Territorial Dynamics and Community Resilience: Transient Housing in Post-earthquake in Al Haouz Rural Regions in Morocco

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Abstract. The integrative strategies for transient housing related to vulnerable rural communities in Morocco, in the aftermath of the recent earthquake, introduces their unique organization and lifestyle. Adopting a field-oriented approach, this study embraces a descriptive-analytical method with a focus on field-survey and post-occupancy-evaluation. The criteria for understanding the adaptive territorial dynamics of transient housing are derived from on-site investigation. Field-research was mainly conducted in the earthquake-affected villages in the Al Haouz region at the south of Marrakech, villages of Asni, Tlet Nyaakoub, Tizi Ouadou and Tafghaght. While drawing insights from community engagement, questionnaires, and spatial observations, sets of criteria are categorized through socio-cultural, physical-functional, and technical-structural elements. This research reveals, accordingly, key insights into the adaptive measures taken by rural communities, who proved indeed tactical patterns of resilience and resourcefulness in their transient housing typologies that are genuinely exposing their local topographies and territories. This study identifies, henceforth, sites, where communities have set temporary housing forms that derive out of their sociocultural context. This demonstrates their local capacity in facing challenges through resilient adaptation processes. Research findings would contribute to developing a strategic emergency territorial planning framework, emphasizing spatial considerations, community engagement, and the preservation of cultural practices as rooted resilient savoir-faire. The purpose of paper is to shed light on the relevancy of local know-how of vulnerable rural communities that have their genius-loci to urgently solve consequences of natural catastrophes. In addition, these findings prove that rurality is not limiting but capitalizes accumulative frugal innovations that ought to be considered once dealing with resilience and sustainability. The local rural communal tactful actions to deal with emergencies are hence to be further researched to set more advanced strategies of transient housing in the global scale.

Keywords: Transient housing · Rural Resilience · Territorial Planning · Communal Adaptation

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1 Introduction

Earthquakes, pervasive natural disasters, continue to expose the heightened vulnerability of human settlements worldwide [1, 2]. Globally, yearly statistics are alarming (Table 1). Earthquakes influence settlement organization and evolution by disrupting infrastructure [3, 4], causing damage to buildings [5–7], and socioeconomic patterns [8–10]. To reduce earthquake impact, high seismic activity regions require strict building codes, advanced early warning systems, and recovery strategies [11]. Conversely, areas with lower seismic activity frequently lack preparedness, leading to higher vulnerability. Recognizing the need for tailored solutions is crucial for all nations, irrespective of seismic activity levels, to minimize earthquake risks, and to dilute post disaster impact.

Table 1. Average of earthquakes happening in the word per year

Number per year	magnitude	characteristics
20,000	2.5 or higher	Vast majority of these are small and go unnoticed
1,300	5.0 or higher	More likely to be felt by people
10 to 20	7.0 or higher	High impact

Source: Global Seismographic Network and International Seismological Centre

Morocco's seismic vulnerability was made evident by the September 2023 earthquake, which shook the country's rural infrastructure. The quake's impact on shelter and housing was widespread, with Marrakech's densely populated areas and the Atlas Mountains' rural villages suffering severe damage. According to the Global Disaster Alert and Coordination System (GDACS), the disaster exposed approximately 320,000 people to high-level seismic activity [12]. The villages in the High Atlas, close to the quake's epicenter, suffered significant losses. Some communities have reported fatalities that exceed 50% of their residents, leaving them in desperate need of assistance and strong recovery plans. The affected communities, typically characterized by structural building flaws and limited access to emergency services, faced additional challenges. This vulnerability permeated beyond the immediate aftermath, infiltrating the complex spatial weave of these communities. Despite these challenges, Morocco's rural settlements demonstrate remarkable resilience, bolstered by a strong sense of community and a wealth of localized knowledge, including a thorough understanding of the land and traditional construction methods.

