

EXPLORING ADAPTABLE ARCHITECTURE FOR CLIMATE MIGRATION COMMUNITIES

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Abstract

Migration as a result of climate turned out to become a major challenge in Pakistan with frequent floods and droughts, and other extreme weather conditions leaving millions of people out of their conventional habitations. This paper discussed the feasible architecture of the climate migration in Pakistan, that is, how to develop resilient as well as flexible housing systems to solve the problem of urgency. The study examined design solutions to the dynamics of displaced populations and adaptation to the varied climatic regions and cultural setting of Pakistan. The paper investigated vernacular architectural principles, sustainable material and modular use of construction techniques that can be applicable in temporary and semi-permanent settlements. The field survey in the flood plagued areas of Sindh and Punjab showed that migrant populations had certain spatial needs and culture. The study examined the case studies of available displacement camps and showed significant gaps in the existing systems of shelter provision. Results showed that flexible architecture and adaptation to local building traditions, climate-sensitive architecture, and community involvement had a substantial positive effect on living standards and social solidarity of displaced communities. The researchers put forward a scalable architectural structure that was affordable, fast to implement, and culturally acceptable. The study added to the expanding literature on climate resilience in South Asia and presented feasible advice to architects, urban planners, and humanitarian agencies in Pakistan to operate with climate-displaced communities.

INTRODUCTION

Climate change has become one of the most significant humanitarian crises in the twenty-first century and its effect on the human settlements in South Asia has been extreme (Mustak 2022). The combination of a repeat floods, longer droughts, and increasing severe weathers of Pakistan has left millions of people without a home, and they are forced to leave their old

places of residence in search of a safer place to live (Mahmood and Hassan 2022). The 2022 floods alone partially covered close to one-third of the country displacing more than thirty million people and damaging about 1.7 million homes. This disastrous displacement did not happen in a vacuum but it was a natural progression of decades of climatic susceptibility

that is gaining momentum with each passing year (Hussain, Chaudhary et al. 2022). The magnitude and intensity of this crisis require answers that are much more than the traditional emergency assistance interventions, and instead calls upon the creation of the architectural practices that are enduring, flexible, and consistent with the particular social and cultural structure of the affected communities (Shahbaz, Liaqat et al. 2024).

The phenomenon of architecture has traditionally been a key factor in human survival in the face of environmental detriment (Arshad, Akram et al. 2025). Indigenous construction in Pakistan extends back through centuries of experience regarding climate-sensitive design in such indigenous constructions as the wind-catchers of Sindhi vernacular buildings and the thick earthen walls of rural Punjab houses. But these traditional systems have been blocked out by the pace and magnitude of modern climate displacement such that millions of people are in inappropriate temporary housing that do not meet the policy of thermal comfort, structural security, privacy and social unity (Akram, Ashraf et al. 2025). The disconnect of the urgency of the displacement crisis and the lack of sufficient response by the current architectural practices is the focal point of the issue that this research is focused on. It was noted that current displacement camps and emergency shelters were built on the basis that people can temporarily live in them, but they had not thought of the fact that the populations can be displaced over years or decades (Akram, Mubin et al. 2025).

Physiographic and cultural diversity of Pakistan is also an addition to the problem of climate migration community design because the country is very diverse. In the dry plains of Balochistan and the damp deltaics of Sindh and the fertile agricultural belt of Punjab, the displaced populations have to deal with very different climatic conditions which call out different architectural solutions (Das and BHUTTA 2025). Ingrained cultural practices of gender separation, intimacy and shared socializing places imply that imported generic shelter arrangements such as those used elsewhere do not get accepted and give

satisfactory dignity to their occupants. The researchers realized that the workable architectural framework to serve displaced communities in the climate must be climate-sensitive, culturally cognizant, economically viable and structurally adaptable to the changing needs over time (Khalid, Savelli et al. 2025).

