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Urban infrastructure under occupation: Reimagining sustainability in Beita municipality

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ABSTRACT

Urban infrastructure in occupied territories is shaped more by political constraint than technical design. This study explores how Israeli occupation affects essential systems–water, electricity, roads, and waste management—in the West Bank town of Beita. Drawing on interviews with municipal officials, engineers, business owners, youth leaders, and residents, it reveals a landscape of infrastructural decay, bureaucratic obstruction, and spatial neglect. Despite these challenges, residents have adopted adaptive strategies such as improvised repairs, shared water storage, and informal livelihoods. These grassroots efforts reflect a form of resilience rooted in everyday resistance and community cooperation. While local institutions attempt to sustain basic services, their work is often limited by external political control and inconsistent aid. The study contributes to political ecology and decolonial urbanism by arguing that sustainability under occupation is a contested, collective practice shaped by power and place. It calls for context-sensitive urban planning that centers local agency in militarized settings.

Introduction

Urban infrastructure is widely recognized as the foundation of sustainable development, supporting the social, economic, and environmental well-being of cities worldwide [1]. However, in contexts marked by protracted political conflict and military occupation, these essential systems face persistent disruption, fragmentation, and deliberate manipulation, challenging prevailing frameworks of urban resilience and sustainability [2]. The Palestinian territories, particularly the West Bank, exemplify such contested urban environments, where Israeli military occupation, land confiscation, and settlement expansion impose severe constraints on urban development and service provision [3].

Despite growing scholarship on urban ecology and sustainability in conflict-affected regions, there remains a significant gap in understanding how occupation-specific political and material pressures actively reshape urban infrastructure and its sustainability outcomes. This study addresses this gap by focusing on Beita Municipality—a microcosm of broader territorial struggles—to explore how critical infrastructure sectors, including water supply, electricity, waste management, and transportation, are impacted by these constraints and how local actors respond.

The central problem guiding this research is the complex interaction between infrastructure vulnerability and political control mechanisms under occupation, which produce systemic barriers to coherent urban development and sustainable service delivery. These barriers are not merely technical challenges but reflect broader dynamics of spatial injustice and political exclusion that limit the community's capacity to pursue sustainable growth and resilience.

Using a mixed-methods approach—combining qualitative interviews with municipal officials, residents, and civil society representatives, alongside detailed document analysis—this study uncovers the everyday strategies of adaptation, grassroots resilience, and subtle resistance that sustain urban life amid infrastructural instability. These findings contribute to expanding current debates on urban sustainability by emphasizing the inseparability of political context, social agency, and infrastructural realities in conflict zones [4,5].

While urban sustainability is conventionally framed through environmental stewardship, economic viability, and social equity [5,6], in Palestine, it must also be understood through the lens of ongoing political struggle and occupation-induced spatial fragmentation. For example, restrictive planning policies, especially in Area C, enforce a "planning siege" that limits urban expansion and consolidates control through the withholding of building permits [11]. This socio-political context creates a fragmented urban fabric, complicating infrastructure development and challenging conventional approaches to sustainable urban planning [7].

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Moreover, existing literature recommends integrated, multi-sectoral urban strategies such as compact design, mixed land use, and enhanced public transportation to foster sustainability [12,13]. Yet, in Beita and similar contexts, factors such as high population growth, land scarcity, and occupation-imposed restrictions amplify the difficulties of applying these models, necessitating innovative, context-sensitive solutions that reflect local realities.

This study thus situates itself at the intersection of urban ecology, political geography, and conflict studies to provide a nuanced understanding of how infrastructure systems in Beita are both constrained and transformed by occupation. It offers empirical insights and theoretical contributions that challenge purely technical or depoliticized views of urban sustainability, advocating for frameworks that incorporate political, social, and behavioral dimensions central to contested urban spaces.

This study also connects to the United Nations Sustainable Development Goals (SDGs), specifically SDG 6 (Clean Water and Sanitation), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 11 (Sustainable Cities and Communities). By examining how occupation-related infrastructural disruptions limit access to water, electricity, and transportation, the study highlights critical barriers to these goals in conflict-affected areas. Understanding local adaptation strategies further emphasizes the need to integrate political and social realities when pursuing sustainable urban development in contested regions.

Geopolitical and infrastructural context of Beita

Beita, a town southeast of Nablus, occupies a critical geopolitical position in the northern West Bank. Its proximity to major transit routes and agricultural zones has made it a focal point of both Palestinian resilience and Israeli settler-colonial expansion. The town's most strategic site, Mount Sabih (Jabal Sbeih), connects northern and central parts of the West Bank and is collectively owned by families from Beita, Qabalan, and Yatma [18]. Since 2021, it has become a national symbol of popular resistance against the establishment of the illegal Evyatar outpost by Israeli settlers.

Beita's residents, known as the "Guards of the Mountain," have organized sustained, community-led resistance campaigns—including night confusion tactics, sit-ins, and public mobilization—to prevent further colonization. These actions have led to significant Israeli military retaliation. Between May 2021 and May 2022, Israeli forces killed ten residents, injured over 6,400 protesters, and imposed collective punishment measures such as arbitrary arrests, road closures, and obstruction of emergency medical services [18]. These repressive tactics have left lasting psychosocial and economic impacts on the community.

This struggle is situated within a broader pattern of environmental and infrastructural degradation under occupation. Since 1948, Israeli policies have included the construction of bypass roads, the apartheid wall, and military outposts, all of which fragment Palestinian land, disrupt ecological systems, and hinder sustainable rural development [21,23,29,30]. In Beita and surrounding areas, such measures have led to restricted access to agricultural zones, habitat loss, uprooting of olive trees, and the erosion of agrobiodiversity [31,34].

Despite these systemic pressures, Beita represents a unique model of grassroots resilience. Here, infrastructure is not merely physical—it is political and symbolic. Local resistance transforms contested terrain into a site of agency, adaptation, and struggle for self-determination [18,35]. The case of Beita underscores how Palestinian communities reframe sustainability not through elite urban planning but through collective defiance rooted in place-based knowledge and intergenerational resistance.

