




The implications of the ongoing war on Gaza for food sustainability

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ABSTRACT

The Gaza Strip, a small and densely populated region in the Middle East, has endured escalating violence since Israel's occupation began in June 1967. The ongoing war has had devastating consequences, severely affecting socioeconomic and environmental aspects, particularly food systems. This work investigates the impact of the ongoing war on food security and food-related sustainable development goals (SDGs) from local, regional, and global perspectives. This review employed a qualitative research approach, specifically a comprehensive analysis of grey literature and official reports, complemented by a thematic synthesis of findings from peer-reviewed articles, to ensure a robust and multi-faceted examination of the topic. The findings reveal that the war and the prolonged blockade have caused acute food insecurity and malnutrition in Gaza due to widespread destruction of infrastructure, including food factories and bakeries, and restrictions on essential supplies like water, fuel, and medical resources. The review highlights the severe food poverty and hunger faced by Gazans while noting the setback to food sustainability and related SDGs. It also underscores the potential for broader regional or global crises, including disruptions to international trade and a worsening food crisis. Key recommendations call for urgent international collaboration to address food poverty, escalating hunger, and the growing risk of famine in Gaza. Efforts must focus on ending the war, restoring access to essential supplies, and implementing sustainable solutions to mitigate the humanitarian crisis. These actions are also critical to addressing broader regional and global implications, including threats to food security and trade stability.

1. Introduction

In 2015, the United Nations (UN) urgently called for action by adopting 17 Sustainable Development Goals (SDGs) to end poverty and hunger, fight against inequalities and injustices, protect the planet, and achieve peace and prosperity by 2030. The SDGs aim to balance the three dimensions of sustainable development: economic, social, and environmental. As the agriculture and food sectors are interconnected with almost all aspects of the economy, environment, and society, food is directly or indirectly related to many SDGs. In this context, “the wedding cake” model was theorized by Rockström and Sukhdev in 2016, to show how SDGs can be achieved regarding the three sustainability

dimensions, through actions connected to food [1–3]. This representation shows that the economic SDGs (i.e., 8, 9, 10, and 12) are embedded in the social SDGs (i.e., 1, 2, 3, 4, 5, 7, 11, and 16), which in turn are embedded in the environmental SDGs (i.e., 6, 13, 14, and 15). The effective implementation of all SDGs in the food sector requires strengthening global partnerships and close collaboration (SDG17) between all national and international actors in the food system.

Although only 6 years are left to achieve these UN SDGs, growing evidence indicates that reaching these goals seems difficult in the current scenario, characterized by both unprecedented natural and human-made extraordinary challenges. Indeed, besides climate changes, recent dramatic events including COVID-19, the Russian-Ukrainian war, and

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the 2023 Turkey–Syria earthquake have had significant impacts and consequences and compromised the world capability to achieve the SDGs [4–9]. Especially armed conflicts, such as the ongoing one in Gaza, have profound negative impacts on food security and food sustainability [10–12].

The Gaza Strip, a small and densely populated region in the Middle East, has faced a series of challenges resulting from decades of conflict, political instability, and economic blockade. With over two million inhabitants living in an area of just 365 square kilometers, Gaza represents one of the most vulnerable regions in terms of food security and sustainable development [13,14]. The protracted blockade, combined with repeated escalations of violence, has severely disrupted agricultural production, destroyed critical infrastructure, and limited access to essential resources such as water, fuel, and food. These conditions have contributed to one of the highest levels of food insecurity globally, with the population reliant on external aid for survival [12,15,16].

Despite its unique context, the specific implications of the ongoing war in Gaza for food sustainability remain underexplored in academic literature. Understanding the interplay between conflict and food-related SDGs in Gaza is essential to address urgent humanitarian needs and to develop long-term strategies for achieving sustainable food systems under conditions of prolonged instability. While numerous recent publications have examined the impact of COVID-19 [7,17–19], 2023 Turkey–Syria Earthquake and other natural disasters [8,20], Russian–Ukrainian war [5,21–24], and other crisis and conflicts [25–28] on food resilience and security, food sustainability, and food supply chain, until now, there remains a significant gap in the literature regarding the implications of the ongoing war on Gaza for food security and food-related SDGs.

Therefore, this review aims to fill this gap by investigating the impact of the conflict in Gaza on key SDGs, particularly those related to food sustainability, food security, and resilience. The study will focus on how the war has disrupted food supply chains, exacerbated food insecurity, and affected local agricultural systems, with a broader lens on its long-term implications for achieving sustainable food systems in the region. By addressing these critical issues, this work will provide valuable insights into the intersection of conflict and food sustainability, highlighting the urgent need for international cooperation and sustainable interventions to mitigate the ongoing crisis.

2. Materials and methods

Given that the war on Gaza is still ongoing and most data on the current topic has not yet been published or disseminated through peer-reviewed sources, this review follows a narrative and descriptive approach, with a focus on thematic synthesis to extract and analyze relevant information.

2.1. Search strategy and source selection

Our search plan was designed based on the best practices for conducting grey literature reviews, as recommended by Paez (2017) [29]. It included customized Google searches, targeted websites, and technical and working papers produced by reputable regional and international organizations, such as Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO), United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA), United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), the World Federation of Public Health Associations (WFPHA), United Nations Economic and Social Commission for Western Asia (ESCWA), United Nations Conference on Trade and Development (UNCTAD), United Nations Educational, Scientific and Cultural Organization (UNESCO), UN High Level Panel of Experts on Food Security and Nutrition (HLPE-FSN), United Nations International Children's Emergency Fund (UNICEF), World Food Programme (WFP), and United Nations Development Programme (UNDP).

To ensure source credibility, we prioritized documents from these reputable organizations and peer-reviewed articles. Each source was carefully screened based on relevance, reliability, and alignment with the objectives of this review. Contradictory reports and perspectives were included to provide a balanced analysis and mitigate potential biases.

The grey literature search was supplemented with peer-reviewed articles extracted from databases such as Scopus, PubMed, Google Scholar, and Web of Science. Search terms included “food sustainability”, “sustainable development goals”, “food security”, “famine”, “hunger”, “malnutrition” and “war on Gaza” or “Gaza conflict”. These terms were chosen to capture a broad and diverse range of literature relevant to the topics investigated. Publications from November 2023 to October 2024 were included to ensure the review remains current and up-to-date.

2.2. Thematic analysis and variables

We utilized a thematic synthesis approach to process and analyze the identified literature. Key themes, such as the intersection of food sustainability and SDGs during the first year of the war, were extracted, categorized, and critically analyzed. Variables analyzed included food security indicators, humanitarian challenges, and the impact of war on achieving SDGs. This approach enabled a structured synthesis of findings, facilitating a clear narrative aligned with the objectives of this manuscript.

