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ASPIRATION PICTURE AND CLIMATE ADAPTATION: HOUSEHOLDS' INCREMENTAL STRATEGIES IN CLIMATE-RESILIENT HOUSING IN RURAL COASTAL BANGLADESH

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Abstract

While housing is a critical component of incremental climate change adaptation, identified by the Intergovernmental Panel on Climate Change (IPCC), climate resilient housing implementation is widely focused on the module's safety and modularity, ignoring the beneficiaries' social adaption process underscored by incremental housing ideas. The study explores the incremental adaptation strategies employed by households in climate-vulnerable rural coastal Bangladesh to understand the complex adaptation attitudes of households in social or climate adaptation. The study uses a case study approach with qualitative methods encompassing household interviews, focus group discussions, and in-depth observation on 10 self-built homesteads, 10 Government of Bangladesh (GoB) provided, and 10 United Nations Development Program (UNDP) provided housing modules at Koyra, Khulna. The study observes that households adopt distinct adaptation strategies depending on sittings, roofs, walls, foundations, bedrooms, kitchens, and toilets of modules, which are prone to climate exposure and sensitivity. Therefore, households tackle the delicate complexity of the aspiration picture and social and climate adaptation when the residential situation is coupled with climate vulnerabilities. The study finds that the incomplete nature of a module allows for more aspiration achievement, while a more complete module leads to aspiration adjustments by changing attitudes toward the aspiration picture. This study underscores that in the design of climate-resilient housing modules, it is essential to consider a minimalist approach that can produce more robust climate-resilient homesteads while offering better opportunities for household engagement to enhance knowledge for building back better and safer.

Keywords: Coastal Vulnerabilities, Climate Adaptation, Climate Change, Climate Resilient Housing, Incremental Housing, Social Adaptation

Introduction

Resilience in the face of climate change, the ability to build back better and safer from disasters, as outlined in the Sendai Framework (2015-2013), involves learning from past disasters, preparing for risks, and ensuring effective responses to future challenges (Pearson & Pelling, 2015). Housing, crucial for vulnerable communities in adapting to climate change, faces challenges in ensuring fair privatization, often neglecting diverse population needs in incremental adaptive development measures (IPCC, 2023). Although housing is integral to a comprehensive approach to disaster resilience and community empowerment, involving social safety net mechanisms and livelihood enhancement (Pearson & Pelling, 2015), the climate-resilient housing implementation often neglects the integration of incremental housing concepts, including participatory design, construction quality, and purpose of environmental infrastructure and climate change concerns (Tran et al., 2014). Moreover, existing literature widely criticizes the implemented housing modules in the exposure and sensitivity of climate vulnerabilities in South Asian coastal regions. The gap in the implemented housing module lies in the lack of effective integration of local knowledge and experiences, which hinders achieving a disaster-resilient environment (Tran, 2015). A significant divide exists between at-risk communities and technical experts in incorporating principles such as safe failure, redundancy, modularity, flexibility, and diversity in constructing resilient Housing (Tran et al., 2014). Shortcomings in housing

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modules are non-participation, inadaptability, lack of contextual responsiveness, income generation opportunity, and user perception of community resilience (Hakim, 2009). Deficiencies in site selection, participatory planning, repair and maintenance, replicability, and livelihood potential are reasons for the module's failure to enhance community resilience (Ahmed & Charlesworth, 2015). Inadequacies in addressing multi-hazard resistance through community consultation, such as undercounting household requirements, flexibility of adaptation, and ignorance of local adaptation knowledge, hinder climate-resilient housing stability to achieve community resilience (Jalem & Mishra, 2020; Saha & Ballard, 2021). Moreover, the climate-resilient housing module cannot meet community resilience if it does not address cultural comfort, legacy, income generation, cost-effectiveness, and cultural reflections in housing modules (Gautam et al., 2016).

However, existing literature provides insights into the on-site failure of housing modules, but household adaptation strategies are widely unknown in discussions on incremental climate-resilient housing. While housing is a social adaptation process, Household adaptation strategies generally attempt to make a residential situation picture and the social aspiration picture as compatible as possible (Adriaanse, 2007; Fleury-Bahi et al., 2008; Priemus, 1986). Also, A housing module cannot be resilient without climate adaptation by household participation, which makes a "module" into a climate-resilient homestead. Implementing ideas for climate-resilient housing often neglects the inclusion of incremental housing concepts such as participatory design and owner-controlled expansion of a basic module. However, these concepts address expansion flexibility, construction quality, environmental concerns, and climate change issues (Atamewan & Olagunju, 2017). When climate resilience primarily depends on incremental adaptation by households, the limited housing discussion suggests how residents adapt to their housing situation through active or passive strategies influenced by the household's social aspirations, imagined by lifecycle and career, implemented by moving out, or structural conversion (Priemus, 1986). People incrementally adapt to their social aspirations through various means, such as moving, altering homes, repurposing spaces, changing attitudes, expressing dissatisfaction, and showing empathy (Priemus, 1986). However, in Bangladesh's recently implemented largest rural housing project (Ashrayan II), people's aspirations regarding their way of life and livelihood are overlooked, and there are examples of unoccupied or abandoned houses (Parvin et al., 2022).

So, it is essential to know, after getting a module, what strategies a household takes as a means of adaptation and how a household aspires for adaptation. Finally, when a module gradually becomes a homestead, does it achieve only social adaptations followed by an aspiration picture, or is it extended to the climate adaptations, where climate adaptation is the only key for climate resilient communities, which refers to the building back better and safer with the continuous learning process. In post-disaster situations in Bangladesh, the government and various donor organizations assist disaster-affected households during housing recovery stages despite not all households having access to this aid. Donor-driven Housing involves construction with external support, while self-built housing relies on independent efforts by households who cannot access aid, utilizing their resources for recovery and reconstruction (Tran et al., 2014). This research investigates the performance of Donor-driven housing modules in meeting household aspirations and the incremental strategies employed by households for social and climate adaptations.

Literature Review

Resilience and Climate Change

Resilience is the dynamic ability of systems to persist through change (Akande et al., 2023; Holling, 1973). It involves coping with unforeseen dangers, bouncing back (Wildavsky, 1988), withstanding extreme events, and adapting resources to new conditions (Mileti, 1999). Resilience is an active process of self-righting, learned resourcefulness, and growth, surpassing expectations (Paton et al., 2000). In a sense, resilience combines persistence, adaptability, proactive resourcefulness, and growth, enabling systems to withstand adverse climate conditions and thrive in continuous change. The 2005 World Conference for Disaster Reduction (WCDR) emphasized resilience in disaster response (Nagaishi, 2006); scholars debate its novelty and express concerns about terms like resilient communities. However, precise definitions from disaster management and sustainable development perspective; the Intergovernmental Panel on Climate Change (IPCC) defines resilience as the capacity to absorb disturbance, maintain structure, and adapt to change (Manyena, 2006).

Resilience has gained significance in responding to climate change and development challenges. Moench 2014, emphasizes the need for pragmatic frameworks that integrate specific circumstances with scientific knowledge to effectively address the conflict between evolution and continuity (Moench, 2014). Defining resilience through typologies like coping, adaptive behavior, and ecosystem recovery denotes the adaptive ability of individuals or systems to navigate challenges, recover, and prosper in adversity (Manyena, 2006). Resilience in the climate change era, the ability to build back better and safer from disasters, is highlighted in the Sendai frameworks (2015-2030). It involves learning from and preparing for risks to reduce their impact and enhance recovery, ensuring a system, community, or society can respond effectively to future challenges (Pearson & Pelling, 2015). Understanding the significance of disaster-resilient housing for community resilience requires a comprehensive understanding of housing vulnerability and its socio-economic effects and considering social and physical vulnerabilities when building resilience to natural disasters and climate change (Tran, 2016). Integrating such insights into housing design is crucial for anticipating outcomes beyond mitigating vulnerabilities and addressing the cumulative impact of individual development actions.

Incremental Adaptation, Housing, and Climate Resilience

Housing is a critical component of climate change adaptation, identified by the IPCC as part of social infrastructure and incremental adaptation and interconnected planning efforts outlined in global agreements of the IPCC, with its impacts ranging from infrastructure inequalities to the potential tradeoffs in economic growth (IPCC, 2023). However, incremental adaptation entails making gradual adjustments in response to low-intensity, small-scale, and short-term changes, focusing on standard methods that address individual costs and benefits while supporting coping mechanisms (Wilson et al., 2020). Moench 2012 developed a Climate Resilience Framework (CRF) by synthesizing insights from diverse literature, collaborating with the Asian Cities Climate Change Resilience Network (ACCCRN) initiative in 10 Asian cities, emphasizing the limitations of traditional approaches, and proposing a shift towards building resilience for providing a simple and applicable guide for planners (Tyler & Moench, 2012). However, The CRF alliance with IPCC defines resilience as the capacity of systems to absorb disturbances, retain structure, self-organize, and adapt to stress, emphasizing flexibility and learning in climate adaptation (Tyler & Moench, 2012). CRF facilitates the assessment of vulnerabilities, risk identification, and the development of inclusive strategies to address climate change uncertainties through action and implementation at the macro level (Friend & Macclune, 2013). However, it cannot provide a micro-level explanation for housing as an incremental adaptation for climate resilience.

