

Rethinking Sustainability Under Siege: The Socio-Political Transformation of Environmental Practices in Gaza

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ABSTRACT

Purpose – This study questions the common assumption in academic and policy debates that environmental sustainability is mainly achieved through post-conflict reconstruction, technological progress, and institutional interventions. Focusing on the Gaza Strip, it examines how environmental sustainability practices emerge under prolonged blockade and occupation. The study aims to demonstrate that sustainability in Gaza develops as a necessity-driven practice rather than a planned environmental strategy.

Design/data/methodology – The research adopts a qualitative design based on document analysis. International reports, technical data, and academic literature published between 2010 and 2025 were systematically reviewed. The analysis is guided by the political ecology of the siege framework, which allows environmental practices to be interpreted within broader political, economic, and infrastructural constraints.

Findings – The findings show that environmental practices in Gaza arise not primarily from environmental awareness or formal sustainability policies, but from structural pressures such as enforced scarcity, infrastructural destruction, and political violence. Practices including material reuse, adaptive water management, and alternative energy solutions function as forms of everyday resilience that sustain daily life and community continuity. However, while these practices help mitigate immediate environmental and urban collapse, they do not resolve the structural conditions that produce these challenges.

Originality/value – The article introduces the concept of “sustainability of necessity,” emphasizing sustainability as a survival strategy shaped by conflict conditions. By politicizing sustainability, the study contributes to political ecology and critical urban studies while drawing attention to the risk of depoliticized sustainability agendas and green colonialism.

Keywords: Political Ecology, Sustainability of Necessity, Siege Economy, Gaza Strip

Kuşatma Koşullarında Sürdürülebilirliği Yeniden Düşünmek: Gazze'de Çevresel Pratiklerin Sosyo-Politik Dönüşümü

ÖZET

Amaç – Çalışma, akademik ve politika tartışmalarında yaygın olan, çevresel sürdürülebilirliğin esas olarak çatışma sonrası yeniden yapılanma, teknolojik ilerleme ve kurumsal müdahaleler yoluyla elde edildiği varsayımını sorgulamaktadır. Uzun süreli abluka ve işgal altında çevresel sürdürülebilirlik uygulamalarının nasıl ortaya çıktığını incelemektedir. Çalışma, Gazze'de sürdürülebilirliğin planlı bir çevre stratejisinden ziyade, zorunluluktan kaynaklanan bir uygulama olduğunu göstermektedir.

Tasarım/veri/yöntem – Araştırma, belge analizine dayalı nitel bir tasarım benimsemektedir. 2010 ile 2025 yılları arasında yayınlanan uluslararası raporlar, teknik veriler ve akademik literatür sistematik olarak incelenmiştir. Analiz, çevresel uygulamaların daha geniş siyasi, ekonomik ve altyapısal kısıtlamalar içinde yorumlanmasına olanak tanıyan kuşatma çerçevesinin siyasi ekolojisi tarafından yönlendirilmektedir.

Bulgular – Gazze'deki çevresel uygulamaların öncelikle çevresel farkındalık veya resmi sürdürülebilirlik politikalarından değil, zorunlu kıtlık, altyapı tahribatı ve siyasi şiddet gibi yapısal baskılardan kaynaklandığını göstermektedir. Malzeme yeniden kullanımı, uyarlanabilir su yönetimi ve alternatif enerji çözümleri gibi uygulamalar, günlük yaşamı ve toplumsal sürekliliği sürdüren günlük direnç biçimleri olarak işlev görmektedir. Bununla birlikte, bu uygulamalar acil çevresel ve kentsel çöküşü hafifletmeye yardımcı olsa da, bu zorlukları üreten yapısal koşulları çözmemektedir.

Özgünlük/Değer – Makale, sürdürülebilirliği çatışma koşulları tarafından şekillendirilen bir hayatta kalma stratejisi olarak vurgulayarak, “zorunluluktan kaynaklanan sürdürülebilirlik” kavramını tanıtmaktadır. Sürdürülebilirliği siyasallaştırarak, çalışma politik ekolojiye ve eleştirel kentsel çalışmalara katkıda bulunurken, siyasetten arındırılmış yeşil sömürgeciliğin riskine dikkat çekmektedir.

Anahtar Kelimeler: Politik ekoloji, Zorunlulu Sürdürülebilirlik, Kuşatma Ekonomisi, Gazze

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1. Introduction

I am that five-year-old child from Gaza, weighing less than the water cans I carry, looking around for help. Yes, I am that child, burdened with the world on my shoulders. I have shown my growth by bringing water to my home, which is not really a home anymore because bombs have destroyed it...

Environmental sustainability has become a key issue in current debates on post-conflict rebuilding, urban resilience, and climate adaptation. In both research and policy, sustainability is often seen as a normative goal to be achieved through technological advances, institutional changes, and externally supported development programs (Mason et al., 2011; Almeida et al., 2023). These approaches usually assume conditions of relative stability, sovereign governance, and voluntary participation. However, such assumptions clash with situations shaped by prolonged occupation, blockades, and political violence.

The Gaza Strip exemplifies how environmental sustainability develops amid enforced scarcity and infrastructure destruction. Since the comprehensive blockade began in 2007, Gaza has faced strict restrictions on the movement of people and goods, repeated military attacks, and the ongoing deterioration of water, energy, housing, and sanitation systems (Hassoun, 2025). In this context, sustainability cannot be seen as a mere policy choice or a post-conflict goal. Instead, it manifests as a set of material practices through which residents strive to maintain daily life amid a continuous siege.

Although existing literature has extensively documented Gaza's humanitarian crises, infrastructural failures (Asi et al., 2024), and environmental decline (Musallam et al., 2023; UNEP, 2024a), a notable research gap persists concerning the conceptualization of environmental sustainability within the context of the ongoing siege. Prior studies predominantly analyze sustainability from two principal perspectives. The first adopts a technocratic viewpoint, considering sustainability as a post-conflict reconstruction objective contingent upon institutional stability and external assistance (Barakat et al., 2018). The second perspective depicts local environmental practices merely as depoliticized humanitarian "coping mechanisms" or informal adaptations to crises (Mason et al., 2011). Consequently, mainstream sustainability frameworks, such as resilience or just transition, frequently overlook the political ecology inherent in a siege economy, where resource deprivation is structurally mandated rather than incidental.

This study addresses this gap and advances current knowledge by politicizing sustainability in conflict zones. It offers three distinct contributions to the literature on political ecology and critical urban studies:

Conceptual Innovation: It introduces the concept of sustainability of necessity, distinguishing it from mainstream sustainability of choice. The study demonstrates that environmental practices in Gaza arise not from normative environmental awareness but from non-voluntary survival strategies driven by infrastructural violence and enforced scarcity (Lubitz, 2018; Mashaqi et al., 2025).

Re-theorizing Local Agency: Unlike previous research that treats local material adaptations, such as rubble reuse, decentralized solar adoption, and water rationing, as marginal informalities, this study analyzes them as a form of "resistance ecology" (Banerjee et al., 2023). It shows how these practices sustain everyday life, collective presence (sumud), and limited spatial autonomy without dismantling military authority.

Critique of Depoliticized Frameworks: By situating these practices within the political ecology of siege, the paper provides a critical corrective to externally imposed, depoliticized environmental agendas, drawing attention to the risks of green colonialism where structural violence is masked as a neutral development challenge (Blanc, 2022; Hamouchene, 2023).