The interplay between strategic planning and cultural preservation becomes apparent as the study explores transient habitations—a critical aspect of post-earthquake recovery. Often, these habitations are deftly adapted to align with the community's lifestyle and cultural preferences, thus integrating into the post-seismic fabric of rural life. Despite the clear need to understand these dynamics, research remains scant, particularly on the adaptive territorial dynamics of transient housing within rural Moroccan contexts.

This study investigates the adaptive strategies used by these communities in response to seismic adversities, through a spatial planning lens that considers seismic resilience, infrastructure robustness, and community preparedness. Our research seeks to close this

gap by providing a nuanced look at resilience, resourcefulness, and encountered challenges, thereby contributing to a strategic emergency planning framework that addresses the unique needs of earthquake-affected rural villages.

This paper's structure is divided into sections, each of which builds on the previous one to form a cohesive narrative. Following the introduction, Sect. 2 describes how we chose our case studies and conducted our research, laying the groundwork for the mixed-method approach. Section 3 summarizes our findings, describing the various transient housing strategies used by the communities. The discussion in Sect. 4 places these strategies in the context of global post-disaster responses, providing a comparative analysis. We conclude with a synthesis of our findings, advocating for strategic and culturally informed emergency planning as critical to the resilience of rural communities in the face of natural disasters (Fig. 1).

2 Case Study and Methods

2.1 Sample Villages Selection

Following the September 23rd earthquake south of Marrakech, Morocco, over 2930 villages were affected to varying degrees. This study focuses on the rural communities that bore the brunt of the earthquake, with representative samples drawn from the Al Haouz region, which suffered extensive damage. Using a random sampling methodology, we chose four villages (Table 2) that represent the range of affected areas: Asni, Tlet N'yaakoub, Tizi Ouadou and Tafghaghte. Because of their different geographies and sizes, the chosen villages provide a diverse perspective on the earthquake's effects. Figure 2 depicts the geographical distribution of these villages, laying the groundwork for future research into their transient housing initiatives and population adaptability.

Table 2. Selected villages

	Village	Population	Rural Commune
Communal Center	2.5 or higher	394	Tlet N'yaakoub
	5.0 or higher	694	Asni
Peripheral village	Tizi Ouadou	292	Ouazkita
	Tafghaght	739	Amaghrass

Source: HCP Morocco, Population Census 2014

2.2 Data Collection and Analysis Methods

To comprehensively assess the adaptive territorial dynamics of transient housing, our study employed a mixed-method approach. This involved descriptive-analytical procedures, underpinned by field research and post-implementation evaluation techniques.

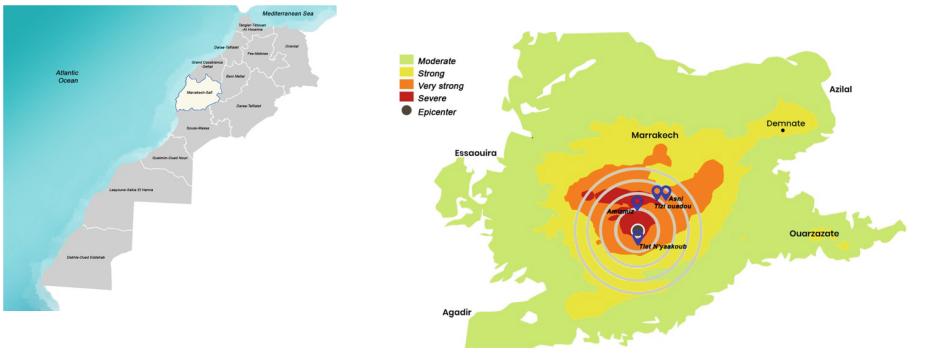

Fig. 1. Maps showing the regions impacted by the September 8 earthquake and the locations of selected villages. Source: United States Geological Survey

Survey and Questionnaire Design

The survey instruments were meticulously crafted to capture a wide range of socio-cultural, physical-functional, and technical-structural variables. Questions were structured to elicit both quantitative data, such as household sizes and material preferences, and qualitative insights into community resilience and resourcefulness. Demographic questions were included to ensure a representative cross-section of the affected populations, with particular attention to age, gender, occupation, and family structure.