2.3. Inclusion and exclusion criteria

Inclusion and exclusion criteria were applied to ensure the methodological rigor of the review. Publications were included if they focused on food sustainability or SDGs within the context of the war in Gaza, were published or disseminated between November 2023 and September 2024, and originated from credible sources or underwent peer review. Publications were excluded if they lacked relevance to the research themes, provided outdated or redundant information outside the specified timeframe, did not meet reliability standards (e.g., unverified claims or unsupported data), or were published in languages other than English.

2.4. Validation of grey literature

To address concerns regarding the reliability of grey literature, cross-referencing was conducted between multiple sources to verify the consistency of reported data and findings. Peer-reviewed studies were used to corroborate key insights from grey literature whenever possible. This approach ensured methodological transparency and enhanced the credibility of the results.

3. Results and discussions

In this section, we begin with a general historical overview of the Palestinian–Israeli conflict. Following this, we describe the implications of Israeli aggressions for food security and sustainability in Gaza prior to the ongoing war. In the following section, the impact of the current war on Gaza on food sustainability will be identified and explained from social, environmental, and economic perspectives. Finally, we will show how a potential wider escalation of this war in the region could impact international trade and provoke a major food crisis.

3.1. A short historical overview of the Palestinian–Israeli conflict

The Palestinian–Israeli conflict dates to the early 20th century, notably the Balfour Declaration of 1917, which laid the groundwork for the establishment of a Jewish homeland in Palestine. On November 29th, 1947, the UN General Assembly adopted the United Nations

partition plan for Palestine as Resolution 181, which recommended the creation of an independent Arab state with a territory of 42%, a Jewish state with a territory of 56%, and a 2% international zone (Jerusalem, Bethlehem, and the adjoining area). Since the announcement of Israel as a state in 1948, Palestinians have faced challenges, including displacement, human rights violations, environmental destruction, and structural violence [30–32].

Above that, this strategy has been accompanied by increased land acquisition and settlement expansion by Israelis [30,33–35]. This colonial strategy has started since the first Arab-Israeli war in 1948–1949. After the 1956 war (the second war), Israel expanded its territorial control in 1967 during the third war, occupying the entire territory of Palestine, including the West Bank, East Jerusalem, and the Gaza Strip. Although the United Nations have repeatedly announced that Israeli occupation is the source of profound human rights violations against the Palestinian people [36], Israel has declared tens of thousands of hectares of Palestinian land for Israeli settlements, leading to the extension of Israel and the disappearance of Palestine (Fig. 1).

In 2005, Israel withdrew from the Gaza Strip, dismantling settlements and relocating Israeli citizens, which created a power vacuum that contributed to the rise of Hamas in the region. Illegal settlements in occupied Palestine have continued to expand despite clear international condemnation, including UN Security Council Resolution 2334. Since 2007, Gaza has been suffering from a deadly siege, imposed by the Israeli occupation; the air space and sea of Gaza have been totally controlled. Nothing could go inside or outside of Gaza without the occupier's permission.

In Gaza, the economic sanctions imposed by Israel through the blockade have severely hampered its economic development. This has led to widespread poverty, unemployment, especially among youth, and a general increase in misery [32,37]. Regarding the consequences on the food sector, in addition to food poverty and food insecurity, the occupation has led to widespread malnutrition and various food-related health problems [38–40].

On October 7, 2023, Hamas and other resistance forces in Gaza led a simultaneous wave of assaults on Israeli communities and military posts in the settlements surrounding Gaza. Israel has responded by cutting off access to food, electricity, and fuel for the more than 2.3 million residents of the Gaza Strip, launching thousands of airstrikes and ground assaults, and killing thousands of people, most of them children and women. The widespread bombing across Gaza, including the southern

areas designated by Israel as safe zones, has devastated hospitals, schools, churches, mosques, and refugee camps. This relentless destruction has disrupted vital supply chains and infrastructure, exacerbating food insecurity and pushing the region to the brink of famine [41–47].

3.2. Food security and sustainability in Gaza before the ongoing war

Following the events in Gaza after the October 7 attacks by Hamas, United Nations Secretary-General Antonio Guterres highlighted the prolonged occupation and the hardships faced by Palestinians since 1948. The history of the region shows that 70% of residents in Gaza are descendants of families displaced from their homes during the 1948 Nakba. Many years ago, the United Nations warned that Gaza would become uninhabitable by 2020 due to the prolonged siege [48], a warning ignored as Israel continued its sanctions and military assaults. In her 2016 book, Sara Roy highlighted how economic pressures were driving de-development, rendering Gaza functionally unviable [35]. Consequently, any Palestinian actions are deeply tied to this long history of occupation, shaping their struggle for basic rights under dire conditions.

The roots of food insecurity in Gaza trace back to the Nakba, when over 250,000 Palestinian refugees were displaced to the small enclave [49]. This sudden overpopulation triggered a severe economic crisis due to limited resources. A famine was averted through the establishment of UNRWA, created to address the "temporary" refugee crisis. Since 1951, UNRWA has provided emergency food aid and created jobs in sectors like health and education. Before the current war, over 75% of Gazans, many living in extreme poverty, still depend on UN food assistance [50].

Food insecurity in Gaza has fluctuated over the years but worsened significantly in 2007 with the Israeli siege. The blockade severely damaged economy in Gaza, which had already been dependent on Israel. The closure of crossings, restrictions on imports and exports, and limited access to essential utilities like water, electricity, and fuel, combined with recurrent assaults, led to widespread unemployment, poverty, and the closure of businesses. As of August 2023, 1.84 million Palestinians face food insecurity, with 1.1 million severely affected, the majority living in Gaza [50,51].

A document from the Israeli Defense Ministry revealed plans to limit Gaza's food supply during the blockade, reportedly using calorie counts to pressure and weaken Hamas [52]. Between 2007 and 2010, certain

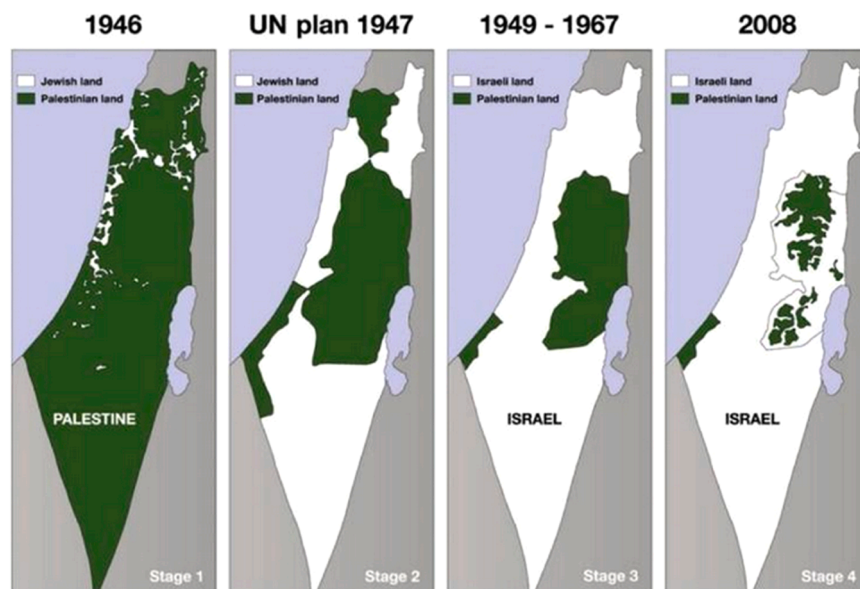


Fig. 1. Disappearing Palestine vs extending Israel.