Study area: The town of Beita

Beita is a Palestinian town in the Nablus Governorate, located roughly 15 km southeast of Nablus city. Formerly part of the El-Beitawy District, the town's name comes from the Arabic word bayt, meaning a house or place of shelter and calm. Historically, Beita served as a resting point for pilgrims and people traveling from northern Palestine, who viewed it as a safe haven, according to the Beita Municipal Council. The town is known for its natural beauty and abundant olive harvests [15]. Positioned centrally, Beita functions as a service center for nearly 30 nearby communities south of Nablus [16].

Its population has steadily grown—from 9,079 in 2007 to 11,682 in 2017, reaching 12,267 by 2022. Beita spans about 8.27 square kilometers, resulting in a population density of approximately 1,483 residents per square kilometer. The town also holds significant archaeological and historical value. Notably, Al-Urma Mountain contains ancient Roman remnants, including tomb caves, which have drawn attention from both Israeli settlers and archaeologists aiming to claim the site for settlement development. Other heritage sites include the Abu Zakari Shrine, dating back to the Crusader period, and various ruins such as Khirbit Olim, Khirbet Rojaan, and Al-Bal'a—a cave featuring pottery fragments and wall carvings [17].

One of the most politically and strategically significant sites in Beita is Mount Sabih. This mountain is vital not only for its agricultural value—owned by Palestinian families from Beita, Qablan, and Yatma—but also for its strategic location connecting the northern and central parts of the West Bank [18] (Jabali et al, 2024). Its occupation disrupts geographical continuity in the region. Since 1984, when Israel built the "Samaria Crossing" road, Mount Sabih has been a site of active resistance. Most notably, in May 2021, Israeli settlers established the illegal outpost "Avitar," prompting mass mobilization from Beita's residents who viewed the occupation as a direct violation of their land rights. Mount Sabih has since become a national symbol of grassroots resistance [18].

Literature review

The environmental conditions in the Palestinian territories, particularly in areas like Beita, have reached a critical state largely due to over 75 years of Israeli military occupation and colonization [19,20]. Prior research has documented various dimensions of environmental degradation, including the impact of Israeli settlements and urban expansion on natural landscapes [21,22], biodiversity loss linked to the apartheid wall [23], resource exploitation [24], and the influence of industrial and military settlements on ecosystems [25]. However, these studies often remain isolated within specific topics and lack a cohesive analysis of how prolonged conflict systematically reshapes ecological systems and undermines sustainability across multiple scales [26,27].

There is a notable gap in understanding the comprehensive effects of ongoing conflict phases—including militarization, active violence, and post-conflict conditions—on environmental degradation and urban infrastructure. The military infrastructure such as roads, outposts, and barriers not only serve strategic security aims but also facilitate land confiscation, fragment habitats, and disrupt ecological balance [28,29]. These disruptions profoundly affect natural water flows, wildlife, and agricultural biodiversity, further exacerbating challenges to sustainable land use and rural development in communities near Beita [20,23,30–34].

Moreover, the widespread confiscation of land and destruction of olive groves exemplify the direct linkage between ecological damage and socio-political control in the West Bank [35]. This intersection threatens not only environmental sustainability but also the livelihoods and cultural practices rooted in land stewardship.

In this context, Beita emerges as a vital case for examining how environmental degradation, infrastructure control, and political occupation converge to produce complex sustainability challenges. Importantly, Beita also exemplifies grassroots resistance, where local adaptive strategies intertwine environmental resilience with political struggle. Contrastingly, other Palestinian urban projects like Rawabi represent elite-driven, capitalist-oriented development, emphasizing divergent

urban responses and political narratives under occupation [36].

This review highlights a critical research gap: the need for an integrated theoretical framework that situates infrastructure and environmental sustainability within the socio-political realities of military occupation. Addressing this gap requires moving beyond fragmented environmental or urban studies to adopt interdisciplinary perspectives that combine political ecology, urban resilience, and resistance theory.

Study purpose and objectives

Building on this gap, the present study aims to investigate how Beita's urban infrastructure sectors—specifically water supply, electricity, transportation, and waste management—are shaped by the enduring pressures of Israeli occupation. It seeks to understand not only the technical challenges but also the social and behavioral responses of local communities navigating these constraints.

The specific objectives are to:

Document the current state of key infrastructure systems under occupation.
Explore grassroots adaptive and resistance strategies employed by residents and local institutions.
Analyze how these strategies reshape the meaning of sustainability and resilience in a conflict-affected context.
Situate these findings within broader theoretical frameworks that link urban ecology, political conflict, and community agency.

To guide this investigation, we propose a conceptual framework that interprets sustainability as an active process of resistance and resilience embedded within political and material realities.

Ultimately, this research hypothesizes that while systemic geopolitical constraints significantly limit autonomous urban development, Beita's community-driven adaptations challenge these restrictions by reframing sustainability as a dynamic and contested process. The study aims to contribute to a deeper understanding of how urban infrastructure in conflict zones functions as both a site of control and a locus of community empowerment, highlighting its critical role in ongoing struggles for sovereignty and self-determination.

Materials and methods

Study design and rationale

This study adopts an exploratory qualitative research design to investigate how infrastructural systems in Beita are shaped by the political and material constraints of Israeli occupation, and how local communities respond through grassroots adaptation, resistance, and indigenous knowledge. The term "exploratory" is used to acknowledge that the small sample size and purposive recruitment aim to generate in-depth, contextual insights into lived experiences rather than statistically generalizable conclusions. The qualitative approach, grounded in semi-structured interviews, was selected for its capacity to uncover nuanced, place-specific understandings of resilience and adaptation, while maintaining alignment with the research objectives.

Sampling strategy and participants

A purposive sampling strategy was employed to recruit 18 participants across four stakeholder categories—municipal officials, engineers, community leaders, and residents (see Table 1). Participants were deliberately selected to ensure diversity of perspectives from groups most directly affected by disruptions in key infrastructure sectors such as water supply, electricity, waste management, and transportation. While not statistically representative of the broader population, this variation enhances the analytical range of the findings.