Post-implementation Evaluation Techniques

The post-implementation evaluation was based on systematic observations and a tailored set of criteria to assess the effectiveness and adaptability of transient housing solutions. These criteria were developed using existing literature and refined during preliminary field visits. They included aspects such as spatial flexibility, cultural adequacy, material durability, and ease of construction and disassembly.

Field Research Methodology

The field research component involved visiting the selected villages, engaging with the local communities, and conducting spatial analysis of the erected transient housing structures. We utilized geolocation techniques to map the distribution and arrangement of these structures, while satellite imagery provided a macro-scale perspective on spatial organization and the extent of earthquake damage.

3 Results

3.1 Spatial Analysis of Transient Housing Initiatives

The provision of tents was a primary form of transient housing, offering quick deployment and a private haven for families amid the turmoil. Although the uniform design of the tents facilitated rapid distribution, they often fell short in the harsh environmental conditions prevalent in the region and did not fully accommodate the longer-term spatial needs of the residents. A deeper spatial analysis revealed that, while these shelters

provided initial relief, they lacked the flexibility to adapt to the varied and evolving requirements of households over time. Confronted with these limitations, local communities took proactive measures to modify and arrange the tents to better suit their needs. Leveraging an innate understanding of the landscape and their daily routines, families adjusted the placement and orientation of tents to shield against weather extremes, maximize shade, and maintain airflow. Inside, spaces were reorganized or combined to preserve familial bonds and accommodate multi-generational living, a common cultural practice in the region. Some residents expanded their living areas by connecting tents or building additional makeshift structures, thus creating compound-like arrangements that emulated the private courtyards central to their pre-disaster lifestyle. These spatial adaptations by the locals not only improved their immediate living conditions but also signaled the importance of incorporating flexibility and cultural sensitivity into the design of transient housing solutions (Fig. 3).

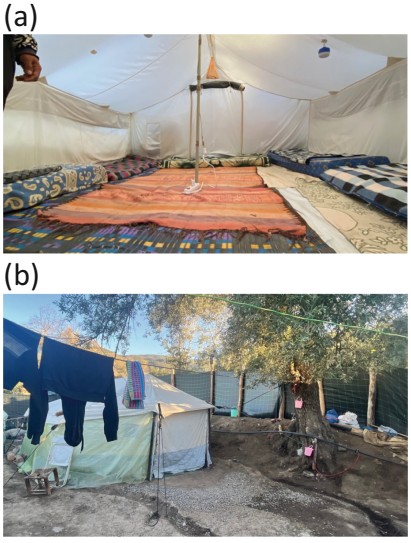

Fig. 2. (a) the inside of a transient housing unit; (b) the outside of the housing unit in Tafeghaght. Source: Authors on site pictures

As a shift from isolated tents to more integrated communal clusters marked a significant evolution in transient housing within certain communities. These clusters, a collective of tents and temporary structures, were meticulously arranged to create a shared living environment, promoting a sense of unity and organization amid the chaos. Such configurations varied from rectilinear patterns, which maximized efficiency and ease of access, to more organic layouts that conformed to the contours of the site and the residents' existing lifestyle and daily activities.

Rectilinear clusters were often seen in areas where the terrain permitted systematic planning, allowing for clear delineation of shared facilities like bathrooms, and communal gathering spots. This structured approach facilitated efficient resource distribution and a semblance of normalcy in day-to-day life. In contrast, in areas with uneven terrain

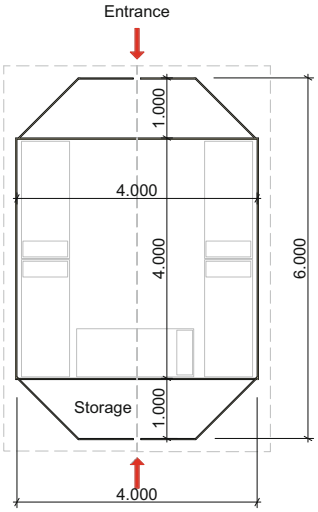

Fig. 3. Plan of transient housing unit. Source: Authors

or where residents' routines were closely tied to the landscape, clusters took on a more spontaneous arrangement. Here, the placement of tents was guided by the need for proximity to farmlands or water sources, preserving the rhythms of rural life and agricultural activities.

