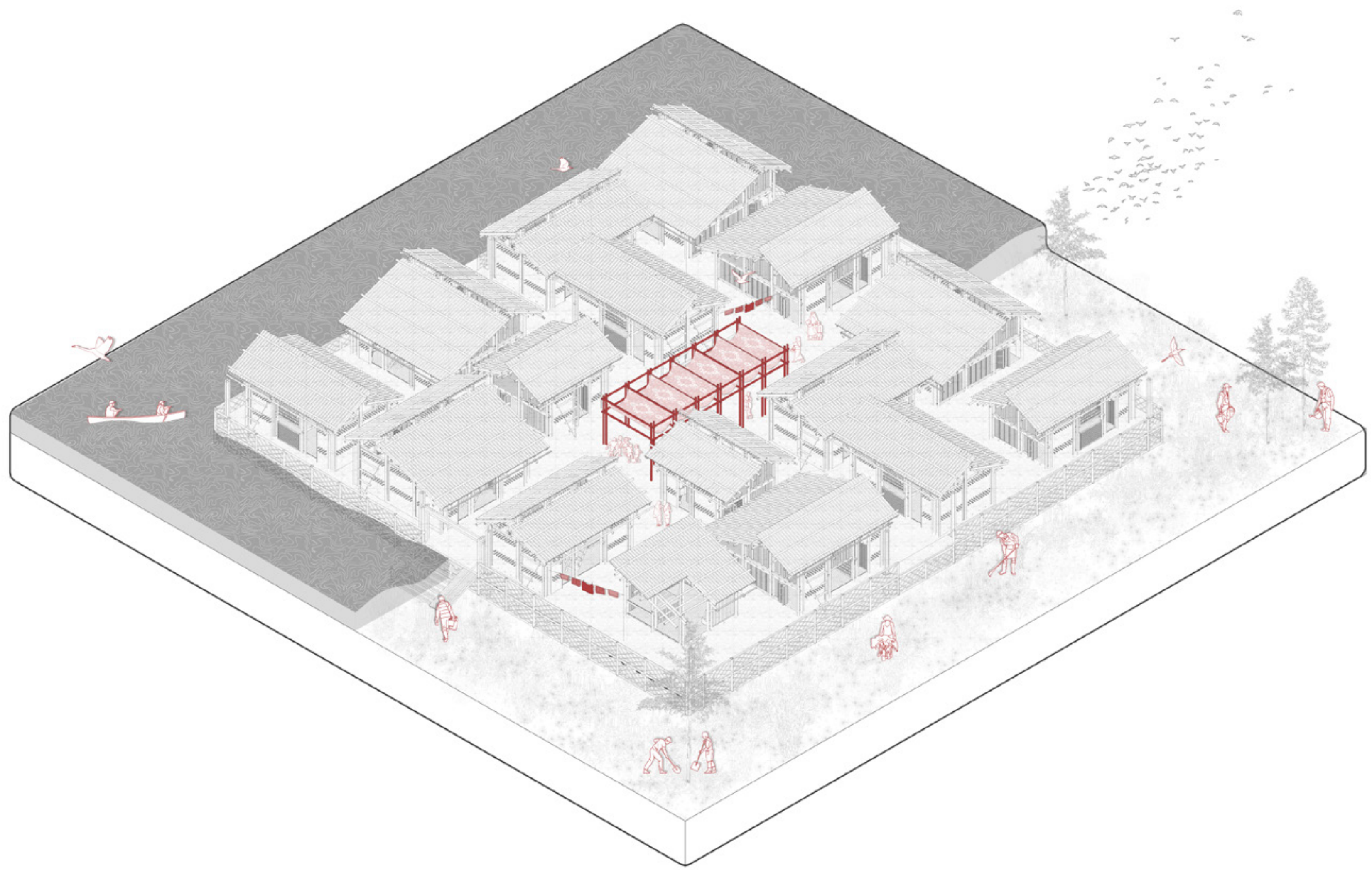
Global Housing Graduation Studio



Architecture of Transition in the Bangladesh Delta

Built on Shape Shifting Land

A Transition towards Amphibious Living

How can the development of **amphibious housing solutions** for **vulnerable urban environments** such as **Sylhet** act as the foundation and key driver for the transition towards **floating cities** as a viable response to **climate change**

01 Research
Ethnographic Research

Throughout the field visit to Bangladesh, the social, economic, and cultural dimensions of the local population were closely examined. Particular emphasis was placed on the varying degrees of social engagement and the spatial configurations that facilitated these interactions.

The Community

Visiting Sylhet

The Shonatola community is made up of three different types of dwellings. The current village sits at an elevation two meters above the agricultural land that surrounds it. The agricultural land makes up 219260.035sq.m of the site (54 Acres)

- Brick
- Concrete
- Bamboo and Tin

The Shonatola Community
Sylhet, Bangladesh

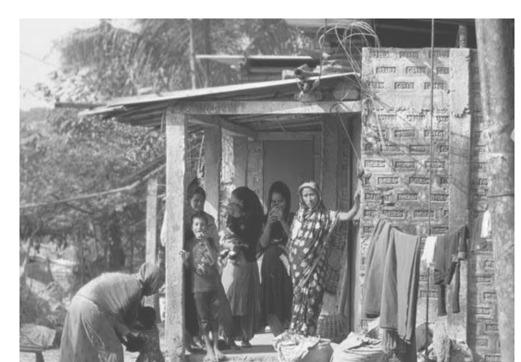
During our site visits, we documented the site boundaries, dwelling types, bodies of water and other notable features to ensure a clear understanding of the context. We also had the pleasure of speaking with the community members to further understand their current and future needs for their families and communities

Neighbourhood Market
Communal Area

Large Open Areas
Communal Area

Small Courtyards
Semi-Private Area

Between Dwellings
Semi-Private Area



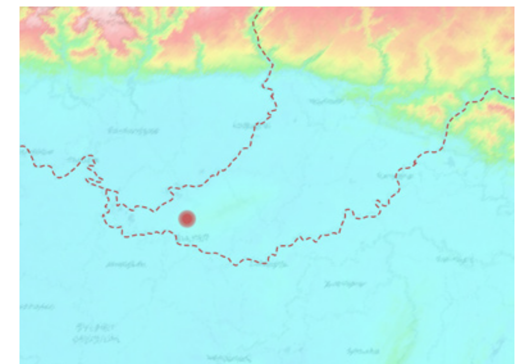
The “Veranda”
Private Area

Relationship with Water

The Shonatola Community

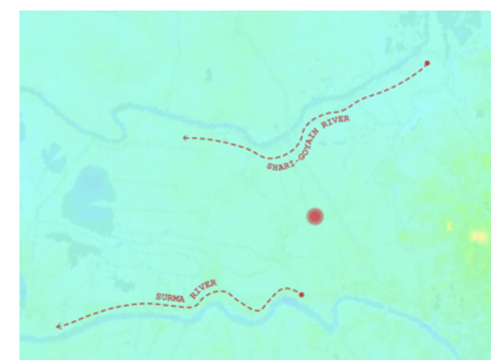
The west end of the site sits at the lowest elevation of approximately 10m. With the east end of the site at an elevation of approximately 13-15m. The site has elevations varying at approximately 4m.

Based on the topographies of the site, the following assumptions can be made for the flow of water



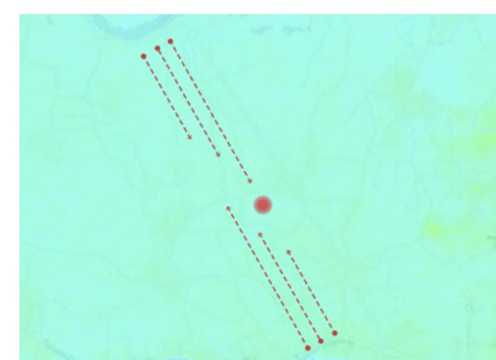
Highest to Lowest Elevation

The rivers flow from the mountains on the north east towards the bay of benga in the south.



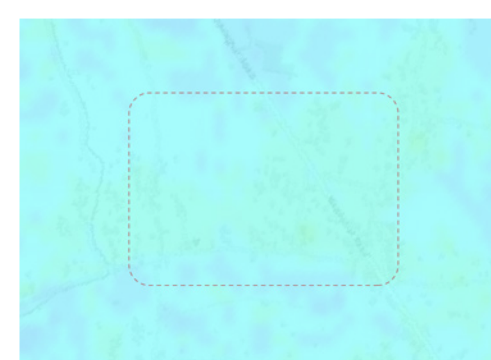
Two Rivers

The Shari-Goyain river to the north and the Surma river to the south.



2km from the Site

Once the river is at capacity water will begin to flow towards the lowest elevations



Site Elevations

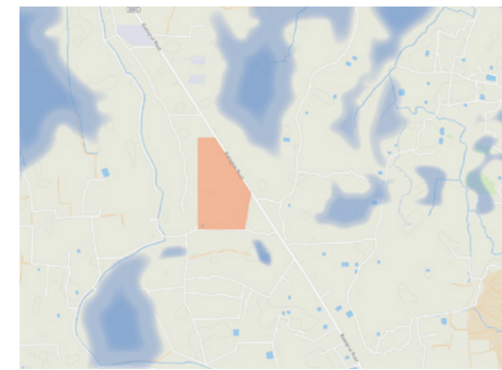
The Shonatola Community sits 2m above the agricultural land

Through the Seasons

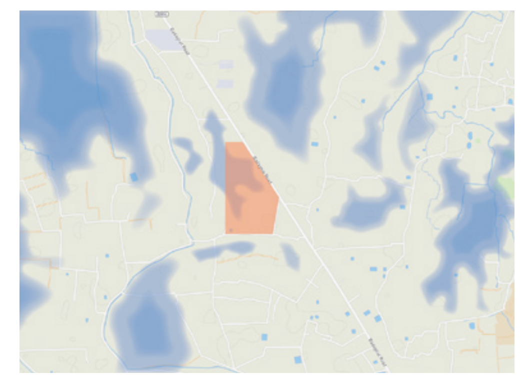
The Shonatola Community

> Predictions made through ClimateChange.org are based on the following criteria

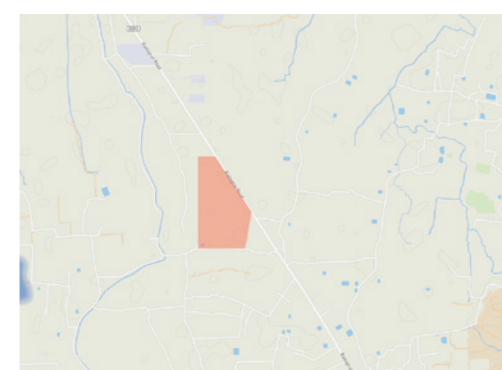
April	- Summer	Pre-Monsoon 61-100mm
May	- Summer	
June	- Rainy	Monsoon > 200mm
July	- Rainy	
August	- Autumn	
September	- Autumn	
October	- Late Autumn	Post-Monsoon 6-30mm
November	- Late Autumn	
December	- Winter	Winter 6-30mm
January	- Winter	
February	- Spring	Pre-Monsoon 61-100mm
March	- Spring	



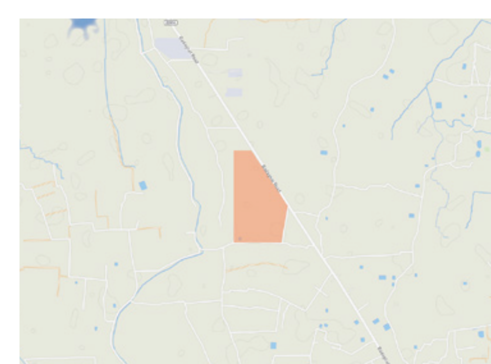
March 2024
Pre-Monsoon



June 2024
Monsoon



September 2024
End of Monsoon



January 2024
Winter

The Community

The project is designed with the community in mind. The project aims to transition the community members living within bamboo and mud housing towards amphibious dwellings due to the threats posed by the ongoing climate crisis. As well as aid in the need for affordable housing for surrounding community members employed in the city

Climate Refugees

The project acts as a prototype for transitioning vulnerable suburban communities around the world towards floating cities