The sample size of 18 was sufficient to achieve thematic saturation, as recurring patterns and perspectives were consistently observed across all stakeholder groups. Verbal consent was obtained from all participants, which was deemed appropriate given the study's minimal risk and the culturally sensitive context, where written consent might have posed unnecessary barriers or discomfort.

Table 1
Interview participants by category and type.

Category	Participant Type	Number
Local Governance and Planning	Former mayor of Beita Municipality	1
	Current mayor of Beita Municipality	1
	Municipal council members	2
	Municipal technical officials (engineers)	2
Community Stakeholders	Local business owners or service providers	4
	Long-term residents (different neighborhoods, including conflict-affected)	4
	Youth or women's group representatives	4

The sample size was determined using iterative, concurrent data collection and analysis. After each interview round, the researcher assessed whether thematic saturation had been reached—that is, whether no new substantive insights were emerging and existing themes were adequately elaborated. Data collection ceased once redundancy in responses was consistently observed across stakeholder groups.

Data collection

Interviews were conducted in Arabic between March and April 2025. Each interview followed a semi-structured format guided by five core questions (Section 2.5), designed to elicit narratives about sustainability, infrastructural challenges, adaptation strategies, and the role of local governance. This format allowed participants to share personal experiences and reflections, while also enabling the interviewer to probe for clarification and explore emergent themes in greater depth.

Prior to fieldwork, the researcher conducted a desk-based document analysis to inform both the thematic scope and wording of the interview guide. Documentary sources included municipal records, NGO reports, and local/regional media articles published between 2020 and 2025. These documents were not only preparatory tools but were later incorporated into the analysis to triangulate interview findings—corroborating areas of convergence and highlighting discrepancies between official accounts and lived experiences.

Development of interview themes and questions

Preliminary desk research and informal consultations with local informants guided the formulation of five core interview questions, each explicitly linked to the study's objectives:

1. What does "sustainability" mean to you in Beita? Is it achievable under current conditions? This question explores local understandings of sustainability in the context of infrastructural and political challenges.
2. What are the major infrastructural challenges in Beita, and how have they evolved? This seeks to identify and characterize key infrastructure issues over time under occupation.
3. How does the Israeli occupation affect infrastructure and daily life?
4. This question addresses the political and material impacts of occupation on services and community functioning.
5. How have local people responded or adapted to infrastructure-related difficulties? This examines grassroots adaptation, resistance, and indigenous knowledge as resilience strategies.
6. What is the role of the municipality or local organizations in supporting resilience and infrastructure development? How could their

efforts be improved? This assesses governance roles and opportunities for enhanced support and development.

Data analysis

Data were analyzed using thematic analysis. The process began with immersion in the transcripts through repeated reading. Relevant text segments were inductively coded to capture key ideas, which were then grouped into preliminary themes. These themes were iteratively refined through comparison across participants and validated against findings from the document analysis to enhance analytical credibility.

To reduce potential interpretive bias, several safeguards were implemented:

- **Reflexivity:** The researcher kept a reflexive journal to record assumptions, analytic decisions, and reflections on positionality.
- **Peer Debriefing:** Two independent qualitative researchers with contextual expertise reviewed the emerging codes and themes.
- **Triangulation:** Findings from interviews were systematically compared with the documentary evidence.

Large Language Models (LLMs) were used exclusively for translating interview content from Arabic to English and for minor language editing; they played no role in coding, thematic development, or interpretation.

Ethical procedures

Ethical principles were rigorously observed throughout the data collection process. Verbal informed consent was obtained from all participants after clearly explaining the study's purpose, their voluntary participation, and their right to withdraw at any time without consequence. No sensitive or personally identifiable information was collected, and all responses were handled with strict confidentiality. Anonymity was preserved by using general descriptors and omitting names, except for the current and former mayors, whose initials appeared in quotations due to their publicly available status on the official Beita municipality website; this was deemed ethically appropriate and respectful of their public roles. Written consent was not sought to prevent discomfort or mistrust given the sensitive political context. All data, including audio recordings and transcripts, were securely stored and accessible only to the research team to safeguard participant privacy. Ethical approval was indeed obtained from the Institutional Review Board (IRB) of An-Najah National University (Approval No. Hum. Nov. 2024/25). All procedures conformed to international ethical standards, including those outlined in the Declaration of Helsinki.

Results

Question 1: What does "sustainability" mean to you in Beita? Is it achievable under current conditions**?**

The first interview question explored participants' understandings of "sustainability" in the context of Beita. Responses highlighted meanings grounded less in abstract environmental policy and more in lived realities shaped by military occupation, infrastructural disruption, and community resilience—a pattern common in conflict-affected localities where sustainability often becomes a practice of survival rather than an aspirational ideal [2,10,18,28].

From the perspective of local governance, the former mayor framed sustainability as a strategy of cultural and resource preservation under threat: "Sustainability for us was never a luxury—it meant making sure our olive groves survived settler encroachments, and our water lasted the whole season." This definition ties ecological sustainability to political resilience, reflecting what some scholars term resistance ecology, where environmental stewardship is inseparable from safeguarding land rights [3,10,28]. Similarly, the current mayor described an ongoing tension between immediate crisis response and long-term planning: "We talk about sustainability not in ideal terms, but in survival terms. Can we still provide services tomorrow if a road is blocked today?" This encapsulates the concept of contingency governance, observed in occupied municipalities where service continuity is constantly under siege [10,19,42,42].

Municipal council members echoed this pragmatism but emphasized structural constraints. One explained: "Even if we plan sustainable infrastructure, we can't always implement it. Permits are denied, roads are destroyed, and we're forced to patch instead of build." This points to an externalized fragility, aligning with literature on infrastructural violence and politically induced urban disruption [10,11,28,42]. Another member stressed the role of financial autonomy: "Donors come and go. A sustainable system is one we can fund ourselves." Here, sustainability becomes not only a technical capacity but also an expression of economic sovereignty, a common theme in postcolonial and conflict-affected urban contexts [1,10,42,42].