The article is organized as follows. Section 2 explains the theoretical framework, introducing the political ecology of siege along with concepts of resistance ecology and sustainability of necessity. Section 3 offers background on Gaza's siege economy. Section 4 describes the research methodology. Section 5 presents the findings and analysis. Section 6 discusses the importance of politicizing sustainability and concludes by considering how sustainability of necessity can inform environmental governance in ongoing conflict settings.

2. Theoretical Framework

This study draws on an interdisciplinary theoretical framework that combines insights from political ecology, urban conflict studies, and critical sustainability scholarship. The framework is organized around four interconnected analytical pillars. First, the concept of siege is used to examine how prolonged restrictions on mobility, materials, and infrastructure shape environmental governance and everyday life. Second, the concept of urbicide highlights the deliberate destruction of urban infrastructure and the spatial dimensions of violence. Third, environmental governance provides a lens for understanding how access to water, energy, housing, and other essential resources is regulated under conditions of political constraint. Finally, the concept of scarcity-driven innovation explains how communities develop adaptive environmental practices in response to prolonged deprivation and infrastructural disruption. Together, these perspectives provide the theoretical basis for conceptualizing sustainability not as a voluntary environmental transition but as a necessity-driven practice emerging under conditions of siege.

The empirical foundation of this research rests on the argument that the systematic destruction of infrastructure, especially water, energy, housing, and sanitation networks, has intensified social and spatial inequalities across Gaza's urban landscape. These processes have not only worsened material living conditions but have also actively created uneven patterns of environmental vulnerability. Infrastructure destruction under occupation acts as a mechanism of spatial control, reshaping access to resources and

changing everyday life. To place these dynamics within their political context, this study adopts a political ecology of siege framework that highlights the causal relationships between occupation governance, demolition practices, and socio-environmental deprivation (Mashaqi et al., 2025; Hassoun, 2025).

Within Gaza, the siege creates a paradoxical situation. On the one hand, it increases public and institutional focus on resource scarcity and sustainability. On the other hand, it frames these issues through depoliticized representations such as humanitarian infrastructure projects or emergency services that detach environmental degradation from its political roots (Mason et al., 2011).

Such framings obscure the structural forces that cause deprivation and reframe sustainability as a technical or humanitarian issue rather than a socio-political practice driven by long-term enclosure, restriction, and violence. Environmental and social discourses in Gaza center on two main narratives, *sumud* and resilience. *Sumud* emphasizes rootedness in land, collective endurance, and political attachment to place, portraying sustainability as the act of staying resilient despite dispossession. Resilience discourse, on the other hand, often reflects feelings of abandonment and loss and tends to normalize adapting to worsening conditions rather than addressing their root causes. The tension between these narratives has led to ongoing debates about which forms of sustainability are realistic or achievable, especially when referencing nostalgic memories of pre-occupation times (Lubitz, 2018; El-Zakka & Diab, 2023).

Under siege conditions, sustainability practices in Gaza go beyond mere survival strategies. They represent an intensified expression of what can be called the innovation of scarcity, where scarcity is not only a limit but also a seed for alternative socio-environmental visions. The problems caused by the blockade therefore involve not just material survival but also the ability to imagine different ways of living amid structural violence. Locally, this is expressed through historical and cultural ideas of loss and constraint, involving a reinterpretation of deprivation as a resource to sustain daily life and to envision alternative futures rooted in environmental care and political struggle (Abreek-Zubiedat, 2025; Samman, 2025).

2.1. Political Ecology of Siege

Understanding environmental domination under siege requires attention to the spatial, temporal, and organizational dimensions of resource access. In Gaza, these dimensions shape access to land, water, and energy resources that are difficult to produce in sufficient quantities and whose prolonged overuse has led to declining availability and quality. As scarcity worsens, access becomes more unequal, creating significant disparities between communities and neighborhoods (Hassoun et al., 2025). Access to land, water, and energy directly affects life chances and is therefore a matter of social justice. Mapping the political regulation of these resources provides a clearer understanding of Gaza's socio-political

crisis than analyses focused solely on economic indicators. This approach aligns with political ecology scholarship that highlights how power relations, governance regimes, and territorial control shape unequal access to environmental resources (Khan, 2013). The political ecology of siege also resonates with literature on uneven development and spatial injustice, which shows how capitalist and colonial governance produce geographically diverse outcomes. Market-based logics generate enclavization and undercapitalization, disconnecting certain spaces from global economic circuits.

Gaza exemplifies an extreme case of enforced disconnection, where mobility restrictions and physical controls fragment urban space and social life (Ahn & Juraev, 2024). Urban analysis should therefore focus on scarcity governance, including negotiations among undercapitalized localities, governing authorities, and humanitarian actors, as well as the adaptive practices that emerge during prolonged deprivation. Within this framework, indicators of resource scarcity can be combined with measures of equity and distribution. Mapping affordability and access to housing and construction materials offers insight into how scarcity is experienced unevenly. Building on arguments that persistent over-extraction requires circular practices, this study explores whether the siege economy enables alternative reconstruction pathways based on resource reuse and social equity rather than growth-driven development (Hassoun, 2025).

2.2. Urbicide and Spatial Violence

The concept of urbicide describes a form of violence directed at the city itself, rather than merely its residents. In Gaza, infrastructural destruction cannot be dismissed as accidental or collateral damage. It is a deliberate strategy to dismantle the physical foundations of urban life and to turn civilian spaces into areas of persistent vulnerability. Urban infrastructure supports daily social activities, mobility, and public health. Its destruction hampers recovery and functions as a tool of modern urban warfare, intensified by the ongoing blockade (McFarlane, 2023; Truelove & Ruszczyk, 2022). Indicators of damage to water, health, education, and electricity systems do more than reveal material loss. They highlight the spatial violence embedded in Gaza's siege economy and provide a lens for analyzing the non-human aspects of urban destruction.

2.3. Sumud Versus Resilience

Resilience has become a dominant framework in sustainability discussions and refers to the ability of social and ecological systems to absorb shocks and adapt while keeping their essential functions. Resilience literature usually sees disruption as occasional and views adaptation as a process of adjustment over time. Sumud, a key concept in Palestinian life, understands siege as a persistent and structurally imposed condition rather than a temporary shock. Explaining sumud highlights the limitations of resilience frameworks in situations of prolonged occupation.

Sumud represents rootedness, political attachment to land, and refusal to be

displaced, operating through collective effort, land-based practices, and participation in local governance (Lubitz, 2018). Practices related to sumud, such as reuse, recycling, and local production, promote environmentally sustainable extraction while building social capital, maintaining public order, and supporting public health. Therefore, sustainability is inseparable from political endurance and collective presence. In this way, sustainability under siege cannot be fully understood through resilience models alone but must be seen within broader struggles over land, resources, and spatial justice (Mashaqi et al., 2025).

