to civilian survival – there is not yet a general, unconditional legal norm outlawing such attacks, even where they predictably cause public health crises or environmental collapse. Oxfam would welcome the adoption of such a principle into international law. See: OpinioJuris. (24 July 2025). *Hands Off Water in War: Weaponization of Water in the Occupied Palestinian Territory*. Retrieved from: https://opiniojuris.org/2025/07/24/hands-off-water-in-war-weaponization-of-water-in-the-occupied-palestinian-territory/

xxviii This is reinforced by the PERAC affirmation of the natural environment as civilian. This emphasizes the application of distinction to Gaza's ecosystem and environmental infrastructure.

and the ICRC's analysis, this supports treating environmental components as protected against attack unless they satisfy the legal test for a military objective.[292] The natural environment encompasses living and non-living natural elements as well as resources and systems on which civilian life depends, including water resources, agricultural land, soils and ecosystems essential to civilian survival. In Gaza, this means that aquifers, coastal waters, agricultural lands and soils, and the ecological systems affected by the destruction of civilian infrastructure, cannot be treated legally as incidental background conditions; they form part of the protected civilian environment against which attacks and military operations must be assessed.[xxix]

IHL explicitly protects both objects indispensable to civilian survival and the natural environment. Article 54 of Additional Protocol I prohibits attacks on drinking water installations, irrigation systems and food production systems, as well as their destruction to deny them to civilians,[293] while customary rules reinforce these protections by prohibiting starvation and the targeting of such indispensable objects in all armed conflicts.[xxx] IHL also provides direct protection to the environment. Articles 35(3) and 55 of Additional Protocol I prohibit methods or means of warfare expected to cause widespread, long-term and severe environmental damage and require parties to take care to protect the natural environment.[294] As clarified by the ICRC, these provisions establish an outer legal limit on environmental destruction, but environmental considerations must also inform the application of distinction, proportionality and precautions more broadly.[295] In other words, even where harm does not reach that threshold, it may still violate IHL through unlawful attacks on civilian objects, attacks on objects indispensable to survival, or failures to take feasible precautions to minimize foreseeable environmental harm. This interpretation is reinforced by post-conflict analysis, including by UNEP, which highlights that failure to account for environmental impacts in targeting decisions leads to protracted human suffering and undermines recovery, and should lead to stricter proportionality assessments when considering reverberating effects in preparation for attacks. UNEP's assessment illustrates that conflict-related damage may generate protracted and indirect environmental consequences, including the degradation of ecosystems, impaired public infrastructure and diminished institutional response capacity. This reinforces the case for proportionality assessments that account, so far as reasonably foreseeable, for reverberating civilian and environmental effects rather than only immediate blast damage.[296]

In Gaza, Israeli military operations have further devastated already degraded water and wastewater systems. Repeated strikes on key infrastructure, combined with restrictions on fuel and repair materials, are difficult to reconcile with the obligation to preserve objects indispensable to civilian survival. Where infrastructure is attacked or disabled in ways that foreseeably contaminate the surrounding environment, the legal assessment extends beyond damage to a specific facility. The resulting contamination of groundwater, soil, air and coastal waters is environmental harm that is legally relevant under IHL. Under the *PERAC Principles*, the conduct of hostilities engages, in particular, the requirements in Principles 13 and 14 concerning environmental protection and the application of distinction, proportionality and

xxix A narrow exception is where military forces are using these civilian objects purely to sustain military forces, or where they are used in direct support of a military occupation.

xxx The analogous rule in the ICRC *Customary IHL Study* is Rule 54 – Attacks against Objects Indispensable to the Survival of the Civilian Population, which should be read together with Rule 53 – Starvation as a Method of Warfare. ICRC. (2026). *Customary International Humanitarian Law Database*. Retrieved from: https://ihl-databases.icrc.org/en/customary-ihl

precautions.[297] Once harm has occurred, the post-conflict principles address information-sharing, environmental assessment, remedial measures, relief and assistance, and hazardous remnants of war. Principle 26 requires parties, as soon as possible and subject to applicable international law, to seek to remove or render harmless toxic or other hazardous remnants of war under their jurisdiction or control where they are causing, or risk causing, environmental damage. Principle 27 recommends cooperation by states and relevant international organizations to ensure that remnants of war at sea do not endanger the environment. These provisions are relevant to UXO only in so far as it constitutes toxic or other hazardous remnants of war and subject to their respective terms. Israel's access restrictions obstruct this work and must be assessed against its existing protection and relief obligations.

Because the natural environment is civilian in character, these consequences must be considered when evaluating the application of the principles of distinction, proportionality and precaution. These risks are compounded in densely populated urban environments and by the use of weapons and tactics such as explosive weapons with wide-area effects and attacks on industrial sites and critical infrastructure. The ICRC has emphasized that such use in populated areas carries a high risk of disproportionate civilian harm, including through environmental damage,[298] while other legal commentators stress that the foreseeability of these impacts must weigh heavily in proportionality assessments and in the obligation to take all feasible precautions, including the choice of alternative means and methods of attack.[299] This is especially acute in Gaza, where a dense civilian population depends on a narrow and already degraded ecological base, and makes the continued use of wide-area explosive weapons against urban targets particularly problematic under IHL.

Under occupation law, additional and more specific duties apply. These duties attach to Israel as the occupying power and are not transferred to, or shared by, the Board of Peace or other bodies operating under United Nations Security Council (UNSC) authorisation for reconstruction during the UNSC-mandated transitional period; occupation law continues to bind Israel unless and until the occupation is lawfully terminated. Article 43 of the Hague Regulations[300] and Article 56 of the Fourth Geneva Convention[301] oblige the occupying power to ensure public order and civil life, including public health and hygiene, and to administer public resources in a way that preserves their capital and benefits the local population. Authoritative interpretations, including by the ICRC, make clear that this includes maintaining essential services and protecting natural resources from exploitation or degradation that harms the occupied population.[302] Wilde further emphasizes that occupation law carries a conservationist logic: in the absence of strict military necessity or genuine benefit to the occupied population, the occupying power must refrain from altering the natural environment or exploiting resources, and where use is exceptionally permissible, it must be sustainable.[303] PERAC Principle 19 provides that an occupying power shall respect and protect the environment of an occupied territory in accordance with applicable international law; take environmental considerations into account in its administration; take appropriate measures to prevent significant environmental harm, including harm likely to prejudice protected persons' health and wellbeing or otherwise violate their rights; and respect the occupied territory's environmental law and institutions, subject to the limits of the law of armed conflict,[304] something that Israel's continued restrictions on independent access to Gaza directly obstruct.

8.3 Environmental damage and state responsibility

The environmental destruction in Gaza engages the law of state responsibility and the duty to make full reparation for internationally wrongful acts. PERAC Principle 9(1) provides that an internationally wrongful act of a state, in relation to an armed conflict, that causes environmental damage entails that state's international responsibility and an obligation to make full reparation, including for damage to the environment in and of itself.[305] The *PERAC Principles* address information-sharing, assessment and remedial measures separately in Principles 23 to 25.[306] The ILC's Articles on Responsibility of States for Internationally Wrongful Acts (ARSIWA) codify the customary principles governing when states incur responsibility for breaches of international law, including IHL and IHRL.[307] Under ARSIWA, any conduct attributable to a state that breaches an international obligation entails duties of cessation, non-repetition and full reparation. Where environmental harm results from violations of IHL or IHRL, including unlawful attacks on civilian infrastructure, destruction of indispensable objects, or failure to take precautions to protect the natural environment, ARSIWA provides the legal framework through which responsibility arises and obligations crystallize. As noted by UNEP in its comments on the ILC PERAC Principles before their adoption in 2022, environmental damage caused in breach of international law should give rise to obligations of restoration and compensation for affected populations and ecosystems.[308]

The environmental destruction in Gaza engages the law of state responsibility and the duty to make full reparation for internationally wrongful acts.

State responsibility in this context extends beyond direct acts of destruction. Wilde situates ARSIWA within a broader account of environmental duties, emphasizing that Israel has obligations of due diligence, including the duty to prevent significant environmental harm, to protect natural resources, and to regulate activities under a state's jurisdiction or effective control.[309] In Gaza, the due-diligence dimension matters because the collapse of wastewater systems, waste management, debris handling and contamination control is not an unforeseeable by-product of military operations, but a prolonged and predictable consequence of repeated destruction, restriction and non-facilitation. PERAC Principle 8 is specifically concerned with human displacement: it recommends that states, international organizations and other relevant actors take appropriate measures to prevent, mitigate and remediate environmental harm in areas where persons displaced by armed conflict are located or in transit, while providing relief and assistance to displaced persons and local communities. The wider due-diligence analysis in this section should instead be grounded in the applicable primary rules identified elsewhere, including occupation law, IEL where applicable, and the factual foreseeability of the harm.[310]

International legal cases over the years have confirmed that environmental damage can be a distinct cause for reparations. The International Court of Justice (ICJ) has recognized environmental harm as a compensable injury, including in its 2018 Compensation judgement in 'Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica v. Nicaragua)'.[311]

Comparable approaches have been advanced in relation to the 2006 Lebanon oil spill, where UNGA resolutions, although non-binding legally, called for Israel to bear the costs of environmental damage resulting from attacks on the Jiyeh power plant, contributing to the international law legitimacy of such claims.[312]

The applicable IHL customary rules discussed above operate in tandem with ARSIWA and are further reinforced by PERAC. A sustained pattern of attacks that foreseeably destroys water infrastructure, agricultural systems, and waste-management capacity, leading to the long-term contamination of soil and aquifers, may constitute breaches of these provisions subject to the requirements of each. In particular, military necessity is not a general exception to IHL prohibitions. As highlighted in many legal analyses, environmental harm that endangers civilian health and survival carries serious legal consequences and may engage state responsibility and international criminal law.[313]

The responsibility of third states must be distinguished from Israel's responsibility for its own internationally wrongful conduct. Israel's responsibility arises from the breach of applicable primary rules of international law. By contrast, third states may incur responsibility through their own conduct under both the secondary rules of state responsibility and independent primary obligations.

Under Article 16 of ARSIWA[314], a state which aids or assists another state in the commission of an internationally wrongful act incurs responsibility if: (a) it provides the aid or assistance with knowledge of the circumstances making the recipient state's conduct wrongful; and (b) the conduct would also be internationally wrongful if committed by the assisting state. The ILC commentary further explains that the aid or assistance must be provided with a view to facilitating the wrongful act and must actually facilitate it. Accordingly, any allegation under Article 16 should identify the particular wrongful act, the support provided, the assisting state's knowledge at the relevant time, and the way in which the support facilitated the breach.[315]

Separate obligations arise where there is a serious breach of an obligation arising under a peremptory norm of general international law. Under ARSIWA Articles 40 and 41, a serious breach is a gross or systematic failure to fulfil such an obligation. In those circumstances, all states must cooperate through lawful means to bring the breach to an end; must not recognize as lawful the situation created by it; and must not render aid or assistance in maintaining that situation. These Article 41 duties are distinct from, though they may overlap with, the responsibility for aid or assistance under Article 16.[316]

Third states may also have independent obligations that do not depend on proving responsibility under Article 16. These include, where applicable, the duty to prevent genocide under Article I of the Genocide Convention and the duty under common Article 1 of the Geneva Conventions to respect and ensure respect for international humanitarian law.[317] The non-establishment of Article 16 responsibility therefore does not determine whether a third state has complied with its own international obligations.

In the context of Gaza, this has direct implications for states providing military, financial or political support, as well as for those engaged in reconstruction. As Wilde argues, where underlying violations engage fundamental norms, including self-determination and core rules

of IHL, third states also have duties of non-assistance, non-recognition and active cooperation to end the unlawful situation.[318] Read with the ICRC's interpretation of the obligation to respect and ensure respect for IHL, third states must ensure that their actions, including arms transfers, intelligence cooperation, diplomatic support and reconstruction financing, do not facilitate environmental destruction, entrench unlawful restrictions or sustain serious breaches of international law.

Recognising environmental damage through the lens of state responsibility has direct implications for Gaza's recovery. The *PERAC Principles*[319] distinguish between legal consequences of internationally wrongful acts and recommended cooperative recovery measures. Principle 9 provides for full reparation where state responsibility is engaged; Principle 23 requires relevant information-sharing and access in accordance with applicable international law; and Principles 22, 24, 25 and 27 recommend environmental provisions in peace processes, cooperation on PCEAs and remedial measures, relief or assistance where reparation is unavailable, and cooperation regarding remnants of war at sea. Reparation, in the strict sense of restitution, compensation and rehabilitation, remains an obligation of Israel as the state responsible for the wrongful acts. The Board of Peace and reconstruction actors instead bear obligations of due diligence and non-complicity in how reconstruction is carried out, which should not be elided with Israel's reparation obligations. It reinforces that the costs of PCEA, clean-up and long-term health monitoring should not be externalized on to Gaza's devastated and impoverished population or humanitarian and development actors, but form part of legally grounded obligations of reparation. This work should not wait for formal reparations from Israel as it is urgent for the health and wellbeing of the population of Gaza. It also underscores the need to embed environmental due diligence and safeguards within reconstruction processes, both to prevent further harm and to document damage for future claims. As UNEP has consistently observed, delays in addressing environmental harm increase both human suffering and the long-term financial cost of remediation.[320, xxxi]

8.4 Potential application of the Rome Statute and the Genocide Convention

The environmental destruction documented in Gaza may engage several provisions of the *Rome Statute* of the International Criminal Court (Rome Statute)[321] and the 1948 *Convention on the Prevention and Punishment of the Crime of Genocide* (Genocide Convention). It also potentially supports any future judicial assessment that Israel has committed genocide against the Palestinian people in Gaza, and merits further investigation. Environmental destruction is not, in itself, an autonomous crime under the Rome Statute. However, targeted environmental destruction or destruction at scale may constitute, facilitate or provide powerful evidence of war crimes, crimes against humanity and genocide where it deprives civilians of the conditions necessary for survival, causes serious harm or is used as part of a wider attack on a civilian population. The Rome Statute deals with these issues as personal criminal liability, as opposed

xxxi UNEP post-conflict country reports 'frequently demonstrate' that conflict causes extensive damage to key natural resources, indicating that prolonged failure to remediate conflict-related environmental damage (including to water infrastructure, soils and hydrocarbon-contaminated sites) exacerbates adverse health outcomes, undermines food security and livelihoods, and entrenches long-term human suffering.

to the international law previously discussed, which focuses on state responsibility. **Section 8.4.1** on the Rome Statute examines the responsibility of individual Israelis in Gaza, not the State of Israel, while **Section 8.4.2** on the Genocide Convention addresses both.[322]

8.4.1. The Rome Statute

The most directly relevant potential war crime is the intentional use of starvation of civilians as a method of warfare, prohibited under Article 8(2)(b)(xxv). This provision criminalizes depriving civilians of objects indispensable to their survival, including through wilfully impeding the delivery of relief supplies. The ICC Elements of Crimes require proof that civilians were deprived of such indispensable objects and that the perpetrator intended to starve civilians as a method of warfare.[323] The ICRC confirms foodstuffs, agricultural areas, crops, livestock, drinking-water installations and supplies, and irrigation works as indispensable objects, and notes that the prohibition can encompass rendering water unusable through contamination.[324]

The documented large-scale destruction and disabling of systems for water, wastewater, desalination, agriculture, food production, health and environmental management, as well as restrictions affecting fuel, electricity, spare parts, treatment chemicals, repair materials, humanitarian access and environmental assessment, may therefore be relevant to the engagement of Article 8(2)(b)(xxv).[325] The collapse of wastewater treatment, the discharge of untreated sewage, degradation of agricultural land, loss of livestock and food systems, and the resulting dependence on aid may all be relevant to whether objects indispensable to civilian survival were destroyed, rendered useless or withheld.