foods like frozen salmon were permitted, while items such as coriander and instant coffee were banned—restrictions difficult to justify as measures against Hamas. During this period, the average monthly truckloads entering Gaza dropped from over 11,000 before 2007 to just 2236 in 2008 [53]. Exports were virtually halted, with only three truckloads leaving Gaza in 2008 compared to 961 before the siege. These measures, combined with economic sanctions, left over one million Palestinians food insecure and severely weakened household resilience [54].

The targeting of entrepreneurial infrastructure in Gaza by Israel has worsened the struggles of the population, compounded by shortages of essential utilities and raw materials. During the 2014 offensive, over 500 factories and workshops were destroyed or damaged [35], including key food producers like Al-Awda, Badr, and Al-Wadiya. The Al-Awda factory, established in 1977 and once employing 450 people, was burned down, reducing its production capacity to less than 25%. Reconstruction remains nearly impossible due to restrictions on construction materials. These actions highlight the systematic targeting of the food production system of Gaza, increasing its dependency on Israel.

The devastation of the food system in Gaza includes the forced reduction of the fishing zone. Under the Oslo Accords, fishing was allowed up to 20 nautical miles off the coast of Gaza, but the siege imposed by Israel reduced this to three miles, severely limiting the ability of fishers to secure sufficient catches [55]. Even within this restricted zone, fishers face naval aggression, including shootings, detentions, and confiscation of boats. By 2019, the number of fishers had plummeted from 10,000 in 2000 to 3617, causing widespread unemployment and depriving the people of Gaza of a vital source of nutrition [56].

Water pollution is a major factor contributing to food insecurity in Gaza, with 97% of the water in the aquifer unsuitable for human use. Since the 1967 occupation, Israel has maintained control over water supplies in Gaza, imposing restrictions on Palestinian access, particularly for water-intensive agriculture such as citriculture. Until 2005, settlers in Gaza were allocated significantly larger water supplies compared to Palestinians, which severely affected agricultural productivity. Palestinians were required to obtain permits from the occupation authorities to dig or construct wells. By the time Israel withdrew, the water aquifer in Gaza was already depleted and contaminated with seawater and sewage. Today, water scarcity remains a critical challenge

for development in Gaza [56–58].

3.3. Implications of the ongoing war on Gaza for food sustainability

Food sustainability and food-related SDGs are essential in addressing global challenges such as poverty, malnutrition, and environmental degradation. The UN set 17 SDGs in 2015 to be achieved by 2030 [59, 60]. Sustainability and food security are interconnected, as social and economic sustainability is crucial for ensuring access to and proper use of food, while achieving food security plays a key role in supporting sustainable food systems [27,61,62]. Therefore, to achieve SDGs in the context of food, it is essential to consider various aspects, such as food security, sustainable agriculture, nutrition, and environmental conservation, which provide a roadmap for addressing key challenges such as poverty, hunger, and disease [1,63,64]. These goals aim to integrate sustainability into various aspects of development, including economic, social, and environmental dimensions, to ensure a better and more sustainable future for all stakeholders [65].

The following section offers a general overview of the SDGs from social, environmental, and economic perspectives, emphasizing the central role of SDG 2 within these three dimensions (Fig. 2). Socially, food security is essential for community stability and well-being. Environmentally, sustainable agricultural practices are crucial for maintaining ecosystems. Economically, a robust food system supports livelihoods and economic growth. The war on Gaza exacerbates food insecurity, disrupts agricultural production, and undermines the economic stability of the region, thus threatening the achievement of SDG 2 and the broader SDGs.

3.3.1. Social food-related SDGs

The ongoing war on Gaza has significant negative impacts on all SDGs related to the social dimension (Fig. 3) of food sustainability, including SDGs 1–5, 7, 11, and 16.

SDG 1 (no poverty) is a fundamental component of this 2030 agenda, and it aims to end poverty in all its forms. SDG 1 has been identified as one of the top three most important SDGs, reflecting the significance of poverty eradication in the sustainable development agenda [66]. Before the ongoing war, poverty levels in Gaza were already severe, affecting nearly two-thirds of the population. This war has drastically worsened the situation, leaving almost 100% of the population in poverty [13,67].



Fig. 2. Food-related sustainable development goals.



Fig. 3. Implication of the ongoing war on Gaza for the social dimension of sustainability.

The relationship between SDG 1 and food security is crucial, as increased poverty limits access to food, leading to higher rates of food insecurity and malnutrition [68].

The continuous bombing and shelling have led to mass destruction of homes and infrastructure, displacing over 1.9 million people, which is approximately 90% of the population in Gaza [69]. This has decreased resilience and increased vulnerability to shocks and disasters. According to recent reports, food insecurity (SDG 2) has risen sharply, with the whole territory classified in IPC Phase 4 (emergency), while nearly half of the households in Gaza were food insecure before the current war. Many households, especially poor families, are struggling to afford basic necessities such as food, water, and medicines [13,15,32,70–72].

Various UN organizations warn that Gaza is actually in famine, not just at risk of famine, due to the unprecedented hunger crisis. The long-standing blockade has severely affected agricultural production and the livelihoods of small-scale food producers [73–75]. Malnutrition rates have soared, with acute malnutrition among children under five reaching alarming levels since the conflict began. Notably, 15.6% of children under two now suffer from acute malnutrition, exceeding the critical threshold established by the WHO [76,77]. In a recent perspective, [78] highlighted the tragic killing of seven international humanitarian staff from the World Central Kitchen (WCK) in Gaza on April 1, 2024. This incident underscores the humanitarian catastrophe unfolding in Gaza, drawing attention to the dangers faced by aid workers and the immense suffering of the civilian population. Philippe Lazzarini, UNRWA Commissioner-General said “*Every little girl and boy I met in an UNRWA shelter in Gaza asked me for bread and water*” [79]. These developments severely undermine efforts to eradicate poverty and hunger in Gaza, pushing SDG 1 and SDG 2 further out of reach.