02 Managerial Framework

Project Development

Placing the community at the core of this development, the implementation process is fundamentally centered on active and ongoing engagement with the Shonatola community. This includes a series of participatory steps such as consultations, workshops, and collaborative planning sessions designed to incorporate local knowledge, address community needs, and ensure that the proposal aligns with their social, cultural, and economic contexts

Stakeholder Analysis

Project Feasability

The projects feasability is based on the relationships fostered among a series of individuals and groups

Architect

Stakeholder

Role

The objective of the role is to identify the project's goals and objectives, conduct research and feasibility and formulate proposals that address the current and future needs of the community

Strategies

Through the incorporation of the local community, local materials and building techniques the design process aims to produce scalable and replicable design principles

Local Community

Stakeholder

Role

The primary beneficiaries and participants in the construction process. The community is involved in all aspects of the project, to ensure their traditions and needs are met and respected. They are the voter population for the CLT Board

Strategies

The community is to be involved through out the design process, to ensure their cultural, social and economic needs are met

Goverment

Stakeholder

Role

The government's cooperation is crucial for providing the infrastructure and permits for the project's realization

Interest

The interest lies on the development of viable solutions for the ongoing climate crisis, impacting millions of people within Bangladesh

Local Suppliers

Stakeholder

Role

The fostering of relationships with local suppliers to provide payment plans for the community, and provide material expertise and advice

Interest

As a prototype for amphibious communities, relationships could be fostered for future collaboration

NGO's

Stakeholder

Role

World Bank Credit, specifically under the "Resilient Infrastructure for Adaptation and Vulnerability Reduction (RIVER)" project, will be used to provide financing for the raft construction

Interest

Provide funding and technical expertise and monitor the project as a prototype for future amphibious developments Within vulnerable communities

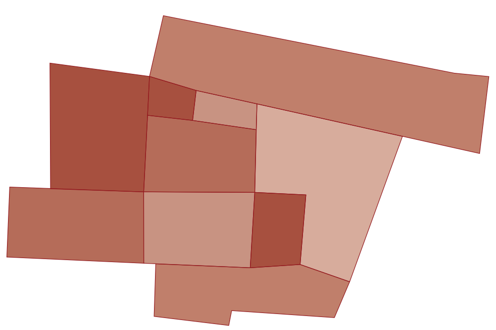
Land Acquisition

CLT Fund

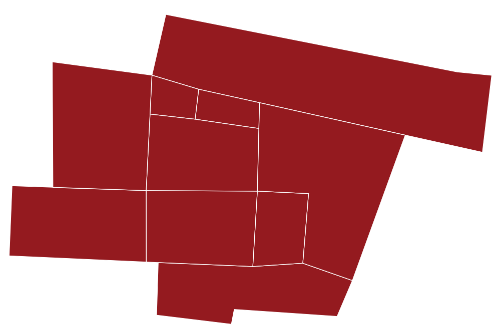
A Community Land Trust (CLT) is a non profit organization that holds lands on behalf of a place-based community.

The CLT will serve as the longterm steward for affordable housing, community spaces, commercial spaces and community assets

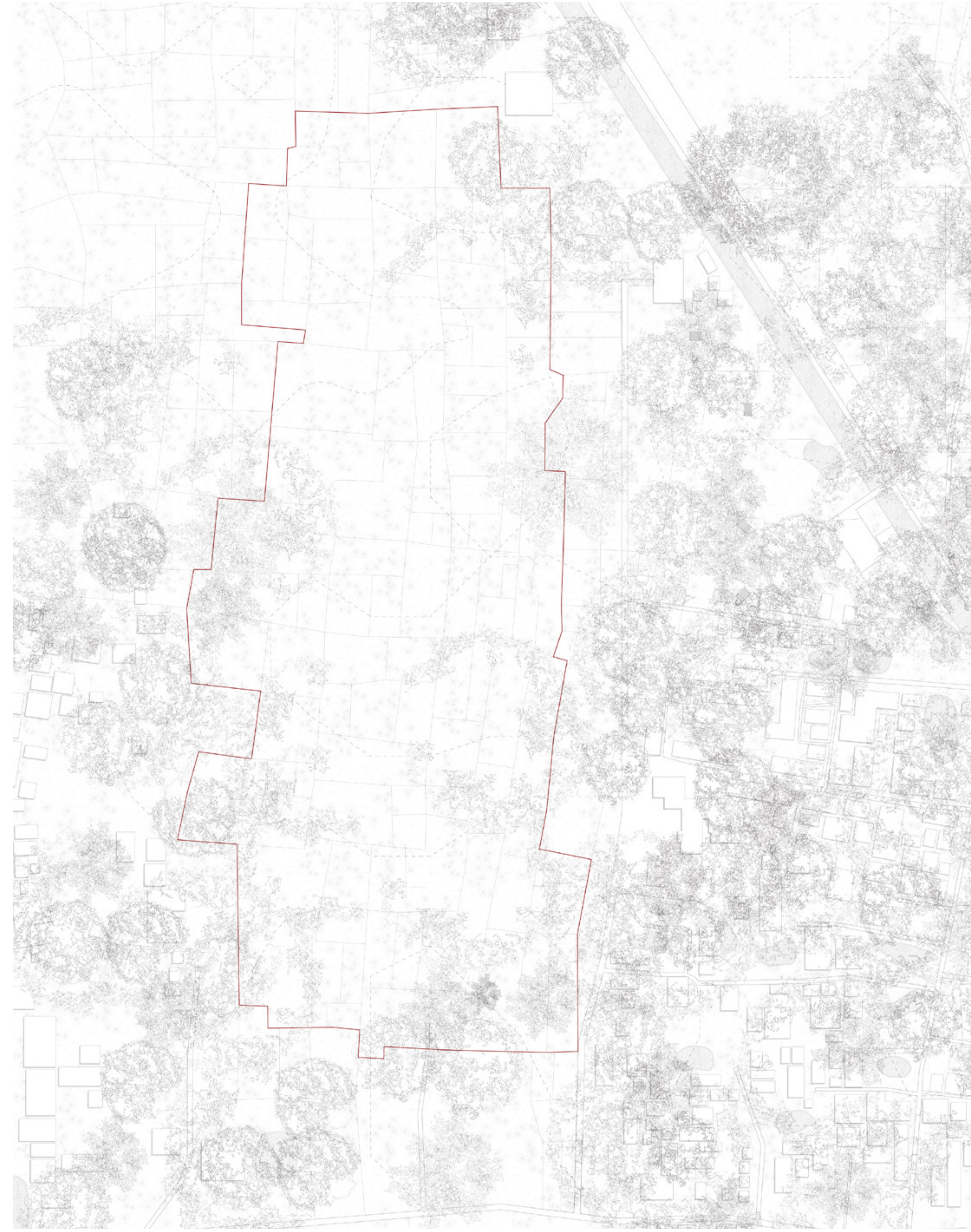
Control of the trust is by an elected board of community members and other stakeholders



Small Individual Owned Plots



Combining into *One Single* **Landholding**



Land Plots

Various Ownership Demonstration

Bamboo Planting

Bamboo and Mud Walls

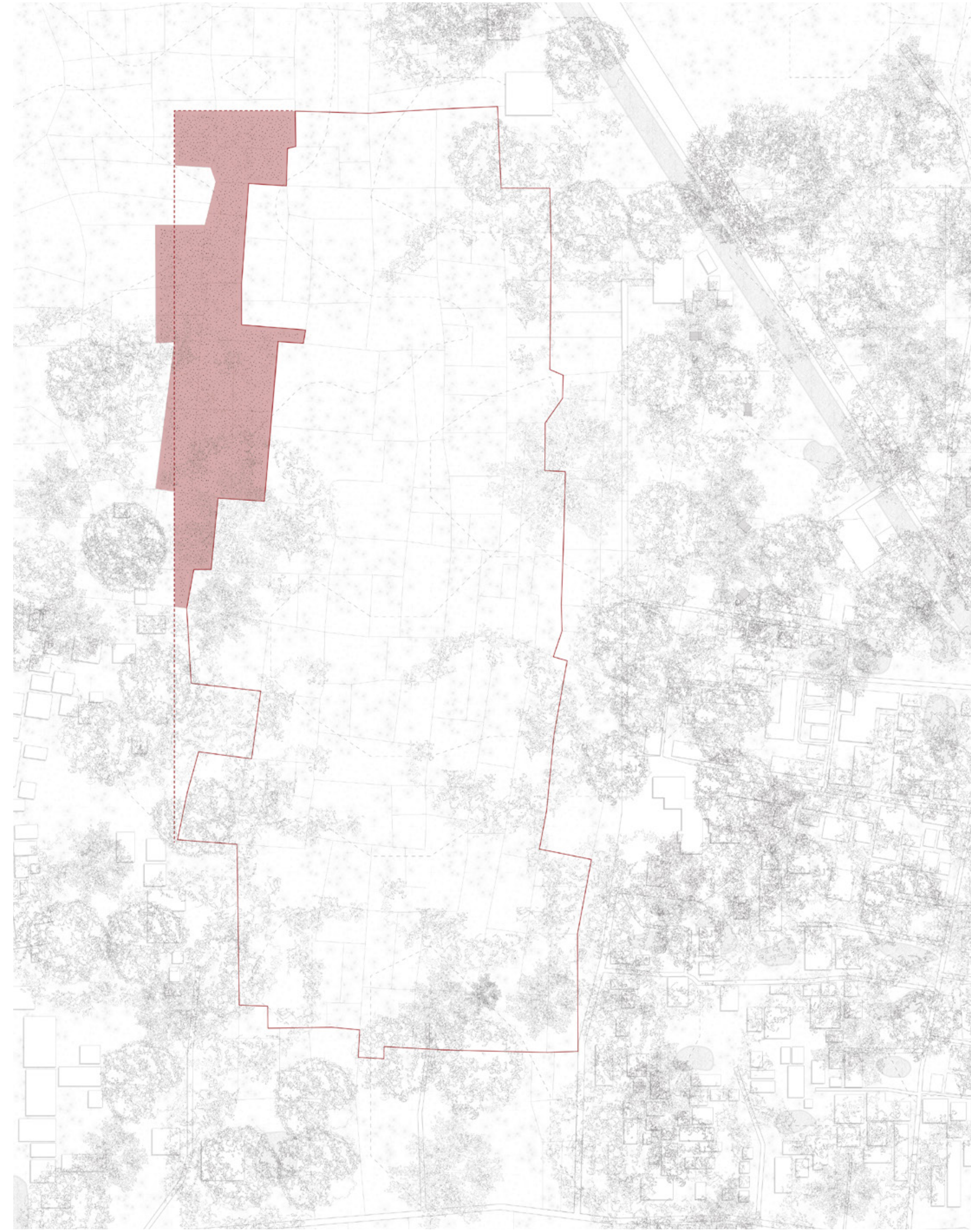
Area Required for Project

Four Rafts per year

- 160 Clumps x 25 sq.m - - 4,000 sq.m
- 4,000 sq.m - Approximately 1 acre

The community will have to start planting 3-5 years before the project begins, if the bamboo will be harvested in a newly planted site. As such, the bamboo needs to be planted during the planning and design phase of the proposal, to mature in time of building.