Tran et al. 2014 studied the CRF in Vietnam, identified a lack of community consultation in housing and the pivotal role of social relationships, revealed a distinct gap between at-risk communities and technical professionals, and highlighted a deficiency in governance for self-construction (Tran et al., 2014). In the study, Tran et al. 2014 underscore the necessity of safe failure, redundancy, modularity, flexibility, and diversity in constructing disaster-resilient housing in climate-vulnerable coastal areas (Tran et al., 2014). Safe failure involves absorbing sudden shocks or increasing stress, ensuring the house provides a secure space during disasters; redundancy and modularity offer replacement capacity for emergencies and efficient bounce back from significant events, while flexibility and diversity enable opportunities for essential adjustments of the house under diverse conditions and adaptability to climate change impacts in terms of functional, spatial and technical considerations (Tran et al., 2014; Tyler & Moench, 2012). However, the design framework for disaster-resilient housing developed by Tran et al. (2014) integrates more comprehensive elements from community consultation, such as technical safety, spatial functionality, aesthetic design, cost-effectiveness, and environmental sustainability as key considerations, aiming to enhance housing regarding disaster safety, economic viability, and cultural appropriateness (Tran et al., 2014).

Moreover, several authors have also promoted insights into the disaster resilience of housing, which refers to incremental adaptation. Hakim (2009) focused on the post-SIDR situation in coastal Bangladesh, offering indicators and variables to assess the sustainability of donor-driven post-disaster shelters encompassing factors such as participation, flexibility and modification options, contextual responsiveness, in-house income generation and user perception (Hakim, 2009). The post-disaster housing study in the Cook Islands and Sri Lanka focuses on construction practices, housing design, site selection and planning, repair and maintenance, replicability, and livelihood potential as crucial factors for assessing resilience (Ahmed & Charlesworth, 2015). The study on flood vulnerability and adaptation practices in residential areas in Abuja, Nigeria, by Akande et al. (2023) reveals the need to enhance awareness and implementation of flood-resilient measures, highlighting the importance of shifting focus from flood risk to flood resilience awareness to reduce damage and create a safer living environment (Akande et al., 2023). Jalem & Mishra (2020) outlined criteria for constructing climate-resilient housing in cyclonic storm-affected regions of Odisha, India, emphasizing multi-hazard resistance, rainwater harvesting, durable materials, emergency provisions, and community consultation (Jalem & Mishra, 2020). Saha & Ballard, (2021) examined factors influencing occupant satisfaction in cyclone-affected regions of Bangladesh, considering room number, window placement, construction quality, flexibility, and Disaster Risk Reduction measures (Saha & Ballard, 2021). Gautam et al., 2016 explored resilient features of vernacular housing technology in Nepal, including safety, serviceability, cultural comfort, patrimony, resilient livelihoods, cost-effectiveness with local materials, and cultural reflections in housing units (Gautam et al., 2016). All these findings indicate that climate-resilient housing implementation needs to be rethought beyond modularity only in technical provisions and towards incremental adaptation by engaging the community and necessarily including incremental housing conceptions.

Incremental Climate-Resilient Housing and Adaptation

Climate-resilient housing implementation often falls short of incorporating incremental housing ideas. Incremental housing underscores participatory design and addresses infrastructure and environmental issues. It also includes building a key incomplete house, which allows gradual time controlled by the owner (Atamewan & Olagunju, 2017). The key success of this approach is regional suitability, emphasizing local material, preference for horizontal expansion, and active participation of the community (Wibowo & Larasati, 2018). Housing incrementality empowers households by promoting flexibility and gradual expansion to meet specific needs (Hamid & Mohamed Elhassan, 2014). The idea of ownership of incremental housing provides the foundation of future development and ensures residential satisfaction (Azizibabani & Bemanian, 2019). The challenges of total housing remain in the construction duration, the decision of room number, settlement location, and financial constraints (Alananga et al., 2015).

The current emphasis on technical safety and macro-level strategies within climate resilience frameworks, as defined by the IPCC and the Resilience Alliance (IPCC, 2023; Tyler & Moench, 2012), tends to overlook the complex localized approach of incremental adaptation. A significant gap exists between at-risk communities and technical professionals, indicating a lack of community consultation and governance in self-built construction (Tran et al., 2014). Moreover, the criteria for climate-resilient housing predominantly focused on technical and sustainability aspects. It is worth noting that while climate-resilient housing projects typically place less emphasis on key elements such as flexibility, risk preparation, and community engagement, these aspects are often prioritized in the context of incremental housing concepts. There is a need to reevaluate current frameworks for housing and integrate incremental housing concepts to enhance the effectiveness of climate-resilient housing. Furthermore, fostering community involvement, adaptation practices, and cultural appropriateness needed inclusion along with the focus on technical and disaster resilience criteria.

Aspiration Picture and Household's Incremental Adaptation

The role of housing aspirations in shaping housing systems is quite significant as it encompasses perspectives such as social, cultural, economic, and political and requires the connection between socialized preferences and their practical feasibility, the household structures in which individuals participate, and the paths they take incrementally in their housing experiences (McArthur & Stratford, 2021; Preece et al., 2020). As Housing is a social adaptation process, household adaptation strategies aim to make a "residential situation picture" and the social aspiration picture as compatible as possible (Adriaanse, 2007; Fleury-Bahi et al., 2008; Priemus, 1986). In between, the "residential situation picture" is influenced by various factors, including the current and previous living conditions, and the "aspiration picture" is the ideal home that a household considers attainable within their budget and specific circumstances, as opposed to an unrealistic ideal (Priemus, 1986).

To achieve compatibility between an aspiration and residential situation, households apply two approaches: passive adaptation, where the household adjusts its way of thinking and adjusts aspirations to fit the current residential situation, and active adaptation, where the household modifies its environment where the aspiration picture acts as a key driver of social adaptation (Priemus, 1986). Stress influences decisions such as moving out or improving; the overall housing decision-making process entails selecting adaptive processes like adaptation and building social ties to bridge the gap between ideal and actual living conditions, while stress may increase due to internal or external changes (Priemus, 1986). Adaptation in housing aspirations encompasses diverse household strategies, including moving to a new residence, modifying existing homes, changing the purpose of spaces, shifting attitudes, expressing dissatisfaction, and exhibiting a lack of interest (Adriaanse, 2007; Priemus, 1986). In the rural context of Bangladesh, it has been observed that housing aspirations play a critical role in determining the outcome of a project. Considering these aspirations while planning and executing any housing-related initiative is imperative to ensure its effectiveness and sustainability. Ashrayan II rural housing project with inflexible design module regardless of location, climate, and cultural characteristics; fails to meet varying household aspirations regarding way of life, hindering livelihoods and making repairs difficult, leading to unoccupied or abandoned houses (Parvin et al.,

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2022). On the other hand, Households' incremental adaptation to climate resilience emphasizes their key roles as decision-makers. Le (2020) recognizes that adaptation responses primarily address current vulnerabilities requiring an integrated approach with socio-economic development (Le, 2020). The adaptation context highlights three dimensions- institutional, collective, and autonomous adaptive capacities covering governance, technology, human capital, and public perception (Le, 2020). Institutions adapt through governance structure and equality; collective adaptation to climate change relies on technology, infrastructure, and social capital, and autonomous adaptation involves human capital and public perception, which is crucial for climate change adaptation (Le, 2020). Understanding household aspiration is imperative for incremental adaptation in building climate resilience, as their diverse strategies in housing choices, influenced by stress, life cycle, and career, play a pivotal role in shaping adaptive processes crucial for addressing current vulnerabilities and integrating a comprehensive approach to climate-resilient housing development.

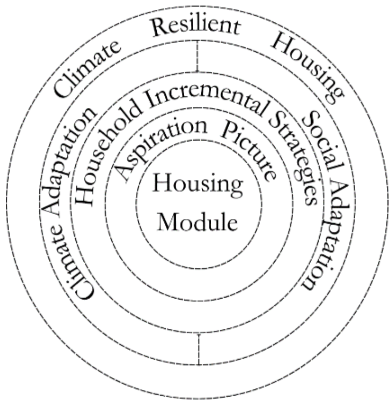

Figure 1. Conceptual framework of the study

Figure 1 shows the overall conceptual framework used for this study. This framework includes the housing module as a center of concern, which will be interpreted through incremental household strategies towards social adaptations or climate adaptations under the broader umbrella of climate-resilient housing.