Technical staff, such as engineers and infrastructure supervisors, highlighted adaptive ingenuity. A municipal engineer noted: "We use the term in engineering plans, but it's a daily fight—how do you design for the future when the present keeps collapsing?" Similarly, an infrastructure supervisor stated: "We use local materials, reuse old piping, and ask residents to help." These insights illustrate grassroots innovation and community-led resilience, consistent with scholarship emphasizing bottom-up strategies in fragile urban environments [4,5,8,10].

Community-based stakeholders expanded the meaning of sustainability to include social empowerment and cultural continuity. An NGO representative explained: "Sustainability here isn't just about clean water or roads—it's about whether people are included in decisions that affect their lives." Another added: "We revive traditional farming methods because they're resilient." These perspectives align with participatory governance and inclusive urban resilience frameworks that integrate community knowledge and indigenous practices [7,9,10,28,46].

Residents provided more personalized, rights-based definitions. A long-term resident from a restricted area remarked: "We just want running water every day, and a way to reach our land." Here, sustainability becomes synonymous with the realization of basic rights rather than environmental optimization [3,10,42,43]. Another resident from a less affected neighborhood described sustainability as everyday adaptation: "We've learned to fix things ourselves." Such localized self-reliance mirrors the concept of quiet sustainability observed in rural and conflict-affected resilience studies [8,10,36].

Youth and women's representatives added generational and gendered dimensions. A young community member emphasized: "A future here—not just survival, but dignity, jobs, and a livable town." This resonates with literature framing sustainability as an intergenerational contract [10,37]. A women's group leader stressed: "We want sustainability to include women's voices, clean streets, access to clinics—things that directly affect our homes and children." This reinforces feminist critiques that sustainability frameworks must integrate everyday care work and health infrastructure to be truly inclusive [10,47].

Finally, small business owners connected sustainability to economic and infrastructural reliability. A local transport operator explained: "No broken roads, no checkpoints that force long detours." A shop owner added: "If the power stays on and the roads are open, I can work." These statements illustrate functional sustainability, highlighting how continuity of services underpins local economic viability and livelihoods in conflict-affected settings [1,5,10,28].

Question 2: "What are the major infrastructural challenges currently facing Beita, and how have they changed over time?"

Participants described Beita's infrastructural challenges as multi-

layered, shaped not only by material limitations but also by geopolitical constraints that actively erode development capacity (Table 2). Across interviews, it was clear that infrastructure here is not simply a matter of engineering or municipal planning, but a contested domain shaped by occupation policies—reflecting what critical infrastructure studies describe as infrastructural precarity in politically constrained environments [39].

From a historical vantage point, the former mayor (FM) framed the town's trajectory as a shift from resource scarcity to spatial and political restriction: "Back in the early 2000 s, our biggest problem was limited funding. Now, it's the checkpoints, the bypass roads, and the inability to access certain areas. We plan, but the occupation redraws our maps every year." This statement captures a temporal shift common in conflict-affected municipalities, where external control increasingly dictates spatial development [40].

The current mayor (MB) focused on operational paralysis under unpredictability: "Electricity cuts, blocked roads, and water shortages are daily realities. But… we can't implement long-term solutions because of unpredictable military interventions." Here, sustainability is undermined by a governance environment in which planning horizons are repeatedly disrupted—what urban resilience scholars call reactive urbanism [38].

Municipal council members illustrated how occupation structures embed reactive planning and fiscal strain into local governance. One explained: "Israeli military orders can freeze a project overnight. Our planning is always reactive, never proactive." Another linked the issue directly to resource reallocation: "We sometimes have to divert funds from roads to emergency water trucking." Such forced budget shifts reflect crisis-driven municipalism, where emergency needs displace long-term investment [40].

Technical staff revealed the systemic underdevelopment embedded in Beita's infrastructure. One engineer noted: "Sewage networks were never fully developed… we aren't permitted to dig new networks in Area C." This points to planned infrastructural underdevelopment, where policy restrictions prevent essential upgrades [41]. Another engineer observed the fragility of the electrical grid: "A small incident—like a settler vandalizing a transformer—can leave hundreds without power." This connects to the concept of infrastructural vulnerability, where basic systems remain exposed to both environmental and political shocks.

Civil society representatives framed these issues as structural neglect. One NGO coordinator said: "Our proposals for infrastructure upgrades often get rejected… especially in areas classified as security zones." Another recounted sanitation deficits in schools due to permit denials. Such examples show how control over physical space produces service deprivation that extends into health and education sectors [14,18].

For residents, the impact was lived and immediate. A resident near Za'tara Checkpoint described: "We have to make a long detour through unpaved routes because the army blocks the way." This illustrates mobility deprivation as both a transportation and economic constraint.

Table 2
Community-identified challenges to infrastructure and resilience in Beita.

#	Challenge	Example Quote from Participants
1	Lack of or inadequate infrastructure	"We often face water shortages and unreliable electricity supply."
2	Deterioration of infrastructure over time	"The roads are in bad condition because there's no regular maintenance."
3	Impact of the Israeli occupation on infrastructure	"Construction permits are hard to get, so we can't build new schools or clinics."
4	Restricted movement and access to land and resources	"Farmers can't reach their lands due to checkpoints and military zones."
5	Limited support or effectiveness of local institutions	"The municipality tries its best, but they don't have enough funding or authority."
6	Need for improved resilience-building efforts	"We rely on each other as a community when the government can't help."

Another, from Sabih Mount, connected water scarcity to family survival: "Water comes once a week if we're lucky… in summer, that's not enough.".

Youth and women's representatives emphasized social isolation and gendered burdens. A young activist said: "Bad roads, no reliable internet—it isolates us." This reflects the digital and physical exclusion of young people in peripheral towns [16]. The Director of Beita Women Development Society highlighted care labor: "When sewage overflows, it's the mothers who clean up." This resonates with feminist infrastructure critiques that reveal how women disproportionately bear the consequences of service breakdowns.

Business owners described economic fragility tied to infrastructure. A shopkeeper said: "I lose income every time the army blocks the entrance to the village." A transport operator explained: "The roads are so damaged… my vehicle needs repairs every month." These statements show how infrastructural decay and restricted mobility compound to create structural economic disadvantage.

