Affordable Housing As An Alternative For Reconstruction After An Earthquake In Rural Areas: Al Haouz, Morocco

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ABSTRACT

Post-earthquake rebuilding planning is essential for the long-term development of earthquake-affected areas. Approaches to community resilience in rural settings focus on how communities adjust to changes and shocks. This study utilizes a resident resilience method to analyze affordable housing during earthquake rebuilding in Morocco in comparison to other countries that took this alternative as a solution. Methods used included semi-structured interviews, participant observation, Geographic mapping, and secondary data analysis. This study describes how resources were mobilized following the tragedy to solve short- and long-term housing options through prefabricated and cheap homes, while considering the area's unique building materials and space management.

Keywords: Affordable housing, post-disaster recovery, Rural housing, Community resilience

1. Introduction

Post-disaster rehabilitation is a complex process, providing temporary or permanent housing appears to be one of the most important duties because it allows people to gradually return to normal lives. It has been employed in the aftermath of major disasters, but it has also been criticized as unsustainable and culturally insufficient. (Daniel Félix, Jorge M. Branco, Artur Feio , 2013),Since 60 million people worldwide have been displaced due to war, environmental catastrophes, and development, leaving them without housing or communities (Stephanie Nebehay 2015, Gaynor 2015). Humanitarian aid groups provide housing for 30% of displaced persons in planned and managed places, while the rest build their shelters (UNHCR 2016).In 2015, just 25% of the expected 1.8 billion dollars in housing needs was met The Western High Atlas area is part of the northern High Atlas range, beginning in Haouz province and terminating in Agadir. This area has outstanding natural beauty and historical, cultural, and geological significance (Louz et al., 2022). On Friday, September 8, 2023, a catastrophic event occurred in the Western High Atlas, revealing a hidden weakness. Marrakech's Haouz High Atlas, known for its cultural history and natural wonders, is not immune to these threats (Khalloufi et al., 2023). This study delves deeply into the fragility of its systems and infrastructure, setting the framework for informed initiatives to increase the region's resilience and readiness.

Understanding fragility begins with exploring vulnerability. A structure's capacity to

withstand seismic pressures is determined by several elements, including construction materials and structural design Recognizing these distinctions is critical for creating successful damage mitigation strategies and positioning (Clementucci et al., 2023). However seismic catastrophes affect more than just buildings; vital infrastructure components such as bridges, highways, and utility networks are also vulnerable. The vulnerability of these elements after an earthquake might have long-term effects as they serve as key arteries for any region.

After the tragedy, the area has shown extraordinary resilience and drive via post-seismic repair and restoration activities. These initiatives provide vital insights into the problems and triumphs of rebuilding in destroyed areas landscape (Stanturf and Mansourian, 2020). The text also addresses sustainability and future planning. This article discusses proactive strategies to enhance the resilience of buildings and infrastructure against future earthquakes. Our research on building and infrastructure fragility in the Haouz region aims to provide valuable guidance for resilient growth and disaster aversion in the High Atlas and beyond. Preparation and expertise are crucial in dealing with unpredictable natural forces. This study employs a community resilience technique to look at cheap housing during earthquake rebuilding in Morocco. The methodologies included in-depth interviews, participant observation, and geographic information analysis. This study describes how resources were mobilized in the aftermath of the disaster to meet short- and long-term housing demands using prefabricated and low-cost structures while taking into account the area's unique architecture and spatial layout.

1.1 Contextualizing Post-Earthquake Reconstruction in Rural Areas

The High Atlas mountains span around 4,000 km^2. They consist of multiple massifs, notably the Toubkal massif, North Africa's highest mountain. The Haouz Mountains are a natural and unspoiled mountain range inhabited by a rural community. The Haouz region is an important element of Morocco's economy and culture. It is a significant agricultural region that produces grains, fruits, and vegetables (Montanari., 2013). The Haouz region is a popular tourist destination for its natural scenery and ancient buildings. On September 8, 2023, at 23:11 local time, Morocco had a magnitude 6.8 earthquake affecting about 380,000 people. Following the first quake, a magnitude 4.9 aftershock occurred 19 minutes later, followed by a magnitude 3.9 aftershock that struck the country (AP 2023, VOA 2023). The most hit provinces were al-Haouz, Azilal, Chichaoua, Marrakesh, Ouarzazate, and Taroudant. The earthquake had a significant impact on distant mountain settlements, causing road closures and hindering rescue attempts (NYT 2023).

Figure 1 depicts a comprehensive picture of the Western High Atlas mountain zone, showing seismically active regions as well as major geological faults. It also gives an overview of past epicenters by magnitude.

An important observation in the chosen research area indicates a substantial concentration of earthquake epicenters. These focal points range in magnitude from below 2° to 7° on the Richter scale. The region's geological faults are mostly situated in the main and pre-Combrian lower level, with a typical NE-SW direction. Alongside these main faults are several vertical faults, mostly oriented N-S and NNE-SSW, especially focused in the commune of Anougale, along the path of the Oued Assif Anougal.