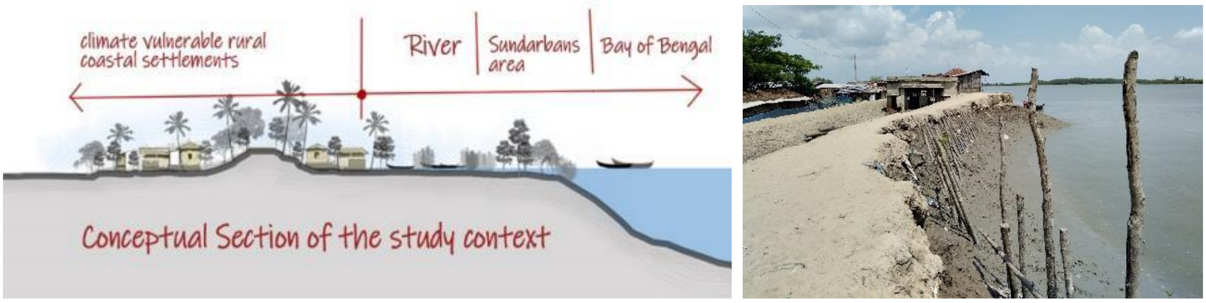

Figure 2. Conceptual drawing of the study area (left) and the embankment vulnerability (right)

Materials and Methods

Study Area

Koyra subdistrict of Khulna district, one of the most vulnerable hotspots (Saha & Ballard, 2021) to climate change in southwest coastal Bangladesh, was selected as the study area (Figure 2) for this research. The sub-district covers 1775.41 sq. km, with only 263.12 sq. km being flatlands and the rest covered by the Sundarbans, the world's largest mangrove forest. Most inhabitants are fishermen, farmers, day laborers, carpenters, and small business owners. The area faces increasing temperature, salinity intrusion, tidal surges, and seasonal floods caused by embankment failure (Sultan & Maharjan, 2022). Due to its geographic location, the area has been prone to devastating cyclones, such as Amphan (2020), Bulbul (2019), Fani (2019), Mahasen (2013), Aila (2009), Sidr (2007), resulting in significant damage to lives, livelihoods, and shelters. Several government and non-government organizations operate in the area, assisting these vulnerable communities, particularly regarding climate-resilient housing aid.

Case Selection
To identify the incremental strategies adopted by households after receiving the donor-driven modules (Figure 3), the study selected 10 modular houses among 40 (approx.) provided by the Government of Bangladesh (GoB) under the Ashrayan-2 project 2021 and 10 modular houses among 93 provided by the United Nations Development Program (UNDP) under Post-Sidr/Aila Housing Recovery (Phase 2), 2014. Additionally, the study selected 10 self-built homesteads randomly from various locations in the study area to investigate local climate adaptation practices in response to different climate-vulnerable situations. The diversity of materials, construction techniques, and locations within the study area was considered to enhance the findings' reliability.

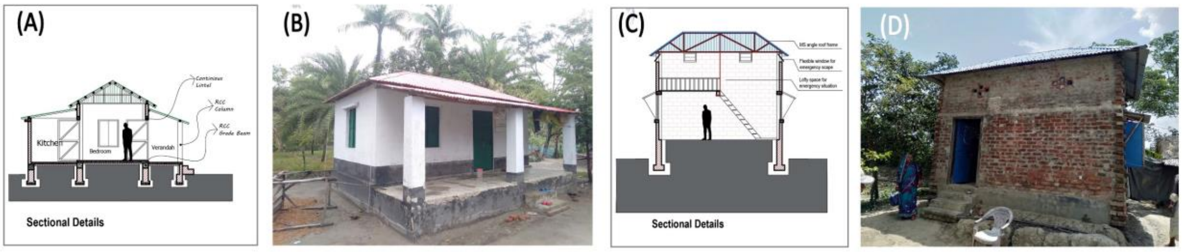

Figure 3. GoB provided modular house details (A, B), and UNDP provided modular house details (C, D)

Data collection
Data was collected using qualitative methods (Table 1) of case study research. Initially, interviews were conducted with community mobilization facilitators (CMF) to understand the local climate adaptation practice and the frequency of climatic events in the study area. Secondary data from the desktop survey supplemented this information. Individual household interviews and focus group discussions were then conducted to gather insights into climate vulnerabilities, activities during disastrous situations, and perceptions of resilience among self-built homestead residents.

Table 1. Data collection methods

Area of inquiry	**Themes** (Structural/Spatial)	**Respondents/ Sources**	**Methods**
Climate adaptation practice in self-built homesteads	• typologies • building material • construction technique • spatial organization • enclosure details • climate vulnerabilities • adaptation technique	• CMF (n=4) • Self-built homestead (n=10) • Local workmen (n=4) • Female house head (n=4) • Male house head (n=6)	• SSQS • FGD • NPO • Freehand drawings • Photographs • Video and audio recording
Residential situation in donor-driven modules	• physical situation • social situation • economic situation	• GoB provided module (n=10) • UNDP provided module (n=10) • Female house head (n=8) • Male house head (n=12)	• SSQS • RC • NPO • Freehand drawings (plan, section)
Incremental adaptation strategies in donor-driven modules	• adaptation attitude • structural adjustment • aspiration adjustment	• Elderly person, both male and female (n=7) • Adolescents (n=2)	• Photographs • Video and audio recording

In the second stage, semi-structured questionnaire survey (SSQS) was conducted with family heads (both male and female), elderly members, and adolescents to investigate the social, economic, and physical situations of households after receiving the donor-driven modules from the government of Bangladesh (GoB) and UNDP. The third stage involved understanding the factors and attitudes behind households' incremental strategies through further reflexive conversation (RC) with family heads. The non-participant observation (NPO) method was used throughout the field visits and data collection to corroborate information obtained from interviews and conversations with households. Instant rough sketches, photographs, audio, and video recordings were employed to document findings and capture structural and spatial details of the homesteads. Architectural details and design decisions of the GoB modules were obtained from official websites (Ashrayan Phase-2, 2021) (PMO, 2023), and local workmen involved in their construction were interviewed to validate this data. Additionally, insight into the design concepts of the UNDP-provided housing modules was gathered through a conversation with a program specialist of UNDP Bangladesh.

Data Management and Analysis

This study managed and analyzed qualitative data collected in Bengali, transcribed, translated, and analyzed for meaning. Complemented by secondary data, sketches, and drawings documented spatial and structural features. The authors synthesized social data with architectural drawings and photos. The study organized Textual data from reflexive conversations and case narratives into tables. Direct interpretation of individual cases revealed insights into household aspirations and climate adaptation strategies. A cross-case synthesis method (Creswell & Poth, 2016) identified similarities and differences, enriching the understanding of household strategies for climate resilience.

Result and Discussion

Households' autonomous climate adaptation practices against different vulnerabilities in self-built homesteads are presented in Table 2. Findings related to the structural elements like roof, wall, plinth, and foundation are presented under the structural aspect section. In contrast, the spatial aspect section presents findings regarding spatial elements such as bedrooms, kitchens, toilets, and overall sitting. Findings on residential situations, households' incremental adaptation strategies, and the nature of adaptations in GoB-provided and UNDP-provided modules are presented in Tables 3 and 4, respectively. In Table 5, a comparative analysis of the climate adaptation performance of both GoB and UNDP modules is displayed. The aspiration picture captured from detailed investigation and conversation with the household is used to evaluate the modules' performance.

Courtyard integrity and spatial layout

The courtyard is the main open space for household activities and circulation in self-built homesteads. People place built forms at the northern or western periphery of the homestead, maximizing wind flow during summer and sunlight for indoor rooms and courtyards, allowing space for future expansion. This layout also confirms the privacy of the courtyard by putting an entrance at the rear portion of the house connected with neighborhood roads. Households arrange the kitchen, toilet, verandahs, cattle, and livestock sheds surrounding the courtyards. However, having income-generating spaces like vegetable gardens or cattle sheds in the courtyard has raised security concerns for residents (Figure 4-A, C, and F). Traditionally, the courtyard and verandahs have been crucial for fostering social interaction and community bonding, serving as significant areas for household communal activities. Autonomous and active adaptation strategies by households include maintaining a plinth height above previously experienced flood levels, positioning the room structure at the edges of the homestead while considering privacy and toilet-born foul odor concerns, constructing with local and temporary materials, and gradually upgrading to more durable materials as resources become available.

"People living in vulnerable rural coastal areas like us require neighbors' help to survive together during emergencies. That is why we organize our homestead so neighbors can come and gather during different socio-cultural activities like Pooja, path, and Trinath Thakur mela (Traditional Hindu religious rituals/ prayer) in the courtyard. It enhances our relationship and bonding with the community."- a male respondent.