The idea of adaptable architecture has been rising on the humanitarian design discourse in the two decades. In contrast with more traditional emergency shelter models, flexible architecture focuses on flexibility, modularity, and the ability to be improved in an incremental fashion as conditions within the community change. Examples of such systems include modular construction systems where settlements can grow and shrink with changing population, as well as the use of locally available sustainable materials that make settlements cheaper and more community-owned (Akram, Mubin et al. 2024). A combination of passive climate control measures includes natural ventilation, thermal mass and shading devices that will greatly enhance the comfort in the indoors without necessarily incurring high costs of using energy-demanding systems. These values, when integrated into a systematic architectural design and guided by the strictest communitarian consultation, have a significant potential in solving the problem of shelter deficit among climate-displaced people in Pakistan (Akram, Nadeem et al. 2025).

This research is based on empirical fieldwork, as well as a critical analysis of available literature and case studies. The researchers gave a comprehensive field survey on both Sindh and Punjab flood-affected settlements and interacted with displaced families to know their spatial choices, cultural needs, and exposure to current shelter solutions. These results were added to a detailed analysis of six models of displacement camps active in Pakistan, which showed substantial structural, thermal, social ineffectiveness in the existing strategies of providing human beings with shelters. The ensuing analysis formed the evidence base in the development of a scalable, culturally informed and climate-responsive architecture framework that could address the demands of the Pakistan

population that is increasing in number as of climate displaced individuals.

The universal implications of this study are beyond Pakistan. In South Asia, Indian subcontinent, and the broader Global South, climate migration is expected to become increasingly dramatic in the next few decades as the sea level increases, glaciers begin to melt faster, and extreme weather patterns become increasingly vehement and more frequent. The developed architectural principles and community-based design approaches based on this research would serve as the transferable model to be applied in other settings where the same problems of the rapid displacement and poor shelter facilities are observed. By connecting the disciplines of humanitarian design, vernacular architecture, sustainable construction, and community engagement, this study can be included in a growing field of knowledge that no longer views climate-displaced communities as people receiving emergency assistance, but as participants in the co-generation of resilient, dignified, and habitable built environments.

Research Objectives

1. To investigate the spatial demands and cultural necessities of climate displaced communities in Pakistan in the flood-impacted states of Sindh and Punjab.
2. To test the current models of displacement camps and locate the structural, thermal and social gaps of the current shelter provision systems.
3. The objective of the project is to come up with a scalable, climate-sensitive, and culturally-related flexible architectural design to climate migration residents in Pakistan.

Research Questions

1. What are some of the spatial, cultural, and climatic demands of climate-displaced populations in Sindh and Punjab and how do these demands shape the design choices of architecture?
2. How well are current models of displacement camps in Pakistan able to address the thermal

comfort, structural stability, privacy, and cultural suitability needs of displaced people?

3. What can be done to unite the concepts of modular construction, vernacular architecture, and community involvement into a flexible system of architecture that is cost-effective and can be quickly established by people that migrate to the climate in Pakistan?

Significance of the Study

This research is important to architects, urban planners, humanitarian organizations and policymakers dealing with climate-displaced populations in Pakistan and in South Asia generally. Through the combination of vernacular principles of architecture and modular construction and participation-based design, the research provided a feasible and scalable model when dealing with the escalating shelter shortage due to climate migration. The results were added to the evidence-based policy formulation and the discussion of climate-resilient, culturally competent humanitarian architecture in the background of the increasing environmental displacement.

LITERATURE REVIEW

Climate change and the issue of human displacement is a widely reported phenomenon in the world development and environmental literature. It has always been claimed by scholars that climate driven displacement is one of the gravest humanitarian emergencies of the modern world, and it is projected that by the mid-twenty-first century hundreds of millions of people will be forced to move because of rising sea levels, desertification, and intense weather patterns (Askland, Shannon et al. 2022). Pakistan finds itself in a very vulnerable situation in the South Asian context because of heavy reliance on the Indus River system, the extent of population within the lowlands which are prone to flooding and the adaptation capacity of Pakistan as compared to their richer counterparts. Frequent Indus floods, and the growing drought cycles in Balochistan and Thar Desert have been proved to be contributing to the chronic cycle of displacement through which people are

permanently deprived of their ancestral residence and means of living (Khan, Abbas et al. 2022).