In both scenarios, the clusters were living systems, continually adapted by their inhabitants. Residents personalized these spaces, adding partitions or extensions, to recreate the familiar sense of home and maintain privacy. Communal areas evolved, reflecting the social fabric of the community, where shared spaces became focal points for interaction, support, and the rebuilding of community resilience. This dynamic adaptation of clusters reveals the importance of adaptable design principles in transient housing, catering to the diverse needs and preferences of disaster-affected populations.

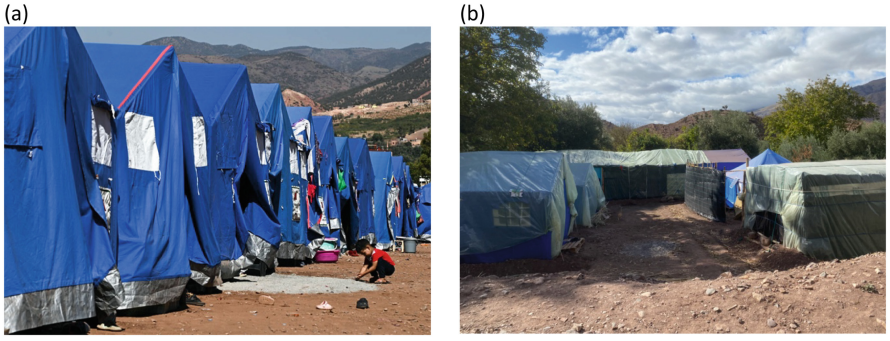

Fig. 4. (a) rectilinear layout cluster; (b) organic layout cluster. Source: (a) Maghreb Arab Presse; (b) Authors on site pictures

Communal Centers

Asni and Tlate Nyaakoub rapidly galvanized their social fabric into cohesive transient housing clusters, leveraging their plane topography, and pre-existing parcel structures to facilitate the inclusive implementation of tent camps. Demographic surveys underscored the effectiveness of this strategy in areas, where the arrangement of communal living spaces was inherently aligned with the residents' preference for close-knit family units. Tlate Nyaakoub demonstrated a remarkable use of its compact layout to enhance resource sharing and maintain vital support networks (Fig. 5). Strategic placement along main roads and rivers allowed for the swift establishment of emergency structures that served public facilities and commercial functions, thus accelerating the rehabilitation of the initial roles these commune centers played in local life. This spatial organization not only provided immediate shelter but also ensured the preservation of community routines, social interactions, and the overall integrity of daily life amidst recovery efforts.