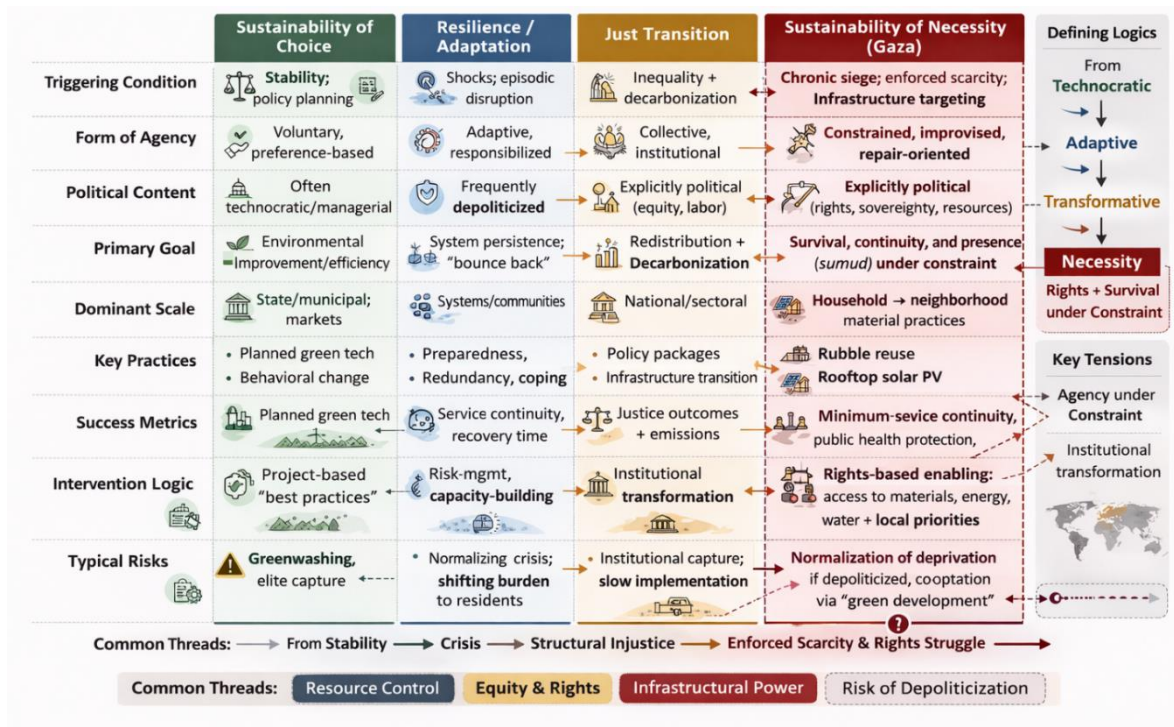
2.4. Innovation of Scarcity

Extreme resource deprivation can encourage circular economy practices that emphasize reuse, recycling, and local production (Chaturvedi et al., 2019). In Gaza, where access to water, energy, and construction materials is severely limited, circular approaches provide immediate material benefits while easing pressure on scarce resources. These practices also address broader socio-economic issues by extending the lifespan of urban assets and lowering the financial burden associated with large-scale reconstruction (Qu, 2025). Scarcity also influences behavior and decision-making. Resource deprivation limits choices and changes evaluation processes, often increasing resource awareness and strategic planning (Hosany and Hamilton, 2023). Under siege, scarcity raises awareness of the political factors affecting access and links humanitarian shortages to military actions targeting civilian infrastructure. This awareness guides sustainability efforts that focus on land, housing, and infrastructure, positioning circular practices as politically informed responses rather than just technical solutions.

Recent studies on Gaza and other conflict-affected contexts show that scarcity and infrastructure disruption can produce localized forms of adaptation and improvisation that go beyond simple coping mechanisms. In the Gaza Strip, prolonged restrictions on electricity, water infrastructure, and construction materials have contributed to the emergence of decentralized solar energy systems, small-scale water treatment practices, and the reuse of rubble in reconstruction (Rantissi et al., 2024; World Bank, 2023). Recent research further highlights that large quantities of demolition waste have been systematically recycled into construction materials such as aggregates and building blocks, forming part of post-conflict recovery practices (AbuHamed et al., 2023). Similarly, energy studies show increasing reliance on decentralized renewable systems, particularly solar energy, in response to chronic electricity shortages (Rantissi et al., 2024; El-Khozondar & El-batta, 2022). However, the literature emphasizes that these practices should not be interpreted as linear innovation processes but as necessity-driven survival strategies shaped by structural constraints, infrastructure breakdown, and political-economic limitations (Hilhorst & Jansen, 2010; Graham & Thrift, 2007). While they demonstrate significant local agency and adaptive capacity, they do not substitute for rights-based reconstruction or equitable access to infrastructure and essential services

(World Bank, 2023; UN OCHA, 2023).

Figure 1. Positioning “Sustainability of Necessity” Among Dominant Sustainability Frameworks Under Conflict Conditions.



Sources: Author’s conceptual synthesis based on Lubitz (2018), Mason et al. (2011), Fischhendler et al. (2022), Blanc (2022), Hamouchene (2023), and Almeida et al. (2023).

As illustrated in Figure 1, sustainability of necessity occupies a distinct analytical position within contemporary sustainability debates. Unlike sustainability of choice, which presupposes relative stability and voluntary policy planning, sustainability of necessity emerges under chronic siege, infrastructural targeting, and enforced scarcity. While resilience frameworks frame disruption as episodic and emphasize system persistence or “bouncing back,” the Gaza case reflects a condition where crisis is continuous rather than exceptional. Similarly, just transition frameworks focus on redistribution and decarbonization within institutional reform processes, whereas sustainability of necessity operates at the household and neighborhood scale through materially grounded practices such as rubble reuse, rooftop solar adoption, and water coping strategies.

The figure highlights three defining features. First, agency under siege is constrained and improvised rather than voluntary or institutionally coordinated. Second, sustainability practices are explicitly political, rooted in claims over rights, sovereignty, and resource control rather than technocratic environmental management. Third, the primary goal shifts from efficiency or transition toward survival, continuity, and presence (sumud) under constraint. The figure also identifies key tensions, particularly the risk that externally driven environmental interventions may depoliticize scarcity and reproduce

forms of green colonialism by reframing structural violence as a neutral development challenge.

By positioning sustainability of necessity alongside dominant frameworks, the figure clarifies that the concept does not reject sustainability as an ideal. Rather, it re-situates sustainability as historically contingent, politically embedded, and shaped by unequal infrastructural power.

2.5. Green Colonialism and Depoliticized Sustainability

Green colonialism refers to the process through which environmental and sustainability agendas become embedded within existing structures of political domination, territorial control, and unequal resource governance. Rather than directly exploiting natural resources, green colonial practices often operate by framing environmental problems as technical or managerial challenges while obscuring the political conditions that produce ecological degradation (Blanc, 2022; Hamouchene, 2023). Within this framework, sustainability interventions may unintentionally legitimize unequal power relations by prioritizing efficiency, adaptation, and resilience without addressing questions of sovereignty, resource rights, and environmental justice.

In conflict-affected territories, environmental programs frequently depend on international donors, development agencies, and humanitarian institutions. While these actors often provide essential support, their interventions may also contribute to the depoliticization of environmental crises when environmental degradation is treated primarily as a problem of infrastructure management rather than a consequence of military occupation, blockade, or territorial fragmentation. Political ecologists therefore argue that sustainability initiatives should be evaluated not only according to environmental outcomes but also according to their implications for local autonomy, resource governance, and political self-determination (Hughes *et al.*, 2023).