Establishing the crime of starvation would nevertheless require proof that the deprivation was intentional and that the relevant perpetrator intended to starve civilians as a method of warfare. The nature and recurrence of attacks, decisions relating to the supply or withholding of fuel and repair materials, knowledge of civilian needs and consequences, official statements, operational directives, warnings by humanitarian bodies, and decisions taken after the effects of deprivation had become clear may all be relevant to establishing this intent.[326] The evidence in this paper demands further investigation by legal authorities, both domestic and international, as it speaks to the probability of crimes that have been committed by individual Israelis and as part of a collective endeavour by the Israeli state.

Article 8(2)(b)(ii) prohibits intentionally directing attacks against civilian objects. Water wells, reservoirs, desalination plants, wastewater-treatment facilities, pumping stations, irrigation systems, agricultural land, food-production facilities, waste-management sites, laboratories and public-health infrastructure are presumptively civilian objects unless, in the circumstances prevailing at the time, they by their nature, location, purpose or use made an effective contribution to military action and their destruction, capture or neutralisation offered a definite military advantage within the constraints of the doctrine of proportionality.[xxxii] The reported scale of damage to these systems requires a formal incident-by-incident investigation of the objects attacked, the information available to those responsible, the military purpose asserted, and the precautions taken to protect civilians.

xxxii A narrow exception is where military forces are using these civilian objects purely to sustain military forces or where they are used in direct support of a military occupation.

Relatedly, Article 8(2)(b)(iv) prohibits intentionally launching an attack in the knowledge that it will cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or widespread, long-term and severe damage to the natural environment that would be clearly excessive in relation to the anticipated concrete and direct overall military advantage. The territory-wide contamination risks, including extensive debris generation, the destruction of sewage treatment and water systems, the contamination of air, soil and groundwater, and the foreseeable long-term health consequences of Israel's military assault, are relevant to this provision. However, an assessment of the environmental damage, as opposed to the death or injury of civilians, or the destruction of civilian objects, must meet the high – and poorly defined – cumulative threshold of being widespread, long-term *and* severe, and clearly excessive when assessed against the anticipated military advantage. This requires a target-specific and evidence-led assessment, rather than an inference based solely on aggregate destruction.[327] One vital question concerns the use of AI for targeting by Israeli security forces. Israeli forces have reportedly used AI-enabled systems, notably 'Lavender', to generate and prioritize potential human targets in Gaza. In 2024, an investigation by *+972 Magazine* and Local Call, based on accounts from six Israeli intelligence officers, alleged that the system was relied upon extensively in the early war.[328] The same investigation alleged that some human reviewers spent only about 20 seconds on each AI-flagged potential target, clearly an utterly inadequate time to assess the reverberating environmental effects from the use of explosive weapons with wide-area effects.

Where the applicable conflict classification and protected-person requirements are met, the reported destruction may also warrant examination under Article 8(2)(a)(iv), concerning the extensive destruction and appropriation of property not justified by military necessity and carried out unlawfully and wantonly; and Article 8(2)(a)(iii), concerning wilfully causing great suffering or serious injury to body or health. Unsafe water, raw sewage, polluted air, contaminated debris, disease exposure, displacement, environmental degradation and weakened health capacity may be relevant to these provisions, particularly where direct causal links can be established.[329]

The same conduct may additionally be relevant to crimes against humanity under Article 7, if it forms part of a widespread or systematic attack directed against a civilian population pursuant to or in furtherance of a state or organizational policy with the required knowledge of that attack. Extermination under Article 7(2)(b) includes the intentional infliction of conditions of life, such as deprivation of access to food and medicine, calculated to bring about the destruction of part of a population. The systematic destruction or disabling of water, sanitation, food, health and environmental systems, if proved to have been part of such an attack and to have constituted or formed part of mass killing with the required intent and knowledge, could therefore be relevant to extermination. Prolonged exposure to toxic contaminants, sewage, unsafe water and disease-causing conditions may also be relevant to the commission of 'other inhumane acts' under Article 7(1)(k), where the conduct intentionally causes great suffering or serious injury to physical or mental health.[330, xxxiii]

xxxiii See, for example: S.R. Freeland. (2022). 'Crimes Against the Environment: What Role for the International Criminal Court?' in E. Sobenes, S. Mead and B. Samson (Eds.). *The Environment Through the Lens of International Courts and Tribunals* (pp. 159–88). T.M.C. Asser Press. Retrieved from: https://doi.org/10.1007/978-94-6265-507-2_6; and D. Kaelin, C. Pellaton and T. Kebebew. (2025). 'Water and survival in war: Upholding IHL's protective purpose and documenting the hidden toll'. International Review

Finally, the environmental destruction documented may be relevant to an assessment of the commission of acts of genocide under Article 6.[xxxiv] The destruction of a group's environmental and material means of survival can be relevant to Article 6(c), where it is deliberately imposed upon a protected group and accompanied by the required genocidal intent.[331] The documented destruction of life-sustaining systems, including water and sanitation infrastructure, food-production capacity, agricultural land, public-health systems, housing and environmental safeguards, together with the resulting contamination and toxic exposure, disease, displacement, and malnutrition, may therefore be relevant to whether those conditions of life capable of bringing about physical destruction of part of the Palestinian population in Gaza have been deliberately inflicted. As well documented, genocide requires a distinct and demanding mental element: the intent to destroy, in whole or in part, a national, ethnic, racial or religious group *as such*. The corresponding Genocide Convention provisions and the evidence are examined in **Section 8.4.2**.

Environmental harm may also be relevant to the potential commission of acts of genocide under Article 6(b), genocide by causing serious bodily or mental harm. Deaths and injuries, respiratory illness, unsafe water, communicable disease, toxic contamination, reproductive and developmental risks, malnutrition, displacement and the collapse of health services may support assessment of serious harm to members of the protected group. Article 6(b), like Article 6(c), requires proof that the harm was inflicted with the specific intent to destroy the group, in whole or in part.

8.4.2. The Genocide Convention

The documented environmental destruction is relevant to the assessment of potential violations of the Genocide Convention[332] by individuals, and those potentially attributable to the State of Israel, including those described in **Section 8.4.1** in Article 6 of the Rome Statute, the language for which is drawn from the Genocide Convention. Oxfam has previously endorsed the authoritative analyses of genocide scholars and many reports and declarations from experts and expert organizations that affirm Israel has state responsibility for acts of genocide in Gaza. Israeli citizens in the Israeli security forces have individual responsibility for crimes committed that violate the provisions of the Genocide Convention where intent to commit genocide can be shown.[xxxv]

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of the Red Cross, 107(930), pp. 1141–1168. Retrieved from: https://international-review.icrc.org/articles/water-and-survival-in-war-upholding-ihls-protective-purpose-and-documenting-the-hidden-toll-930

xxxiv Oxfam, alongside many academic experts and human rights organizations, has determined to its satisfaction that Israel is committing acts of genocide against the Palestinian people in Gaza. See, for example: The International Association of Genocide Scholars. (2025). *IAGS Resolution on the Situation in Gaza*. Retrieved from: https://genocidescholars.org/wp-content/uploads/2025/08/IAGS-Resolution-on-Gaza-FINAL.pdf. A judicial case to determine that legal and factual issue sits before the ICJ, but the obligations of states not to commit an act of genocide, and the obligations of third states to take steps to prevent assisting such acts are not dependent on that ultimate judicial finding. They are preventative in nature. See: ICJ. *Application of the Convention on the Prevention and Punishment of the Crime of Genocide in the Gaza Strip (South Africa v. Israel*). Retrieved from: https://www.icj-cij.org/case/192

xxxv International Association of Genocide Scholars. (2025). *IAGS Resolution on the Situation in Gaza*, (concluding that 'Israel's policies and actions in Gaza meet the legal definition of genocide' under Article II of the 1948 Genocide Convention), op. cit.; O. Bartov. (15 July 2025). *I'm a Genocide Scholar. I Know It When I See It. New York Times*. Retrieved from: https://www.nytimes.com/2025/07/15/opinion/israel-gaza-holocaust-genocide-palestinians.html. Bartov writes that his 'inescapable conclusion' is that Israel is committing genocide against the Palestinian people; R. Segal. (13 October 2023). *A Textbook Case of Genocide. Jewish Currents*. Retrieved from: https://jewishcurrents.org/a-textbook-case-of-genocide. Segal argues that Israel's assault and siege of Gaza displays 'explicit, open and unashamed' genocidal intent; F. Albanese. (25 March 2024).

Article II of the Genocide Convention defines genocide as certain prohibited acts committed with intent to destroy, in whole or in part, a national, ethnical, racial or religious group, as such.[333] The most directly relevant categories are killing members of the group under Article II(a); causing serious bodily or mental harm under Article II(b); and deliberately inflicting conditions of life calculated to bring about the group's physical destruction, in whole or in part, under Article II(c). Palestinians undoubtedly constitute a protected national group for the purpose of the convention.[334]

Article II(c) is particularly relevant. International criminal jurisprudence and academic analysis understand 'conditions of life' to include the deliberate deprivation of resources indispensable to physical survival, including food, water, medical care, shelter, clothing, hygiene and means of subsistence. Such conditions may also result from the systematic expulsion of people from their homes or the destruction of civilian systems on which survival depends. Article II(c) is therefore capable of encompassing destructive conduct undertaken through deprivation and environmental degradation, and is not limited to the immediate acts of the killing of individuals or groups of individuals.[335]

The documented evidence of extensive damage to water supply, desalination, reservoirs, wells, wastewater treatment, sewage pumping, agricultural land, food production, healthcare, housing, waste management, and environmental monitoring, together with restrictions affecting the fuel, electricity, treatment chemicals, spare parts, equipment and technical access needed to operate or restore these systems, is relevant to whether life-sustaining conditions have been deliberately impaired. The resulting conditions of unsafe or inadequate water, raw sewage, infectious-disease risks, contaminated soil and food, loss of agricultural production, displacement, polluted air, toxic debris and diminished healthcare capacity may further contribute to this.

The cumulative character of these alleged harms is legally important. The destruction of a water system, for example, will reduce drinking water availability, and will also disable sanitation, increase waterborne disease, undermine food preparation, reduce healthcare capacity, and contaminate groundwater. Where such effects are foreseeable, sustained and affect a large proportion of a protected population, they may provide evidence that conditions of life were capable of contributing to physical destruction in whole or in part.[336]

The central legal requirement remains the special or genocidal intent: the perpetrator must intend to destroy the protected group, in whole or in part, as such. That intent must be

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Anatomy of a Genocide: Report of the Special Rapporteur on the Situation of Human Rights in the Palestinian Territories Occupied since 1967, A/HRC/55/73. Geneva: UNHRC. Retrieved from: https://www.un.org/unispal/document/anatomy-of-a-genocide-report-of-the-special-rapporteur-on-the-situation-of-human-rights-in-the-palestinian-territory-occupied-since-1967-to-human-rights-council-advance-unedited-version-a-hrc-55/. This report finds reasonable grounds to believe that the threshold for Israel's commission of genocide in Gaza had been met; Amnesty International. (5 December 2024). *'You Feel Like You Are Subhuman': Israel's Genocide against Palestinians in Gaza*. Retrieved from: https://www.amnesty.org/en/documents/mde15/8668/2024/en/. This report concludes that Israel had committed and was continuing to commit genocide against Palestinians in Gaza; B'Tselem. (July 2025). *Our Genocide*. Retrieved from: https://www.btselem.org/sites/default/files/publications/202507_our_genocide_eng.pdf. B'Tselem conclude that Israel is committing genocide against Palestinians in the Gaza Strip; and UNHRC, Independent International Commission of Inquiry on the Occupied Palestinian Territory, including East Jerusalem, and Israel. (2025), *Legal Analysis of the Conduct of Israel in Gaza Pursuant to the Convention on the Prevention and Punishment of the Crime of Genocide*, A/HRC/60/CRP.3. Retrieved from: https://www.ohchr.org/en/press-releases/2025/09/israel-has-committed-genocide-gaza-strip-un-commission-finds. This analysis concludes that Israel has committed genocide against Palestinians in Gaza.

established from the evidence as a whole, including public statements of officials of the state intended to direct the actions of individuals. Foreseeable harm alone is insufficient. The required intent may be inferred from a pattern of conduct and surrounding circumstances in addition to official statements of intent, including repeated attacks upon objects indispensable to survival;[xxxvi] the deliberate geographic and demographic reach of deprivation; official statements; operational orders; knowledge of humanitarian consequences; decisions to maintain restrictions despite known risks; and the absence or rejection of less harmful alternatives.[337]

The environmental harms may also be relevant to Article II(b), which prohibits causing serious bodily or mental harm to members of a protected group. Deaths and injuries, respiratory illness, waterborne and communicable disease, toxic contamination, hunger, malnutrition-related vulnerability, displacement, maternal-and-child health risks, and the collapse of health services may be capable of supporting such an inquiry. Serious bodily harm need not mean death, but it must be sufficiently grave and must be connected to conduct directed against group members.[338] Article II(a), killing members of the group, may also be engaged where deaths can be causally linked to attacks, deprivation, disease, the denial of indispensable services or other conduct. However, the environmental harms are most likely to support the engagement of Article II(a) as part of a broader evidential record, rather than as a stand-alone account of individual killings.

