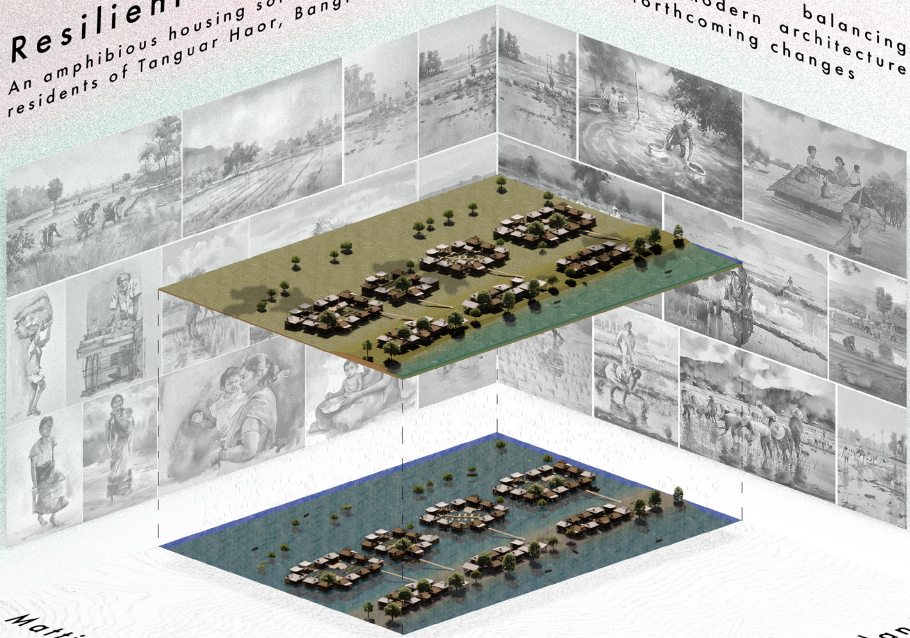
Resilient Waters:

An amphibious housing solution for the residents of Tanguar Haor, Bangladesh

A resilient design balancing vernacular and modern architecture to navigate forthcoming changes



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Dwelling studio 2023/2024: **Global Housing**

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Resilient Waters: An amphibious Housing Solutions for the residents of Tanguar Haor, Bangladesh

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Global Housing studio (AR3AD105):
Architecture of Transition in the Bangladesh Delta

Master thesis MSc Architecture, Delft University of Technology
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Cover image: A resilient design for a Tanguar Haor Community

Fig 1: Project location (Tanguar Haor) in Bangladesh

Abstract

This thesis addresses the challenges of poverty and environmental sustainability in Tanguar Haor, Bangladesh, by developing an innovative amphibious rural design. The project integrates critical elements of vernacularity, modularity, resilience, and self-reliance to enhance the livability of this flood-prone region.

Tanguar Haor, characterized by its unique wetland ecosystem, faces significant issues related to seasonal flooding, which aggravates poverty and interferes with sustainable development. The proposed design uses local building traditions to ensure cultural relevance and acceptance. It employs modular construction techniques to facilitate easy assembly, maintenance, and scalability, making it adaptable to the dynamic environmental conditions of the haor.

A key design principle is resilience, which aims to withstand and quickly recover from flooding events. Amphibious structures ensure that buildings can float during high water levels and return to their original positions as waters recede, minimizing damage and displacement. The design also places a strong emphasis on community self-reliance, incorporating features such as rainwater harvesting and local material usage. These elements not only enhance community autonomy but also reduce dependency on external resources.

Through a holistic approach that integrates traditional knowledge with innovative design principles, this thesis illustrates how an amphibious rural design can offer a sustainable and practical solution to improve the living conditions in Tanguar Haor, addressing both poverty and environmental challenges. The findings highlight the importance of this interdisciplinary approach, which has the potential to create resilient and self-sufficient communities in vulnerable regions, ensuring long-term success.

Preface

This booklet contains the results of my graduation research in the Global Housing Studio. This experience has tested my perseverance and significantly contributed to my personal development.

I have enjoyed this final project of my studies more than any other, and I would like to express my gratitude to the tutors Dick van Gameren, Nelson Mota, Rohan Varma, Mo Smit, and Marina Tabassum, who have guided me throughout these ten months and made this studio possible. I also thank the students and teachers of SUST for their assistance during the field trip.

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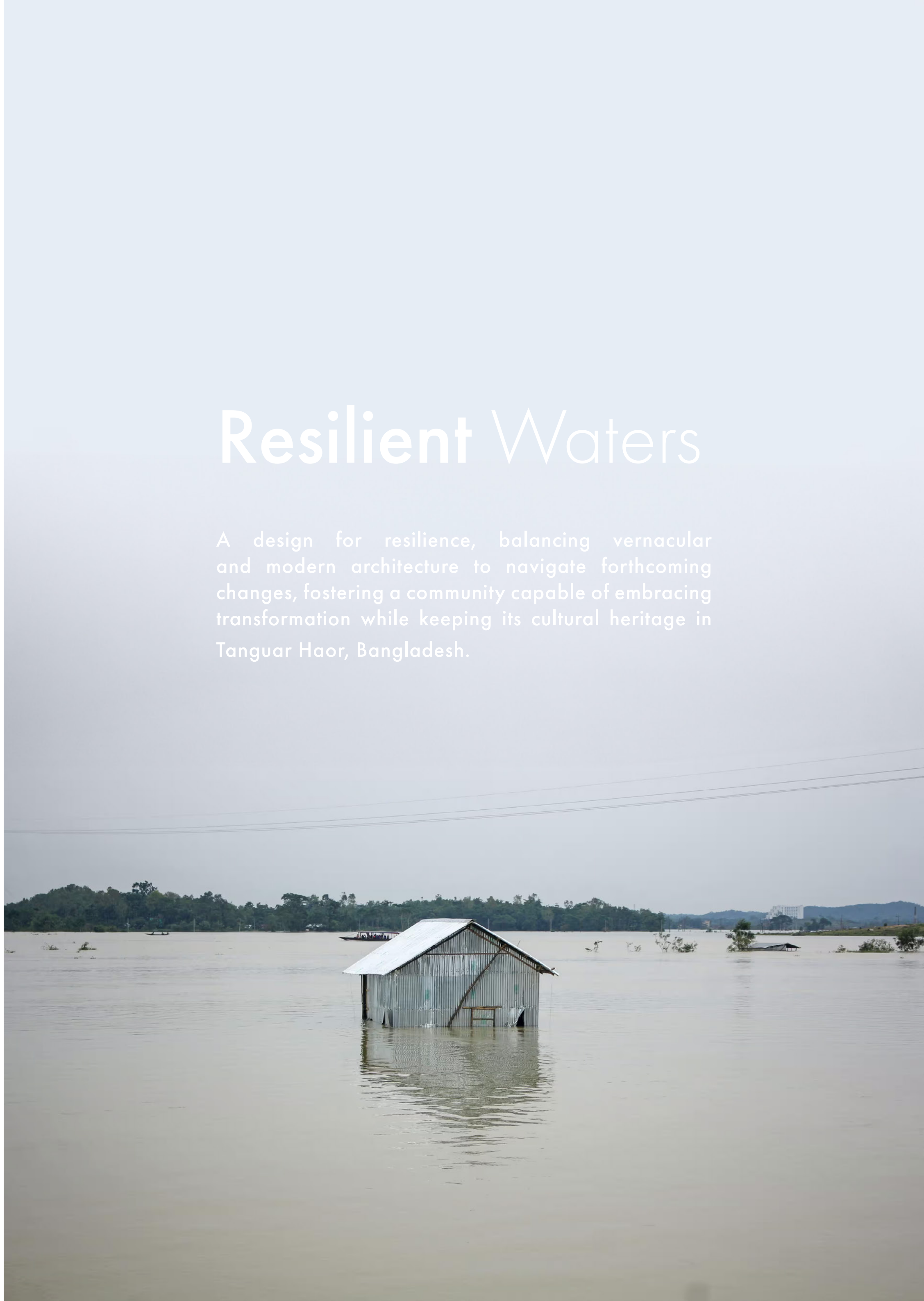
01 **Research Plan**

Fig. 2: An inundated house beside the banks of the overflown Surma River in Sylhet (Hossain, 2022).

Resilient Waters

A design for resilience, balancing vernacular and modern architecture to navigate forthcoming changes, fostering a community capable of embracing transformation while keeping its cultural heritage in Tanguar Haor, Bangladesh.



a. Introduction

The world faces a critical challenge that demands innovative solutions - the need to adapt to rising waters. This challenge is particularly pressing in regions like Sylhet, Bangladesh, where the intersecti on of environmental change and cultural heritage preservation presents a complex and urgent issue (Ahsan, 2019; Saha et al., 2021).

Bangladesh, as a whole, is struggling with the multifaceted impacts of climate change, including rising sea levels, heavy monsoon rains, and unpredictable weather patterns. The country's northeastern part is particularly susceptible to these changes due to its low-lying terrain. In recent years, the region has experienced a surge in flooding and erosion events, which have led to the displacement of communities, loss of livelihoods, and damage to vital infrastructure. As urbanisation continues to accelerate, these challenges are compounded as more and more people move to urban centres, further altering the region's social and environmental landscape (Ahsan, 2019; Anik & Khan, 2012).

Navigating the flooded Tanguar Haor region, Bangladesh, one witnesses a land of beauty and cultural significance. This low-lying floodplain is a unique ecological space known for its landscapes, traditional agriculture, and cultural heritage. However, among various risks, the primary existential threat of the region is flooding (Paul & Routray, 2010; Younus et al., 2013). This research explores how the Haor region, with its resilient communities and vernacular architecture, can adapt and thrive in this growing challenge.

The Haor's geography is intimately linked with its cultural and economic identity. With their intricate waterways and seasonal flooding, the Haor wetlands support the local inhabitants' distinct way of life (Hossain et al., 2017). These natural wetlands cover an area of approximately 9,727 ha, expanding in the dry months and contracting during the monsoon season (Rahaman et al., 2016). It is the seasonal habitat for various migratory and local wildlife (Pandit et al., 2023). The region's uniqueness lies in the balance between its environment and people and the architectural and cultural traditions developed over centuries to cope with the dynamic waters (Ara et al., 2019).

Resilient rural planning works to address the impacts of climate change on vulnerable regions like the Haor. It involves a dynamic and adaptive approach to development, integrating strategies that reduce vulnerability and enhance the capacity of communities to bounce back from setbacks (Caldwell, 2015). However, resilient planning can face difficulties regarding heritage conservation. The Haor region holds generations of knowledge about how to adapt to its unique environmental conditions. Integrating modern innovations and technologies and preserving vernacular architecture poses challenges and opportunities in a search for resilience. Innovative solutions, such as climate-responsive architecture, advanced flood prediction systems, and sustainable water management techniques, can play a pivotal role in mitigating the effects of rising waters (Watson & Adams, 2011). However, the challenge lies in embracing modern technologies and safeguarding cultural heritage.

This research aims to create a sustainable and culturally rich future for the Haor region by blending vernacular architecture with modern technology. It seeks to develop a resilient transition framework that addresses climate change challenges while preserving cultural heritage. Through interdisciplinary research, community engagement, and design thinking, this study looks for a solution where innovation revitalises tradition, offering its communities an improved living environment.

Fig. 3: Lessons from nature: "Leaves exemplify the resilience of trees and forests. Leaves are nourished by sunlight and moisture, carry nutrients to and from their roots, adapt to their microclimate with sizes and shapes determined by their place in the sun, are able to heal and continue life functions when damaged by storms or attacked by animals and insects, carry time - release nutrients to nourish the soil, and, in some tree species, signal chemical messages when threatened by disease to initiate new roots and ofshoots or slowly build immunity through regeneration" (Own Work, 2023; Watson & Adams, 2011).

b. Problem statement

The Haor region, Bangladesh, stands at a crossroads where the balance between nature and human existence is under threat due to the impacts of climate change (Uddin et al., 2015). This literature review explores the challenges posed by climate change in the Haor region, the concept of resilient rural planning in response to these challenges, and the importance of vernacular architecture in sustaining cultural and environmental resilience.

1. Climate Change in the Haor Region

The Haor region has historically relied on the seasonal flooding of its wetlands for agricultural activities. The natural flooding pattern was predictable, and local communities had adapted their livelihoods and agricultural practices to this cycle (Bagchi et al., 2020). However, climate change is disrupting this balance in different ways:

- *Increased Rainfall*: One of the primary manifestations of climate change in the Haor region is the increased intensity and duration of monsoon rainfall. Intense rainfall events lead to rapid inundation of the floodplains, which can overwhelm traditional flood management systems (Muzaffar & Ahmed, 2006).
- *Rising Sea Levels:* Rising sea levels in the nearby Bay of Bengal lead to increased saltwater intrusion into the Haor region's freshwater ecosystems. This poses a significant threat to agriculture and freshwater resources, as it can render soil and water sources unsuitable for cultivation and consumption (Milliman et al., 1989).
- *Altered Flooding Patterns:* Climate change has brought about shifts in the timing and intensity of the monsoons. The traditional predictability of seasonal flooding has been disrupted, making it challenging for communities to plan their agricultural activities and adapt to changing water levels (Raihan et al., 2021).
- *Loss of Biodiversity:* The changing environment is also affecting the rich biodiversity of the Haor region. Many migratory bird species and aquatic life that depend on the seasonal wetlands face habitat loss and alterations in their natural breeding and feeding patterns (Rahaman et al., 2016).

Food Security Challenges: The agriculture of the Haor region, primarily reliant on rice cultivation, is threatened. Prolonged flooding can damage or destroy crops, leading to significant food insecurity for the local population (Sultana et al., 2022).

Fig. 4: Housing on river banks (Own work, 2023).

Deforestation
In Tanguar Haor, deforestation has been a long issue. Deforestation in the upstream areas, which increases the amount of sand in water, can lead to impacts on the Haor's biodiversity and ecosystem such as erosion and sedimentation, habitat alterations, and worsened water quality (Ara et al., 2019).

Displacement and Livelihood Loss
As flooding becomes more unpredictable and severe, communities in the Haor region face the risk of displacement and loss of their traditional livelihoods. This increases vulnerability and pressure on already limited resources (Raihan et al., 2021).

Impacts on Local Communities
The implications of these climate change-related challenges are profound for the communities in the Haor region. They are exposed to increased risks of food insecurity, displacement, loss of livelihoods, and the erosion of cultural and social structures that have sustained them for generations. In a region where agriculture is the primary means of subsistence, the disruption of the traditional flood pattern has profound implications for local economies and well-being (Raihan, 2021).

The Need for Adaptation
The Haor region has reached a critical stage, requiring adaptive solutions to the challenges posed by climate change. Traditional coping mechanisms are increasingly inadequate due to extreme and unpredictable weather events. Resilient rural planning involves adaptive strategies to broaden the region's capacity to withstand and recover from climate-induced shocks (Islam et al., 2020).

Resilient rural planning is not only about infrastructure and technological solutions; it should integrate the unique cultural and architectural identity of the Haor region. This thesis will explore innovative approaches to address the dual challenge of adapting to rising waters while preserving the vernacular architecture that reflects the region's heritage and culture. Balancing these objectives will aim to ensure a sustainable and resilient future for the Haor region and its communities.

2. Resilient Rural Planning as an Adaptive Strategy

Resilient planning is a strategy to prevent the impacts of climate change on vulnerable regions such as Tanguar Haor. It is a dynamic and adaptive approach that seeks to reduce vulnerability and enhance the capacity of communities to bounce back from shocks and stressors. Resilience in rural planning contains multiple environmental, economic, social, and cultural dimensions (Caldwell, 2015).

In the context of Tanguar Haor, resilient rural planning addresses the following key aspects (Caldwell, 2015):

Disaster Preparedness: With increased flooding and changing weather patterns, disaster preparedness and response mechanisms must be strengthened. This includes early warning systems, safe shelters, and community training.
Sustainable Agriculture: Adaptations in agriculture are crucial to ensure food security. Crop diversification, water management, and climate-resilient farming practices are essential.
Infrastructure and Housing: Resilient rural planning should incorporate infrastructure that can withstand floods and rising waters. Housing designs should be adaptable to the changing environment.
Community Involvement: Local communities should be actively engaged in decision-making processes. Their knowledge of the land and environment is invaluable in developing practical strategies.
Ecosystem Preservation: Maintaining the ecological balance is essential. Preserving wetlands and wildlife habitats can contribute to resilience.
Economic Diversification: Economic activities beyond agriculture should be encouraged to reduce dependence on a single livelihood source.

3. Vernacular Architecture: Resilience and Adaptation in Sylhet's Architecture and Planning

Vernacular architecture plays a crucial role in the resilience of the Haor region. It represents a wealth of indigenous knowledge that has evolved over

Fig. 5: Housing and landscape situation after monsoon months (Own work, 2023)

Fig. 6: Uniting Tradition and Modernity. Gando School Extension, Designed by Francis Kéré, Burkinabe, active Berlin (Ouwekerk, 2016)

generations to address the challenges of living in a region prone to seasonal flooding. Sylhet possesses a distinctive vernacular architectural heritage deeply intertwined with the region's unique environmental conditions and cultural heritage. Traditional Sylheti houses, often characterised by raised platforms, steeply pitched roofs, and bamboo construction, have historically provided solutions for coping with the region's monsoon rains and flooding. These architectural features offer protection from inundation and promote natural ventilation and passive cooling. In recent years, there has been a renewal of interest in Sylhet's vernacular architecture as a source of inspiration for resilient building design (Saha et al., 2021). Architects and planners are exploring integrating traditional building techniques with modern materials and technologies to create adaptive and sustainable structures (Kumar, 2018). By drawing from the knowledge embedded in centuries-old building practices, these efforts aim to develop resilient architectural solutions that align with the cultural and environmental context of Sylhet. These innovative architectural interventions cover various strategies, from using locally sourced materials to incorporating traditional design elements that improve a building's resilience to flooding and other environmental challenges. This revival of vernacular architecture not only addresses the practical aspects of resilience but also fosters a sense of cultural continuity and identity within the rapidly changing urban landscape of Sylhet (Monzur & Jany, 2022).

This research will examine specific case studies highlighting the integration of Sylhet's vernacular architecture into contemporary adaptation efforts. These case studies will offer valuable insights into how traditional wisdom can inform and enhance modern architectural and planning solutions for resilience in Haor.

4. Current Initiatives and Global Best Practices

Several initiatives and best practices from around the world provide valuable insights into resilient rural planning and the preservation of vernacular architecture.

For example, in the Netherlands, the concept of "floating houses" has been embraced in flood-prone areas. These houses can rise with the water level, ensuring residents remain safe and dry. Integrating resilient architecture with sustainable construction materials has helped create adaptable communities (Moon, 2015). Another example is the Makoko floating school in Lagos, Nigeria, designed by the architect Kunlé Adeyemi (Collins, 2015).

In Indonesia, traditional stilt houses have been adapted to modern needs and materials to address rising sea levels. This demonstrates the potential for balancing tradition and innovation in architectural solutions (Nursaniah et al., 2019).

In India, community-based disaster management strategies have built resilience among vulnerable populations. Local communities are actively involved in decision-making and planning, strengthening their adaptive capacity. The Orissa Cyclone Preparedness Programme is a notable example of such an initiative (Thomalla & Schmuck, 2004).

The review of global best practices emphasises that resilient rural planning is not a one-size-fits-all solution. It must be context-specific, integrating local knowledge and culture. While some innovations can be adapted from other regions, the Haor region's unique challenges and opportunities demand a tailored approach that respects its cultural heritage and ecological intricacies.

Fig. 7: Makoko Floating School, Photograph: Iwan Baan (Collins, 2015)

c. Research questions

How can innovative, resilient rural design be integrated with preserving vernacular architecture to enable the Haor region in Sylhet Division, Bangladesh, to adapt to rising waters and ecological changes while safeguarding its unique cultural and architectural identity in the face of climate change challenges?

Sub-question	Problem	Research Method
What are the specific climate change-induced challenges the Haor region faces regarding flooding, changing ecological dynamics and their impacts on local communities?	Unpredictable flooding patterns, increased rainfall, rising sea levels, biodiversity loss, and food security threats.	Literature review of climate change impacts in the Haor region, analysis of historical data, and interviews with locals.
How has vernacular architecture traditionally addressed the challenges of seasonal flooding and ecological shifts in the Haor region, and what is the cultural significance of these architectural practices?	Traditional architecture faces challenges due to changing flood patterns, and there is a need to understand vernacular architecture's historical and cultural significance in addressing ecological shifts.	Ethnographic research through interviews/ questionnaires with locals and experts, site visits, and architectural practices/cultural narratives analysis.
What are the main principles and strategies of resilient rural planning, and how have these been applied in other regions similar to the Haor context, especially in dealing with rising waters and environmental changes?	Considering rising waters and environmental changes, resilient rural planning principles must be identified and adapted to the Haor context.	Literature review on resilient rural planning principles, comparative analysis with case studies from similar regions worldwide.
How can vernacular architecture be integrated into innovative, resilient rural design in the Haor region, balancing the preservation of cultural heritage with the adaptation to climate change-induced challenges?	Balancing the preservation of cultural heritage through vernacular architecture with the need for innovative, resilient design to address climate change challenges.	Case studies of successful integration of vernacular architecture in other regions, studies for implementing vernacular elements in innovative designs.

1. Literature Review

Booklet & Articles
The Global Housing Graduation Studio conducted a background study of Bangladesh, resulting in a research booklet forming a collective knowledge base on these categories: Territory and Environment, History and Politics, Society and Economy, and Design and Technology.

Alongside this booklet, articles have been read and discussed weekly, treating topics such as urbanisation in the global south, climate change, gender-segregated culture, vernacular architecture and dwelling in Sylhet.

Literature
A literature review will be conducted to get a better understanding of rising waters, their consequences and how to deal with them using texts such as Design for Flooding by Donald Watson (2010), Retrofitting for Flood Resilience by Edward Barsley (2020) and Planning for Rural Resilience by Wayne Caldwell (2015).

2. Ethnographic Research

Engaging with Locals
It will be important to communicate with residents to understand their perceptions of rising waters, their understanding of the associated risks, and their known adaptive solutions.

Site Visits and Observation
Field visits to selected rural and urban areas in Sylhet will be conducted to assess the physical environment, infrastructure, and the extent of vulnerability to rising waters. Detailed observations will be made regarding the built environment, land use patterns, and existing adaptation measures.

3. Case Study Approach

Contextual research
A selection of rural sites will serve as case studies to represent different levels of vulnerability and adaptation efforts. These areas will be chosen based on similar geography, population density, and exposure to rising waters as Sylhet.

Comparative Analysis
A comparative analysis of rural case studies will be conducted to identify similarities, differences, and best practices. This analysis will help determine the transferability of solutions between different contexts.

02 **Research**

a. Comparative Analysis

Fig. 8: People in this area are forced to live in stilted houses over the water (Montu, 2020)

In this chapter, design interventions are selected from diverse locations, including Bangladesh, Vietnam, India and the Netherlands. Despite the contextual differences, these interventions offer invaluable insights and potential solutions that exceed geographical boundaries. Through thorough analysis, a series of precedents are presented that directly influenced the final proposed design.

- The ‘Hanging Village’ of Kalabagi
- Floating house, Sunamganj district
- Amphibious houses, Mekong Delta, Vietnam
- Buoyant Foundation Project Vietnam
- Stilt Houses in Assam, India
- Floating Homes ‘De Gouden Kust’, Maasbommel, The Netherlands

The ‘hanging Village’ of Kalabagi

Floating house, Sunamganj district

Buoyant Foundation Project Vietnam

Amphibious houses, Mekong Delta, Vietnam

Stilt Houses in Assam, India

Floating Homes ‘De Gouden Kust’, Maasbommel, The Netherlands

Fig. 9: Comparative analysis case studies

The ‘Hanging Village’ of Kalabagi

Kalabagi village in Bangladesh’s Khulna district highlights the severe impact of Cyclone Aila in 2009, which devastated the coastal regions. The cyclone demolished homes and land, forcing villagers to adapt by constructing elevated houses on bamboo poles to survive the frequent high tides of the Shibsa River. The cyclone disrupted livelihoods, especially those dependent on the Sundarbans and the Shibsa River for activities like shrimp catching (Montu, 2020).

Post-cyclone, Kalabagi faced numerous challenges, including land erosion. Efforts such as World Bank-funded embankments aim to reduce these risks. Economically, the village suffers from restrictions on shrimp catching and limited alternative employment, worsening financial difficulties. Access to clean drinking water is problematic due to salt intrusion, further impacting health, with increased miscarriages reported from saline exposure. Residents express frustration over insufficient government support (Montu, 2020).

Kalabagi’s hanging houses show resilience and vulnerability, symbolizing the necessity of adaptation and resilience-building. These elevated homes offer protection from flooding during monsoons and high tides, using limited land effectively while preserving cultural and traditional architectural styles.

However, the Hanging Village faces sustainability challenges. Rising sea levels and frequent flooding threaten the long-term viability of elevated homes, which also require regular maintenance. Proximity to water bodies increases health risks, such as waterborne diseases and mosquito breeding. The remote location hinders access to essential services, worsening socio-economic disparities and community development (Montu, 2020).

In summary, while Kalabagi’s hanging village design demonstrates innovative adaptation to flood-prone environments, it highlights the need for sustainable and inclusive architectural solutions that address the long-term impacts of climate change and prioritize residents’ well-being.

Fig. 10: The ‘hanging village’ is by the Shibsa river. Across the river is The Sundarbans (Montu, 2022).

Fig. 11: The ‘hanging Village’ of Kalabagi (Montu, 2022).

Floating houses in Sunamganj district

The floating house initiative in Sunamganj district responds to the housing crisis caused by recurrent floods. These houses are built on plastic drums with bamboo framing and corrugated iron sheets for walls and roofs, enabling them to float during floods and ensure residents' safety. This innovative approach addresses immediate shelter needs and strengthens community resilience against environmental disasters (Islam, 2022).

The chosen materials, local bamboo and CI sheets are affordable and practical. Bamboo is lightweight and strong, making construction more accessible. However, the long-term maintenance of these materials requires attention, especially rust prevention for CI sheets and ensuring the structural integrity of bamboo (Islam, 2022).

Despite their benefits, floating houses have limitations, such as spatial constraints that require creative interior designs and thermal challenges from CI sheets, which necessitate effective insulation strategies for comfortable living conditions (Islam, 2022).

Fig. 12: Floating homes have been offered as a possible solution to annual flooding (Ahmed, 2022).

Fig. 13: Floating houses in Sunamganj to combat flood damage (Islam, 2022).

Chang Ghar in Assam, India

Annual floods inflicted along the Brahmaputra River have devastated lives, livestock, crops, and properties in India's northeast. Originating in the Tibetan Himalayas, this river ranges through India and Bangladesh before merging with the Bay of Bengal (Guha, 2021).

The Mising community, indigenous to the region, has long dwelled along the river's banks, confronting floods with innovative architectural solutions. Residing primarily in Assam and Arunachal Pradesh, they have mastered coexistence with floods, settling in some of the most vulnerable areas, like Majuli River island, the world's largest such island, now diminishing due to severe flooding and erosion (Guha, 2021).

Their distinctive homes, Chang Ghars or Kare Okum, stand on bamboo stilts, each layer serving a specific function. From the Meram (fireplace) on the ground to shelves (Perab and Rabbong) for food storage and a balcony extension (Tunggeng), these structures display adaptability (Guha, 2021).

The Misings predict flood extents and elevate their homes accordingly. They have fostered an understanding of river behaviour using wooden rafts

Fig. 14: People row a boat past partially submerged huts in Morigaon district, Assam, during the 2017 floods (Krishna, 2021).

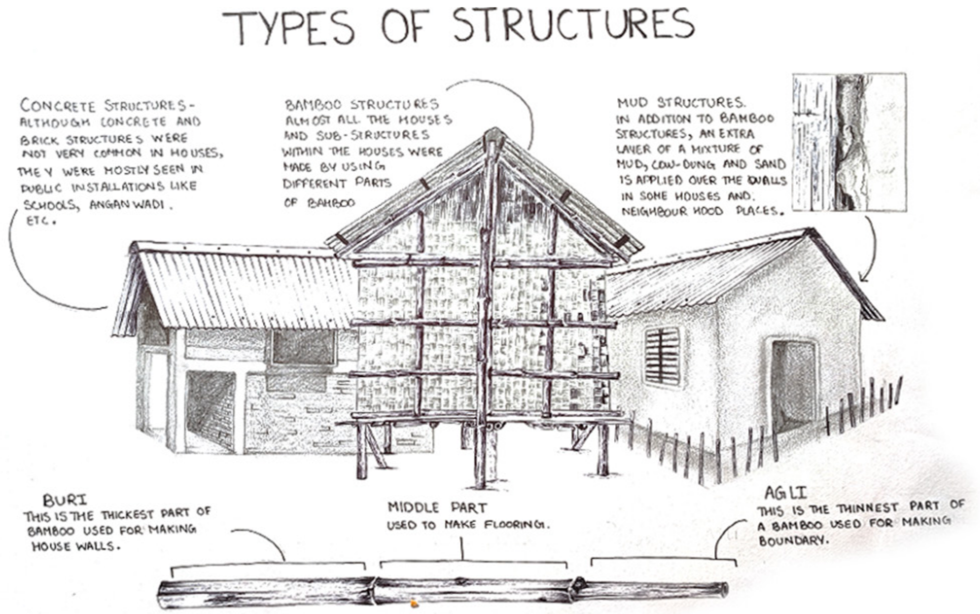


Fig. 15: Structure analysis of a Mising village, Assam (Rastogi, 2022).

(Ollung) for mobility during floods. Yet, changing rainfall patterns since the 1980s have challenged their coping mechanisms. With erratic weather causing heavy rains and flash floods, the Misings' traditional knowledge faces new tests. Assam, bearing 40% flood-prone territory, is one of India's most climate-vulnerable regions (Guha, 2021).

As adaptation becomes more expensive and complex, with bans on logging and erosion compounding challenges, the Misings seek newer innovations. Cheaper alternatives like banana boats reduce immediate threats, but other sustainable solutions are urgent. Efforts to integrate traditional techniques into modern disaster management plans, such as the Pradhan Mantri Awas Yojana (PMAY), offer assurance. NGOs like NEADS are designing hybrid Chang Ghar models to improve durability. However, challenges persist in accessibility and scalability (Guha, 2021).

Holistic approaches surrounding traditional knowledge, modern technologies, and community-driven initiatives are essential to strengthen resilience. As the Assam State Disaster Management Plan prioritises climate-resilient habitats, integrating Mising expertise into sanitation and education becomes critical (Guha, 2021).

By analysing climate change and cultural heritage, the Misings' adaptive knowledge is an important example. Embracing innovation while keeping tradition, they present resilience among environmental adversity, offering valuable lessons for a sustainable coexistence with nature.

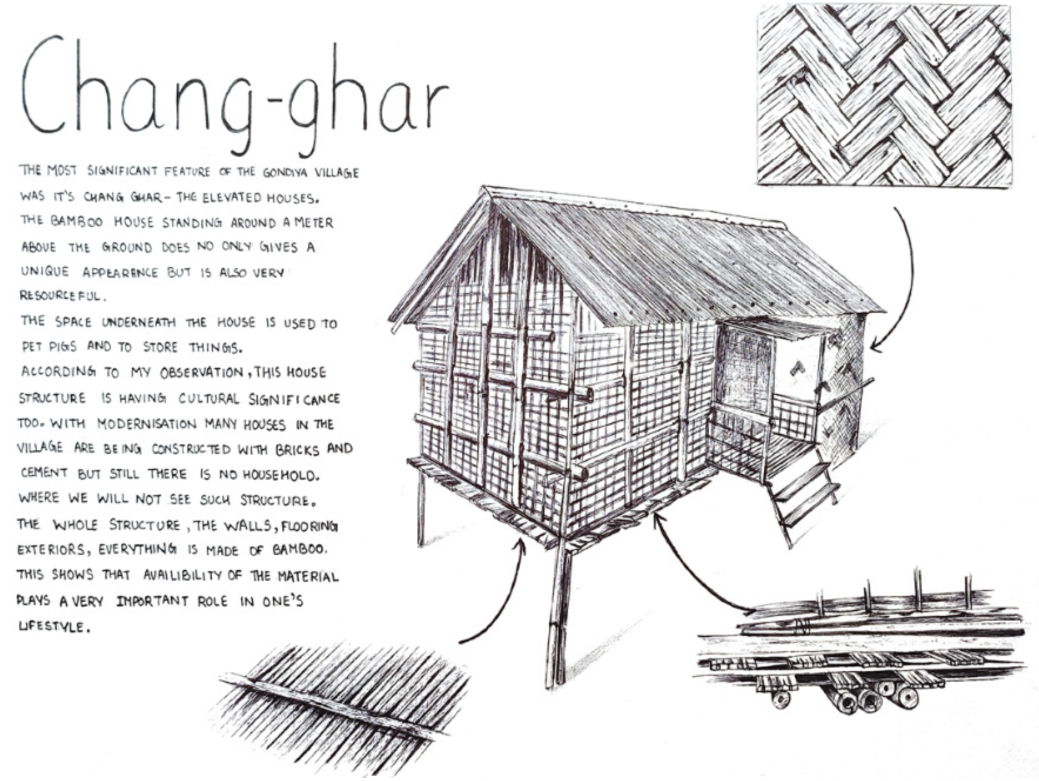


Fig. 16: Chang-ghar analysis of a Mising village, Assam (Rastogi, 2022).

Amphibious houses, Mekong Delta, Vietnam

Elizabeth English, a professor of architecture at the University of Waterloo, explains that amphibious houses can be straightforward and cost-effective, especially for homes without basements. This involves installing buoyant blocks beneath the building, which lift the house as floodwaters rise. Vertical rails ensure the house ascends and descends vertically, returning to its original position once the water decreases (YCC Team, 2022).

English collaborated on retrofitting four rice farmers' homes in Vietnam, reporting high satisfaction from the new homeowners. While a few amphibious houses exist in rural Louisiana and the Netherlands, widespread adoption is hindered by current building codes that need to recognize this approach. English advocates for changing these regulations, emphasizing that amphibious houses, such as Indigenous groups, could enable communities with strong ties to their land to safely remain in their homes despite flooding risks (YCC Team, 2022).

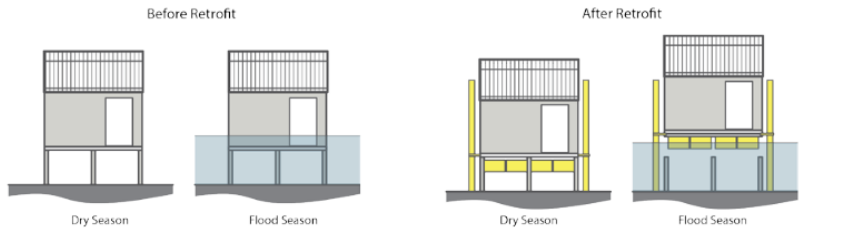


Figure 1: Diagrams showing how a regular elevated house compares to an amphibious retrofit during flooding (BFP/Teresa Tran)

Fig. 17: Diagrams showing how a regular elevated house compares to an amphibious retrofit during flooding (English, 2022).