In the Gaza context, the risk of green colonialism emerges when sustainability projects focus exclusively on adaptation to scarcity while leaving intact the political and institutional mechanisms that generate scarcity itself. Under such conditions, environmental interventions may improve short-term living conditions yet simultaneously normalize prolonged restrictions and dependency. This distinction is particularly important for understanding sustainability of necessity, which arises from structurally imposed deprivation rather than from voluntary environmental transition (Khalidi, 2020).

3. Contextual Background: The Siege Economy

Israeli restrictions on access and movement, officially called a blockade, have deeply influenced Gaza's socioeconomic structure. The siege mainly functions through a dual-use regulatory system that bans the import of materials considered to have potential military uses. Construction materials like cement, steel, and pipes are central to this system, even

though they are vital for civilian housing, infrastructure repairs, and urban renewal. Regulating these materials has not only been a security measure but also a way to control the economy and space, disproportionately impacting civilian life (Jones et al., 2024; Capone, 2025). Since the 1990s, the construction sector has constituted one of the primary sources of employment for engineering graduates in Gaza and has played a central role in urban development processes. Following the establishment of the Palestinian Authority, construction activities expanded significantly, contributing to private sector growth and labor absorption (World Bank, 2015). However, after the imposition of the blockade in 2007, the sector's development trajectory became structurally constrained due to severe restrictions on the import of construction materials classified as "dual-use" items (UNCTAD, 2015).

Although a limited degree of expansion occurred between 2010 and 2015—largely driven by internationally funded reconstruction initiatives and the temporary easing of certain import channels—the sector remained heavily dependent on externally regulated material flows (World Bank, 2015). The 2014 Gaza conflict further intensified the housing deficit, with extensive destruction of residential infrastructure. By 2015, approximately 40,000 housing units were reported as unfinished or pending reconstruction due to material shortages, regulatory controls, and bureaucratic constraints embedded in the Gaza Reconstruction Mechanism (GRM) framework (UNCTAD, 2015). These conditions indicate the presence of systemic structural barriers rather than temporary cyclical disruptions in the construction market.

Limited access to planning data, uncertainty over permit approvals, and fragmented governance further hindered construction efforts under siege. Meanwhile, strict restrictions on cement, steel, and pipes have led to adaptive practices. These include material replacement and reuse, informal procurement networks, and incremental building methods. Such strategies highlight the dual nature of a siege economy, where scarcity creates both deprivation and innovation, reshaping how people produce and survive without formal rebuilding options. Gaza mostly depends on the coastal aquifer as its only source of freshwater. Power generation and industry rely on limited desalination plants, centralized power stations, and water treatment systems. Electricity production is inadequate, especially in outer urban areas, while wastewater treatment is well below capacity. Less than one-fifth of sewage is properly treated, and only a small part undergoes secondary or tertiary processing, putting heavy pressure on soil, groundwater, and coastal ecosystems (Musallam et al., 2023; Noui & Guesbaya, 2025). Rainwater drainage systems are inadequate for seasonal flooding, causing frequent inundation of urban underground levels and informal housing zones. These conditions worsen water pollution and accelerate infrastructure deterioration. As water quality drops, access to safe drinking water for households has sharply declined, increasing health risks and harming livelihoods (Shomar & Rovira, 2023; Farajallah & Farajallah, 2024).

3.1. The Blockade and the Institutionalization of Protracted Reconstruction

Israel imposed a comprehensive blockade on the Gaza Strip in June 2007 following Hamas's takeover of the Palestinian Authority in Gaza. Officially framed as a security measure, the blockade quickly evolved into a highly institutionalized regime of restrictions on movement and materials, particularly through the classification of "dual-use" items (Barakat et al., 2018; Jones et al., 2024). Construction materials, including cement, steel, aggregates, and certain electrical and water infrastructure components, were either severely restricted or required complex approvals. Although justified on security grounds, these measures effectively constrained large-scale reconstruction and urban development, embedding structural limitations in Gaza's housing and infrastructure sectors (UNCTAD, 2015).

Between 2007 and 2014, Gaza experienced repeated cycles of destruction and partial reconstruction. Material entry was controlled through quota systems and case-by-case approvals, leading to chronic shortages. The blockade not only restricted the supply of construction materials but also limited access to the technical expertise and equipment needed for infrastructure maintenance. As a result, housing deficits widened steadily, while existing infrastructure, including electricity grids, water networks, and sewage systems, degraded at an accelerated pace (Farrant, 2018; Field, 2023; Middle East Institute, 2024).

International donors pledged substantial reconstruction funds following successive escalations. However, implementation remained slow and fragmented due to excessive coordination requirements, permit delays, funding suspensions, and unpredictable border closures. Reconstruction thus became conditional, externally mediated, and politically contingent rather than rights-based and development-oriented (Barakat et al., 2018).

Following the 2014 war, reconstruction efforts were channeled through monitoring frameworks such as the Gaza Reconstruction Mechanism (GRM), which introduced digital tracking and approval systems for construction materials. While intended to facilitate reconstruction, the mechanism further bureaucratized material access. Approval processes, layered verification procedures, and shifting eligibility criteria prolonged rebuilding timelines (UNCTAD, 2015).

During this period, reconstruction increasingly resembled what scholars describe as "protracted recovery" or "permanent temporariness," a condition in which rebuilding is technically ongoing yet structurally incomplete. Despite international aid initiatives often exceeding one million USD per project, only a fraction reached full completion and final approval. Development was hindered not only by material scarcity but also by funding interruptions, donor fatigue, and political volatility (Alagha & Hussein, 2024).

Spatially, new housing developments began emerging on the urban periphery due to land scarcity and planning constraints within central areas. This peripheralization

deepened socio-spatial fragmentation, distancing residents from employment hubs, extended family networks, healthcare services, and educational institutions. Consequently, housing reconstruction did not merely address physical damage but reshaped urban geography and intensified social inequality within the Strip (Guardian, 2026).

The escalation beginning in 2023 marked a structural rupture in Gaza's built environment. The destruction of Gaza's infrastructure during the Israeli military campaign in October and November 2023 was unprecedented in both scale and intensity. Over forty-six days, critical civilian facilities, including health, education, water, and energy systems, were extensively damaged or destroyed across all governorates. The concentration of damage around key civilian infrastructure suggests systematic targeting and raises serious concerns about violations of international humanitarian law (Asi et al., 2024). The extensive destruction of residential neighborhoods, public facilities, and infrastructure drastically reduced the housing stock, transforming an already chronic deficit into an unprecedented shelter crisis. Unlike previous cycles, the scale of damage overwhelmed existing reconstruction frameworks and rendered prior mechanisms functionally inadequate (Jones et al., 2024).

By 2024–2026, reconstruction efforts faced compounded constraints:

- Severe material shortages under tightened entry controls,
- Institutional fragmentation,
- Damaged administrative capacity,
- Funding uncertainty amid shifting geopolitical priorities,
- And the erosion of local construction sector capabilities (Middle East Institute, 2024).

Under these conditions, reconstruction shifted from a development challenge to a humanitarian emergency. Many residents resorted to informal, self-built, or makeshift housing solutions, often lacking compliance with engineering standards, safety regulations, or urban planning codes. The normalization of informal construction further institutionalized precarity within the housing sector (OCHA, 2025).

Moreover, prolonged displacement altered demographic distribution patterns, intensifying overcrowding in certain areas while depopulating others. Urban fragmentation, already present before 2023, deepened into spatial discontinuity, weakening economic networks and social cohesion. Reconstruction, once envisioned as a pathway to recovery, increasingly appeared as an indefinite and politically contingent process (UNCTAD, 2015).