The incompleteness of the UNDP module allowed residents to actively create and organize necessary elements of their homesteads, such as kitchens, toilets, and verandas, based on their traditional practices (Figure 4). However, the more complete GoB module had a rigid spatial organization, offering limited incremental growth, which caused issues contrary to local aspirations. This inflexible approach resulted in underutilized backyard space and constrained spaces for socio-economic activities in the front yard (Figure 6). Initially, residents viewed the provided module as a gift. Still, they incrementally opted to construct new structures in the frontal courtyard, such as kitchens, toilets, and cattle or livestock sheds, rather than modify or strengthen the module. As a result, this social adaptation compromised essential spaces required for income generation, social-cultural activities, and the house's safety, durability, and buffer capacity in front of climate vulnerabilities.

Table 2. Households' autonomous climate adaptation practice in self-built homesteads

	Climate adaptation practice	Aspirations
Structural aspect	**Roof**	
	Type: Heap roof (four roofs) for core shelter and single (*ekchala*) or double roof (*dochala*) for kitchen and other functions. **Material:** Thatch, Nipa Palm leaf (*Golpata)*, Corrugated Iron (CI) sheet, and Asbestos Sheet tied with wooden frames **Climate vulnerabilities:** low durability, Corrosion, wind uplifting, water leakage, heat absorption **Local adaptation techniques:** Roofs are kept low and anchored with rope or wire to the ground to reduce wind load. As economic capability grows, false ceilings with wooden or bamboo mesh and durable materials are used.	• structural safety • thermal comfort • local aesthetics
	Wall	
	Type: load-bearing walls and partition or non-load-bearing walls **Material:** Mud, Nipa Palm leaf (*Golpata)*, thin wood, CI sheet, asbestos sheet. **Climate vulnerability:** Prone to strong wind, tidal surge, salinity intrusion, abrasion, fragility, corrosion, and heat absorption. **Local adaptation technique:** People protect mud walls with polythene sheets, add verandahs to reduce heat gain, use burned motor oil *(pora mobil)* to enhance wooden wall durability, and coat the lower part of CI sheet walls with bitumen.	• structural safety • flexibility • thermal comfort
	Plinth and foundation	
	Type and material: compacted mud plinth, mud plinth safeguarded by brick wall. **Climate Vulnerability:** salinity intrusion, abrasion, soil destabilization by tidal surge, heavy rain, or water inundation **Local adaptation techniques:** To prevent flooding, households maintain a sloping edge for the plinth, extend the roof overhang, cover it with plastic, safeguard the mud plinth with a brick wall, gradually raise it to a safe height, and improve it as their income grows.	• durability • height-safe plinth • minimal maintenance • plasticity
Spatial aspect	**Bedrooms**	
	Type: There are three types of rooms: single bed with a single entrance, double bed with flexible partition, and double bed with separate entrances. All are accessible from linear, U, or L-shaped verandahs. **Climate vulnerabilities:** High indoor temperatures in summer and lack of suitable storage for emergencies like tidal surges or cyclones. **Local adaptation technique:** Add openings in the front and opposite, south, or east-facing walls. Use temporary materials for partition walls and front façades. Utilize verandahs for multiple purposes, such as storing crops, arranging sleeping spaces, and sheltering livestock in emergencies.	• thermal comfort • spatial flexibility • multi-functionality • safety of assets • privacy • adult autonomy
	Kitchen	
	Types: suitable for cooking with firewood and mud stove, integrated with food serving (dining) and firewood storage spaces. **Position:** Create access from the verandah when attached to the core shelter, access from the courtyard when detached, or locate at the peripheries to observe activities and interact with neighbors. **Material and technology:** Build with wood or bamboo posts, make roofs with thatch, CI sheet, or asbestos sheet, plinths with compacted mud, and façades with maximum perforation and minimum enclosure. **Climate vulnerability:** Kitchens are often less durable than the core shelter because residents invest less. Due to their size and changing position, kitchens are vulnerable to wind damage and require frequent maintenance. **Local adaptation technique:** Residents cook using firewood, leaves, and dry cow dung. In a post-disaster situation, building a temporary kitchen with minimum enclosure and shading in a dry place requires a minimum skill set.	• structural flexibility • social interaction • spatial permeability • incremental investment
	Toilet	
	Type: single pit toilet with or without overhead sheds **Material:** Four wooden posts enclosed with coconut leaves or sheets recycled from cement bags, salt bags, jute bags, or coconut leaves. **Position:** the periphery of the homestead, close to the water source and in a less visible space. **Climate vulnerability:** Tidal surges and waterlogging can wash away toilets and make low-height plinth toilets unusable, forcing elderly and female members to find alternative ways to relieve	• structural safety. • usability in emergence • water source proximity.

themselves. **Adaptation practice:** When economic capability increases, people keep the plinth height above the previously experienced flood level and gradually upgrade the toilet with permanent materials like RCC posts, brick plinths, and CI sheet walls.	• cultural sensitivity.
Sitting	
Organization of built forms: People design homesteads by placing buildings at the perimeter for future expansion, creating space for social activities, livestock rearing, and vegetation. They prioritize South or East-facing core shelters for maximum wind flow in the summer. **Climate Vulnerabilities:** Vegetable gardens, cattle, and livestock sheds are often damaged by natural disasters such as tidal surges, saltwater intrusion, water inundation, and fallen trees during cyclones. **Local adaptation technique:** People raise their homestead land and avoid planting large trees to the south. They prefer raising goats, ducks, and poultry instead of cows for easy emergency shelter.	• entrance orient ation (south or east) • optimum sunlight and airflow • expansion scope • income-generating space

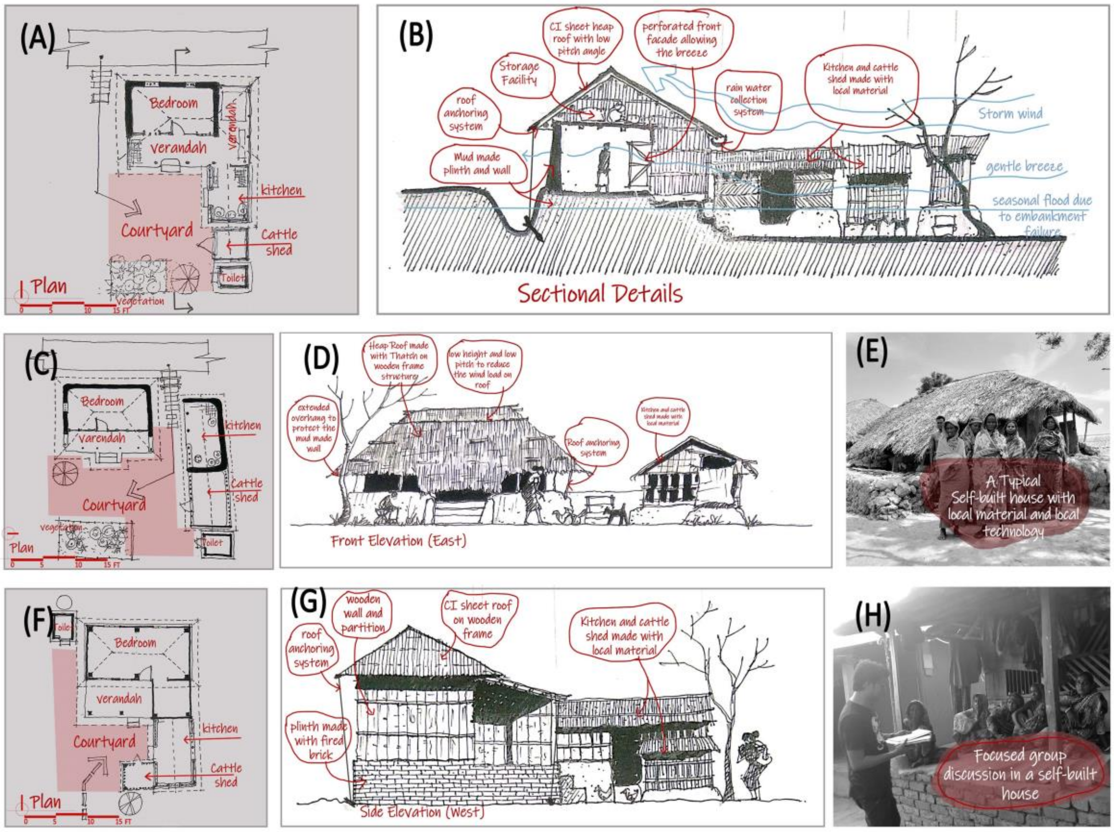

Figure 4. Climate adaptation practice and Self-built homestead details (Source: Author)

Flexible Bedrooms

Most self-built homes have a simple south or east-facing bedroom layout consisting of two rooms separated by non-load-bearing walls and accessed through a single doorway. The front door is typically on a wooden or semi-permanent fence (Figure 4- A, C, and F). This setup allows flexibility in adjusting, expanding, and relocating the bedrooms to meet the household's privacy needs, especially for adult children. The flexibility of these rooms to accommodate various furniture arrangements such as double-size beds, cloth hangers, showcases, tables, sewing machines, and big tin boxes for winter clothing storage highlighted the aspiration for a minimum of 10.5 feet x 12 feet space per room. Despite the benefits of GoB modules, the inflexibility of bedroom layouts (Figure 6) presented significant challenges for residents. Due to the limited space, residents had to downsize their furniture and reduce the amount to adjust to the confined living space. Prioritizing climate safety with a strong shelter over their social needs, such as privacy, is an adaptation strategy, a passive shift in household attitudes with compromised social aspirations. Afterward, specific households implemented measures to meet their spatial and privacy requirements by building temporary separate rooms or repairing existing structures using locally available materials because using durable materials is always a financial burden for respondents. However, this incremental adaptation often led to the loss of valuable courtyard space, reducing household economic opportunities and resource utilization, destroying prominent social aspirations within the community, and losing climate resilience.