Fig. 18: Amphibious houses, Mekong Delta, Vietnam (YCC Team, 2022).

Amphibiation project in the Mekong River Delta

The Buoyant Foundation Project is a collaboration between Canadian and Vietnamese teams. It aims to improve flood resilience in Vietnam's Mekong Delta. The team retrofitted four houses in flood-prone areas, integrating amphibious foundations with traditional stilt elevations. This addresses the limitations of traditional stilt houses, which are insufficient against the increased flooding expected from climate change. The amphibious retrofits protect homes and possessions, reducing disruptions to local culture and economy (Buoyant Foundation Project, n.d.). The retrofits serve as practical solutions for disadvantaged communities, providing a proof-of-concept for broader implementation across Southeast Asia. 2018 Canadian team members coordinated the construction in An Giang and Long An provinces. Vietnamese team members monitored the homes during flood season and conducted post-flood interviews to evaluate the new homeowner's satisfaction. The project's future goals include scaling up through training workshops and more retrofits across the Mekong Delta (Buoyant Foundation Project, n.d.).

Fig. 19: Amphibious Retrofitting in the Mekong River Delta, Vietnam (Buoyant Foundation Project, 2020)

Floating Homes 'De Gouden Kust', Maasbommel, The Netherlands

The Floating Homes 'De Gouden Kust' project in Maasbommel demonstrates Dutch ingenuity in addressing the challenge of flooding in low-lying areas. This project contains innovative approaches to adapt and reduce flood risks, offering a solution for resilient housing (Boiten raadgevende ingenieurs bv & Factor Architecten bv., 2011).

The project emerged as one of the first experiments adapting to flood risks. Integrating amphibious and floating homes optimises land use and ensures safety and stability in flood-prone regions (Boiten raadgevende ingenieurs bv & Factor Architecten bv., 2011).

The project contains several features and design principles to ensure resilience and functionality under varying water conditions. Concrete hulls, as the foundation for amphibious homes, provide stability and buoyancy, enabling them to adapt to fluctuating water levels. The blend of floating and amphibious homes offers residents a unique living experience while adjusting to rising water levels during floods. Moreover, a lightweight timber frame structure atop concrete hulls emphasises stability and a low centre of gravity, further increasing resilience (Boiten raadgevende ingenieurs bv & Factor Architecten bv., 2011).

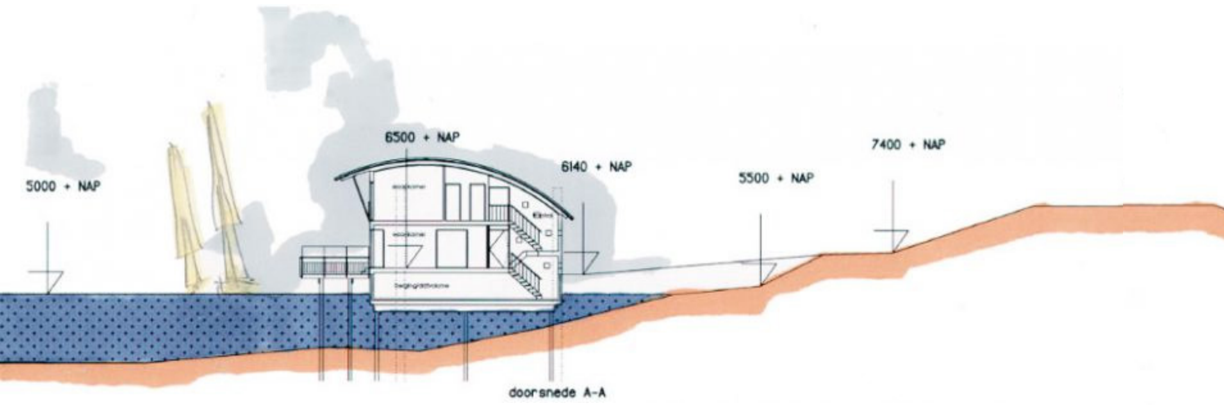


Fig. 20: Section of the floating houses (Urban Green-blue Grids, n.d.)

Fig. 21: Aerial view of the project (Google Earth, 2024).

Innovative connection systems for basic facilities such as water, sewage, electricity, and gas accommodate fluctuating water levels, ensuring functionality and safety during flood events. During flood events, the amphibious homes showcased their flood-resilient design, adapting to rising water levels and ensuring the safety and well-being of residents (Boiten raadgevende ingenieurs bv & Factor Architecten bv., 2011).

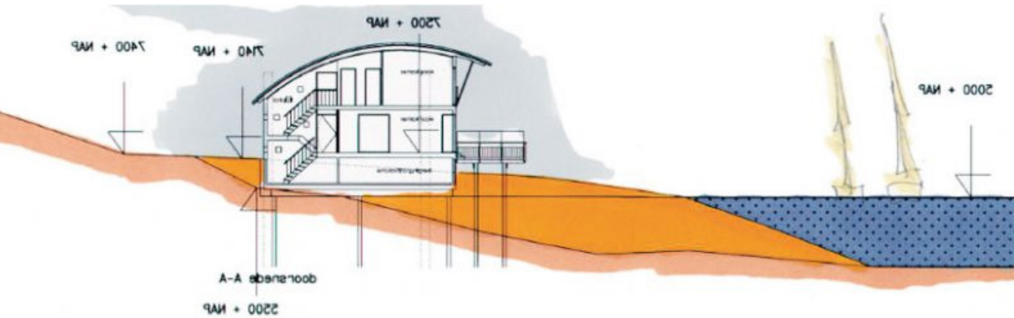


Fig. 22: Section of the semi-floating houses (Urban Green-blue Grids, n.d.)

b. Contextual Analysis

The following analyses are part of the *Architecture of Transition* research done by the students within the Global Housing studio to create a shared knowledge base about Bangladesh. This allowed me to provide my graduation report with the needed research and beautifully accompanying drawings.

Fig. 23: Site visit picture

Fig. 24: Maps showing Asia, South Asia and Bangladesh

Geography

Location
Bangladesh, located in Asia, is mostly flat and has a complex river network prone to annual floods (Brammer, 2016; Husain, 2024). While it has some hilly areas, its low-lying terrain faces challenges from rising sea levels and monsoons (Tinker, 2024).

Geographically, Bangladesh is in a seismic zone influenced by the Indian and Eurasian plates, and is prone to earthquakes, particularly in regions like Sylhet (Ray, 2019).

Elevation
Bangladesh is primarily flat and low-lying, but about 21% of its land is hilly, especially in the southeast and northeast, where elevations can reach up to 1,000 meters. However, most of the country's elevations are below 10 meters above sea level, with the flat terrain gradually decreasing in height towards the coastal areas (Brammer, 2016). The Sylhet division features hills ranging from 30 to 240 meters, surrounded by hillocks, with low-lying flood plains in the centre, known as haors (info@theworldinfo.com, n.d.).

Land use
Bangladesh's land use is predominantly agricultural, with 70% of the land dedicated to various types of cultivation, including rice paddies and other crops like tea and mixed agriculture. The majority of the land (59%) is used for temporary crops, while only 6.5% is for permanent crops (Hays, n.d.). Land use is influenced by physiography, climate, and flooding patterns, with changes occurring due to population growth and alterations in flooding depths, impacting soil quality (Uddin, 2019).

The country's topography, shaped by intricate river networks, notably the deltaic landscape, is in constant flux. During the monsoon season, rivers overflow, bringing fertility through silt deposition but also damaging crops and settlements (Hussain, 2024).

Climate

Bangladesh is situated at the border of the Indo-Himalayan and Indo-Chinese subregions. It experiences a subtropical humid climate with notable seasonal variations in rainfall, warm temperatures, and high humidity (Shahid, 2010). The country faces increasing heavy rainfall and severe weather events like floods, cyclones, and tidal surges (Mallick, 2010). The climate is categorized into four main seasons: dry winter (December-February), warm pre-monsoon summer (February- June), wet monsoon (June-October), and post-monsoon autumn (October- December) (Shahid, 2010). Over 71% of yearly rainfall happens during the monsoon, impacting water resources, agriculture, and the economy (Khatun,

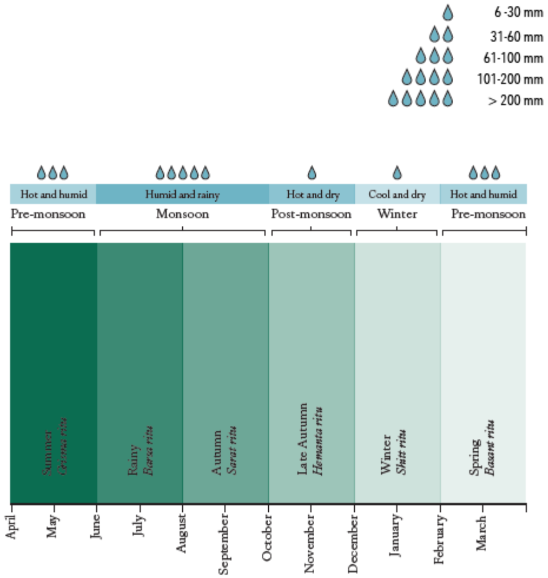


Fig. 25: Climate seasons in Bangladesh

2016). Temperatures range from 12.3°C to 28.1°C in winter and from 22.8°C to 33.4°C in summer, with January being the coldest and May the warmest month (Climate Change Knowledge Portal n.d.). Moreover, monsoon winds bring heavy rainfall from March to September, with regional variations in wind patterns across the country (Mukut, 1970). Bangladesh experiences high precipitation levels, with an average annual rainfall of about 2,200 millimetres, varying from 1,400 mm in the west to over 4,400 mm in the east, with most rainfall occurring during the monsoon season (Shahid, 2010).

Fig. 26: Wind rose Bangladesh

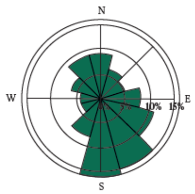


Fig. 27: Wind rose Dhaka

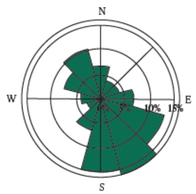
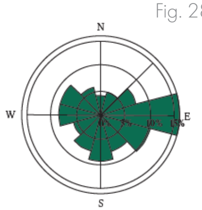


Fig. 28: Wind rose Sylhet



Climate Change

Climate change is undeniably one of the most critical global issues of our time, comprising a multitude of complex challenges. Despite Bangladesh contributing a mere 0.56% to global emissions, it is one of the most vulnerable nations due to its geographical conditions and location. By 2050, the country is projected to witness the displacement of millions due to rising sea levels and floods, forcing many to seek refuge in higher ground or urban centres like Dhaka and Chittagong (Rojas, 2021). However, these cities are ill-prepared to handle such mass migrations, further compounded by their susceptibility to climate change-induced floods and other environmental pressures such as heavy rainfall and sinking ground levels (McPherson, 2015).

Flooding
Much of Bangladesh resides in the Ganges-Brahmaputra-Meghna river delta, which is marked by extensive flat lands that are susceptible to flooding. Intense rainfall, upstream or in the catchment areas, triggers overflow

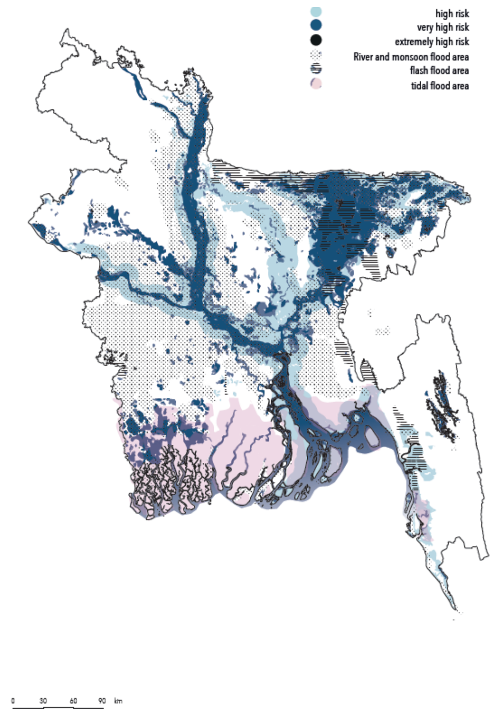


Fig. 29: Flood risk map and flood areas

downstream, breaking riverbanks and flooding nearby regions (Banglapedia, 2015). The flat topography hinders natural drainage, extending the duration of flooding.

Bangladesh has experienced over 78 extreme floods since gaining independence in 1971, resulting in thousands of deaths and significant economic losses (Letsch, 2023). Various factors contribute to these floods, including the nation's low topography, heavy rainfall, and proximity to the Himalayan mountains, where melting snow and glacial movements contribute to rising river levels (Banglapedia, 2015). River siltation, erosion, landslides, tides, and wind patterns can also exacerbate flood risks. Human activities, such as the construction of dams and embankments, can inadvertently worsen flooding if not executed correctly (Banglapedia, 2015). Deforestation also plays a role in exacerbating floods, as tree roots provide structural integrity to land; their removal can result in erosion and reduced river water capacity, leading to overflowing (Banglapedia, 2015). Efforts to reduce flood risks include developing flood risk maps, which assess dangerous areas based on past flood data, elevation, population density, and proximity to rivers. These maps aid in predicting the potential impact of floods and identifying vulnerable areas for targeted interventions (Uddin, 2021).

Flooding Sylhet

Flooding is a significant issue in Bangladesh. Approximately 25% of the land is flooded annually, escalating to 60% during extreme events like the flash flood of 2022, a trend likely to worsen due to climate change (Letsch, 2023). The Sylhet Division, particularly the Sunamganj district, is severely affected by monsoon and flash floods, as the flood risk map indicates. The 2022 floods in Sylhet, worsened by heavy rainfall in Cherrapunji, India, caused rivers Surma and Kushiara to overflow significantly, displacing millions and damaging agricultural land. With the onset of the monsoon season, numerous rivers overflow, posing a substantial threat to inhabitants, as depicted by river flows during dry and heavy monsoon seasons (Doctors Worldwide, 2022).

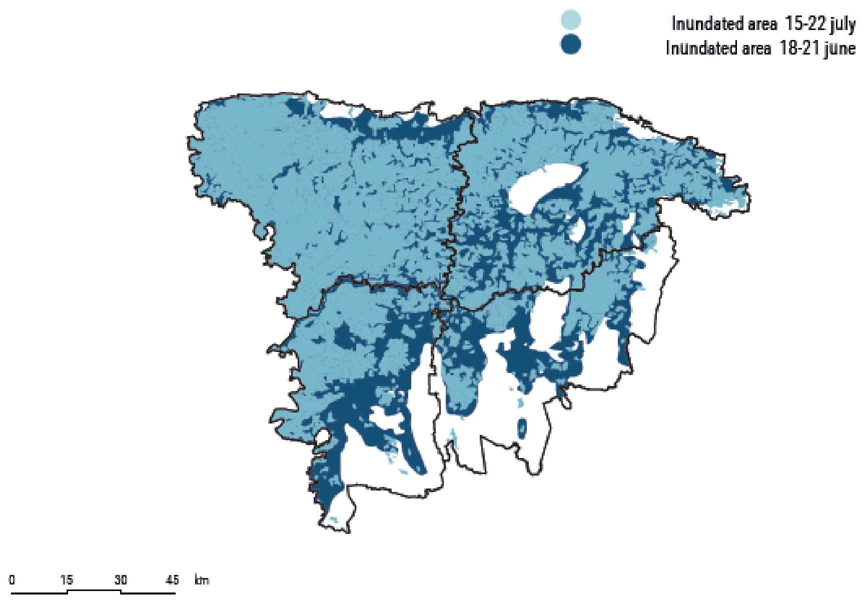


Fig. 30: Flash floods Sylhet 2022

Cyclones

Bangladesh's vulnerability to cyclones is worsened by its location and the shape of the Bay of Bengal to its south (Rojas, 2021). The past century's most devastating and deadly tropical cyclones have struck Bangladesh. Cyclones typically form over the Bay of Bengal and lose strength upon landfall, with the most affected areas being those close to the sea (Kabir, 2016).

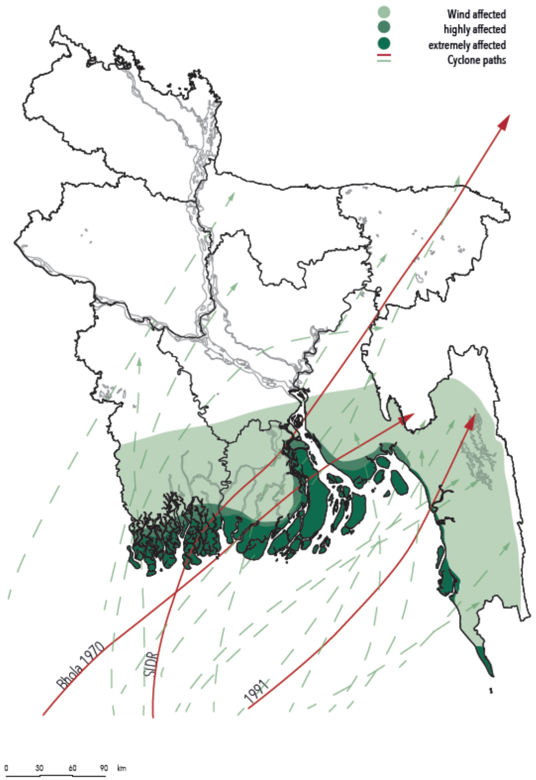


Fig. 31: Cyclone paths and most affected areas

Sea Level Rise

Climate change-induced sea level rise poses significant global flooding risk, with Bangladesh being the second highest in population exposure, following The Netherlands (Rentschler, 2022). Predictions of sea level rise consider factors such as ice cap melting rates and global emissions. In a worst-case scenario with no emission reductions, sea levels could rise by over 1 meter by 2100, potentially even higher if ice caps melt faster (Jevrejeva, 2019). Figure 32 maps out land projected to be submerged under new tide levels by 2030, 2050, and 2100.

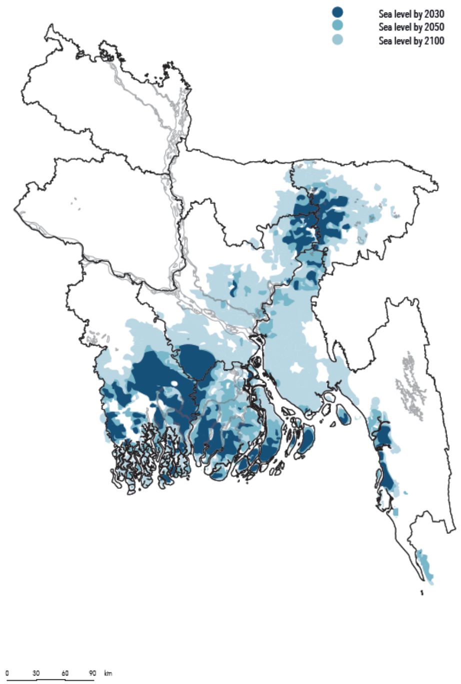


Fig. 32: Sea level rise predictions

Biodiversity

Agriculture

Agriculture is fundamental to Bangladesh's economy and way of life, with over 70% of the land dedicated to crop cultivation and approximately half of the population employed in the agricultural sector (FAO, 2023). The agriculture map (Fig. 33) highlights essential crops such as rice, tea, potato, and wheat. Rice is cultivated nationwide, while potato and wheat are grown in all divisions except Barishal in the south. The map also shows a concentration of crops around major rivers, which benefit from fertile soil. Bangladesh's climate favours rice cultivation, explaining its widespread presence nationwide.

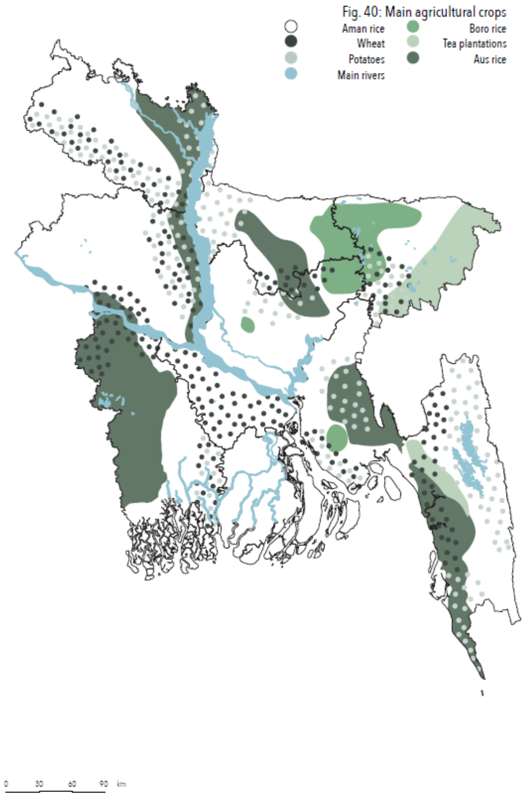


Fig. 33: Main agriculture crops

Tanguar Haor

The Tanguar and Hakaluki haors are vital wetlands in Bangladesh due to their unique ecosystems. Located in the Sylhet division, these haors support diverse flora and fauna and are crucial for food and income for its population. Tanguar haor alone possesses 120-150 plant species, including various types like floating and submerged plants (Mukul, 2007). The wetlands are home to 208 bird species. Additionally, 188 fish species are found, playing a significant role in local livelihoods. The haors also host 34 mammal species, 45 amphibians and reptiles, and 12 butterfly species. However, poor management, driven by rural poverty, leads to overfishing and pesticide damage. Unauthorized hunting, invasive plant species, and lack of awareness threaten biodiversity in these wetlands (Mukul, 2007).

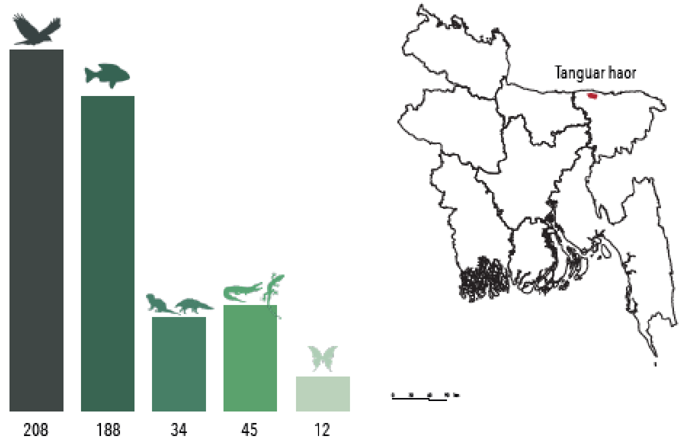


Fig. 34: Number of species per animal type present in the Tanguar Haor

Bangladesh

Bangladesh has many vernacular architectural styles shaped by its subtropical monsoon climate and diverse landscapes. These buildings reflect the adaptation of local communities to their environment and present a combination of culture and practicality. Various construction techniques and materials contribute to the country's distinctive architectural landscape (Saha, 2021).

Some examples are shown in figure 35.

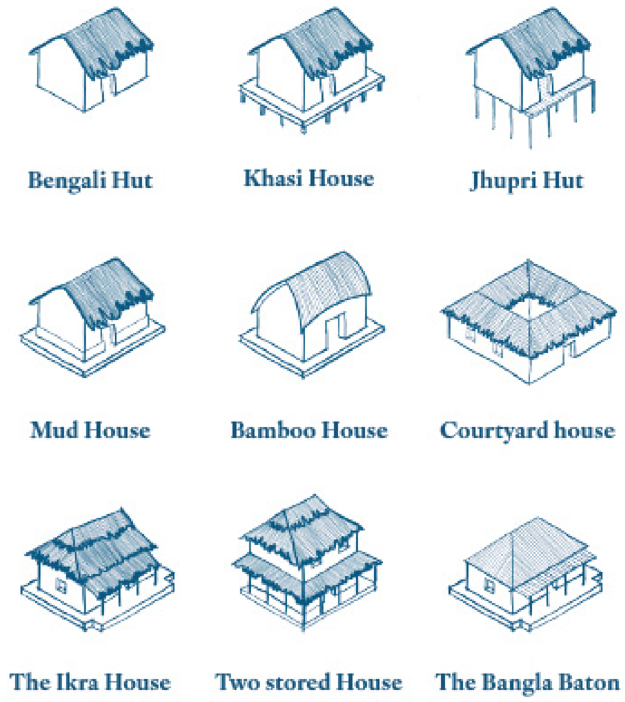


Fig. 35: Map of vernacular typologies of Bangladesh

Sylhet

The Sylhet Division in Bangladesh possesses a unique vernacular architecture that mirrors the area's distinct geographical, cultural, and environmental features:

The following are analysed in connection to this research:

1. The Bengali Hut
2. The Khasi House
3. The Ikra House
4. The Bangla Baton

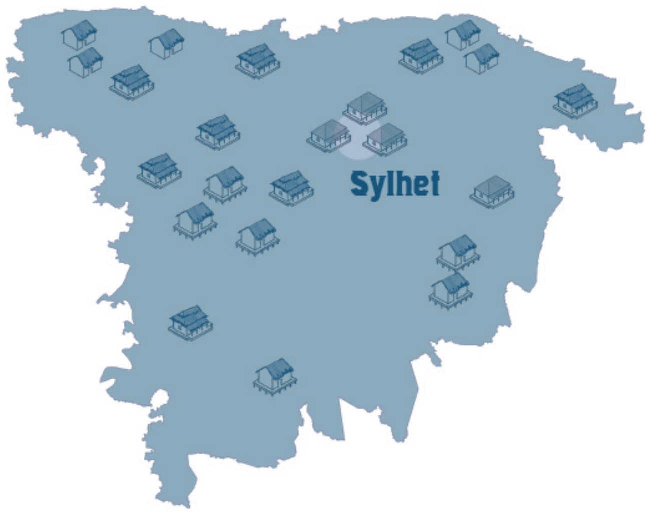


Fig. 36: Map of vernacular typologies in Sylhet

The Bengali Hut

The Bengali Hut are typically clustered surrounding a central courtyard. Each hut is a single-roomed square structure constructed from woven bamboo, reed matting, or mud on a framework (Tabassum, 2019).

Optimal orientation is required for indoor climate control, with huts ideally facing south for cross ventilation and minimising direct sun exposure (Ul Haq, 1992). The arrangement of houses in a quadrangular layout ensures that each dwelling faces all cardinal directions, with the most comfortable cabin traditionally designated for the most important person (Ul Haq, 1992). Distinctive features of Bengali Huts include thatched roofs made from locally available materials, such as dried palm leaves or straw, providing natural insulation. Walls are constructed using mud, clay, and straw applied to a bamboo or wooden framework, offering sturdiness and heat resistance. Bamboo and wood are commonly used for the structural framework due to their strength and availability (Ul Haq, 1992).

Bengali Huts typically have low ceiling heights to facilitate construction with local materials and natural cooling. They often consist of a single room serving various purposes, such as sleeping, cooking, and socialising. The design is highly adaptable to the local environment and available materials, making Bengali Huts a sustainable and eco-friendly housing option (Ul Haq, 1992).

Fig. 37: Bengali hut at Kankalitala (Ancheta, 2008).

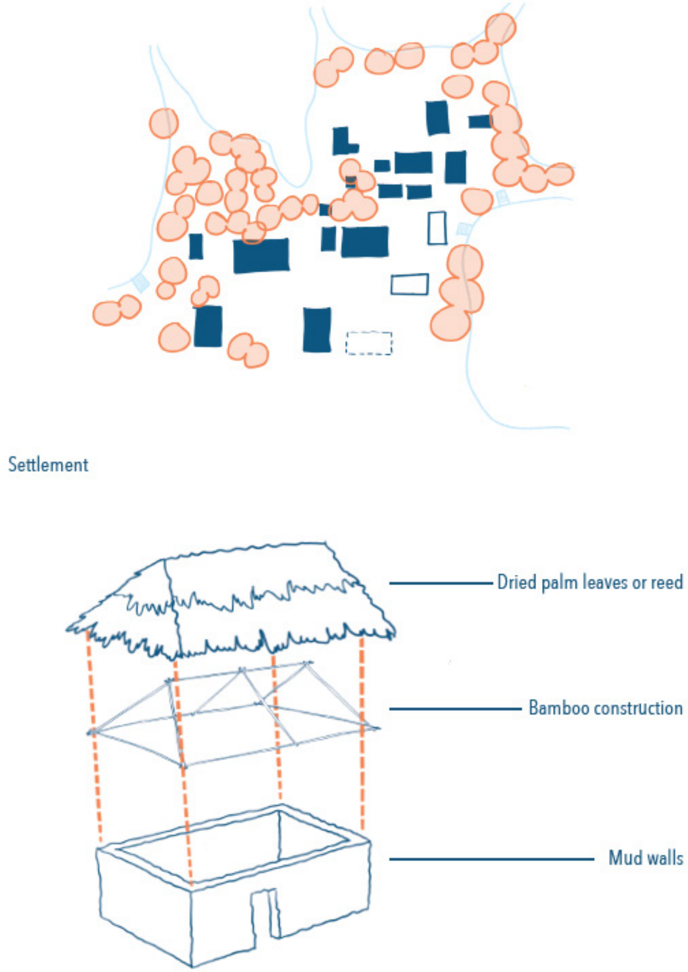


Fig. 38: The Bengali hut explained

The Khasi House

The Khasi people are an indigenous ethnic group in northeastern Bangladesh with distinctive cultural and architectural traditions. Historical records show that Khasi homes were originally situated near Punji settlements on hilly slopes, with houses aligned in parallel rows and interconnected by narrow village streets and steep stone steps. Settlements used a linear distribution of courtyards or streets accessible to all residents without predefined zoning regulations (Monzur, 2022).

Khasi houses typically feature a porch, a central room, and a retiring room, with fencing at the front. Thatched roofs and stilted designs, using bamboo or wooden stilts, are standard to protect against floods during the rainy season. Bamboo and wood are primary construction materials, emphasizing sustainability, while stone plinths sometimes provide structural support (Monzur, 2022).

Traditionally, Khasi architecture prioritizes natural materials like bamboo, wood, stones, mud, and clay or lime plaster. However, modern Khasi dwellings contain new building methods, with larger homes using alternative materials such as concrete and steel. Modern designs feature vibrant embellishments, colourful tiles, and enclosed spaces with glass elements, departing from traditional open designs (Monzur, 2022).

Fig. 39: A photo of a Kashi Settlement

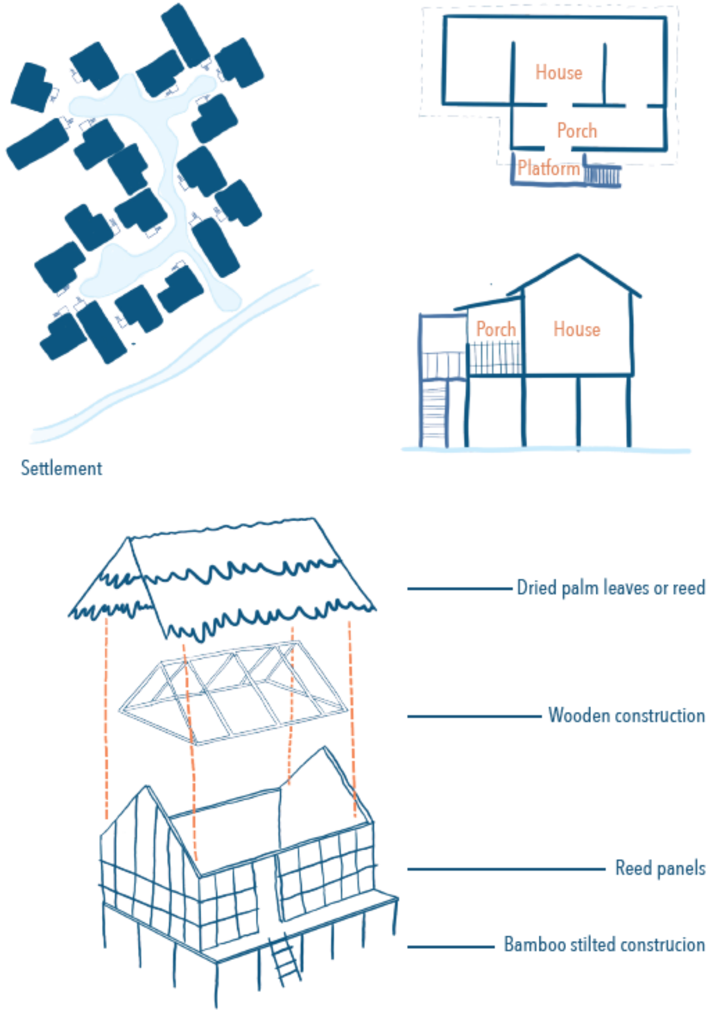


Fig. 40: The Kashi house explained

The Ikra house

The Ikra house is a traditional architectural style from Assam and neighbouring regions like Sylhet. It is designed to withstand the area's environmental challenges, including rainfall and high humidity. Its flexible design effectively serves residential purposes and provides some level of earthquake resistance (Das et al., 2014; Kakkad, 2008).

Traditional Assam-type houses reflect the values and style of the local people, showcasing their commitment to building without modern technology. These structures typically stand apart from neighbouring buildings, with dimensions ranging from 6 to 12 meters in length and 3 to 6 meters in width (Kaushik, 2009).

The pitched roof is integrated with parallel walls and is often covered with Ikra reed or metal sheets. Brick or stone walls, bamboo columns or wooden beams, and extensive use of Ikra reed for wall construction are mainly used as construction materials. The walls are coated with a mud-dung mixture or concrete and firmly attached to the foundation using steel angles, flats, bolts, and nails. This construction method emphasizes precise joinery between various elements for structural integrity. The lightweight construction and local materials used in Ikra houses contribute to their basic earthquake-safe design, making them resilient against natural disasters like earthquakes (Kaushik, 2009).

Fig. 41: A photo of an Ikra house

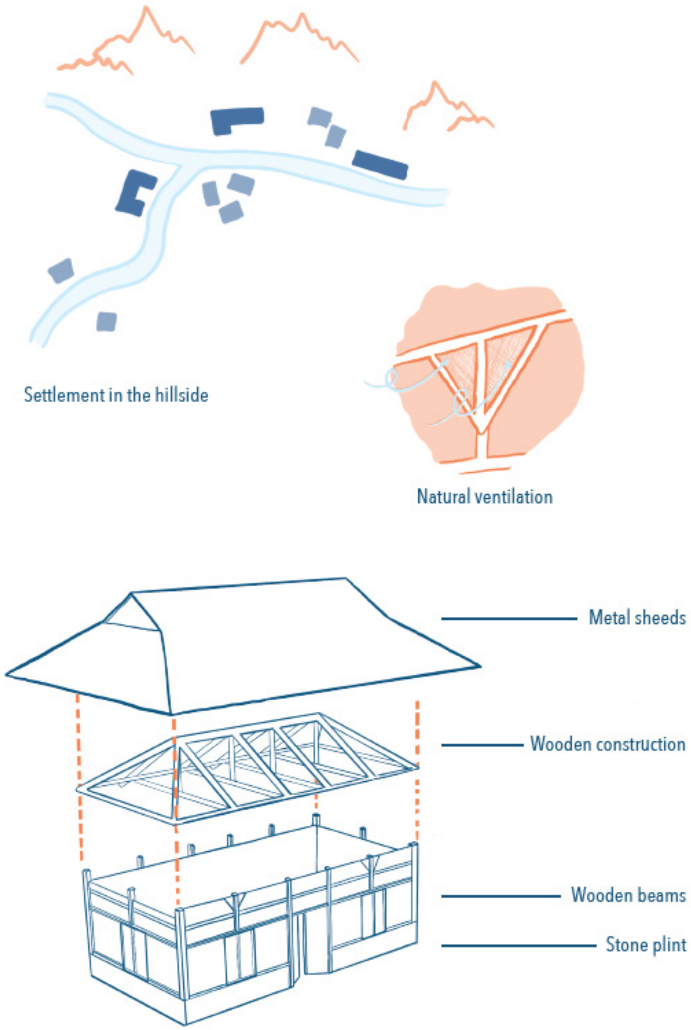


Fig. 42: The Ikra house explained

The Bangla Baton House

Historically, Sylhet saw significant emigration to England, integrating local and colonial influences in the architecture, producing "Bangla Baton," an urban residential style derived from Assamese traditions but adapted to local conditions and colonial influences (Saha et al., 2021).