SDG 3 (Good health and well-being) is a fundamental human right and a key indicator of sustainable development. It encompasses the

implementation of healthcare systems, the improvement of health conditions, and the promotion of well-being. The achievement of SDG 3 is crucial as it has far-reaching impacts on education, economic activities, poverty reduction, and gender equality [80,81]. That is why the SDG 3 was chosen as one of the top three most important SDGs [66]. The connection of SDG 3 with food sustainability is evident since access to healthy food and nutrition is a crucial prerequisite for achievement of good health and well-being.

However, the embargo on fuel for the Gaza Strip imposed by the occupation has led to power blackout in hospitals and critical facilities, causing unprecedented scale of death, carnage, and suffering. Moreover, Israel's bombing of Gaza has devastated the healthcare system, with the destruction of key facilities like al-Shifa hospital and other medical centers. This has resulted in the deaths of numerous Palestinians, including patients and health workers, who were caught in the bombings inside hospitals and other healthcare settings [44,82–84]. Moreover, the large-scale displacement of people and patients in the besieged Strip has significantly increased the risk of a surge in infectious diseases. The overcrowding, combined with strained healthcare systems, creates a fertile environment for the spread of communicable and non-communicable diseases [85–89]. Even before the current war, it was shown that malnutrition in Gaza was a significant concern, with 68.9% of children not consuming a minimally diverse diet daily, high levels of food insecurity across households, and notable prevalence of stunting (2.5%), wasting (4.4%), and anaemia (29.8%) among children [15]. A recent study conducted amid the ongoing hostilities to assess the prevalence of hepatitis A and awareness levels among displaced populations revealed that over 32% of the 384 respondents reported contracting the virus during this period [90].

SDG 4 specifically focuses on education and aims to ensure inclusive and equitable high-quality education, promoting lifelong learning

opportunities for all. SDG 4 is considered one of the top three most important SDGs. The impact of SDG 4 on food security can be observed through various interconnected factors, including among others, nutrition education programs to educate food engineers and technologists, food producers, and other professionals to become more sustainable [66, 91].

The ongoing war on Gaza has been catastrophic for schools, universities, and other educational institutions due to the destruction of most educational infrastructure. Before this war, Palestinians, including those in Gaza, were among the most literate populations globally, with literacy rates reaching an impressive 98%. However, Gazan students have now been deprived of education for more than a year, with many of them and their teachers losing their lives to relentless bombardments from air, land, and sea. Additionally, Israeli forces have systematically targeted qualified educators, leading scholars, and scientists in the Gaza Strip [92–97]. This devastation of the educational system has also disrupted critical nutrition education and food assistance programs, further exacerbating food insecurity and malnutrition among vulnerable populations.

SDG 5 (gender equality) focuses on the empowerment of women and ending violence and discrimination against women and girls. This goal plays a crucial role in enhancing food security and sustainable development. Literature studies emphasize the need for additional research to capture the influence of gender within the food supply chain, highlighting the potential impact of SDG 5 on food systems. Women's empowerment in agriculture has been found to have a positive impact on household food security [98–100].

The ongoing war on Gaza has increased the risk of physical and sexual violence and human trafficking for sexual exploitation of women and girls due to forced displacement and aggression. Moreover, there has been growing dangers for pregnant women of dangerous deliveries with increased risk of preterm birth and low birthweight as a result of the destruction of health-care facilities in Gaza [101–104]. Approximately 50,000 pregnant women in Gaza face heightened risks of adverse birth outcomes due to maternal stress, physical harm, malnutrition, and the destruction of healthcare infrastructure [105,106].

This escalation in gender-based violence and the compromised health of mothers directly undermine food security and nutrition, as women play a pivotal role in food production, preparation, and the overall well-being of their families. Consequently, the disempowerment and trauma experienced by women exacerbate malnutrition and food insecurity within the community.

SDG 7 focuses on ensuring access to affordable, reliable, sustainable, and modern energy services. The impact of SDG 7 on food security is complex and interconnected with various other SDGs [107]. Enhancing access to electricity and improving energy efficiency, as outlined in SDG 7, can significantly bolster food security by increasing food availability and utilization, as well as by enhancing economic access to food through income generation [108].

The ongoing aggression on Gaza has severely disrupted the energy sector, leading to significant energy vulnerability. Israeli forces have destroyed power plants and transmission lines and imposed strict limitations on fuel and electricity access. Notably, the Gaza Electricity Distribution Corporation reports initial losses in the electricity sector estimated at approximately \$450 million. The destruction includes 90% of its machinery and equipment, such as trucks and cranes, and 70% of its buildings and facilities entirely or partially demolished. This devastation has resulted in a complete blackout of electricity since November 2023, exacerbating the humanitarian crisis by crippling essential services such as hospitals, water supply, and sanitation systems [109,110].

Although the occupation regime has hindered development initiatives and investment in clean energy in Palestine for years, Palestinians have increasingly adopted renewable energy solutions based solar systems. However, solar panels have been targeted by Israeli bombardment and destroyed along with buildings, increasing dependency on non-climate-friendly options [79,111].

The Energy shortages severely disrupt the entire food supply chain, affecting storage, preservation, and agricultural productivity. This leads to increased food spoilage, reduced availability, and exacerbates food insecurity and malnutrition.

SDG 11 aims to make cities and human settlements inclusive, safe, resilient, and more sustainable. The concept of sustainable cities encompasses a broad range of factors, including environmental impact, economic productivity, social inclusivity, and resilience for future generations [112]. Orsini and others [113] emphasized the positive impact of urban agriculture on dietary adequacy, supporting the potential contribution of urban agriculture to SDG 2. Several other literature studies have also investigated various challenges and opportunities associated with urban agriculture, including its impact on food security, livelihoods, income generation, and poverty alleviation for urban households [114–116].

The Israeli heavy bombardment and shelling have transformed Gaza into a formidable battleground with no safe place in the entire Gaza Strip. Since October 2023, Gazans have been experiencing unprecedented levels of destruction, including urban settings and cities, weakening their resilience and making them more vulnerable to other catastrophes or shocks, e.g., floods and earthquakes. By the end of 2023, Israel destroyed over 70% of Gaza homes, including the destruction of 75% of all structures of northern Gaza [117,118]. The Guardian has documented the sheer level of destruction in Gaza until 17 January 2024 using Satellite imagery and images prior to the 2023 war [119]. The analysis of these images shows a massive destruction of civilian infrastructure by Israel, forcing more than 1.9 million people to leave their homes (Fig. 4). Time-series satellite imagery reveals that only from October 2023 to March 2024, nearly 60% of buildings, including homes, schools, and hospitals, were either destroyed or severely damaged, forcing widespread displacement [120]. Additionally, over 34% of agricultural land was devastated, significantly reducing food production and further exacerbating the humanitarian crisis in the region. Recent



Fig. 4. Damaged buildings in Gaza since 7 October 2023 (Source: The Guardian).

reports show much more damage to crop fields and other agricultural land [71,121]. Besides, evidence shows that Israel is committing a cultural genocide as well since according to the UNESCO, damage to 22 sites (as of January 2024) in Gaza has been verified, while about 200 sites of historical importance have been destroyed since the war began [122,123].