Another option, is for the community to begin by harvesting existing forests for the beginign faces of the project while the planted bamboo matures. In either case 25% of the bamboo will be harvested in order to maintain a continous cycle of harvesting



Bamboo Harvest
Appoximately Five Acres

Materiality

Bamboo and Mud Walls

> A selection of bio sourced materials were utilized within the project

Bamboo

- Local Material

All Bamboo species utilized are native to Bangladesh

- Strength

Tensile strength comparable to steel and a compressive strength similar to concrete

- Lightweight
- Fast Growing Plant (Regenerative)

Grows much faster than traditional hardwoods

- Economic Benefits

Supporting local economies

Mud and Lime

- Thin Walls
- Lightweight
- Carbon Neutral
- Flexible
- Thermal Mass (Porous)

Moderate fluctuations of temperature

- Cost-Effective

Affordable Material

Steel Bolts

- Life Span

Life Span equal to Bamboo

- Strength
- Dismountable
- Easy Application

Traditional rope connections require specialized skill

Bamboo Connections
Bolted

Bamboo Connections
Bolted

Mud & Lime Walls
Permanent

Mud & Lime Walls
Permanent

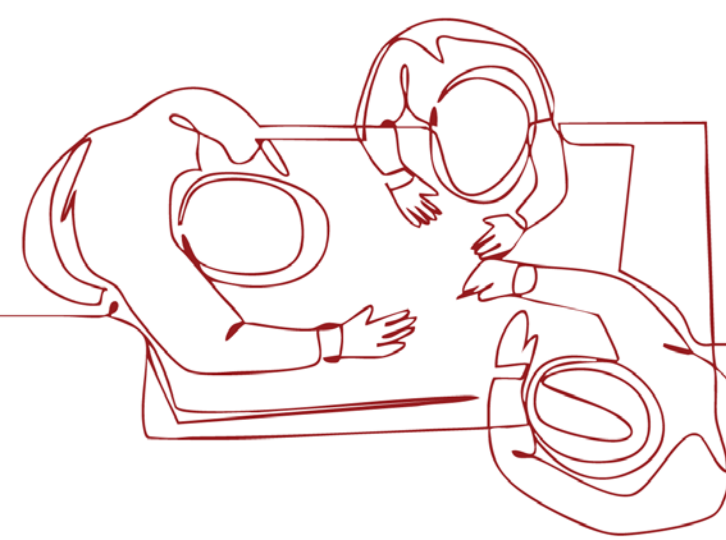
Mud & Lime Walls
Permanent

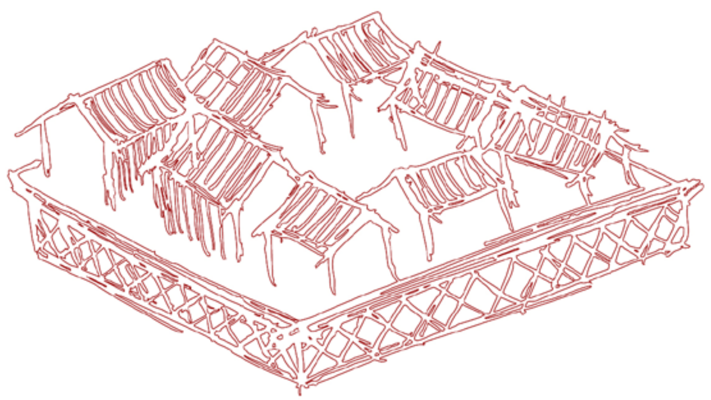
Woven Bamboo Walls
Non-Permanent

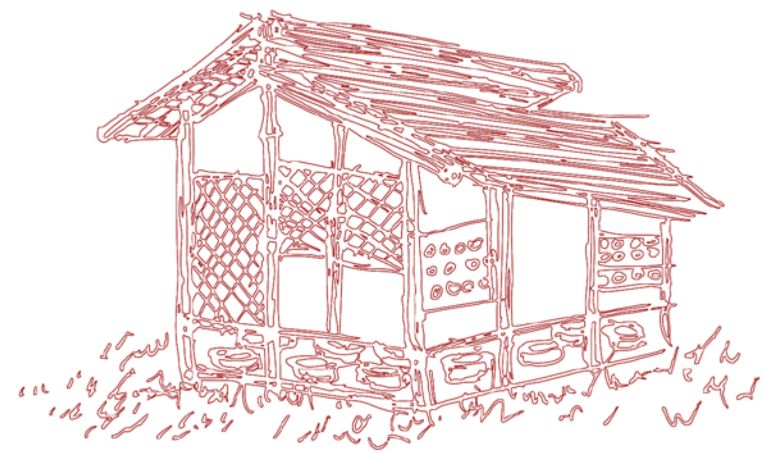
03 Design Scales

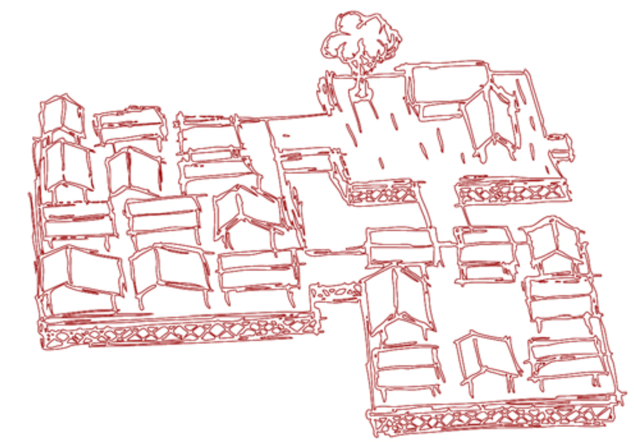
Design Principles

The proposal aims to offer a viable strategy for transitioning the Shonatola community toward amphibious living typologies. To ensure the approach is contextually appropriate, a set of guiding principles has been developed to address the community's social, economic, and cultural needs.









The Raft

Top Down Approach

A specified raft dimension and dwelling quantity is provided

Bottom Up Approach

The community can decide which dwelling types make up their raft

The Dwelling

Top Down Approach

The base dwelling design and dimensions are provided

Bottom Up Approach

Each household can dictate the configuration of their own dwellings through a series of bamboo panels

The Master Plan

Top Down Approach

A set of rules is provided to ensure the plan responds to the site's relationship with water

Bottom Up Approach

The masterplan is flexible based on the site and community factors

Project Scales

Raft, Dwelling & Master Plan

Program Requirements

Key Characteristics

The creation of self reliant communities is at the forefront of the proposal. As climatic situations worsen, the dependency on existing infrastructure is unstable

Vernacular Techniques

Construction process to be undertaken by the community

Local Materials

Investing in the local community and their economy

Affordability

A solution for vulnerable communities

Incremental Housing

Meeting the ever-changing needs of the occupant

Viable Response

Combating yearly flooding and preparing for rising sea levels

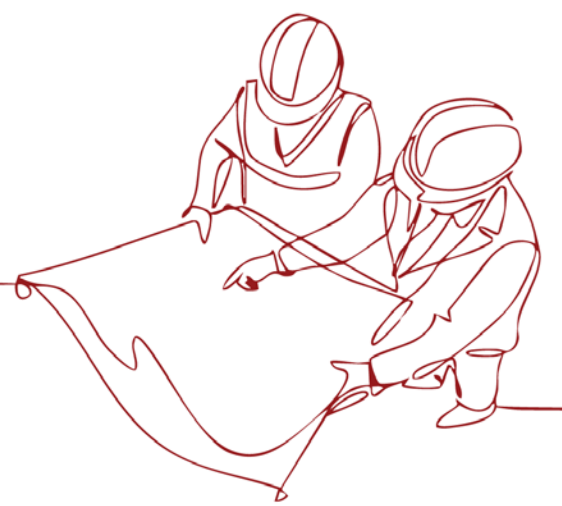
Ubiquitous within Bangladesh

Meeting the everchanging needs of the community

03A The Raft

"Heart of the Project"

At the heart of the architectural proposal lies the raft, envisioned as a catalyst for establishing a resilient, water-based community. It aims to foster a strong sense of social cohesion and interpersonal relationships, even in the absence of permanent land. The design strategically incorporates a range of social scales—ranging from intimate to collective spaces—to support cultural expression and communal interaction, both of which are fundamental to Bangladeshi social life.



Case Studies
Analysis and Documentation

A curated selection of design interventions, drawn from a broad spectrum of projects, forms the basis of this study. Although the projects differ in their contextual and cultural frameworks, the interventions examined yield significant insights and propose viable solutions. Through comprehensive analysis, a collection of precedents was established, each of which played a direct role in shaping the final proposed design.

Case Studies

- The Buoyant Foundation Project, Nicaragua
- Makoko Floating School, Nigeria
- Floating house, Sunamganj District

The Buoyant Foundation Project
Raft Design

Makoko Floating School
Flotation Devices

Floating Bamboo House
Flotation Devices

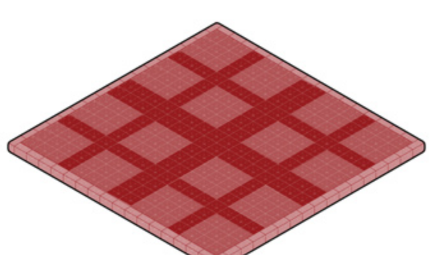
The “Raft”

The heart of the project

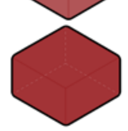
The proposal is based on the idea of the “Raft”. This component has been designed in a way that respects the cultural, economic and social aspects of the Bangladeshi culture.

Although the story of the “Raft” will take place within the Shonatola Community, its flexibility, scalability and modularity allow it to be implemented within vulnerable communities around the world.

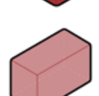
For the “Raft” to meet an FSI of 1.0, the larger dwellings must be favoured.



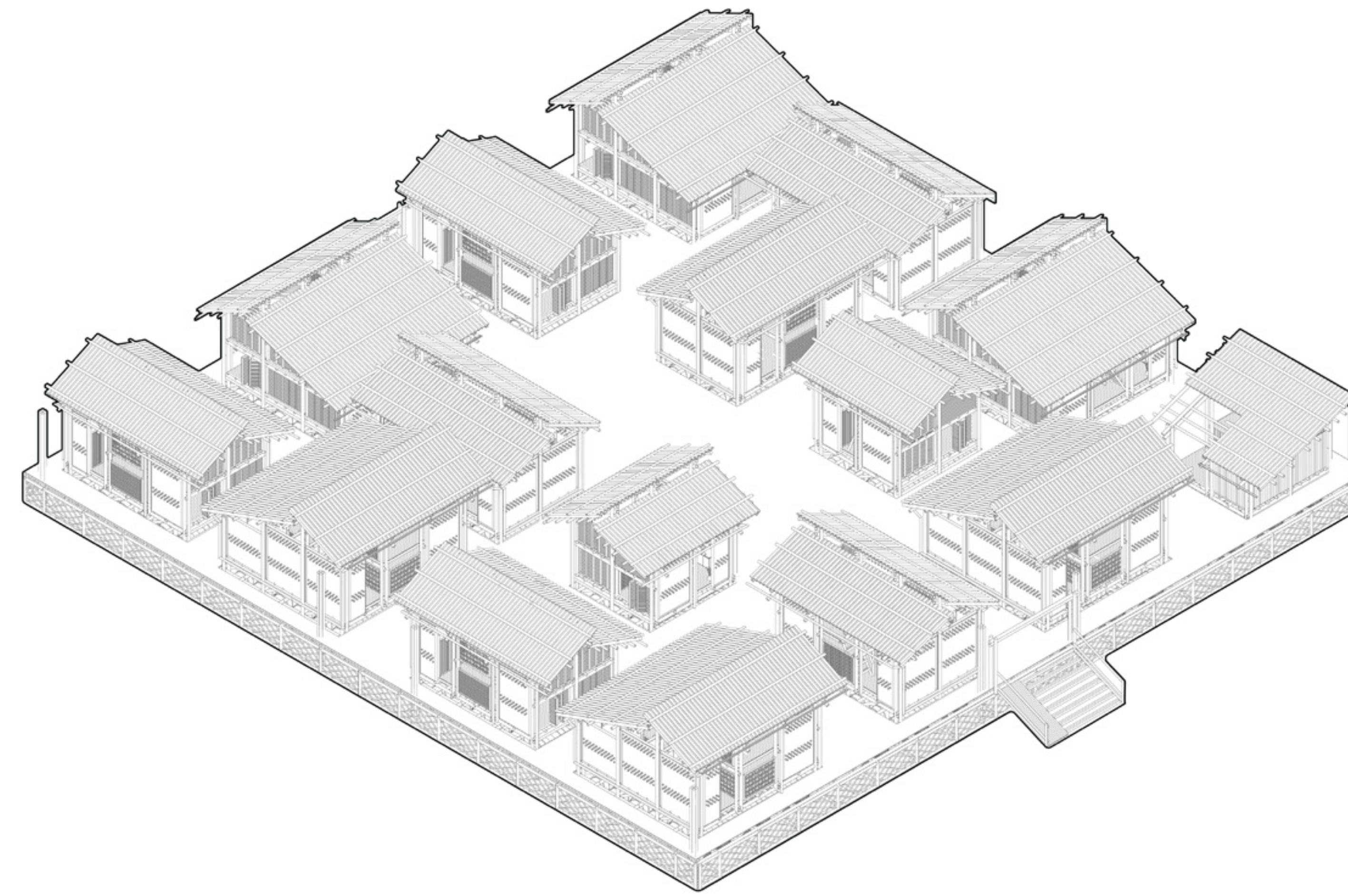
Living
2.5 x 2.5 x 1.5
96 Cubes per Raft