In contrast to the GOB module, the UNDP module had a larger indoor space, allowing residents to have flexible furniture arrangements according to aspirations. However, the brick walls were rigid, and the front door was positioned in a fixed location, compromising privacy (Figure 7). As a result, respondents felt that separate entrances were necessary to divide the rooms for adults. Furthermore, the overhead emergency half floor, designed to provide sleeping and storage facilities during water inundation, tidal surges, and seasonal floods, reduced the overall privacy of family members within the space. Households played an active role in enhancing the spatial layout of the module. They extended the overhead wooden floor covering the entire lower bedroom space as their economic capability increased. They have also built U or L-shaped verandahs (Figure 7-A, D, and G), with enclosed wooden façades with windows to accommodate guests and provide additional sleeping and dining space. These enhancements fulfill their aspirations for privacy, human comfort, and flexible spatial arrangements followed by more robust climate adaptation.

"The house given by UNDP had one room and one fixed door. We have two children, a boy and a girl. Our daughter will soon be at the age of marriage; she requires a private space, which is very difficult to arrange within this single space. So, we decided to build a three-sided verandah surrounding the house so that two other sleeping spaces could be arranged. If a guest or someone from outside comes, we could arrange them there."- a 45-year-old male respondent.

Impermanent Kitchen

A self-built homestead typically includes a minimalist kitchen as the hub for social interactions and oversees household and courtyard activities. Traditional kitchen construction includes locally available and easily repairable materials, such as wooden posts and bamboo or wooden fences, and should have adequate lighting, ventilation, and a perforated façade (Figure 4, 5). Households upgrade parts of their kitchen, such as plinths and posts, as they gain the ability to do so, but they do not view the kitchen as a permanent and fixed space. Respondents shared that they recreate kitchens on higher roads or lands from their houses during emergencies like seasonal floods and water inundation, using portable mud stoves with dry leaves and tree branches for cooking. The minimalist aspirations of households about kitchens with remarkable portability and impermanency underscore a more robust climate adaptation strategy for the resilient coastal community.

Figure 5. Mud stove and firewood-friendly self-built kitchen in the study area. (Source: Author)

"When the people of the government came to construct the house for us, we asked them to build the kitchen along with the front yard. Otherwise, we would not be able to see all the activities in the courtyard, the chickens and ducks, the kids playing, and nothing in front of our eyes, but they said the design could not be changed as it was. Consequently, we had to build a new kitchen in the front yard. I would have been happy if they had made our house a little bigger rather than wasting space in the backyard," said a female respondent living in a GoB module.

In contrast to the traditional homesteads, the GOB module positioned the kitchen at the backside of the house, making it unsuitable for firewood cooking, and adequate ventilation and fixed placement led to reduced flexibility for multitasking, difficulties in monitoring courtyard activities and unmatched for social interactions.

Consequently, in the GoB module, residents resorted to passive adaptations, repurposing the kitchen for prayer space or storage (Figure: 6-A, C) while constructing another temporary kitchen in the courtyard with locally available materials and technology. The kitchen space allocated by the GoB was considered valuable by people as it served as a safe place during emergencies. They repurposed it for other uses instead of leaving it unused. As a result, the compromise between structural safety and social needs became apparent in the context of the kitchen's functionality. The incompleteness of the UNDP module without a kitchen prompted households to take proactive adaptation measures to fulfill their aspirations. They accepted this by gradually enhancing their structure and constructing their kitchens. Households independently built kitchens, utilizing locally available materials that could withstand saline conditions and were easy to repair. They also featured a perforated facade to ensure proper ventilation that allows firewood cooking. Moreover, households strategically positioned these kitchens by attaching them to the verandah or keeping them detached from the core module while providing an activity hub with the courtyard. These improvements were made in small, incremental steps, allowing them to realize their aspiration for a flexible and functionally appropriate kitchen (Figures: 7) with the ability to stand confronting climate sensitivity.

Figure 6. Incremental adaptation strategies in GoB modules (Source: Author)

Table 3. Household's incremental adaptation strategies in GoB modules

Aspect	Vulnerabilities/ Residential situation	Incremental adaptation strategies	Nature of adaptation
Structural aspect	**Roof**		
	Physical: Wooden frame and Corrugated Iron (CI) sheet are industrial roofing materials that make the roof prone to corrosion, wind uplifting, leakage, and heat absorption. **Social:** Residents appreciate the traditional roofing of the module, especially the heap roof with extended eaves and adjoined single-roofed verandah. **Economic:** Colorful CI sheets raise purchasing costs for residents during post-climatic reconstruction or repairs since they are not easily found in local markets.	**Moved-in:** Finding similarities with traditional roofing patterns and local technology.	Active
		Moved in with Structural improvement: strengthening the joining and anchoring material (like J hooks, steel wires) and using false ceiling with locally available materials like thin wood slices, and bamboo meshes.	Autonomous, Active
		Change in attitude: nurturing the culture of dependency and looking forward to external support.	Passive
	Wall		
	Physical: Plastered brick walls offer safety and confidence against cyclones and tidal surges despite thermal discomfort, heat absorption, salinity intrusion, and high costs.	**Change in attitude:** People are getting habituated to the rising temperature instead of modifying the walls to create a more comfortable indoor environment.	Passive
	Socio-economic: Though it was a donated house, durable materials like brick, plastered, and painted exterior of the module increased the social status of the residents.	**Moved in:** with increased belongingness and social status	Active
	Plinth and foundation		
	Physical: The RCC footing and short column added to the brick foundation and plastered surface increased the durability; vulnerability remains due to plaster erosion, mold and mildew growth, water infiltration, saltwater intrusion, and soil destabilization; height safety is not ensured for low-land lands.	**Moved in:** considering durability, better plasticity, and minimal maintenance.	Active
		Moved in with structural improvement: strengthening the plinth by soil mounting and coating with bitumen for salinity protection.	Autonomous, Active
		Change in attitude: compromising plinth height safety for waterlogging and tidal surge.	Passive
Spatial aspect	**Bedrooms**		
	Physical: Two-bedroom layout with constraints of space size, Absence of proper cross ventilation system, absence of emergency storage, rigid walls with permanent materials **Socio-economic:** Internal doorways through the bedrooms create privacy problems for adults and grown-up members; modification is difficult due to costly permanent materials.	**Moved in:** Small families satisfied with the multifunctionality and privacy of space, ensuring the safety of assets during cyclones.	Active
		Moved in with structural improvement: Accommodating a small sleeping space in a verandah with local materials/spared materials from previous houses.	Autonomous Active
		Change in attitude: Compromising number of furniture use, thermal comfort, freedom of expansion and modification, safety of assets, privacy, and adult autonomy.	Passive
	Kitchen		
	Physical: Attached to bedroom and toilet, inappropriate wall enclosure for cooking with firewood, insufficient ventilation. **Socio-economic:** Adding a kitchen to the back of the bedroom ruins the front courtyard and reduces social interaction and income generation space.	**Change in use:** Households use the kitchen as storage or a prayer space and build temporary kitchens with local materials, compromising the valuable space in the front yard.	Passive
	Toilet		
	Physical: Double pit toilet with water-sealed pan; built with plastered brick wall, CI sheet roof, and proper ventilation system; attached to bedroom and	**Moved in:** Considering usability during night times, cyclones, and waterlogged situations.	Active

kitchen, distant from a water source. **Social:** lacking cultural acceptance.	**Change in use:** Households using the attached toilet as a storeroom, building another toilet detached from the bedroom close to the water source following cultural practice.	Passive
	Change in attitude: changing cultural practice and adapting to the attached toilet, ignoring distances from the water sources, prioritizing resilience.	Passive
Sitting		
Physical: The compact and rigid layout of two bedrooms, one kitchen, and one toilet ruins the backyard and front yard spaces, creating inflexibility in orientation. **Socio-economic:** lack of decision-making flexibility	**Change in attitude:** compromising the orientation of the entrances, optimum sunlight and airflow, expansion scope, social gathering (festivals, rituals, and interaction with neighbors), and income-generating spaces (livestock, cattle sheds, and vegetation) in the front yard.	Passive