Regular, symmetrical floor plans characterize Bangla Baton houses. Single-family residences typically adopt a rectangular I-shape layout, while multi-family homes may feature U, L, or C-shaped designs. The spatial organization divides the space into semi-private and private zones, with a buffer area serving as an inner court. The orientation is typically eastward, with access to semi-private zones through the outhouse and indirect access to private zones (Saha et al., 2021).

These single-story structures feature unique pitched roofs, allowing indoor and semi-outdoor spaces to share a single roof, resulting in taller profiles. Large projected roof overhangs and spacious shaded verandas provide extended shading, enhancing thermal properties and reflecting a sustainable approach. Initially, Bangla Baton structures incorporated timber frames and bamboo mesh plastered walls, later reinforced with iron angles for larger spans. Local artisans developed a modular system aligned with the region's topography, addressing earthquake vulnerability with base isolation and lightweight materials (Saha et al., 2021).

Fig. 43: A photo of a Bangla Baton house

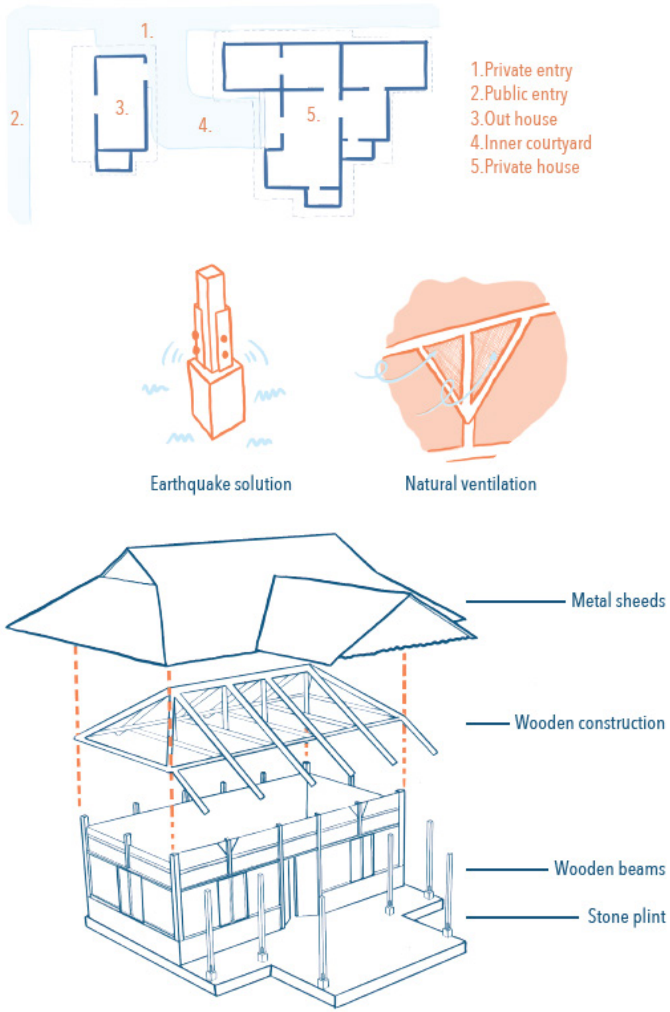


Fig. 44: The Bangla Baton house explained

Bricks
The demand for clay-fired bricks has increased in recent years due to industrial growth and rapid urbanization (Hassan, 2019). Despite the country's lack of natural stone aggregate, it has abundant clay and loamy soils and ample coal and wood for kiln firing. Initially, kilns could extract clay nearby, but overconsumption has necessitated mining from other areas (Hossain, 2019; Kieran, 2015).

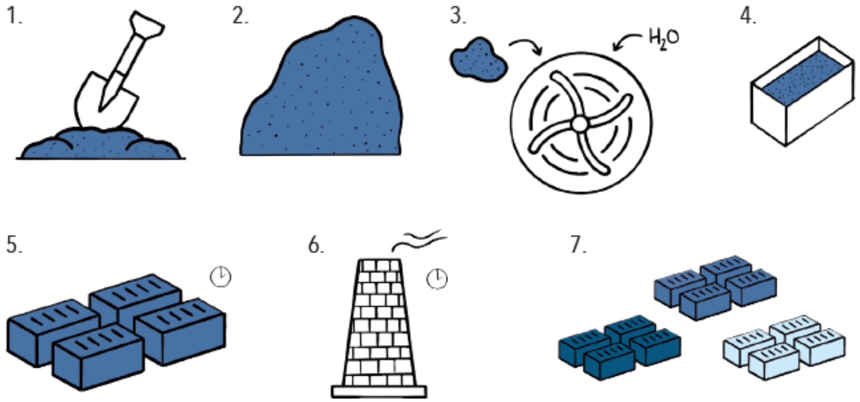


Fig. 45: Brick kiln production

Bamboo

Bamboo is extensively used in Bangladesh for construction, furniture, paper, and crafts, comprising over 70% of building materials. Despite susceptibility to fungi and bacteria, proper treatment can extend its lifespan to 20-30 years, making it suitable for earthquake-resistant housing (de Vries, 2002). Locally sourced bamboo is cost-effective, with more than 90% of yearly harvests used in construction. Its versatility is evident in various applications, from framework and stilts to floors, walls, and window screening, with weaving techniques allowing for diverse designs in partitions and window openings, balancing airflow and privacy (Ahrens, 2002).

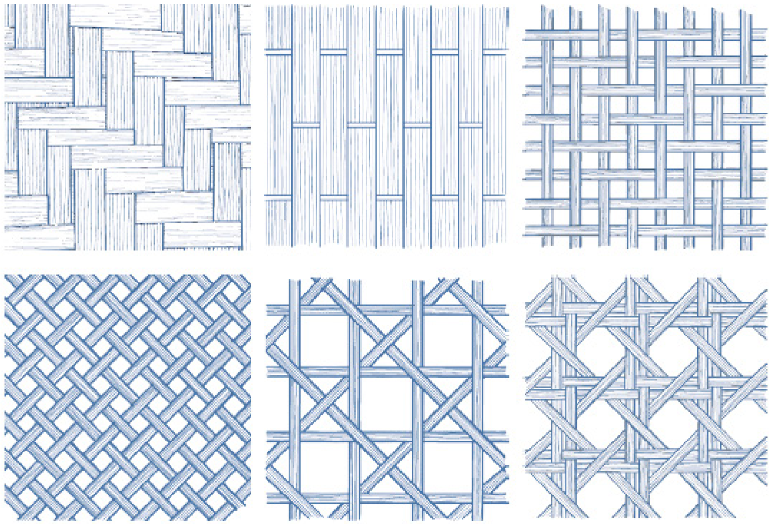


Fig. 46: Woven bamboo patterns

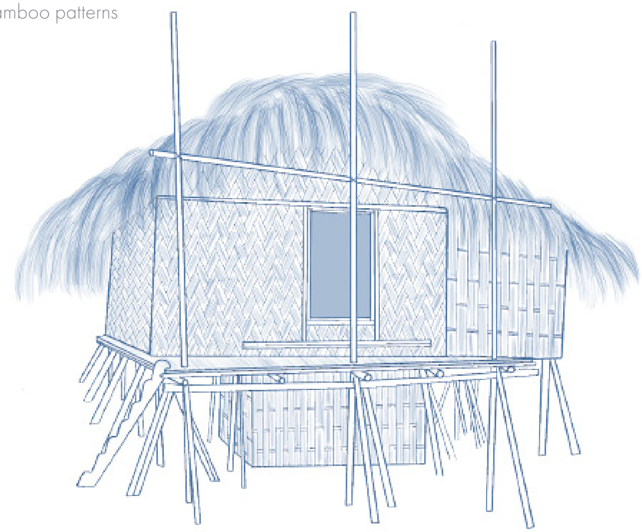
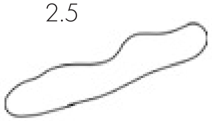


Fig. 47: Bamboo housing

	Village 1:	Village 2:	Village 3:	Project location:
Density:	900	200	650	900 approx.
Size (ha):	2.5	0.6	1.6	
Outline:				

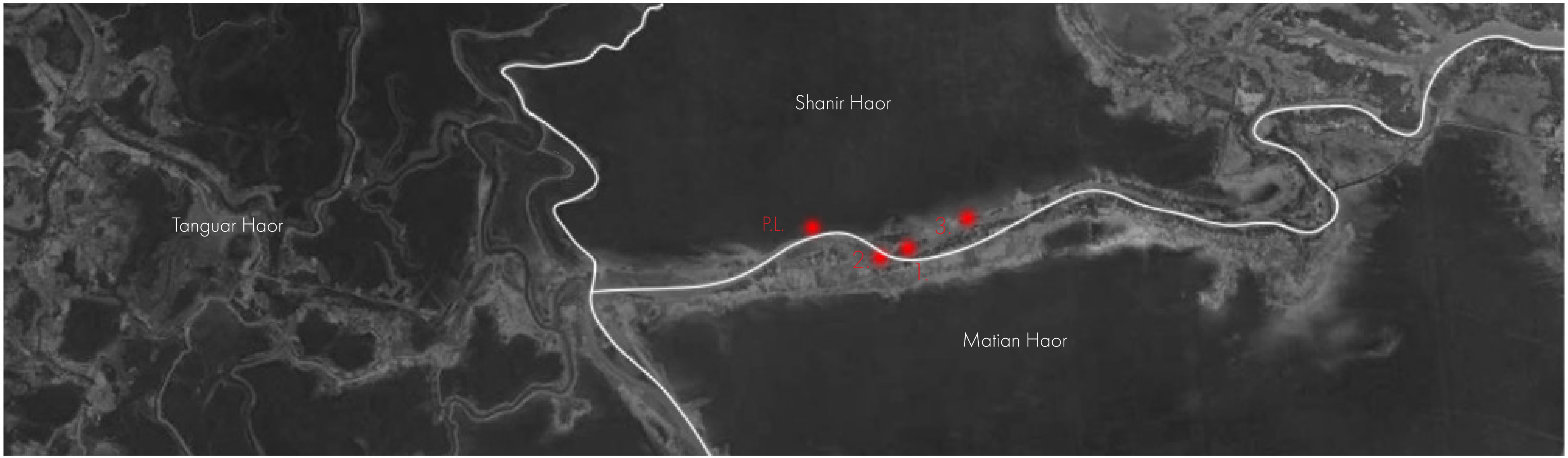
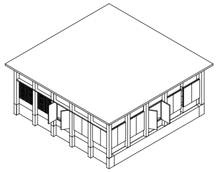


Fig. 48: Site analysis

Fig. 49: Location facilities

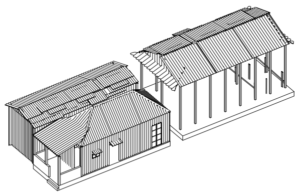
Site analysis village 1

Dwelling type 1



(Concrete/Brick)

Dwelling type 2



(Corrugated sheets/Bamboo)

Fig. 50: Construction materials

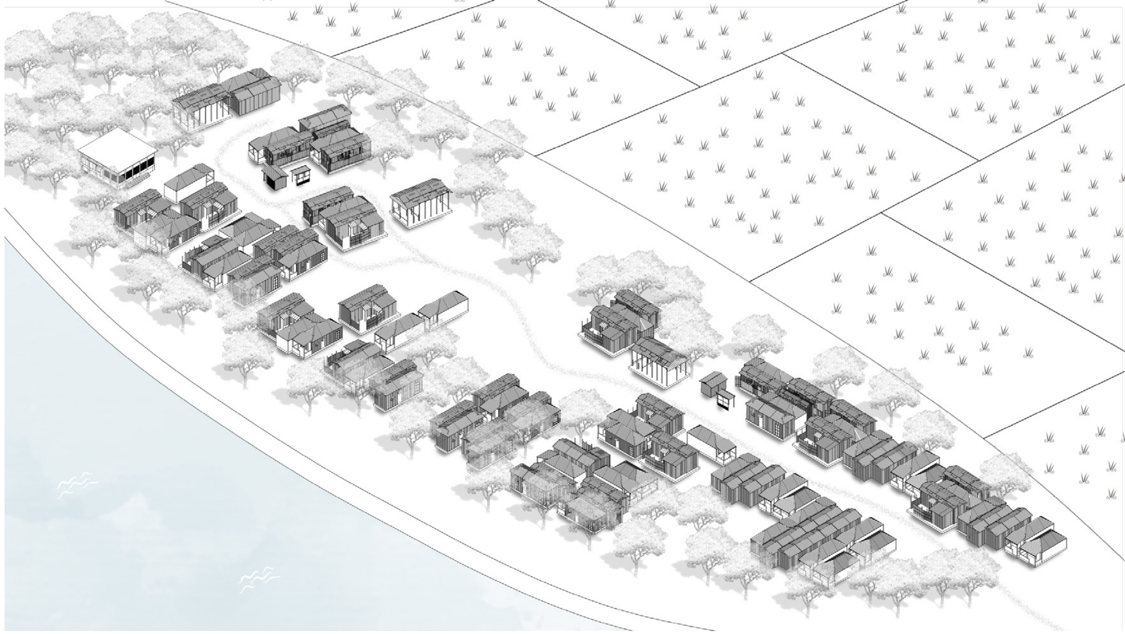


Fig. 51: Location current density

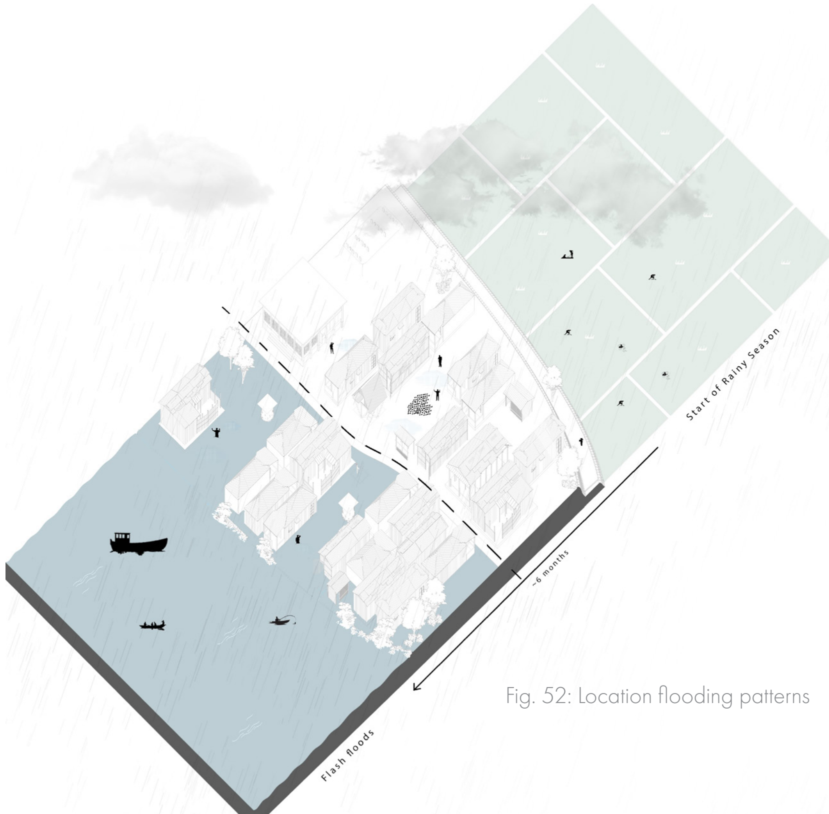
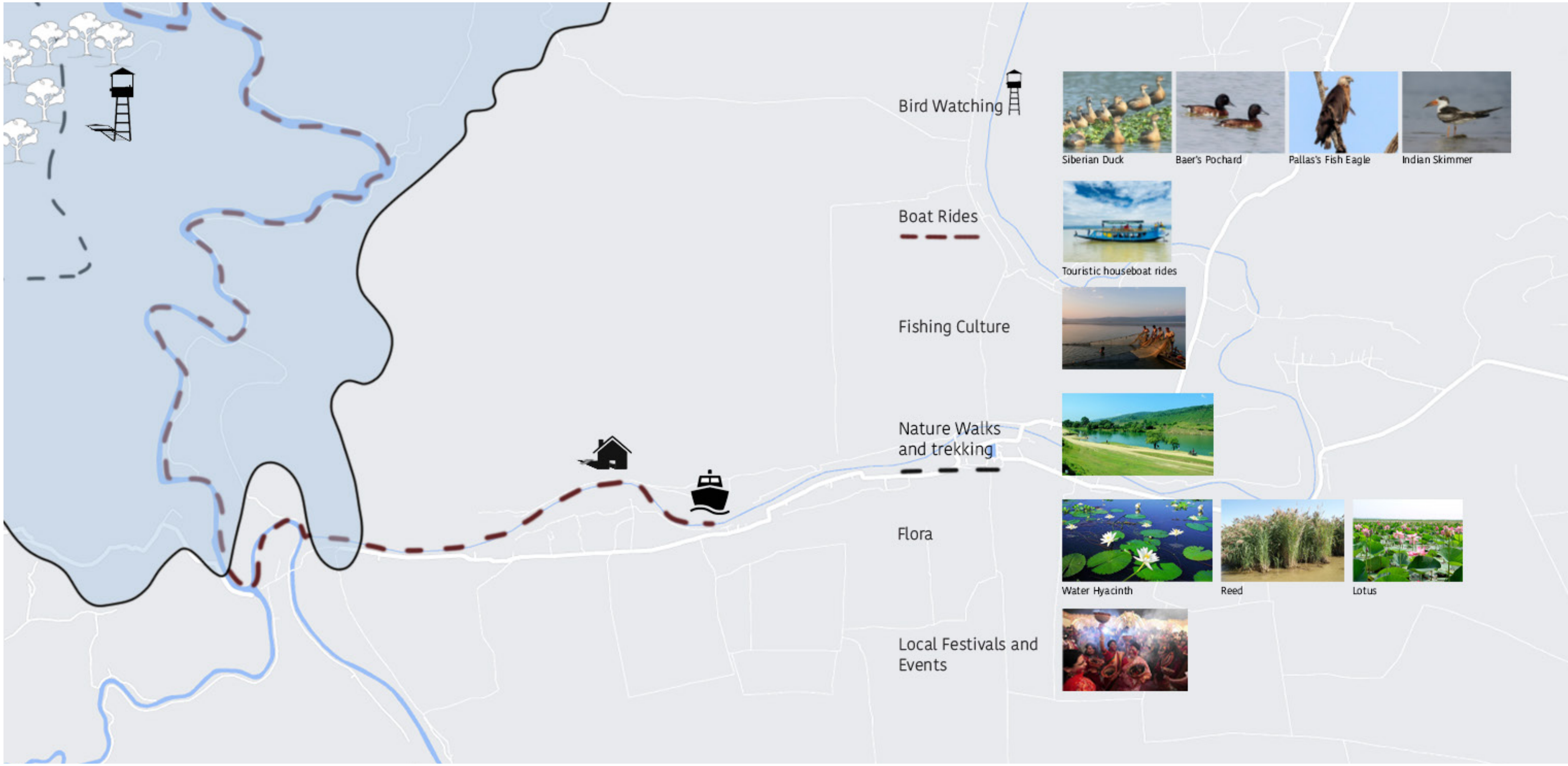


Fig. 52: Location flooding patterns



Tanguar Haor tourism is primarily seasonal, with most locals relying on the four-month monsoon tourist season for income. The high water levels create picturesque landscapes that draw many tourists, leading to a demand for boat tours and related services. During peak season, over 160 small transport boats and large houseboats are available daily. In the off-season, locals farm, fish, and duck rearing to earn a modest income (UNDP, n.d.).

Fig. 53: Tourism map Tanguar Haor

C. Ethnographic Research

Fig. 54: Site visit photo of local residents

Site Visit

On the 24th of October 2023, during our graduation trip to the villages near Tahirpur in Tanguar Haor, Bangladesh, we could walk through the densely built settlements.

Walking through the villages, we encountered many closely built houses. The narrow pathways between the structures created a maze-like environment full of activity and colour. This construction resulted from the limited land available in the area. Despite the density, the villagers ingeniously used every available space.

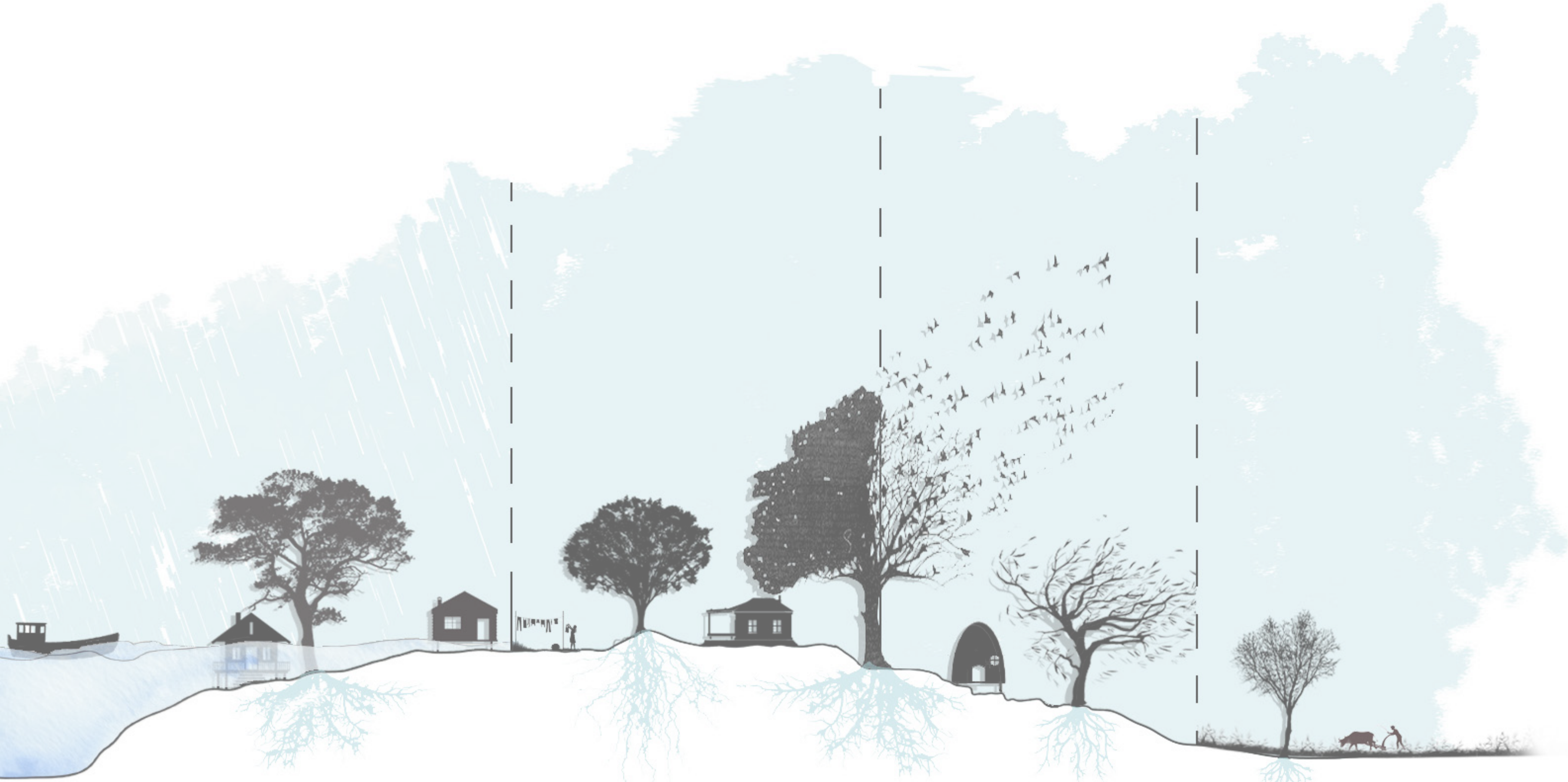
Despite the densely built environment, the villages retained a vibrant and lively atmosphere. Children played in the narrow streets while adults did their daily chores.

Our visit to these villages offered us a glimpse into the resilience and resourcefulness of the local communities, which had held on in the face of geographical constraints.

As we continued our visit to the villages, we admired the ingenuity and warmth of the people we encountered, leaving us with a great appreciation for the richness of rural life in Bangladesh.

Fig. 55: Photo collection of site visit Tanguar Haor

Resilient Waters:
A Design for all Seasons



03 **Design Proposal**

a. Design Approach & Principles

This design aims to tackle the challenges of climate change and promote community sustainability in similar environments, focusing on resilience, modularity, self-reliance, and vernacular architecture by answering the research question:

How can innovative, resilient rural design be integrated with preserving vernacular architecture to enable the Haor region in Sylhet Division, Bangladesh, to adapt to rising waters and ecological changes while safeguarding its unique cultural and architectural identity in the face of climate change challenges?

Resilient Housing

Design with Nature

Resilient housing is at the centre of this design, incorporating innovative amphibious architecture. Each dwelling is carefully designed to adapt to the changing water levels, providing shelter amidst nature's unpredictability.

Modular Housing

Flexibility

Modular housing is another aspect of this approach. By using modular construction techniques, we ensure flexibility and scalability in building homes. Residents can customise and expand their living spaces over time, fostering a sense of ownership and empowerment within the community.

Self-Reliant Community

Design for People

Central to this vision is the cultivation of a self-reliant community. Traditional practices inspire this design and promote sustainability through rainwater harvesting and food production. These elements integrate into daily life, entrusting residents to minimise environmental impact and widens resilience against external challenges.

Vernacular Architecture

Local and Traditional

This design embraces the region's vernacular architecture. From stilted houses to the use of local materials, most details reflect traditional building practices. This connection to the past fosters a sense of belonging and continuity within the community. As the project unfolds, it shows innovation and respect for nature. Rooted in resilience, modularity, self-reliance, and vernacular knowledge, it offers a possibility of a future where humans and the environment can coexist, enabling sustainable living that lasts for future generations.

Target Groups

The people living in and around Tanguar Haor depend on its resources for their livelihoods, including fishermen, farmers, and artisans. Designing for their needs could involve providing sustainable housing, infrastructure for fishing and agriculture, and facilities for community gatherings and cultural activities.

Tanguar Haor can attract tourists interested in its unique wetland ecosystem. Designing infrastructure for eco-tourism, such as accommodations, guided tours, and recreational activities, could attract this group.

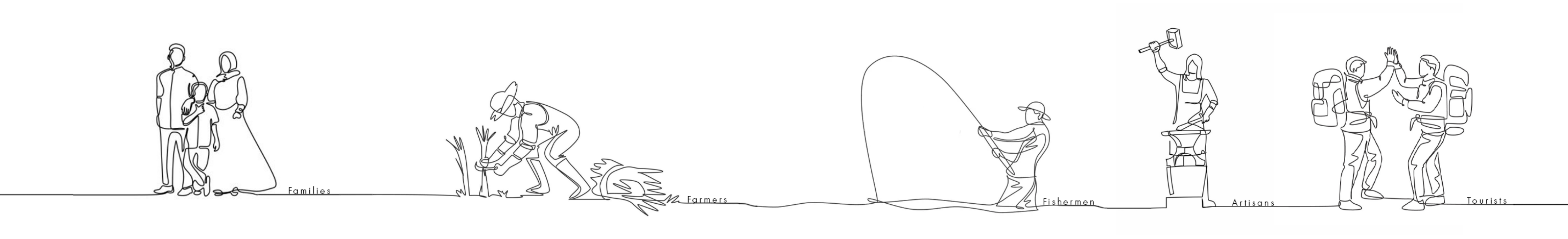


Fig. 56: Target groups

Program of Requirements

Resilience
- Ability to adapt to extreme natural conditions
- Implementation of robust infrastructure and architectural designs to withstand floods and other environmental challenges

Flexibility
- Easily expandable for residents
- Modular design approach allowing for incremental development and scalability

Housing
- Circa 170 (at least 60% of floating plots)
- Variability in housing types to accomodate diverse socioeconomic backgrounds

Community space
- Designated areas for social gatherings, cultural activities and events
- Promote social cohesion and inclusivity within the community

Educational facility
- Learning Centre accessible for all young age groups

Marketplace
- Provision of space for a local market to facilitate commerce and economic activity
- Encourage entrepeneurship and local trade for a self-sustaining economy

Sustainable food production
- Allocation of areas for agriculture, aquaculture, and other sustainable food production methods

Waste management system
- Implemt eco-friendly waste management solutions, including recycling and composting, to minimize environmental impact

Water supply and sanitation
- Ensure access to clean water and sanitation facilities, possibly through rainwater harvesting

Recreactional spaces
- Include spaces for recreational activities, like community gardens, playgrounds

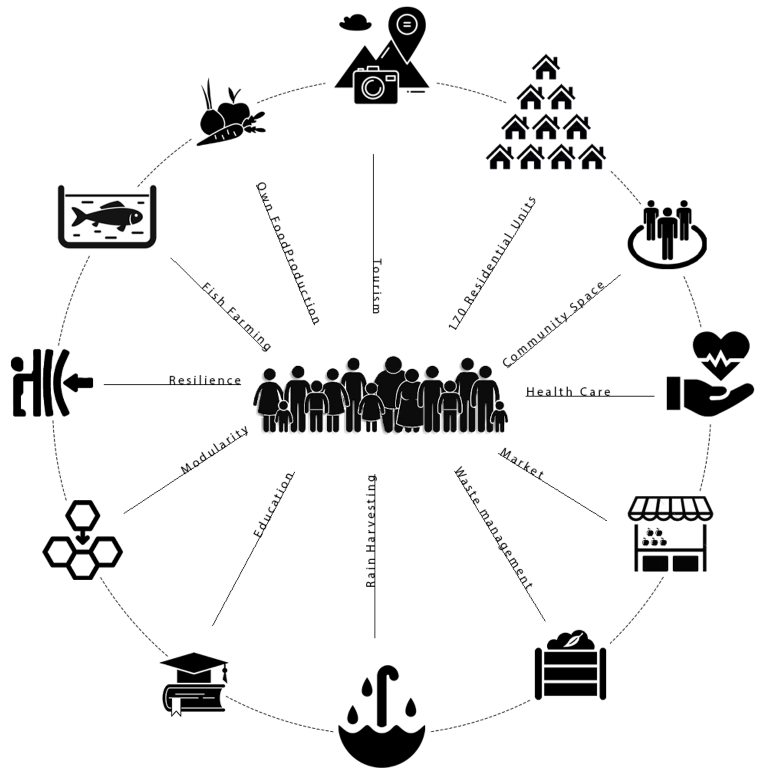


Fig. 57: Program of Requirements

In designing sustainable housing for Tanguar Haor, Bangladesh, the DCBA methodology used by Lasarati (2007) has served as a guiding framework to ensure that the outcome aligns with sustainability principles and meets the needs of future inhabitants. This methodology considers various aspects such as design, cost, benefit, and acceptance to evaluate the effectiveness of the design in achieving sustainability goals.

Given that this design is not to be realized and is situated in a different context, it is important to draw upon the highest-ranking scenarios identified through the DCBA method as benchmarks and adapt them to fit the current context of Tanguar Haor. By using these top-ranking situations as guidelines, I aim to create a project that optimally caters to the day-to-day lives of future dwellers, ensuring that their domestic environment is sustainable and helping their well-being and satisfaction. Through this approach, I try to develop a housing solution that not only meets the immediate needs of its inhabitants but also fosters long-term resilience and balance with the surrounding environment.

Fig. 58: Scoring cards

Own food production

Natural ventilation

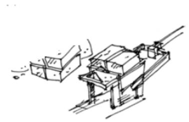
Own house assembly

Reduce non constructive elements

Regular maintenance

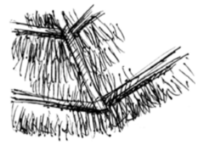
Sustainable & organic materials

Fig. 59: Scoring cards pt. 2



Lightweight materials

Local bamboo



Local thatcges

Grow/make own materials

Water harvesting

Affordable housing

Fig. 60: Scoring cards pt. 3

b. Architecture

The design of 'Resilient Waters' is used as an instrument to answer the research question to the fullest. Making a design based on comparative analysis research and considering all the aspects of the contextual analysis could give any design. Many more experiments and explorations have to be carried out, giving more depth to the research carried for the research question: 'How can innovative, resilient rural design be integrated with preserving vernacular architecture to enable the Haor region in Sylhet Division, Bangladesh, to adapt to rising waters and ecological changes while safeguarding its unique cultural and architectural identity in the face of climate change challenges?'

In consideration of the scale of the chosen site plan and the limited amount of design time, an effort has been made to focus on the main aspects that would give a considerate answer to the research question. Public amenities have thus been left to a basic form and structure, given that this only adds so much value to the chosen research than the dwelling design already does.

Fig. 61: Design impression from Rakti River

1. Site level

In pursuing sustainable housing, a comprehensive approach has been adopted to address the challenges and opportunities of the region's dynamic landscape. Integrating innovative design principles with understanding local environmental factors and community aspirations stands central.

The dwelling landscape is divided into stilt houses on elevated terrain and amphibious dwellings clustered along the water's edge. Stilt houses, strategically situated on higher ground, provide a stable refuge amidst seasonal floods. An axis lies through the stilt cluster, promoting community interaction.

Bordering the paddy fields lie clusters of amphibious dwellings designed to adapt to changing water levels. These homes embody flexibility and sustainability. At the centre of the amphibious cluster, residents find essential public amenities and floating vegetable gardens, promoting self-reliance and prosperity during monsoon seasons.

Fig. 62: Masterplan - Winter situation

Central Community Hub:
Centrally located within the community, a hub hosting essential amenities, including a market, a school, a mosque, and a park. This vibrant space is central to social gatherings, economic exchanges, and cultural celebrations. Here, residents connect to daily rituals and communal activities, enabling a sense of belonging and cohesion.

Sustainable Practices:
Sustainability and preserving the natural environment are central to the design. From integrating floating vegetable gardens to harvesting rainwater, every aspect of the design reflects a commitment to environmental protection. By using the region's resources and embracing eco-friendly solutions, the aim is to create a living environment that sustains the resident's lives.