Across the 2007-2026 period, the blockade evolved from an immediate security response into a structural condition shaping Gaza's urban trajectory. Rather than producing temporary hardship followed by recovery, the regime of restriction institutionalized chronic underdevelopment, infrastructural fragility, and housing

precarity. Recurrent destruction combined with constrained reconstruction has generated a cyclical system in which rebuilding rarely restores pre-destruction capacity, let alone enables growth (Barakat et al., 2018; UNCTAD, 2015).

In this sense, Gaza's reconstruction cannot be understood as a linear post-conflict recovery process. Instead, it represents a prolonged, externally mediated, and structurally constrained condition in which urban life is continuously rebuilt yet persistently destabilized (Jones et al., 2024; Middle East Institute, 2024; OCHA, 2025).

3.2. The Environmental Crisis

The blockade has triggered a serious environmental crisis in Gaza, notably impacting groundwater resources, electricity supply, and waste management systems. The coastal aquifer, Gaza's main water source, is near collapse. Water is available for an average of only fifteen hours a day, and about 95 percent of groundwater is unsafe for drinking due to salinization and pollution (Zeitoun et al., 2017; Shomar & Rovira, 2023). Electricity shortages worsen these issues. Insufficient power disrupts hospital operations, food storage, wastewater treatment, and schools, undermining basic living conditions. Waste management systems are also overwhelmed. Daily solid waste ranges from 2,600 to 3,500 metric tons, yet less than a quarter is collected regularly. Accumulated waste blocks drainage channels and damages urban environments (Davidson, 2006). Wastewater treatment covers only a small part of sanitation needs. Untreated sewage is often discharged into soil and waterways, increasing the risk of waterborne diseases such as cholera, hepatitis, and other infectious illnesses. These environmental pressures together threaten the long-term survival of civilian life in Gaza.

The water crisis is one of Gaza's most severe environmental challenges. Decades of over-extraction, seawater intrusion, and inadequate infrastructure maintenance have significantly degraded the quality of the coastal aquifer, which remains the territory's primary freshwater source. Studies indicate that the vast majority of groundwater fails to meet safe drinking-water standards, increasing reliance on desalination facilities, bottled water, and household filtration systems (Shomar & Rovira, 2023; Musallam et al., 2023). Restrictions on infrastructure repair and the import of essential materials have further limited water authorities' capacity to address long-term deterioration.

Energy insecurity is a second major dimension of the environmental crisis. Chronic electricity shortages affect nearly every aspect of daily life, including healthcare delivery, education, food preservation, water pumping, and wastewater treatment. Limited fuel availability and repeated damage to energy infrastructure have contributed to a persistent gap between electricity demand and supply. In response, many households and institutions have increasingly relied on decentralized energy solutions, particularly rooftop solar systems, to compensate for unreliable grid access (Fischhendler et al., 2022; El-Khozondar & El-batta, 2022). At the same time, deficiencies in solid-waste management

and wastewater treatment continue to pose significant environmental and public-health risks, contributing to pollution of coastal ecosystems, groundwater resources, and densely populated urban areas (UNEP, 2024a; Musallam et al., 2023).

3.3. Aid Dependency and Local Agency

The blockade has systematically restricted access to construction materials and dual-use items, constraining both public and private investment in housing, infrastructure, and essential service provision (Miller, 2016). These restrictions have not only delayed reconstruction but have also weakened long-term infrastructural planning and maintenance capacity. In response to deteriorating water quality and persistent material shortages, local authorities and households have adopted a range of adaptive coping strategies. Within the Strip, neighborhoods have developed different coping strategies by negotiating access to materials and services through local collective mobilization. These strategies include the drilling of additional (often informal) wells, the installation of household-level filtration systems, and the expansion of small-scale reverse osmosis units. While such measures provide short-term mitigation and reflect localized forms of agency under constraint, they remain technically palliative rather than structurally transformative (Musallam et al., 2023; Hassoun, 2025).

4. Methodology

4.1. Research design

This study employs a qualitative research design based on document analysis. Ongoing access restrictions caused by the blockade make sustained fieldwork in Gaza impossible. In these conditions, document-based qualitative inquiry offers a rigorous and ethically suitable way to examine socio-environmental dynamics under siege. Rather than replacing the lack of field data, this approach aligns methodologically with the study's goal of analyzing structural conditions, governance regimes, and material practices shaping sustainability in Gaza.

4.2. Data sources

The primary empirical material for this study consists of institutional and policy reports published between 2010 and 2025 by the United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA), the United Nations Environment Programme (UNEP), and the World Bank. These documents provide longitudinal assessments of environmental degradation, infrastructure damage, access to basic services, and reconstruction constraints under prolonged blockade conditions. Reports addressing water and sanitation systems (WASH), environmental impact assessments, conflict-generated rubble, and large-scale infrastructure damage constitute the core documentary basis of the environmental analysis.

Rather than relying on independently collected primary datasets, the study draws

on technical data as reported within these institutional assessments. These include documented figures and sectoral analyses concerning electricity supply deficits, fuel dependency, construction debris volumes, groundwater quality and salinization trends, and wastewater treatment capacity and discharge practices. The analysis interprets these reported technical indicators as evidence of cumulative environmental stress and infrastructural attrition associated with repeated military escalations and movement restrictions.

To contextualize and critically assess institutional reporting, the study triangulates these documents with a systematic review of peer-reviewed academic literature on Gaza's infrastructure, urban development, water security, and environmental governance. Academic studies are treated not as independent primary data, but as analytical sources that provide sectoral depth, methodological clarification, and political-economic interpretation. This three-layered approach combining humanitarian documentation, reported technical sectoral data, and scholarly analysis strengthens interpretive reliability and enables a governance-oriented understanding of how sustainability practices evolve under conditions of structural restriction and recurrent infrastructural disruption.

4.3. Analytical strategy

A total of 58 documents were systematically analyzed using thematic analysis. These documents comprised institutional policy reports (e.g., World Bank, UNEP, UN-OCHA), technical environmental assessments, and peer-reviewed academic literature. To manage, organize, and code the textual data, manual coding was used instead of qualitative data analysis software, given the relatively contained dataset and the iterative, interpretive nature of the analysis.

The thematic analysis followed a structured five-stage process to ensure methodological rigor and analytical transparency. First, during the familiarization stage, all selected documents were read repeatedly to develop a comprehensive understanding of the dataset and the broader context of the Gaza siege economy. Second, in the initial coding stage, data were systematically coded to capture meaningful segments related to resource access, infrastructure deterioration, adaptive material practices, and spatial governance challenges. Third, during the theme development stage, these initial codes were grouped into broader analytical themes, with particular focus on how scarcity is framed, governed, and reinterpreted by both local actors and international institutions. Fourth, in the review stage, the emerging themes were continuously checked against coded extracts and the full dataset to ensure conceptual coherence, internal consistency, and representational accuracy. Finally, in the interpretation stage, the themes were refined and synthesized into an integrated analytical narrative.

This entirely desk-based document analysis, which excludes any fieldwork or interviews due to access constraints and methodological design, does not aim to measure

causal impact or evaluate program effectiveness. Instead, it seeks to understand how sustainability practices emerge and evolve under conditions of prolonged restriction and structural deprivation. Through this analytical approach, sustainability is conceptualized as a necessity-driven process rather than a product of voluntary environmental choice.