Farmers linked infrastructural decline directly to land dispossession and settler violence. One explained: "We used to grow olives… now it's too dangerous." Such accounts illustrate how physical infrastructure and agricultural viability are co-impacted by settlement expansion, producing both economic and cultural loss [17].

Across responses, infrastructural challenges in Beita emerge as the product of structural violence—where policy restrictions, settler activity, and chronic neglect converge to produce a state of ongoing infrastructural crisis, constraining both present functionality and future development.

Question 3: How does the Israeli occupation affect infrastructure and daily life in Beita?

Across all interviews, participants consistently identified the Israeli occupation as the principal structural force shaping both the physical infrastructure and the everyday experiences of residents in Beita. The occupation imposes multifaceted constraints that affect urban planning, access to resources, and social dynamics, thereby profoundly disrupting

Table 3
Impacts of the Israeli occupation on infrastructure and daily life in Beita.

Theme	Illustrative Example / Quote
Blocked Development Projects	"Every time we tried to implement something, the occupation authorities either blocked it or delayed it with endless permits." – Former mayor
Restricted Access to Land (Area C)	"Half the land we need is in Area C, and we can't touch it." – Current mayor
Interference in Municipal Services	"Even basic maintenance is a struggle… If we act without coordination, soldiers come and shut everything down." – Municipal council member
Deliberate Sabotage of Planning Efforts	"Sometimes we plan a project… then the area gets declared a closed military zone. All that work—gone." – Municipal engineer
Suppression of Civil Society Initiatives	"We installed solar panels at a women's center. A week later, soldiers came and took them down." – NGO worker
Psychological and Social Suppression	"We organized youth to clean a park. Then settlers came nearby, and the army told us to stop gathering for 'security reasons.'" – Environmental activist
Threats to Children's Safety and Mobility	"My children are afraid to walk to school… the road is blocked and we have to walk through the fields." – Resident mother
Loss of Access to Agricultural Lands	"We used to harvest olives… Now it's too risky. Soldiers say it's closed, and settlers destroy the trees." – Local farmer
Youth Disempowerment and Insecurity	"Every event we organize… we have to check first if there's a closure." – Youth center volunteer
Daily Disruptions and Economic Decline	"I sit here all day with full shelves and no customers." – Shopkeeper"I spend more on repairs than I make some weeks." – Transport operator
Militarized Movement Restrictions	"Soldiers stop us and check every ID… people start to avoid traveling altogether." – Taxi driver

the rhythm and security of daily life. The emergent themes (Table 3) reflect these layered impacts and resonate with broader studies on occupation and infrastructural control [37; 18, 43, 12].

Blocked development projects

The former mayor described how development efforts are persistently thwarted by the occupation authorities through bureaucratic delays and permit denials. "We used to have long-term plans—better roads, new water lines—but every time we tried to implement something, the occupation authorities either blocked it or delayed it with endless permits." This theme illustrates how planning autonomy is undermined, confirming findings that show the occupation's control over infrastructure as a form of political domination that restricts Palestinian self-determination [11,42].

Restricted access to land (Area C)

The current mayor emphasized that about half of Beita's needed land lies in Area C, where Israeli control prohibits Palestinian development. "We can't touch it. We submitted proposals to build a new road and expand the sewage system, but nothing moves forward." This spatial restriction aligns with literature on fragmentation and land confiscation in occupied territories [11,17], highlighting how land denial limits urban expansion and service provision.

Interference in municipal services

Municipal council members detailed the practical challenges caused by military oversight. "Even basic maintenance is a struggle… If we act without coordination, soldiers come and shut everything down." This constant interference demonstrates the erosion of municipal sovereignty, a condition described by literature on settler-colonial governance, where military control disrupts routine public services [17,42].

Deliberate sabotage of planning efforts

Municipal technical staff reported that planned projects are sometimes nullified by sudden declarations of military zones. "Sometimes we plan a project… then the area gets declared a closed military zone. All that work—gone." This points to a tactic of spatial control and political violence that interrupts Palestinian development and echoes insights from critical urban theory on how state violence shapes urban infrastructures [11,42].

Suppression of civil society initiatives

Local NGOs face similar obstacles, with efforts to improve resilience often dismantled by military actions. One worker recalled, "We installed solar panels at a women's center. A week later, soldiers came and took them down." This suppression restricts grassroots empowerment and aligns with research on occupation-imposed limitations on community resources [17,24].

Psychological and social suppression

Civil society actors described how settler proximity and military restrictions create an atmosphere of intimidation. "We organized youth to clean a park. Then settlers came nearby, and the army told us to stop gathering for 'security reasons.' It's psychological warfare." Such tactics limit social cohesion and public life, reflecting themes in political geography about how space is militarized to enforce control and induce fear [18,42].

Threats to children's safety and mobility

Residents reported direct impacts on children's freedom and safety. "My children are afraid to walk to school… the road is blocked and we have to walk through the fields." This illustrates the human cost of militarized mobility restrictions, corroborated by studies on the psychosocial impacts of occupation on Palestinian youth [18,43].

Loss of access to agricultural lands

Farmers highlighted economic and cultural losses as access to their lands diminishes. "We used to harvest olives… Now it's too risky. Soldiers say it's closed, and settlers destroy the trees." This theme reflects the ongoing dispossession and environmental degradation under occupation [17,28].

Youth disempowerment and insecurity

Youth and women's group representatives described how constant closures and unpredictability erode community agency. "Every event we organize… we have to check first if there's a closure." This points to a pervasive sense of instability affecting social and cultural life, consistent with research on the generational impacts of protracted conflict [17,18,36].

Daily disruptions and economic decline

Business owners and service providers emphasized the direct economic costs of infrastructural instability. "When they block the main entrance, no one comes into town… I lost almost half my weekly income." The cumulative effect of movement restrictions and infrastructural neglect undermines local economies, as shown in economic analyses of occupation's impact on Palestinian livelihoods [18,36,43].

Militarized movement restrictions

Transport operators and drivers described how militarized checkpoints and ID checks create pervasive obstacles. "Soldiers stop us and check every ID… people start to avoid traveling altogether." This militarization of everyday mobility curtails freedom of movement and access to essential services, a central theme in the literature on occupation and spatial control [11,42].