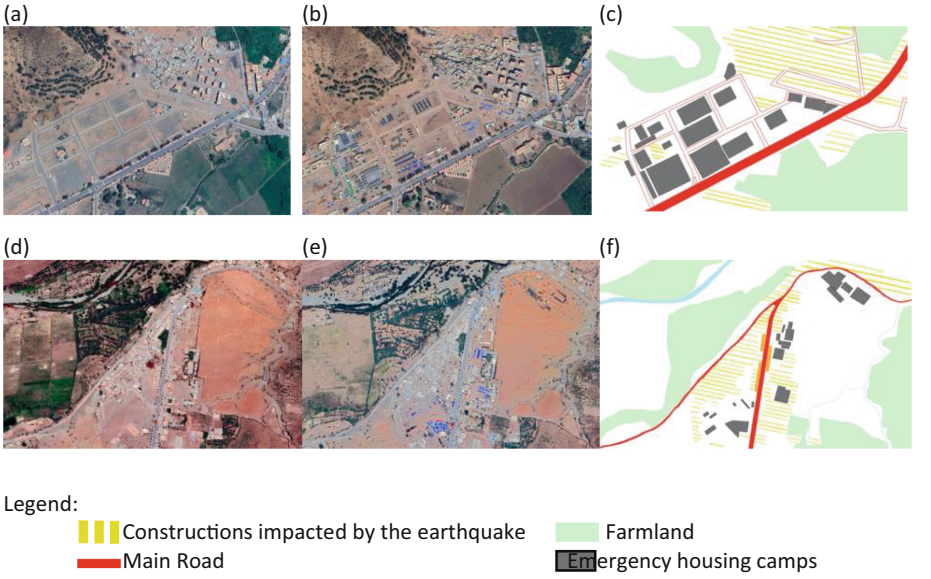

Fig. 5. (a) Satellite image of Asni center in May 2022; (b) Satellite image of Asni center on September 2023; (c) Spatial distribution of transient housing in Asni; (d) Satellite image of Tlate Nyaakoub on May 2022; (e) Satellite image of Tlate Nyaakoub on September 2023; (f) Spatial distribution of transient housing in Tlate Nyaakoub. Source: Lansat images https://landsat.visibleearth.nasa.gov/ and authors.

Peripheral Village

In Tafghaght and Tizi ouadou, the seismic aftermath posed unique challenges, reflected in the scattered array of transient housing. Demographic surveys indicate that these households often host up to three or four generations, linking them intrinsically to their agricultural land. Here, the topography is unforgiving, yet the residents, whose mainstay is agriculture, have shown remarkable resilience. They have strategically placed their

temporary tents and structures to ensure proximity to their farmland (Fig. 6), maintaining the crucial link to their livelihood. Despite the rugged landscape, families endeavored to recreate the private courtyards integral to their daily life, setting up tents in configurations that aimed to replicate their pre-earthquake living conditions as closely as possible. This adaptation not only speaks to the physical needs but also to the cultural continuity, with each tent placement a testament to their enduring commitment to preserve their traditional way of life amidst the challenges of disaster recovery.

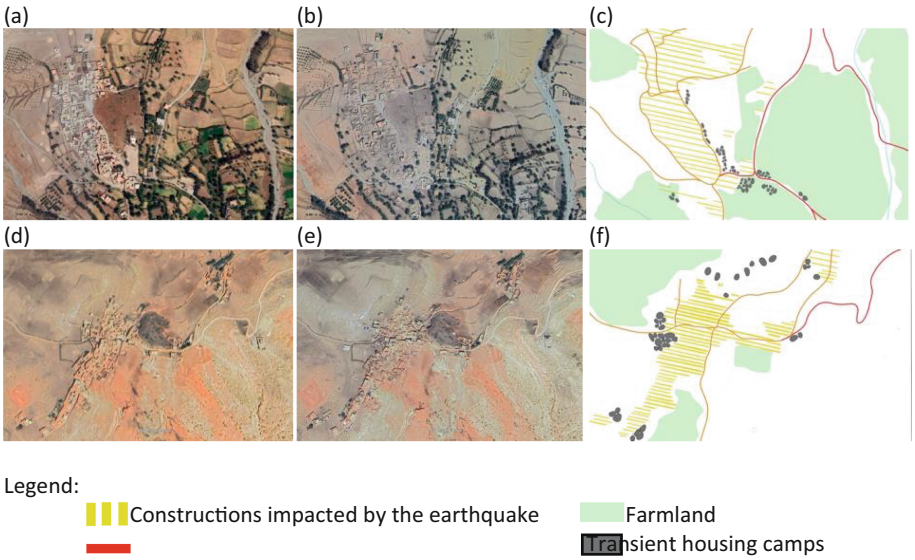

Fig. 6. (a) Satellite image of Tafghaght on May 2022; (b) Satellite image of Tafghaght on september 2023; (c) Spatial distribution of transient housing in Tafghaght; (d) Satellite image of Tizi Ouadou on May 2022; (e) Satellite image of Tizi Ouadou on september 2023; (f) Spatial distribution of transient housing in Tizi Ouadou. Source: Lansat images https://landsat.visibleearth.nasa.gov/ and authors