The western high Atlas region is seismically active, having undergone multiple seismic events over its history. In 1995, there was a 6.2 magnitude earthquake, the strongest in modern history. The event caused substantial harm across the Atlas Mountains, including Marrakech, located 30 kilometers from the epicenter in the Al Haouz plain. It is important to be mindful of the seismic danger in the Western High Atlas region and prepare for future earthquakes.

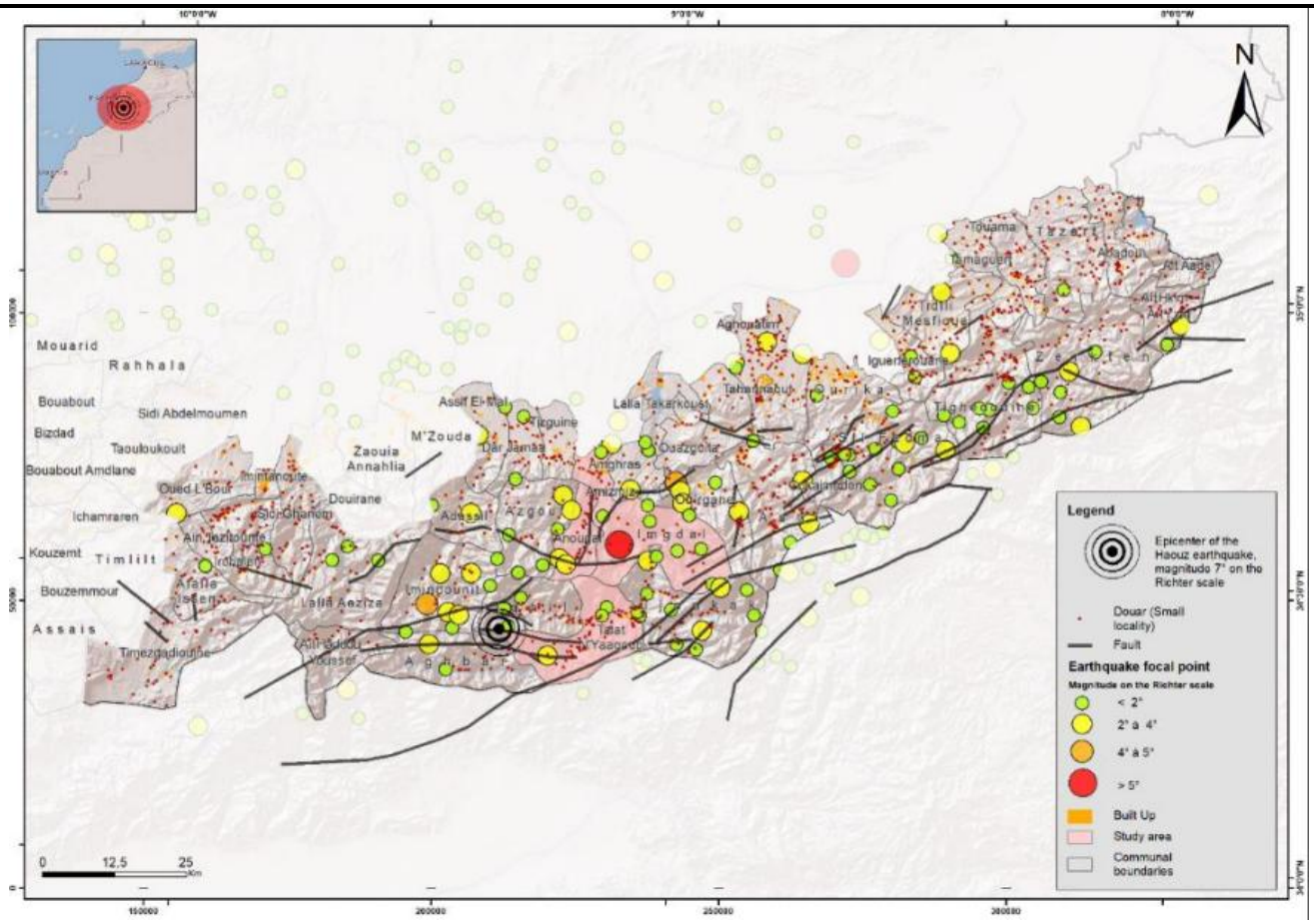

Figure 1 Overview of the earthquake on diffrent areas in the region,(Ait Zamzami, H., Elaanzouli, M., Saidi, J., & Boumeaza, T. 2024)

The statistics supplied by the Institut National de Géophysique (ING) provide a history of documented earthquakes across time, along with their magnitudes. These data are from 1933 until 2023. Our extended observation period allows us to track the evolution of earthquakes in the research region and discover potential trends.

Earthquake magnitudes range from 0.6 (very minor) to 5.8. These statistics show that the region is prone to shocks of varied intensity. Stronger disasters can significantly affect both the environment and the community at large.