The documented evidence of widespread, and apparently deliberate, environmental destruction may therefore contribute to the factual record relevant to Articles II(b) and II(c), and potentially Article II(a), of the Genocide Convention. It may also be relevant to the convention's preventive purpose. States Parties have a positive and immediate duty to act to prevent genocide when they know, or should normally have known, of a serious risk and where they possess means capable of influencing the relevant conduct. The reported degradation of water, food, sanitation, health and environmental systems is consequently relevant both to ultimate judicial accountability and to the delivery of urgent preventive action.[339] In 2024, the ICJ issued orders for provisional measures under the Genocide Convention to prevent the infringement of the rights of the Palestinian people, therefore recognising them as a protected category under the convention.[340]

8.5 Future legal and financial liability risks

While the IHL, international criminal law and IHRL obligations apply to parties to the conflict, private law liabilities may arise during the recovery and reconstruction phase for the agency created to manage that process. The Board of Peace was created by UNSCR 2803 as 'a transitional administration with international legal personality' empowered to set the framework for, and coordinate the funding of, Gaza's redevelopment.[341] The resolution authorizes the Board of Peace and participating member states to enter into the arrangements necessary to achieve the *Comprehensive Plan* and to establish operational entities 'with, as necessary, international

xxxvi ICJ. (15 November 2023). *Joint Declaration of Intervention of Canada, Denmark, France, Germany, the Netherlands and the United Kingdom: Application of the Convention on the Prevention and Punishment of the Crime of Genocide (The Gambia v. Myanmar)*, paras. 51–68. Retrieved from: https://www.icj-cij.org/node/203299.

legal personality and transactional authorities' for governance, reconstruction, service delivery, the facilitation of humanitarian assistance and the movement of persons. The Board's governing instruments, the conduct of its bodies and the allocation of control must ensure that environmental assessment is integrated into, and precedes, reconstruction, that safeguards are applied to the works they finance, and that those harmed by contamination have effective routes to remedy. Since this authority derives from a UNSC resolution rather than a treaty ratified by the Palestinian people or a domestic legislature, and because the Board of Peace's own *charter*, which was signed 16 January 2026 and launched in Davos on 22 January 2026, rather than the resolution itself, defines the Board's internal governance, the precise scope of legal responsibility borne by the Board, its Office of the High Representative for Gaza, and the sub-agencies it has created remains contested and only partially codified.

The Board of Peace and those participating in reconstruction must fulfil their respective obligations under international law. Oxfam calls for Palestinian-led, rights-based and reparations-oriented reconstruction, clear responsibilities, environmental and public-health safeguards, and effective ways for Palestinians to seek remedy. These arrangements do not displace Israel's obligations as the occupying power.

Oxfam calls for Palestinian-led, rights-based and reparations-oriented reconstruction, clear responsibilities, environmental and public-health safeguards, and effective ways for Palestinians to seek remedy.

8.5.1. Private law liabilities

Failure to assess and manage environmental contamination in Gaza may expose states, donors, contractors and implementing agencies to significant legal and financial liability. While obligations under IHL primarily apply to parties to the conflict, environmental harm and resulting exposure pathways can create downstream risks for those responsible for reconstruction and recovery, particularly where hazards are foreseeable but not assessed. In such contexts, failure to undertake adequate environmental due diligence, monitoring and risk communication may give rise to private law obligations, liabilities, claims of negligence concerning breach of duty of care, or failure to meet applicable environmental and social safeguards.

In the Gaza context, the scale of damage and contamination risk suggests that failure to undertake comprehensive PCEA could expose involved actors in the territory, principally Israel but also other states engaged through the Board of Peace, to future legal challenges, compensation claims and long-term financial costs.

A draft immunity resolution reported by *the Guardian* in June 2026 raises separate accountability concerns. The draft would reportedly grant members of the Board of Peace, the Office of the High Representative, Palestinian administrators working under the Board, international military personnel and non-resident contractors protection from 'any arrest, detention or legal proceedings in the courts or other entities in Gaza,' with the Board Chair empowered to waive an individual's immunity subject to the majority approval of the executive Board.[342] Legal experts warned that the framework could shield officials from accountability while conferring broad

administrative powers over Palestinian territory. Whether or not such a framework is ultimately formalized, and at the time of writing it remains unadopted, its circulation demonstrates that the question of who may be held liable for Board of Peace and agency conduct in Gaza, and in which forum, is unresolved and actively contested.

Uncertainty over legal status does not reduce liability; it may defer and, in some cases, magnify it. Where an authority such as the Board of Peace operates through operational entities that are funded voluntarily, lack individually codified legal personality and are shielded by a contested immunity framework, foreseeable harms arising from reconstruction activity, procurement, security operations or environmental and public health hazards may still generate claims of negligence or breach of duty against the states and institutions that funded, staffed or contracted with those entities. In the context of Gaza, the principal possible exposure falls on member states participating in the Board of Peace and the International Stabilization Force (ISF), the World Bank as the Gaza Reconstruction and Development Fund (GRAD) trustee, and implementing contractors, rather than on the Board's own budget, which is not assessed and depends on pledges that, as of May 2026, remained substantially undisbursed against the US$71.4bn *Gaza Rapid Damage and Needs Assessment* estimate.[343] However, unclear legal arrangements can obstruct access to remedy. They do not automatically establish liability for the Board's members, donors or the World Bank. Any claim requires analysis of the applicable law, attribution, jurisdiction, causation and relevant immunities. Reconstruction arrangements should specify responsibility and provide accessible, independent routes to remedy.

8.5.2. International law standards

A further area of law to consider in Gaza recovery and reconstruction is international disaster law. Developed principally through the International Federation of Red Cross and Red Crescent Societies' (IFRC) Disaster Law Programme and its 2007 *Guidelines for the Domestic Facilitation and Regulation of International Disaster Relief and Initial Recovery Assistance* (the *IDRL Guidelines*),[344] international disaster law provides a body of soft-law standards that, while not binding on the Board of Peace as such, is likely to inform how the Board's obligations under UNSCR 2803[345] are interpreted and assessed by donors, cooperating humanitarian actors, and eventually by courts or oversight bodies. The resolution itself underscores 'the importance of the full resumption of humanitarian aid in cooperation with the BoP [Board of Peace] into the Gaza Strip in a manner consistent with relevant international legal principles and through cooperating organizations, including the United Nations, the International Committee of the Red Cross, and the Red Crescent'.[346] The Board's practice in Gaza, including any customs, movement, visa or access restrictions imposed on relief personnel and goods through its operational entities, may therefore be assessed against these standards, despite its operation under a UNSC mandate rather than domestic disaster legislation.

The International Law Commission's Draft Articles on the Protection of Persons in the Event of Disasters, adopted on second reading in 2016,[347] are addressed to states rather than transitional administrations, but articulate obligations relevant to functions the Board of Peace has assumed in Gaza. Article 10 assigns the affected state 'the primary role in the direction, control, coordination and supervision' of relief assistance in its territory, a role

that the Board of Peace has in practice displaced or shared with the Palestinian technocratic committee it oversees. Article 11 requires the affected state to seek external assistance where national response capacity is manifestly exceeded, a condition plainly met in Gaza, while Article 13 requires that consent to external assistance not be withheld arbitrarily. Whether these obligations now fall in practice on the Board, rather than a Palestinian authority, raises important questions about the legal responsibilities accompanying the authority it exercises. Article 15 requires the prompt and effective facilitation of external assistance, including the appropriate treatment of relief personnel, equipment and goods, while Article 16 requires the protection of relief personnel and goods present in the territory. These provisions closely correspond to the coordination and access functions that the International Gaza Support Center (IGSC), formerly the Civil-Military Coordination Center, and the Office of the High Representative for Gaza have exercised since October 2025.[348] If the Board is treated by donor states, humanitarian actors or future review mechanisms as having assumed the affected state's disaster-response role without assuming the affected state's corresponding duties to cooperate, to seek and not arbitrarily refuse assistance, and protect humanitarian personnel and goods, it risks facing legal and reputational claims that the authority it exercises exceeds the obligations it accepts. Neither UNSCR 2803 nor the Board's own charter currently closes this gap.

8.6 The political and reputational risks of delayed action

Beyond legal and financial liability, the unresolved scope of the Board of Peace's authority and the accountability of its agencies carry significant political and reputational consequences, and can trigger sustained media scrutiny, political pressure and reputational damage for the Board, its donor states, and its operational entities. More importantly, it creates risks for the people of Gaza, including health impacts and potential displacement and exposure to industrial pollutants. In Gaza, inadequate safeguards and inaccessible remedies would expose communities to further harm and undermine public trust. As reconstruction progresses in the absence of environmental safeguards, foreseeable environmental harm, such as contaminated water, unsafe debris or public-health impacts, may generate sustained media coverage and political pressure. In such conditions, environmental contamination risks can become points of scrutiny, with long-term implications for the credibility and legitimacy of recovery efforts.

The conditional character of the Board's mandate under UNSCR 2803, which authorizes the Board of Peace and the ISF only 'until Dec. 31, 2027, subject to further action by the Council', and which makes any transfer of authority back to the Palestinian Authority conditional on its completion of an undefined 'reform program', has drawn sustained criticism from states and commentators concerned that a body chaired by a sitting head of a guarantor state, and reporting to the UNSC only every six months, lacks the independent oversight mechanisms typically associated with UN-administered territories.[349]

9. CONCLUSION AND RECOMMENDATIONS

Israel's unprecedented military assault has created an environmental crisis spanning the entirety of the Gaza Strip; the consequences of this will extend far beyond the period of active hostilities. Explosive weapons have destroyed entire neighbourhoods, pulverized asbestos-containing materials and obliterated water and sanitation infrastructure, dispersing a complex mixture of heavy metals, explosive and combustion residues, particulate matter and persistent organic pollutants across air, soil and water systems. The resulting debris poses extensive and persistent contamination risks. The documented destruction and obstruction of repair have deliberately undermined the systems needed for civilian survival. It is a foreseeable and lasting consequence of Israel's military strategy and the methods by which it was implemented in Gaza.

The scale and systematic nature of this destruction, and the resulting widespread contamination, have created conditions incompatible with civilian survival, engaging serious obligations and potential violations under IHL, IHRL and occupation law. These findings are also relevant to ongoing proceedings before the ICJ concerning alleged violations of the Genocide Convention, in which the destruction of systems indispensable to civilian survival forms part of the broader legal and factual context under examination.

As established in this report, Gaza's environmental systems have now been pushed into systemic collapse. Contamination is widely dispersed across Gaza and no longer localized. It is embedded across environmental media, creating persistent exposure risks for civilians, humanitarian actors and those engaged in reconstruction. A full, independent, field-based PCEA is urgently needed to identify and begin to mitigate risks to Palestinians in Gaza. In the absence of that, the population will be forced to live and rebuild within a hazardous landscape for years, if not decades.

The central challenge facing Gaza is no longer determining whether a contamination crisis exists but understanding its full extent before recovery and reconstruction. The international community must therefore act collectively and decisively to ensure that any future recovery and reconstruction in Gaza is safe, lawful and environmentally sustainable. Much of that responsibility now runs through the mechanisms established under UNSCR 2803[350]. The Board of Peace and the entities operating under its authority will determine in practice whether a PCEA precedes reconstruction, whether safeguards are applied to the works they finance, and whether those harmed by contamination have any route to remedy.

9.1 Framework for safe recovery and reconstruction

Oxfam calls for a Palestinian-led, rights-based framework for safe recovery and reconstruction that is grounded in the rights, needs and priorities of the people and communities who will live with their environmental consequences. The Palestinian Environment Quality Authority (EQA) should lead environmental assessment and monitoring, while other relevant State of Palestine institutions should exercise their respective mandates, including the Palestinian Water Authority and Coastal Municipalities Water Utility for water-related functions. Municipalities, civil society, women's rights organizations and affected communities should shape priorities and

oversight, with local knowledge informing hazard identification. UNEP and the wider UN system should provide technical support, methodology and laboratory capacity to enable Palestinian-led assessment and monitoring, ensuring that they support rather than substitute Palestinian institutions. Israel retains its separate responsibilities for the environmental consequences of the conflict, while the Board of Peace and entities operating under UNSCR 2803, as temporary and transitional structures, have a distinct role in determining the framework within which reconstruction proceeds. Third states and donors have responsibilities beyond their role as funders, including in relation to safe recovery and environmental safeguards. Accountability and remedy should remain distinct from the recovery and reconstruction process, ensuring that environmental, health and property harms are documented, preserved and addressed through appropriate accountability and claims mechanisms.

Given the scale, complexity and uncertainty surrounding environmental contamination in Gaza, recovery requires a structured environmental process to identify hazards, establish the evidence base, reduce immediate exposure, guide remediation and ensure that reconstruction does not create or deepen environmental risks. This process should link emergency protection, environmental assessment, recovery and reconstruction, with the level of evidence and safeguards increasing as interventions become more permanent.