3.2 Adaptations Analysis

The extensive survey across the selected earthquake-impacted villages revealed that the average household comprised 5.4 members, with a strong preference for transient housing materials that offered thermal comfort and quick assembly, predominantly sourced from governmental initiatives and local supplies. The qualitative data underscored a resilient community fabric where, despite a scarcity of resources, there was an evident pattern of communal support and shared problem-solving. The demographic profile was diverse, with a balance in gender representation, occupations largely within the agricultural sector, and family structures spanning multiple generations. The adaptability of transient housing was found to be highly influenced by cultural context. Communities displayed spatial flexibility by repurposing or expanding shelters to accommodate family

units or communal activities, with modifications aligning with traditional practices like communal dining and social gatherings. Material durability was variable, with a general inclination toward enhancing resistance to environmental factors (Fig. 7). The construction and disassembly process was prioritized for its ease, reflecting the community's need for mobility and the potential for future relocation.

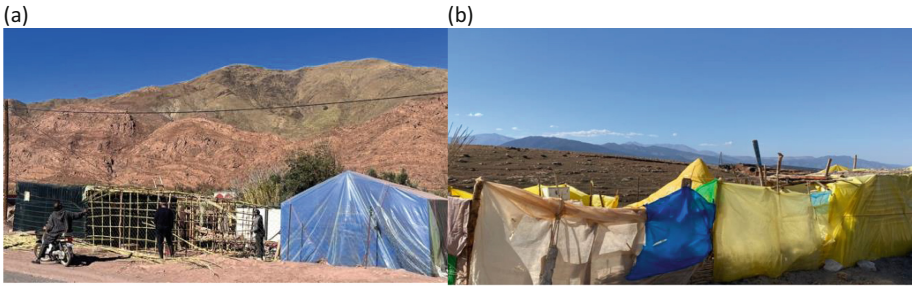

Fig. 7. Emergency houses community adaptation (a) Tafeghaght and (b) Tizi ouadou. Source: Authors on site pictures

Geolocation and spatial analysis revealed distinct patterns of housing organization. Central villages, such as Asni and Tlate Nyaakoub, exhibited structured clusters that optimized shared resources and reinforced community cohesion. In contrast, peripheral villages like Tafghaght and Tizi ouadou demonstrated a dispersed arrangement, indicative of individual space needs and a connection to agricultural livelihoods (Fig. 4b). Satellite imagery provided an overarching view of the damage extent and post-disaster landscape alterations (Fig. 6b and Fig. 6e). New communal areas emerged organically, signaling efforts to re-establish social structures disrupted by the earthquake.

The results from both survey data and field observations illustrate a community adept at navigating the complexities of post-disaster housing, displaying a resilient and adaptive approach tailored to their unique socio-cultural and environmental contexts.

4 Discussion

This research meticulously unravels the multifaceted transient housing strategies in the wake of a devastating earthquake in Morocco's Al Haouz region. Bridging local applications with global experiences, it provides a lens through which to examine the synthesis of urgent human needs with the resilience and adaptability of communities.

In examining the structured transient housing clusters within Asni and Tlate Nyaakoub, parallels can be drawn to the proactive disaster management approaches seen in rural Japan [13–15]. Japanese communities often implement pre-planned, organized clusters that enable efficient resource distribution and communal support [16–18], mirroring the structured approach seen in communes' centers. Peripheral villages displayed a more individualized approach to transient housing, with dispersed settlements that maintained agricultural practices and rural lifestyle continuity. This adaptation strategy is reminiscent of the post-disaster housing response in the rural areas of Nepal [19, 20],

where dispersed settlements allowed residents to remain close to their farmlands, thereby sustaining their livelihoods even in the aftermath of a disaster [21].