1.2 Research Aims and Objectives

This research aims to analyze the vulnerability in the rural region in terms of sustainability in recovery after a disaster, rural communities around the world are not only characterized by limited resources and infrastructures, but also by a high level of risk associated with sustainability challenges,(Safapour, E.; Kermanshachi, S.; Pamidimukkala, 2021) whether social, ecological, or economic. . The fact that rural areas are often overlooked in recovery and response plans aggravates the situation by depriving vital times of need of enough attention and help. Through examining the point of view of community-based organizations, we will be able to see how rural areas cope and recover from disasters, as well as their fragile bass in numerous studies the gap in the effort on the previous examples while taking Morocco as a current approach of efforts across various sectors for effective recovery, one of the main proposed solutions in Morocco was an affordable how's things strategy to rebuild damaged houses and facilities around the region this study driven by the following question which barriers hinder disaster recovery efforts in rural settings how governments try to improve the future of sustainability and resilience is affordable housing a successful option in such difficult times.

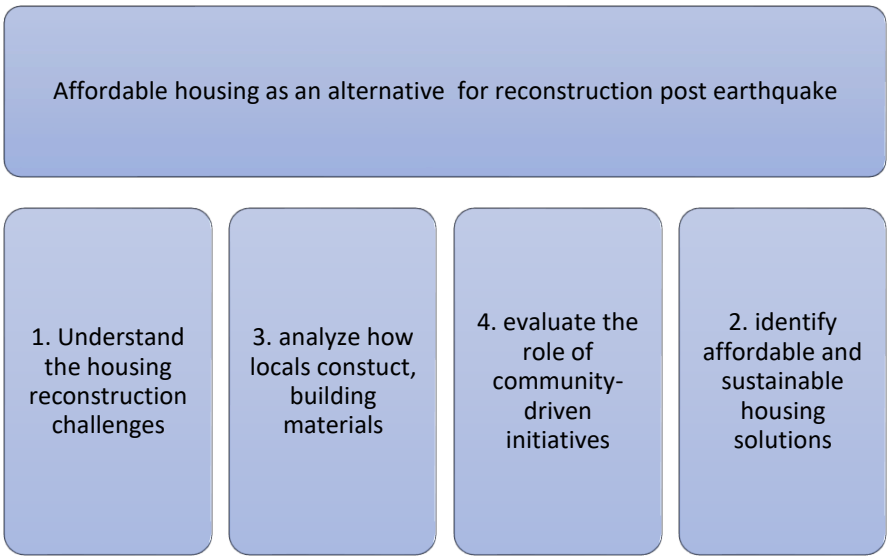

Figure 2. Objectives of the Study

The objectives of this research consist of 4 parts:

- To investigate the home rebuilding issues encountered by rural Moroccan populations after the earthquake by understanding the architectural features and building methods in the region. Rural mountain buildings in the Haouz region are distinguished by the usage of diverse building materials.

- Identify cost-effective and sustainable housing alternatives, encompassing prefabricated and economical designs. The Ministry of Construction has released a tender for temporary shelters in the region to private sector contractors, who are accountable for architectural design, infrastructure construction, and the selection of building materials and technologies. Following the catastrophe, the construction of the first temporary shelter took approximately eight months. Certain temporary shelters remain unused by disaster victims due to deficiencies.

- Examine how native building materials and traditional space management methods might be blended into contemporary rebuilding plans. Housing in Morocco varies from medieval to ultramodern.

- To assess the role of community-led activities in promoting resilience during disaster recovery, community resilience refers to how a community responds to stressors caused by manmade or natural changes..

1.3 Formulation of the Hypotheses

This paper aims to put the affordable housing test as a solution for recovery method from the earthquake, and to analyze the vulnerability in the rural region in terms of sustainability in recovery after a disaster, rural communities around the world are not only characterized by limited resources and infrastructures but also by a high level of risk associated with sustainability challenges, by answering 3 main questions:

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What makes rural construction one of the most vulnerable structures?

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What are the characteristics of affordable housing in rural areas?

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is affordable housing an alternative for community resilience after an earthquake?

1.4 Contribution to the Field and Article Structure

This document is organized into four parts. The first chapter understands the background, context and aim of the research. The second presents the analysis of previous research in a reconstruction post-disaster, profile of traditional lifestyle in rural areas, dwelling cultural signification, and community management. The third one identifies both the materials and methods used to collect and analyze the data. The fourth chapters consider the discussion and results from different approaches such as community-driven projects and local material-using houses for sustainability in resilience, as recommendations for future efforts on the same topic.