The framework is presented in five stages, but these stages should not be understood as strictly sequential. Immediate exposure reduction begins before the contamination baseline is complete; assessment proceeds alongside urgent recovery; remediation begins as risks are sufficiently characterized; and reconstruction proceeds where appropriate environmental safeguards are in place. What changes across the stages is the level of environmental knowledge, risk control and permanence of the intervention. Emergency action should not wait for the PCEA; however, increasingly permanent decisions should be based on increasingly robust environmental evidence.

The stages that follow set out key measures for safe recovery and reconstruction. They are not intended to be exhaustive, but to provide a practical framework for sequencing environmental risk management as evidence and conditions evolve.

Stage 1: Establish the conditions for safe recovery

The first priority is to reduce immediate exposure and establish the minimum conditions under which humanitarian operations, environmental assessment and early recovery can proceed safely. Existing conflict and remote-sensing information can be used to identify areas of elevated potential risk, but this should be treated as precautionary information rather than confirmation of contamination. All technical interventions should be guided by the precautionary principle, recognizing that contamination risks may exist even where field verification remains incomplete. The absence of field data resulting from the Government of Israel's denial of access must not be used as a justification for delaying action where credible contamination risks have already been identified.

Immediate exposure reduction and protection

- Emergency water supply systems must incorporate multi-barrier treatment capable of removing conflict-related contaminants, including heavy metals, explosive residues, hydrocarbons, salinity and microbial pathogens. This requires combining technologies such as coagulation–filtration, activated carbon adsorption and membrane processes (for example, reverse osmosis or nanofiltration) with disinfection, as conventional chlorination alone does not address toxic metals or organic pollutants present in conflict-affected environments.
- Debris management and clearance operations must include exposure mitigation measures, including the wet suppression of dust, controlled handling and the provision of PPE, as exposure to fine particulate matter, asbestos, and heavy metals is associated with long-term respiratory and systemic health risks.[351, 352]
- All debris clearance, environmental assessment and reconstruction activities must be preceded by explosive ordnance risk assessment and, where necessary, clearance by qualified personnel.[353]
- Rapid food safety screening must be implemented to test high-risk food products, including crops, livestock products and fish, to prevent contaminated food from entering the food chain, in line with Codex Alimentarius standards.[354, 355]
- Health systems must establish baseline health data for populations and workers at risk of environmental exposure and implement longitudinal monitoring to identify, document and track exposure-related health effects over time. This should be accompanied by the capacity to provide timely preventive and curative care for identified conditions and to respond rapidly to acute exposure-related illness.
- Existing conflict and remote-sensing data must be used to inform the precautionary management of areas identified as having elevated potential contamination risks, while recognizing that these areas require field verification before contamination can be confirmed. Exposure-reduction measures should be implemented where warranted, particularly in areas where civilian activity, humanitarian operations or recovery works are planned.
- WASH service providers, debris-clearance teams, environmental assessment personnel and other workers undertaking high-risk activities must be provided with appropriate occupational health and safety measures, including exposure monitoring, PPE, training and procedures for managing risks from raw sewage, hydrogen sulphide, chlorine, contaminated dust, asbestos-containing materials and unexploded ordnance.

Stage 2: Establish the contamination baseline

Once access is secured, the next step is to move from precautionary management to systematic field-based evidence. The purpose is not simply to identify individual hotspots, but to establish the scale, distribution, concentrations and exposure pathways of contamination across Gaza, and to restore the analytical capacity required to support subsequent recovery decisions.

Comprehensive field assessment and analytical capacity

- A full, independent, field-based PCEA should be undertaken under Palestinian leadership, with UNEP technical support, to identify contamination types, concentrations, exposure pathways, and their spatial distribution across Gaza. The assessment should be sufficiently comprehensive to characterize contamination at scale, rather than being limited to selected hotspots.
- Environmental and public health analytical capacity must be restored and strengthened, including appropriately equipped laboratories and, where necessary, mobile laboratories, to enable the testing of water, soil, food and other environmental media for relevant contaminants. This should include trained personnel, quality assurance systems and reliable access to laboratory supplies and reagents.
- The assessment should proceed alongside urgent humanitarian and exposure-reduction measures rather than becoming a precondition for them. The resulting evidence should progressively inform decisions on recovery, remediation and reconstruction.

Stage 3: Risk reduction and controlled recovery

As field evidence becomes available, recovery interventions should move from precautionary management towards measures targeted to identified risks. Recovery should not proceed on the assumption that all areas or materials are contaminated; nor should the absence of evidence from an area be treated as evidence of safety where a field investigation has not yet taken place. At this stage, recovery decisions should remain proportionate to the level of evidence available and should be revised as further field investigation establishes the presence, absence or changing distribution of contamination.

Environmental screening and controlled recovery

- All recovery interventions must undergo environmental screening aligned with international safeguard frameworks, including the World Bank Environmental and Social Framework and UNEP guidance, to assess contamination risks prior to implementation.
- Water system rehabilitation must integrate contamination monitoring and risk management, ensuring that groundwater sources are tested prior to use and that infrastructure is designed to address degraded water quality.
- Food safety monitoring systems must be established and maintained, including the routine testing of agricultural and livestock products, to prevent chronic exposure through the food chain.

Stage 4: Remediation and environmental restoration

Where contamination is confirmed and presents unacceptable risks, recovery must move beyond risk avoidance towards remediation and environmental restoration. The choice of remediation approach should be based on the contaminant, site conditions, exposure pathways and intended future use, with appropriate safeguards for health, livelihoods and land rights. Remediation should therefore be undertaken where field evidence establishes the need, rather than treating the entire territory as uniformly contaminated.

The remediation and management of contaminated materials

- Soil contamination assessments must be conducted in agricultural and peri-urban areas, with targeted remediation applied where contamination exceeds safe thresholds, including methods selected for contaminants, site conditions and intended use with safeguards for health, livelihoods and land rights.
- Conflict-generated debris must be treated and managed as a hazardous waste stream, including classification, controlled disposal and restricted reuse, to prevent the redistribution of contaminants within rebuilt environments.

Stage 5: Safeguarded reconstruction and long-term monitoring

Only as contamination risks become sufficiently understood and controlled should increasingly permanent reconstruction decisions be made. Reconstruction should incorporate verified environmental risks into land-use planning and infrastructure design, while establishing permanent systems for environmental monitoring and occupational protection. The environmental monitoring and regulatory system should be Palestinian-led, with independent technical oversight, and should form part of the permanent environmental governance system rather than being treated as a temporary reconstruction measure.

Protected reconstruction and long-term oversight

- Verified contamination risks must be integrated into Palestinian-led land-use planning. Any necessary temporary safety restrictions should be proportionate, regularly reviewed and paired with safe alternatives, remediation and the protection of housing, land, property and return.
- Infrastructure design must account for degraded environmental conditions, including water systems capable of treating chemically contaminated sources and drainage approaches that prioritize containment, sedimentation and controlled conveyance (for example, lined channels and temporary settling to reduce pollutant transport).
- A Palestinian-led environmental monitoring system must be established and institutionalized with independent technical oversight, covering groundwater, soil, air, coastal waters and food systems.
- Workers engaged in debris clearance and reconstruction must receive appropriate training, PPE and preventative health screening commensurate with identified environmental and occupational exposure risks.

9.2 Immediate asks

The Government of Israel must:

- End its genocide in Gaza, immediately cease unlawful attacks, fully comply with the Geneva Conventions and applicable IHL, and respect all ceasefire arrangements. Continued attacks will further disperse hazardous materials and increase long-term risks to human health and environmental systems.

- Lift all restrictions on the entry of humanitarian assistance, environmental assessment teams and essential materials, including fuel, engine oil, laboratory equipment, water treatment inputs, and spare parts required to restore and safely operate critical systems. The continued blockade of these items undermines the ability to prevent exposure and manage environmental risks. These restrictions are imposed by the Government of Israel and constitute a policy decision rather than a logistical constraint. Restrictions on essential recovery inputs under Israel's dual-use and 'special approval' regime must be lifted.
- Guarantee unimpeded access for assessment teams and for the export of samples for laboratory analysis. Third states must press Israel to enable access while continuing urgent assistance and exposure reduction.

UNEP should:

- Support the State of Palestine to undertake a full, independent, field-based PCEA aligned with international standards, to identify contamination types, concentrations, exposure pathways, and their spatial distribution across Gaza. The assessment should be sufficiently comprehensive to characterize contamination at scale, rather than being limited to selected hotspots.

Third states must:

- Suspend all transfers of arms, military equipment, components and relevant dual-use items for military use to Israel, which aid or assist sustaining the continuing occupation, where an overriding risk of serious violation of IHL exists, and review military, security and intelligence cooperation, to prevent further violations. Applicable legal duties arise under Common Article 1 and the Genocide Convention, and for its States Parties, the Arms Trade Treaty, including Articles 6 and 7.[356] Continued transfers contribute directly to the further generation of conflict-related contamination.
- Ensure that the environmental dimensions of the destruction are addressed within existing accountability mechanisms rather than treated as a separate technical process. This includes supporting the Independent International Commission of Inquiry to examine the contamination of water, soil and food systems, and pursuing reparation for the environmental damage caused. States should also establish, under a UNGA mandate, a register of damage covering environmental, health and property harm in Gaza, so that harm is recorded while evidence remains recoverable and claims remain possible. Accountability obligations of this kind are distinct from humanitarian donorship and should not be treated as satisfied by it.

9.3 Actor-specific recommendations

The Government of Israel must:

- Immediately lift the siege and all restrictions on Gaza, to allow unhindered and sustained access of humanitarian assistance, environmental assessment teams and essential materials required for safe recovery and reconstruction, and to facilitate the safe removal and export of environmental samples for laboratory analysis.
- Allow full and safe access for technical personnel, including engineers, environmental experts and humanitarian actors, to assess, repair and rehabilitate critical infrastructure and environmental systems.
- As the state responsible for internationally wrongful conduct causing this damage, Israel is under an obligation to make full reparation, including restitution, compensation and the rehabilitation of the affected environment and of the populations exposed to it. This obligation is owed to the Palestinian people, including affected individuals, communities and institutions, and does not displace claims brought by the State of Palestine. It is not contingent on donor-financing arrangements.
- Disclose the information required to enable accurate environmental assessment, including the types, quantities and impact locations of munitions used, and the locations of military installations, waste sites and burn pits. This information is necessary to identify contamination hotspots and to prioritize field investigation.
- Grant access to mandated international bodies, including the Independent International Commission of Inquiry, the relevant Special Rapporteurs and UNEP, in addition to technical and humanitarian personnel.

Third states, donors and UN agencies must:

- Support existing international accountability mechanisms, including the UN Commission of Inquiry and the proceedings before the ICJ concerning the Genocide Convention, to ensure that environmental destruction, contamination, attacks on infrastructure indispensable to civilian survival, and the denial of safe water and sanitation are considered within their respective mandates. States should fully cooperate with relevant investigations and judicial proceedings.
- Fund a full, independent, field-based PCEA of Gaza and ensure that reconstruction financing integrates environmental due diligence, contamination risk assessment and appropriate safeguards to minimize long-term health risks and environmental liabilities. Such financing must be without prejudice to Israel's obligation to provide full reparation for damage caused.
- Ensure that engagement with Gaza's reconstruction, environmental assessment and assistance reflects states' duties of prevention and non-complicity under the Genocide Convention, including through appropriate due diligence in relation to assistance, trade and other forms of cooperation. States must act on the applicable prevention and transfer-prohibition thresholds; a final judicial determination is not required before preventive action.

- Suspend all transfers of arms, military equipment, components and dual-use items for military use to Israel, and review military, security and intelligence cooperation. Assess each state's responsibility against the applicable legal tests; the risks identified demand immediate preventive action.
- Suspend or review trade, association and cooperation agreements where these sustain the unlawful situation, including through Article 2 of the EU-Israel Association Agreement, and give effect to the obligations of non-recognition and non-assistance identified by the ICJ.
- Provide financing for environmental assessment and remediation without prejudice to the Government of Israel's obligation to make reparations and ensure that such financing is not treated as a substitute for it. Urgent state responsibility should proceed while states pursue Israel's reparation obligations and preserve evidence of costs and harm.
- Refrain from financing or endorsing reconstruction arrangements that entrench the separation of Gaza from the West Bank including East Jerusalem, place Gaza under external trusteeship or facilitate the displacement of its population. Environmental monitoring and regulatory systems require a unified and Palestinian-led governance framework in order to function.
- Require that the Board of Peace's periodic reporting to the UNSC addresses progress on environmental assessment; the management of contamination risk in areas opened to return and reconstruction; and occupational exposure among those engaged in debris clearance and reconstruction. Reporting should be measurable against outcomes rather than activity, including access granted, priority sites assessed, hazards reduced, essential services restored, funds disbursed to Palestinian-led work, and complaints received and remedied.

The Board of Peace, participating states and others operating under UNSCR 2803 must:

- All actors must comply with their applicable obligations under international law. Reconstruction must respect Palestinian self-determination and must not reinforce Israel's unlawful occupation or diminish Israel's obligations as the occupying power.
- Require independent, field-based environmental assessment or precautionary safeguards appropriate to the risks where assessment remains incomplete before reconstruction works proceed in affected areas. Fund urgent assessment, hazard reduction and essential repairs in parallel, with measures to protect residents and workers.
- Apply mandatory environmental and social safeguards to reconstruction financing, including any funding channelled through the Gaza Reconstruction and Development Fund. Publish each project's safeguarding standards, assessment findings and required measures to prevent or reduce harm.
- Exclude environmental harm, occupational exposure and public health damage from any privileges or immunity arrangements adopted for the Board of Peace, the Office of the High Representative for Gaza, the ISF, Palestinian administrators working under the Board or contracted implementers. An arrangement that places such claims beyond the reach of any

competent forum would leave those exposed to contamination without remedy. Privileges and immunities do not extinguish the underlying legal duties of the Board, participating states or implementers, nor responsibility for serious crimes; any arrangement adopted should say so expressly and provide an alternative route to remedy.