Question 4: How have local people responded or adapted to infrastructure-related difficulties?

Residents of Beita have developed a complex set of adaptive strategies that blend practical necessity with collective resilience in response to chronic infrastructure challenges—such as unreliable electricity, deteriorating roads, irregular water supply, and restricted mobility. These adaptations operate across multiple scales, from individual improvisation to community-led initiatives, reflecting a dynamic form of survival and resistance (Table 4 themes are discussed below with illustrative quotes).

Self-organized road and infrastructure repairs

The current mayor described how, facing the absence of formal support, locals take initiative by organizing repairs themselves: "Locals organize themselves… bring gravel, sand, even old tires to fill potholes." This practice exemplifies what James C. Scott (2013) conceptualizes as "infrapolitics," where everyday acts of maintenance become subtle forms of resistance to structural neglect by asserting agency over local space [36,44].

Shadow planning and volunteer fixes

Municipal council members highlighted the creation of "shadow

Table 4
Community adaptations and local initiatives in response to infrastructure challenges in Beita.

Theme	Illustrative Example / Quote
Self-Organized Road and Infrastructure Repairs	"Locals organize themselves… bring gravel, sand, even old tires to fill potholes." – Current mayor
Shadow Planning and Volunteer Fixes	"We develop shadow plans… volunteers implement small fixes like waste collection or drainage cleaning." – Municipal council member
Public Involvement in Water Maintenance	"We teach people how to maintain their own water tanks and pipes… leaks are constant." – Municipal engineer
Emergency Response by Local Youth	"When electricity poles fall… local youth with basic training help with quick repairs using salvaged materials." – Municipal official
Individual Investment in Solar Energy	"We installed solar panels ourselves… Without them, I couldn't run my barbershop or refrigerate medicine." – Shopkeeper
Alternative Transport and Routes	"We use alternative back roads to reach Nablus or Ramallah… better than waiting for the army to open the main entrance." – Transport operator
Mutual Aid During Military Disruptions	"We helped each other get food and medicine through back paths." – Resident
Water Sharing and Storage Cooperation	"Water comes once every few days… We help each other store it in tanks. If someone runs out, others give them what they need." – Resident
Collective Farm Path Restoration	"We work together—men, youth, even some women—to clear stones and fix the path so we can reach our trees." – Farmer
Grassroots Environmental Activism	"We started a campaign to clean up public spaces and plant trees… It's not just beautification—it's resistance." – Youth activist
Women's Home-Based Economic Initiatives	"Many of us started home-based businesses… We use WhatsApp and word-of-mouth to sell." – Women's society leader
Civil Society Support with Resilience-Building	"We hold community events with solar-powered lights during blackouts… It reminds us that we're still here, still resisting." – Civil society actor

plans" that circumvent official channels: "We develop shadow plans… volunteers implement small fixes like waste collection or drainage cleaning." This echoes concepts of "DIY urbanism" [36,45], where residents take ownership of urban management tasks typically reserved for formal institutions, signaling a shift toward grassroots governance amid state incapacitation.

Public involvement in water maintenance

Municipal engineers reported actively training residents to manage aging water infrastructure: "We teach people how to maintain their own water tanks and pipes… leaks are constant." Such capacity-building supports community self-reliance and aligns with literature on community-driven infrastructure maintenance in fragile contexts [2,8,43].

Emergency response by local youth

Local officials noted how trained youth volunteers provide rapid repairs during infrastructure failures: "When electricity poles fall… local youth with basic training help with quick repairs using salvaged materials." This mobilization highlights the role of youth in fostering resilience and social solidarity in crisis situations, a dynamic documented in conflict-affected societies [2,36,42].

Individual investment in solar energy

Shopkeepers reported adopting solar panels independently to mitigate frequent power outages: "We installed solar panels ourselves… Without them, I couldn't run my barbershop or refrigerate medicine." This form of "transformative adaptation" [2,8,46] demonstrates how small-scale technological solutions enable economic continuity despite infrastructural instability.

Alternative transport and routes

Transport operators described the necessity of rerouting via back roads to avoid military checkpoints: "We use alternative back roads to reach Nablus or Ramallah… better than waiting for the army to open the main entrance." This adaptive mobility strategy reflects the navigation of militarized space constraints documented in studies of movement under occupation [2,18,43].

Mutual aid during military disruptions

Residents recounted mutual support during blockades: "We helped each other get food and medicine through back paths." This cooperation underscores the critical role of social capital in sustaining communities facing recurrent crises, consistent with disaster resilience literature emphasizing networks of mutual aid [18,35,46].

Water sharing and storage cooperation

Residents also shared water resources amid supply shortages: "Water comes once every few days… We help each other store it in tanks. If someone runs out, others give them what they need." Such practices represent adaptive communal resource management in water-scarce, conflict-affected environments [2,18,46].

Collective farm path Restoration

Farmers described collaborative efforts to maintain access to agricultural land: "We work together—men, youth, even some women—to clear stones and fix the path so we can reach our trees." This highlights collective agency in preserving livelihoods and counters land access restrictions, aligning with agrarian resistance frameworks [2,36,42].

Grassroots environmental activism

Youth activists linked environmental campaigns to broader resistance: "We started a campaign to clean up public spaces and plant trees… It's not just beautification—it's resistance." Such initiatives merge ecological stewardship with political identity, reflecting place-based resilience under occupation [2,36,46].

Women's home-based economic initiatives

Women's groups adapted economically by establishing home-based businesses using digital tools: "Many of us started home-based businesses… We use WhatsApp and word-of-mouth to sell." This adaptive entrepreneurship resonates with gendered strategies of economic survival and empowerment in constrained contexts [2,8,47].

Civil society support with resilience-building

Civil society actors described community events using alternative energy to maintain morale: "We hold community events with solar-powered lights during blackouts… It reminds us that we're still here, still resisting." This highlights the psychosocial dimension of resilience fostered through collective cultural practices [18,36,46].

Question 5: What is the role of the municipality or local organizations in supporting resilience and infrastructure development? How could their efforts be improved?