4.4. Contextual and temporal framing

The analysis is situated within the broader environmental governance regime that has shaped Gaza since the imposition of the blockade in 2007. The blockade operates through a dual-use regulatory system that restricts the import of materials categorized as potentially usable for military purposes, including cement, steel, and essential piping. These restrictions have systematically constrained reconstruction capacity, infrastructure maintenance, and long-term service provision across water, sanitation, energy, and housing systems (World Bank, European Union, & United Nations, 2021). In governance terms, the regulatory framework has limited not only material inflows but also institutional planning capacity, thereby embedding infrastructural fragility within the territory's development trajectory.

The study's temporal scope (2010–2025) was chosen to capture a full cycle of environmental degradation, reconstruction, and adaptation under prolonged siege conditions. The period encompasses several major military escalations and their environmental consequences, including the 2012 conflict (Operation Pillar of Defense), the 2014 war (Operation Protective Edge), the May 2021 escalation, the 2022 conflict (Operation Breaking Dawn), and the ongoing war that began in October 2023 and remained active throughout the study period. Examining these successive episodes within a single analytical framework allows the study to trace how sustainability practices evolved across repeated cycles of destruction and reconstruction, rather than as responses to a single conflict event. The endpoint of 2025 was selected because it represents the most recent period for which comprehensive institutional assessments and environmental reports were available at the time of writing.¹

The 2014 hostilities resulted in widespread destruction of housing and critical infrastructure, with thousands of residential units destroyed and extensive damage reported across electricity and water networks. Although reconstruction initiatives followed, persistent movement and access restrictions continued to constrain recovery processes. The May 2021 escalation generated additional physical damages estimated between US\$ 290–380 million, while economic losses were assessed between US\$ 105–190 million. Immediate and short-term recovery and reconstruction needs were projected between US\$ 345–485 million, with the housing sector accounting for the largest share of

¹ One of the authors is a native resident of Gaza and has personally witnessed the major military escalations that occurred during the study period, including the conflicts of 2012, 2014, 2021, 2022, and the ongoing war that began in October 2023. While this experience did not constitute a primary data source, it informed the contextual understanding of the temporal scope selected for the study.

losses (World Bank, European Union, & United Nations, 2021).

More recently, the 2025 Interim Rapid Damage and Needs Assessment (IRDNA) identified a substantial intensification of infrastructural damage. The report estimated approximately US\$ 30 billion in physical damages and US\$ 19 billion in economic losses, with total recovery and reconstruction needs projected at over US\$ 53 billion over the coming decade (World Bank, United Nations, & European Union, 2025). From an environmental governance perspective, these successive assessments demonstrate not merely episodic destruction but the cumulative consequences of prolonged material restrictions, fragmented reconstruction authority, and constrained institutional capacity. Rather than enabling adaptive or resilient governance, the regulatory environment has generated recurrent infrastructural disruption and limited sustainability planning capacity under conditions of chronic instability.

4.5. Empirical focus

The empirical data highlight significant deficiencies in basic services. Gaza's population of approximately 2.28 million residents living within 365 square kilometers experiences only a few hours of electricity daily. Access to safe drinking water and proper sewage treatment remains severely limited. Nearly two million tons of rubble from repeated bombings impede reconstruction efforts, while groundwater sources often do not meet national water-quality standards for much of the population (Al Butmah et al., 2013). Energy consumption data from 2006 to 2023 reveal notable fluctuations linked to military escalations and infrastructure damage. Estimates suggest that the rubble amounts to several million tons of concrete and debris scattered across densely populated areas, including large piles in Gaza City and other centers. These conditions form the empirical basis for analyzing sustainability practices under siege.

4.6. Availability of data and materials

The study is based on publicly available institutional reports and peer-reviewed publications. All documents analyzed in this research are accessible through the official websites of the United Nations Office for the Coordination of Humanitarian Affairs (UN-OCHA), the United Nations Environment Programme (UNEP), the World Bank, and academic journal databases. No new primary datasets were generated or analyzed during the current study.

4.7. Analytical scope and limitations

Data limitations prevent a quantitative assessment of the environmental or social impact of sustainability initiatives. Instead, the analysis focuses on identifying material practices that continue despite urban violence and infrastructural collapse. Three such practices are examined: the repurposing of construction rubble to reduce reliance on imported aggregates; the decentralized adoption of rooftop solar photovoltaic systems to lessen dependence on external electricity sources; and water-related measures including

rainwater harvesting and small-scale desalination. Although often pursued for immediate household or community benefits, the cumulative expansion of these practices helps restore social support structures and collective capacity. The study conceptualizes these emerging dynamics as a form of non-violent resistance ecology, rooted in everyday material practices rather than formal political mobilization.

5. Findings and Analysis

Civil infrastructure in Gaza was already fragile before 2007 due to long-term occupation governance, chronic underinvestment, and fragmented public administration. The blockade did not just add pressure to this system; it transformed pre-existing vulnerabilities into a low-intensity siege economy where external funding seldom results in locally initiated, context-appropriate construction and rehabilitation. In this environment, humanitarian efforts tend to maintain minimal service provision while leaving the political and material barriers that hinder infrastructural recovery largely unchanged (Mason et al., 2011; Hassoun, 2025). Across key sectors, the evidence shows ongoing deterioration of environmental and infrastructural standards. Water insecurity remains the most documented issue. OCHA reports have long shown that approximately 97 percent of groundwater drawn in Gaza is unsafe for drinking according to WHO standards, due to over-extraction, salinization, pollution, and restrictions that limit system-wide repairs (OCHA, 2018). After October 2023, UNEP's preliminary assessment described water, sanitation, and hygiene systems as nearly non-functional, with all five wastewater treatment plants shut down, worsening contamination risks across coastal waters, soils, and freshwater sources (UNEP, 2024a).

Peer-reviewed studies on the aquifer further support these findings by highlighting how human pressures and seawater intrusion are driving declining groundwater quality (Musallam et al., 2023). Similarly, geospatial analysis shows that critical civilian infrastructure has been extensively affected. Data from the first phase of the October to November 2023 military campaign reveal widespread damage to health, education, and water facilities, with clustering around essential infrastructure, raising important legal and governance concerns and clarifying the material limits for any reconstruction efforts (Asi et al., 2024). The key point is that reconstruction is not a separate post-conflict phase outside the siege; it is an ongoing struggle over access to materials, energy, and repair capacity under conditions of enforced scarcity. Meanwhile, the findings also reveal that sustainability practices in Gaza are not merely auxiliary to reconstruction agendas; they constitute a vital parallel infrastructure for survival, repair, and partial autonomy. These practices have expanded into gaps created by stalled formal reconstruction and limited institutional capacity, serving as socio-technical responses to structural deprivation rather than purely environmental initiatives (Fischhendler et al., 2022; Hassoun, 2025).

5.1. Material Practices: From Rubble to Reconstruction

The blockade-era construction economy is characterized by two interacting dynamics: limited access to cement, steel, and aggregates, and the repeated generation of conflict-related debris. The result is a material landscape where rubble serves both as a hazard and a resource. UNEP estimates that conflict-related debris occurs on an unprecedented scale, highlighting the environmental and logistical challenges of debris management and the risk of hazardous contamination within mixed rubble streams (UNEP, 2024a; UNEP, 2024b). This shifts the analytical focus from traditional reconstruction supply chains to localized material recovery and reprocessing.