These previous figures, while indicative of the extensive devastation, may vary due to the ongoing mass destruction and significant security challenges that hinder data verification on the ground. The dynamic and volatile situation in Gaza makes it difficult to obtain precise and consistent data, leading to discrepancies in reported statistics. For instance, some reports suggest that the number of destroyed infrastructures, and displaced individuals may be higher or lower than stated, reflecting the challenges in data collection amidst active conflict. Therefore, while these numbers provide a snapshot of the crisis, they should be interpreted with caution, acknowledging the potential for contradictory data due to the complex and rapidly changing circumstances.

The destruction of communities as well as displacement disrupt food supply chains and access to markets, increasing food insecurity and malnutrition.

SDG 16 aims to promote peace, justice, and inclusive societies for all, and prevent violence, children abuse, and other violations of human rights. This goal is essential for the implementation of all other SDGs [124]. The importance of SDG 16 to food security and achievement of sustainable food systems can be understood through its contribution to addressing governance, justice, and peace, avoiding conflicts that can be trigged due to food insecurity and lack of food [125].

The current war on Gaza has pushed back SDG 16 and all its targets since this war has violated the peace and the security and increased violence, repression, and violation of human rights and the dignity of Palestinians. Children in Gaza are especially affected by this war, leaving them with increased risk for death, sexual abuse, trafficking, and exploitation [126]. Since October 2023, the UNICEF declared that Gaza has become a graveyard for thousands of children [127]. A recently released study revealed a severe psychological crisis among children in Gaza, indicating that 96% of these children feel their death is imminent and 49% express a desire to die. Additionally, 92% are in denial about their reality, 83% experience intense fear, and 73% exhibit aggressive behavior. Many also show signs of withdrawal, anxiety, and a pervasive sense of hopelessness [128].

The breakdown of peace and justice systems hampers efforts to provide humanitarian aid, exacerbating food insecurity and malnutrition among vulnerable populations.

Table 1 sums up the social impacts of the ongoing war on Gaza, including widespread poverty, healthcare collapse, disrupted education, and urban destruction, and how these challenges worsen food insecurity and malnutrition.

3.3.2. Environmental food-related SDGs

Recent reports demonstrate that current food systems are unsustainable and have significant impact on climate change and other environmental degradations such as pollution, loss of biodiversity, overexploitation, etc. [129–132]. This underscores the urgent need for radical systemic transformation, with recommendations such as enabling social licensing, safeguarding against adverse effects, and designing market incentives [133,134]. Environmental sustainability is integral to the SDGs, underpinning goals such as SDG 6, and 13–15. However, it remains the weakest pillar of sustainability, often overlooked in favor of social and economic dimensions [135].

The ongoing aggression on Gaza has caused catastrophic environmental destruction, severely impacting ecosystems and food sustainability (Fig. 5).

SDG 6 (clean water and sanitation for all) is essential for multiple human well-being outcomes and ecosystem health. Indeed, clean water is indispensable not only for drinking and washing but also for food

Table 1
SDGs related to the social pillar and their impact on SDG 2 and malnutrition.

SDGs	Impact of the ongoing war on Gaza	Impact on SDG 2 and malnutrition
SDG 1: No poverty	Widespread poverty due to destruction of livelihoods, homes, and essential infrastructure.	Increased poverty limits access to nutritious food, exacerbating food insecurity and malnutrition.
SDG 3: Good health and well-being	Collapse of healthcare systems, destruction of hospitals, and shortages of medical supplies.	Health crises worsen malnutrition, especially among vulnerable groups, including children.
SDG 4: Quality education	Destruction of educational infrastructure and the inability of students to access schools and universities.	Loss of education reduces knowledge transfer on sustainable nutrition and worsens malnutrition.
SDG 5: Gender equality	Increased gender-based violence; significant number of births occur without medical assistance.	Low birth weight and maternal health issues worsen malnutrition.
SDG 7: Affordable and clean energy	Destruction of power plants and restricted fuel supply, leading to long-term energy shortages.	Energy shortages impact food quality, availability, and nutritional value.
SDG 11: Sustainable cities and communities	Devastation of urban infrastructure, rendering cities uninhabitable and increasing displacement.	Displacement disrupts food supply chains, increasing hunger and malnutrition risks.
SDG 16: Peace, justice, and strong institutions	Escalation of violence, instability, and violations of human rights across Gaza.	War blocks aid delivery, worsening hunger and malnutrition.

preparation, processing, and production [136]. As for food and medicine, the occupation regime has significantly restricted access to water in the context of its starvation war against Gaza. Due to the tight blockade imposed on the Gaza Strip, the destruction of water infrastructure, and the reduction of water supply by 95%, Gazans are struggling to have access to drinkable water, which has dramatically reduced sanitary conditions, pushing families to use unsafe and unfit for human consumption water [79,137].

The ongoing conflict in Gaza has led to severe water pollution and degradation of groundwater quality, exacerbated by the destruction of wastewater treatment facilities and frequent power outages. Damage to critical infrastructure has resulted in untreated sewage being discharged into the Mediterranean Sea, contaminating both marine and freshwater resources. The use of chemical weapons and other warfare materials has introduced hazardous substances into the ecosystem, compounding the contamination of water sources [138–140].

These factors collectively threaten food security, public health, and the environment sustainability in Gaza. These conditions have decimated local agricultural production, increased diseases, and increased reliance on external aid, further jeopardizing food security and worsening malnutrition.

The aim of **SDG 13** (climate action) is to take actions to combat climate change and its impacts in different sectors, including food systems. To understand the impact of SDG 13 on food, it is essential to consider the interconnectedness of climate change and food insecurity. The implications of climate change on food security and nutrition can result in lower nutritional quality of dietary intakes, exacerbate obesity, and amplify health inequalities [131,141].