- Establish an independent, accessible mechanism, designed with Palestinian civil society, local authorities and affected communities, which is able to decide claims and deliver enforceable remedies. Publish its procedures and decisions while protecting claimants' safety and privacy. Claims and remedy arrangements should be grounded in Palestinian authority and rights, with Palestinian institutions and affected communities leading their design and claims decided independently of the actors concerned. The Board and reconstruction actors must cooperate with these arrangements and provide effective remedies for harm for which they are responsible. Neither these arrangements nor reconstruction financing replaces or limits Israel's obligation to make full reparation for harm caused by its violations, including harm caused before October 2023.
- Publish the instruments governing the roles and responsibilities of the Board of Peace and each participating body, alongside reconstruction contracts and procurement criteria. Clearly identify who controls decisions and funds, the arrangements for accountability, and rules on conflicts of interest and data use.
- Respect Palestinian authority over environmental standards, assessment methodologies and spatial planning. Ensure that the EQA, the Palestinian Water Authority and the Coastal Municipalities Water Utility hold decision-making roles within their mandates, with affected communities, civil society and women's rights organizations shaping priorities and oversight.
- Publish a phased and dated plan to transfer any environmental regulatory and monitoring functions the BoP exercises to accountable Palestinian public authorities. The transition must be strictly time-bound, support Palestinian leadership from the outset, and respect the unity of Gaza, the West Bank and East Jerusalem.
- Do not condition humanitarian assistance, environmental assessment or essential equipment on disarmament, political compliance or population screening. Reject shelter and reconstruction arrangements that confine Palestinians to controlled enclaves, corridors or buffer zones, or otherwise facilitate forcible displacement. Protect UN-led civilian coordination, including UNRWA's mandate.
- Require all entities involved in debris clearance and reconstruction to apply occupational health and safety standards to debris clearance and reconstruction work, including exposure monitoring, PPE and access to preventative health screening. Publish compliance reports.
- Maintain the distinction between reconstruction financing and reparation. Donor funding through the Board of Peace does not discharge Israel's obligation to make full reparations for harm caused by its violations of international law, including the environmental damage caused. Urgent recovery funding should proceed while reparations are pursued.

Humanitarian and development actors must:

- Support Palestinian environmental monitoring and regulatory systems to enable the long-term management of contamination risks and sustainable recovery. The EQA, the Palestinian Water Authority and the Coastal Municipalities Water Utility hold the relevant mandates. The EQA is the competent national authority for environmental assessment and monitoring, and should coordinate with UNEP and other national and international institutions. Support should be directed to restoring their institutional and laboratory capacity, and to ensuring their leadership of the design and oversight of assessment and remediation activities.
- Integrate environmental contamination risks into the design, implementation and monitoring of all humanitarian and recovery programmes, including WASH, food security, shelter, livelihoods, health and infrastructure.
- Ensure that all personnel engaged in debris clearance, environmental assessment, infrastructure rehabilitation and reconstruction receive appropriate occupational health and safety training, PPE and contamination risk awareness.
- Prioritize exposure reduction through risk-informed design, including safe water treatment, dust control, food safety monitoring and contamination-aware infrastructure rehabilitation.
- Apply international environmental and social safeguard frameworks, ensuring that recovery and reconstruction do not exacerbate contamination risks or create new exposure pathways.
- Document and report contamination identified in the course of humanitarian and recovery operations and ensure that the resulting data is shared with Palestinian institutions and, where appropriate – with safeguards for consent, confidentiality and protection – made available to accountability mechanisms.

ANNEX 1. SPATIAL ANALYSIS: DATA SOURCES AND METHODOLOGY

Overview

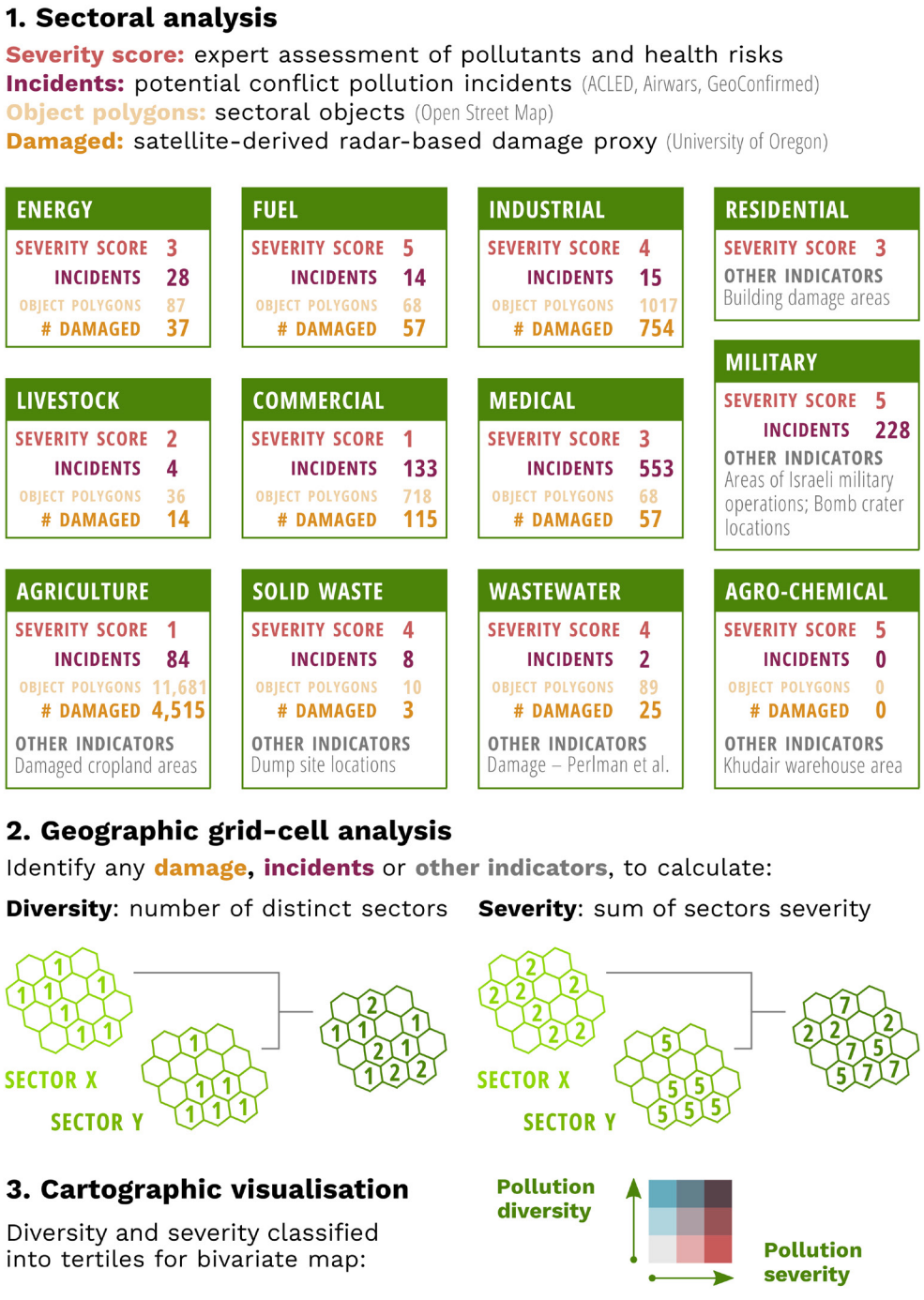
The spatial analysis underpins this paper's assessment of conflict-related contamination across Gaza. It integrates multiple geospatial datasets to characterize the distribution, diversity and relative hazard profile of potential contamination sources across the territory. The objective is not to confirm contamination levels or quantify exposure risks directly, which would require independent field-based evidence that Israel's continued restrictions on access have made impossible, but to identify areas where contamination is most likely to occur, where multiple contamination sources converge, and where environmental investigation should be prioritized. The resulting maps provide a screening-level assessment based on the convergence of multiple geospatial indicators. They are intended to support the prioritization of field investigation and environmental assessment, rather than confirm the presence, concentration or extent of contaminants.

The analysis is based on a 500m hexagonal grid covering Gaza, comprising 1,821 cells in total. A 500m resolution was selected as a pragmatic spatial scale for this screening-level assessment, balancing the need to capture local variation in the underlying damage and incident data with the limitations of the source datasets. The 1,821 cells represent the complete 500m hexagons intersecting Gaza's land boundary. Coastal cells retain their full hexagonal geometry, but only source data falling within Gaza's land area contributes to the analysis; offshore areas do not contribute data or scores. Importantly, the analysis provides spatial indicators of potential contamination sources and associated risk, rather than measurements of contamination levels on the ground. For each cell, 12 contamination source sectors are assessed: agriculture, agrochemical, commercial, energy, residential, fuel storage, industry, livestock, medical, military, solid waste and wastewater. Two aggregate metrics are computed for each cell:

- **Diversity score**: the count of distinct contamination sectors present in the cell, reflecting the complexity and variety of potential contamination sources.
- **Severity score**: a weighted sum of sector presence, with each sector assigned an ordinal score based on an expert assessment of the pollutants and health risks associated with that sector. The scores are intended to indicate relative contamination potential, rather than measured contamination levels.

The results are visualized using a bivariate colour scheme combining both metrics, allowing the identification of areas where contamination is likely to be both most widespread and most hazardous.

Figure A1: A summary of the spatial analysis methodology



Source: Incidents: ACLED, Airwars and GeoConfirmed. Object polygons: OpenStreetMap. Damage: satellite-derived, radar-based damage proxy, University of Oregon.

Data sources

The full dataset inventory is provided in **Table A1**. For each sector, two primary evidence streams are incorporated:

- **Damaged infrastructure**: OpenStreetMap (OSM) features (pre-October 2023) filtered using sector-specific tag queries and intersected with satellite-derived damage proxies based on Sentinel-1 radar-based coherent change detection (data reference: SD1). This identifies infrastructure that is likely to have been damaged or destroyed.
- **Incident data**: geolocated incident records compiled from open sources and classified into contamination sectors. Additional sector-specific indicators are incorporated where relevant. For example, locations of informal waste sites for the solid waste sector, and M84 bomb crater locations for the military sector.

A sector is considered present in a grid cell if any of these indicators are positive. This binary approach avoids imposing equivalence between different evidence types or double counting. The analysis incorporates all available data from 7 October 2023 to April 2026, although many underlying datasets have limited temporal coverage. The analysis would be more robust if equivalent datasets were available consistently across the full study period.

Sectoral setup and OpenStreetMap queries

For each sector, the datasets used, OSM queries applied, severity weighting, and the number of incidents and damaged polygons identified are set out below.

1. **Agriculture**

- Severity weighting: 1
- Additional datasets: polygons of damaged cropland
- Incidents: 84
- OSM polygons: 11,681; damaged: 4,515

Key	Values
building	barn; greenhouse
crop	fruit; olives; vegetables
landuse	allotments; farmland; greenhouse_horticulture; orchard; plant_nursery
man_made	irrigation_system; silo
trees	orchard
Compound rules	landuse=greenhouse_horticulture + building=greenhouse

2. **Agrochemical**

- Severity weighting: 5
- Additional datasets: location of Khudair Warehouse
- Incidents: 0
- OSM polygons: 0; damaged: 0

Key	Values

industrial	chemical; fertilizer
shop	agrarian
Compound rules	shop=agrarian + agrarian=fertilizer; shop=agrarian + agrarian=pesticides; man_made=storage_tank + content=chemicals; building=storage_tank + content=chemicals; man_made=silo + content=chemicals; man_made=works + product=chemicals; man_made=pipeline + substance=chemicals

3. **Energy**

- Severity weighting: 3
- Incidents: 28
- OSM polygons: 87; damaged: 37

Key	Values
generator:source	solar
plant:source	solar
power	cable; compensator; converter; generator; line; minor_line; plant; pole; substation; switch; tower; transformer
Compound rules	power=generator + generator:source=solar

4. **Fuel**

- Severity weighting: 5
- Incidents: 14
- OSM polygons: 68; damaged: 57

Key	Values
amenity	fuel
man_made	fuel_pump
shop	fuel
Compound rules	man_made=storage_tank + content=fuel; man_made=storage_tank + content=diesel; man_made=storage_tank + content=gasoline; man_made=storage_tank + content=petrol; man_made=storage_tank + content=oil; man_made=storage_tank + content=gas; man_made=storage_tank + content=LPG; man_made=storage_tank + content=LNG; man_made=storage_tank + content=hydrocarbons; man_made=pipeline + substance=oil; man_made=pipeline + substance=gas; man_made=pipeline + substance=LPG; man_made=pipeline + substance=LNG; man_made=pipeline + substance=fuel; amenity=fuel + fuel:diesel=yes; amenity=fuel + fuel:lpg=yes

5. **Industrial**

- Severity weighting: 4
- Incidents: 15
- OSM polygons: 1,017; damaged: 754

Key	Values
building	factory; industrial; manufacture
industrial	factory; manufacture; processing
landuse	industrial

man_made	works
Compound rules	man_made=works + product=machinery; man_made=works + product=steel; man_made=works + product=electronics; man_made=works + product=pharmaceuticals; man_made=works + product=bricks; man_made=works + product=furniture; man_made=works + product=packaging

6. **Livestock**

- Severity weighting: 2
- Incidents: 4
- OSM polygons: 36; damaged: 14

Key	Values
building	cowshed; goat_shed; livestock; poultry_house; sheepfold; stable; sty
building:use	livestock
landuse	animal_keeping; farmyard
Compound rules	landuse=animal_keeping + animal_keeping=cattle; landuse=animal_keeping + animal_keeping=sheep; landuse=animal_keeping + animal_keeping=goat; landuse=animal_keeping + animal_keeping=poultry; landuse=farmyard + livestock=cattle; landuse=farmyard + livestock=sheep; landuse=farmyard + livestock=goat; landuse=farmyard + livestock=poultry; landuse=meadow + livestock=cattle; landuse=meadow + livestock=sheep; landuse=meadow + livestock=goat