Fig. 63: Masterplan - Summer situation

Site activities

Image 1 - Amphibious Cluster:
Residents of the amphibious cluster begin their day by engaging in various activities. Some are seen tending to their floating vegetable gardens, nurturing crops that provide food during the monsoon season. Others gather by the water's edge, engaging in conversation and communal tasks, fostering community within the cluster.

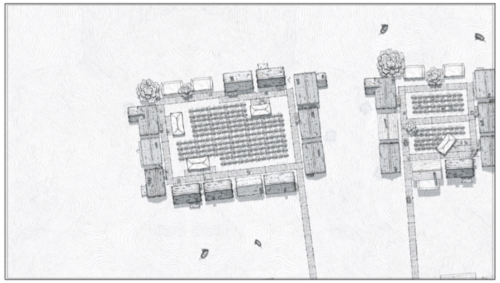
Image 2 - Walking Through the Stilt Cluster:
Residents can walk through the axis or take the public road next to the river.

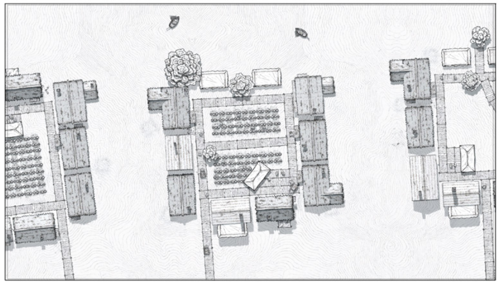
Image 3-4 - Green Axis:
Residents continue along the green axis in public spaces filled with native flora. Here, they can pause to appreciate the beauty of their surroundings and converse with neighbours in the green clusters. The axis serves to connect residents to various amenities and foster a sense of connectivity within the community. Adults tend to the communal gardens, cultivating fresh vegetables. Main Road Next to the River: By crossing the main road next to the river, residents walk towards the centre of the community where the school, market and mosque are located. At the market, vendors sell fresh products, handmade goods, and other local products, attracting shoppers from surrounding villages. The market serves as a hub of activity, attracting tourists and allowing residents to come together to shop, socialize, and support local businesses.

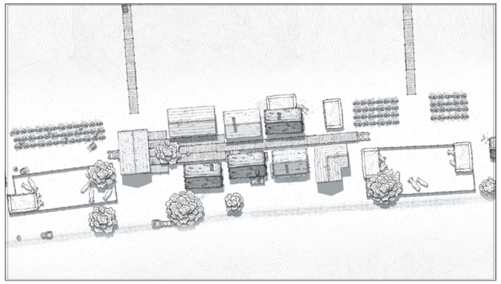
Image 5 - School:
The playground is filled with children. This fundamental community facility provides children opportunities for growth, development, and social interaction.

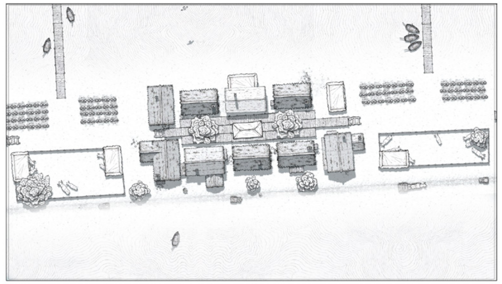
Image 6 - Market:
The market is filled with activity as residents browse the stalls, buying goods. It offers a selection of items, from fresh fruits and vegetables to handmade crafts and artisanal goods.

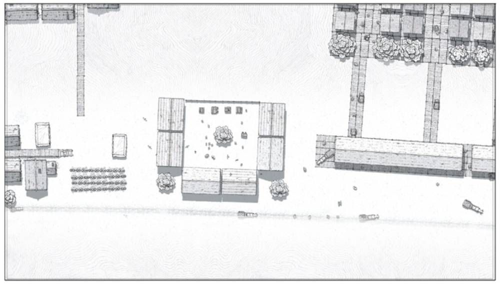
Image 7-8 - Taking Goods to Market:
Residents are seen carrying their purchases from the market, their arms loaded with bags and baskets filled with supplies. During this monsoon period, the floating market permits residents to bring goods by boat.

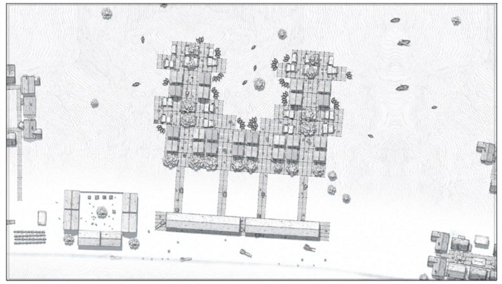

1. Amphibious cluster 10 dwellings

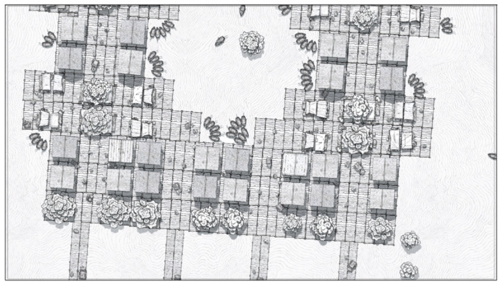

2. Amphibious cluster 8 dwellings


3. Stilt cluster 7 dwellings


4. Stilt cluster 9 dwellings


5. School


6. School & Floating market


7. Market activities

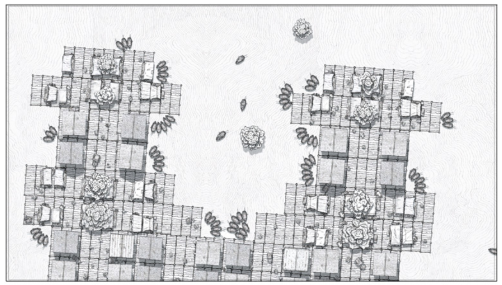

8. Market activities & transport

Fig. 64: Masterplan activities

The formation of the masterplan follows specific rules established to create a coherent design. First, the plot sizes have been carefully considered. A standard-built house has a living area of 20m². This plan allows inhabitants to expand their living areas while maintaining a comfortable distance from their neighbours. Therefore, corner plots are sized at 10m x 12.5m, and side plots are 10m x 10m. At the centre of the amphibious cluster are private floating vegetable gardens accessible to the surrounding houses, fostering a sense of community and self-sufficiency.

Fig. 65: Masterplan: Plot limitations

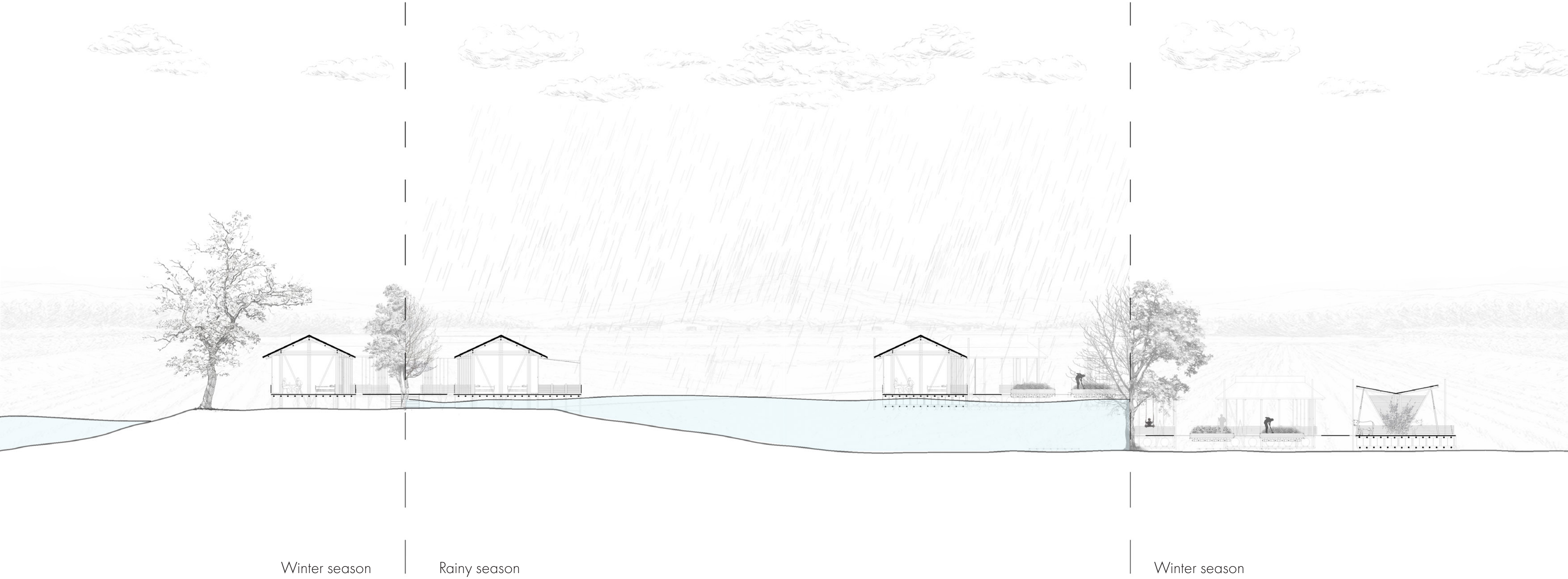


Fig. 66: Layout amphibious & stilts: Section 1:200

2. Public Amenities

Local effects:

Economic development
Social development
Environmental sustainability
Source of income and information
Provides tourist facility
Awareness about local culture and environment

Tourist effects:

Creates awareness
Ensures better facility and Safety
Share information
Gather experience
Spends money

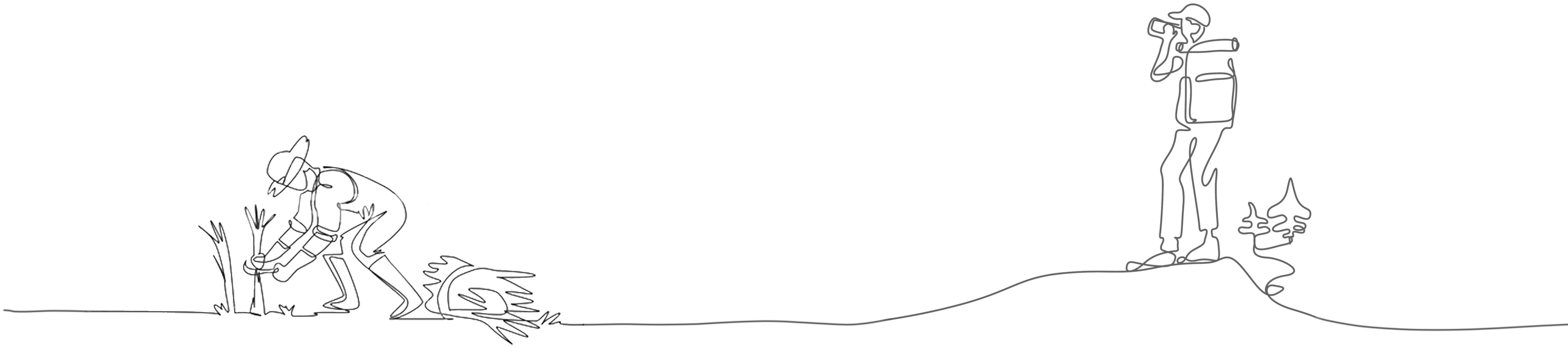


Fig. 67: Tourism effects

Fig. 68: Public funtions

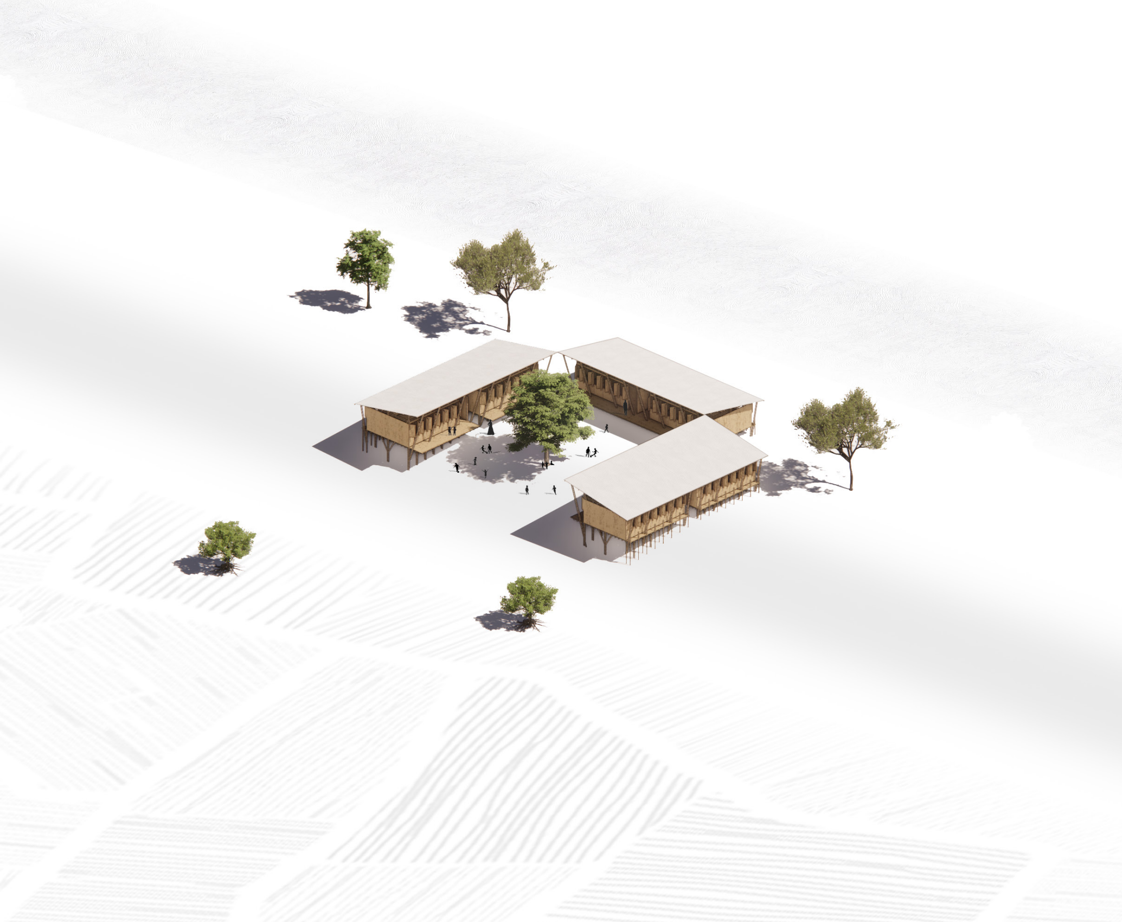


Fig. 69: School proposal

"There is a big change in the landscape. Water is one of them. We must divise a strategy for that future. I'm not saying we have a solution here. But we have a thinking that has been initiated. Let's find out how we can develop a response to that condition."

"This particular place opens the childrens imagination to the experience of nature and learning from nature I think is very important when you grow up as a child."

- Saif Ul Haque Sthapati

Community: Education

The school within this floating community in Bangladesh plays a crucial role in shaping the residents' future. With an estimated 172 children requiring access to education, the school is designed to accommodate their needs and aspirations.

The school, containing six classrooms, each with a capacity of 30 children, is equipped to educate every student within the community. In addition to the classrooms, the school includes administrative offices, restrooms, and a spacious courtyard.

Built on stilts, the school embodies the same forward-thinking approach as the dwellings. Recognizing the challenges posed by rising tides and fluctuating water levels, the school is divided into six separate buildings, and its foundation has been designed for adaptability. The intention is to future-proof the school by enabling it to be retrofitted into an amphibious structure when needed. This approach ensures that the school remains resilient and functional in the face of environmental changes, safeguarding access to education.

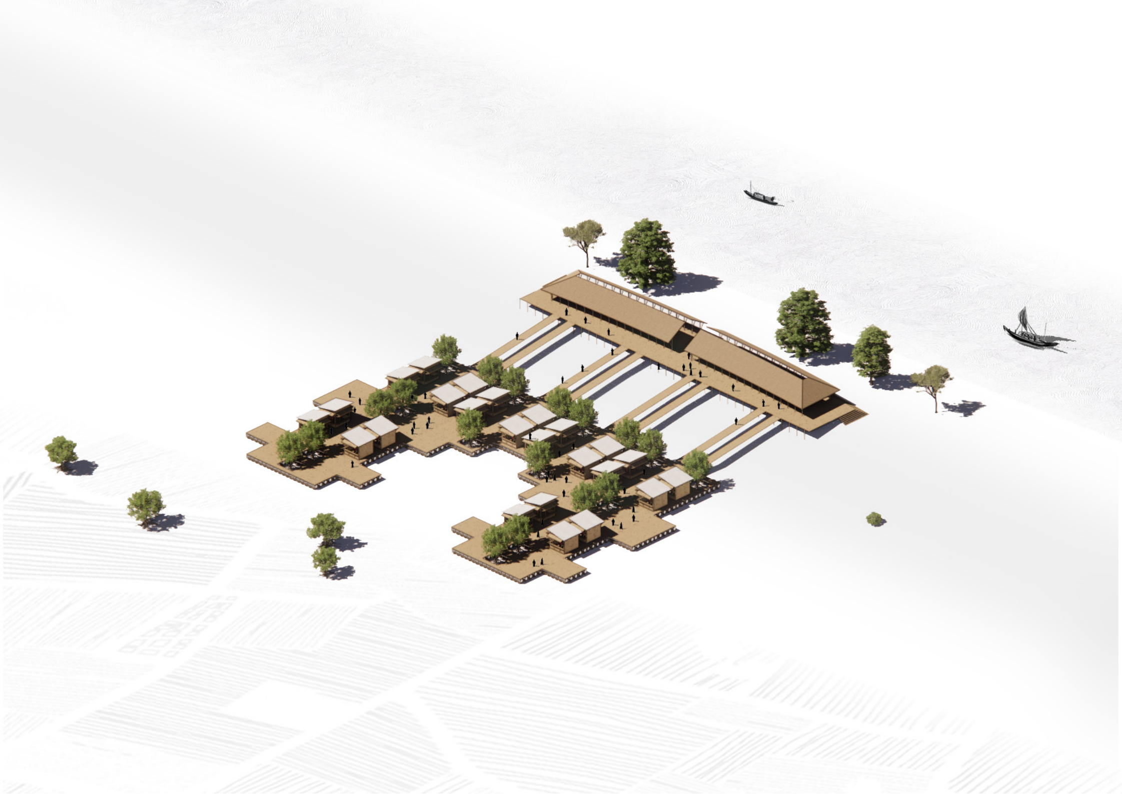


Fig. 70: Amphibious market proposal

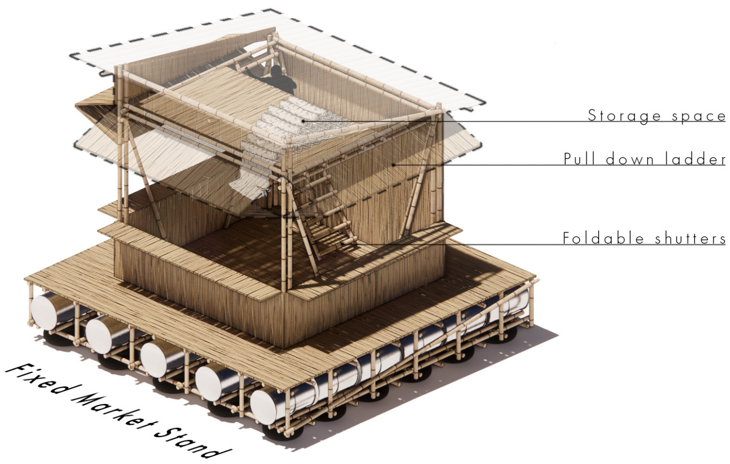


Fig. 71: Amphibious market stand

Community: Amphibious IV

Fig. 72: Amphibious market modular parts

Fig. 73: Mosque proposal

Fig. 74: Mosque impression

3. Cluster level

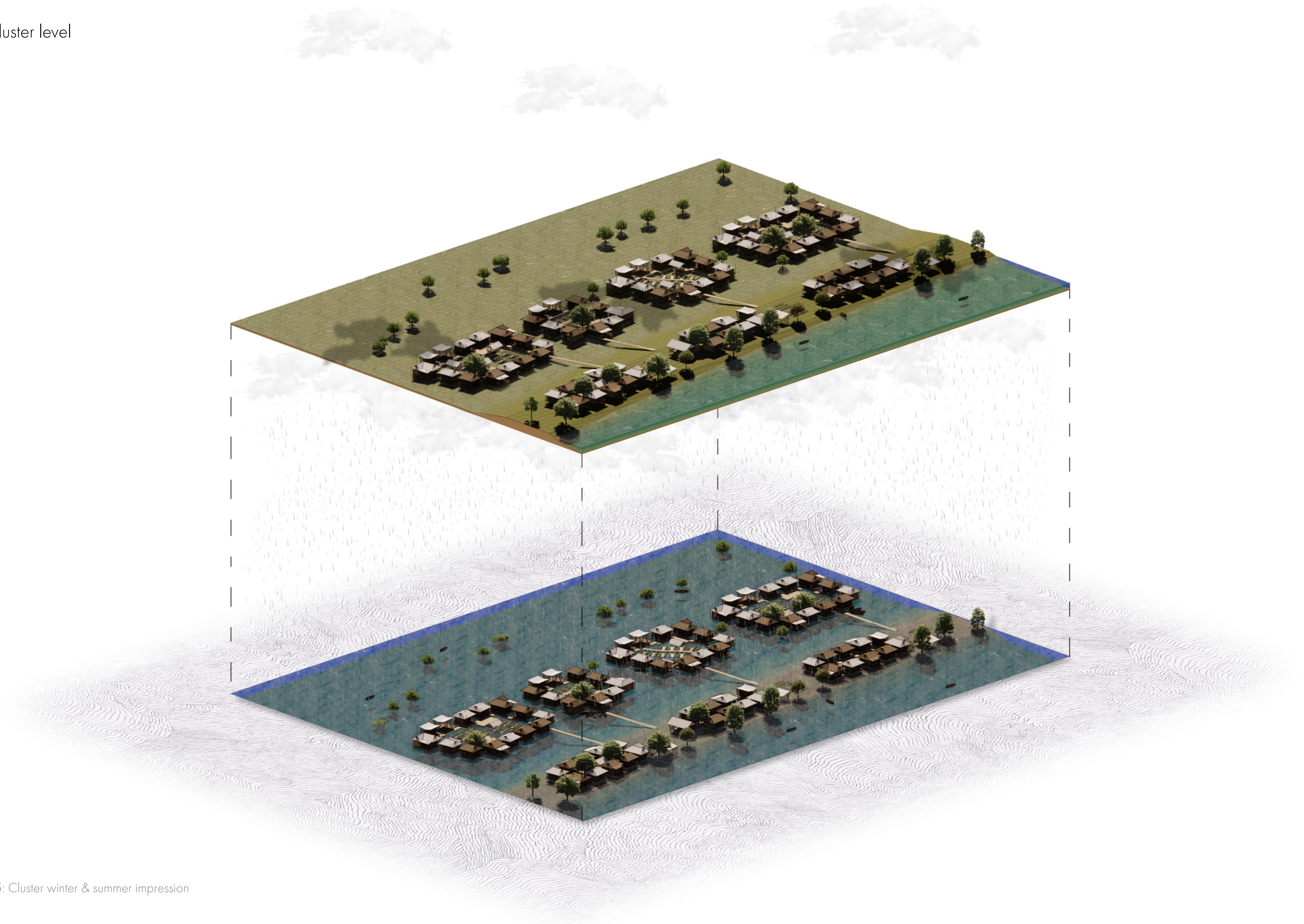


Fig. 75: Cluster winter & summer impression

One of the houses in the floating cluster is used as tourist accommodation. During the monsoon, floating helophyte filters are used on the side of the toilets. The amphibious cluster is also equipped with stables, which can be expanded during the dry season. The stables on dry land are built so the animals have enough free space to roam.

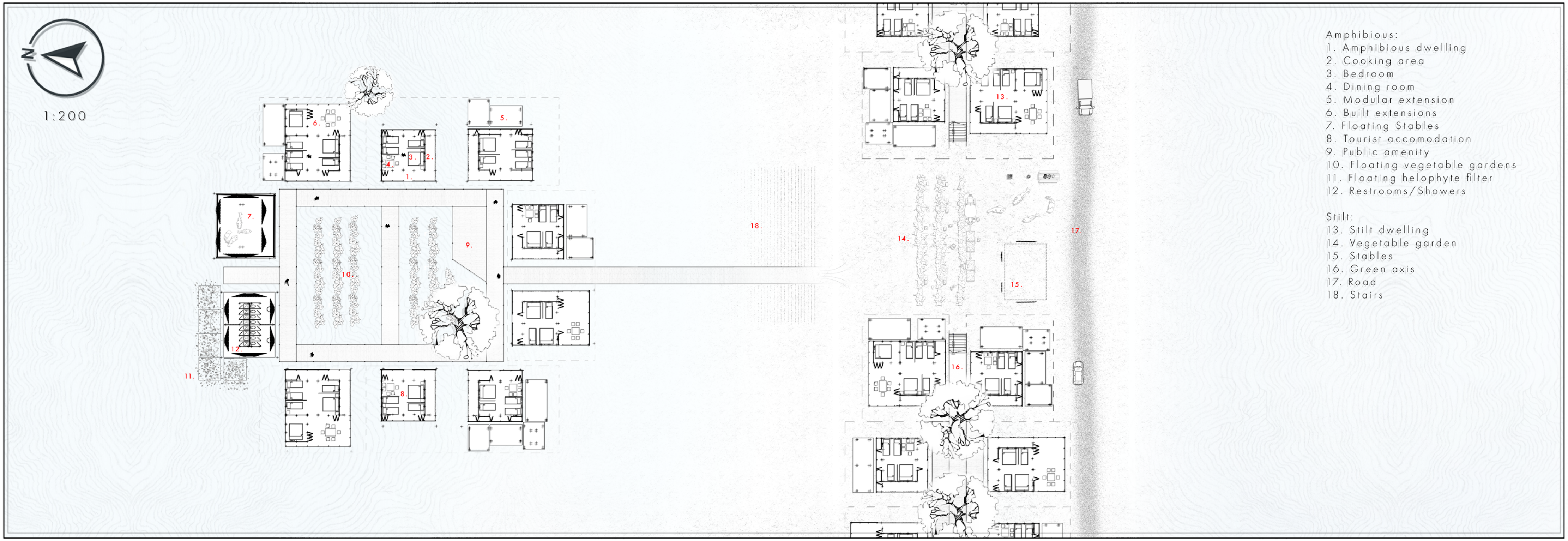


Fig. 76: Floorplan

Fig. 77: Stairs impression

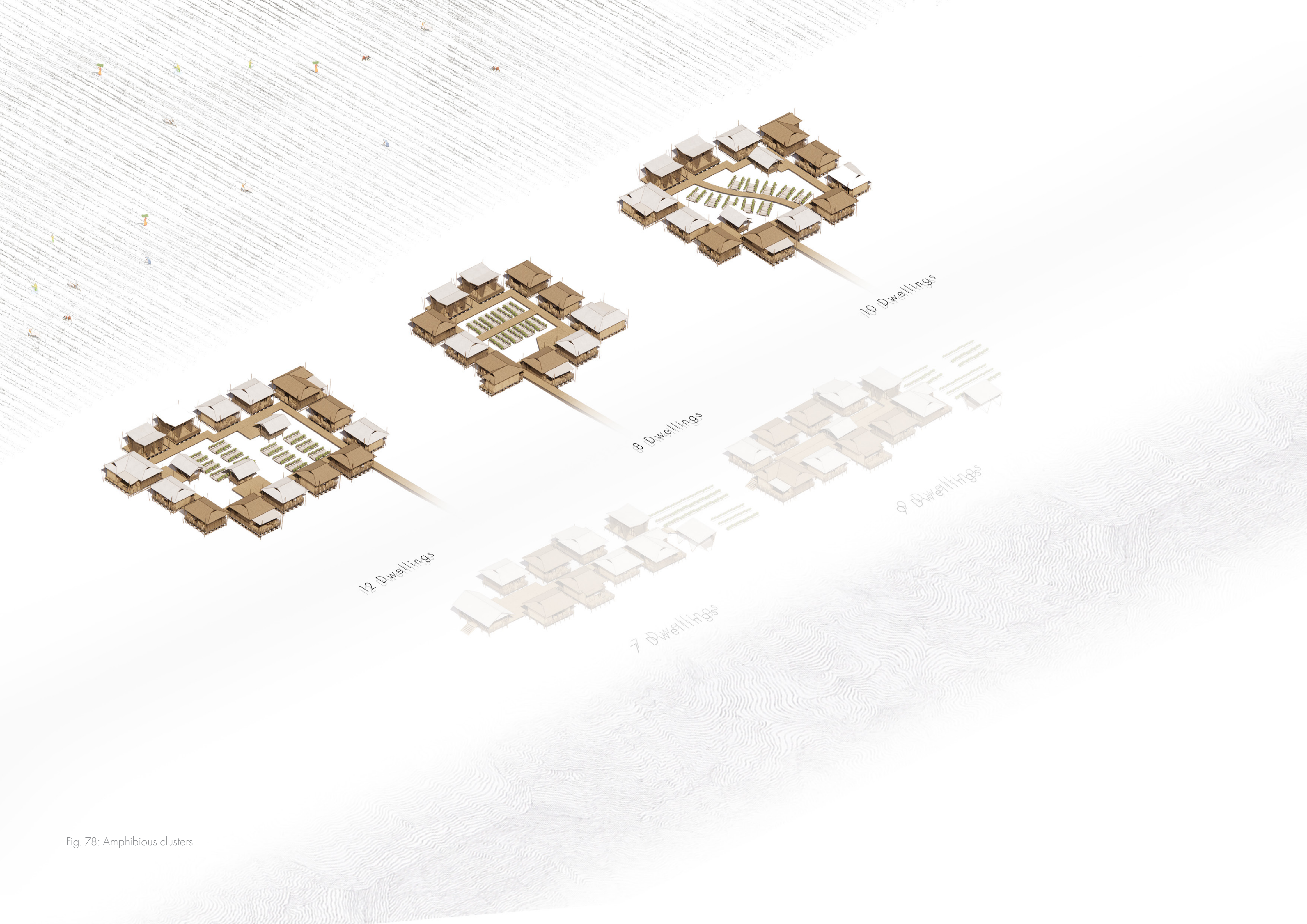


Fig. 78: Amphibious clusters

Fig. 79: Amphibious cluster impression

Fig. 80: Amphibious dwellings impression

Fig. 81: Amphibious dwellings impression

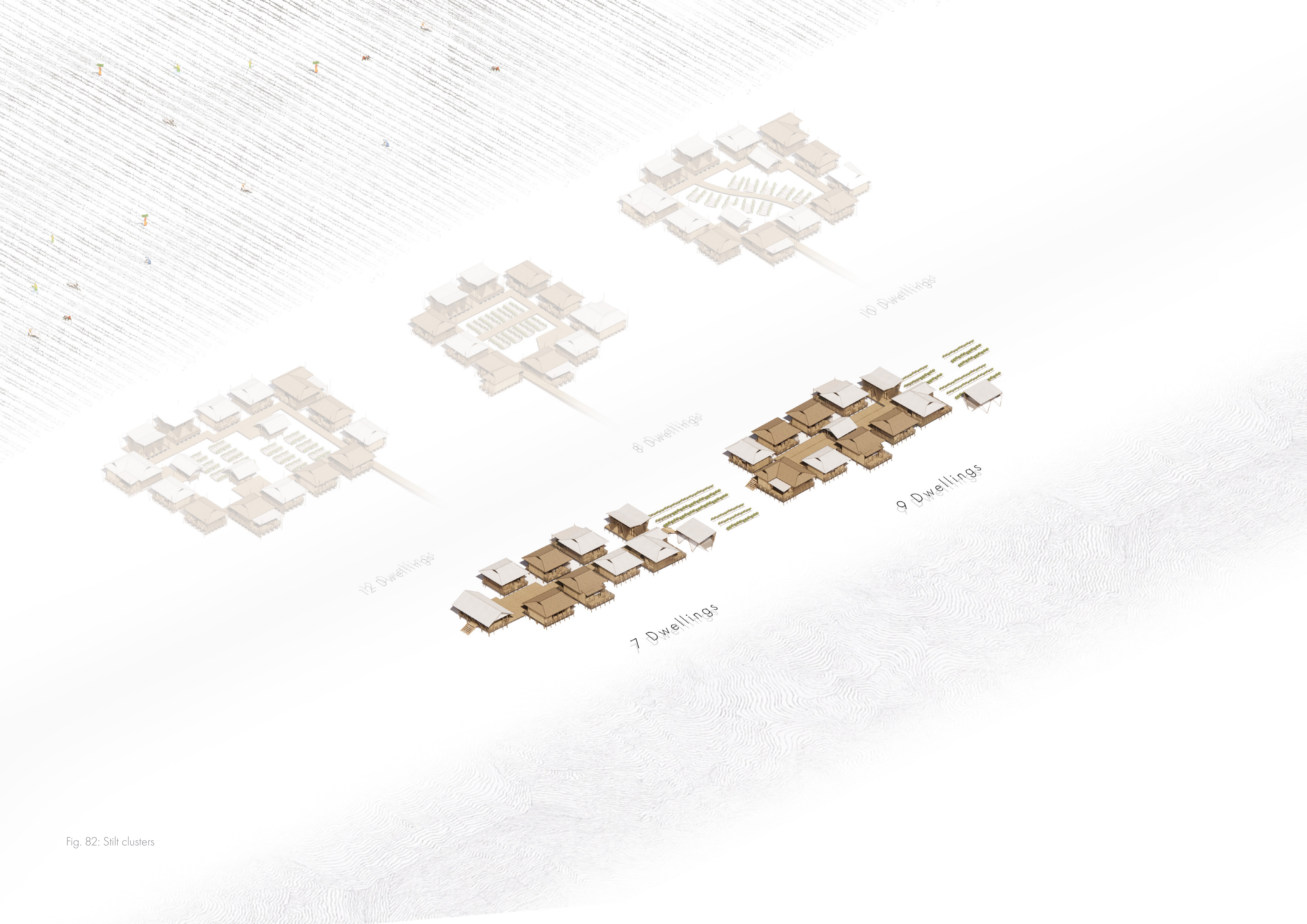


Fig. 82: Stilt clusters

Fig. 83: Stilt clusters seen from Rakti River

Fig. 84: Life in a stilt cluster

Fig. 85: Life in a stilt cluster

4. Dwelling level

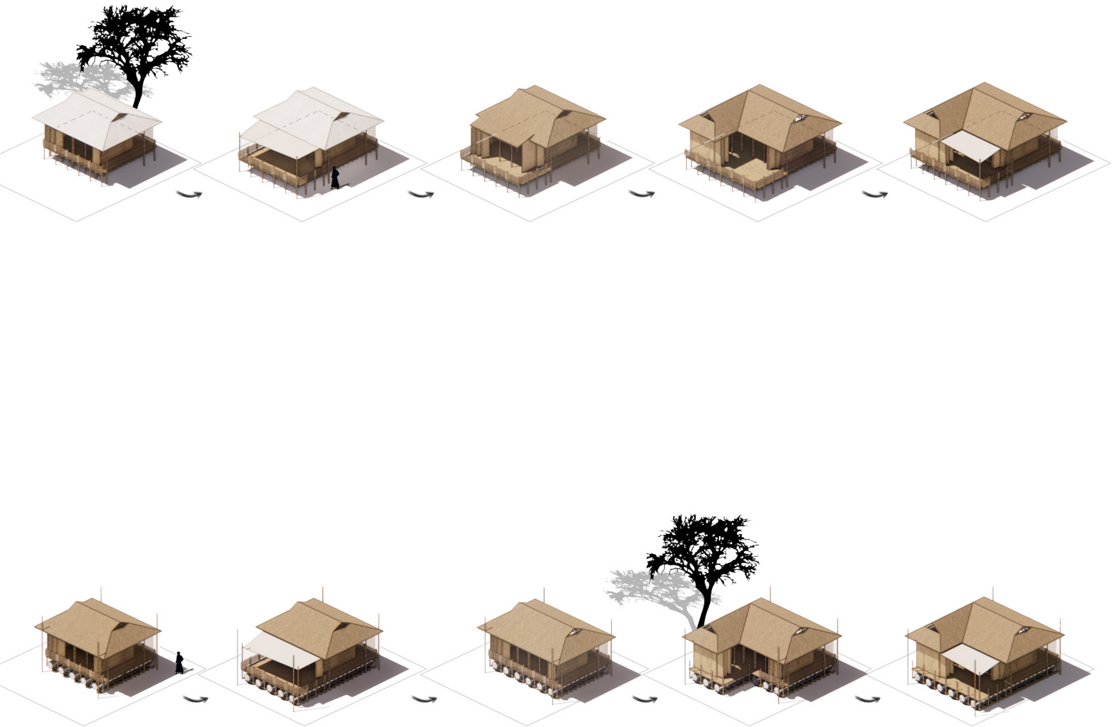


Fig. 86: Amphibious/Stilt expansion variations

In this innovative design concept, flexibility and modularity are fundamental principles forming the dwellings. Residents start by acquiring a standard house unit, which acts as the initial framework for their dwelling. These units are intentionally designed with simplicity and practicality in mind, enabling residents to construct their homes independently.