2. Literature review

2.1 Post-Earthquake Reconstruction: Concepts and Practices

Reconstruction is the process of restoring physical facilities and social structures after disasters, wars, or urban decline. It entails not just rebuilding structures, but also increasing resilience, sustainability, and social cohesion (Vale & Campanella, 2005). In post-disaster circumstances, reconstruction attempts to offer safe and long-lasting housing while incorporating risk-reduction techniques to avoid future vulnerabilities (Alexander, 2013). Scholars distinguish two main approaches to reconstruction: in-situ rebuilding, which promotes community-led initiatives and cultural continuity, and displacement, which relocates impacted populations to safer regions (Davidson et al., 2007). Architecture and urban planning play an important part in rebuilding since design decisions affect long-term habitability and economic regeneration Sustainable reconstruction uses local resources, traditional building methods, and participatory planning to boost resilience while preserving cultural identity (Duyne Barenstein, 2006). Effective rebuilding not only rebuilds infrastructure but also strengthens communities, resulting in a more adaptable and disaster-resistant constructed environment.

Reconstruction activities following an earthquake are crucial for recovering the lives and livelihoods of those impacted. (Bolin and Stanford, 1990) underlined that post-earthquake rehabilitation must satisfy the urgent demand for housing while taking into account long-term economic and cultural consequences. Similarly, emphasized that housing rebuilding is critical to recovery, influencing community resilience and the rate of economic recovery. (Barakat, 2003)

Traditional building traditions, resource constraints, and geographic isolation all contribute to the specific problems of reconstruction in rural Morocco. Rodriguez-Navarro et al. (2012) investigated the endurance of traditional earth construction techniques in the Northern High Atlas, highlighting its affordability and cultural significance. These findings underscore the need for incorporating indigenous materials and practices into disaster recovery efforts.(Rodríguez. N, 2012)

Furthermore, the Al Haouz earthquake demonstrated the susceptibility of mud-brick houses, a classic but unstable building type. Zafra et al. (2023) found that this home style greatly contributed to the earthquake's mortality toll, emphasizing the urgent need for durable yet inexpensive alternatives. (Mariano Zafra, Aditi Bhandari, Dea Bankova, Adolfo Arranz, and Prasanta Kumar Dutta, 2023)

2.2 Affordable Housing Strategy

Affordable housing is defined as housing that is financially available to low- and middle-income people without risking their capacity to meet other basic necessities like food, healthcare, and education. It is a vital aspect of sustainable urban development and social fairness since it ensures that those most in need have access to secure and adequate housing (Hulchanski, 1995). Housing affordability is often measured using income-to-housing cost ratios, with a conventional threshold of 30% of household income (Stone, 2006). Governments and policymakers utilize a variety of initiatives to increase affordable housing availability, including aid, rent supervises, and inclusionary zoning (UN-Habitat, 2020). Furthermore, architects and urban planners demonstrate the relevance of new construction technologies, such as prefabricated houses and locally produced materials, in cost reduction while retaining quality and sustainability. (Tipple,

2000). The concept of accessible housing is critical for tackling urbanization issues, ensuring socioeconomic variety in cities, and promoting equitable communities.

Affordable housing is increasingly acknowledged as a critical component of successful post-disaster rehabilitation, and Davidson (2006) advocated for combining affordability and sustainability to develop resilient housing alternatives. They cited the prefabrication and construction using modules as possible approaches to achieving cost savings without sacrificing quality.

In Morocco, affordable housing has shown to be critical for meeting both urgent shelter requirements and long-term sustainability. Hidayat and Egbu examined the function of project management in disaster recovery and emphasized the significance of affordability in housing options. Their findings are consistent with those of who investigated transportable and adaptable architectural solutions. They are especially relevant for Morocco, where economic constraints prevent high-cost rehabilitation programs, including prefabricated modules, from being cost-effective disaster restoration strategies. (Hidayat and Egbu, 2010)

2.3 Application of Local Materials and Comminity Engagement

Incorporating local materials and traditional knowledge into rebuilding initiatives has received significant support from scholars and practitioners. Bedoya (2004) argued for using local construction techniques to guarantee cost and cultural suitability. Similarly, Rodriguez-Navarro et al. (2012) investigated the efficacy of earth-building techniques in Morocco's High Atlas area, focusing on their durability and cost savings. (Rodríguez. N, 2012)

Arslan (2007) and Arslan and Cosgun (2008) emphasized the need for reusing and recycling temporary housing materials. Their research showed that incorporating these approaches can lower costs and harm to the environment while promoting long-term healing.

The utilization of local materials and traditional expertise in rebuilding reflects Morocco's architectural legacy. Bedoya (2004) and Rodriguez-Navarro et al. (2012) demonstrated how techniques like rammed earth and stone building may save money while preserving cultural authenticity. These ideas are appealing to rural Moroccan populations, where traditional traditions are strongly established. (Rodríguez. N, 2012)

Furthermore, research has demonstrated that participatory design techniques improve the success of restoration initiatives. The need for incorporating local populations in the design and execution of housing projects. This viewpoint is especially pertinent in Morocco, where strong community relationships may foster collective action and resource sharing. (Lizarralde and Bouraoui (2012)

Community engagement is important to the success of post-earthquake housing developments. Davidson et al. (2007) dispelled illusions about community engagement and highlighted its importance in attaining long-term healing. The researchers emphasized that empowering impacted communities promotes ownership and ensures that housing solutions are tailored to local requirements and interests. Boen and Jigyasu (2005) shared these thoughts, highlighting the significance of cultural factors in catastrophe rehabilitation. By including communities in deciding, efforts to restore may successfully address social, cultural, and economic components.