The diversity in housing strategies between communes' centers and peripheral villages reflects broader socio-economic and infrastructural dynamics. Centralized communities, better equipped with resources and infrastructure, naturally gravitate towards organized structures, enhancing automated, community-based housing response framework [22]. This can emphasize customized housing plans tailored to displaced populations, resonating with the centralized approach. Conversely, the peripheral villages, which face mobility and resource access challenges, maintain dispersed housing patterns to adapt with the site topography. This pattern is indicative of the need for adaptable temporary housing, as highlighted in Chile and Peru, where families adapt their houses to meet their midterm needs [23], emphasizing the importance of guidance in safely altering temporary structures.

Moreover, the insights from researches exploration of temporary housing in earthquake relief work, which emphasizes integral use of containers [24], offer an interesting contrast to the local material preferences observed in Moroccan villages. However, the Moroccan reliance on local materials for quick assembly echoes the sustainable approach advocated in the literature [25, 26]. However, the basic form and composition of these emergency houses needs to be upgraded and adequated to thermal comfort and arid climate [27]. Equally, review of temporary housing management models further supports our findings, advocating for adapted management and sustainability in housing solutions [28, 29]. Moroccan communities' efforts to adapt their living spaces, despite limited resources, align with the community resilience required for successful post-disaster housing management.

The Moroccan approach to earthquake recovery, when viewed alongside global practices, reveals a dynamic process of adaptation that interlinks cultural resilience with practical environmental strategies and social unity. This synergy demands a thoughtful recovery approach, deeply rooted in community collaboration and forward-looking planning [30–33]. Strategic planning here is not just about immediate rebuilding but about cultivating a culture of resilience, sustainable development, and the capacity to thrive post-adversity.

Resilience in this context is iterative, with each cycle drawing on new learnings and community strength. It's about leveraging local insights for a living, evolving strategy for reconstruction that transforms the remnants of disaster into the foundation of a stronger, more adaptable society [34, 35]. The aim is to embed resilience into every aspect of strategic planning, ensuring that every post-disaster decision contributes to a future where communities are not just protected from natural calamities but are flourishing alongside them. Morocco's experiences, echoed by global recovery efforts, chart a course toward resilient rebuilding and sustainable growth in the aftermath of earthquakes.

5 Conclusion

The study of post-earthquake transient housing in rural Morocco provides a compelling narrative of resilience and adaptability. The earthquake of September 2023 not only tested the structural integrity of housing but also the social fabric of the affected communities.

In the face of adversity, the varied responses—from the structured clusters in Asni and Tlate Nyaakoub to the dispersed individualized adaptations in Tafeghaght and Tizi ouadou—highlight a collective ingenuity rooted in deep-seated cultural practices and a profound connection to the land.

The comparison with international illustrates a universal challenge in post-disaster housing: balancing immediate needs with long-term sustainability and cultural integrity. This study has shown that while tents offer a quick-fix solution, they are a precursor to more nuanced, culturally sensitive, and socially cohesive housing strategies.

Our findings underscore the critical need for a strategic, context-specific emergency planning framework that accounts for both the socio-cultural nuances and the geotopographic realities of rural settings. Such a framework should not only facilitate rapid deployment of emergency shelters but also pave the way for sustainable, community-driven housing solutions. The insights garnered from the Moroccan experience contribute to a growing body of knowledge that underscores the importance of localized, participatory approaches to disaster recovery—approaches that honor the cultural, social, and economic fabric of communities.

The adaptive strategies of Morocco's rural communities in the aftermath of the 2023 earthquake reflect a broader narrative of human resilience and the capacity for innovation in crisis. These strategies, born out of necessity, have the potential to inform and enhance future transient housing interventions, ensuring that they are not only responsive but also respectful of the communities they aim to serve. This study calls for a continued dialogue on post-disaster housing, advocating for solutions that are as dynamic and diverse as the communities they support.

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Disclosure of Interests. The authors declare they have no competing interests.

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