7. **Commercial**

- Severity weighting: 1
- Incidents: 133
- OSM polygons: 718; damaged: 115

Key	Values
amenity	marketplace; warehouse
building	retail; supermarket; warehouse
building:use	warehouse
man_made	warehouse
shop	bakery; beverages; butcher; convenience; general; greengrocer; kiosk; supermarket; wholesale
Compound rules	building=warehouse + shop=wholesale

8. **Medical**

- Severity weighting: 3
- Incidents: 553
- OSM polygons: 68; damaged: 57

Key	Values
amenity	ambulance_station; clinic; doctors; health_centre; hospital; pharmacy
building	clinic; hospital; pharmacy
emergency	ambulance_station
healthcare	centre; clinic; doctor; hospital; pharmacy

9. **Solid waste**

- Severity weighting: 4
- Incidents: 8
- Additional datasets: temporary dump sites; formal dump sites
- OSM polygons: 10; damaged: 3

Key	Values
amenity	recycling; waste_disposal; waste_transfer_station
landuse	landfill
man_made	wastewater_plant
waste	landfill
Compound rules	amenity=recycling + recycling_type=centre; amenity=recycling + recycling_type=container; landuse=landfill + waste=industrial; landuse=landfill + waste=municipal

10. **Wastewater**

- Severity weighting: 4
- Incidents: 2
- Additional datasets: damage to wastewater facilities
- OSM polygons: 89; damaged: 25

Key	Values
man_made	pipeline; wastewater_plant; water_tower; water_works
pipeline	sewer
sewer	combined; industrial; sanitary; storm
Compound rules	man_made=pipeline + pipeline=sewer; man_made=wastewater_plant + sewage=industrial; man_made=wastewater_plant + sewage=domestic

11. **Residential**

- Severity weighting: 3
- Additional datasets: building damage data from coherent change detection of interferometric SAR data
- Incidents: sector not included in search
- OSM queries: none

12. **Military**

- Severity weighting: 5
- Incidents: 228
- Additional datasets: M84 bomb crater locations; area of current Israeli military control and previous ground operations
- OSM queries: none

Table A1: Data sources used in the spatial analysis

Data ID	Provider	Description	Figure	Temporal characteristics		
				Start	End	Resolution/ frequency
Derived data						
DD1	Visual inspection of Sentinel-2/ PlanetScope imagery	Timeline of sewage discharge events at Deir al-Balah	Exposure pathway: seawater	April 2024	August 2025	Daily
DD2		Large-scale fire instances	Exposure pathway: air	October 2023	May 2025	Irregular/ episodic
DD3	SD13, SD14, SD15	Unified potential conflict pollution incident dataset	Exposure pathway: soil	October 2023	April 2026	Irregular/ episodic
DD4	SD1, SD4	Sectoral radar damage grids		October 2023	April 2026	Aggregated
DD5	DD4, DD3, SD2, SD9, SD11, SD32, SD35	Contamination sources proxy map	Conflict pollution sources	October 2023	April 2026	Aggregated
DD6	SD1, SD4, SD26, SD28	Dust risk map	Exposure pathway: air	October 2023	April 2026	Aggregated
DD7	SD10, SD29	Proxy indicator layer for soil pollution retention	Exposure pathway: soil			Not applicable
Source data						
SD1	Conflict Ecology Lab, University of Oregon	Building damage data identified using coherent change detection of interferometric SAR data (Sentinel-1)	Explosive weapons pollution	October 2023	October 2025	Weekly
SD2	OSINT Investigator – 'Stinky E'	Polygons of areas previously under Israeli military control	Explosive weapons pollution		April 2026	Aggregated
SD3	Yin et al. (2025)	Polygons of damaged cropland and greenhouses	Explosive weapons pollution	October 2023		Monthly
SD4	Humanitarian OpenStreetMap	Gaza OSM Buildings Baseline			October 2023	Not applicable
SD9	Perlman et al. (2025)	Damaged WASH infrastructure		October 2023	February 2024	Irregular/ episodic
SD10	Francos et al. (2025)	Soil map of Israel (includes all of the oPt) via Ravikovitch (1969)		May 1905		Not applicable
SD11	Kunichoff et al. (2024)	M84 bomb crater locations		October 2023	November 2023	Irregular/ episodic
SD13	ACLED	Armed Conflict Location and Event database – Gaza	Explosive weapons pollution	October 2023	April 2025	Daily
SD14	GeoConfirmed	Israel/Gaza/Lebanon Map		October 2023	April 2026	Daily

Data ID	Provider	Description	Figure	Temporal characteristics		
				Start	End	Resolution/ frequency
SD15	Airwars	Database of events of civilian harm		October 2023	February 2026	Daily
SD16	NASA FIRMS	Satellite-detected fire hotspots	Exposure pathway: air	October 2023	April 2026	Daily
SD17	CMWU	Status of public water wells	Exposure pathway: water	April 2026		Aggregated
SD19	CMWU	Status of private water wells	Exposure pathway: water	April 2026		Aggregated
SD20	CMWU	Status of desalination plants	Exposure pathway: water	April 2026		Aggregated
SD21	CMWU	Status of water reservoirs and pumping stations	Exposure pathway: water	April 2026		Aggregated
SD22	CMWU	Sewage outfalls to the Mediterranean Sea	Exposure pathway: seawater	April 2026		Aggregated
SD24	Humanitarian OpenStreetMap	Palestine OSM waterways		October 2023		Not applicable
SD25	UNEP	Contaminated debris type and volume		October 2023	October 2025	Aggregated
SD26	Copernicus	Sentinel-2 NDVI scene, 16 May 2024		May 2024		Not applicable
SD28	Global Wind Atlas	Wind Rose Data		2008–2017		Aggregated
SD29	Shomar et al. (2010)	Soil map of Gaza (accessed via IOM data)		May 1905		Not applicable
SD30	Baalousha (2010)	DRASTIC groundwater vulnerability map of Gaza	Exposure pathway: water	January 2010		Not applicable
SD31	Global Fishing Watch	SAR vessel detection data		January 2021	December 2025	Monthly
SD32	UNDP	Formal waste dumping sites	Exposure pathway: water	May 2025		Aggregated
SD33	Global Fishing Watch	Fishing extent		October 2023	December 2025	Daily
SD35	UNDP	Temporary dump sites	Exposure pathway: water	May 2025		Not applicable
SD36	Applied Research Institute of Jerusalem	Orange/yellow line locations (via Reuters, 30 April 2026)	Explosive weapons pollution	April 2026		Not applicable
SD37	Copernicus	Sentinel-5P OFFL NO2: Offline Nitrogen Dioxide		October 2023	December 2025	Weekly
SD38	NASA VIIRS	Aerosol Optical Depth – VIIRS/SNPP Deep Blue Aerosol L2 6-Min Swath 6 km (v2.0)		October 2023	December 2025	Daily

Data ID	Provider	Description	Figure	Temporal characteristics		
				Start	End	Resolution/ frequency
SD39	IOM	Drainage network	Exposure pathway: water; Exposure pathway: seawater			Not applicable
SD39	IOM	Inundation zones	Exposure pathway: water	2019	2024	Aggregated

Conflict-incident classification

Data from three conflict-incident databases is integrated into the analysis: ACLED, Airwars and GeoConfirmed. These datasets differ in scope and format and were unified into a single dataset retaining common elements: source, source ID, date, description, key links, latitude, longitude and geolocation precision. A new geolocation precision schema was developed to account for varying levels of spatial precision across source datasets. Records from the three datasets were manually reviewed for duplication, and apparent duplicate records were removed. The analysis uses a binary indicator of sector presence, meaning that one or more relevant incidents within a sector and grid cell are sufficient to record that sector as present. Multiple records of the same incident within the same cell therefore do not increase the diversity or severity score. Incident records were used as spatial indicators of reported conflict-related activity and potential contamination sources. Their inclusion does not constitute independent verification of the reported incident, attribution of responsibility, confirmation of civilian or military status, or evidence that environmental contamination occurred at the reported location.

Each conflict incident was assessed for whether it described a potential pollution-causing event and, if so, classified into the relevant contamination sector. The three source datasets contributed this data:

- **ACLED**: 33,270 incidents in total; 9,630 used (geo_precision = 1); 822 classified as pollution-related.
- **GeoConfirmed**: 3,698 incidents in total, all used; 208 classified as pollution-related.
- **Airwars**: 1,904 incidents in total; 879 used (exact location or nearby landmark); 94 classified as pollution-related; classified by matching Airwars Infrastructure categories to the sectors defined for this analysis.

Given the volume of incidents, an initial classification was performed using OpenAI GPT-5.4-nano. The ACLED classification was run on 21 April 2026 and the GeoConfirmed classification on 22 April 2026. All records identified by the large language model (LLM) as belonging to one or more relevant domains were subsequently manually reviewed in spreadsheets. This comprised 1,140 ACLED records and 314 GeoConfirmed records, or 1,454 records in total. During this review, analysts removed incorrect domain tags and added additional domain tags where incidents were considered relevant to more than one domain. Records not assigned to a relevant domain by the LLM were not all manually reviewed; random spot-checks were undertaken to assess whether relevant incidents had been missed. The 879 Airwars records were handled separately

using Airwars' existing infrastructure classifications. The classification prompt used is outlined in the next section. Where damage was not explicitly stated but was considered likely from the incident description, it was classified as inferred damage and assigned an appropriate confidence level.

The environmental categories identified through this classification do not constitute an assessment of the legality of any attack or whether a site was a lawful military target under international humanitarian law.

Incident classification prompt

Step 1

Does the incident describe any physical damage, destruction or disruption to a site, object, activity or stored goods?
If NO -> move to Step 5.
If YES -> assess both Step 2 (civilian domains) and Step 3 (military assets), then move to Step 4.

Step 2 (civilian domains)
A. Classify domains as one or more of:
Water_Sanitation_Hygiene [e.g. drinking water, wells, water tanks, water storage, water supply infrastructure]
Agriculture [e.g. crops, farmland, irrigation, greenhouses, orchards, olive trees, seeds, soil, crop burning, equipment]
Fisheries [e.g. fishing boats, nets, aquaculture facilities, sea access]
Medical [e.g. hospitals, clinics, pharmacies, ambulances, medical transport, medical supplies]
Markets_Shops_Storage [e.g. shops, markets, warehouses, storage, cold stores, distribution, civilian/food goods]
Industrial [e.g. factories, manufacturing, production sites]
Energy [e.g. power plants, grid, generators, solar panels, substations, pylons, transmission lines]
Fuel [e.g. petrol, diesel, gas, civilian fuel storage or distribution]
Solid_Waste [e.g. waste collection, landfills, recycling facilities]
Livestock [e.g. cattle, sheep, goats, poultry]
Agrochemical [e.g. fertilizers, pesticides, herbicides, chemical storage or processing]
Wastewater [e.g. sewage outflow, treatment plants, pumping stations, drainage – distinct from drinking water supply, which is Water_Sanitation_Hygiene]
If no domain is clearly supported, set domains = ["Unknown"].

B. A domain is supported only if the text names or clearly implies a specific matching asset, site, activity or goods from that domain's example list. General words alone (e.g. "infrastructure" or "facilities") are not sufficient.

C. Assign Domains_Confidence:
High: a named or clearly identified asset with confirmed or likely damage, disruption or harm.
Medium: asset implied by context; damage probable but not explicit.
Low: weak textual basis for a matching asset, site or activity; damage possible but uncertain. Proximity alone does not qualify.

Rules:
Infer damage if likely, even if not explicit.
Medical != casualties; casualties alone -> ["Unknown"]
Destruction != Solid_Waste unless waste collection or disposal systems are involved.
Energy and fuel apply only to civilian systems.
Military assets do not support civilian domains unless the text also names or clearly implies a civilian asset, site, activity or goods.
Dual-use assets: classify by likely end-user. A fuel depot or storage facility serving civilians = Fuel, even if located near a military zone. A fuel truck explicitly supplying military forces = not a civilian domain; assess under Step 3 only.
Houses, people, camps, mosques, streets, squares, schools and generic public buildings do not imply a domain unless clearly linked to a listed domain asset or activity.

Step 3 (military assets)
A. Were any military assets destroyed or damaged in a way that could plausibly release fuel, chemicals, metals, explosives residue or other pollutants?
Military assets include: tanks, armoured vehicles, warplanes, helicopters, drones, weapons systems, ammunition stores, military fuel stores, military chemical stores, military workshops or maintenance facilities, and militant infrastructure.
If NO or UNCLEAR -> set Military_Assets_Destroyed = false, Military_Confidence = "low"
If YES -> set Military_Assets_Destroyed = true

B. Assign Military_Confidence:
High: named military asset with confirmed or likely destruction.
Medium: military asset implied by context; destruction probable but not explicit.
Low: proximity only, or heavily inferred with limited textual basis.

Step 4 (validator):
If "Unknown" appears alongside any other domain, remove "Unknown".
For each assigned domain, verify that the text names or clearly implies a specific matching asset, site, activity or goods from that domain's example list. Remove any domain that fails this check.
If all domains are removed, set Domains = ["Unknown"] and Domains_Confidence = "low"

Step 5
Return JSON only:
[
"incident_id": "STRING_OR_NULL",
"Domains": [],
"Domains_Confidence": "low",
"Military_Assets_Destroyed": false,
"Military_Confidence": "low"

Visualization

For each cell, both metrics are classified into three categories using fixed, manually selected thresholds. Class boundaries were set at 2 and 4 for diversity, and 5 and 9 for severity. These thresholds were selected to provide meaningful differentiation across the discrete score distributions, rather than to divide cells into equal-sized groups. This generates a 3×3 bivariate classification, where rows represent diversity (low to high) and columns represent severity (low to high), visualized in **Figure 2**.