2.4 Insights from the Al Haouz Earthquake

The reaction to the Al Haouz earthquake taught us vital lessons about the need for adaptation and inclusion in reconstruction. Relief agencies and experts have emphasized the necessity for solutions that combine cost and resilience. Prefabricated housing modules, for example, were recommended as a temporary solution to meet urgent shelter requirements while providing time for long-term restoration. While affordable housing has several advantages, obstacles remain in its implementation. Davidson et al. (2008) identified logistical challenges in distributing prefabricated units to remote places, which are also present in the High Atlas region. Furthermore, budgetary restrictions and limited technological capabilities might impede the scaling of novel housing options. .(Davidson, 2008)

However, Morocco's restoration efforts create the potential for creativity. By combining current technology with ancient knowledge, stakeholders may create hybrid methods that satisfy both immediate and long-term requirements. The concepts of "Building Back Better" are consistent with these objectives, promoting reconstruction that enhances pre-disaster circumstances.

The Key is people in post-disaster reconstruction have contributed insights that apply to the Moroccan setting. Researchers such as Lizarralde, Davidson, and Johnson have underlined the need for including affordability and sustainability in housing solutions. Their outcomes are consistent with those of Rodriguez-Navarro et al. (2012) on the robustness of traditional construction methods in the High Atlas.

Furthermore, the contributions of Zafra et al. (2023) and other field-based research on the Al Haouz seismic have shed light on rural housing risks and the possibility of novel solutions.

3. Materials and Methods

3.1 Study case Area: Al Haouz Province

The Haouz region is an important element of Morocco's economy and culture. It is a significant agricultural region that produces grains, fruits, and vegetables (Montanari., 2013). The Haouz region is a popular tourist destination for its natural scenery and ancient buildings. The Haouz region is an important element of Morocco's economy and culture. It is a significant agricultural region that produces grains, fruits, and vegetables (Montanari., 2013). The Haouz region is a popular tourist destination for its natural scenery and ancient buildings.

Those living near the earthquake's epicenter, notably around the Haouz mountain range, were hit hard. The earthquake was felt as far away as Algeria and Tunisia. Preliminary data from the Institut National de Géophysique indicate the following geographical coordinates: Longitude: -8.413; Latitude: 30.961. The focal point was in Ighil commune, Al Haouz province. The seismic event measured 7 on the Richter scale and occurred at a depth of 8 kilometers. It happened at 23 hours and 11 minutes (Yeck et al., 2023). We selected to analyze four communities that had a devastating influence on all of their neighbors. These were the municipality of Amizmiz, Morocco's hardest-hit town.

- Amizmiz
- Anougal
- Tikhth
- Talat and Yacoub
- Imdgal
- Mejdid

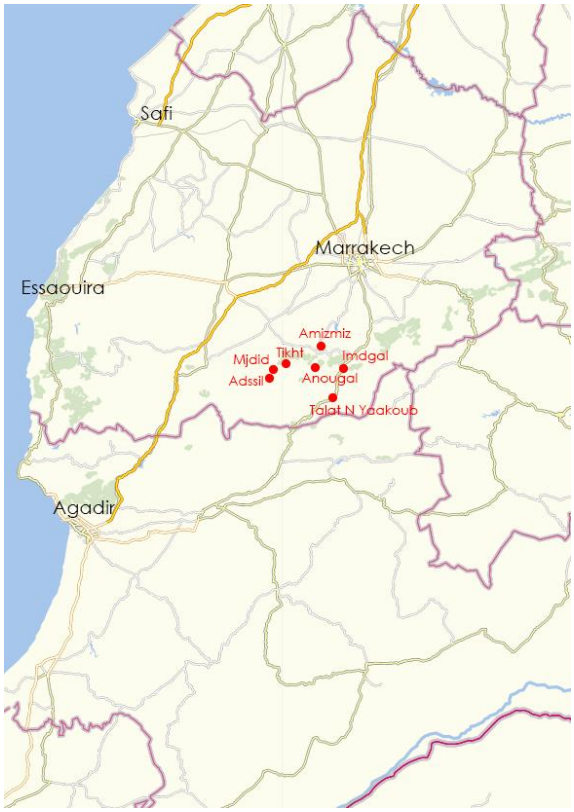

Figure 3. **Map showing the villages in the study.** Source: Google Maps, added annotations by Author.

3.2 Research Methodology

This study takes a combination of qualitative and quantitive methods that include:

- Semi-structured discussions with beneficiaries, such as village people, architects, and administrators, to comprehend rebuilding techniques and obstacles.
- Observation to document reconstruction activities and outreach to the community.
- Satellite captures are used to study spatial distributions of damage and rehabilitation.
- Secondary data analysis of reports, case studies, and earlier research on house rebuilding in Morocco and related cases, as well as rural region rehabilitation.