Communal
2.5 x 2.5 x 1.5
112 Cubes per Raft



Boundary
1.25 x 2.5 x 1.5



“A number of para’s (groups of dwellings) comprise a mohalla, meaning a village”

The “Raft”
Overall

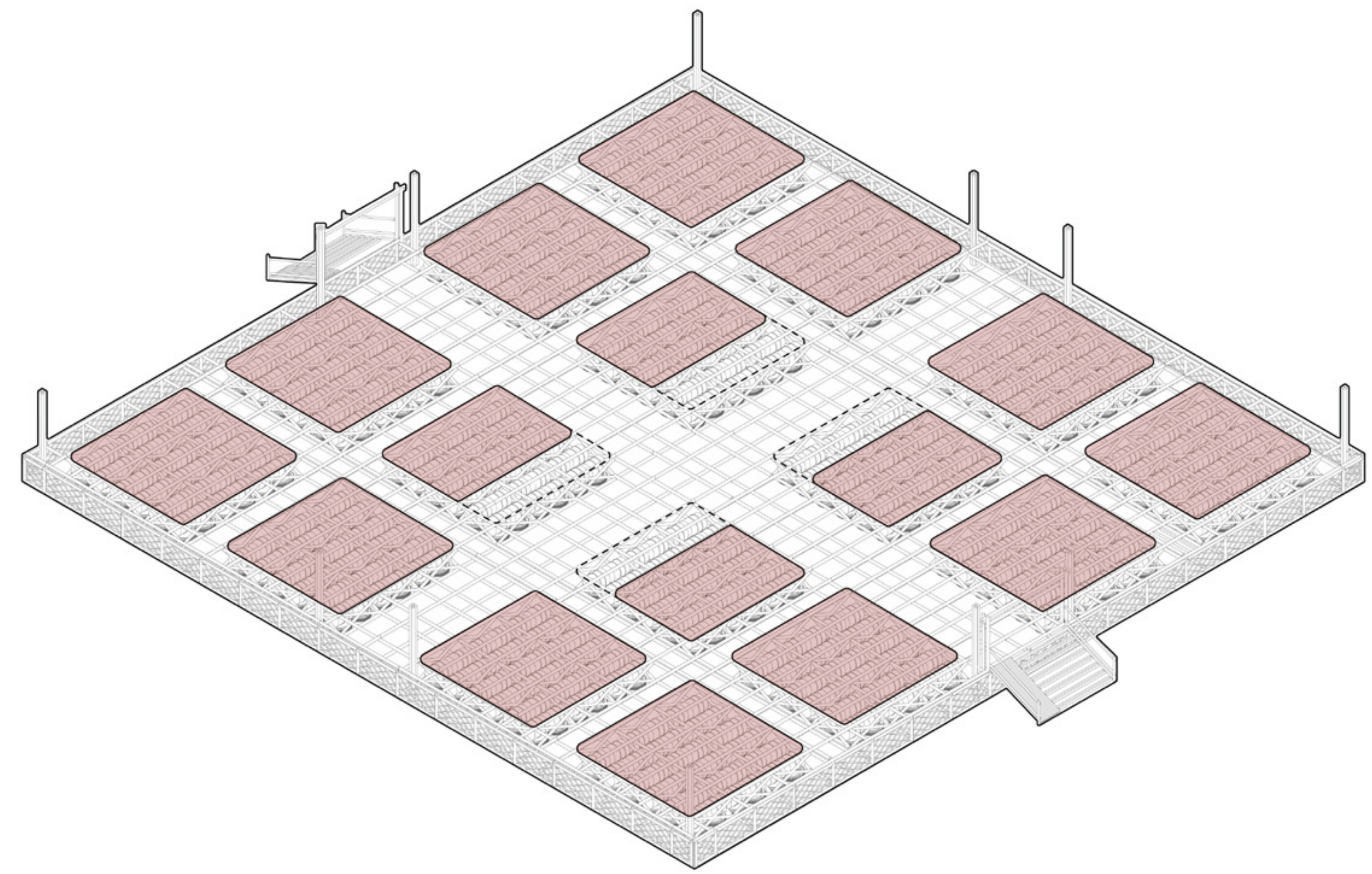
Plot Areas

The “Raft”

Each “Raft” can accommodate 15 homes and a space for livestock. There are three dwelling types that can be implemented within the raft

The plot areas allocated are 12 large plots of 56.25 sq.m and four smaller plots 37.5 sq.m. The smaller plots act as the framework for the communal area within the raft

The design encourages varied dwellings to be clustered in groups of four, to create pockets for communal outdoor spaces



The “Raft”
Plot Areas Impression

68 Cubes per Raft

Social
The "Raft"

Although the "Raft" is a flexible component that allows communities to dictate the way they live, the number of dwellings and their arrangements are designed to foster different levels of social engagement based on Dunbar's Number

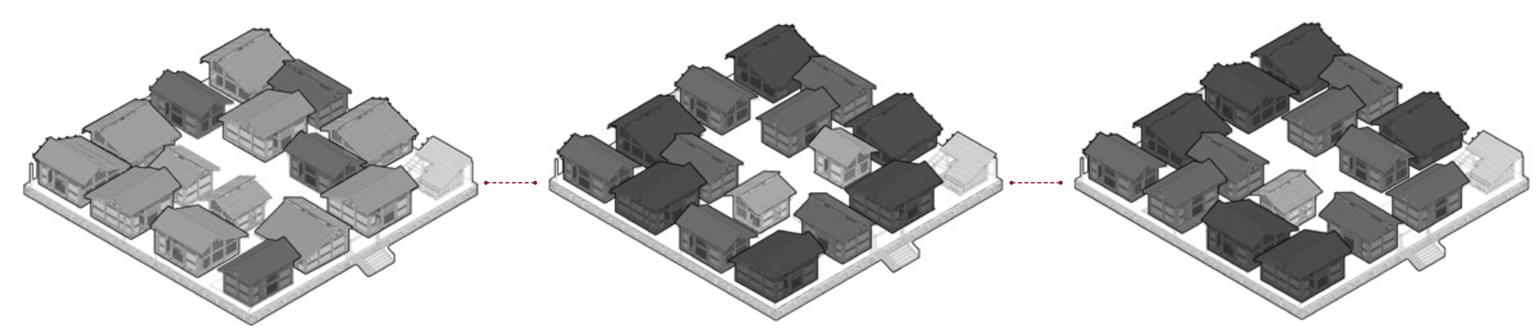
Dunbar's Number is a theory proposed by British anthropologist Robin Dunbar, suggesting that humans can maintain stable social relationships with approximately 150 people

The theory relates to the neocortex, the part of the brain responsible for cognition, language, and sensory perception

Within this group, it is theorized that individuals can have about five intimate friendships. The concept has been influential in understanding social networks and relationships

The Theory -

150 PEOPLE - A TRIBE
50 PEOPLE - A CLAN
15 PEOPLE - A SYMPATHY GROUP
5 PEOPLE - A SUPPORT GROUP



The "Raft"
Dwellings

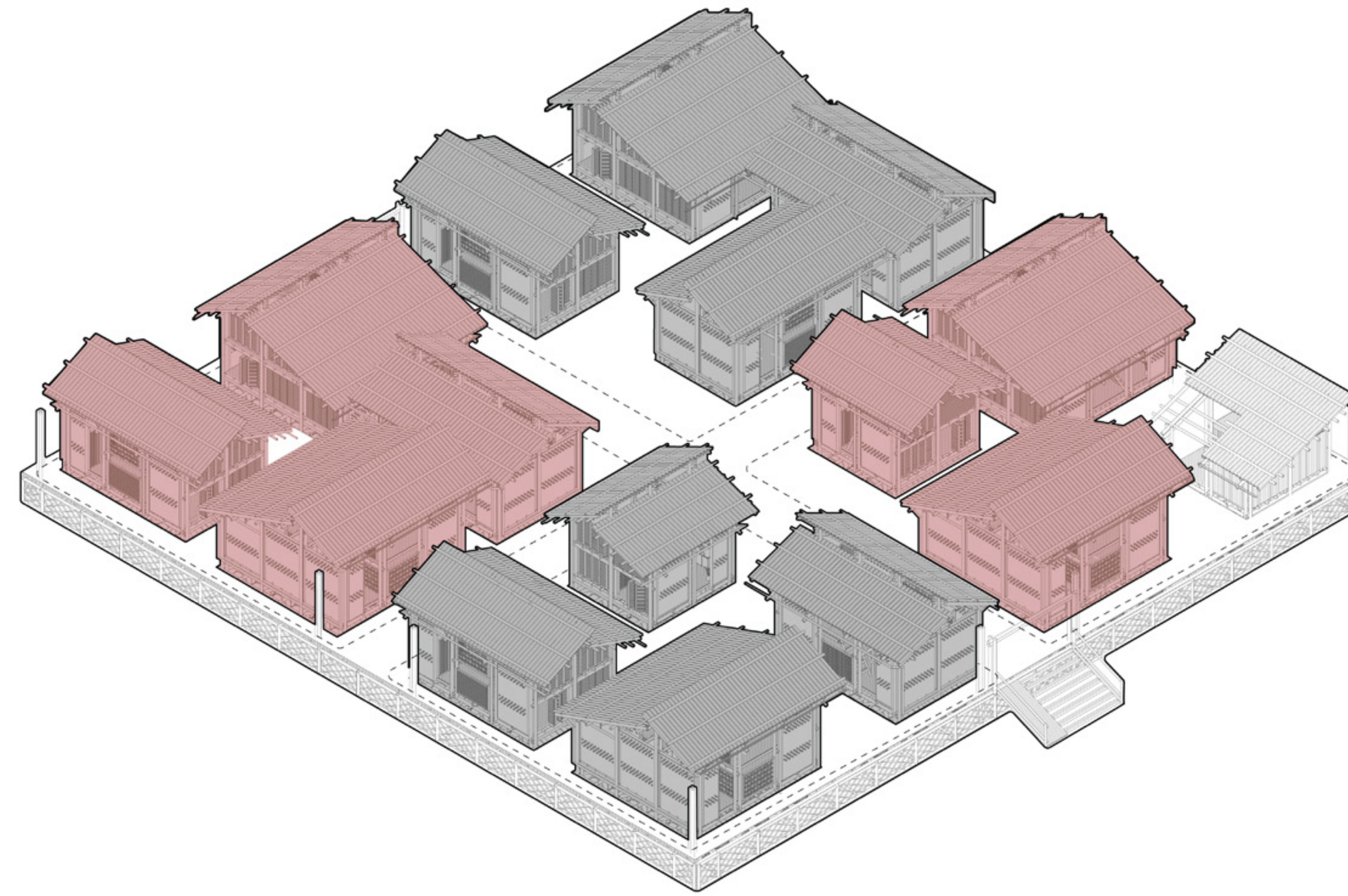
Social

The "Raft"

Within the larger raft smaller groupings of four dwellings have been created. This allows for a second form of social engagement within the larger community

The Theory -

150 PEOPLE - A TRIBE
50 PEOPLE - A CLAN
15 PEOPLE - A SYMPATHY GROUP
5 PEOPLE - A SUPPORT GROUP



"A number of bari (a dwelling) grouped together is a para"