Once the core house structure is established, residents can expand their homes while keeping it as one cohesive unit. Through thoughtful planning, residents can integrate additional rooms, floors, or amenities, broadening the functionality and livability of their homes. This expansion process allows residents to adapt living spaces to suit their changing needs and preferences while maintaining the original house unit. This model promotes individual autonomy and encourages creative expression within the limits of their plot size in home design by allowing residents to expand their homes.

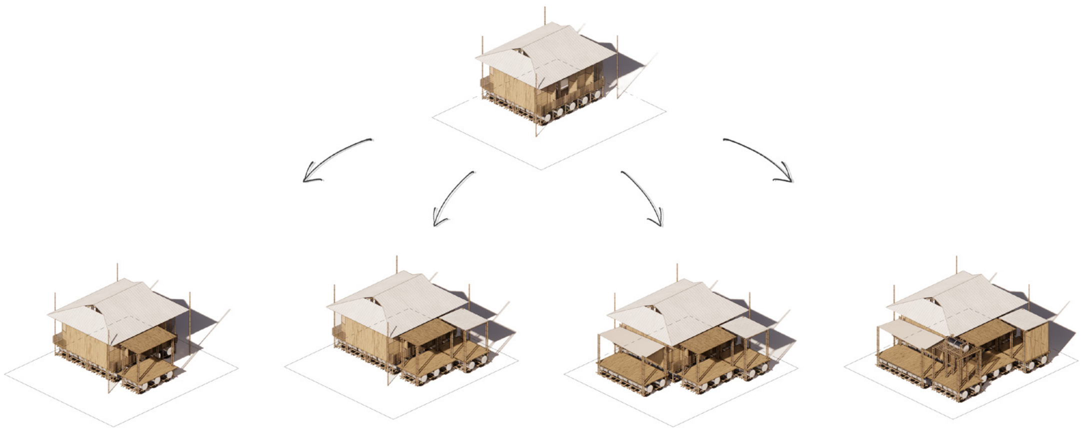
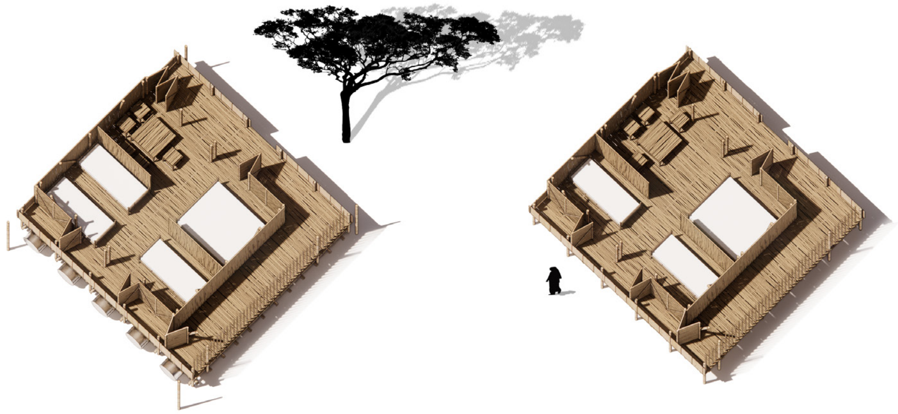


Fig. 87: Amphibious additions variations

In addition to expanding their houses while keeping them as one unit, residents can add small modular parts in a more flexible and adaptable manner. Through a system of modular extensions and add-ons, residents can integrate additional rooms, floors, or amenities, such as an extra water tank, into their homes, tailoring them to suit their evolving needs and preferences. This modular approach allows for greater flexibility and customization, entrusting residents to adapt their living spaces according to changing circumstances or preferences. By providing residents with multiple options for expanding their homes, this model promotes versatility and encourages residents to engage in the evolution of their living environment actively.



Unit Variation:	1.1.	2.1.
Size (m²):	20	20
Capacity:	5	6

Fig. 88: Base dwelling floorplan suggestions

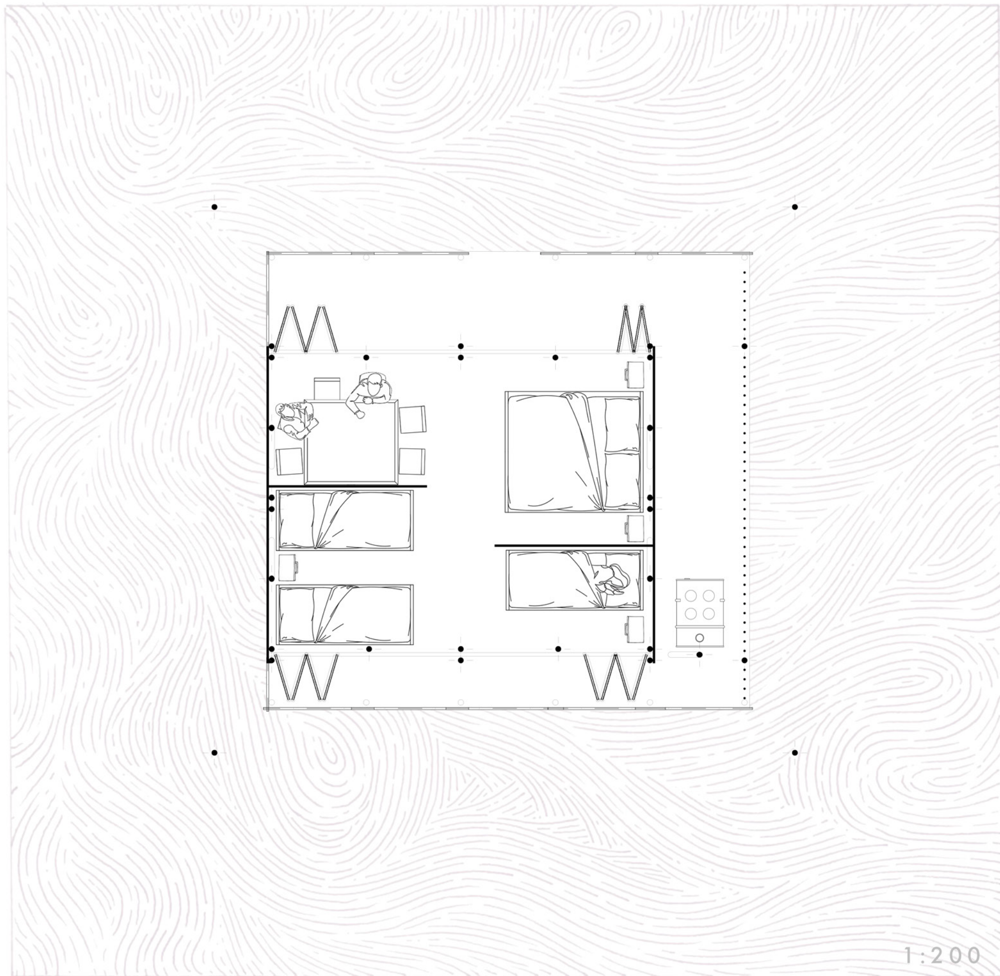
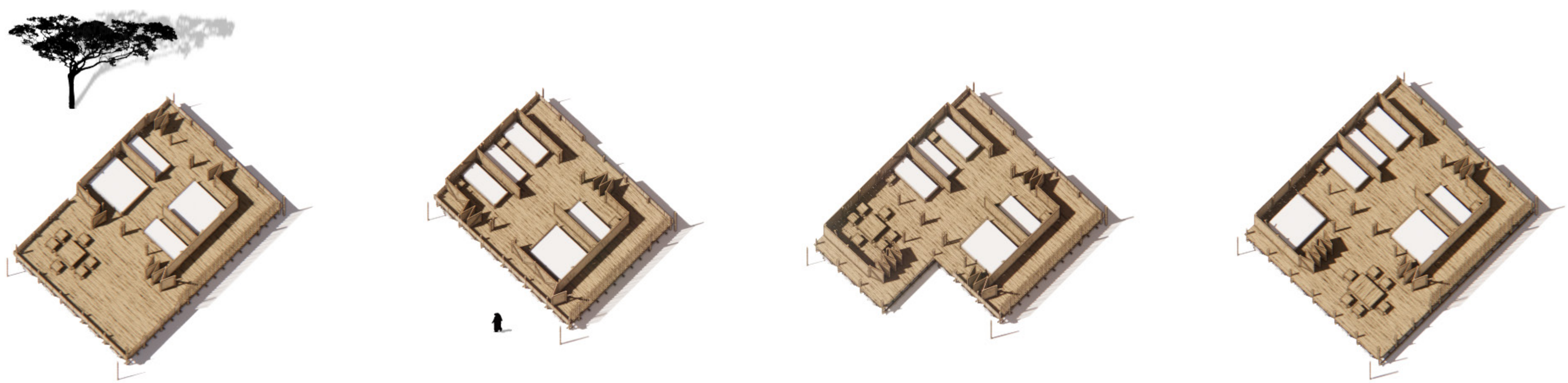
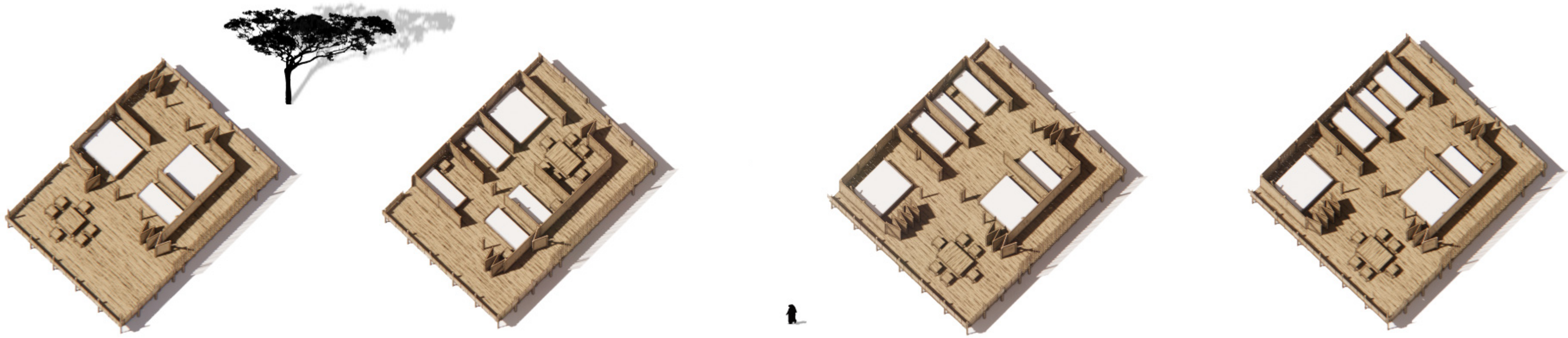


Fig. 89: Base dwelling floorplan suggestion 1:100

These are floorplan suggestions for a standard dwelling inspired by the traditional Bengali hut, which originally consisted of a single space. After the house is finished, residents can divide it into separate rooms according to their preferences, using bamboo walls and blinds for partitions. The following floorplan expansions are merely suggestions, showcasing the different configurations residents can create and demonstrating how much can be efficiently accommodated within the space. This approach emphasizes adaptability and efficient use of the dwelling's interior.



Unit Variation:	1.2.	1.3.	1.4.	1.5.
Size (m^2):	20	25	30	30
Capacity:	5	6	6	8



Unit Variation:	2.2.	2.3.	2.4.	2.5.
Size (m^2):	20	25	30	30
Capacity:	5	6	8	8

Fig. 90: Floorplan suggestions

Fig. 91: Standard 20m² dwelling impression

Fig. 92: Interior impression of a standard 20m² dwelling

C. Building Technology

Fig. 93: Tanguar Haor, Sunamganj, Bangladesh (Mustakim, 2018)

Hip roofs are more resistant to wind damage than gable roofs, making them a practical design choice for amphibious housing in Bangladesh. The sloping sides of hip roofs provide a more aerodynamic shape, reducing wind pressure on the structure during storms and high winds, which are common in the region. This design minimizes the risk of roof uplift and detachment, establishing overall stability and durability of the house. Hip roofs offer better drainage, which is crucial for areas prone to heavy rainfall and flooding. By incorporating hip roofs into the amphibious housing design, residents can benefit from increased protection and resilience.

Fig. 94: Roof choice

Sliding doors

The design choice to use sliding doors that span the length of two walls is supported by several practical arguments. In the summer, these doors can be opened entirely to provide residents with maximum cross-ventilation, causing airflow and cooling the interior. When closed, the doors still function as windows due to the louvres on the top half, which can be adjusted to control light and airflow. The doors are mounted on a bottom railing and supported by another railing at the top, ensuring smooth and stable operation. A standard 20m² house features eight panels on each side, offering ample opportunities for privacy by allowing residents to open or close individual louvres as needed. This flexibility ensures that the space remains airy and private, adapting to the residents' changing needs throughout the day and year.

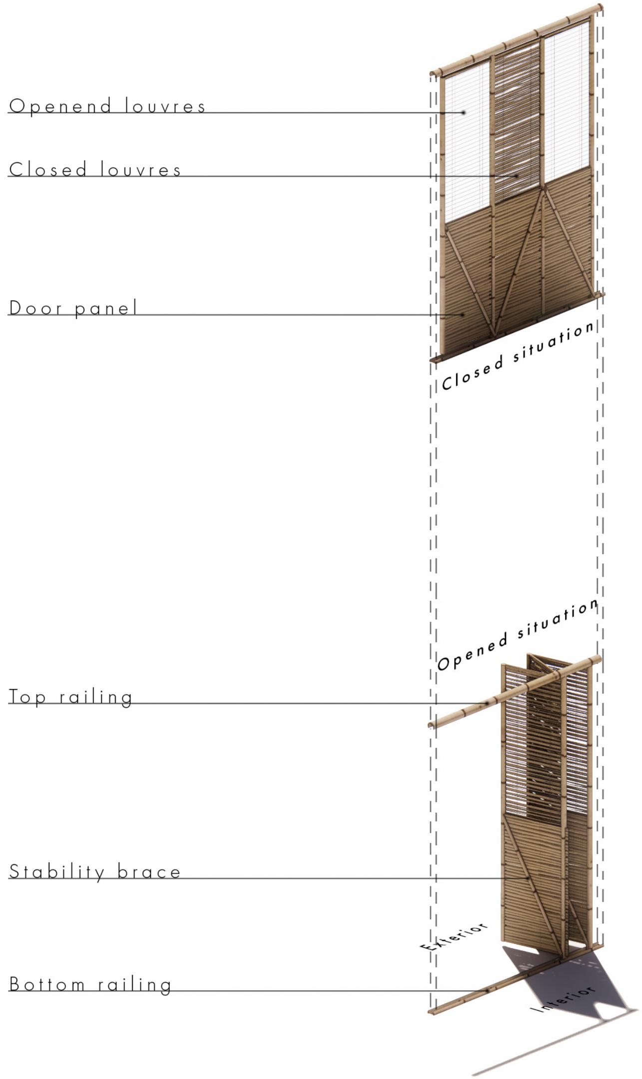


Fig. 95: Sliding bamboo doors

Climate

The dwelling incorporates a passive cooling system that provides comfort in various weather conditions. It can be completely closed, retaining warmer temperatures gathered during the day in the colder months, providing a more comfortable environment during colder nights. Conversely, the sealed structure in the summer prevents outside heat from fully penetrating, keeping the interior cooler during the day. This effect lasts for the first few hours of the day, after which sliding doors can be opened to create natural ventilation by fully opening two sides of the dwelling. Additionally, the roof features opposite openings that keep the attic ventilated, helping to maintain a cooler temperature on the ground floor. The added ceiling, serving as storage space, acts as an extra layer to stop heat from the roof from instantly entering the living space. These design elements ensure optimal comfort year-round by effectively managing indoor temperatures through passive cooling techniques.

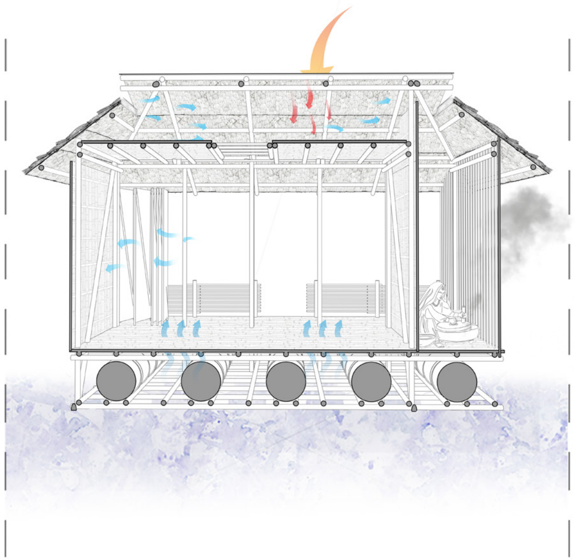


Fig. 96: Climate section

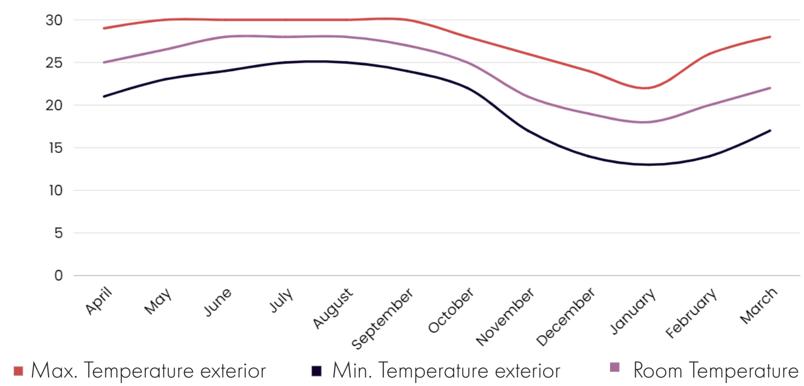


Fig. 97: Temperature differences

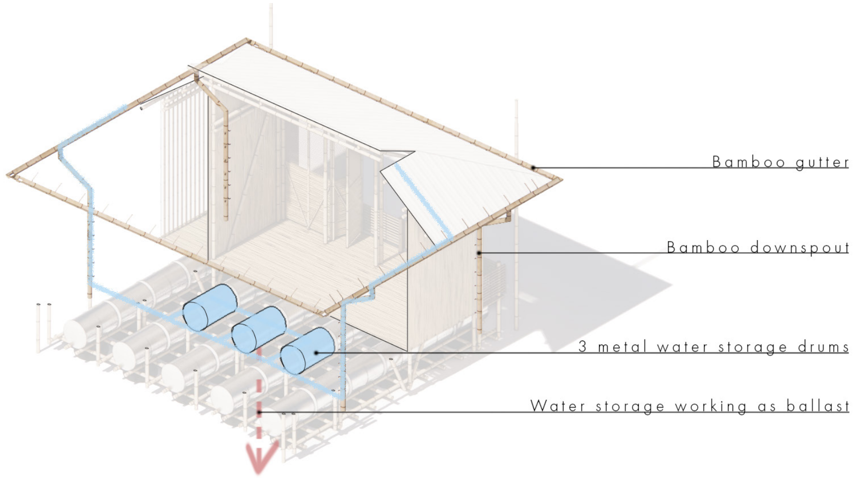


Fig. 98: Water harvesting

The amount of water needed for a family of five in Bangladesh can vary depending on several factors, such as daily activities and access to clean water sources. However, a family of five in Bangladesh typically requires around 100-150 litres of water per day for drinking, cooking, cleaning, and other household needs. This estimate can differ depending on factors like weather conditions, availability of water infrastructure, and individual consumption habits.

Three drums, capable of holding 732 litres of water, are situated underneath the house to serve as a ballast system. This construction ensures that the household has enough water for approximately one week.

The drums, placed centrally beneath the house, provide stability and a low centre of gravity, increasing resilience

The cooking space is outside, next to the living area of the house. The stove can be constructed from steel drums, similar to those used for the buoyancy system. A small brick wall is placed around the drum to limit heat emissions toward the bamboo structure and reduce the fire risk. This set-up ensures that cooking activities are safe and do not adversely affect the house's structural integrity, nor do they increase heat or introduce cooking smells into the living space.

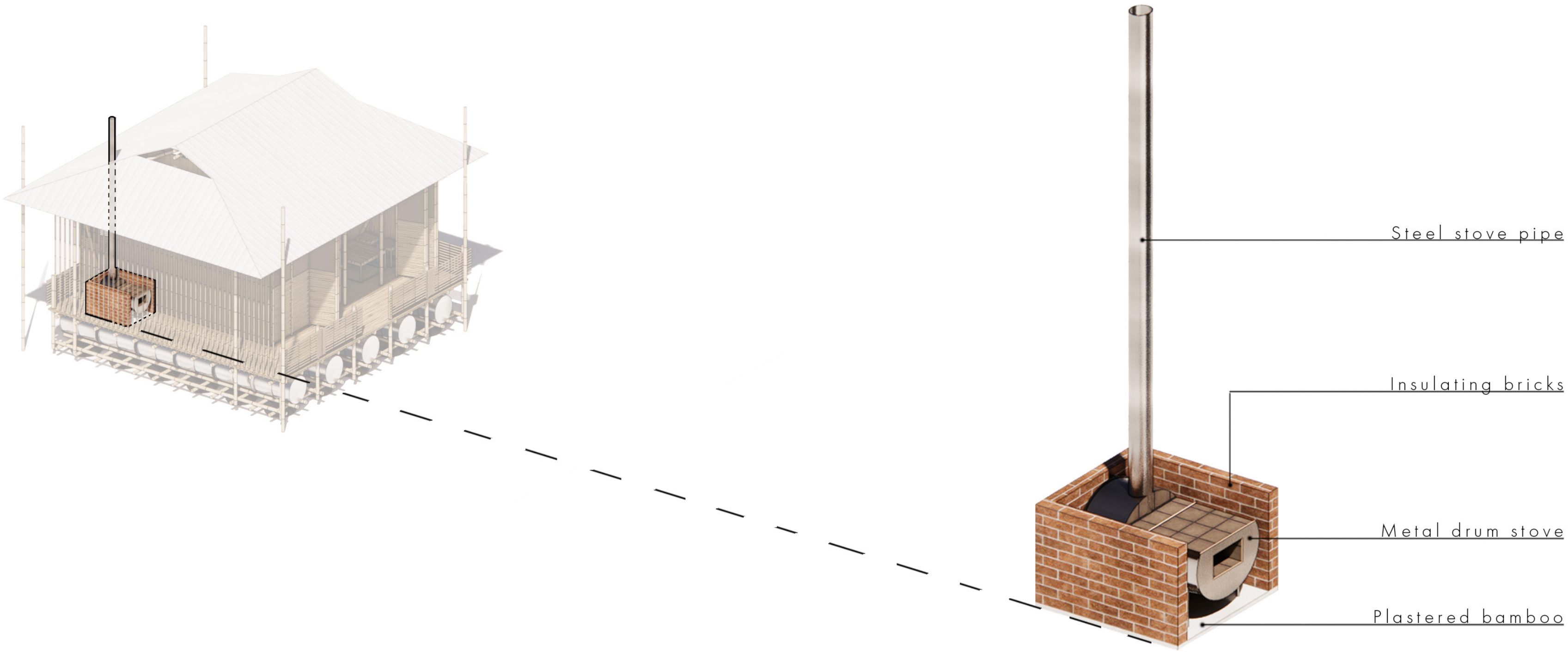


Fig. 99: Cooking (Metal drum stove)

The design of these toilets incorporates plants to counteract odours and add privacy from the outside, creating a more pleasant and environmentally friendly experience. Additionally, the toilets are thoughtfully divided into separate sections for men and women, ensuring privacy and convenience for all users. This design not only addresses sanitation needs but also establishes the overall usability and comfort of the facilities.

Fig. 100: Sanitation unit impression

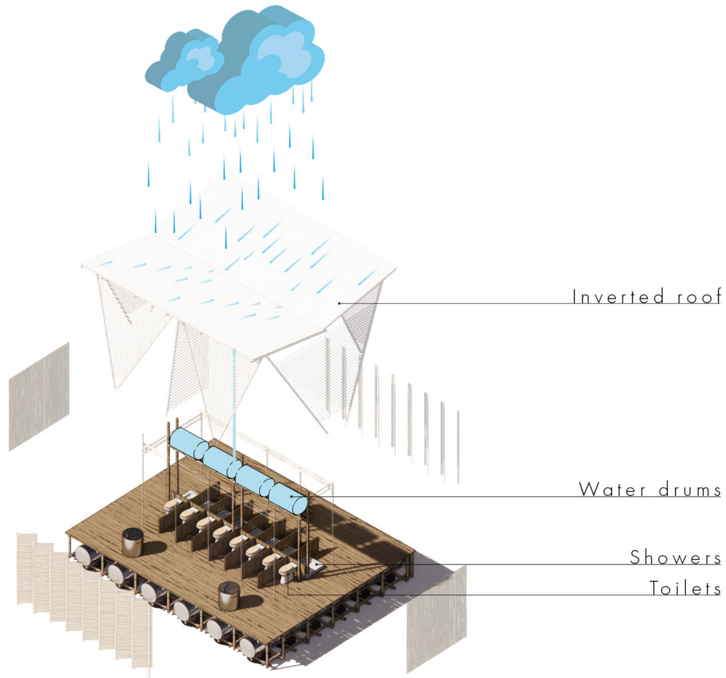


Fig. 101: Sanitation exploded view

Fig. 102: Restroom & stables view

Fig. 103: Amphibious cluster view from paddy fields

Within this community, amphibious and stilt toilets are used. During the dry season, the amphibious and stilt toilets use a helophyte filter connected to a filtering bamboo plantation, with the filtered water released into the river. During the monsoon period, the amphibious toilet rises with the water level, disconnecting from the initial helophyte filter and switching to a floating helophyte filter. This system ensures that the clean water is released directly into the surrounding water. Meanwhile, the stilt toilet continues to use the primary helophyte filter system, discharging the filtered water into the river regardless of the season. This dual approach ensures adequate sanitation and environmental protection throughout the year.

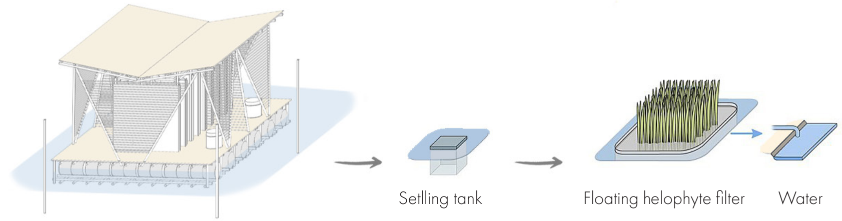


Fig. 105: Floating helophyte filter (Summer situation)

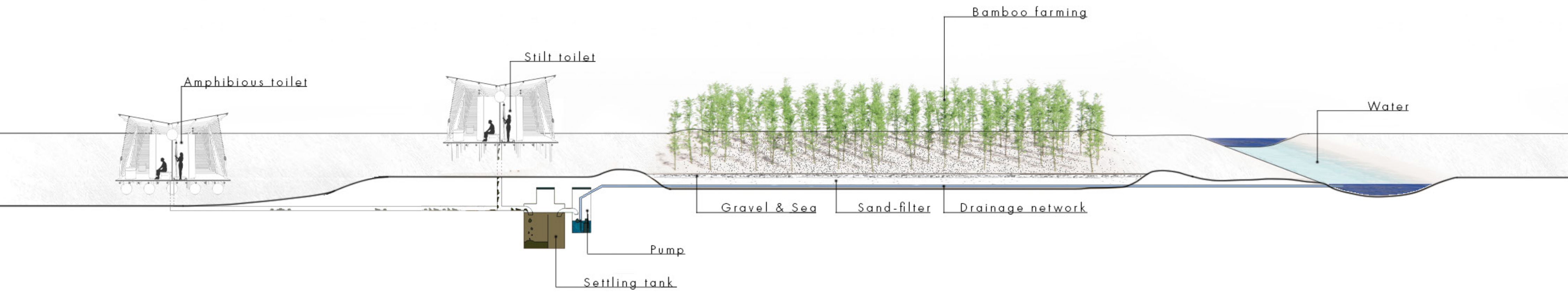
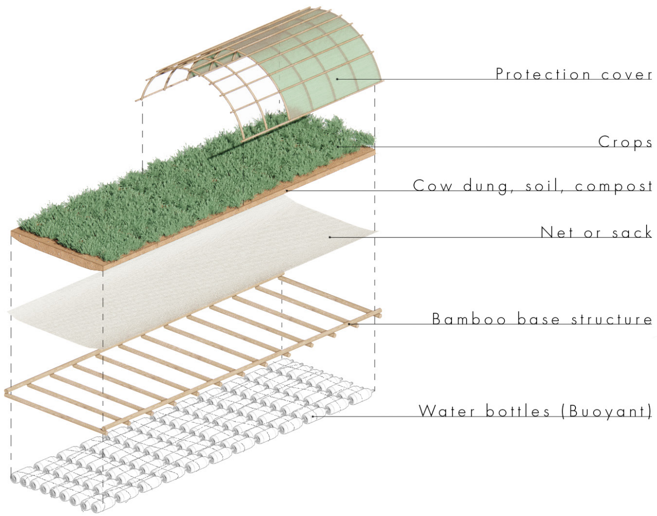


Fig. 104: Helophyte filter (Winter situation)



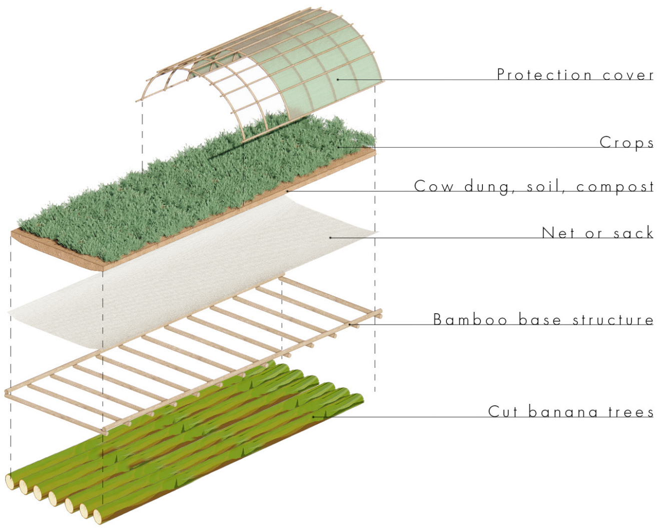


Fig. 106: Floating vegetable garden exploded view

The floating vegetable gardens achieve buoyancy through reused water bottles placed beneath their structure. Cut banana trees can be used as an alternative to reduce reliance on plastic bottles and foster a more sustainable approach. Beneath the soil, a net is installed to maintain contact with the water, keeping the soil wet and reducing the need for frequent watering. Additionally, nets can be positioned between the floating gardens to create an environment suitable for raising fish, helping counteract illegal fishing activities.