Caveats and limitations

This analysis is a screening-level tool intended to support prioritization and further investigation. It is not a direct measure of environmental contamination or health risk. Several limitations should be noted:

- The analysis incorporates all available data from 7 October 2023 to April 2026, but many underlying datasets have limited temporal coverage. For example, the M84 bomb crater dataset covers only the first two months following 7 October 2023. The analysis would be more robust if equivalent datasets were available consistently across the full study period.
- Rather than presenting a single aggregated map, the spatial distribution of sources could ideally be analysed and displayed over time to capture the evolving contamination landscape.
- The binary presence/absence approach for each sector avoids double counting but does not capture variation in the intensity of contamination within a sector.
- Remote-sensing products used for damage detection are subject to limitations of spatial resolution, temporal sampling and sensitivity to localized or short-duration events.
- Independent field-based verification of contamination remains impossible under current access conditions. Results should be interpreted as indicative rather than definitive.

ANNEX 2. MUNITIONS AND WEAPONS SYSTEMS

This annex outlines the munitions systems deployed in Gaza since October 2023 and their associated contamination profiles.[357, 358, 359, 360] Contaminant properties and health risks are detailed in **Annex 3**. Environmental fate, transport and exposure pathways are detailed in **Annex 4**.

- **Guided aerial bombs (confirmed):** MK-80 series bombs, including the MK-82 (500lb), MK-83 (1,000lb) and MK-84 (2,000lb), have been deployed both in guided form fitted with JDAM kits and as unguided general-purpose bombs, alongside BLU-109 bunker-buster penetrators and GBU-39 precision glide bombs.[361, 362, 363, 364] The composition of explosive fillers varies between munition types and variants. Detonation can deposit a complex mixture of explosive residues including TNT, RDX, HMX and 2,4-DNT.[365, 366] Heavy metals including lead, copper, antimony, tungsten and zinc are associated with military munitions and can be released into the environment through projectile impact, fragmentation and corrosion.[367] The destruction of buildings and fires associated with explosive attacks can additionally release asbestos fibres, crystalline silica and combustion-related contaminants including PAHs, dioxins and furans.[368]
- **Heavy artillery fire (confirmed):** 155mm high-explosive artillery shells have been deployed extensively in and around Gaza.[369, 370] Fragmentation can deposit steel and other metals from the projectile body and components across the surrounding area.[371] Propellant residues can include nitrocellulose, nitroglycerine and other energetic propellant constituents, depending on the propellant formulation.[372, 373] Partial or low-order detonation can leave energetic residues, including TNT and RDX, in surrounding soils.[374]
- **Tank fire (confirmed):** Merkava main battle tanks equipped with 120mm guns have been deployed extensively in Gaza's ground offensive.[375] The environmental contaminants depend on the ammunition type used. Tank-fired munitions can introduce heavy metals and energetic residues through projectile fragmentation and the deposition of munition components, while the combustion associated with firing and impacts can generate fine particulate matter and combustion-related contaminants.[376, 377, 378]
- **Guided missiles and UAV-launched munitions (confirmed):** Precision-guided missiles, Hellfire missiles and loitering munitions have been deployed in targeted strikes across Gaza.[379, 380] Loitering munitions, small autonomous or semi-autonomous aerial platforms that loiter over a target area before striking, represent a distinct subcategory given their extended flight time prior to detonation. Where rocket propulsion systems are used, combustion can generate aluminium oxide particulate and carbon-based combustion products; perchlorate may be associated with the propellant itself and with residues from incomplete combustion or unburned propellant.[381] Explosive residues and heavy metals may also be associated with these munitions, depending on their warhead and other components.[382]
- **Armoured vehicle demolition charges (confirmed):** Decommissioned M113 armoured personnel carriers packed with one to three tonnes of explosives, remotely detonated to demolish structures;[383] reportedly approximately 120 such vehicles were detonated in residential areas of Gaza City over one week in September 2025, averaging more than 17 per

day.[384] These large-scale detonations create potential point sources of explosive residues and vehicle-derived contaminants, including petroleum hydrocarbons, lubricants, hydraulic fluids, battery constituents and metals from vehicle components.[385]

- **Weapons with incendiary effects (confirmed):** The use of white phosphorus in Gaza since October 2023 has been documented, including airburst application over populated areas.[386, 387] These weapons burn at extremely high temperatures on contact with oxygen, igniting buildings and causing deep, slow-healing chemical burns.[388] Elemental phosphorus can persist in oxygen-depleted soils and sediments and may degrade to phosphine under anoxic conditions. Combustion produces phosphorus oxides that can react with moisture to form phosphoric acid, while phosphorus-containing particles can be transported through the atmosphere and deposited onto surrounding soil and water.[389]
- **Rocket artillery (reported):** Ground-launched rockets have been reported in the Gaza conflict, though specific systems are not consistently verified.[390] Explosive residues and heavy metals from rocket components are associated with high-explosive munitions.[391] Propellant systems can generate perchlorate as an environmental contaminant.[392] The wide-area use of unguided rockets can result in residue deposition across a broader area than more precisely targeted systems.[393]
- **Naval bombardment (confirmed):** Naval artillery and missile strikes targeting Gaza's coastal area.[394] Explosive residues, heavy metals and combustion by-products are associated with naval artillery and missile munitions.[395]
- **Thermobaric weapons (reported/unconfirmed):** Possible use has been suggested in the context of tunnel-targeting operations, with some media reports alleging that victims were 'vaporized'; however, these claims remain contested.[396] Thermobaric weapons are designed to produce intense blast and thermal effects, particularly in enclosed or confined spaces.[397] If their use were confirmed, combustion could generate gaseous and particulate by-products, while the fragmentation of weapon components could contribute metals to the surrounding environment.[398]

A note on unexploded ordnance (UXO): A significant proportion of the munitions listed above will have failed to detonate on impact, leaving explosive remnants of war embedded within rubble, soil, damaged infrastructure and agricultural land across Gaza.[399, 400] UXO is not a distinct weapons system but represents the residual contamination legacy of all munition categories listed above. Corroding casings leach energetic compounds including TNT, RDX and perchlorate, and heavy metals into surrounding soils and groundwater over time, with the rate of leaching accelerating as casings corrode and fracture. UXO distribution across agricultural land and debris fields constrains access and delays clearance operations, prolonging contamination exposure for Gaza's civilian population for years, potentially decades, beyond the period of active hostilities.

ANNEX 3. CONTAMINANT PROFILES BY SECTOR

This annex provides detailed contamination profiles for each sector of conflict-related pollution identified across Gaza. These contaminants arise both from the composition of weapons and from their interaction with buildings, infrastructure and industrial materials during detonation and fires. Many are environmentally persistent, mobile across soil and water systems, and toxic to human health even at low concentrations. Each contaminant is evaluated for exposure pathways, health risk, and evidentiary status. The annex complements the sector overview presented in **Table 1** in **Chapter 2**, the munitions profiles in **Annex 2**, and the environmental fate and transport analysis in **Annex 4**.

Evidentiary scale

A four-tier scale has been used to assess the strength of evidence for the presence of specific contaminants in Gaza:

★☆☆☆ **Anecdotal/plausible**: The contaminant is theoretically plausible or weakly indicated, based on limited, unverified or anecdotal information. There is no clear evidence of a relevant release source or activity.

★★☆☆ **Credible indirect evidence:** There is credible evidence of a source or activity known to release the contaminant, but the contaminant itself has not been directly identified or measured.

★★★☆ **Strong inference/near certain:** The contaminant's presence is near-certain based on widespread, repeated or system-level release processes. The link between the documented source and contaminant is well established, and its release would be expected based on the nature of the damaged or disrupted system, even without direct measurement. Gaza-specific concentrations and exposure remain unverified.

★★★★ **Directly confirmed:** The contaminant has been directly identified through sampling, laboratory analysis or authoritative technical reporting.

Table A2: **Priority environmental contaminants, sources, exposure pathways, potential health effects and evidentiary status**

Sector	Contaminant	Exposure pathway	Health risk	Evidentiary status
Military	DNT (dinitrotoluene)	Contaminated water ingestion; dust inhalation; skin contact.	Toxic; possible human carcinogen; liver damage, blood and cardiovascular effects.	★★★☆
	HMX (cyclotetramethylene-tetranitramine)	Contaminated water ingestion; dust inhalation; skin contact.	Toxic; liver and central nervous system effects; limited evidence for cancer risk in humans.	★★★☆

Sector	Contaminant	Exposure pathway	Health risk	Evidentiary status
Military	Ammonium perchlorate	Contaminated water and food ingestion.	Disrupts thyroid function by interfering with iodine uptake; greatest risk to pregnant women, foetuses and infants.	★★★☆
	TNT (2,4,6-trinitrotoluene)	Contaminated water ingestion; dust inhalation.	Liver damage and anaemia from prolonged exposure; possible human carcinogen.	★★★☆
	RDX (cyclotrimethylene-trinitramine)	Contaminated water ingestion; dust inhalation; skin contact.	Neurotoxic; short-term exposure linked to seizures; long-term exposure may cause liver and kidney damage; not classified as a human carcinogen.	★★★☆
	Heavy metals (lead, mercury and cadmium)	Contaminated water and food; dust inhalation; skin contact.	Neurological damage; kidney and liver dysfunction; increased cancer risk; effects vary by metal.	★★★☆
	White phosphorus	Skin contact; inhalation of smoke and combustion products; ingestion of contaminated water or food; contaminated soil contact.	Severe chemical burns; systemic absorption causing liver, kidney and cardiovascular damage; phosphine gas generation in anoxic environments poses longer-term environmental risk.	★★★★
	Depleted uranium (DU)*	Inhalation of resuspended particles; ingestion of contaminated water and food.	Kidney damage from chemical toxicity; potential radiological harm from inhalation of fine DU particles.	★☆☆☆
Residential	Asbestos	Inhalation of airborne fibres during building destruction, debris disturbance or clearance.	Asbestosis; lung cancer; mesothelioma; risks increase with cumulative exposure; diseases emerge decades after initial exposure.	★★★☆
	Crystalline silica	Inhalation of airborne dust during building collapse, debris clearance or wind-driven resuspension.	Confirmed human carcinogen (IARC Group 1); causes silicosis, lung cancer, COPD and kidney disease; silicosis is irreversible.	★★★☆

Sector	Contaminant	Exposure pathway	Health risk	Evidentiary status
Residential	Lead-contaminated construction materials	Ingestion of contaminated dust or soil; inhalation of airborne particles; skin contact.	No safe level of exposure; irreversible neurological damage and cognitive impairment in children; kidney and cardiovascular effects at higher exposures.	★★★☆
	Flame retardants (PBDEs)	Inhalation and ingestion of contaminated dust; skin contact with debris; ingestion through food.	Endocrine disruption affecting thyroid; neurodevelopmental effects in children; reproductive harm; persistent and bioaccumulative.	★★☆☆
Fuel	Petroleum hydrocarbons (diesel, petrol and fuel oil)	Ingestion of contaminated water or food; inhalation of vapour; skin contact with contaminated soil or liquids.	Acute toxicity; long-term liver, kidney and nervous system damage; benzene is a confirmed human carcinogen.	★★★☆
	BTEX compounds (benzene, toluene, ethylbenzene and xylene)	Inhalation of vapours; ingestion of contaminated water; skin contact.	Benzene is a confirmed human carcinogen (IARC Group 1) linked to leukaemia; other BTEX compounds cause neurological effects and long-term organ toxicity.	★★☆☆
	Polycyclic aromatic hydrocarbons (PAHs)	Inhalation of smoke and dust; ingestion of contaminated food or water; skin contact with soot or polluted soil.	Benzo[a]pyrene is a confirmed human carcinogen; several other PAHs are probable or possible carcinogens; respiratory, cardiovascular and immune system harm.	★★★☆
Energy	Polychlorinated biphenyls (PCBs)	Ingestion of contaminated food or water; skin contact with contaminated soil or oils; inhalation of dust or vapours.	Confirmed human carcinogens linked to melanoma and non-Hodgkin lymphoma; immune suppression; endocrine disruption; developmental effects; persistent and bioaccumulative.	★★★☆
	Transformer oils	Skin contact with contaminated soil or liquids; ingestion of contaminated water; inhalation of vapours.	Skin irritation and systemic toxicity; persistent soil and groundwater contamination; formulations containing PCBs carry additional carcinogenic and endocrine-disrupting risks.	★★★☆

Sector	Contaminant	Exposure pathway	Health risk	Evidentiary status
Energy	Battery chemicals (lead-acid electrolytes and lithium compounds)	Skin contact with leaked liquids; ingestion of contaminated water or soil; inhalation of fumes from damaged or burning batteries.	Lead causes irreversible neurological damage, especially in children; sulphuric acid causes chemical burns; damaged lithium batteries release toxic gases causing respiratory and systemic toxicity.	★★☆☆
Wastewater	Pathogens (bacteria, viruses and parasites)	Ingestion of contaminated water or food; direct contact with polluted water; poor hygiene conditions.	Wide range of infectious diseases including diarrheal illness, cholera, hepatitis and parasitic infections; most acute and large-scale public health risk, particularly to children and the elderly.	★★★★
	Antimicrobial-resistant (AMR) bacteria	Ingestion of contaminated water or food; direct contact with polluted water; person-to-person transmission.	Infections caused by AMR bacteria are harder to treat, resulting in prolonged illness and higher mortality; risk significantly elevated in conflict settings.	★★★★
	Nutrients (nitrogen and phosphorus compounds)	Ingestion of contaminated drinking water and food; indirect exposure through degraded water quality.	Elevated nitrate levels can cause methemoglobinemia in infants, a potentially fatal condition that reduces the blood's ability to carry oxygen.	★★★☆
	Microplastics	Ingestion of contaminated drinking water; food; inhalation of airborne particles.	Evidence still emerging; associated in laboratory and animal studies with inflammation and oxidative stress; can carry toxic additives and other pollutants.	★★☆☆
	Chlorination by-products (trihalomethanes and haloacetic acids)	Ingestion of treated drinking water; inhalation of volatile compounds during water use; skin contact.	Long-term exposure associated with increased risk of bladder and colorectal cancer and adverse reproductive outcomes.	★★☆☆
	Pharmaceutical residues	Ingestion of contaminated water or food; indirect exposure through contaminated water systems.	Direct risks at environmental concentrations not fully established; antibiotic residues contribute to antimicrobial resistance; hormone-based compounds disrupt endocrine systems.	★★☆☆