Attached and non-attached toilets

Toilets in self-built houses have long been subject to cultural beliefs that connecting them directly to the kitchen or bedrooms is unhygienic and irreligious. Additionally, toilets built with local materials and techniques are vulnerable to various risks, such as water surges that can wash away the toilet or cause it to be inundated, unusable, or destroyed by cyclonic winds. Traditional adaptation strategies have included structural improvements and spatial modifications to achieve social aspiration and disaster safety, such as keeping the plinth height above the previously experienced flood level, positioning the toilet at the peripheries of the homesteads (Figure 4) near the water source, and considering privacy and odor issues, constructing with local and temporary materials, and gradually upgrading to more durable materials as economic capability increases. It is worth noting that the UNDP module did not have a permanent attached toilet, so households had to build their toilets actively according to their traditional autonomous practices. While this approach met their socio-cultural aspirations, it prevented them from achieving climate resilience. During the disaster, the toilets built this way became unusable, highlighting how social aspirations can hinder climate adaptation efforts.

"I was delighted to have a toilet inside, like an urban house. Soon after using it for several months, it started to smell bad, and getting water for it was tough. So, we made a new toilet outside. We still use the inside one sometimes, especially if there is a flood or cyclone. It could be helpful during those times, so we use it occasionally," - a 45-year-old female respondent.

The GoB module introduced a toilet directly attached to the bedrooms at the rear (Figure 6), while the UNDP module did not. The respondents faced several challenges due to this direct attachment - they found managing and cleaning the water and odor issues difficult. This layout led to a cultural contradiction and functional inadequacy, which compelled them to adapt to the toilet passively. They changed their attitude towards using the attached toilet and began using it occasionally, especially during adverse climatic events. However, following traditional practices, they also constructed an additional toilet outside their homes for regular use (Figure 6-D, E). This attitude change highlights the household's strategy of passive adaptation with a shift in social aspirations, followed by climate adaptations.

Roof resilience and local aesthetics

A well-designed heap roof with a proper overhang towards the adjacent verandah is the traditional roofing practice for the local climate and aesthetics (Figure 4- D, G, E). The visual appearance of GOB-provided modules, similar to the local context, encouraged households' visual aspiration to accept and actively move into the new module. However, corrugated iron (CI) sheets are a vulnerable building material. After years of use and exposure to cyclonic winds, salinity, and rising temperatures, the roofs confronted corrosion, wind damage, rainwater leakages, and increased heat absorption. In response, households employed local technologies such as safeguarding the roof frame with pulled rope or wire and constructing a false ceiling using timber or bamboo mesh beneath the roof surfaces for indoor heat reduction, showcasing households' aspirations of comfort and safety followed by autonomous climate adaptation. On the other hand, the financial constraints of households hold back the replacement of damaged CI sheets prone to salinity, overlooking climate safety.

Table 4. Household's incremental adaptation strategies in UNDP modules

	Vulnerabilities/ Residential situation	Incremental Adaptation strategies	Nature of adaptation
Structural aspect	**Roof**		
	Physical: CI sheet heap roofs without eaves tied with MS angle with the wall, leaving the wall unprotected from driving rain **Socio-Economic:** Constructed by experts using non-local technology and mismatched with local roofing practice, it increased the reconstruction and repair costs in the case of damaged roofs caused by cyclonic events.	**Moved in with Structural improvement:** Users collectively asked for expert assistance to extend the roof up to 18 inches on four sides to protect the wall from driving rain and achieve local aesthetics. **Change in attitude:** unwilling to pay for repair works and waiting for technical and financial support from the agency.	Active, Collective Passive
	Wall		
	Physical: built with non-plastered bricks, with fewer and smaller surface openings **Socio-economic:** The mezzanine emergency floor inside increased the wall height, causing a non-local appearance and costly maintenance.	**Moved in:** Structural safety gained with durable material, **Moved in with Structural improvement:** Construct verandahs surrounding the walls (1,2 or 3 sides) to increase thermal comfort, reduce moisture gain, salinity intrusion, and the impact of driving rain, and recreate local aesthetics. **Change in attitude:** Compromising thermal comfort and space modification flexibility, compromised social status with house appearance	Active, Active, Autonomous Passive
	Plinth and foundation		
	Physical: The durable brick foundation without a plastered surface remains vulnerable to salinity intrusion, mold and mildew growth, water infiltration, and soil destabilization; height safety is ensured for low-land plots.	**Moved in:** Considering the material's durability, the plinth's safe height, and the low maintenance. **Moved in with Structural improvement:** added verandah floor and strengthened the plinths by soil mounting, plastering the exposed brick surfaces, and coating them with bitumen. **Change in attitude:** compromising plasticity of the exterior surface and waiting for donor aid for upgradation.	Active, Active, Autonomous Passive
Spatial aspect	**Bedroom**		
	Physical: A single bedroom with a single entrance and three windows, no windows in the front façade, built with a mezzanine emergency wooden floor (for storage and shelter) accessed from the inside with a ladder and two emergency escape windows during an emergency **Socio-economic:** Bedrooms are incompatible with extended families with grown-up children and guest accommodation; large single spaces are multifunctional only for small families.	**Moved in:** Small families found Spatial flexibility and Multifunctionality; the mezzanine emergency floor increases the safety of assets **Moved in with Structural improvement:** Extending the wooden emergency floor covering the whole space (only when economic capability increases) to increase usable space and storage area, constructing a U or L-shaped verandah for additional sleeping and guest accommodating spaces for privacy and adult autonomy **Change in attitude:** Compromising thermal comfort and lack of initiatives for additional living spaces	Active Active, Autonomous Passive
	Kitchen		
	Physical: The module did not have a kitchen. **Socio-economic:** The module allowed households to make decisions and have the freedom to achieve their aspirations.	**New Construction:** The households self-built the kitchens, confirming Structural flexibility, social interaction opportunities, and Spatial permeability with Incremental investments.	Active, Autonomous
	Toilet		
	Physical: The agency assisted in constructing single-pit toilets on raised mud plinths, with CI sheet walls and roofs, reducing the risk of inundation and increasing hygiene performance.	**Moved in:** Households' own decision to locate the toilet ensured the water source proximity and the cultural practice of separating the toilet from the main living spaces	Active, Autonomous

Socio-economic: Building with local technology and improved sludge containment in toilet construction reduced the cost and improved hygiene situation; the location of the toilet was accepted in terms of female privacy	**Moved in with Structural improvement:** Upgrading the plinth material from mud to bricks and raising the plinth height (as their economic capacity grows) based on the experienced flood level.	Active, Autonomous
Sitting		
Physical: The residents decided on the orientation and positioning of the modules, considering future expansion, maximum ventilation, and lighting. **Socio-economic**: Modules were positioned at the edge of the sites to maximize the front yard spaces.	**Moved in:** Decision-making freedom enabled households to gain the traditional practice of entrance orientation (South or East), which ensured. Optimum sunlight and airflow inside the module	Active, Autonomous
	Moved in with Structural improvement: The module's minimal design allows for additional sleeping spaces and verandahs and provides room for a courtyard for income-generating spaces and social gatherings.	Active, Autonomous

"We examined several homes devastated by Cyclone SIDR in 2007 and discovered that roof overhangs were the main cause of the houses being lifted by the cyclonic wind, and the connection mechanism with the wooden frame was unable to sustain the wind pressure during a cyclone. Thus, our design team placed a heap roof without an eave on top of a brick-walled home module and combined it with a sturdy MS (Mild Steel) angle bar frame" – a UNDP program specialist.

There are notable dissimilarities in the roofing design in the UNDP modules compared to local practice. The design aimed to tackle cyclonic winds by removing overhangs of the CI sheet-made heap roof and adding mild steel (MS) frames to reinforce the roof's integrity. UNDP's design was unfamiliar to the local populace and differed from their traditional methods. Despite processing adaptive features suited to the climate, households initially showed unwillingness upon receiving the module. During the rainy season, the inadequacy of the design became evident as rainwater infiltrated the water gutter, causing overflow into the rooms and making them inhabitable. Using MS bar in the roof frame also posed challenges for locals attempting to extend, modify, or repair the roof using traditional techniques (Figure: 7- B and I). Consequently, the inhabitants collectively expressed their concerns, particularly households receiving the UNDP module. Through a collective effort of households, they successfully convinced UNDP facilitators to extend the roof overhang. The roof adjustment fulfilled the module's local visual integrity and ensured climate safety against cyclonic wind and rainwater infiltration of the wall. This collaborative effort showcased that the incompleteness of the UNDP module allowed the community to achieve social aspirations followed by collective climate adaptation.