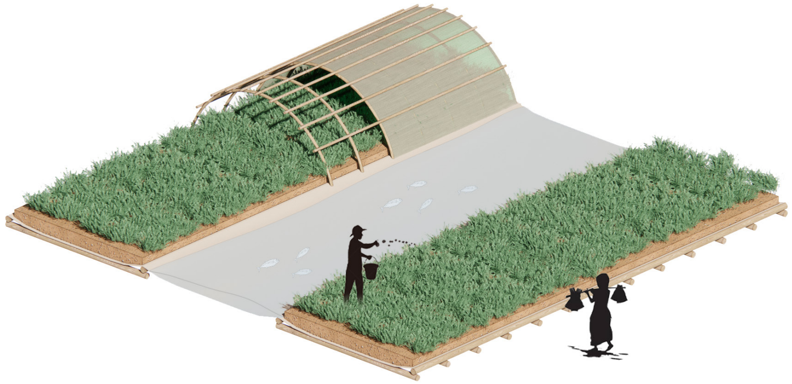


Fig. 107: Floating vegetable gardens impressions

Fig. 108: Vegetable garden from dwelling

Fig. 109: Vegetable gardens impression

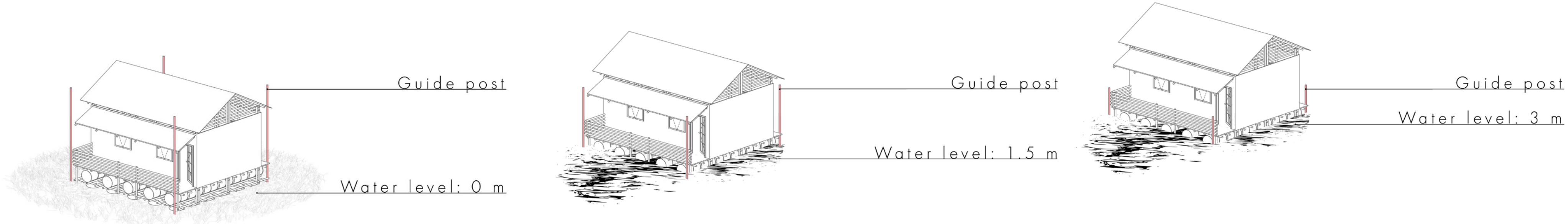


Fig. 110: Buoancy sytem

1. Weight of bamboo poles (d = 75mm):

Total length of columns and beams (L): 720 meter
Density (P): 675 kg/m³
$r = d/2 = 0.0375$ m

Volume of the bamboo:
$V = \pi r^2 \times L$
$V = 3.14 \times (0.0375)^2 \times 720$
$V \approx 3.18 \text{ m}^3$

Weight (W) of the bamboo:
$W = V \times P$
$W = 3.18 \times 675$
$W_{bamboo} \approx 2{,}147$ kg

2. Weight of walls, floors and doors (W_{wfd}):

V_{Floor} = Area × Thickness

$V_{Door} = 0.06 \times 20 = 1.2^3$
$W_{Door} = 1.2^3 \times 675$
$W_{Door} = 810$ kg

$V_{Floor} = 54 \text{ m}^2 \times 0.015 \text{ m} = 0.81 \text{ m}^3$
$W_{Floor} = 675 \text{ kg/m}^3 \times 0.81 \text{ m}^3$
$W_{Floor} = 546.75$ kg

$V_{Wall} = 38 \text{ m}^2 \times 0.015 \text{ m} = 0.57 \text{m}^3$
$W_{Wall} = 675 \text{ kg/m}^3 \times 0.57 \text{ m}^3$
$W_{Wall} = 383.25$ kg

$W_{wfd} = W_{Door} + W_{Floor} + W_{Wall}$
$W_{wfd} = 810 + 546.75 + 383.25 = 1{,}740$ kg

3. Weight of CI sheets:

$W_{CI\ sheet} = 10$kg:
$W_{total} = 13 \times 10$
$W_{total} = 130$ kg

4. Average human body weight bangladesh:

Average Bangladeshi weight: 60 kg.
$W_{Household} = 5 \times 60$
$W_{Household} = 300$ kg

5. A rough estimate of the belongings weight:

Basic furniture: 150 kg.
Personal belongings: 100 kg per person, approximately 500 kg for the household.
Kitchenware and appliances: 100 kg.
Total weight of belongings in a rural five person houselhold in Bangladesh:
$W_{Belongings} = 750$ kg.

This is a rough estimate and actual weights may vary depending on the specific circumstances of the family and their possessions.

6. Water harvesting weight:

$V = \pi r^2 h$
Height (h) = 925 mm
Diameter = 580 mm
Number of drums: 3

$V = \pi \times (290\text{mm})^2 \times 925\text{mm}$
$V = \pi \times (290\text{mm})^2 \times 925\text{mm}$
$V = \pi \times (290\text{mm})$
$V \approx 244{,}263{,}276 \text{mm}^3$

The density of water is approximately 1 g/cm³ or 1000 kg/m³.

Given that the volume of water the drum can hold is approximately 244.26 liters, we can convert this to cubic meters:
Volume in cubic meters ≈ 0.24426m³

Weight of water in three metal drums:
$W_{Water} = 0.24426\text{m}^3 \times 1000 \times 3 \text{ kg/m}^3$
$W_{Water} = 244.26 \times 3$
$W_{Water} = 737.78$ kg

Adding the weight of the three drums:
Assuming a steel drums weighs 22kg:
$W_{Water} = 737.78 + 22 \times 3$
$W_{Water} = 798.78$ kg

5. Total

$W_{Total} = W_{bamboo} + W_{wfd} + W_{CI\ sheet} + W_{Bangladeshis} + W_{Belongings} + W_{Water}$

$W_{Total} = 2{,}147 + 1{,}740 + 130 + 300 + 750 + 798.78$

$W_{Total} = 5{,}865.78$ kg

Buoancy System: Calculations

The volume of water displaced by a cylinder (such as the metal drums) is given by the formula:

$V = \pi r^2 h$

Where:
- V is the volume of water displaced
- r is the radius of the cylinder (half of the diameter)
- h is the height of the cylinder

The weight of the water displaced by the drums is equal to the buoyant force, which can support the weight of the house.

The chosen drums have a diameter (d) of 580mm (radius r = d/2 = 580mm/2 = 290mm = 0.29m) and a height (h) of 925mm (0.925m), we can calculate the volume of water displaced by one drum:

$V_{drum} = \pi \times (0.29)^2 \times 0.925$

Now, we have the volume of water displaced by one drum. To find the total weight capacity of the 27 drums, we multiply this volume by the number of drums and by the density of water (P = 1,000 kg/m³) to get the total weight capacity:

$$\text{Total weight capacity} = V_{drum} \times 27 \times P$$
$$= (\pi \times (0.29)^2 \times 0.925) \times 27 \times 1000$$
$$= 0.249 \times 27 \times 1000$$
$$\text{Total weight capacity} = 6{,}723 \text{ kg}$$

So, the weight capacity of the 27 drums is approximately 6,723 kilograms. This means the amphibious house can weigh up to 6,723 kilograms to remain afloat using these drums.

Buoancy System: Calculations

The total estimated weight that one initial house would have to carry is approximately 5,865.78 kg. This results in approximately 15% buffer beyond the total expected weight load which is a reasonable amount for to account for fluctuations, waves, and other environmental factors.

Maintaining a comfortable margin between the current load and the maximum weight capacity helps preserve the structural integrity of the house over time. It reduces the risk of structural fatigue, deformation, or failure due to long-term stress.

If one or more drums were to fail, having a reserve weight capacity ensures that the remaining drums can still support the structure adequately. This enhances the safety and reliability of the amphibious house, reducing the risk of failure due to a single point of failure.

4. Material Choices

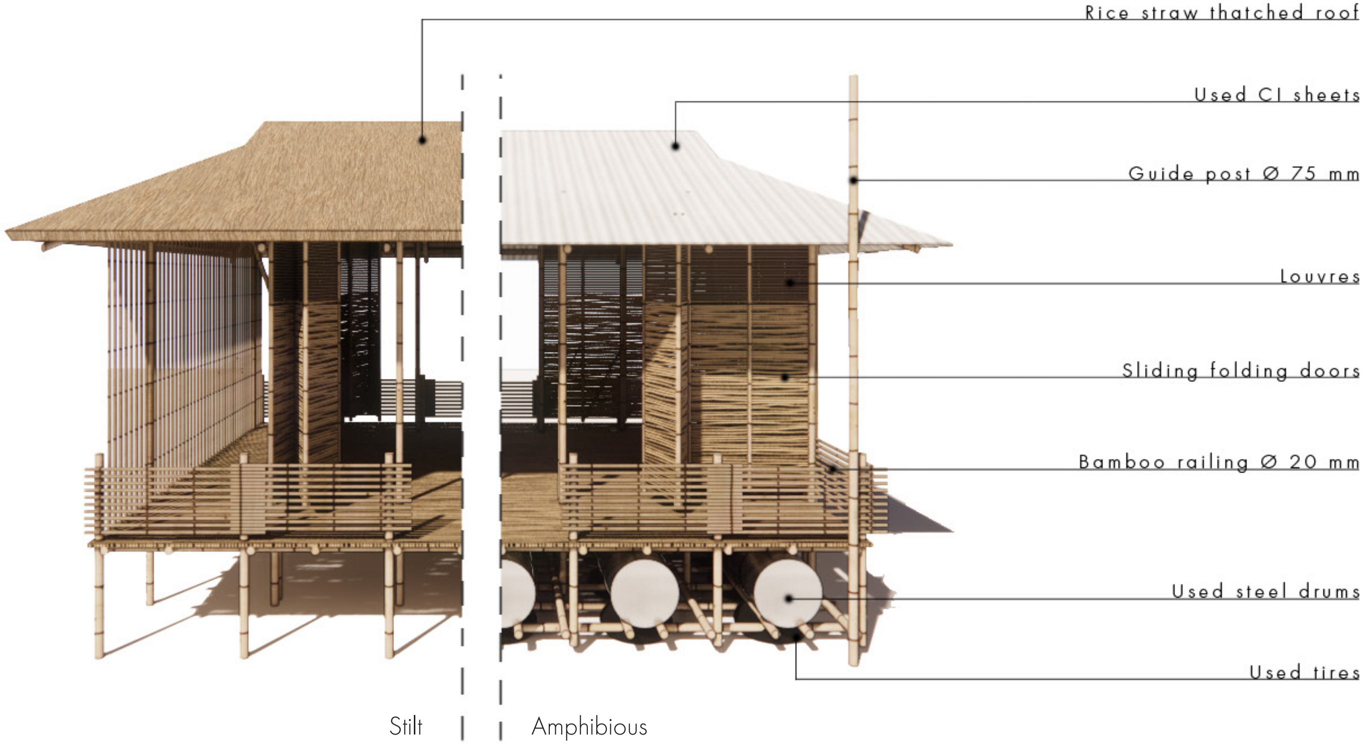


Fig. 111: Elevation

Fig. 112: The bamboo walls are not plastered, allowing natural ventilation in Assam's humid climate (Image © SEEDS / Siddharth Behl)

Fig. 113: Lift House, Prosun Architects

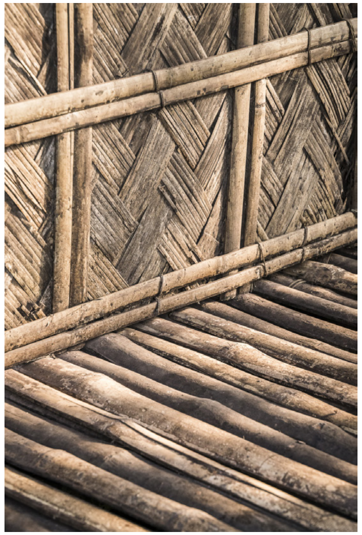


Fig. 114: Aga Khan Trust for Culture / Sanndro di Carlo Darsa (photographer)

Fig. 115: House on stilts made of bamboo screens and thatch roofing

5. Structural Design

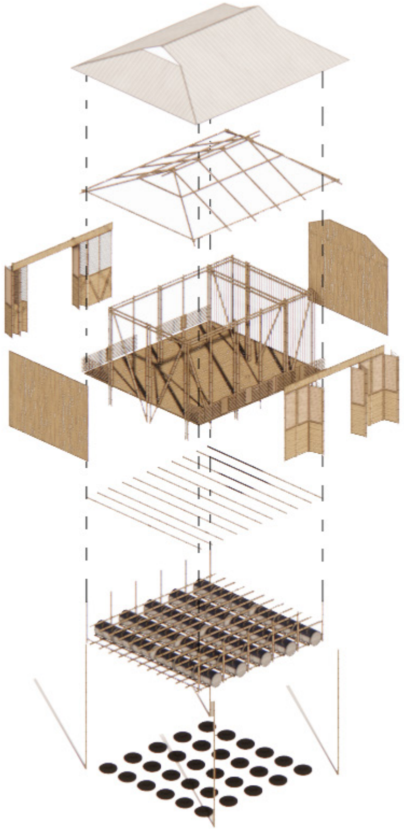


Fig. 116: Axonometry amphibious dwelling

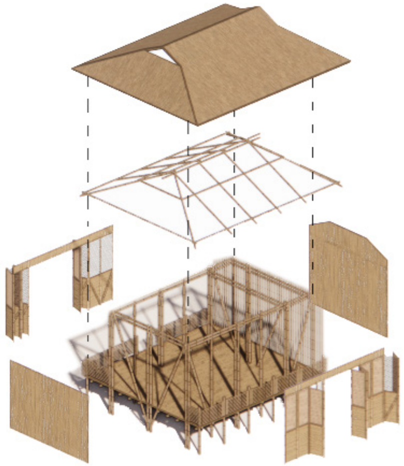


Fig. 119: Axonometry stilt dwelling

Fig. 117: Rope/bolt connections

Fig. 118: Used tyres as sub-structure

Fig. 120: Used steel drums as floating system

Fig. 121: A construction within the capacities of the locals.

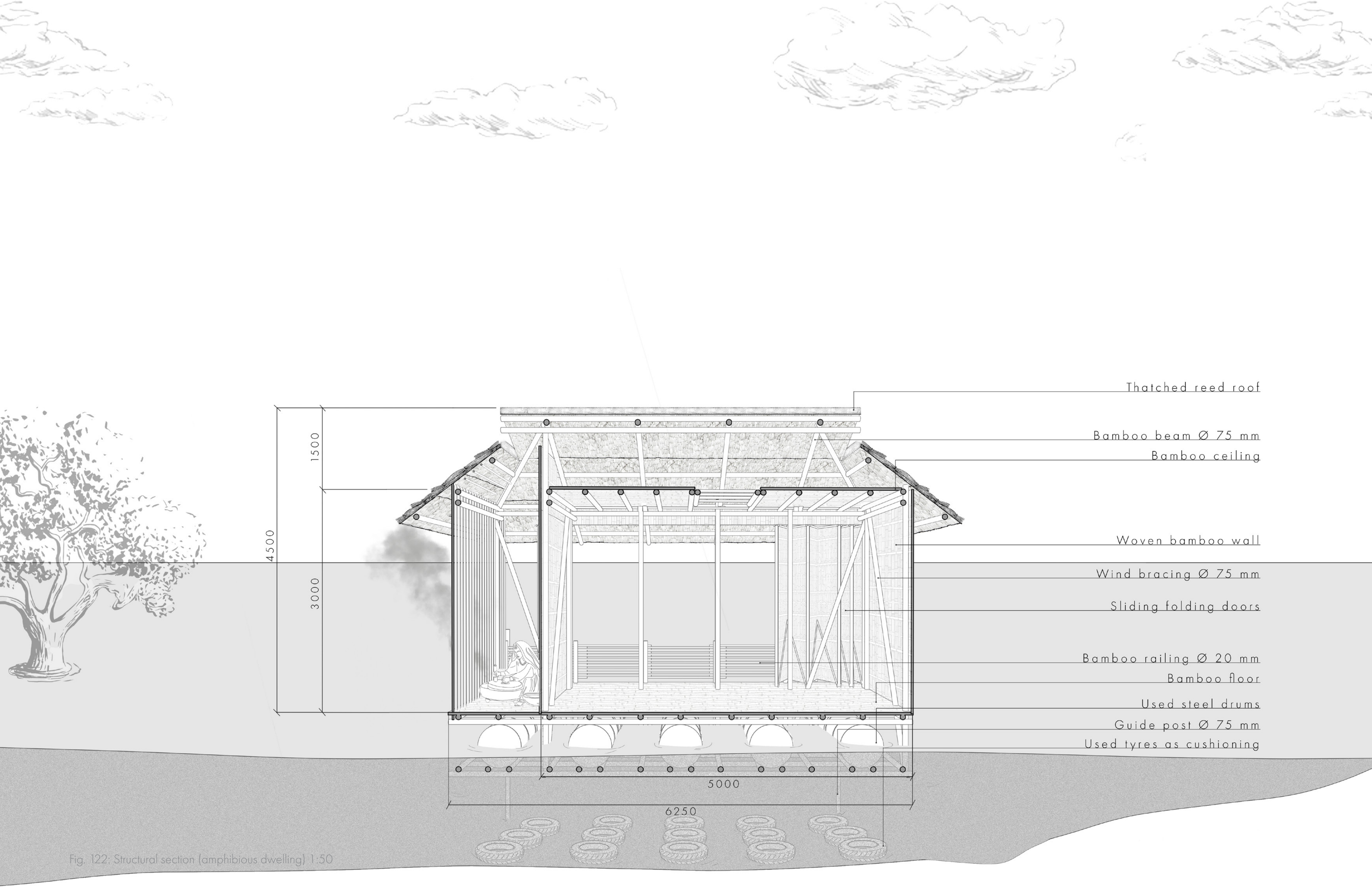


Fig. 122: Structural section (amphibious dwelling) 1:50

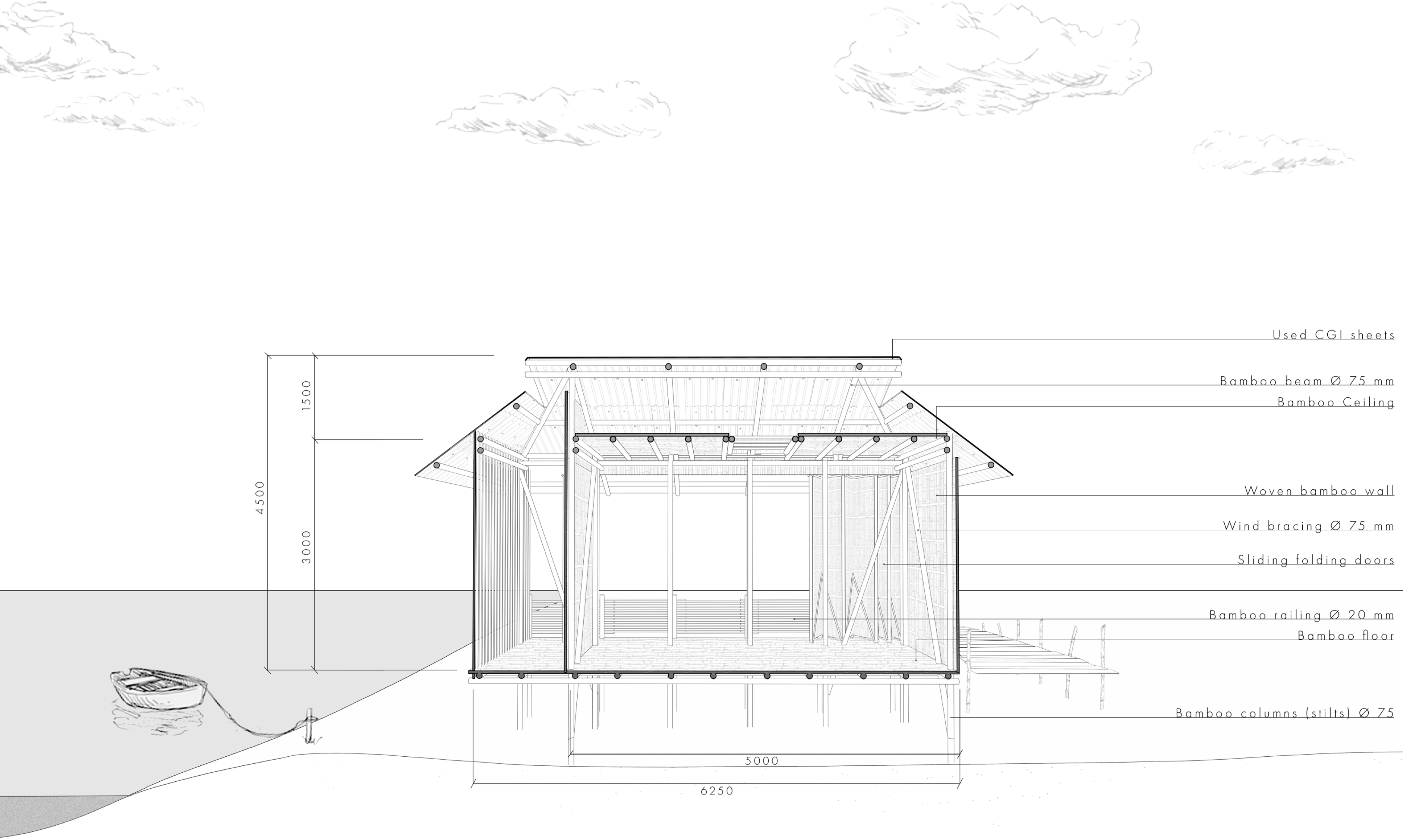


Fig. 123: Structural section (stilt dwelling) 1:50

The main construction of the living area is mainly made of bamboo. Bamboo poles, connected with rope for more flexibility, are used for the constructive part, woven bamboo for the walls, and bamboo strips for the floor in the living area and storage attic.

The same bamboo poles are used for the buoyant system, but here, in addition to the rope, they are connected through bolts for more solidity and longevity.

Underneath the construction, bricks are placed on the ground to retain a level surface during flooding. On top of these bricks, tyres are placed to protect the bamboo during the dry season.

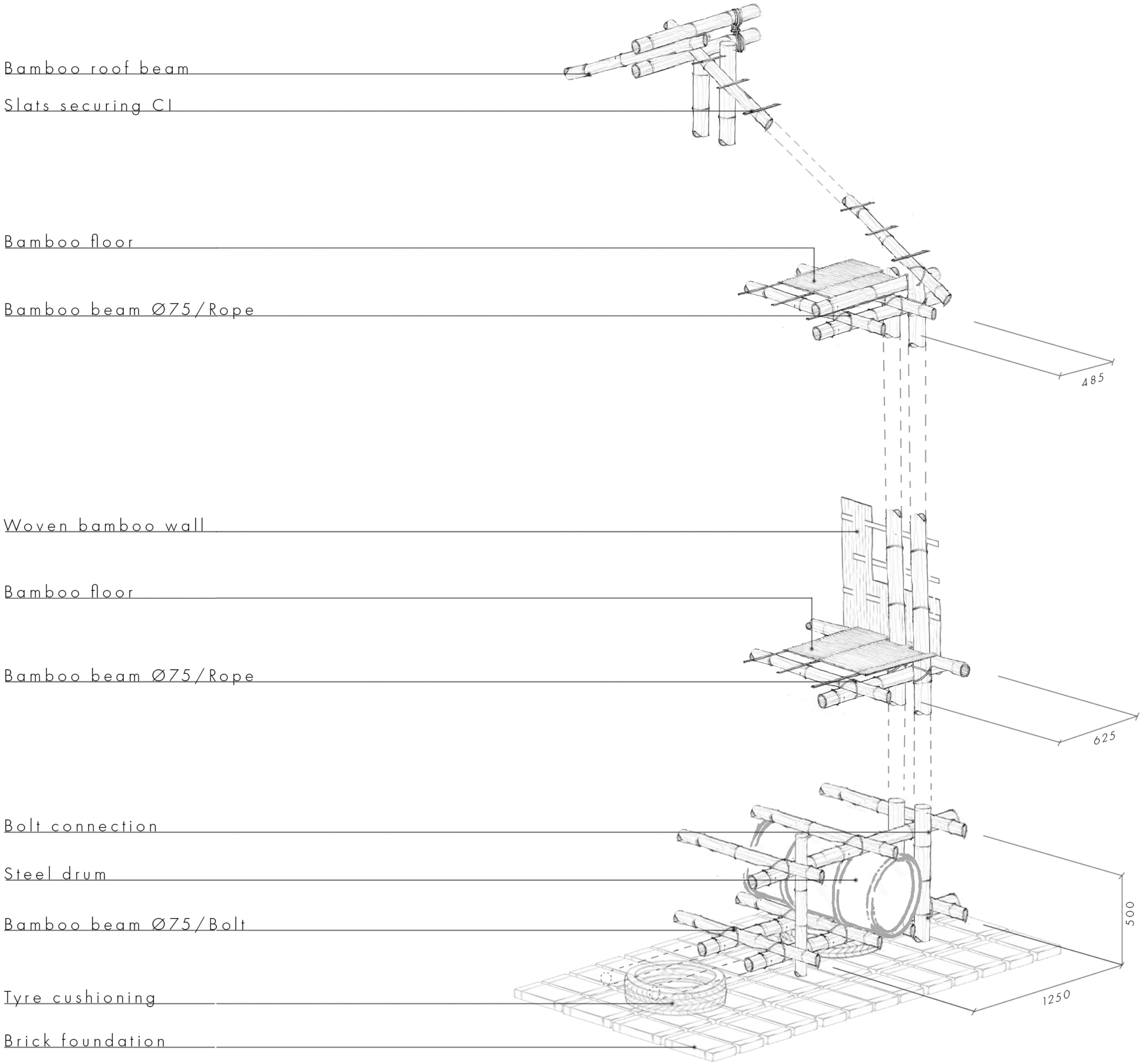


Fig. 124: Structural details 1:50

The rafters are supported by two bamboo columns and are held in place by a beam positioned underneath their intersection and another beam above it. These two beams are tightly bound together with rope, ensuring stability, and are fastened to the bamboo columns.

The columns support the rafters and are tightened with rope. Two beams are placed on top of each other at a 90-degree angle, with another set of beams similarly arranged on top to ensure stability. The right column is connected to one of the V-shaped stability braces and is tightened with rope, providing additional support and reinforcement to the structure.

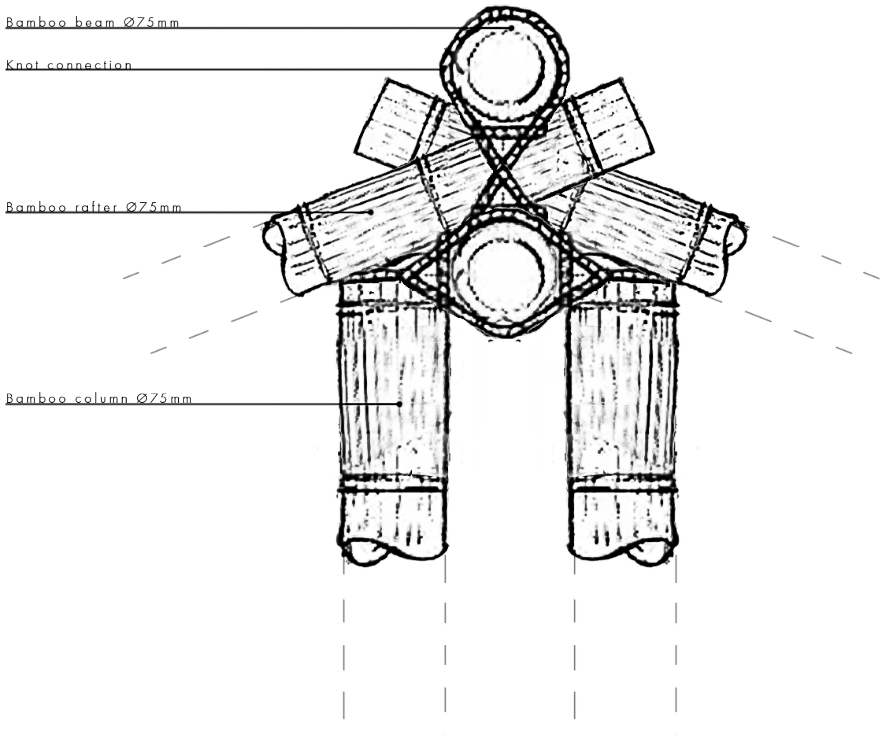


Fig. 125: Ridge 1:5

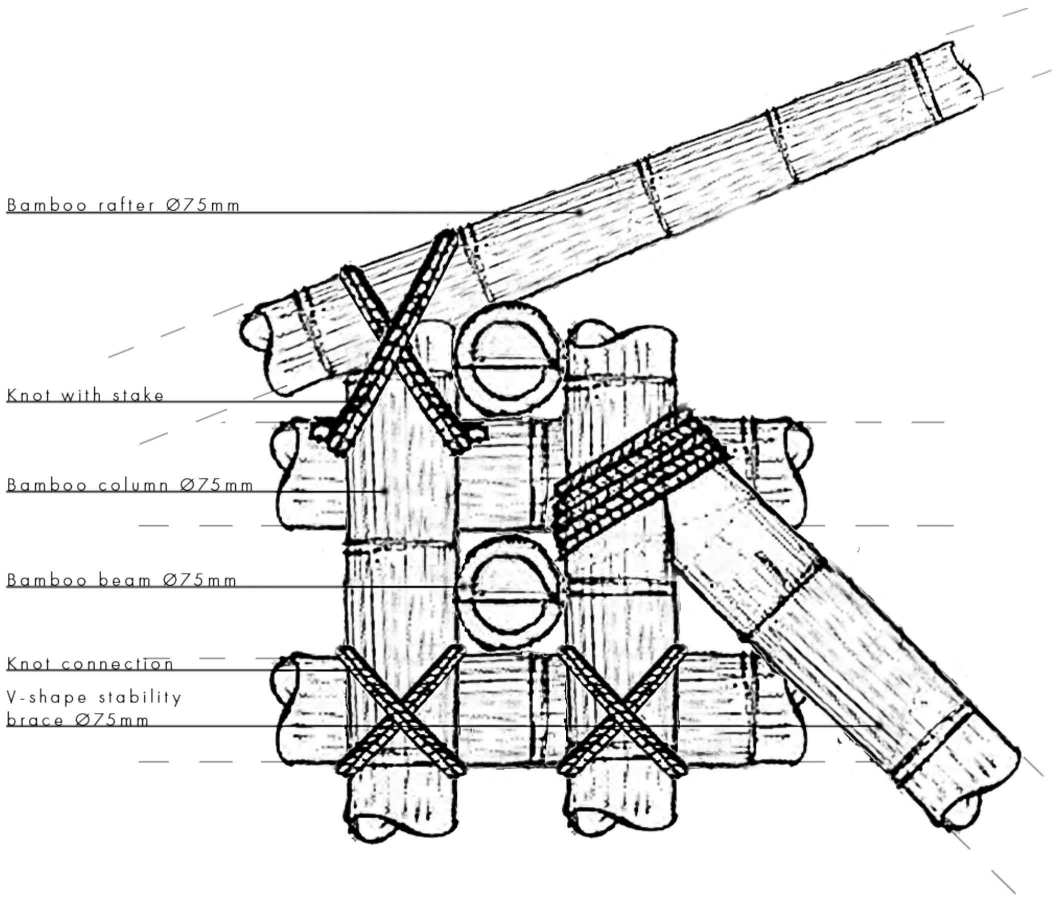


Fig. 126: 1st floor 1:5

The columns support two beams and fasten them with bolts. On top of these beams lies the floor, composed of bamboo strips derived from bamboo poles cut longitudinally and pressed into nearly rectangular shapes. Between the two columns is a half-cut bamboo pole, which serves as a railing for the sliding doors.

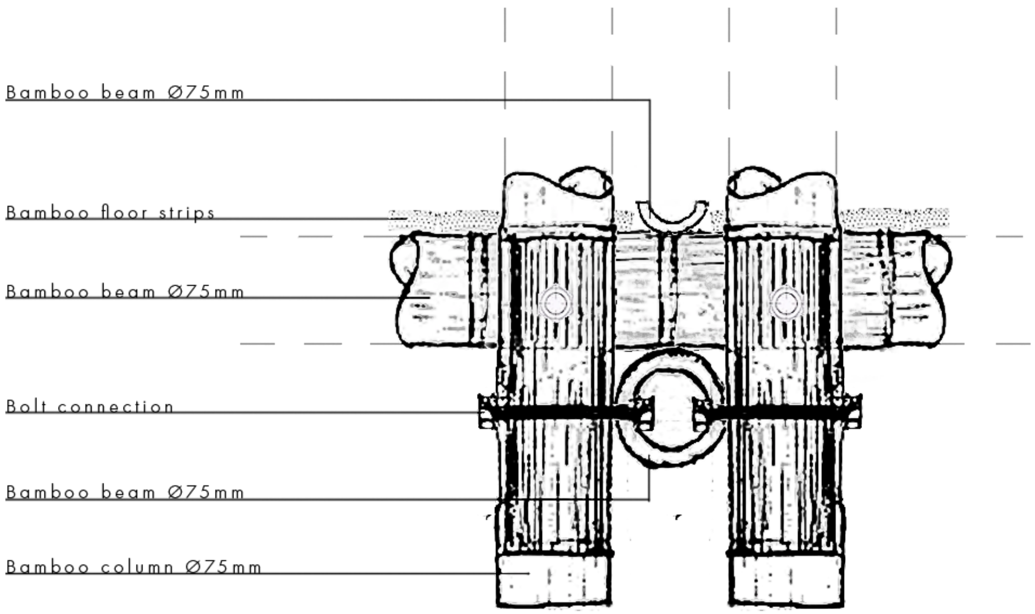


Fig. 127: Ground floor 1:5

The extremity connection of the two columns at the central point of the construction links the V-shaped bracing with bolts. This connection also integrates with the lower part of the structure, providing support for the barrels.

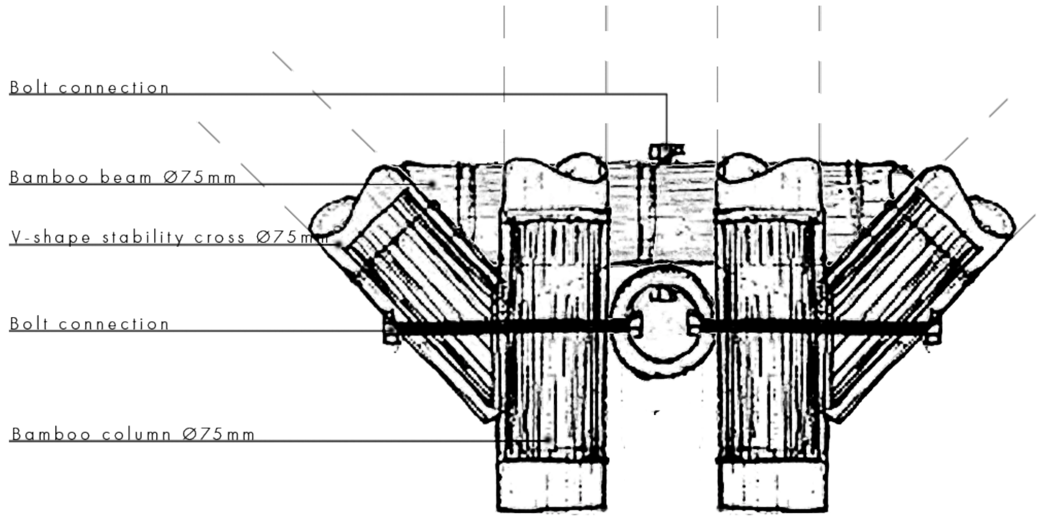
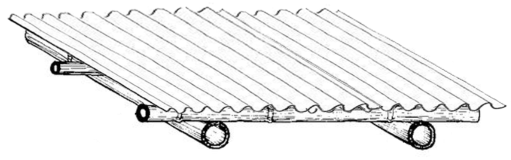
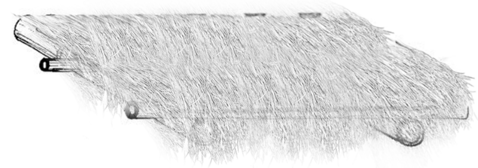


Fig. 128: Amphibious structure 1:5

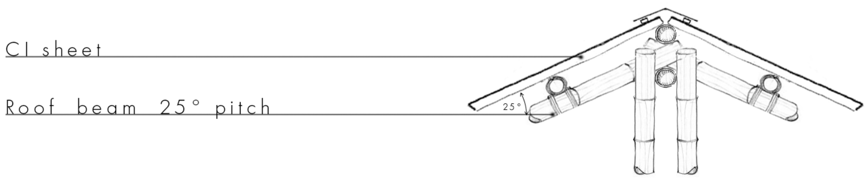
Residents can select their preferred roofing material for their homes, choosing between thatched and CI sheet roofs based on personal preferences. The CI sheet roof provides a simple, affordable solution with a 25-degree pitch and minimal maintenance requirements. In contrast, the thatched roof, inspired by traditional Akha houses constructed with palm leaves or cogon grass, offers greater comfort but necessitates more maintenance. The Akha, who often reside in mountain villages across southwest China, eastern Myanmar, western Laos, northwestern Vietnam, and northern Thailand, live in climates similar to that of Bangladesh, making their traditional roofing methods relevant and suitable.