Participants described a mix of appreciation and frustration when discussing the role of local authorities and organizations. While most recognized the crucial role played by the municipality and grassroots groups in maintaining basic services and sustaining community resilience, their efforts were often seen as limited by structural, financial,

and political constraints.

The former mayor acknowledged the municipality's dedication but stressed the magnitude of the challenges: "We try to do what we can with what little we have. But every project needs permits from Israeli authorities, which are rarely granted. We're managing a city with one hand tied behind our back." The current mayor emphasized transparency and community cooperation in the face of scarcity: "People know we don't have much money or power. But we work transparently, prioritize emergencies, and listen to what people need most—like emergency road repairs or water distribution during shortages".

Municipal council members and technical staff explained that much of their work is reactive rather than planned: "We fix broken pipes, and distribute aid when it comes—but long-term planning is nearly impossible." "We submit plans for new sewage lines or better electricity grids, but they never get approved. So we keep repairing the same old systems".

Despite these constraints, residents acknowledged that local officials often go beyond their formal roles, particularly in emergencies. One engineer added: "We repurpose old materials, train residents to fix tanks or leaks themselves—whatever we can do to keep things functioning".

Local business owners and service providers offered mixed reviews. A shopkeeper shared: "Sometimes they help us connect to electricity or fix a broken pipe. Other times, we just wait and nothing happens." Another business woman added: "They want to help, I believe that—but the budget isn't enough".

Residents in conflict-affected areas often turned to NGOs and civil society for practical solutions. A farmer said: "When the army destroyed part of our irrigation system, it was a local organization that helped us rebuild it. "They gave us solar panels and helped dig rainwater cisterns—things the government can't do." Still, many noted the instability of such support: "They come and go. One year there's a youth training program, the next year it disappears," explained a local organizer.

Youth and women's group representatives stressed how grassroots action, often unfunded, plays a critical role: "Women's societies run literacy programs, sewing workshops, even legal awareness sessions—all with no funding. We clean public spaces, plant trees, and help organize home-based businesses. But with more support, we could do so much more".

Long-term residents described neighborhood-level initiatives that often step in when formal bodies cannot: "During road closures, we coordinated among ourselves—sharing water, medicine, and using alternative routes to reach families".

Discussion

This study not only documents the infrastructural challenges faced by Beita but also critically examines the behavioral and social dimensions underlying residents' perceptions and adaptive responses. Beyond descriptive accounts, the findings reveal how individuals and communities exercise agency within deeply constrained political and material conditions, offering important insights into behavioral adaptation under chronic conflict and occupation.

While previous scholarship has established infrastructure as essential to sustainable development and urban resilience [1], this research foregrounds the lived experiences of Beita's residents to interrogate how ongoing military occupation transforms infrastructure into a contested and politicized resource. The perceptions of municipal officials and community members alike reveal a collective consciousness shaped by repeated experiences of bureaucratic obstruction, surveillance, and physical insecurity. This aligns with behavioral theories of learned helplessness and resilience [e.g., 9,11], where individuals confronted with chronic adversity develop coping strategies that blend acceptance, improvisation, and subtle forms of resistance.

The study's findings highlight the distinct yet interconnected challenges facing key infrastructure sectors in Beita, shaped decisively by the ongoing occupation.

Water infrastructure is severely affected by limited access to natural resources and restrictions on developing new networks, resulting in irregular and insufficient supply. Residents' cooperative water storage and sharing practices not only reflect immediate coping mechanisms but also embody social capital that mitigates scarcity and fosters collective resilience [19]. These adaptations underscore how water access becomes both a material necessity and a locus of community solidarity under political constraint.

Electricity supply is characterized by frequent outages and grid instability, driving grassroots innovation such as self-installed solar panels. This illustrates residents' behavioral flexibility and problem-solving agency, representing transformative adaptation to infrastructural neglect [12]. Such energy autonomy initiatives also serve symbolic functions, reinforcing community independence and resistance in a context of imposed dependency.

Road infrastructure suffers from degradation exacerbated by movement restrictions, military checkpoints, and restricted access to land (Area C). Community-led road repairs and the strategic use of alternative routes are not merely pragmatic responses but enact spatial agency that challenges occupation-imposed mobility constraints. These practices align with the concept of "infrapolitics," as subtle acts of territorial claiming and resilience [26].

Waste management remains a neglected sector, constrained by limited municipal capacity and regulatory restrictions. Informal volunteer clean-up efforts and "shadow" planning reflect residents' self-efficacy and local stewardship despite systemic neglect. This area warrants further attention given its implications for public health and environmental sustainability under siege conditions.

By examining these sectors individually and in relation, the study enriches the understanding of how occupation reshapes infrastructure from neutral systems into contested sites of political control and community resistance. The behavioral adaptations observed reflect a complex interplay of material necessity, social cohesion, and political assertion, reinforcing calls for integrated, context-sensitive approaches to urban resilience in conflict zones [8,26].

The ethnographic data show that Beita's residents do not passively endure infrastructural neglect; rather, they enact adaptive behaviors that reinforce social cohesion and community efficacy. For example, grassroots road repairs and "shadow planning" demonstrate collective problem-solving and community self-efficacy, concepts from social cognitive theory [8], where agency is exercised through locally organized efforts despite limited resources and formal authority. These actions also embody what Scott (1998) describes as "infrapolitics"—quiet, everyday resistance that sustains dignity and territorial belonging under political siege [26].

Economic adaptations, such as self-installed solar panels and alternative transport routes, illustrate transformative coping strategies that alter residents' interaction with infrastructural systems [12]. These behaviors reflect behavioral flexibility and innovation in response to uncertainty, providing empirical evidence for theories of adaptive capacity in disaster and conflict contexts [8]. The use of alternative pathways to circumvent army checkpoints, for instance, reflects not only practical navigation but also the assertion of spatial agency in a militarized landscape.

Moreover, the study highlights the critical role of social capital and mutual aid in sustaining well-being. The cooperative sharing of scarce water and the coordination during military blockades are emblematic of collective resilience [19], whereby trust, reciprocal support, and shared identity mitigate the psychological and material impacts of crisis. These findings contribute to behavioral science by illustrating how community-level networks buffer individual stress and foster adaptive social norms under conditions of prolonged instability.