The architectural reaction to the humanitarian displacement has significantly changed in the last 50 years (Siddiqi, University et al. 2024). Initial emergency shelter solutions were centered on tent solutions that had only been widely used in short-term military and refugee solutions, and were ill adapted to deal with thermal extremes, dust and seasonal rainfall that characterized the various climatic zones of Pakistan (Khalid, Hafeez et al. 2024). Later humanitarian shelter design trends saw the creation of transitional shelter designs that might form the basis of more permanent housing solutions, with organizations like the United Nations High Commissioner for Refugees and the International Federation of Red Cross and Red Cresser Societies releasing influential guidelines that promoted the use of locally sourced material, community engagement and cultural suitability as the foundation of designs. Regardless of such developments, field experience has continued to demonstrate that very wide discrepancies exist between design intent and built reality in most displacement contexts, and that sub-optimal funding, logistical factors, and poor community consultation can nullify the effectiveness of even the best designed shelter programs (Shad 2024).

Vernacular architecture has emerged as an increasingly popular field of study given its role as a storehouse of climate-responsive knowledge that may apply to modern humanitarian design issues (Imtiaz 2025). Within the Pakistani context, scholars have indicated the advanced passive cooling and ventilation models entrenched in the conventional building shapes in the regional climatic conditions. The Thatta wind catchers of Sindh, the massive adobe and shaded courtyards of Punjab havelis and the lightweight bamboo and reed construction of communities in the delta are all locally developed solutions built out of centuries of occupation. These vernacular traditions have been discussed by scholars as providing priceless insights into designing modern climate-sensitive housing, both regarding the choice of materials, the layout of the space, and the incorporation of passive environmental

control mechanisms. The difficulty is in how these principles can be converted into systems of construction, capable of being installed quickly and in large amounts in displacement situations, without losing the cultural appeal and climatic performance of the vernacular prototypes (Akram, Malik et al. 2026).

Prefabricated and modular construction systems have become a popular subject of research with regards to addressing the speed and scale issues of providing humanitarian shelters. It has been proven that with appropriate design of modular shelter systems used in the context of disasters in Turkey, Bangladesh, and the Philippines, semi-skilled community labor can work to put up a modular unit quickly, change the modular unit to suit different household size and structure, and improve the modular unit over time as communities stabilize (Sakib, Chowdhury et al. 2025). Critics have, however, noted that in numerous prefabricated shelter systems, the industrial materials used are costly to ferry to remote areas, may not be appropriate in local climatic conditions and in many cases, may not meet the quantity and spatial arrangements and privacy needs of local cultures. Hybrid methodologies between the speed and scalability benefits of modular systems and the climate performance and cultural suitability of locally sourced vernacular construction methods, locally-available materials, are therefore of increasing demand in the literature (Harun-Or-Rashid, Castro et al. 2022).

Participation of communities in shelter design and structure has been found to be a very important target to the success and long-term sustainability of the displacement housing programs. Research that has been carried out in various areas of humanitarian has revealed that settlements in which communities participated actively in the design had much greater levels of satisfaction, social cohesion and physical upkeep than settlements in which shelter solutions were enforced externally (Jayakody, Malalgoda et al. 2022). Participatory design processes in the Pakistani context have to negotiate the complicated social forces such as gender norms which limit the freedom of women to participate

in the publicity, caste and tribal affiliation which affect the spatial territories within settlements and the religious requirements which determine the direction and internal organization of domestic space. Studies have revealed that culturally informed participatory processes that actively reach out to the contribution of women, elders, and marginalized groups are likely to yield more diversity in terms of shelter solutions and there is more likely to be maintainability and adaptation over time (Conzatti, Kershaw et al. 2022).