Data Collection:

A couple of site visits (Al Haouz) to understand closely the situation on the field, meeting professionals that have been working on both reconstruction and community engagement

Data Analysis

GIS Mapping, Employing geographic information programs to analyze the damage caused by the earthquake on a larger scale

Visual Analysis :

After collecting pictures, a visual study is done manually based on the observation and investigation

Integration of data

Analysis based on comparing and analyzing the previous projects in different locations

However, this paper will only highlight qualitative methods used to attain a clear image of the situation of rural areas post-earthquake and how affordable housing is an alternative for resilient reconstruction

3.3 Data Collection
GIS Mapping and Spacial Analysis

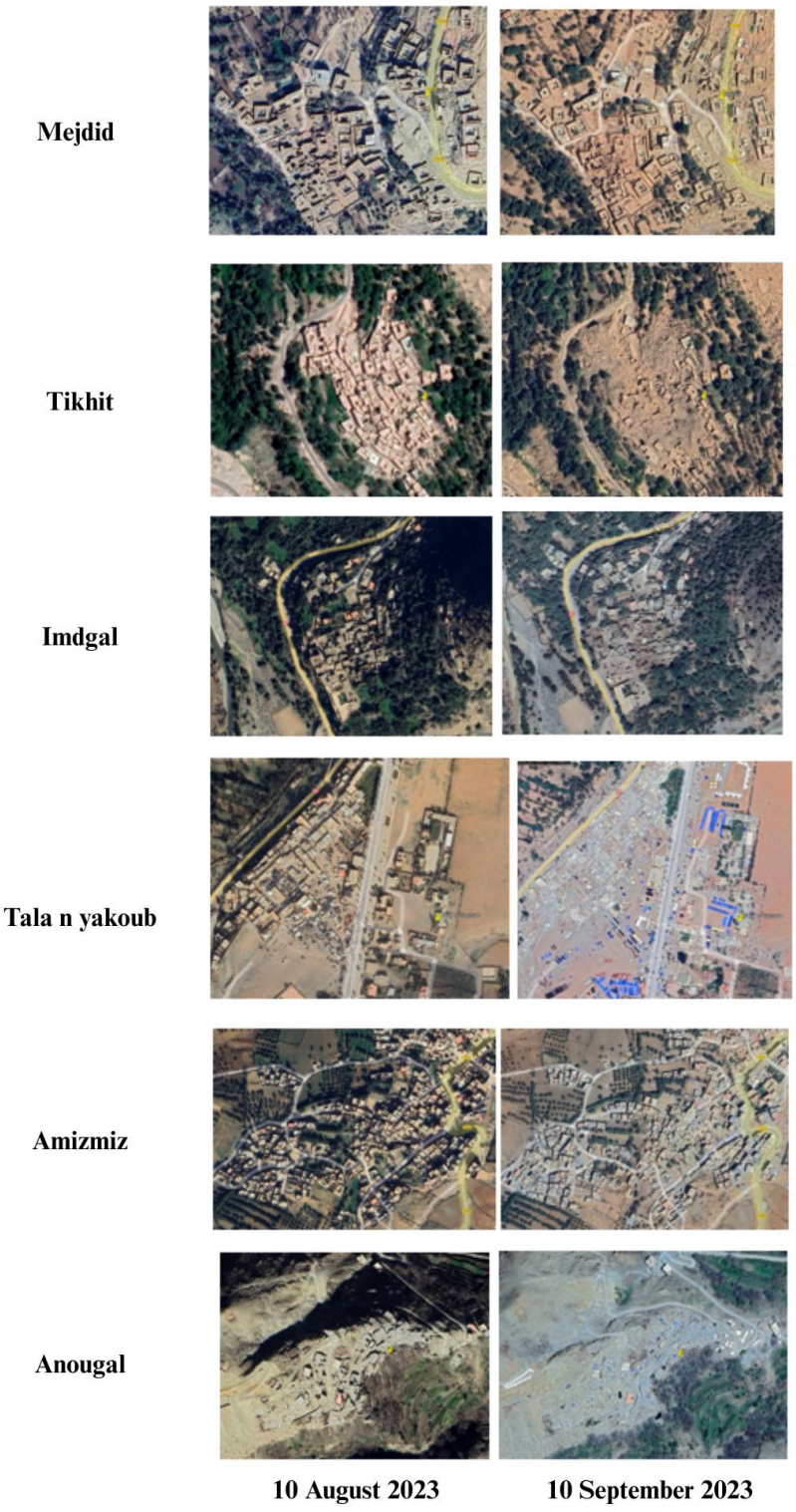

Figure 4. Present maps of various villages illustrating the conditions prior to and subsequent to the earthquake. Source: Google Earth, with annotations contributed by the author.