Flexible wall and climatic safety

House walls, traditionally made of mud, CI sheets, asbestos, wood, or Golpata, are critical and vulnerable to damage caused by cyclones, tidal surges, and temperature fluctuations (Figure 4). However, each of these walls had its unique drawbacks. For instance, mud walls were prone to salinity intrusion, abrasion, and strong winds. On the other hand, CI sheet and asbestos sheet walls were fragile and prone to corrosion and heat insulation. Wooden or Golpata-made walls, although made using local materials and technologies, had low durability and were also vulnerable to salinity intrusion. Nonetheless, people still adapted to these diverse climatic conditions using these traditional materials and techniques. People often use traditional autonomous and active adaptation strategies correlated with the aspiration of comfort, including making structural modifications like using polythene sheets to protect mud walls, adding verandahs to reduce heat gain, coating the lower part of walls with bitumen (Figure 4), and enhancing the durability of wooden walls by using motor oil (locally known as "Pora-Mobil").

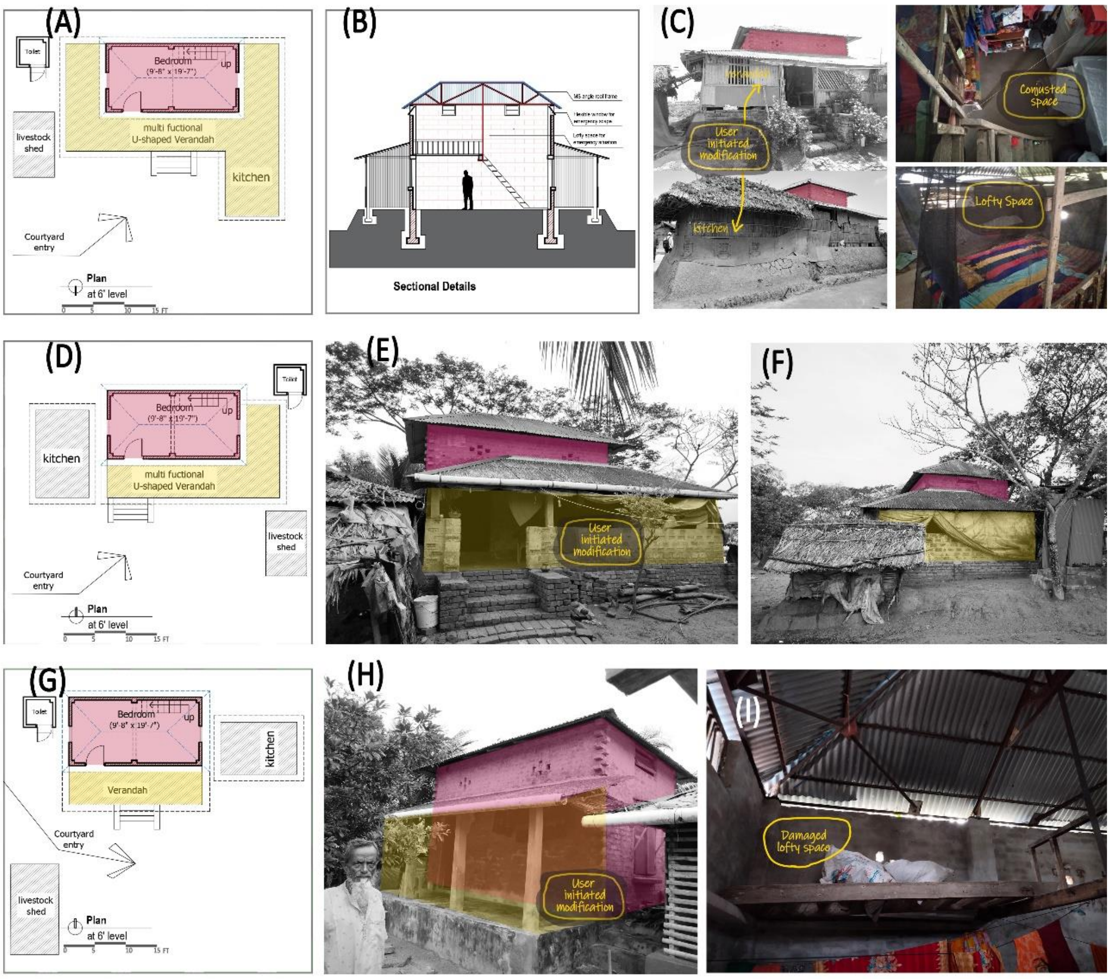

Figure 7. Incremental adaptation strategies in UNDP modules

"We used to feel scared during storms in our old mud-walled houses, thinking it might collapse on us. However, now, with this new house from the government, we are less afraid. Even in storms, we feel safe inside because this house is made of bricks and has a strong base. It is small inside and can get heated in the summer. However, we adjusted things and arranged the furniture differently because this house makes us feel safe and secure." – a 40-year-old female respondent.

Therefore, households prefer bricks and consider them a dream building material, offering durability and safety, particularly for walls and foundations against climatic events, despite the vulnerability to gradual deterioration caused by salinity. Consequently, people experiencing homelessness welcomed the brick-walled houses of the GoB modules. Despite having issues like plaster erosion, mold, water infiltration, saltwater intrusion, and heat absorption, the residents expressed positive aspirations toward these walls. However, brick walls are sensitive to erosion of plaster, mold and mildew growth, water infiltration, saltwater intrusion, and heat absorption. Nevertheless, the change in attitude is reflected by households towards the brick wall provided in the GoB module, relying on effectiveness for structural safety and rising temperatures and resulting in an aspirational compromise on the space requirements for families by living in small rooms. Additionally, households faced financial constraints that significantly hampered their repair activities due to the high cost of labor and brick. As a result, households approached a passive adaptation with high dependence on external assistance, which is missing in the GoB provision but does not make the household climate resilient.

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Table 5. Residents' aspiration picture and climate adaptation performance of Donor-driven modules

Resident's aspiration picture			**Climate adaptation performance of Donor-driven modules**																			
			GoB provided module										UNDP provided module									
			1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
Structural aspect	**Roof**	Structural safety	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○
		Thermal comfort	●	●	●	●	○	○	○	○	○	○	□	□	□	□	□	□	□	□	□	□
		Local technology	●	●	●	●	●	●	●	●	●	●	□	□	□	□	□	□	□	□	□	□
		Local aesthetics	●	●	●	●	●	●	●	□	□	□	○	○	○	○	○	○	○	○	○	○
	Wall	Structural safety	●	●	●	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○	○	○
		Thermal comfort	□	□	□	□	□	□	□	□	□	□	□	□	□	○	○	○	○	○	○	○
		Flexibility	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	□
		Social status	●	●	●	●	●	●	●	●	●	●	□	□	□	□	□	□	□	□	□	□
		Local aesthetics	●	●	●	●	●	●	●	●	●	●	○	○	○	○	○	○	○	○	○	□
	Plinth and founda -tion	Durability	●	●	●	●	●	●	●	○	○	○	●	●	●	○	○	○	○	○	○	○
		Height safe plinth	□	□	□	□	□	□	□	□	□	□	●	●	●	○	○	○	○	○	○	○
		Plasticity	●	●	●	●	●	●	●	●	●	●	□	□	□	□	□	□	□	□	○	○
		Minimal maintenance	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Spatial aspect	**Bedroom**	Thermal comfort	□	□	□	□	□	□	□	□	□	□	□	□	□	○	○	○	○	○	○	○
		Spatial flexibility	□	□	□	□	□	□	□	□	○	○	●	●	●	○	○	○	○	○	○	○
		Multifunctionality	●	●	●	●	□	□	□	□	□	□	●	●	●	●	○	○	○	○	○	○
		Safety of assets	●	●	●	●	●	●	□	□	□	□	●	●	●	●	●	●	●	●	●	●
		Privacy	●	●	●	●	●	●	●	□	□	□	○	○	○	○	○	○	○	○	○	○
		Adult autonomy	□	□	□	□	□	□	□	□	□	□	○	○	○	○	○	○	○	○	○	○
	Kitchen	Structural flexibility	■	■	■	■	■	■	■	■	■	■	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		Social interaction	■	■	■	■	■	■	■	■	■	■	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		Spatial permeability	■	■	■	■	■	■	■	■	■	■	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		Incremental investment	■	■	■	■	■	■	■	■	■	■	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	Toilet	Usability in emergence	●	●	●	●	●	●	●	■	■	■	○	○	○	○	○	○	○	○	○	○
		Water source proximity.	□	□	□	□	□	□	□	■	■	■	●	●	●	●	●	●	●	●	●	●
		Cultural sensitivity.	□	□	□	□	□	□	□	■	■	■	○	○	○	○	○	○	●	●	●	●
	Sitting	Entrance orientation	□	□	□	□	□	□	□	□	□	□	●	●	●	●	●	●	●	●	●	●
		Optimum sunlight and airflow	□	□	□	□	□	□	□	□	□	□	●	●	●	●	●	●	●	●	●	●
		Expansion scope	□	□	□	□	□	□	□	□	□	□	○	○	○	○	○	○	○	○	○	○
		Income-generating space	□	□	□	□	□	□	□	□	□	□	○	○	○	○	○	○	○	○	○	○
		Social gathering space	□	□	□	□	□	□	□	□	□	□	○	○	○	○	○	○	○	○	○	○