Table 1. Indicators of the Gaza Environmental and Infrastructure Crisis (2010–2025)

Sector	Indicator	Estimated Condition	Structural Drivers	Source
Water	Groundwater is unfit for human consumption	95–97%	Over-extraction, salinisation, and infrastructure repair restrictions	Zeitoun et al. (2017); OCHA (2018); Shomar & Rovira (2023)
Water	Average daily piped water supply	~12–15 hours/day	Electricity shortages, restrictions on pipe imports	Mason et al. (2011); Noui & Guesbaya (2025)
Wastewater	Treated wastewater share	<20% (secondary/tertiary treatment extremely limited)	Power deficits, damaged treatment facilities	Musallam et al. (2023); UNEP (2024a)
Energy	Average daily electricity availability	4–8 hours/day (with spatial variation)	Fuel access constraints, power plant damage	Fischhendler et al. (2022); Hassoun (2025)
Energy	Household-level solar PV adoption	Rapidly increasing but fragmented	Avoidance of dependence on the central grid	El-Khozondar & El-batta (2022)
Solid Waste	Daily solid waste generation	2,600–3,500 tons/day	Insufficient collection capacity	Davidson (2006); UNEP (2024b)
Built Environment	Conflict-generated rubble volume	Several million tons (sharp increase after 2023)	Recurrent bombardment, reconstruction restrictions	UNEP (2024a); Abdelnour (2025)
Housing	Incomplete housing units (2015)	~40,000 units	Cement and steel import restrictions	Mason et al. (2011)

Within this context, rubble recycling and on-site material recovery become practical workarounds for reconstruction. Evidence shows that small crushers and local processing networks have been in operation for years, producing substantial monthly amounts of recycled aggregates that support low-grade construction and limited repairs when imports are restricted (Abdelnour, 2025). These practices reduce reliance on imported aggregates and help reopen economic opportunities for local entrepreneurs, even though they cannot fully replace access to standardized construction materials.

Analytically, rubble recycling should be viewed as a form of infrastructural pragmatism under siege rather than a green transition. It serves as a technical adaptation to enforced scarcity that also carries social meaning: rebuilding becomes an act of maintaining social continuity and livability under conditions where formal planning is repeatedly disrupted (Molavi, 2024; Hassoun, 2025).

Table 1 summarizes key indicators of Gaza's environmental and infrastructural crisis under siege conditions, showing how water insecurity, energy shortages, waste buildup, and lack of construction materials form a system of deprivation that is structurally produced rather than due to isolated sector failures.

5.2. Energy Sovereignty: The Solar Transition

Chronic electricity deficits and fuel insecurity have made rooftop photovoltaic systems one of the most visible and scalable bottom-up energy solutions. Household-level solar adoption in Gaza is widely documented as a response to unreliable grid supply and fuel dependency, with systems designed to ensure minimal continuity for domestic life and small institutions (El-Khozondar & El-batta, 2022). Rather than reflecting a traditional policy-driven renewable transition, this expansion is better understood as a necessity-driven pursuit of energy sovereignty. Political economy research further explains why and how this transition happens under contested governance. Fischhendler et al. (2022) demonstrate that renewable energy development in Gaza is influenced by the interplay between geopolitical conflict, permissions, and infrastructural control, creating a paradox where decentralized solar systems serve as both a coping strategy and a partial workaround for centralized energy vulnerabilities (Fischhendler et al., 2022). In other words, solar adoption functions as a de facto energy policy generated from below, not as a government-led transition.

The findings thus support a core argument of this study: sustainability practices under siege are fundamentally rooted in survival and repair. They are not primarily driven by environmental awareness narratives but by infrastructural deprivation, disrupted supply chains, and the need to stabilize everyday life through decentralized systems.

5.3. Water and Urban Resistance

Water-related practices demonstrate how sustainability becomes part of daily resilience during crises. The ongoing decline in groundwater quality and limited institutional repair capacity have led communities to develop coping strategies at the household and neighborhood levels, such as small desalination units, filtration systems, and water storage solutions. Although these measures do not solve structural scarcity, they help shift risk and offer some protection against supply disruptions and system failures (OCHA, 2018; Farajallah & Farajallah, 2024). Moreover, increased groundwater extraction accelerates aquifer depletion and salinization, intensifying long-term environmental degradation and obscuring the structural drivers of infrastructure decline. Hydrogeological studies highlight the critical nature of the water crisis, showing how seawater intrusion and human activities threaten the future of coastal aquifers, making recovery impossible without major infrastructure intervention (Musallam et al., 2023). In sanitation, governance-focused research points to issues with incentives and coordination that hinder service delivery, explaining why sanitation systems remain vulnerable despite available technical solutions (Zaqout, 2023).

Recent escalations reported by UNEP indicate that wastewater treatment shutdowns and widespread failures in WASH systems have caused serious contamination risks with long-term environmental impacts on marine and land ecosystems (UNEP, 2024a). These conditions transform water practices into an urban politics of endurance: instead of overt conflict, it involves the material work of maintaining life, health, and household routines under structural constraints. Overall, the evidence shows that water, energy, and material recovery practices form a connected web of survival infrastructure. These systems help reduce siege impacts, stabilize aspects of urban life, and expand options for rebuilding when formal reconstruction is blocked.

6. Discussion and Results

This study demonstrates that environmental sustainability in Gaza emerges primarily as a necessity-driven practice rather than a voluntary environmental choice. While sustainability is commonly associated with lifestyle preferences, technological progress, or policy-driven environmental goals, the Gaza case reveals a fundamentally different political and material context. Under prolonged blockade, occupation governance, and repeated infrastructural destruction, sustainability practices develop from the need to manage everyday survival rather than from normative environmental awareness. These practices remain deeply connected to the spatial and political conditions that shape access to land, water, energy, and construction materials (Mason et al., 2011; Hassoun, 2025; Asi et al., 2024).

The findings support the concept of resistance ecology, which refers not to the deliberate adoption of environmentally innovative technologies but to material practices

that enable population survival, preserve social cohesion, and maintain essential infrastructures under conditions of structural constraint. In Gaza, such practices often involve decentralized solar energy systems, rubble reuse in construction, and adaptive water management strategies. These practices partially counter the systematic weaponization of environmental resources—particularly water and energy—by creating limited autonomy through decentralized provision, repair, and improvisation. In this sense, sustainability initiatives function as nonviolent strategies of persistence that allow continued presence on the land despite severe restrictions (Banerjee et al., 2023; Fischhendler et al., 2022).

However, the analysis also highlights the limitations and risks associated with externally driven sustainability interventions. Sustainability initiatives designed outside the local political context, or those prioritizing technocratic environmental goals while ignoring occupation and structural violence, risk reproducing forms of green colonialism. In such cases, sustainability becomes detached from lived experience and is reframed as politically neutral development, potentially reinforcing existing power asymmetries and systems of deprivation (Blanc, 2022; Hamouchene, 2023; Almeida et al., 2023). External support may strengthen local initiatives only when it acknowledges political rights over environmental resources and aligns with local priorities and practices.