The general discussion of climate resilience in buildings has long since stopped asking how a single building can be made resilient to climate-driven challenges and started to worry about how a whole settlement or community can be made resilient to these conditions. Researchers have suggested that and indeed resilient settlements need to be in a position to absorb shocks, adjust to new circumstances and change due to long term trends without losing their critical functions and social structures. This, when applied to climate migration, would involve creating settlements capable of accommodating the changes in population, sustaining various livelihood practices, continuing social networks and cultural traditions and continually enhanced as the communities that have been uprooted by climate change shift between emergency, recovery, and recovery plus (Mehan and Mostafavi 2023). The literature has identified the significance of governance frameworks, land tenure setup, and service accessibility as equally vital predictors of settlement resilience to the physical design of shelter units, and has indicated the need to adopt the multidisciplinary methodology based on the integration of the architectural, social, economic, and institutional aspects of climate adaptation.

RESEARCH METHODOLOGY

Research Design

The researchers employed mixed research design to explore flexible architectural solutions to migrant communities who relocate due to climate in Pakistan. This design enabled the researchers to both measure and get the contextual human

experiences associated with the displaced populations.

Study Area and Sampling

The researchers chose flood-prone areas of Sindh and Punjab as areas of main research because of high occurrence rate of climate displacement. Purposive sampling was applied by the researchers to select 12 displacement settlements in the two provinces. Structured surveys were conducted with 240 displaced households and in-depth interviews were held with the community members, local architects, and humanitarian workers (18).

Data Collection

The primary data used by the researchers were in the form of field survey, structured questionnaire, semi-structured interview and direct observation of the sites. Secondary data was collected through already existing literature, government housing reports and case studies of displacement camps. The researchers mapped out spatial configurations, material use and cultural practices in the selected settlements by use of photographic and sketch-based mapping.

Case Study Analysis

The researchers analyzed six known models of displacement camps in order to determine structural and operational gaps in the existing shelter provision models. All cases were measured on the basis of such factors as climate responsiveness, cultural suitability, the speed of construction, and expense.

Data Analysis

Quantitative data were examined with the help of descriptive statistics, and the qualitative data were analyzed with the help of thematic analysis. There was triangulation of findings that were made in both methods which guaranteed validity and reliability.

Ethical Considerations

All the participants provided informed consent to the researchers and had confidentiality during data collection and reporting.

Results and Data Analysis

QUANTITATIVE ANALYSIS

Table 1: Demographic Profile of Displaced Households (n=240)

Characteristic	Sindh (%)	Punjab (%)	Total (%)	Frequency (n=240)
Male Headed HH	62	58	60	144
Female Headed HH	38	42	40	96
Avg. Household Size	6.4	5.8	6.1	-
Displaced < 1 year	45	38	41.5	100
Displaced 1-3 years	35	40	37.5	90
Displaced > 3 years	20	22	21	50

Table 1 presents the demographic profile of the 240 displaced households surveyed across Sindh and Punjab. The data revealed that sixty percent of households were male-headed while forty percent were female-headed, with an average household size of 6.1 members. Displacement

duration analysis showed that 41.5% had been displaced for less than one year, indicating a predominantly recent displacement crisis, while 21% had remained displaced for over three years, highlighting the chronic nature of climate-induced homelessness in the study region.