Aspiration achieved by: ● Moved in; ○ Moved in with structural improvements; ▲ New Construction
Aspiration adjusted by: ■ Change in use; □ Change in attitude

The brick, employed in the UNDP and GoB modules, shared similar situations. They both aimed to construct brick wall houses. The vulnerabilities faced were alike. However, differences arose due to distinct construction techniques, leading residents to adopt different adaptation strategies (Table 4). For instance, elevated floors within the walls resulted in nearly two-storied buildings, and inadequate roof overhangs persisted even after UNDP's extension (Figure 7). These differences rendered the houses unfamiliar to the locals and disrupted the contextual harmony.

"*When I saw the house constructed by UNDP, it looked odd and different. It did not resemble any of the houses around here. There was no overhang on the roof or verandah around the house, making living inside uncomfortable during hot summer days. Some people even said it looked like a temple. So, later, we decided to make it look more like the local houses. We built a veranda on three sides and decorated it with wooden detailing to make it seem local and match the nearby houses better," said a 43-year-old male respondent.*

An additional issue emerged due to the exposure of the brick without plastering and the absence of windows in the front façade, causing ventilation issues and increasing indoor temperature. Seeking aesthetic aspiration and improved human comfort, households autonomously constructed verandas around (one, two, or three sides) the walls (Figures

7- A). The structure must be designed with both safety and flexibility in mind to build a house that can endure various weather conditions, which means that the walls should be strong enough to provide protection against external threats and adaptable to the households' aspirations. Modifying the walls according to the local customs and traditions will make the residents feel more at home and comfortable in their living space, helping to create a sense of belonging and community. Therefore, the flexibility of the walls is a crucial factor in constructing a climate-resilient house meeting social aspirations.

Robust plinth and foundation

Self-built homesteads have traditionally adapted households prone to natural disasters, but structures exposed to tidal surges, seasonal floods, and salinity. The mud plinth of these structures is particularly sensitive to such factors, as it has low durability and can be easily affected by salinity intrusion, abrasion, and soil destabilization. Households have developed autonomous and active traditional adaptation strategies, including safeguarding the mud plinth with a brick wall, extending the roof overhang, covering it with polyethylene sheets or plastic bags, and gradually improving it with plastering and coating it with bitumen as the household income grows.

"During cyclones or floods, we rush to cyclone shelters, praying that our house's Vit (plinth) and khuti (post) stay strong. If the plinth gets damaged, fixing it takes a long time, delaying our house's reconstruction. However, if the plinth and post remain intact, we can rebuild our house easily using our traditional building materials and methods. So, having a strong and durable foundation is important for us." – FGD with self-built house owners.

This significance was evident in the GoB and UNDP modules, which used brick as foundation material. Both faced challenges with plinths vulnerable to salinity and soil destabilization during tidal surges, seasonal floods, and water inundation. Consequently, most households chose active adaptation strategies to achieve their aspiration of a stable base or plinth, enhancing structural conditions by mounting soil around the plinth to prevent soil destabilization. Some residents of the UNDP module managed to plaster and coat their plinths of verandahs (Figure: 7-C, E, and H) with bitumen to withstand inundation and protect against salinity. Despite economic constraints, some residents covered their kitchen's plinth with bricks, cement plaster, and bitumen coating, highlighting the importance of plinths and safeguarding them with active participation, followed by climate adaptation.

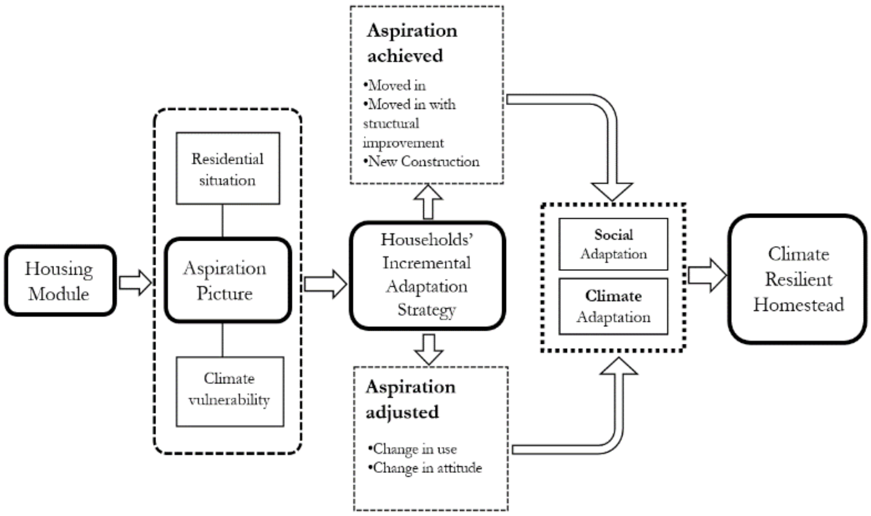

Figure 8. The relationship between households' aspiration picture, incremental adaptation strategies, and climate-resilient homesteads.

Conclusion

Since housing is a social adaptation process, households with active or passive adaptation strategies achieve or adjust their aspirations and balance their residential situation with the aspiration picture. This study analyzed incremental household adaptation strategies to transform a housing module into a climate-resilient homestead to achieve the desired outcome. Firstly, this study explored how the aspiration picture influences the incremental adaptation strategies adopted by households in donor-driven modules. Secondly, it analyzed whether household strategies lead to social or climate adaptation, resulting in climate-resilient housing. The study found that the aspiration picture created based on residential situations and climate vulnerabilities creates a complex relationship between social and climate adaptation and resilience (Figure 8). Households of both modules adopted strategies like moving in, moving in with structural improvement, and new construction to achieve their aspiration picture. They also adopted strategies like change in use and attitude to adjust their aspirations. In this respect, the module's structural and spatial design played an important role in determining the performance of donor-driven modules.

The findings of cross-case synthesis, presented in Table 5, indicate that the incompleteness of the UNDP module offers more scope for achieving aspirations, and the complete nature of the GoB module leads primarily to aspiration adjustments. The study found that residents moved into the GoB module and improved their living conditions through structural modifications influenced by aspirations such as safety, durability, local aesthetics and technology, low maintenance, flexibility, and elevated social status. Parallelly, achieving the ambition of using toilets in emergencies, residents changed their attitude towards structurally stable attached toilets, adjusting their aspiration of cultural sensitivity and water use proximity.

On the other hand, the rigid structure causes households to adjust their aspirations by changing attitudes toward income generation, future expansion, comfort, entrance orientation, and social interaction. The residents changed the use of the inappropriate kitchen and built a new one, compromising structural stability for social interaction, permeability, structural flexibility, and incremental investment. However, the incomplete UNDP module performs better regarding aspiration achievements toward climate-resilient housing. The module's bedroom possesses an innovative and secure design that prioritizes the safety of its residents and their belongings. Furthermore, the design encourages residents to incrementally enhance and personalize the space to improve their living experience further.

The flexibility to select the preferred location of the core shelter within the UNDP modules empowers households to make informed decisions about their relocation options. After moving in, Households also improved the necessary structures to achieve the aspiration pictures, which engaged households in learning climate resilience. The decision not to provide any kitchen with the UNDP module triggered them to construct a new kitchen autonomously to achieve the aspiration of the impermanent kitchen with structural flexibility, permeability, social interaction, and incremental investment. Moreover, the incomplete exterior with exposed bricks, non-local appearance, and construction technology of the UNDP module led the residents to build more envelope spaces to gain climate protection and local aesthetics.

When designing climate-resilient housing modules, this study finds it essential to consider which module offers the most potential for achieving an aspiration picture with both social and climate adaptation. This study advocates for a more minimalist approach to module design that can produce more robust climate-resilient homesteads. However, it noticed that the autonomous building process initiated by the residents faces a lack of updated knowledge of upcoming disastrous events. So, it is also necessary that a module offers better opportunities for the engagement of households that will enhance community knowledge for building back better and safer.

Conflict of Interest

The authors declare no conflicts of interest.

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