CI sheets roof impression



Thatched roof impression



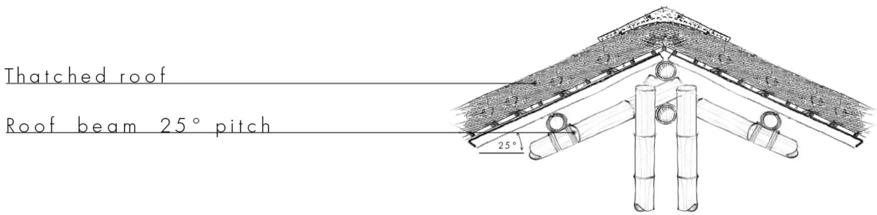


Fig. 129: Roof details

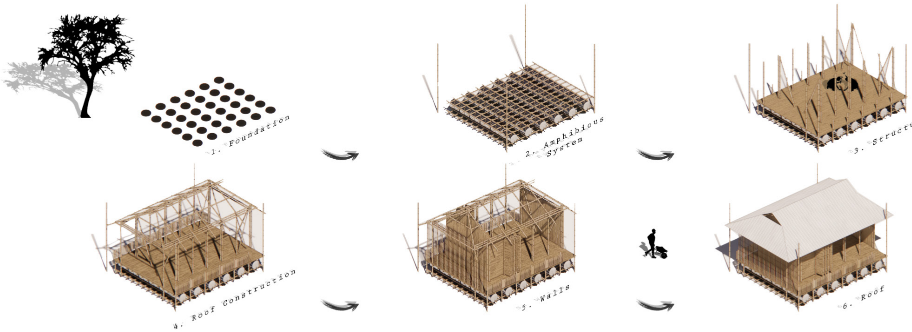


Fig. 130: Phasing diagram amphibious house construction

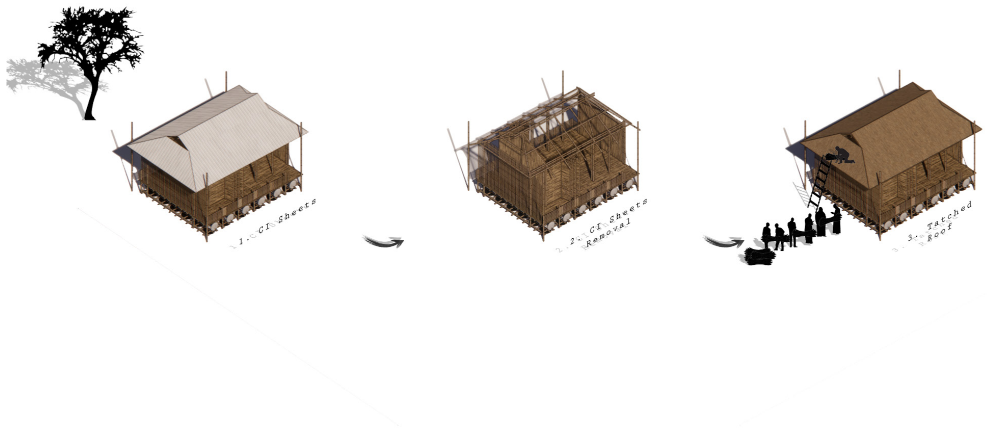


Fig. 131: Diagram thatched roof upgrade

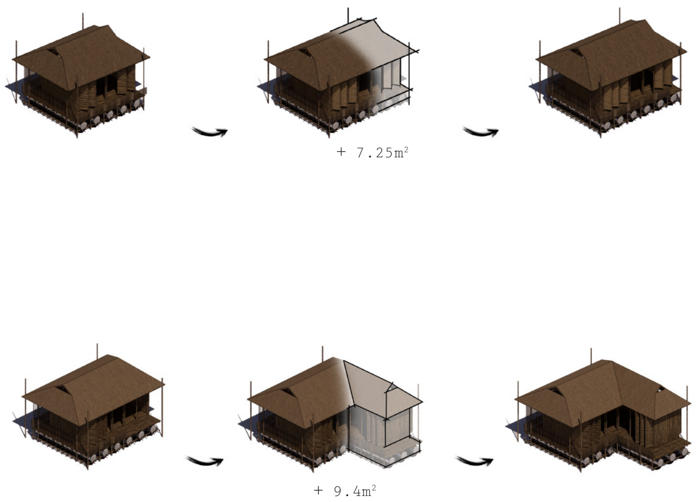


Fig. 132: Extension I-type & L-type

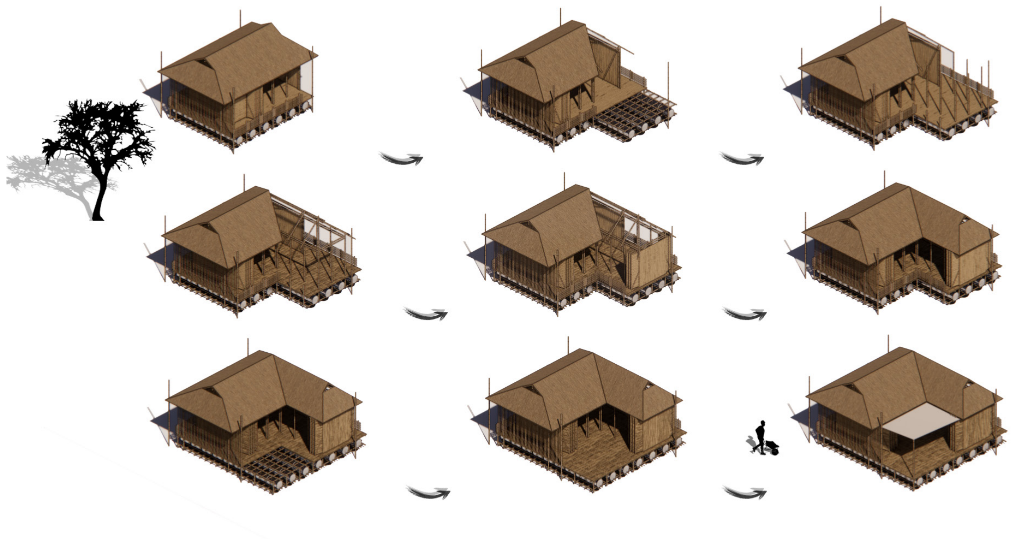


Fig. 133: Extension construction diagram

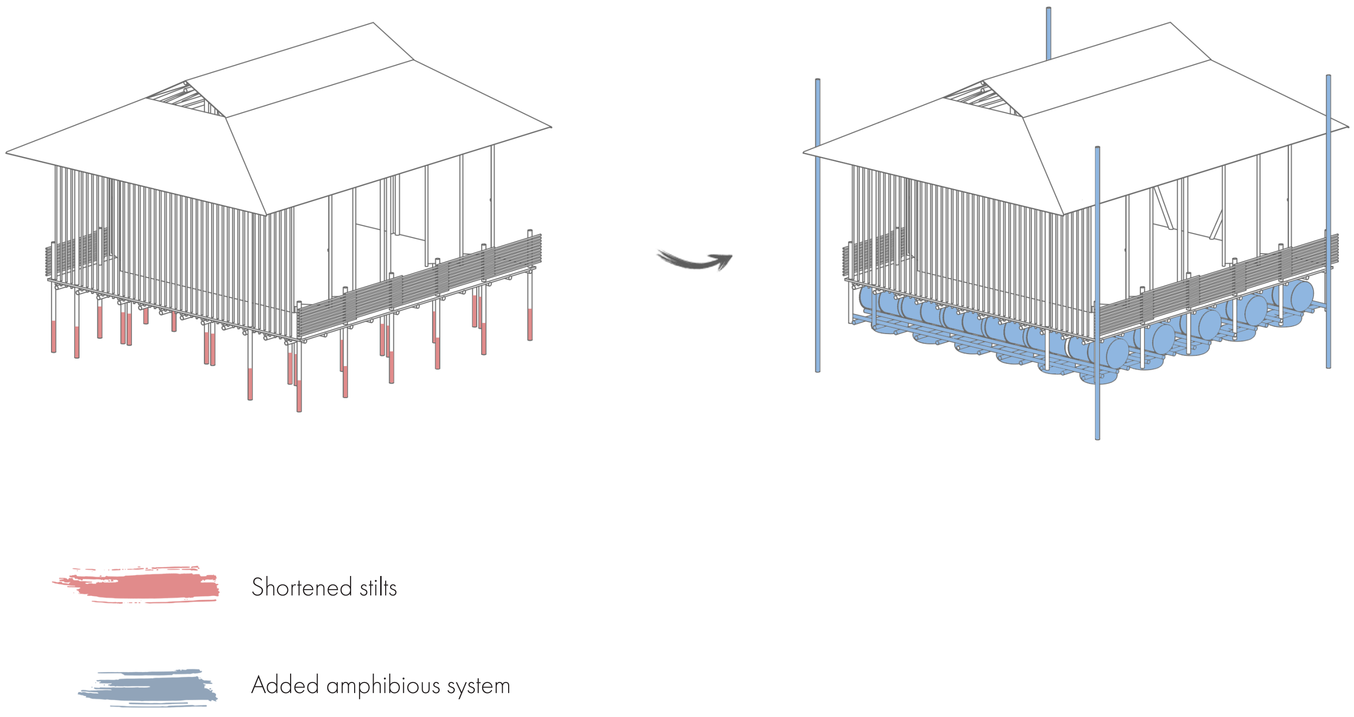
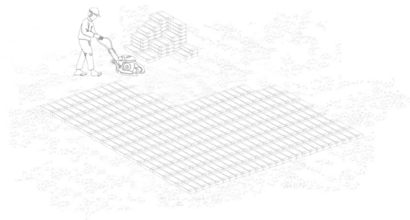


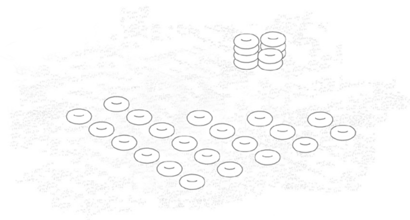
Fig. 134: Amphibious retrofit

Fig. 128: Khudi Bari construction (Marina Tabassum Architects, 2020)

Construction Manual

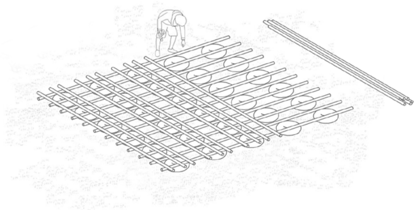


1. Brick Foundation for level surface

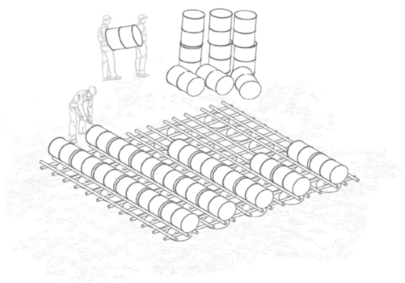


2. Used tyres for cushioning

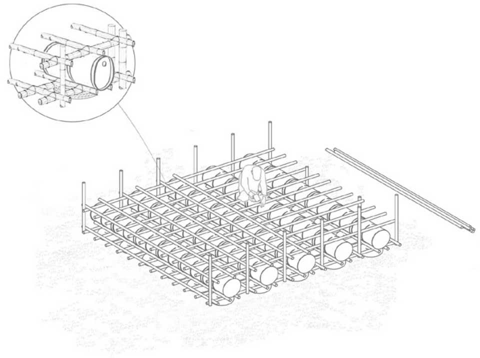
Fig. 135: Construction manual pt. 1



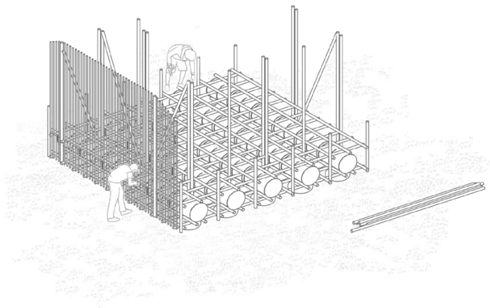
3. Start construction substructure



4. Addition of the steel drums

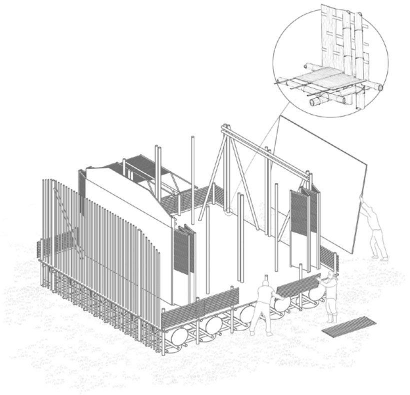


5. Finishing substructure

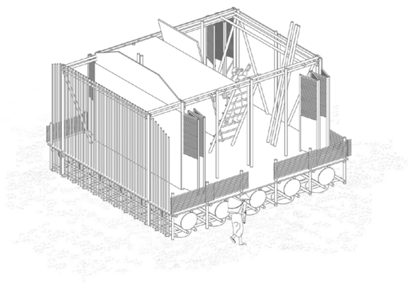


6. Mounting bamboo poles

Fig. 136: Construction manual pt. 2

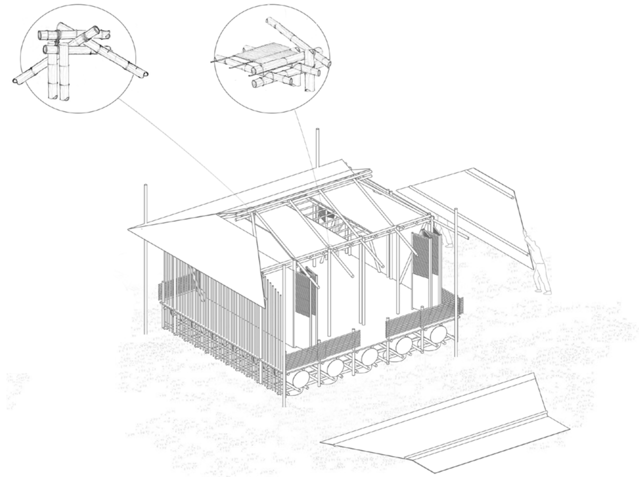


7. Attaching woven bamboo walls and floors

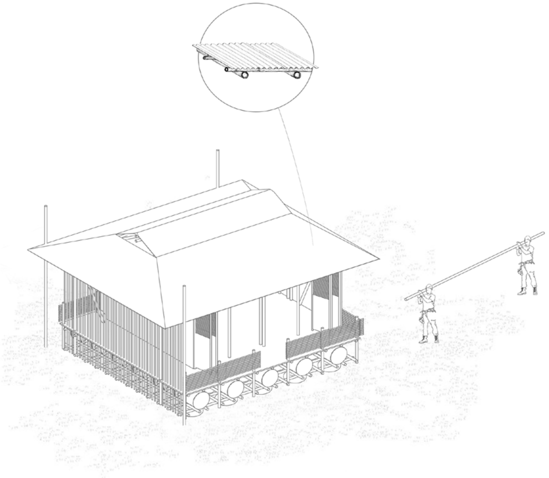


8. Building cealing/attic

Fig. 137: Construction manual pt. 3



9. Mounting CI sheet roof



10. Planting the guiding posts

d. Managerial Framework

1. Stakeholder analysis

1. Architect (Myself):
Role: As the initiator of the design process, I take the lead in conceptualizing and planning the project. My role involves identifying the project's objectives, conducting initial research and feasibility studies, and formulating design proposals that address the community's needs and challenges.
Interests: Innovation, portfolio development, sustainable design.
Strategies: Engage in participatory design processes with the community, incorporate local materials and techniques, and focus on scalable and replicable design principles.

2. Local Community Members:
Role: Primary beneficiaries and participants in construction, maintenance, and daily operations.
Interests: Safe, affordable housing; income generation through tourism and agricultural activities; community development.
Strategies: Involve them in the design process to ensure the project meets their needs, provide training on construction techniques and sustainable farming, and promote community ownership.

3. Government (Local and National):
Role: Regulators, possibly investors or grant providers.
Interests: Economic development, tourism promotion, disaster risk reduction, and sustainable development.
Strategies: Seek partnerships for funding, permits, and support. Leverage the project as a model for sustainable development.

4. NGOs and Environmental Groups:
Role: Funding, technical expertise, and project monitoring.
Interests: Sustainable development, innovation in housing, community empowerment, climate change adaptation.
Strategies: Partner for access to technical expertise in amphibious architecture and sustainable agriculture; secure grants or low-interest loans; leverage networks for project dissemination and replication.

6. Local Entrepreneurs and Businesses:
Role: Support services and supply chain management.
Interests: Economic opportunities, market development.
Strategies: Encourage local entrepreneurship, provide training and support for business development, and create links with the tourism sector.

7. Material Suppliers:
Role: Suppliers of materials essential for the project's implementation, such as bamboo, CI sheets, metal drums, etc.

Interests: Securing contracts for the supply of materials, maintaining profitability, and establishing long-term relationships with project developers. They may also be interested in supporting sustainable practices and environmentally friendly materials.

Strategies:
1. Offer competitive pricing to attract project contracts while maintaining profitability.
2. Ensure timely materials delivery to meet project deadlines and construction schedules.
3. Offer environmentally sustainable materials and practices to align with project goals.
4. Collaborate with project developers to optimize material usage and minimize waste.

Influence and Interest:

Engineers/Architects:
Influence: High - They provide technical expertise and design solutions, influencing project implementation.
Interest: Moderate to High - They are deeply involved in the project's design and construction.

Investors/Donors:
Influence: High - They have significant financial resources and can influence project decisions based on funding.
Interest: High - They are highly interested in the project's success as it aligns with their investment goals and social impact objectives.

Government:
Influence: High - The government plays a regulatory and financial role in the project.
Interest: High - The project aligns with government objectives for the community development and environmental sustainability.

NGOs/Environmental Groups:
Influence: High - They support environmental protection and community empowerment, influencing project decisions and policies.
Interest: High - The project aligns with its mission and objectives, and they are actively involved in supporting its success.

Material Suppliers:
Interest: Moderate to High - Material suppliers are interested in the project's success as they provide essential construction resources. Their interest may vary depending on factors such as the required volume of materials, the project's duration, and the potential for long-term business relationships.
Influence: Moderate to High - Material suppliers can influence project decisions to some extent, particularly regarding the availability, cost, and quality of materials. Their influence may increase if they hold a dominant position in the market or if they have established relationships with project stakeholders.

Local Community Members:
Influence: Low to Moderate - While they are the primary beneficiaries and operators of the project, their influence may be limited in decision-making processes.
Interest: High - They are interested in the project's success as it directly impacts their livelihoods and well-being, but they may not be as directly involved in its planning and implementation.

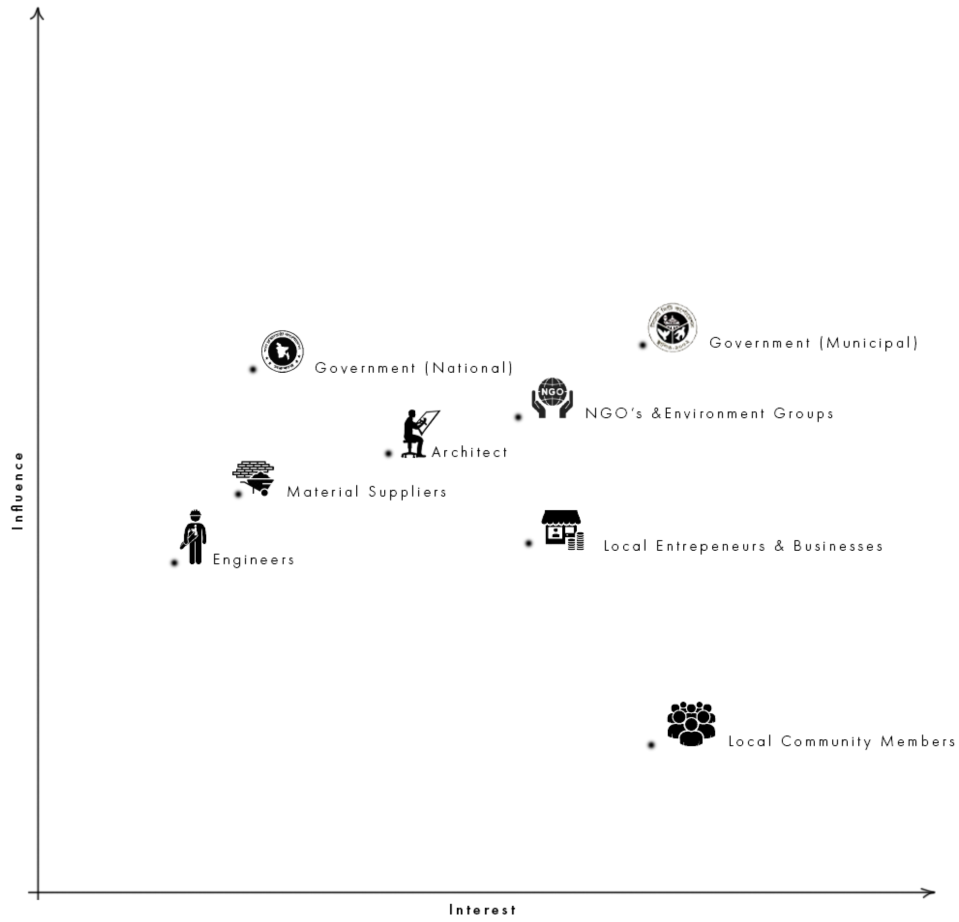


Fig. 139: Stakeholder analysis diagram

Collaboration:

Local Community Members and Engineers/Architects collaborate on the design and construction of houses, providing local knowledge and labour. Government and NGOs/Environmental Groups collaborate on policy development and implementation related to environmental protection and community development.

Dependency:
Community members depend on government support for funding, infrastructure development, and regulatory approvals. Investors and donors may depend on government policies and regulations to ensure a favourable investment environment.

Influence:
Engineers/Architects and Investors/Donors influence the design and implementation of the project based on technical expertise and funding availability.

Support:
Investors/Donors and Local Community Members provide financial support for infrastructure development, housing construction, and community initiatives. NGO's/Environmental Groups and Local Community Members provide support through capacity building, advocacy, and environmental conservation efforts.

Impact:
Government policies and actions can significantly impact the livelihoods and well-being of local community members.

2. Development

Project Initiation:
This is the initial phase where the project is conceptualised and stakeholders are identified. It sets the foundation for further development.

Development:
In this phase, the project is developed further, including detailed planning, feasibility studies, and securing funding and permits. It lays the groundwork for the design phase.

Design:
The design phase involves translating the project concept into detailed plans and specifications. This includes architectural and engineering designs, environmental assessments, and stakeholder consultations.

Construction:
Once the design is finalised, the project moves into the construction phase. This involves building the amphibious houses, infrastructure, and community facilities according to the approved plans and timelines.

Operation and maintenance:
After construction is complete, the project enters the operational phase. This involves managing and maintaining the community, including providing services, ensuring safety, and fostering community engagement.

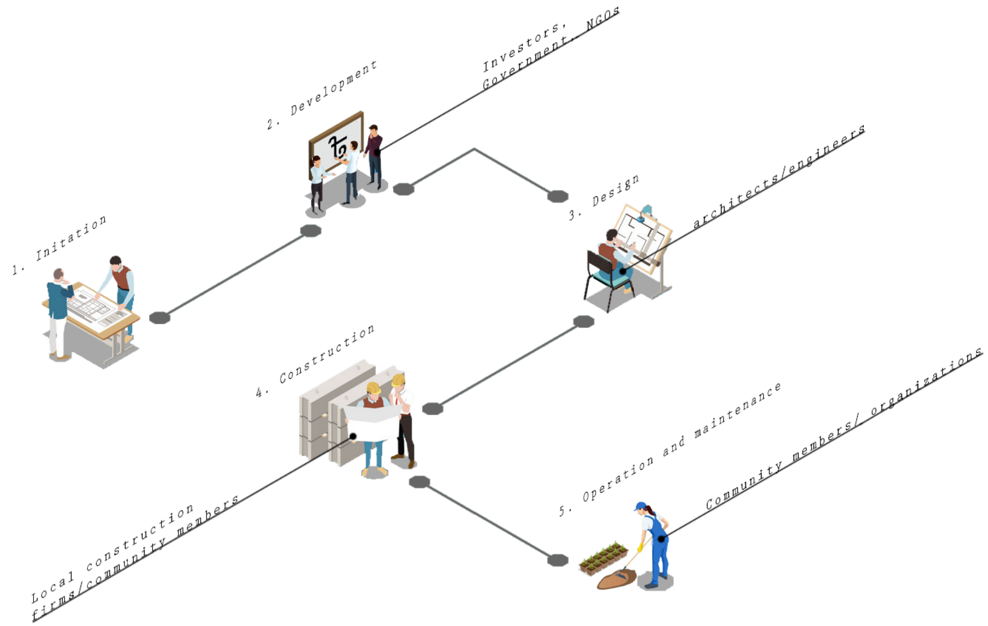


Fig. 140: Project management structure

Phasing

Fig. 141: Phase 1

Fig. 142: Phase 2

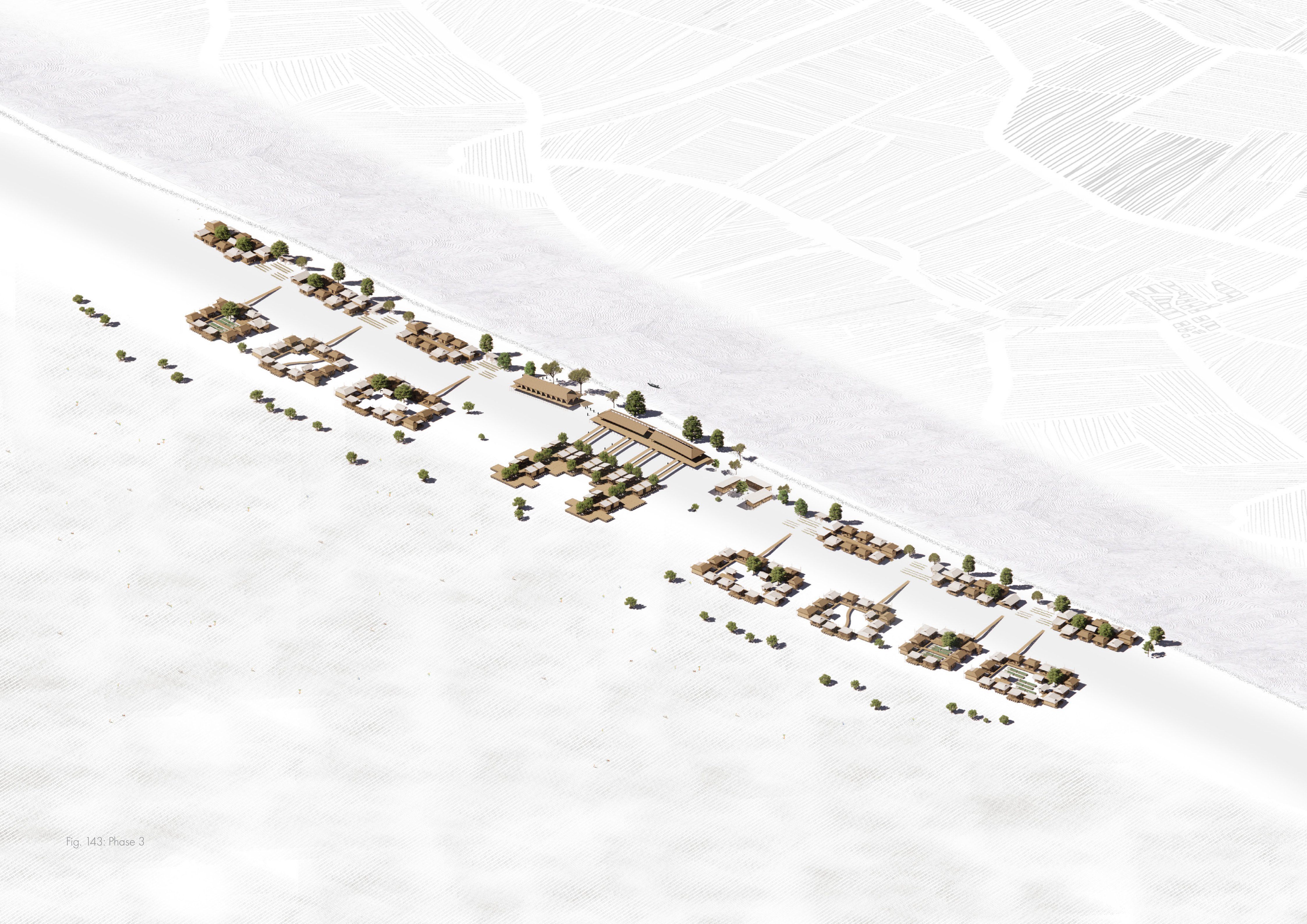


Fig. 143: Phase 3

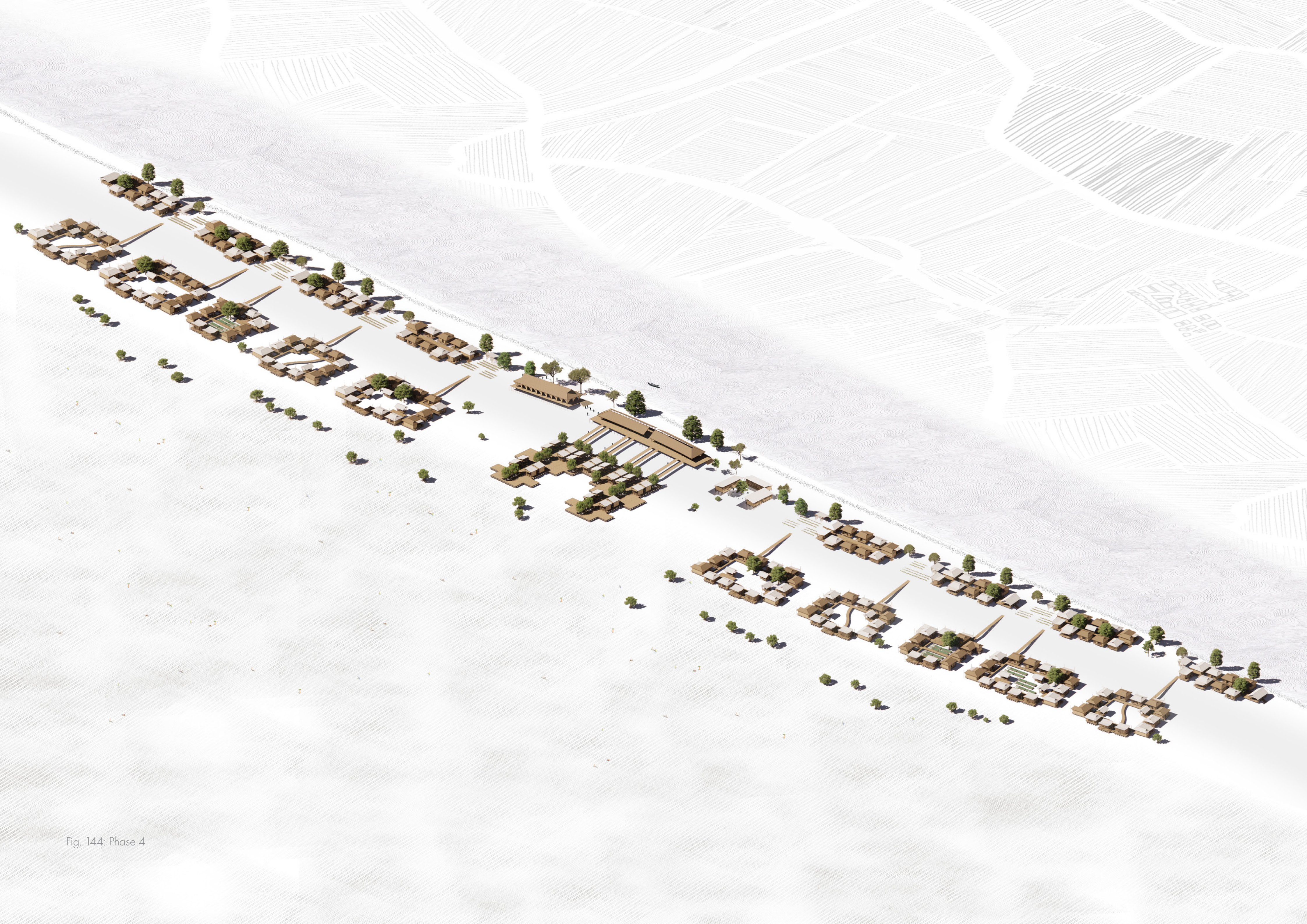


Fig. 144: Phase 4

3. Data Analysis: Social-Spatial Data:

1. Density:
Density = residents/ha
Density = 860/6.5
Density ≈ 132

2. Floor Space Index (FSI):

FSI = (Total built-up area)/(Total land area)
FSI = 8900m^2 / (6.5 hectares x 10,000 m^2)
FSI = 8900 / 65,000
FSI ≈ 0.1369

3. Ground Space Index (GSI):
GSI = (Total built-up area)/(Area of the plot on the ground)
Total built-up area = 8900 m^2
Total land area = 6.5 hectares = 65,000 m^2

GSI = 8900/65,000
GSI ≈ 0.1369

In this housing project in Bangladesh, the Floor Space Index (FSI) and Ground Space Index (GSI) are calculated to be the same, approximately 0.1369. This is because all the houses are single-story structures, meaning the total built-up area is equivalent to the ground area occupied by the buildings. In architectural and urban planning terms, FSI measures the density of the total floor area relative to the plot size. In contrast, GSI measures the footprint of the buildings relative to the plot size. Typically, these differ in multi-story developments where the FSI would be higher than the GSI, reflecting additional floors.

This design is characterized by low density and focuses on amphibious living solutions. The project is divided into two sections: stilt houses and amphibious houses. These two sections are separated by a slope, leaving significant open space, which contributes to the low density of the design.

4. Cost Analysis: Material cost analysis for standard 20m² dwellings

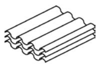
Fig. 146: Housing price amphibious & stilt 20m² dwelling

Fig. 145: Bamboo market Bangladesh

- Ropes are mainly used to tie bamboo joints, they are stronger than steel wire, which rusts over time.

- Re-used plastic/Steel drums are used as floating foundation.

- Bamboo is used for the main part of the construction. Different types of bamboo are used for different purposes. During the fist steps of the development , this material will mainly be purchased at nearby markets. At the same time, a nearby bamboo plantation will be established for future constructions.



- Re-used CI sheets are used for basic roofs.

- For better insulation, rice straw roofs can be applied. This is a choice for the residents preferences. CI sheets could be replaced in the future with these materials when/if this bigger investment shall be possible for the residents.

- Over time, trees could be implemented in the design. They could be used to stabilise the amphibious dwellings during the monsoon seasons. At first, bamboo will be used. The main issue with this material is the needs of maintenance and repair.