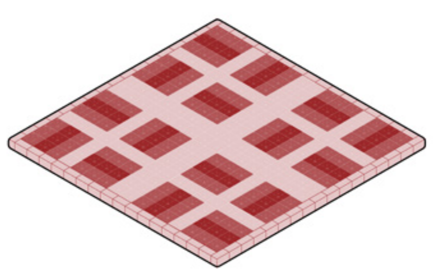
Grouping of Four
Grouping of Four

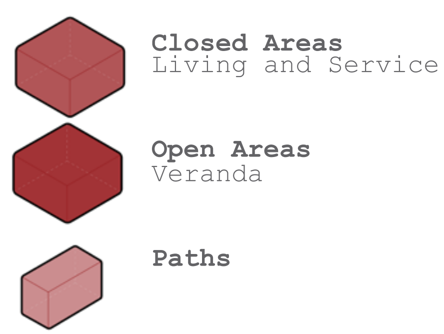
The "Raft"
Groupings

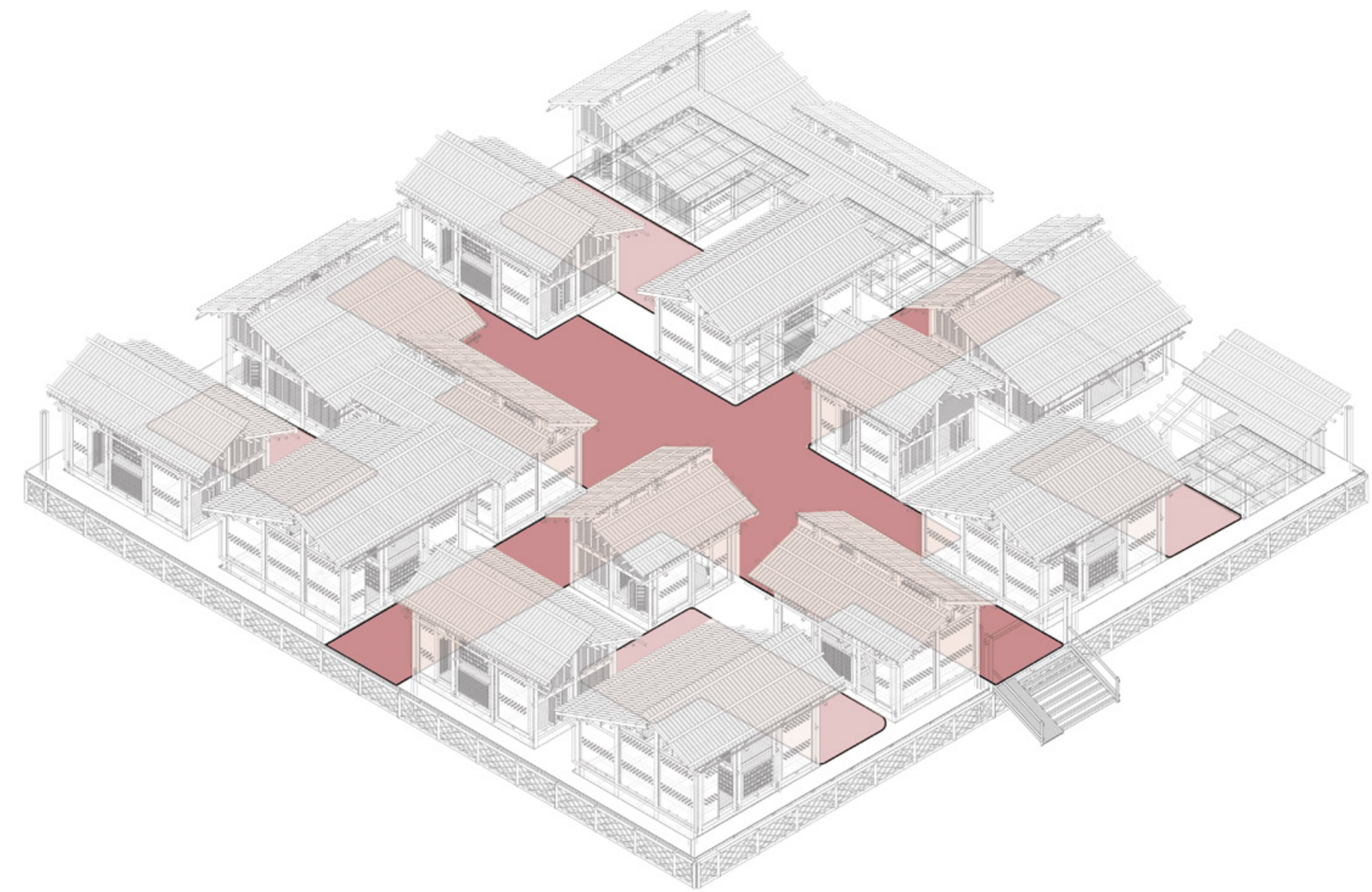
Communal Areas

The "Raft"

Each "Raft" promotes two different levels of social engagement, promoting relationship within the tribe and clan as explained in Dunbar's number

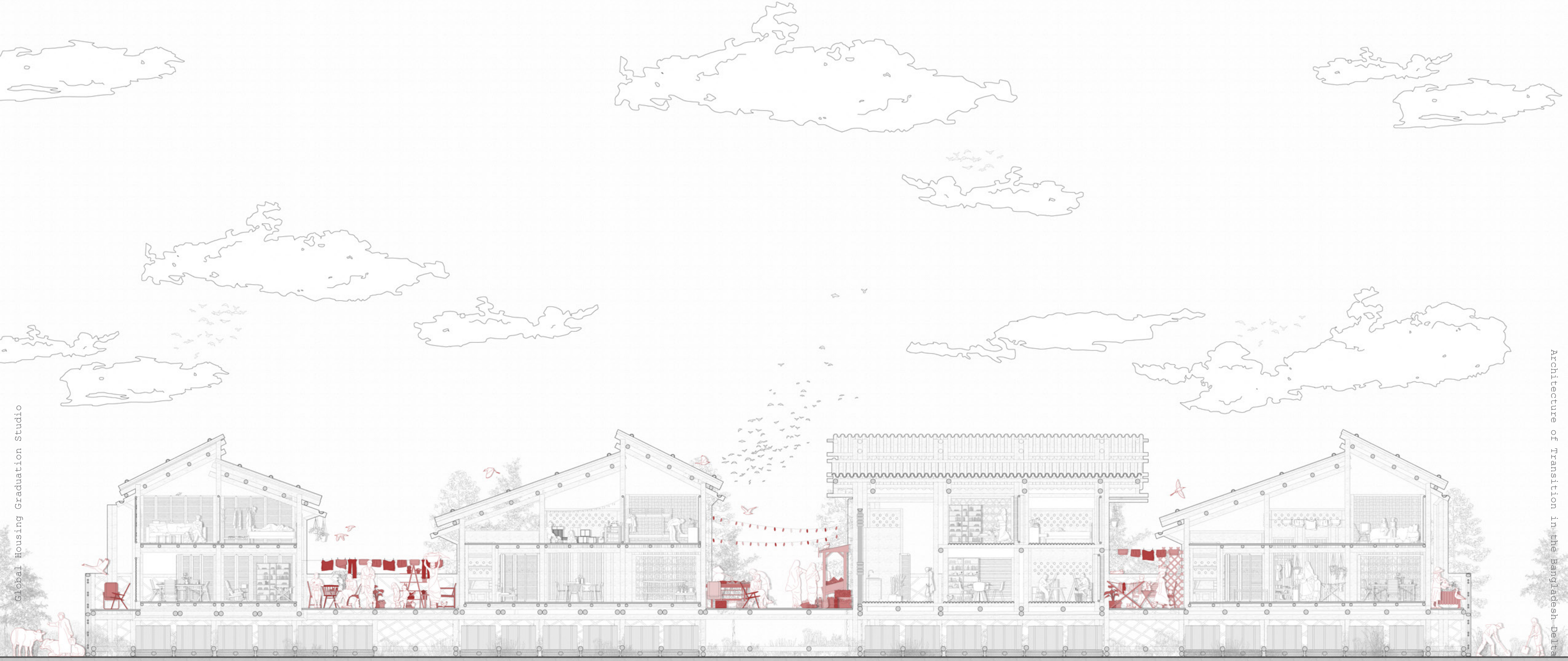






"The Maidan is a term used to refer to an open space or square, commonly found in various cultures. It often serves as a communal area for gatherings, protests, festivities, and significant socio-cultural activities"

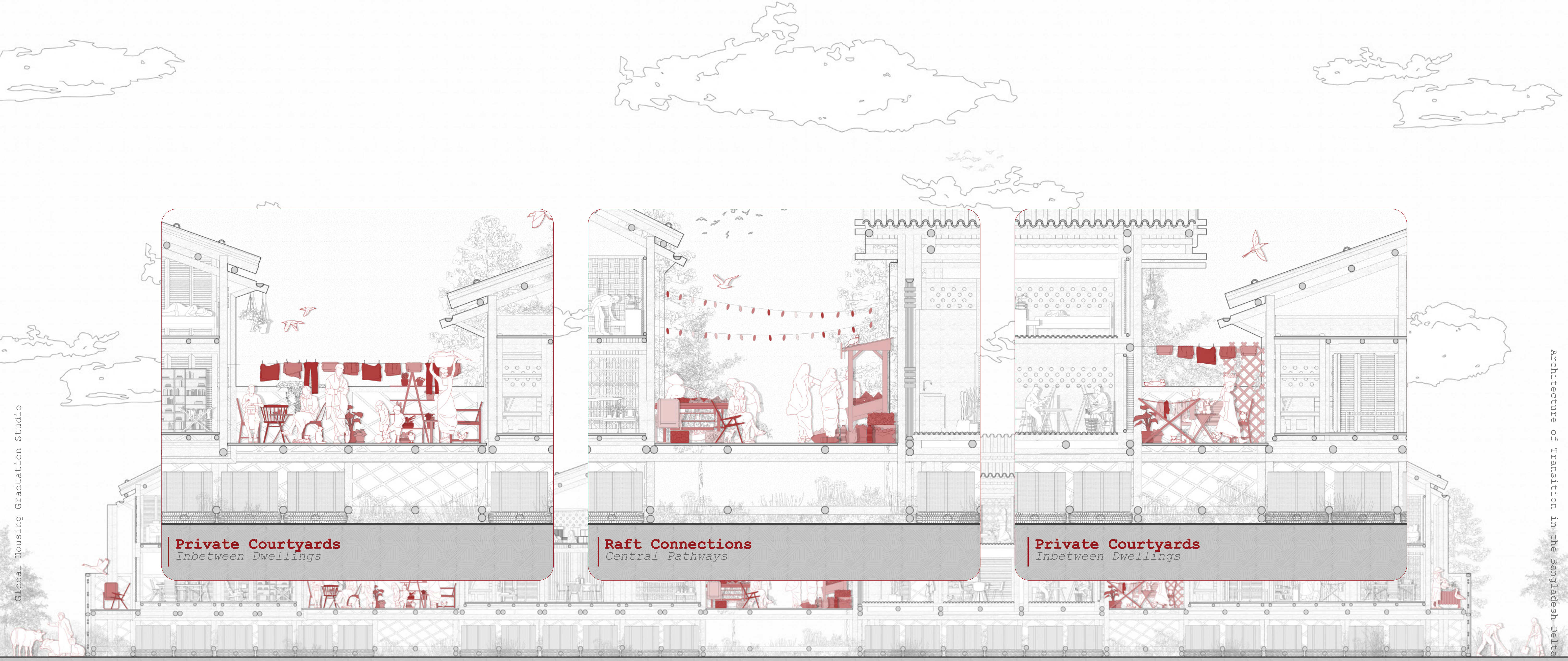
The "Raft"
Communal Areas



Community Areas

Longitudinal Section

The drawing aims to convey the different levels of community spaces. The space allocated for community areas is based on the dwelling options chosen per four clusters