The narratives also reveal psychosocial dimensions of resistance and place attachment. Youth and women's grassroots initiatives function as both practical survival mechanisms and symbolic acts affirming cultural identity and political presence, consistent with research on resistance

identities in occupied territories [33]. These behaviors underscore the intertwined nature of environmental stewardship, political expression, and community empowerment, offering fertile ground for interdisciplinary inquiry linking behavioral ecology, political psychology, and urban studies.

Local authorities' and NGOs' roles are perceived ambivalently, reflecting behavioral tensions between institutional constraints and community expectations. While municipal actors strive to maintain services under severe restrictions, residents' perceptions of inefficacy and dependency on external aid resonate with theories of institutional trust and legitimacy [9,10]. This ambivalence impacts community engagement and the sustainability of interventions, highlighting the importance of integrating behavioral insights into governance models in conflict-affected settings.

Finally, the study contributes to critical urban and environmental scholarship by emphasizing that infrastructural and ecological degradation cannot be dissociated from the behavioral realities of living under occupation. Beita's residents negotiate their environment through a repertoire of cognitive, social, and material strategies that reflect both constraints and creativity. This nuanced understanding challenges technocratic or purely structural analyses of urban resilience, calling for approaches that incorporate the behavioral sciences to fully grasp human-environment dynamics in conflict zones [8,26].

The findings of this study have clear implications for several Sustainable Development Goals, including SDG 6, SDG 9, and SDG 11. The documented challenges—ranging from disrupted water and electricity systems to constrained transportation and waste management—illustrate the difficulties of implementing SDG targets under conditions of occupation and political control. At the same time, the adaptive strategies and grassroots resilience observed among residents and municipal actors provide insight into how communities can sustain urban functionality, contributing to SDG 11. By situating these outcomes within the SDG framework, the study underscores the necessity of incorporating conflict-sensitive approaches into global sustainability planning and policy implementation. These findings highlight the importance of integrating local adaptive strategies into global sustainability planning, particularly in conflict-affected contexts.

In summary, this research advances knowledge by linking ethnographic evidence to behavioral theories of agency, coping, collective efficacy, and social capital, thereby uncovering the scientific value of residents' perceptions and experiences. Beita exemplifies how sustainable development under occupation involves not only technical fixes but also profound behavioral adaptations embedded in social and political realities. This case underscores the need for interdisciplinary frameworks that integrate behavioral insights with political ecology to inform more effective and just resilience-building strategies in conflict-affected urban contexts.

Conclusion

This study aimed to explore how residents, municipal officials, and local institutions in Beita respond to infrastructure challenges under the protracted conditions of Israeli occupation. The key findings reveal that infrastructure in Beita—spanning water, electricity, transportation, and waste management—is not only technically deficient but is fundamentally shaped by geopolitical constraints such as land access restrictions, permit denials, and systemic neglect [2,3,8,11].

Beyond documenting these material conditions, the study highlights the behavioral and social dimensions of resilience. Residents employ adaptive strategies including informal repairs, community-led initiatives, mutual aid, and economic innovation, demonstrating agency and collective efficacy despite constrained political and material environments [8]. These practices reflect the concept of "infrapolitics" as everyday resistance [8], and resonate with behavioral theories of resilience, adaptive capacity, and social cognitive agency [26,27].

While the municipality operates under severe political and financial limitations, it continues to play a crucial role in coordinating services and supporting local responses [9,10]. Together, these findings underscore that sustainability and resilience in conflict-affected urban contexts must be understood as socio-political processes enacted through everyday practices that intertwine survival, resistance, and community cohesion [7,10].

By centering the lived experiences and behavioral adaptations of Beita's residents, this research contributes to a critical rethinking of infrastructure as a contested terrain of political struggle and decolonial resilience [2,3,8]. It calls for future research and policy approaches that integrate behavioral science with political ecology, aiming to foster sustainable, just, and contextually grounded urban development in occupied and conflict-affected regions.

Limitations

Several limitations must be acknowledged. First, the qualitative nature of the study, while offering rich narrative insights, limits generalizability beyond Beita. Second, the sample size, though diverse in participant categories, may not fully capture the experiences of more marginalized sub-groups such as internally displaced persons or people with disabilities. Third, the political sensitivity of the topic may have influenced participant openness, despite the use of anonymized interviews. Finally, infrastructural conditions can change rapidly in conflict zones, meaning the findings represent a specific temporal snapshot.

Future research

Building on the insights from Beita, future research could examine the effectiveness of community-led water and electricity management initiatives in other conflict-affected municipalities, assessing which strategies most reliably sustain service continuity. A second direction is to conduct longitudinal studies tracking the psychosocial impacts of repeated infrastructure disruptions on youth well-being, resilience, and educational outcomes. Third, research could evaluate the role of local digital technologies, such as mobile applications or social media platforms, in facilitating citizen-led infrastructure monitoring and rapid response during crises. These directions would generate actionable knowledge for both scholars and practitioners seeking to strengthen urban sustainability and resilience under conditions of occupation.

Practical implications

Given the exploratory nature and limited scope of this study, the recommendations presented here should be interpreted with caution. If the experiences of the participants are representative of broader community patterns in Beita and similar contexts, then these findings suggest several practical implications for policymakers, humanitarian actors, and urban planners.

Firstly, municipalities may benefit from increased financial autonomy and political protection to implement sustainable, long-term infrastructure projects, reducing dependence on inconsistent international aid. Secondly, donor organizations and NGOs might consider prioritizing capacity-building initiatives that empower local actors to independently maintain and manage infrastructure. Lastly, grassroots initiatives—already playing a crucial role in urban survival and social cohesion—could be more effectively supported, not only through financial investment but also via legal and logistical facilitation.

Future research with larger, more representative samples is needed to confirm these trends and further refine practical strategies tailored to communities facing similar infrastructural and political challenges.

CRediT authorship contribution statement

Oqab Jabali: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation,

Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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