The ongoing war on Gaza has significantly hindered progress toward achieving SDG 13. The extensive use of military vehicles and incendiary weapons has led to a substantial increase in carbon and greenhouse gas emissions (GHG), intensifying climate change. Additionally, the destruction of infrastructure and the use of chemical weapons (such as white phosphorus bombs) have resulted in the release of hazardous materials and debris (50 million tons of debris), further degrading the environment. This environmental degradation has adversely affected food security and nutrition by decreasing local agricultural production,

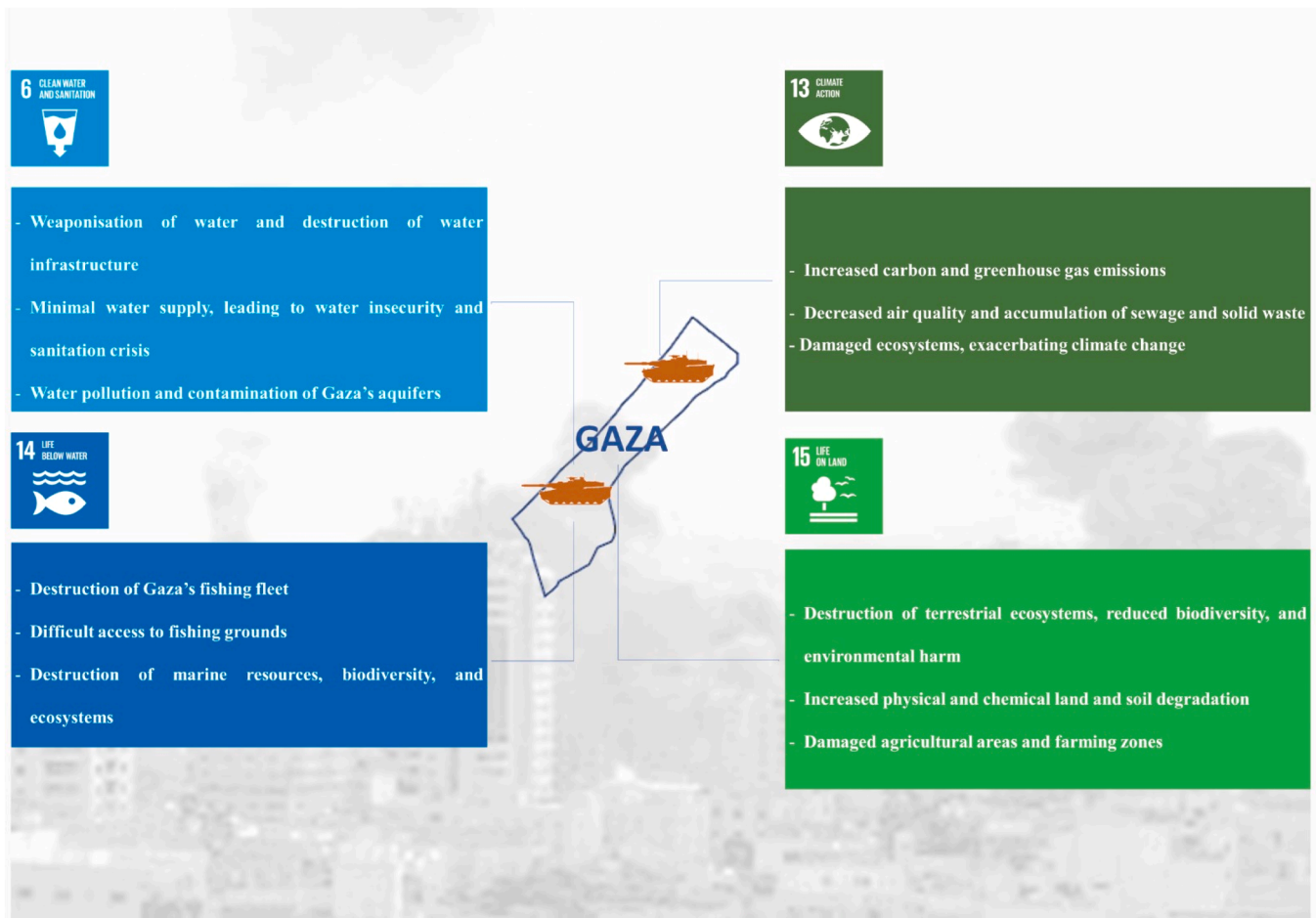


Fig. 5. Implication of the ongoing war on Gaza for the environmental dimension of sustainability.

increasing hunger, malnutrition, and disease prevalence, and heightening reliance on external aid [73,139,142,143].

SDG 14 (life below water) aims to conserve and sustainably use the oceans, seas, and marine resources. Fisheries and aquaculture plays a significant role in achieving multiple SDGs, including ending poverty, achieving food security, promoting sustained economic growth, and reducing inequalities [144]. However, one of the critical challenges to achieving SDG 14 is the impact of ocean acidification and warming on marine ecosystems. There are other concerns related to overfishing, plastic pollution and GHG emissions that could limit progress toward environmental sustainability [145,146].

The marine part of the Gaza Strip has been highly damaged by the intense bombardment, destroying Gaza's fishing fleet, and harming marine resources and biodiversity along the coast in Gaza and the surrounding areas due to increased warfare activities and pollution. The Israeli airstrikes on the port of Gaza have limited access to the fishing zones, while the lack of feed has paralyzed the aquaculture sector in Gaza [73,79,147]. According to a recent statistics released by Gaza's Ministry of Agriculture, since October 2023, 200 fishers have been killed by Israel's forces, with loss of 4600 tons of fish production, forcing about 4000 fishers supporting 50,000 dependents out of employment, and fishing sector suffering \$20 million loss [148].

SDG 15 (life on land) is a crucial component of SDGs that aims to achieve sustainable terrestrial ecosystems, focusing on combating desertification, land degradation, and biodiversity loss. The goal is fundamental and interconnected with various aspects of food systems and with other SDGs, and its impact has been studied in relation to poverty, poverty alleviation, food security, gender equality, water and energy access, and economic growth [107,149].

The war on Gaza has fostered terrestrial ecosystem degradation directly or indirectly, causing mass ecological damage. Indeed, this war is causing both physical and chemical land and soil degradation owing to crevices for the mass graves to bury the dead as well as war remnants containing metals and toxic energetic materials. Biodiversity loss and habitat degradation have also been reported with similar wars, such as Russo-Ukrainian conflict [6,150].

Although comprehensive studies on Gaza are limited due to security challenges, the ongoing war, and persistent blockades, the damage is expected to be disproportionately severe. This is attributed to Gaza's small geographical size, the intensity of military aggression, and the destructive weaponry used in this war [139]. Approximately 70% of agricultural land in Gaza has been rendered unusable due to bombing, soil contamination, and the presence of unexploded ordnance [71,121]. According to recent reports, the ongoing war on Gaza has had a profound impact on biodiversity, directly undermining SDG 15. For example, the Gaza Valley, a crucial stopover for migratory birds traveling between Africa, Europe, and the Americas, is now at risk of losing 150 to 200 bird species, including both endemic and migratory species. Additionally, 20 species of mammals and 25 species of reptiles face the threat of complete extinction [151].

This degradation of land reduces its suitability for farming, exacerbating food shortages. Furthermore, the significant loss of biodiversity has severe implications for food security in the region. The destruction of natural habitats disrupts ecosystems that are vital for agriculture, such as pollination and pest control, leading to decreased crop yields, contributing to a worsening food security crisis in Gaza.