Community Areas

Longitudinal Section

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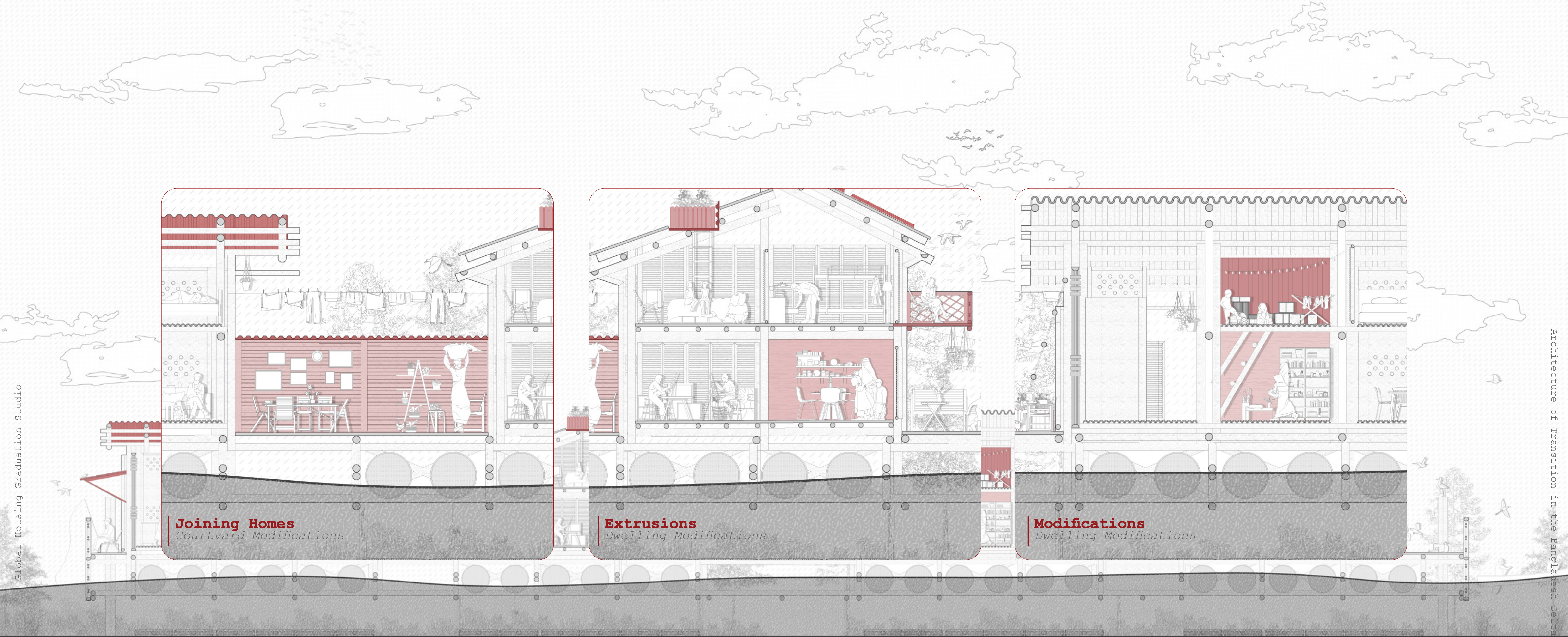


Residential Adaptations

Longitudinal Section

The drawing aims to convey the various adaptations that could be made by the community over time. The adaptations that are made cannot be permanent structures as that would interfere with the amphibious system

Raft Visualization
Dry Season

Future Visualization
Dry Season

Raft Visualization
Monsoon Season

Construction Sequence
Phasing

The construction of the raft is dependent on a few key points. The harvesting of the local materials and the use of community engagement for the actual assembly.

Phasing of Rafts
Four Rafts per year

- Assuming 50 Culms per mature clump
- 8,000 Culms (2,000 per raft) / 50 Culms per Clump - 160 Clumps Needed
- Assuming each clump requires 25 sq.m of space

Area Required for Project
Four Rafts per year

- 160 Clumps x 25 sq.m - - 4,000 sq.m
- 4,000 sq.m - Approximately 1 acre

One time Harvest
Four Rafts per year

- Require one acre of land

Sustainable Harvesting
Four Rafts per year

- Harvesting only 20-30% each year
- Requires 3-4 acres of land
- Allowing for healthy clumps, providing a steady supply of Bamboo

Harvesting
Four Rafts per year

- Harvest takes place during the dry season
- The project will require 4-5 years to be completed with the master plan showcased

Growing
Each raft requires approximately 2,000 bamboo culms made up of three different varieties

Harvesting
To ensure an ongoing productive farm only 25-30% of the bamboo should be harvested each year

Waterproofing
The bamboo culms are chemically treated by applying a liquid made by boiling local Gaab fruits. This traditional Bangladeshi method waterproofs bamboo (1-2 Mature fruits are needed per culm)

Transportation
Bamboo is harvested in the Sylhet and Chittagong Divisions, and transported to the site

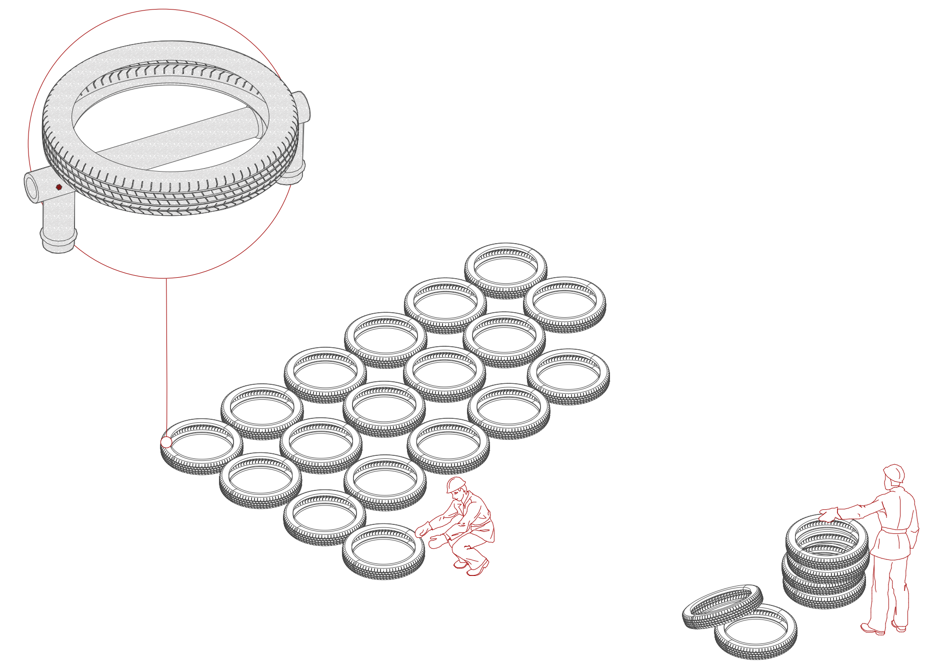
Preparation
The bamboo is dimensioned into pieces that would require approximately 4-8 individuals to transport the largest pieces

Assembly
The project is designed to not require large machinery to assemble

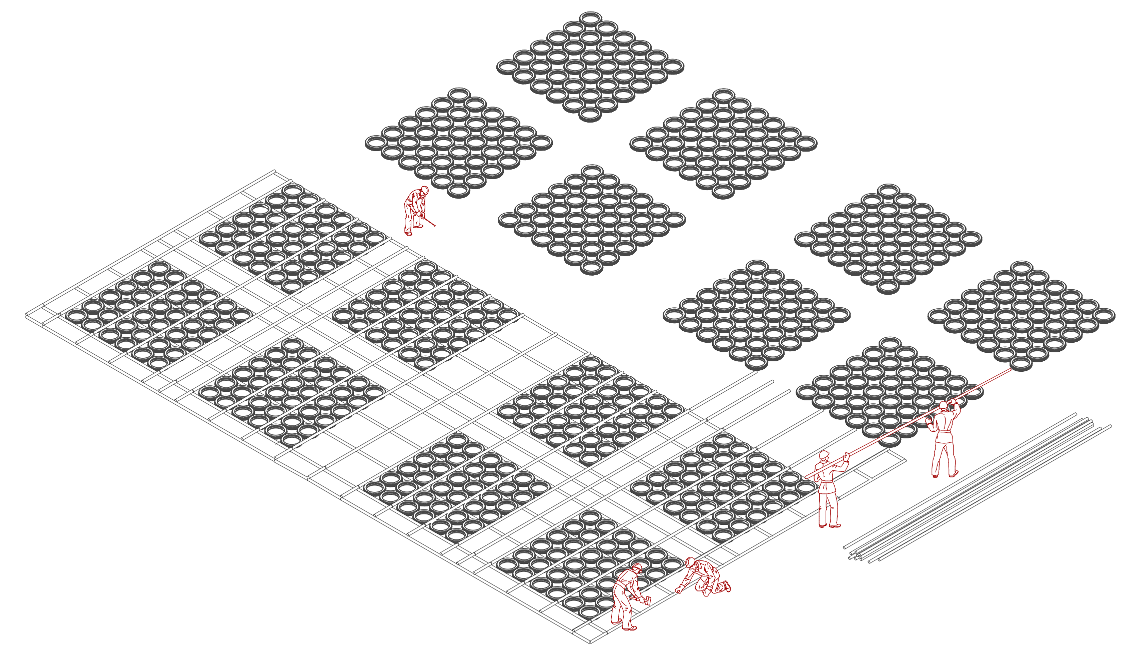
Construction Sequence
Cushioning Layer

The raft assembly begins with the laying of recycled tires, as a cushioning element for the steel drums.

The tires are secured in place using a single bamboo connection and planted into the ground. The inspiration for the connection is derived from a series of projects utilizing bamboo and used tires.



“It is estimated that around 1.0 billion scrap tires are produced every year all over the world, out of which around 150,000 tons are produced by Bangladesh”



In Bangladesh, the annual production of Bambusa balcooa ranges between 1,200 to 1,700 culms per hectare

Construction Sequence
Bamboo Raft Structure

> The construction of the raft structure begins with the base layer of Bamboo.
>
> *The structure is composed of Bambusa Balcooa and Steel Connections*

Bambusa Balcooa
- 96 x 5m
- 200 x 18.75m
- 212 x 1.25m
- 768 x 2.5m (Cross-Bracing)

◦ Total of 6,415m of Bamboo
- *320 Bamboo Culms*

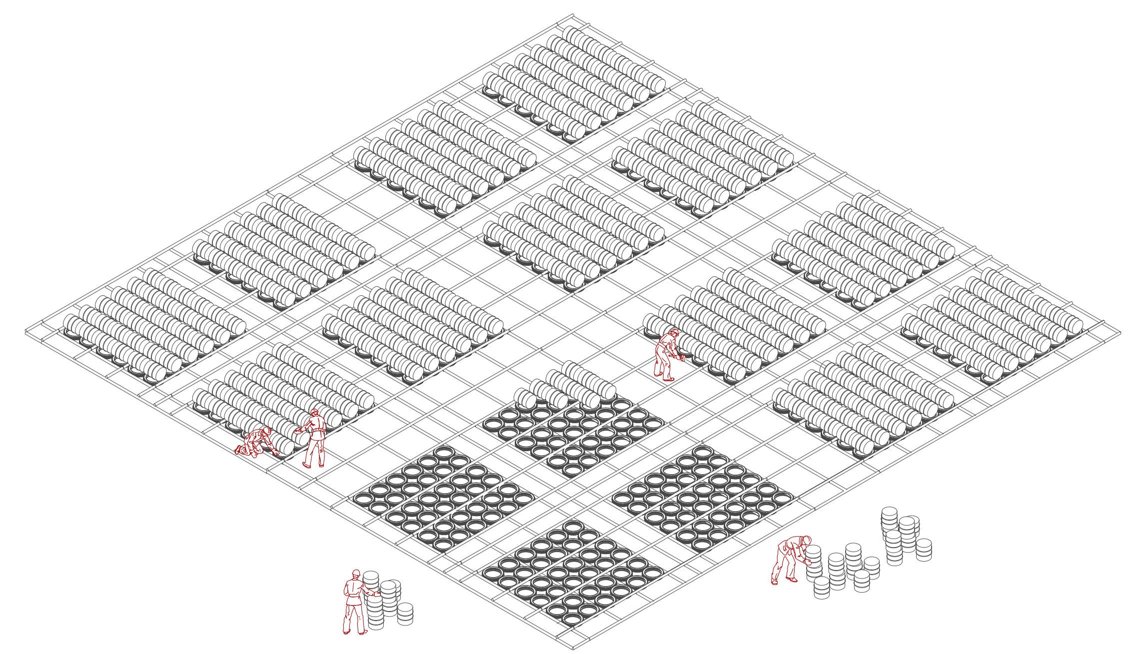
Construction Sequence
Steel Drums

After the first layer of horizontal and vertical structural elements, the steel drums are incorporated into the raft.