The Western High Atlas consists of sedimentary, metamorphic, and igneous rocks. The oldest rocks in the range are prehistoric metamorphic formations, which are covered by Paleozoic sedimentary strata. The region contains Mesozoic sedimentary formations, comprising limestone, dolomites, shales, and sandstones. The Western High Atlas region exhibits structural complexity, characterized by numerous faults and fold systems. The primary faults in the region are the Tizi n'Tichka fault and the Ourika fault. Cornée et al. (1987), Dias et al. (2011), and Ilmen et al. (2016) have identified strike-slip faults characterized by horizontal movement. This mountain range links the Atlas and Meseta mountain ranges, two significant tectonic zones in northwest Africa. (Inoh et al., 2022, Bouatmani et al., 2003).

In addition to home rebuilding and reconstruction, disaster resilience, building back better, climate neutrality, and inclusiveness concepts must be integrated into the process of rehabilitation.

In the Moroccan earthquake, the death toll makes the quake the deadliest in the country since 1960, and rescuers and experts warn that the region's conventional mud, brick, and stone-built houses are vulnerable, exacerbating the harm and loss of life. "It's difficult to pull people out alive because most of the walls and ceilings turned to earthen rubble when they fell, burying whoever was inside," a military rescue laborer, who asked not to be called due to forces rules against communicating with the media, said at an army center south of Marrakech, not far from the epicenter of the earthquake.

Victims of Morocco's biggest earthquake in almost 60 years are struggling to find nourishment, shelter, and water as the desperate hunt for the missing continues in rural areas.

The catastrophe resulted in around 2,100 fatalities, and this number is anticipated to increase. The United Nations estimates that the magnitude 6.8 earthquake on Friday night affected over 300,000 individuals. Individuals rendered homeless or apprehensive about subsequent aftershocks congregated on the streets of Marrakesh or slept under improvised canopies in severely affected Atlas Mountain locales, including Moulay Brahim.

Inhabitants of that area and Amizmiz expressed particular apprehension regarding the detrimental impact on isolated communities. The most significant destruction transpired in rural areas accessible exclusively by dirt roads that meander over the steep landscape and are currently obstructed by falling rocks.

3.4 Visual Analysis for Rural Vulnerability

These structures are constructed with the earth as its base. It generally originates from the same site, eliminating the initial 80 cm to avert soil contamination. Debris from deconstructed structures is frequently repurposed, exemplifying sustainable design principles. The soil is intermittently processed by screening to remove extraneous materials and coarse gravel. Certain regions are recognized for possessing superior soil quality appropriate for construction purposes. The following is a granulometric analysis of the earth's "qualities sanctioned by practice" obtained in situ. The specimen is reddish, slender, and devoid of any organic material. When moist, this might generate unpleasant scents. (P. Rodríguez-Navarro, F. Juan Vidal, T. Gil Piqueras & F. Fantini, 2012)

Traditional houses, despite their rich history and cultural attractiveness, have a structural weakness that makes them vulnerable to natural forces, especially earthquakes. To understand why traditional ecosystems are vulnerable, it's important to investigate the fundamental causes (Moujane et al., 2023). Factors to consider include structural strength restrictions, extreme discomfort, inadequate connections, and heavy building materials. To further understand why traditional housing might become brittle during earthquakes, let's examine the following factors. Traditional dwellings are fragile due to a variety of issues, which are described below:

- Structural force limitations: Traditional construction materials often have lower durability than contemporary materials like reinforced concrete and steel.
- Excessive stiffness: Many of these materials, for instance, stone and raw earth, are firm, rendering them susceptible to breaking and failure during seismic shocks. For example,

smectite-based mud swells when exposed to water and contracts as it dries, making it brittle rather than flexible enough to absorb seismic energy.

- Inadequate structural connections: Traditional structures frequently lack strong structural links, which means that the structure's many components are not securely attached. This can cause partial or complete collapse in the case of an earthquake.

-Heavyweight: Some traditional materials, such as stone, are quite heavy, making them more prone to collapse in an earthquake. Their substantial mass exerts additional strain on the foundations, which are typically 40-50 cm thick.

4. Data Analysis and Discussion of results

4.1 Investigating affordable housing post earthquake in rural areas

This part of the research was based on administrative documents, data collection from professionals and technicians, The This part of the research was based on administrative documents, and data collection from professionals and technicians, The kingdom of Morocco has adopted a housing policy based on private-public partnerships. Private developers participate in numerous government social projects in exchange for tax breaks and other benefits. The Social Housing Programme, worth Dhs 250,000 (US$24,862), exempts developers from corporation tax, income, authorization and stamp duty, land register fees, business tax, and undeveloped land tax. Purchasers benefit from the value-added tax associated with social housing. (Ministry of National Spatial Planning, Urban Planning, Housing, and City Policy, 2020)