Table 2 outlines the environmental consequences of the ongoing war on Gaza, including damage to water systems, ecosystems, and

Table 2

SDGs related to the environmental pillar and their impact on SDG 2 and malnutrition.

SDGs	Impact of the ongoing war on Gaza	Impact on SDG 2 and malnutrition
SDG 6: Clean water and sanitation	Destruction of water systems and contamination of water resources.	Unsafe water use exacerbates malnutrition through contaminated food and poor hygiene.
SDG 13: Climate action	Environmental degradation caused by pollution, destruction of ecosystems, and use of toxic weapons.	Environmental damage reduces agricultural productivity, increasing hunger and malnutrition.
SDG 14: Life below water	Damage to marine ecosystems and biodiversity along the coast of Gaza.	Loss of fish stocks worsens food scarcity and reduces nutritional diversity.
SDG 15: Life on land	Massive ecological damage, including soil contamination and deforestation.	Soil degradation limits food production, exacerbating hunger and malnutrition.

biodiversity, and explains how these issues contribute to reduced agricultural productivity and worsening food insecurity and malnutrition.

3.3.3. Economic food-related SDGs

It is crucial to consider the synergies and trade-offs between economic development and food-related SDGs to understand the interplay between these goals. According to the “wedding cake” model, economic SDGs are on the top, meaning that the fulfilment of environmental and social SDGs will automatically lead to the achievement of the economic SDGs. The main economic food-related SDGs are SDG 8 (decent work

and economic growth), SDG 9 (industry, innovation, and infrastructure), SDG 10 (reduced inequality), and SDGs 12 (responsible production and consumption). Economic SDGs have been tremendously affected by the ongoing war on Gaza (Fig. 6).

SDG 8 calls for inclusive and sustainable economic growth and seeks to create new jobs and promote entrepreneurship, thus increasing economic productivity, enhancing the economic growth per capita, and strengthening capacity of financial systems [152]. In Gaza, the war has led to an economic contraction of 86% in the first half of 2024 [153]. According to UNCTAD, the unprecedented destruction will take at least several tens of billions of dollars and decades to reverse owing to destruction of physical infrastructure, capital stock, and productive assets [13]. The economic situation in Gaza before the war was already dire as unemployment rate was 45%, while it reached about 80% by the end of 2023, making it one of the highest unemployment rate in the world. Reports show that Gaza’s Gross Domestic Product (GDP) declined by 84.7%, providing clear evidence of the downward economic spiral in the enclave [154]. The agricultural sector, a vital component of the economy in Gaza, has suffered extensive damage.

SDG 9 focuses on building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation. Building resilient food infrastructure, promoting sustainable agriculture and food industry, and fostering food innovation are essential to achieve food security, especially in developing countries [129,155,156].

The ongoing war on Gaza has destroyed most infrastructure, including agricultural lands, food factories, and bakeries, significantly aggravating the already acute food insecurity in Gaza. For example, as of September 2024, approximately 67.6% of cropland—totaling over 10,183 hectares—has been damaged. The devastation has led to a



Fig. 6. Implication of the ongoing war on Gaza for the economic dimension of sustainability.

substantial decline in agricultural output, causing prices for essential commodities to soar (over 300%), which intensifies the challenges faced by Gazans [13,121,157]. The widespread destruction of industrial and infrastructural facilities has halted production, disrupting food production and reducing the supply of nutritious food.

SDG 10 aims to reduce inequality within and among countries by empowering and promoting the social, economic, and political inclusion of all individuals, regardless of age, sex, disability, race, ethnicity, origin, religion, or economic status. A recent report by the High-Level Panel of Experts on Food Security and Nutrition (HLPE-FSN) underscores the ethical, socioeconomic, legal, and practical imperatives of addressing inequalities within food systems. It recommends sustainable actions across food and other systems to enhance food security and nutrition [158].

One of the consequences of the current war on Gaza is the increased inequality and discrimination against Palestinians who have been living under occupation and blockade for many years and have become further marginalized and deprived of their basic rights under this war. Gazans have been also subjected to forced mobilization and displacement to the southern part of the strip, declared as “safe zones” by Israel before being targeted by airstrikes. These huge forced displacements (at least 1.9 million people - or about 90% of the population) have led to severe humanitarian crises, including overcrowded shelters lacking adequate food, water, sanitation, and medical care [69,157,159]. This situation has led to increased food insecurity, malnutrition, and poverty among the displaced populations due to limited resources.

SDG 12, which focuses on responsible consumption and production, is essential for achieving several other SDGs, including eradicating extreme poverty and hunger, promoting gender equality, reducing child mortality, and ensuring environmental sustainability. SDG 12, is of ultimate importance to food waste since the target 12.3 of SDG 12 aims to reduce food waste by 50% at the retail and consumption stages as well as to reduce food losses along production and supply chains, including post-harvest losses, while the target 12.5 seeks to reduce waste through prevention and recycling [160,161].

All production and consumption patterns have been disturbed by the current war on Gaza. As mentioned previously, the destruction of agricultural infrastructure, including croplands, irrigation systems, and other food-related facilities has drastically reduced local food production. Therefore, dependence on humanitarian aid, especially food supplies, has increased, increasing the amounts of food waste and litter. Additionally, the blockade and continuous hostilities have disrupted supply chains, limiting access to essential farming inputs such as seeds, fertilizers, and machinery. This disruption has forced farmers to abandon sustainable practices, further diminishing agricultural productivity. Moreover, power blackouts and destruction of sewage pumping stations and wastewater treatment plants have reduced capacity of waste management and treatment, leading to unsafe and unsustainable waste management practices, such as landfilling and burning [12,16,46,139,162].

These combined factors have drastically reduced the availability of nutritious food, worsening food insecurity and contributing to rising levels of malnutrition, particularly among vulnerable populations like children and pregnant women.

Table 3 examines the economic repercussions of the conflict, focusing on the destruction of industries, infrastructure, and livelihoods, and their subsequent effects on food access, availability, and malnutrition.

3.4. Risk of wider regional conflagration and global food security and sustainability implications

The consequences of the ongoing war on Gaza in terms of social, environmental, and economic outcomes have been most profoundly felt by Gazans at present. However, the ongoing war in Gaza will undoubtedly have far-reaching impacts that extend beyond the immediate

Table 3

SDGs related to the economic pillar and their impact on SDG 2 and malnutrition.