Table 2: Household Satisfaction with Current Shelter Conditions

Housing Indicator	Satisfied (%)	Neutral (%)	Dissatisfied (%)	Mean Score (1-5)
Structural Durability	22	18	60	2.1
Thermal Comfort	18	14	68	1.9
Privacy & Space	25	20	55	2.3
Cultural Appropriateness	30	22	48	2.5
Access to Utilities	20	15	65	2.0

Table 2 illustrates household satisfaction levels with current shelter conditions across five key indicators. The data revealed widespread dissatisfaction, with thermal comfort recording the lowest mean score of 1.9 on a five-point scale and 68% of respondents expressing dissatisfaction. Structural durability and utility

access also performed poorly, each with over 60% dissatisfaction rates. Cultural appropriateness received the highest satisfaction rating at 30%, yet still showed that nearly half of all respondents considered their current shelter culturally inadequate, confirming significant gaps in existing shelter provision.

Table 3: Community Preferences for Construction Materials

Material Type	Preferred (%)	Climate Suitable (%)	Locally Available (%)	Cost Feasibility (%)
Compressed Earth Block	42	78	85	88
Bamboo/Timber Frame	35	70	65	82
Prefabricated Panels	15	60	30	45
Conventional Brick	8	50	55	35

Table 3 presents community preferences for construction materials and their perceived suitability. Compressed earth blocks emerged as the most preferred material at 42%, with the highest local availability rating of 85% and strong cost feasibility at 88%. Bamboo and timber frames ranked second in preference at 35% and demonstrated reasonable climate suitability at

70%. Prefabricated panels, despite their construction speed advantages, recorded only 15% community preference and low local availability at 30%, indicating significant alignment barriers between externally sourced industrial materials and community needs and capacities.

Table 4: Community Participation Levels and Satisfaction Outcomes

Participation Level	Design Stage (%)	Construction (%)	Management (%)	Satisfaction (%)
High Participation	28	35	30	74
Moderate Participation	42	38	40	58
Low Participation	30	27	30	32

Table 4 demonstrates a clear positive relationship between community participation levels and shelter satisfaction outcomes. Households reporting high participation across design, construction, and management stages recorded a satisfaction rate of 74%, compared to only 32% among those with low participation. Moderate participation yielded intermediate satisfaction at 58%. These findings confirm that participatory processes are strongly associated with improved housing outcomes and underline the critical importance of integrating structured community engagement mechanisms into the design and delivery of climate migration shelter programs in Pakistan.

QUALITATIVE ANALYSIS

Theme 1: Loss of Cultural Identity and Spatial Disorientation

Those who provided their response in both provinces were deeply upset about the fact that they lost their traditional way of life and the cultural practices which are inbuilt in it. Numerous people wrote about how the uniform structure of displacement camps did not permit gender-specific areas, prayer rooms, and community meeting places that were vital to the daily social and religious life. The lack of recognizable spatial hierarchies led to the feeling of cultural displacement and social disintegration which exaggerated the psychological trauma of displacement itself, which implied that a response

to architecture had to take the form of actively integrating cultural spatial values.

Theme 2: Thermal Discomfort and Health Impacts

The most frequently complained of grievance in all of the surveyed settlements was thermal discomfort as people reported their shelter conditions to be unbearable in summer and dangerous in winter. Lack of insulation and unlined corrugated metal roofs with insufficient vents provided an ideal internal temperature conditions which were associated by the respondents with heat-related illnesses, respiratory diseases and chronic fatigue. The references to their initial earthen and brick houses are often cited as the examples of thermal comfort by the participants, which further substantiates the evidence base of vernacular climate-responsible construction principles.

Theme 3: Privacy, Gender, and Safety Concerns

Women respondents especially came out with acute complaints regarding the unavailability of privacy and physical safety in the current displacement settlements. The conditions that ensured that women could not move freely and take their own decisions in settlements were shared sanitation, thin and easily permeable shelter walls, and lack of enclosed external spaces. Some of the participants indicated episodes of harassment and that a lack of space between unrelated households went against their strongly cherished cultural practices, which caused social frictions and inhibited women to enjoy complete participation in community and livelihood activities.