Fig. 147: Materials

Material	Source
Bamboo	- Locally sourced from bamboo groves in the area. - Later on from self grown bamboo.
Plastic Drums	Procured from dumping grounds or local shops.
Steel Drums	Sourced from nearby manufacturing facilities or scrapyards.
CI Sheets	- Manufactured locally. - Obtained from nearby towns. - Re-used from demolished houses.
Rice Straw	Harvested from local paddy fields during rice cultivation seasons.
Rope	Crafted from natural fibers such as jute or obtained from local markets.
Tyres	Obtained from local scrapyards or tyre repair shops.

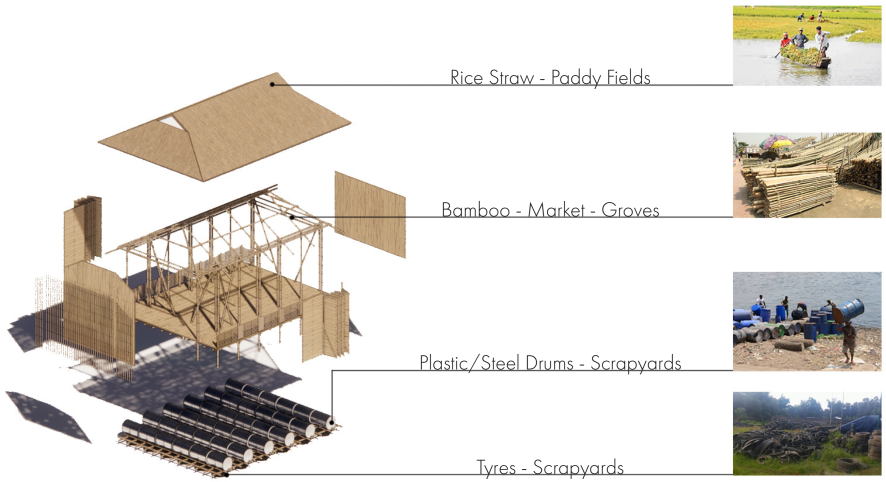


Fig. 148: Materials origin

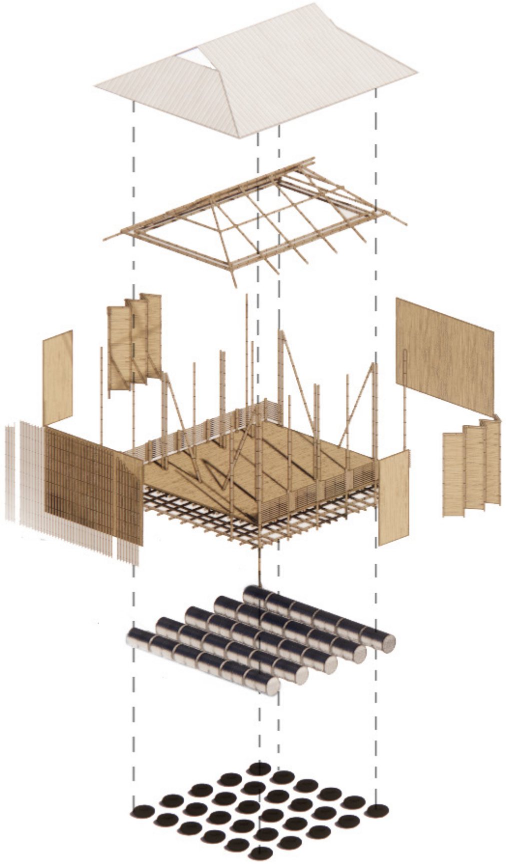


Fig. 149: Amphibious 20m² dwelling exploded view

1. Bamboo roof construction: 136.5m Ø75mm
2. x27 Bamboo beams 6,044mm Ø75mm
3. x12 Bamboo beams 6,385mm Ø75mm
4. x12 Bamboo beams 6,385mm Ø75mm
5. Bamboo floor 38m²
7. 2x 12m² CI sheets
8. 30 used tyres
9. 30 used steel drums
10. Bamboo wall 36.5m²
11. x16 door panels: 16 x 1.9m²
12. x22 bamboo columns: 89.5m Ø75mm
13. Bamboo columns: 68.5m Ø75mm
14. Bamboo slats: 132m Ø30mm
15. Bamboo railing: 128m Ø30mm

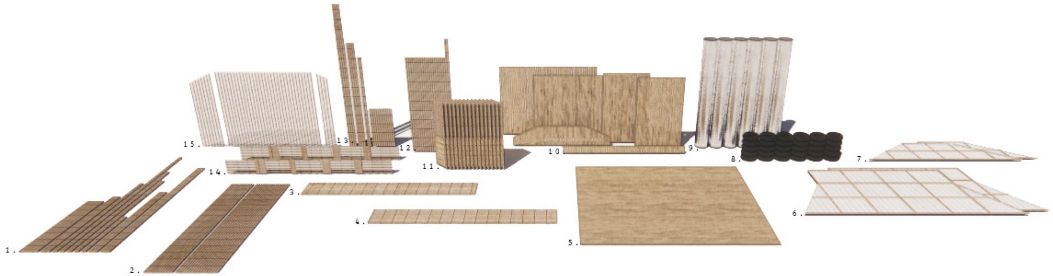


Fig. 150: Material construction package

Material	Quantity	Price ($)	Estimate ($)
Bamboo	Amphibious: 155 Units -> 720 meter Stilt: 415 meter	1.26 (per meter)	907.2 (amphibious) 522.9 (stilt)
Drums	30	9.11	273.3
CI Sheets	13	1,039/Ton 5.97 (New) 2.73 (Used)	35.5
Rope	200 meter	0.091/meter	18.2
Tyres	30	55/ton	15
Land costs		17/sq.m	425
Labor	4 workers/25 days	500	500
Total			2,174 (amphibious) 1,498.4 (stilts)

Fig. 151: Cost analysis standard 20m² dwelling

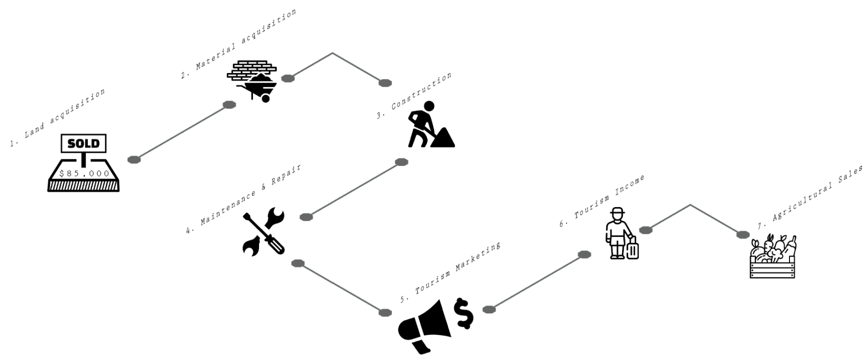


Fig. 152: Construction process

Revenues & Costs

1. Revenue streams

Tourism Income:

15 Tourist houses (40 beds):
- 4 family units/12 couple units

Average daily rate per tourist: $25
Occupancy rate dry season (November to March): 60% - 80%
Occupancy rate monsoon season (June to September): 20% - 40%
Average occupancy rate: 50%

Calculations:
Year 1 (1 family unit/3 couple units):
$25 * (40/4) * (365 * 50%) = $45,625

Year 2 (2 family units/6 couple units):
$25 * 20 * (365 * 50%) = $91,250

Year 3 (3 family units/9 couple units):
$25 * 30 * (365 * 50%) = $136,875

Year 4 (4 family units/12 couple units):
$25 * 40 * (365 * 50%) = $182,500

Agricultural Sales: $30,000

Each house can generate an average of $150 worth of vegetables per year.
There are 200 houses in the community.

Total revenue from agricultural sales per year:
$150/house * 172 houses = $25,800

2. Ongoing Costs:

Waste Management:

Households: 172

Using the same estimated range of waste management costs per household per month ($1 to $5), the monthly cost for waste management collection for the entire community would be:

Estimate: 172 households * $5/household/month = $860/month
Estimate/year = $10,320

Therefore, for a community of around 860 people with an average household size of 5 people, the yearly cost for waste management collection could approximate to $10,320.

Recovery Estimate

1. Initial Investments:

- Land Acquisition (Investors/Developer/Government): $85,000
- Infrastructure Development: $200,000 (includes roads, utilities, and community facilities).
- 64 Stilt Houses Construction: $95,897.
- 104 Amphibious Houses Construction: $226,096.
- Training and Capacity Building: $20,000 (budget for providing training programs to locals in construction techniques and community management).

Total Initial Investments: $541,993

2. Year 1 (43 Built Dwellings):

2.1. Ongoing Costs (per year):

Maintenance and Repair: $390 ($15/Amphibious Dwelling Unit)
Marketing (Tourism attraction): $5,000
Waste management: $2,580

Total Ongoing Costs: $7,970

2.2. Revenue Streams:

Tourism Income: $45,625
Agricultural Sales: $6,450

Total Revenue Streams: $52,075

2.3. Net Income year 1:

Total Revenue Streams - Total Ongoing Costs = $52,075 - $7,970 = $44,105

3. Year 2 (83 Built Dwellings):

3.1. Ongoing Costs:

Maintenance and Repair: $780 ($15/Dwelling Unit)
Marketing (Tourism attraction): $5,000
Waste management: $5,160

Total Ongoing Costs: $10,940

3.2 Revenue Streams:

Tourism Income: $91,250
Agricultural Sales: $12,900

Total Revenue Streams: $104,150

3.3 Net Income year 2:

Total Revenue Streams - Total Ongoing Costs = $104,150 - $10,940 = $93,210

4. Year 3 (129 Built Dwellings):

4.1 Ongoing Costs:

Maintenance and Repair: $1,170 ($15/ Dwelling Unit)
Marketing (Tourism attraction): $5,000
Waste management: $7,740

Total Ongoing Costs: $13,910

4.2 Revenue Streams:

Tourism Income: $136,875
Agricultural Sales: $17,100

Total Revenue Streams: $153,975

4.3 Net Income year 3:

Total Revenue Streams - Total Ongoing Costs = $153,975 - $13,910 = $140,065

5. Year 4 (172 Built Dwellings - Final Design):

5.1 Ongoing Costs (per year):

Maintenance and Repair: $1,560 ($15/ Dwelling Unit)
Marketing (Tourism attraction): $5,000
Waste management: $10,320.

Total Ongoing Costs: $16,880

5.2 Revenue Streams (per year):

Tourism Income: $182,500
Agricultural Sales: $25,800

Total Revenue Streams: $208,300

5.3 Net Income year 4:

Total Revenue Streams - Total Ongoing Costs = $208,300 - $16,880 = $191,420

5. Duration for the initial investments to be fully repaid

Total Investments$^{-\text{Year 1}}$ = Total Initial Investments - Net Income$^{\text{Year 1}}$ = -$541,993 - $44,105 = -$497,888

Total Investments$^{-\text{Year 2}}$ = Total Investments$^{-\text{Year 1}}$ - Net Income$^{\text{Year 2}}$ = -$497,888 - $93,210 = -$404,678

Total Investments$^{-\text{Year 3}}$ = Total Investments$^{-\text{Year 2}}$ - Net Income$^{\text{Year 3}}$ = -$404,678- $140,065 = -$264,613

Total Investments$^{-\text{Year 4}}$ = Total Investments$^{-\text{Year 3}}$ - Net Income$^{\text{Year 4}}$ = -$264,613- $191,420 = -$73,193

Total Investments$^{-\text{Year 5}}$ = Total Investments$^{-\text{Year 4}}$ - Net Income$^{\text{Year 5}}$ = -$73,193- $191,420 = **$118,227**

This project aims to recover its investment within 5 years.

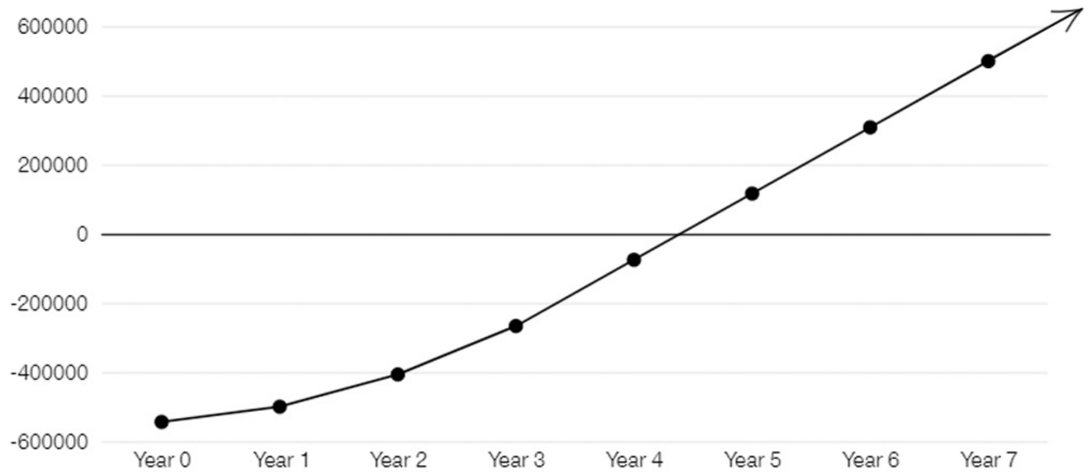


Fig. 153: Cost recovery diagram

04 Reflection

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Relationship Between Graduation Project, Master Track, and Master Programme

My graduation project centred on constructing a resilient floating community in Tanguar Haor, Bangladesh, which aligns with the Global Housing studio theme within the Architecture master's track of the MSc Architecture, Urbanism and Building Sciences (AUBS) program. This effort explores the combination of sustainable and adaptable living spaces within the unique wetland ecosystem of Tanguar Haor, addressing the complexities between environmental adaptability and socio-cultural dynamics. The studio's focus on dwelling in the global south broadens the contextual understanding necessary for creating habitable, resilient spaces across diverse environments. The architectural track provides students with skills and theoretical knowledge essential to tackle the architectural challenges in such a project. Moreover, the multidisciplinary nature of the MSc AUBS program, including aspects of urbanism and building sciences, is important in providing a holistic perspective. This ensures that the project meets architectural standards and integrates all the elements of sustainability, community planning, and technological innovation.

The Influence of Research and Tutoring on the Design

The carried out research significantly influenced the design process. Initial research into the socio-economic conditions, environmental challenges, and cultural aspects of Tanguar Haor shaped the direction of my design choices. For instance, understanding the seasonal flooding patterns and the community's reliance on water resources guided the decision to develop amphibious structures that adapt to fluctuating water levels. As the design progressed, feedback from my mentors highlighted the need to integrate vernacular architectural elements and emphasise the community's lifestyle preferences. This led to further research into local building techniques and cultural practices, which refined the proposal into a more affordable and location-adapted design. At the start of the project, I sometimes found

myself initiating a design that failed to integrate all the aspects of my research, which eventually led to a dead end.

Overall, the tutoring helped me to work towards this final design proposal and often gave me a new perspective on the direction I was working towards. I tended to stay with the initial ideas I came up with without taking a step back and keeping my options open. These tutoring sessions often made me take this step back and look at the broader picture, allowing me to ask myself other questions regarding the assignment. At the start of the graduation year, I had undervalued the discussion as part of the tutoring sessions as a design method.

An example would be a situation that followed my P2 design proposal, where the design was questioned for its contextual integration. Not finding a feasible solution, other complications followed this chosen design. By asking myself regarding my design over aspects that I, until this point, I sometimes neglected, I could see that this design would eventually fail to convince if pursued. This helped me to take several steps back within the design process, seeking other solutions. By having to start over, I was able to reinitiate the design process, knowing that I had to question every choice I made and and consider possible implications. This helped me to create an integrated design where most decisions are connected.

The tutoring and feedback I received throughout the year significantly influenced my design process. While I did not adopt every suggestion, the input I received often gave me new ways of thinking and encouraged me to question different aspects of my work, which, I suppose, is the whole idea. However, presenting the same element to different tutors sometimes resulted in contradictory feedback. This experience highlighted that seeking a single correct answer is not always necessary. Instead, it is crucial to understand what best suits my design. It also taught me the importance of knowing when to stop exploring options and make final decisions to proceed with the design. Additionally, this process underscored the necessity of well-reasoned arguments for these final choices, ensuring they withstand given criticism.

Process: Value of Approach, Methods, and Methodology

This final design reflects the research and feedback. I tried my best to employ a cyclic design process, where research-informed design and vice versa ensured the project's development and the methods used, including ethnographic, comparative, and contextual research, were essential in generating informed design solutions adapted to Tanguar Haor's context.

Phase 1 - Phase 2

Before heading to Bangladesh, we aimed to gather as much information as possible for our Global Housing studio so that each could develop a research plan. I settled on resilience and vernacular architecture as my focus areas. My research plan reflected my preferences, leaning towards practical and technical aspects. Hence, resilience became the primary subject of my thesis. However, the studio's objectives emphasised the importance of other architectural aspects, not just technicality.

Following the field trip to Sylhet, the core subjects of my research plan remained unchanged, but I saw room for improvement in how I applied them into my design. My initial idea was to create a design bridging urban and rural spaces, addressing both environments. However, I needed something more suitable for my research after exploring potential sites. Eventually,

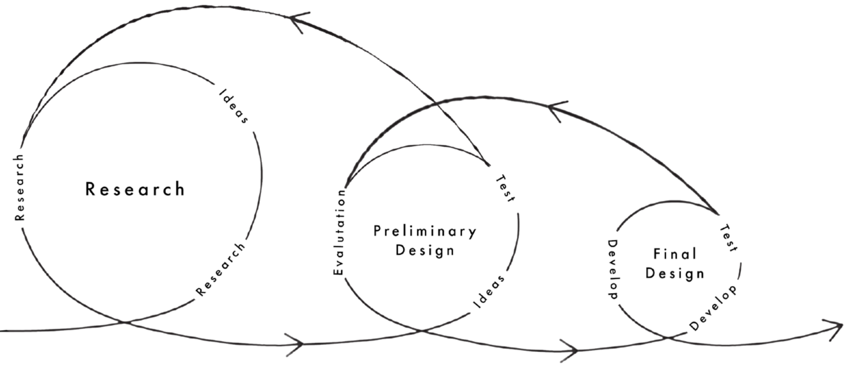

Fig. 154: Cyclical design process

a trip to Bolawara, a village on the outskirts of Sylhet, provided the perfect fit. Upon reflection, I realised I struggled to create a strong design for that location, driving me to switch my focus to Haor, an urban area, for a more stable ground to work with. This decision marked a shift from rural-urban to solely rural research, clarifying my direction and moving past the uncertainty of the initial design phase.

Phase 2 - Phase 3

The uncertainty of a successful outcome with the choices made can be challenging. I learned that solid research knowledge is not always enough. This is why I often started with one of the first ideas from the research and then worked on a trial-and-error approach. This way of working continuously made me question all the design interventions. By instantly making several proposals, I became more familiar with the situation we had to deal with than only the comparative and contextual analysis would give me. From these proposals, I was able to see different added values that each one can bring. I often interrupted the design and tried to blend best assets. This way of working provided me with a solid knowledge base, combining different ideas with solutions so that from this point onwards I was able to elaborate in detail. I have encountered issues with knowing what to do or not to do.

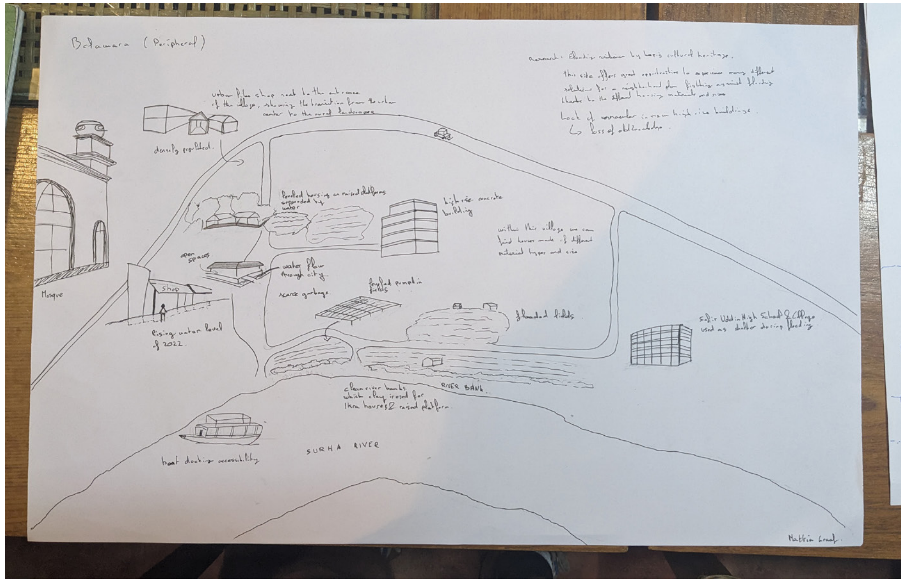

Fig. 155: Bolowara analysis

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Tradition within Innovation

(Design Hypothesis)

Ecotourism: In spite of its relative inaccessibility and lack of facilities, it is an attractive area for ornithologists and bird watchers. If the environment for tourism can be developed, the local economy can be boosted.

Floating Gardens: A large portion of the local people at Tanguar Haor are extremely poor. Therefore, the locals need to become self-reliant by providing alternative forms of employment in order to reduce the pressure on the haor resources during the flood periods.

Raised Plinths: Raising the plinths with flood resistant materials is essential for the safeguarding the livelihoods of local communities and fostering a more sustainable and secure environment.

Cyclone Resisant: Architectural designs and materials engineered to withstand the impacts of cyclonic storms, offer a possible shelter that ensures the safety and well-being of residents.

Bamboo: Its lightweight yet robust composition are leveraged to create dwellings that not only withstand cyclones but also contribute to environmentally conscious and cost-effective solutions

1. Current Situation:

Within the current state of the settlement, houses are built closely next to each other, with, for example, stables next to the residents' sleeping areas. This deprives the residents of spaces to go outside in times of high water levels.

Most of the existing homes are not ideally constructed and are not built to resist heavy winds or flooding. Nor are the houses equiped with sustainable systems.

2. Proposed Situation:

This renewed plan based on Banni Rajasthan village plans showcases the importance of temporality by considering a design that works at all times throughout the year.

Here, one household can be divided into separate buildings, each having one function, such as the kitchen or the sleeping area. This would create more resistant housing against disasters and indirectly create improved outdoor spaces.

The accessibility of other spaces within the plan during high floods could be improved by levelling the walking paths. One of these buildings would accommodate tourists to generate a separate income for the residents.

Another form of income can be created by ponds that would be dug to form a space for floating gardens, which can not be placed on the river's water due to its current.

This new plan would be constructed using locally available materials. This includes building against disasters with circular housing. Water collectors would enhance the sustainability of the area.

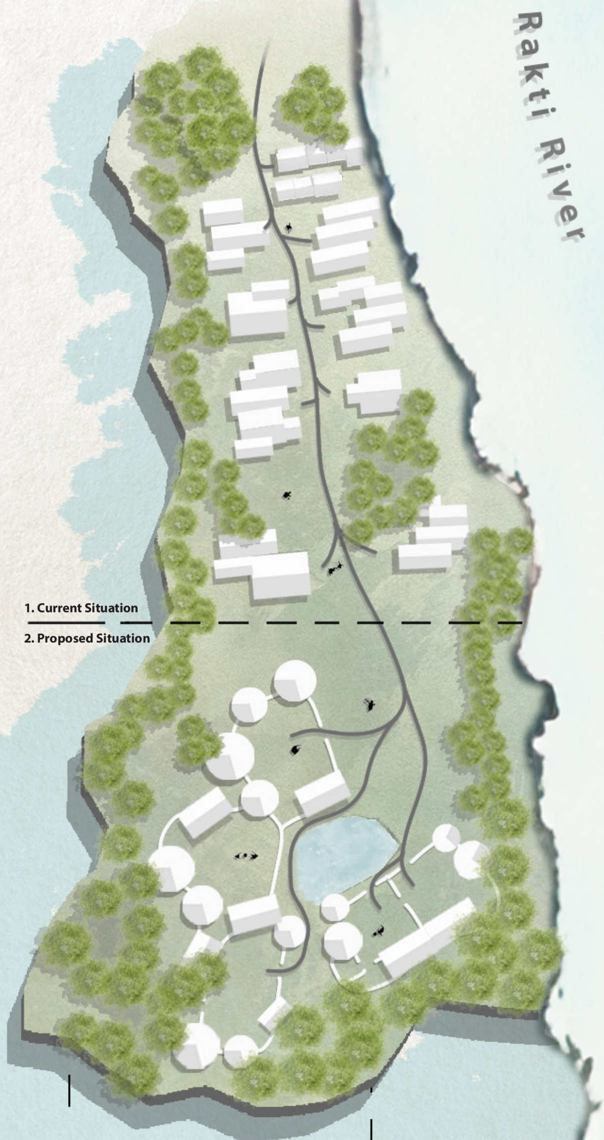

Fig. 156: Phase 1 poster

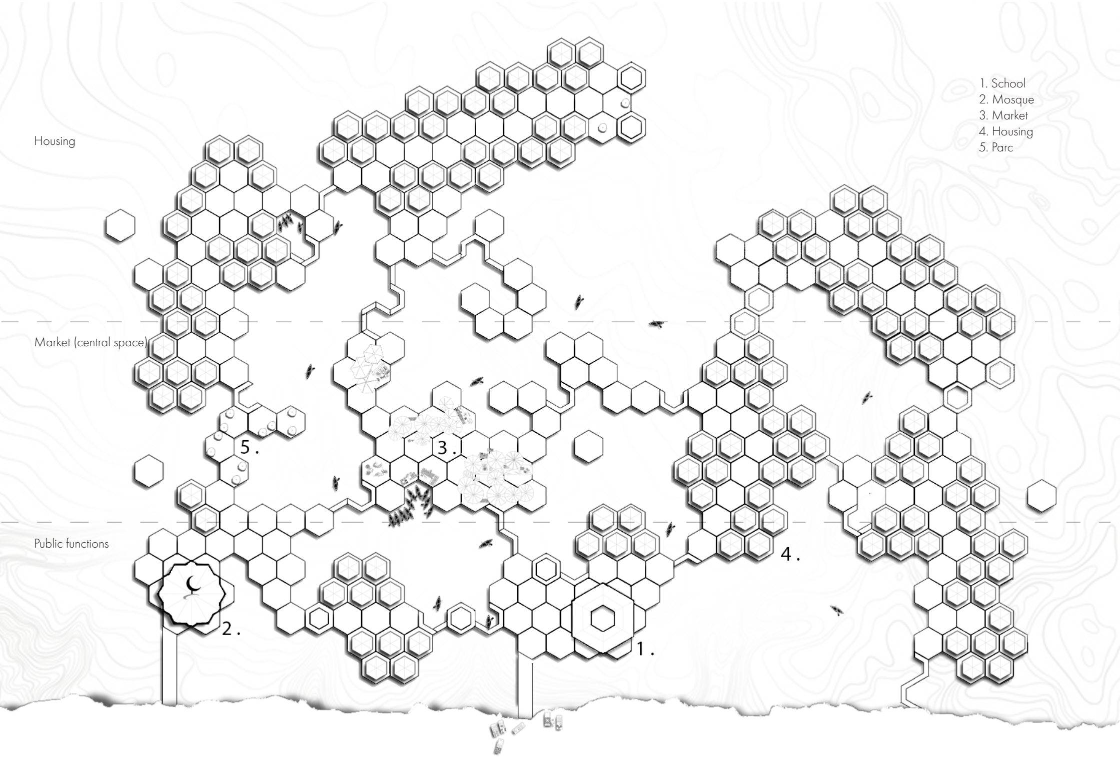

Fig. 157: Phase 2 masterplan

Fig. 158: Phase 2 dwellings impression

Fig. 159: Phase 2 cluster impression

Fig. 160: Phase 2 vegetable garden impression

Fig. 162: Phase 2 street impression

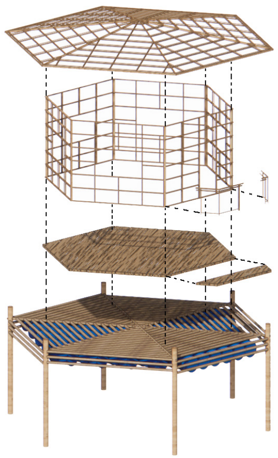

Fig. 161: Phase 2 construction

A construction possible to be reproduced within the capacities of the residents.

Reusing materials for an affordable sustainable solution:
- Tyres
- Drums
- Plastics bottles
- PVC pipes

Images: Arcadia Education Project
- Saif Ul Haque Sthapati

Image: Floating floor on amphibious house in Bangladesh

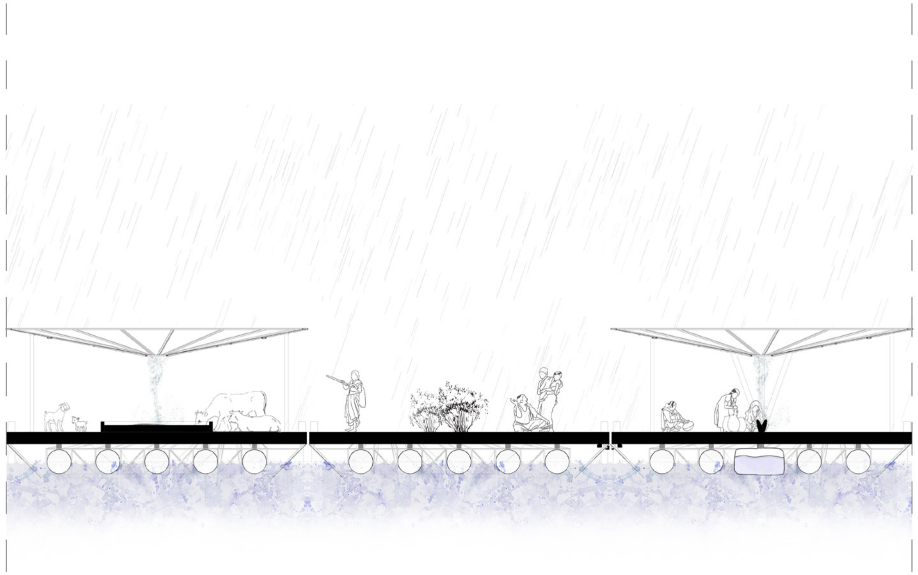

Fig. 163: Phase 2 stables & cooking area impression

This is what happened after my P2 when I completely changed the configuration of my design. Since all the ideas and main structure stayed the same, the amount of time I had to spend to change the design into a more fitting representation in this environment was quite manageable. Towards the end of my design, I reused a lot of the work done for this first effort. Within the following technical and managerial phases, I found my design to become more and more realistic. It surprised me how much the managerial part influenced the technical aspects of the designed dwellings. For example, when calculating the buoyancy of a separate house, I found that I had used three drums too many that could be used as water harvesting tanks. This would allow a family of five to use a week's clean water next to the shared water pump and serve as a water ballast system. Thus, by going into more detail, I was able to adjust this design with many more features improving the housing and, thus, the quality it would bring to the possible residents. Through this methodology, I arrived to the same conclusion as in the P2 presentation, which is that exploring many possibilities results into unique fitting solutions. After these two phases, I implemented this into my masterplan; however, I was still uncertain about its configuration. This site level also started forming after facing most aspects of the detail scale. This led me to understand that it is often necessary to move to another scale to find the right solution. I finished everything I wanted for the P3 review. I then started developing my ideas and products in more detail and visualised the project into atmospheric impressions by reusing pictures I took from the site visits. These impressions are pleasant to look at, allowing to perceive this project on a human scale and visualise how people can use these developed ideas.

I am finalizing my graduation booklet for my final presentation. I would love to continue exploring and developing some ideas I wrote on the infinite amount of lists I made during this project. However, another lesson I have learned is dealing with limited time. Therefore, it is wiser to leave these ideas for now and spend my leftover time building models. In this report, I have tried to the best of my ability to answer the posed research

Fig. 164: Pictures of ideas, lists and work methods

question with my design and analysis and have developed this design in more detail than I imagined possible at the beginning of this graduation year.

Academic and Societal Value, Scope, and Ethical Implications

The project's academic value lies in addressing resilient housing design in flood-prone regions, offering insights into sustainable architecture and urbanism practices. Societally, the project addresses pressing housing needs in vulnerable communities, promoting social equity and environmental responsibility. Ethically, the project prioritises community engagement and empowerment, ensuring that the proposed solutions align with local values and aspirations.

The Value of Transferability

The project's transferability extends beyond Tanguar Haor to other flood-prone regions globally, particularly in the Global South, where flooding poses significant challenges to lesser-developed housing security and resilience. The adaptable design principles and innovative construction techniques can be applied in similar contexts, fostering resilience and promoting sustainable development. By acknowledging the shared vulnerabilities faced by communities in the Global South, the project offers scalable solutions that transcend geographical boundaries. Moreover, the process-oriented approach employed in this project can serve as a model for interdisciplinary collaboration and community-driven design initiatives, facilitating knowledge exchange and capacity-building across regions.

Cultural Sensitivity, Long-Term Sustainability, and Maintenance Strategies

Throughout my design process, I prioritised cultural sensitivity and contextual appropriateness by integrating local traditions, customs, and cultural identities into my design solutions for the resilient floating community in Tanguar Haor. For instance, I implemented reused drums as a floating technique for the dwellings. I repurposed plastic bottles to create floating vegetable gardens aligned with sustainable principles while addressing food security concerns. I implemented maintenance strategies based on the local context to ensure the project's long-term sustainability. Bamboo, a key material in my design, requires annual reapplication of gaab fruit liquid to maintain its durability and resilience against water degradation. Similarly, the drums used in the floating structures need yearly repainting with waterproof paint to preserve their structural integrity and buoyancy over time. Moreover, this design embraces the principles of modular expansion and adaptability. The houses are based on local vernacular architecture, using building techniques that align with the community's construction practices. Initially designed to mitigate flood risks, stilt houses can be retrofitted into amphibious houses as rising tides heighten, ensuring adaptability to changing environmental conditions. Additionally, the modular nature of the design allows for the expansion or addition of modules, accommodating the evolving needs of the community while fostering social cohesion and inclusivity. By integrating cultural sensitivity, long-term sustainability, and maintenance strategies into my design approach, I aimed to create a resilient floating community that addresses immediate challenges and empowers the local community to thrive in the face of environmental uncertainties.

Equity and Inclusivity

In my design process, I prioritised equity and inclusivity by dividing the houses into stilt and amphibious dwellings while ensuring that both share the same frame structure. This decision aimed to address the diverse socio-economic situations of the community in Tanguar Haor. Stilt houses were designed to be more affordable and accessible, offering a housing option within reach for a more significant portion of the residents. Through cost-effectiveness and simplicity in construction, these stilt houses aim to provide basic shelter and security to residents with limited financial resources. The shared frame structure between the stilt and amphibious houses facilitates future adaptability and resilience. The stilt houses can be retrofitted into amphibious houses when the initial investment has been repaid and/or when rising tides necessitate it. This approach allows for a phased transition towards more resilient housing solutions, ensuring that residents can gradually upgrade their homes as their financial means allow or as environmental conditions evolve. By offering a range of housing options with the potential for future adaptability, the design promotes social equity and inclusivity.

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