SDGs	Impact of the ongoing war on Gaza	Impact on SDG 2 and malnutrition
SDG 8: Decent work and economic growth	Economic collapse with massive unemployment and destruction of businesses.	Economic collapse limits access to food, worsening hunger and malnutrition.
SDG 9: Industry, innovation, and infrastructure	Widespread destruction of industrial and infrastructural facilities, halting production.	Loss of infrastructure disrupts food production, reducing nutritional food supply.
SDG 10: Reduced inequalities	Increased inequalities due to systemic marginalization and displacement.	Marginalized populations face increased malnutrition due to limited resources.
SDG 12: Responsible consumption and production	Disruption of production and consumption patterns, leading to dependence on external aid.	Disrupted production reduces access to diverse, nutritious food, worsening malnutrition.

region, affecting global food sustainability, economic stability, security, and humanitarian conditions. This war poses the constant risk of regional conflagration due to the multitude of parties involved and the possibility of an escalation of violence. For example, the Houthi attacks on Israeli allies in the Red Sea and the attacks carried out by armed groups in Syria, Lebanon, and Iraq that have been intensified in recent times are signs of possible expanding violence beyond Gaza [163].

As an act of solidarity with Gaza, the Houthis have targeted ships heading to or from Israeli ports in the southern Red Sea and Bab al-Mandab. This region is key to controlling almost all shipping between the Indian Ocean and the Mediterranean via the Suez Canal. The Yemeni attacks have disrupted global trade flows as shipping and oil companies avoid the Suez Canal, increasing freight costs and making ships longer as they reroute to the African continent [164]. The Windward maritime analysis company stated that in the second week of December 2023, there was a 70% decrease in container vessels passing through the southern entrance to the Red Sea, compared with the 2023 weekly average; at the same time, there was a 136% increase of voyages through the Cape of Good Hope [164]. In response to the Houthi attacks the United States and Britain have launched multiple rounds of strikes on Houthi targets in Yemen. These military operations have increased the risk of regional escalation and raised serious concerns about widening the conflict. According to Candid organization, these airstrikes could limit humanitarian assistance and access to 17 million food insecure people living in Yaman [165].

The war on Gaza is deeply destabilizing the situation in the immediate neighboring countries, including Egypt, Syria, Lebanon, and Jordan. Egypt has struggled with fiscal pressures, slow growth, and high unemployment, deterring much-needed investment and hurting consumption and trade. The country has already been significantly impacted by the Russian-Ukrainian war due to its dependency on food imports from Russia and Ukraine [166]. The spread of war to Syria will make the already dire humanitarian crisis in the country even worse with Syrian civilians once again suffering the consequences [167].

The war on Gaza has added a burden to the already bleak socio-economic situation in Lebanon. The war on Gaza has provoked tensions around the southern Lebanese borders between Israel and Hezbollah; an Iran-backed political party and militia, leading to considerable consequences on key economic sectors, particularly tourism and the service sector due to waves of Israeli military attacks in southern Lebanon. As Lebanon is highly dependent on imports to meet its necessities, including food and other goods, disruption of international trade is expected to have dramatical economic consequences on the country. The main impact of this war on South Lebanon includes losses in agriculture, livestock, animal production, aquafarming, and forestry, imposing a real threat to the country's food security and sustainability. Given its geographical proximity to the conflict, the war on Gaza has also challenged several Jordan's economic activities and fields (especially the

tourism and energy sectors) [147]. In September 2024, Israel significantly expanded its military operations into Lebanon, resulting in the deaths of over 1400 people in less than three weeks and the displacement of over 1 million more [168]. This escalation has further exacerbated the already dire food insecurity and sustainability crisis in the region, compounding the effects of ongoing conflicts and economic instability.

The economic collapse in Gaza has far-reaching regional and global implications. Environmental degradation caused by the war, including pollution and soil contamination, does not respect borders and poses significant risks to neighboring regions. Pollutants from destroyed infrastructure, chemical weapons, and waste mismanagement can seep into shared water resources and spread through atmospheric and marine pathways, affecting ecosystems and human health across borders. For example, the contamination of coastal waters in Gaza by untreated sewage and chemical pollutants could have detrimental effects on the Mediterranean ecosystem, impacting fisheries and marine biodiversity regionally.

The destruction of the agricultural sector of Gaza also disrupts regional food supply chains, reducing food availability and driving up prices in neighboring countries. Globally, rising prices for key commodities such as grains and vegetable oils exacerbate food insecurity in vulnerable regions. The long-term consequences of pollution, resource depletion, and disrupted trade routes extend beyond Gaza, underscoring the urgent need for coordinated international efforts to mitigate these cascading effects.

4. Conclusion

The scale of the humanitarian disaster that is currently unfolding in Gaza is unprecedented and has even exceeded all our worst imaginations. The implications of the ongoing Israeli aggression for SDGs in the Gaza Strip are daunting in all fields, including the food sector. Food insecurity and malnutrition are most apparent in Gaza and have reached high unprecedented levels.

Food sustainability in Gaza in its three dimensions, namely social, environmental, and economic has been deeply impacted by the current situation. The continuation of the war on Gaza for more than a year now has broken all the chains of food security, leaving the entire population in highly food insecure, poor, and at risk of famine. In addition to the catastrophic death toll (which currently stands at more than 45,000, as of December 2024), most of them women and children, destruction of vital infrastructure, including schools, universities, hospitals, as well as agriculture and food sectors have dramatically exacerbated the humanitarian crisis in Gaz. Degradation and contamination of land and soil owing to the use of chemical weapons and bombs have made the Strip unsuitable for agriculture, aggravating the already high unemployment, poverty, and food insecurity. The long-term socio-economic implications of this war are significant since rebuilding Gaza is expected to cost tens of billions of dollars and the social impact of this war is likely to last for generations.

The ongoing war in Gaza has the potential to escalate into a regional or even global conflict if it persists and broadens, leading to severe and enduring consequences such as deepening global food insecurity. We underline that the data presented in this study needs to be updated regularly to reflect the latest developments as the situation in Gaza keeps evolving dramatically. Consequently, we highlight the urgent need to stop this genocide in Gaza immediately in order to provide a possible glimpse of hope amid the current Palestinian-Israeli sea of despair and to restore the hope of achieving the UN's SDGs by 2030. We suggest further in-depth assessment of the implications of the ongoing war on Gaza for each SDG as directions for future research.

CRedit authorship contribution statement

Abdo Hassoun: Writing – review & editing, Writing – original draft,

Supervision, Methodology, Formal analysis, Conceptualization. **Ahmed Hamad:** Writing – original draft, Methodology, Formal analysis. **Dalal Iriqat:** Writing – original draft, Methodology, Formal analysis. **Mohammed Nijim:** Writing – original draft, Methodology, Formal analysis. **Yamina Bouchikh:** Writing – original draft, Methodology, Formal analysis. **Mohamed Buheji:** Writing – original draft, Methodology, Formal analysis. **Tahani Z. Aldahdouh:** Writing – review & editing.

Declaration of competing interest

There is no conflicts of interest.

Data availability

Data will be made available on request.

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