Sector	Contaminant	Exposure pathway	Health risk	Evidentiary status
Agrochemical	Ammonium nitrate	Ingestion of contaminated water; inhalation of dust or aerosols; skin contact.	Respiratory and skin irritation; high concentrations in water contribute to nitrate poisoning including methemoglobinemia in infants.	★★☆☆
	Organophosphate pesticides	Ingestion of contaminated food or water; inhalation of aerosols or dust; skin contact.	Highly toxic; inhibits acetylcholinesterase causing acute respiratory failure, seizures and death; chronic exposure causes lasting neurological damage.	★★☆☆
	Pyrethroids	Ingestion of contaminated food or water; inhalation of aerosols or dust; skin contact.	Less acutely toxic than organophosphates; higher exposures cause neurological symptoms and potential endocrine disruption; highly toxic to aquatic organisms.	★★☆☆
Agriculture and livestock	Livestock waste	Direct contact with contaminated soil or water; ingestion via contaminated food or water; inhalation of gases from decomposing organic matter.	Pathogen transmission; nutrient pollution and water quality degradation; decomposing animal matter releases ammonia and other gases posing respiratory risks.	★★★☆
	Microplastics	Ingestion via contaminated food and water; inhalation of airborne particles; skin contact with contaminated soils.	Evidence still emerging; microplastics carry toxic additives and adsorbed pollutants with potential for inflammation, oxidative stress and indirect chemical exposure.	★★☆☆
	Food production wastes	Indirect exposure via contaminated water, soil and food systems.	Primarily indirect risk; decomposing organic matter depletes oxygen in water bodies, attracts disease vectors and creates conditions for secondary pathogen and chemical contamination.	★★★☆

Sector	Contaminant	Exposure pathway	Health risk	Evidentiary status
Medical	Medical waste	Direct contact with contaminated materials; injury from sharps; indirect exposure through environmental contamination of soil and water.	Infection risk, injury and disease transmission including exposure to bloodborne pathogens; improper disposal in conflict settings significantly elevates community-level infection risk.	★★★★
	Pharmaceutical residues	Ingestion of contaminated water or food; indirect exposure through contaminated water systems.	Direct risks at environmental concentrations not fully established; antibiotic residues contribute to antimicrobial resistance; hormone-based compounds disrupt endocrine systems in aquatic environments.	★★☆☆
	Disinfectants and sterilization chemicals (chlorine compounds, alcohols and aldehydes)	Skin contact with contaminated surfaces or liquids; inhalation of vapours; ingestion via contaminated water.	Skin and respiratory irritation and chemical burns at high concentrations; toxic to aquatic organisms; environmental persistence generally low.	★★☆☆
Commercial	Cold-chain refrigerants (hydrofluorocarbons and ammonia)	Inhalation of released gases, particularly in confined or poorly ventilated spaces.	Most refrigerants have low toxicity at typical exposure levels but can cause respiratory irritation, dizziness or asphyxiation at high concentrations; ammonia is more acutely toxic and corrosive to the respiratory tract and eyes.	★★☆☆
	Contaminated stored goods	Indirect exposure through contaminated water and soil; accumulation of decomposing organic matter.	Primarily indirect public health risk through pest proliferation and pathogen spread; compounds existing sanitation pressures and disease burden.	★★★☆
Industrial	Volatile organic compounds (VOCs) and industrial solvents	Inhalation of vapours and contaminated dust; skin contact with contaminated materials; ingestion of contaminated water.	Formaldehyde is a confirmed human carcinogen (IARC Group 1); styrene a probable carcinogen (Group 2A); others cause respiratory irritation, neurological effects, and liver and kidney damage.	★★★☆

Sector	Contaminant	Exposure pathway	Health risk	Evidentiary status
Industrial	Acids and alkalis (corrosive industrial chemicals)	Skin contact with contaminated liquids or surfaces; inhalation of corrosive vapours or aerosols; ingestion of contaminated water.	Chemical burns, respiratory irritation and eye damage at point of contact; spills can contaminate soil and water though these chemicals generally neutralize or degrade relatively quickly.	★★☆☆
	Heavy metals (lead, chromium, nickel and cadmium)	Ingestion of contaminated water and food; dust inhalation; skin contact.	Neurological damage; kidney and liver dysfunction; respiratory disease; increased cancer risk; they persist in the environment and accumulate in body tissue over time.	★★★☆
	Dye and printing chemicals	Skin contact with contaminated materials; inhalation of vapours or dust; ingestion of contaminated water.	Some aromatic amine-based dyes associated with increased bladder cancer risk; others cause skin and respiratory irritation.	★★☆☆
Solid waste	Plastic waste combustion products (chlorinated compounds, dioxins, furans and PAHs)	Inhalation of smoke and fine particulates; ingestion of contaminated dust or food; skin contact with soot-contaminated debris or soil.	Dioxins and furans are highly persistent, accumulate in body tissue and are associated with cancer and endocrine, immune, reproductive and developmental effects; PAHs include confirmed and probable carcinogens and cause respiratory and cardiovascular harm.	★★★☆
	Leachate	Ingestion of contaminated groundwater or surface water; skin contact with polluted water or soils; indirect exposure through contaminated food.	Health effects depend on composition but include exposure to toxic chemicals, pathogens and heavy metals; poses risks of both acute illness and long-term groundwater contamination.	★★★★
	PFAS (per- and polyfluoroalkyl substances)	Ingestion of contaminated water or food; inhalation of contaminated dust; skin contact with polluted soils or materials.	Accumulate in body tissue and do not break down in the environment; associated with immune suppression, endocrine disruption, liver damage, developmental effects and increased risk of certain cancers.	★★★☆

Sector	Contaminant	Exposure pathway	Health risk	Evidentiary status
Solid waste	Electronic waste (e-waste)	Inhalation of contaminated dust or fumes; ingestion of contaminated soil or water; skin contact with damaged components or residues.	Releases heavy metals, flame retardants and other toxic compounds associated with neurological, respiratory, endocrine and developmental harm.	★★★★
	Airborne biological particles	Inhalation of contaminated airborne particles and dust, particularly near waste accumulation sites or disturbed debris.	Respiratory irritation, allergic reactions and asthma exacerbation; prolonged exposure in damp, unsanitary conditions increases risk of opportunistic infections, particularly in immunocompromised individuals.	★★★☆

* Recent independent and government studies in Lebanon have found no evidence of DU use following Israeli attacks, and its use in Gaza is not expected on the basis of the weapons employed. It is included here for completeness given the evidentiary uncertainty.

ANNEX 4. ENVIRONMENTAL FATE AND THE TRANSPORT OF CONTAMINANTS

Once released, contaminants do not remain at their point of origin. They are mobilized through environmental processes that determine how they disperse and transform, and where exposure ultimately occurs. This annex examines how conflict-related contaminants move through environmental media and how they reach Gaza's civilian population. It complements the contamination profiles in **Annex 3** and supports the analysis in Chapters 3 to 7.

Exposure pathways

Conflict-related contamination can reach populations and ecosystems through four primary environmental exposure pathways. These pathways do not operate independently; contaminants are transferred across environmental media, linking air, soil, water and biological systems. This environmental movement determines how contaminants reach people and ecosystems, while exposure occurs through different routes depending on the contaminant and environmental medium. As a result, populations and ecosystems are exposed through multiple routes simultaneously, resulting in cumulative exposure that underpins both immediate and long-term impacts across health, food systems, water security and environmental recovery.

- **Airborne transport and inhalation of contaminated air:** Explosive weapons generate large quantities of fine particulate matter (PM2.5 and PM10) composed of dust, combustion residues and microscopic fragments of metals.[401] These particles often carry toxic substances, including heavy metals, dioxins and polycyclic aromatic hydrocarbons (PAHs). Once airborne, they can travel considerable distances before being deposited onto soil and water bodies. The destruction of buildings releases asbestos fibres and crystalline silica that remain airborne long after the original event, and are resuspended repeatedly by wind, vehicle movement and ongoing disturbance.[402] Once inhaled, fine particles penetrate the lungs and can enter the bloodstream, distributing toxic substances through the body.[403, 404]
- **Soil and food system transfer:** Following detonation and infrastructure destruction, heavier particles and metal residues settle onto soil and surfaces, where they persist, accumulate and are redistributed through environmental processes. Contaminants are subsequently taken up by crops, accumulated in livestock and transferred through irrigation with contaminated water, entering the food chain and exposing populations through the consumption of contaminated food. These processes also facilitate the longer-term redistribution of contaminants across agricultural landscapes.[405] Exposure also occurs through ingestion of contaminated dust, which is particularly common among children due to their hand-to-mouth behaviour.
- **Waterborne transport and ingestion of contaminated water**: Substances such as perchlorate and heavy metals are deposited onto soils and urban surfaces and leach into the aquifer through infiltration.[406, 407] Bomb craters may act as preferential flow pathways accelerating the downward migration of contaminants into groundwater systems.[408, 409] The collapse

of wastewater infrastructure introduces untreated sewage, pathogens, nitrates and antimicrobial-resistant bacteria directly into groundwater and surface water systems.[410]

- **Direct contact with contaminated soils, dust and debris:** Following bombardment and the destruction of buildings and infrastructure, civilians are routinely exposed through direct contact with contaminated soils, dust and debris.[411] Dermal contact occurs during daily activities, including walking through damaged areas, sheltering within partially destroyed buildings, debris clearance, waste collection and children's play. Fine contaminated dust adheres to skin, clothing and household surfaces, and is readily transferred through hand-to-mouth behaviour, particularly among young children. Repeated contact with contaminated debris also increases opportunities for inhalation and incidental ingestion, making direct contact an important pathway for exposure to heavy metals, asbestos fibres, crystalline silica and explosive residues.

Environmental fate and transport

Table A3 maps the primary contaminant groups to their sources and principal environmental transport pathways. Contaminant behaviour is governed by physical and chemical properties including solubility, volatility, particle size and affinity for soil organic matter and clay minerals, which determine how far and how fast contaminants travel from their point of release.[412, 413]

Table A3: **Environmental fate and transport pathways of conflict-related contaminants**

Contaminant/group	Associated munitions/sources	Primary environmental pathways
Perchlorate (ClO_4^-)	Rocket propellants, guided missiles and explosive formulations.	High water solubility → rapid dissolution → leaching into groundwater → contamination of drinking water sources; highly mobile and persistent.[414]
Uranium and isotopic ratios (U-238/U-235)[415]	Penetrator munitions and military residues.	Deposition in soil → resuspension as dust → potential groundwater migration; isotopic analysis allows forensic differentiation between natural background and anthropogenic sources.
Heavy metals (Pb, Sb, Cu, W, Zn)	Aerial bombs, artillery shells, tank rounds, missile components and vehicle demolition charges.	Fragmentation → deposition in soil → accumulation in sediments → uptake by crops → inhalation of contaminated dust; hotspot concentrations of antimony reported in the cited Lebanon study at up to 500 times historical background levels in some locations.[416]
Explosive residues (TNT, 2,4-DNT, RDX, HMX)	High-explosive bombs, artillery shells, missile warheads and UXO.	Residual deposition after detonation → infiltration into soil → leaching into groundwater → persistence in debris; aqueous solubility varies widely due to use of binders and stabilizing products in explosive manufacture; transformation products from sunlight, chemical reduction, and biological degradation can be more toxic than original compounds.[417]
PAHs (polycyclic aromatic hydrocarbons)	High-temperature explosions, fires from airstrikes, fuel combustion, urban burning and waste burning.	Formation during incomplete combustion → adsorption onto airborne particles → atmospheric transport → deposition onto soil and water surfaces; black carbon acts as a carrier phase extending atmospheric lifetime.[418]

Contaminant/group	Associated munitions/sources	Primary environmental pathways
PCDD/F (dioxins and furans)	Burning of buildings, plastics, fuels; large-scale fires; weapons with incendiary effects including white phosphorus.	Airborne transport → adsorption onto fine particulate matter → deposition into soils and sediments → long-term persistence and bioaccumulation in food chains; highly resistant to degradation.[419]
PCBs	Combustion of older electrical equipment, transformers and building materials.	Release during destruction of energy infrastructure → binding to dust and soil particles → environmental transport and deposition; persistent and bioaccumulative.[420]
Asbestos fibres	Destruction of buildings across all munition types.	Structural collapse → airborne fibre release → inhalation exposure → deposition in soil and indoor environments; fibres are bio-persistent and do not degrade.[421]
Petroleum hydrocarbons	Damaged fuel storage, petrol stations, vehicles, generators and vehicle demolition charges.	Spills → infiltration into soil → migration toward groundwater; volatile fractions evaporate, contributing to air pollution; aromatic compounds including BTEX are most mobile in groundwater.[422]
Pathogens and AMR bacteria	Collapsed wastewater systems, open sewage discharge and medical waste.	Direct environmental release → surface water contamination → groundwater infiltration through porous soils → person-to-person transmission in overcrowded conditions; accelerated AMR development in contaminated environments.[423]
Nitrates and phosphates	Wastewater discharge, agrochemical release and livestock waste.	Dissolution in water → rapid migration into groundwater → accumulation in the shallow Coastal Aquifer; elevated concentrations documented in Gaza's Coastal Aquifer prior to conflict.[424]
Pesticides and agrochemicals	Damaged agrochemical storage, destroyed greenhouses and farmland.	Release into soil → variable mobility depending on compound; organophosphates degrade relatively quickly; persistent compounds migrate into groundwater and accumulate in soils and sediments.
Mixed debris contaminants (metals, POPs and particulates)	Urban destruction from repeated bombardment across all munition types.	Dust generation → inhalation exposure → redistribution via wind → runoff into water systems; repeatedly resuspended by vehicle movement, salvage activities and ongoing disturbance.[425]

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