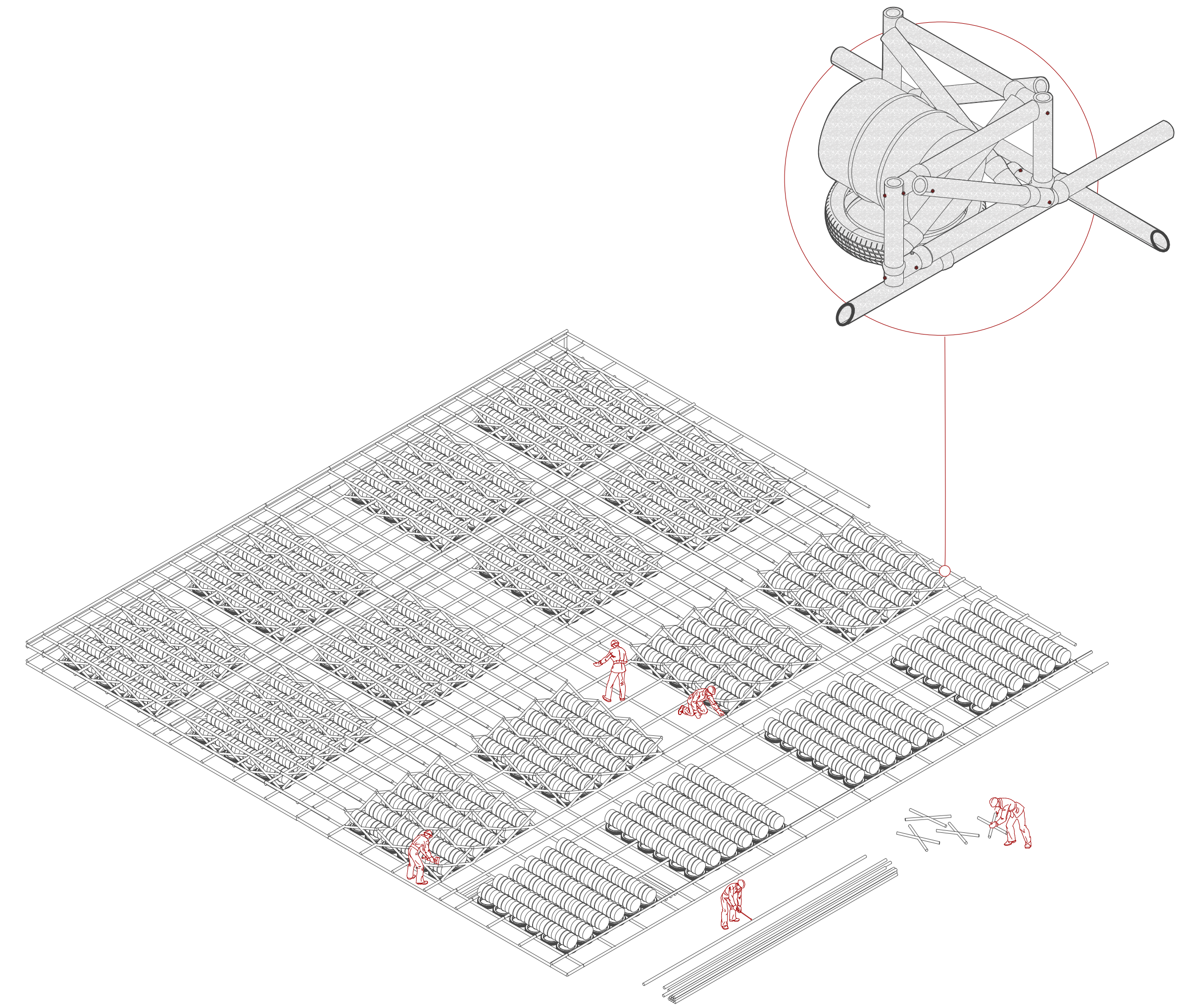
Each 210-liter drum has a diameter of 572mm (22.5 inches) and a height of 851mm (33.5 inches) internally. As such, each drum can displace a maximum of 210kg. To ensure the feasibility of the project a maximum of 2/3rd of this theoretical maximum is used as the maximum displacement - this accounts for the weight of the drum itself, and provides an adequate safety margin to ensure the raft floats

The drums are checked before application to ensure they are airtight and that the structure supports the weight of the dwellings without deforming the drums.

Each raft holds 576 drums, resulting in a total weight of 72,576kg being supported



Small Steel Drum recycling factories can be found within Old Dhaka and be transported to the site



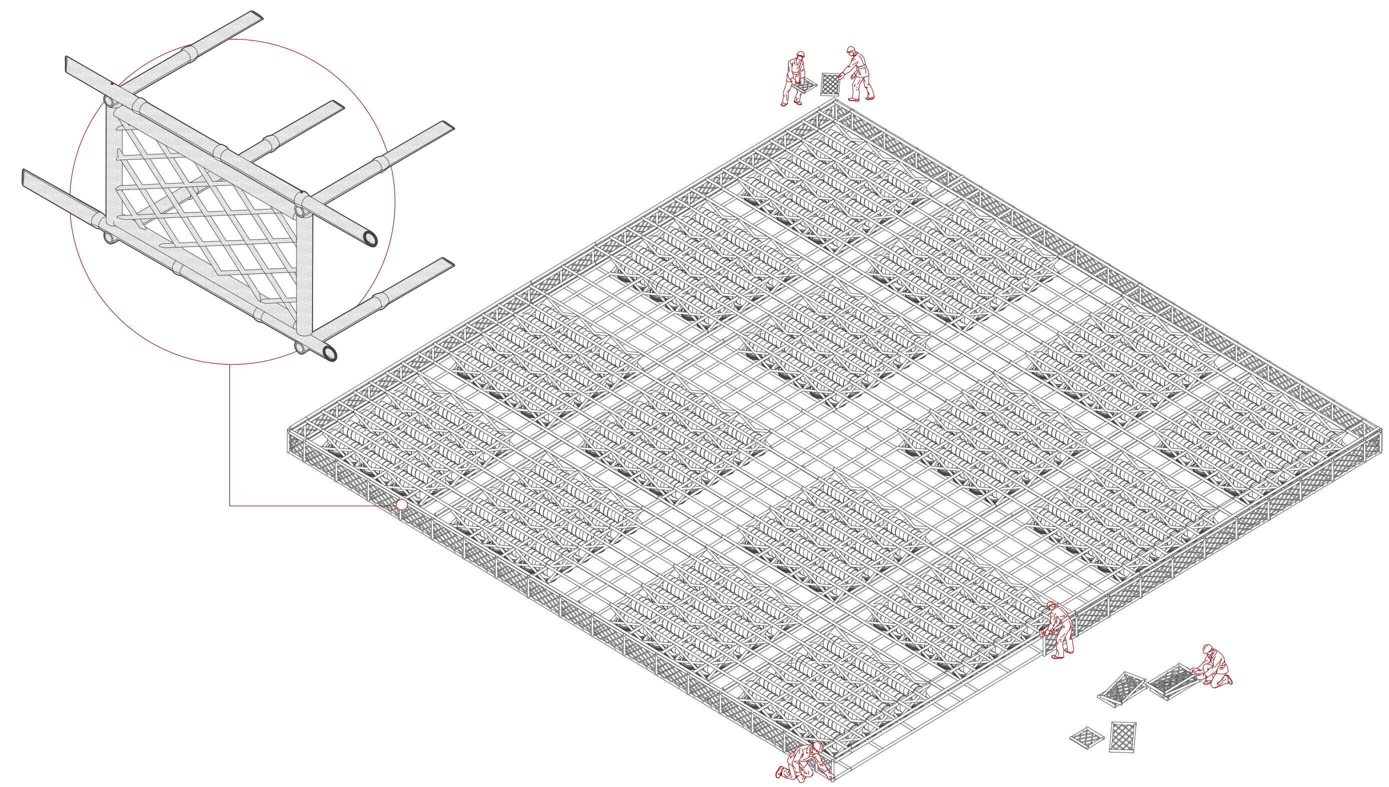
The method aims to aid in the distribution of loads as well as resist forces from different directions

Construction Sequence
Cross Bracing

Cross bracing is added to the areas supporting the steel drums, to limit the lateral movement of the raft and prevent any deformation of the drums by the weight of the dwellings

The structure is composed of Bambusa Balcooa and Steel Connections

Once the bracing is complete the top layer of horizontal and vertical structural elements is implemented



M. baccifera occupies roughly 100,000 hectares in the Sylhet and Chittagong Hill Tracts regions. (11,000 culms per hectare)

Construction Sequence

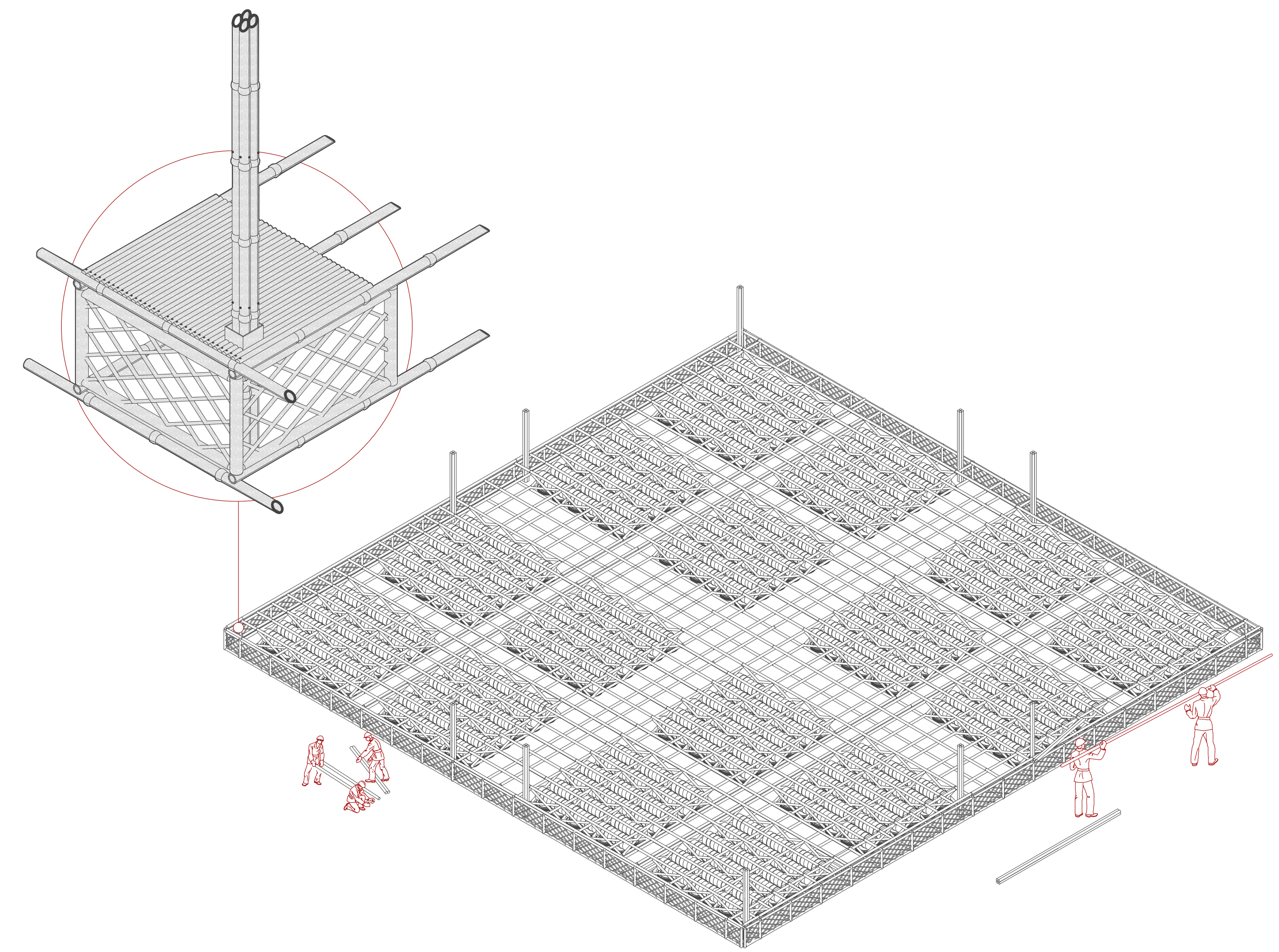
Bamboo Panels

> The raft structure is finished of with a set of woven panels that ensure there is no manipulation to the amphibious system
>
> *The structure is composed of Bambusa Balcooa and Steel Connections*

Melocanna Baccifera

- 64 x 20m

◦ Total of 1,280m of Bamboo
- 64 Bamboo Culms



Four bamboo culms are bolted together to increase the lateral strength during flash flooding

Construction Sequence

Guiding Posts

> Planting of the guiding posts.
>
> Four bamboo culms are bolted together for each guiding post