To start the reconstruction process the victims needed to go through several steps to ensure a delegated Rehabilitation with the surveillance of the authorities to make sure That the assessments meet all safety and regulatory standards:

a)Damage Evaluation

b)Aid Application

c) Approval and Disbursement: Once the aid application is approved, money is distributed in installments. For example, by August 2024, 56,607 families had received a first payment of 20,000 dirhams (approximately $2,070). (The New Humanitarian, 2024).

d)Receiving Reconstruction Permits

e) The Reconstruction Operation

f)Observation and Compliance

4.2 Comparing Al haouz to other study cases

For an accurate investigation, this part was divided into community-driven projects such as Programa VACA in Chile, Working together by Mara Papavasileiou, projects the main concept was about the use of local materials for sustainable reconstruction like Anti-seismic earth brick house Aziza Chaouni Al Haouz, Morocco, The new Gourna by Hassan Fathy, Egypt

Reconstruction projects following natural disasters in several regions, spreading from Chile to Morocco, illustrate the potential for using local supplies and grassroots-driven methods to recover from disasters. These efforts emphasize not just the imperative of developing resilient, culturally suitable, and sustainable homes, but also the need to promote local involvement and ownership. These projects have shown that affordable, earthquake-resistant, and ecologically conscious housing is achievable, even in the most vulnerable populations, by integrating traditional building techniques with new technology. Integrating local knowledge, such as building using natural materials like adobe and compressed earth bricks, has been demonstrated to be both cost-effective and environmentally friendly.

4.3 Recommendation and future Research

A guideline for professionals involved in frontline decision-making after a disaster to enhance the accessibility of affordable housing. It is advised that experts involved in decision-making following a disaster prioritize inexpensive housing as a viable choice that emphasizes cultural legacy, community resilience, and a sustainable solution for rural socioeconomic attributes.

- Enhance professional cognizance regarding the significance of safeguarding the historical and architectural heritage of rural areas, alongside the vital matter of cultural preservation, to

devise accessible materials and methodologies for residents to facilitate sustainable reconstruction following an earthquake.

- Global collaboration: International partnerships and financial support can enhance the region's resilience to natural disasters. Insights from global regions addressing earthquake hazards can be exceedingly beneficial. The advancement of AI methodologies is essential for forecasting disasters and evaluating their spatial effects through historical data analysis..

- Raise awareness: The population must be educated on how to respond in the event of an earthquake, as well as the necessary safety precautions. Public understanding of seismic dangers is an essential component of preparedness.

- Urban planning: Local governments must incorporate earthquake resilience into urban and geographical plans. This includes identifying high-risk regions, and limiting construction in certain areas while encouraging safer building zones.

- Resilient facilities: Bridges, roads, and drinking water systems must be built to resist earthquakes. Existing infrastructure must also be rehabilitated and reinforced.

- Seismic construction norms: It is important to adopt and follow strict seismic construction guidelines for both new and renovated structures. This will improve the ability of structures to endure seismic shocks.

- The administrative procedures must be well organized to make sure the victims get their paperwork as soon as possible

5. Conclusion

To summarize, the earthquake in Morocco showed the risks of traditional rural housing, notably in the High Atlas region, where constructions are mainly composed of native materials such as stone, mudbrick, and wood. Although these materials provide climate-responsive advantages and inexpensive solutions, they are inadequately designed to endure seismic forces, resulting in extensive destruction and loss of life. The devastating consequences of this disaster emphasize the critical necessity to incorporate earthquake-resistant designs and resilient building practices into the reconstruction process. Furthermore, local knowledge, environmental practices, and cultural implications must be stressed to ensure that future housing options are structurally solid as well as contextually relevant.

Despite these limitations, the continued use of old materials and processes shows their potential for future growth, especially when paired with modern technical solutions. Enhancing the structural strength of historic structures by improving the use of new materials may help to preserve their original shapes while assuring safety during seismic occurrences. The case studies of post-earthquake damage in diverse regions, such as Amizmiz and Tikht, illustrate the importance of improving disaster resilience in rural dwellings to protect both lives and history. The future of rural Moroccan homes may rest in a balanced strategy that combines traditional construction methods with modern advances to ensure that they continue supporting their communities successfully while reducing environmental impact and maintaining cultural heritage.

Integrating GIS Mapping added a clear idea of the impact the earthquake had on rural areas, the region saw an impressive display of resilience and drive in a variety of post-seismic repair and restoration initiatives. These activities provide vital insights into the problems and successes of restoring a destroyed landscape. The study addresses sustainability and future planning. It investigates preventative strategies that can be adopted to strengthen the resilience of buildings and infrastructure to future earthquakes. As the research progresses, we hope that this thorough examination of the fragility of buildings and infrastructure in the Haouz region will not only demonstrate the region's strength but also provide helpful recommendations for resilient development and disaster decrease in the High Atlas and beyond.

A structure's ability to withstand seismic forces is determined by a variety of elements, ranging from building materials to structural design details. In addition to identifying the key problems and their cause which lay into their way of construction and the utility of the materials, that made the buildings vulnerable.

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