From a political ecology perspective, the Gaza case illustrates that access to and control over environmental resources are central political questions rather than peripheral environmental concerns. Local adaptations and innovations do not dismantle the broader structures of domination that shape everyday life. Nor should they be interpreted as evidence of inherent resilience detached from political conditions. Instead, they represent pragmatic responses to enforced scarcity that stabilize fragments of urban life without addressing the structural causes of vulnerability (Mason et al., 2011; Hassoun, 2025).

These practices therefore fall within what this study conceptualizes as sustainability of necessity. Unlike sustainability of choice—typically associated with environmentally conscious development in relatively stable contexts—sustainability of necessity is characterized by material reduction, incremental adaptation, and collective improvisation under conditions of deprivation. Interpreting these practices through a political ecology lens restores their political significance, which is often obscured when they are framed merely as coping mechanisms or technical fixes. Sustainability, in this context, should be understood not as a universal model but as a historically and politically situated practice shaped by unequal power relations (Banerjee et al., 2023; Almeida et al., 2023).

Importantly, survival in Gaza cannot be understood solely as passive endurance or humanitarian crisis. The findings indicate that survival itself can become an active form of nonviolent resistance. Through everyday practices related to housing reconstruction, decentralized energy generation, and water management, communities sustain social life

despite extremely limited access to basic resources. Survival and spatial degradation are therefore not equivalent processes. Instead, survival practices represent deliberate attempts to maintain social continuity within a landscape shaped by structural violence (Lubitz, 2018; Fischhendler et al., 2022; Asi et al., 2024).

The study also reveals that development and reconstruction policies in Palestine are rarely politically neutral. Many sustainability-oriented interventions are designed externally and implemented through fragmented institutional mechanisms. Even when motivated by humanitarian goals, such interventions often operate within a broader political economy that shifts attention away from issues of rights, sovereignty, and resource control toward narrow technical solutions. As a result, sustainability of necessity should not be mistaken for a pathway to transformation as suggested by resilience or just transition frameworks. Instead, it reflects a locally grounded relationship between environmental practices, political ecology, and *sumud*—a form of political endurance rooted in continued presence on the land.

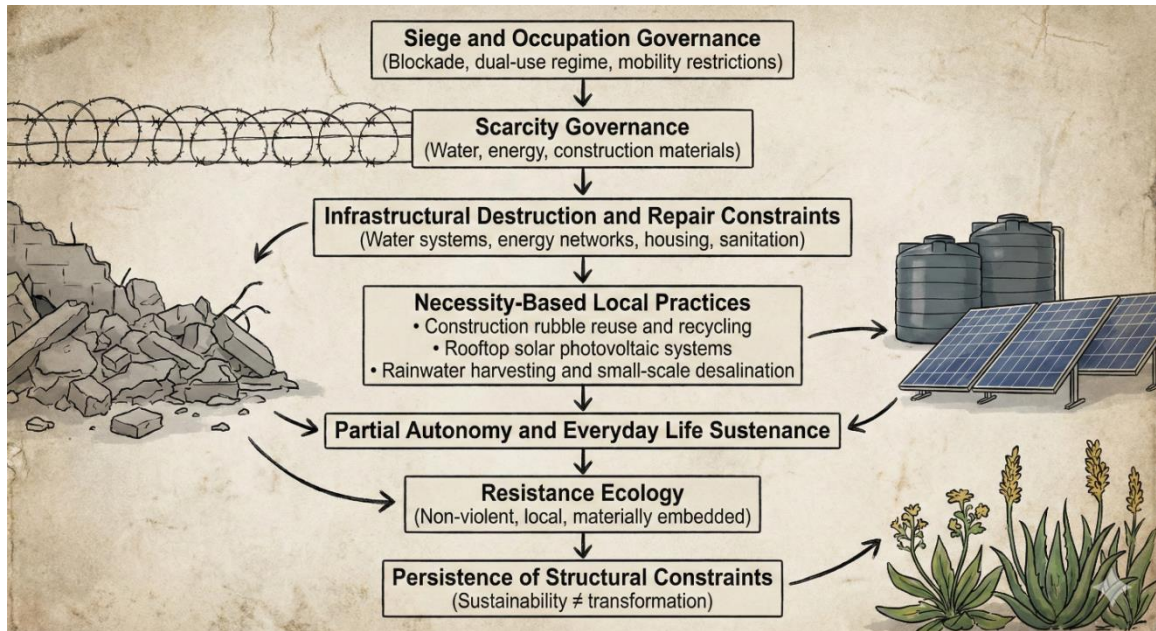
Critiques of green colonialism therefore do not reject sustainability as a normative ideal but emphasize the importance of autonomous and context-specific approaches that are not subordinated to external funding priorities or geopolitical interests (Lubitz, 2018; Blanc, 2022; Hamouchene, 2023). Promoting sustainability without addressing inequality, exploitation, and political violence risks turning environmental discourse into a mechanism of domination rather than a pathway toward justice.

Figure 2 conceptualizes this relationship by illustrating sustainability of necessity as a politically situated process emerging under prolonged siege conditions. Rather than representing a normative environmental policy model, sustainability practices in Gaza arise from structurally produced scarcity and infrastructural destruction. The framework demonstrates how siege governance leads to resource deprivation, which in turn produces locally embedded practices—such as rubble reuse, decentralized solar energy production, and adaptive water strategies—that support everyday survival and partial autonomy. These practices form a type of resistance ecology that mitigates environmental and social collapse without eliminating the structural conditions of domination that produce scarcity.

The analysis further indicates that sustainability of necessity has implications beyond the Gaza context. Similar patterns can be observed in other regions experiencing prolonged conflict, occupation, or infrastructural warfare. In Yemen, for example, the destruction of water systems and energy infrastructure has generated locally improvised practices such as water reuse and decentralized energy production. In the West Bank, fragmented governance and land control regimes produce uneven sustainability practices linked to land retention and agricultural adaptation. The recent conflict in Ukraine also illustrates how rubble reuse, decentralized energy systems, and emergency water supply strategies function as mechanisms of urban survival rather than indicators of green

transition. Across these contexts, environmental practices operate primarily as mechanisms of social reproduction under structural violence rather than as markers of resilience or recovery.

Figure 2. Sustainability of Necessity under Siege: A Political Ecology Framework



Sources: Author's conceptual synthesis based on Mason et al. (2011), Fischhendler et al. (2022), Hassoun (2025), Asi et al. (2024), and UNEP (2024a).

These findings suggest that sustainability frameworks developed for stable, post-industrial contexts cannot be uncritically applied to conflict zones. Instead, recognizing sustainability of necessity as a distinct analytical category enables a more accurate understanding of environmental practices in situations shaped by occupation, siege, and infrastructural destruction. Such recognition also helps prevent the depoliticization of sustainability discourse in contexts where environmental governance is inseparable from questions of power, sovereignty, and justice.

Ultimately, politicizing sustainability is essential for understanding how social life continues under siege conditions. In Gaza, sustainability practices are not expressions of environmental ideology but minimum material requirements for maintaining everyday life. Recognizing this distinction is crucial for designing reconstruction and environmental policies that prioritize justice, autonomy, and collective survival rather than reproducing depoliticized development agendas. Future research should therefore explore how sustainability of necessity operates in other contexts of prolonged political violence and infrastructural warfare, and how environmental governance can support local agency without reinforcing existing structures of domination.

Author Contribution Statement

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