Theme 4: Community Ownership and Self-Help Construction

One such theme that was replicated through the interviews is the overwhelming desire of the displaced communities to be actively involved in the construction and enhancement of their own shelters and not passive receivers of solutions that were delivered to them. The participants, who had provided labor and materials to their shelter units, said that they were much more satisfied

and felt ownership than the participants who had been provided with ready-made buildings. The members of the community were shown to have considerable existing construction knowledge and skills that had not been utilized by the traditional models of humanitarian shelter delivery, and the possibility of self-help construction programs was identified as a means of improving shelters, as well as a means of livelihood recovery.

Theme 5: Livelihoods, Productive Space, and Settlement Layout

The respondents stressed that proper shelter did not only refer to sleeping and cooking facilities but also to productive ones that would enable them to earn an income through small-scale farming, livestock rearing, craft work, and petty trade. Lack of separate space to meet in or around shelter units in current camps was disastrous to livelihood recovery and financial independence. The principles of settlement layouts suggested by community members combined residential and productive areas, with typical village morphologies and the necessity of the architectural structures that would not separate shelter and livelihood as two aspects that cannot be divided as inseparable aspects of recovery.

Theme 6: Trust, Governance, and Shelter Allocation Processes

The respondents in various settlements raised serious issues regarding the equality and transparency of the process of shelter allocation by governmental and non-governmental agencies. Cases of favoritism, corruption, and discrimination of neediest households out of shelter schemes destroyed the community confidence and social cohesion in settlements. These results drew attention to the fact that the success of even the well-established architectural solutions relies on the principles of fair governmental systems and responsible community involvement procedures that support, as opposed to weakening, social integration within the displaced communities.

DISCUSSION

The results of this research established the fact that current provision of shelter facilities among the communities displaced by climatic disasters in Pakistan were inadequate in addressing thermal, structural, cultural and social requirements of affected community. The quantitative data was characterized by widespread dissatisfaction with the existing sheltering circumstances, and especially thermal comfort and constructive longevity, whereas the qualitative analysis brought out the rich cultural and psychological aspects of the insufficient space that can be easily overlooked by conventional humanitarian measures. The high level of correlation between community engagement and satisfaction with shelter, and the overall community desire to use locally available materials like compressed earth blocks and bamboo as one of the direct arguments gave strong empirical evidence towards the principles of the adaptive, community-based, and vernacular-informed architecture. These results were consistent with and complementary to the available literature regarding participatory humanitarian design, and confirmed that sustainable shelter solutions have to be co-produced with communities but not imposed upon them.

CONCLUSION

This study has shown that an architecturally adequate response to migrations of climate in Pakistan had to be based on the essential re-orientation of the generic, externally imposed emergency shelter paradigms to a versatile, culturally sensible, and community-oriented structure based on vernacular construction knowledge and local material resources. The study determined that the displaced populations in Sindh and Punjab had the capacity to participate in meaningful roles in designing and constructing their own shelter solutions by having not only the adaptive knowledge, but also the participatory capacity, when given the right technical support as well as fair governance systems. The architectural paradigm of scale suggested by the researchers, which incorporated

the concept of modular construction, passive climate control, and organized participatory mechanisms, provided a viable avenue in managing shelter delivery that upheld dignity, aided livelihood restoration, and created the resiliency of the community in the context of rising displacement due to climate in Pakistan and the wider South Asian localities.

RECOMMENDATIONS

The study suggested that humanitarian organizations and government agencies in Pakistan should implement vernacular-informed architectural models based on the use of locally obtained materials, such as compressed earth blocks and bamboo that have shown the most acceptable attention by the community and economic viability. Institutionalized as compulsory elements of shelter initiatives should be structured participatory design procedures which involved women directly and marginalized groups. The policy frameworks should be in a way that livelihood productive spaces are incorporated in the settlement designs and clear community accountable governance structures must be instituted in order to provide fair distribution of shelters and to provide long term social cohesion among climate displaced people.

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