Bambusa Balcooa

- 12 x 6m

◦ Total of 72m of Bamboo
- 3.6 Bamboo Culms

Construction Sequence

Raft Flooring

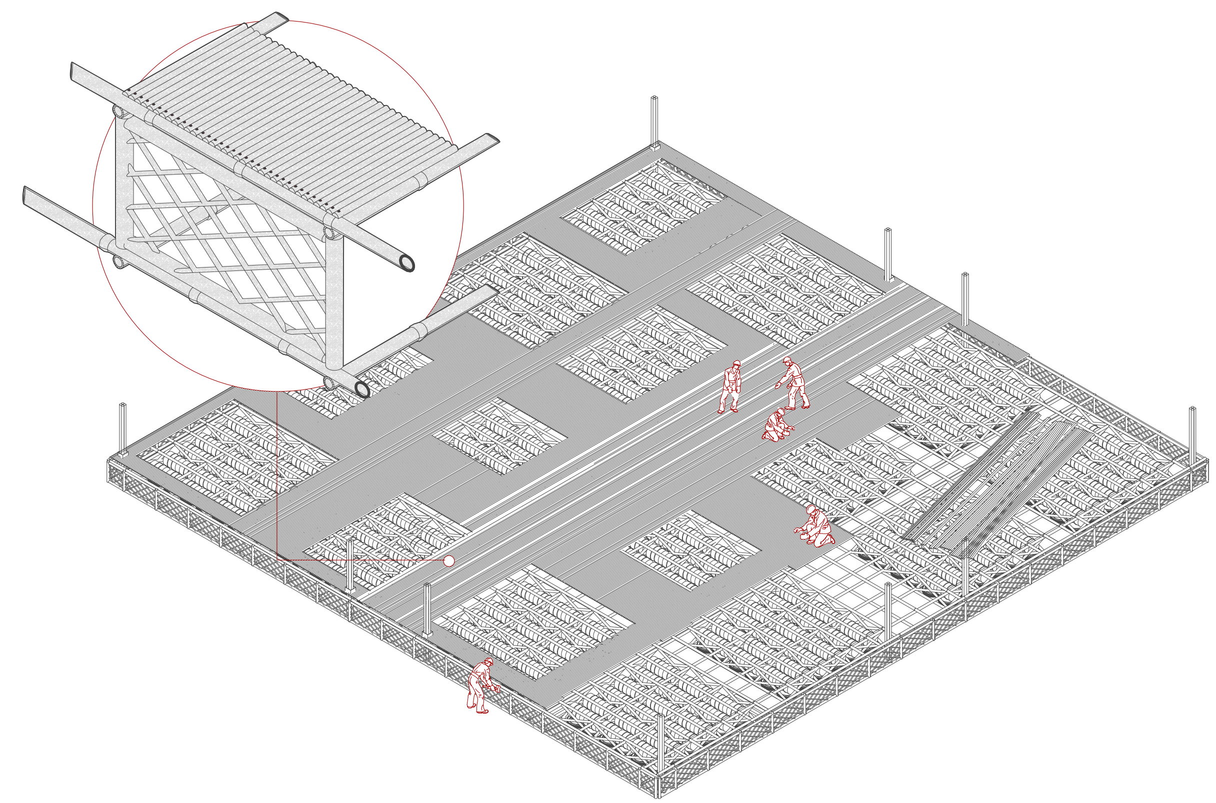
The boundaries of each home are planned per cluster, and the split bamboo flooring is mounted on the raft

The floor structure is composed of Dendrocalamus Longispathus and Steel Connections

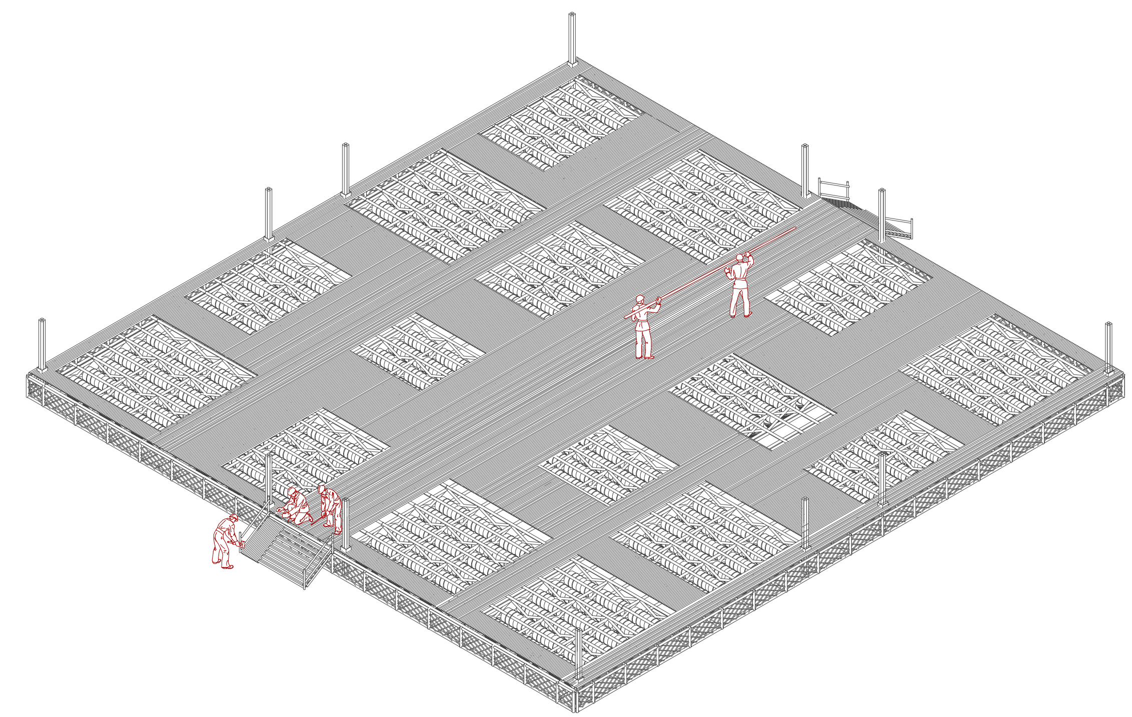
Dendrocalamus Longispathus

▪ Approximate Total of 10,500m (18,062.5-Dwelling Base Floor Area) of Bamboo

• 700 Bamboo Culms



Gaps in the flooring are based on the dwelling perimeters that are pre-planned



The staircase design aims to create an experiential entry point onto the community raft

Construction Sequence

Raft Staircase

Two points of access are provided for each raft with the ground and serve as boat docking areas during flooding.

A bridge system is implemented within the design and utilized during the flooding seasons to connect the rafts together. *The staircase location varies based on the masterplan layout chosen per community.*

03B The Dwelling

Modular Construction

The dwelling is designed to honor the cultural and social customs of the Bangladeshi community. It is organized into three distinct zones to provide the appropriate balance of private and semi-public spaces required for daily life

Case Studies
Analysis and Documentation

A curated selection of design interventions, drawn from a broad spectrum of projects, forms the basis of this study. Although the projects differ in their contextual and cultural frameworks, the interventions examined yield significant insights and propose viable solutions. Through comprehensive analysis, a collection of precedents was established, each of which played a direct role in shaping the final proposed design

Case Studies

- Post Tsunami Housing
- METI School
- Blooming Bamboo House
- Bangla Baton

Post Tsunami Housing
Floorplan Design

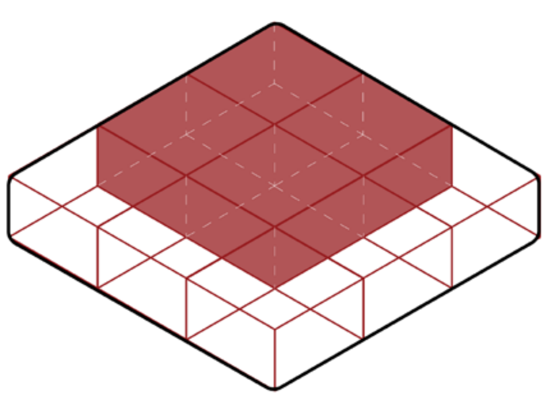
METI School
Bamboo Construction

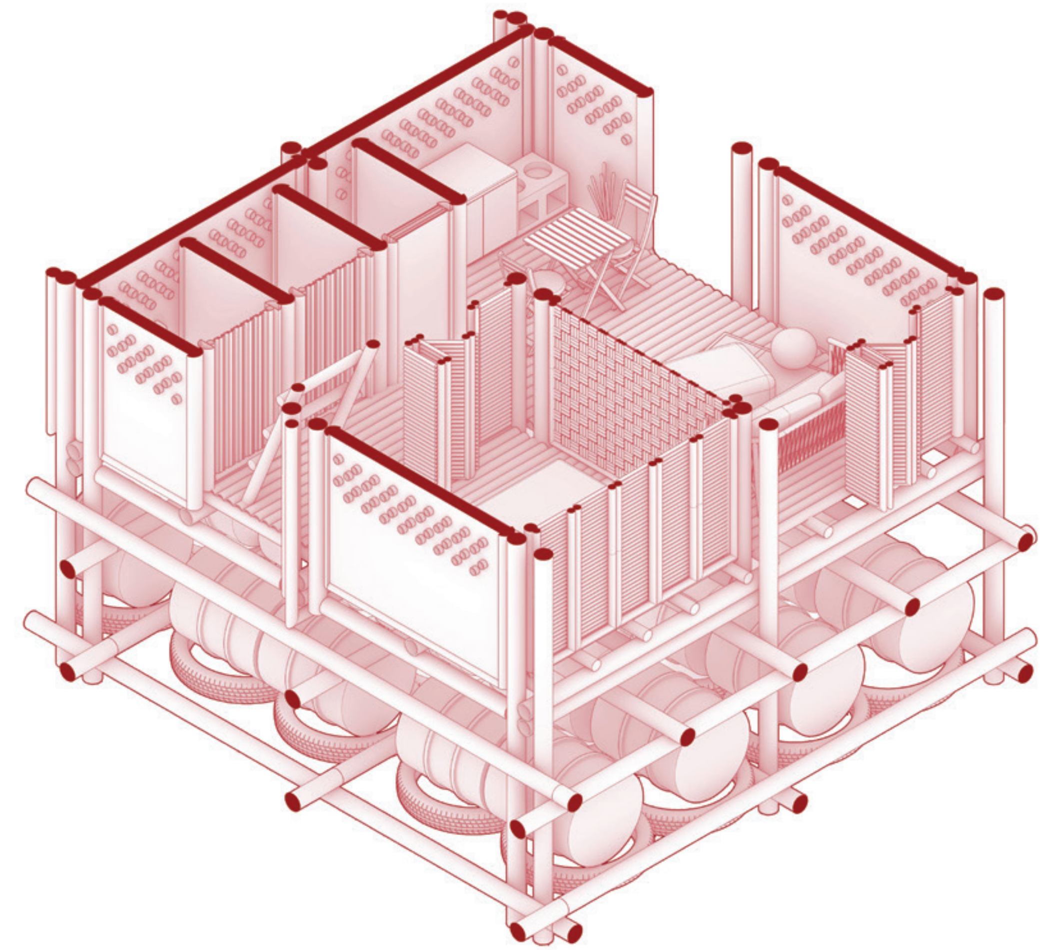
Blooming Bamboo Home
Bamboo Construction & Bamboo Panels

Bangla Baton
Dismountable Structures

Dwelling - Option A
First Floor

Dwelling A , is the smallest dwelling provided to the community. It is made up of four grid squares on the ground floor, measuring 25 sq.m. The dwelling is meant for small families of 4-6 people.

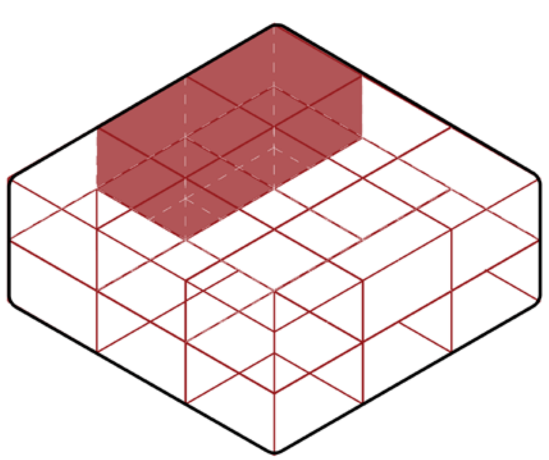


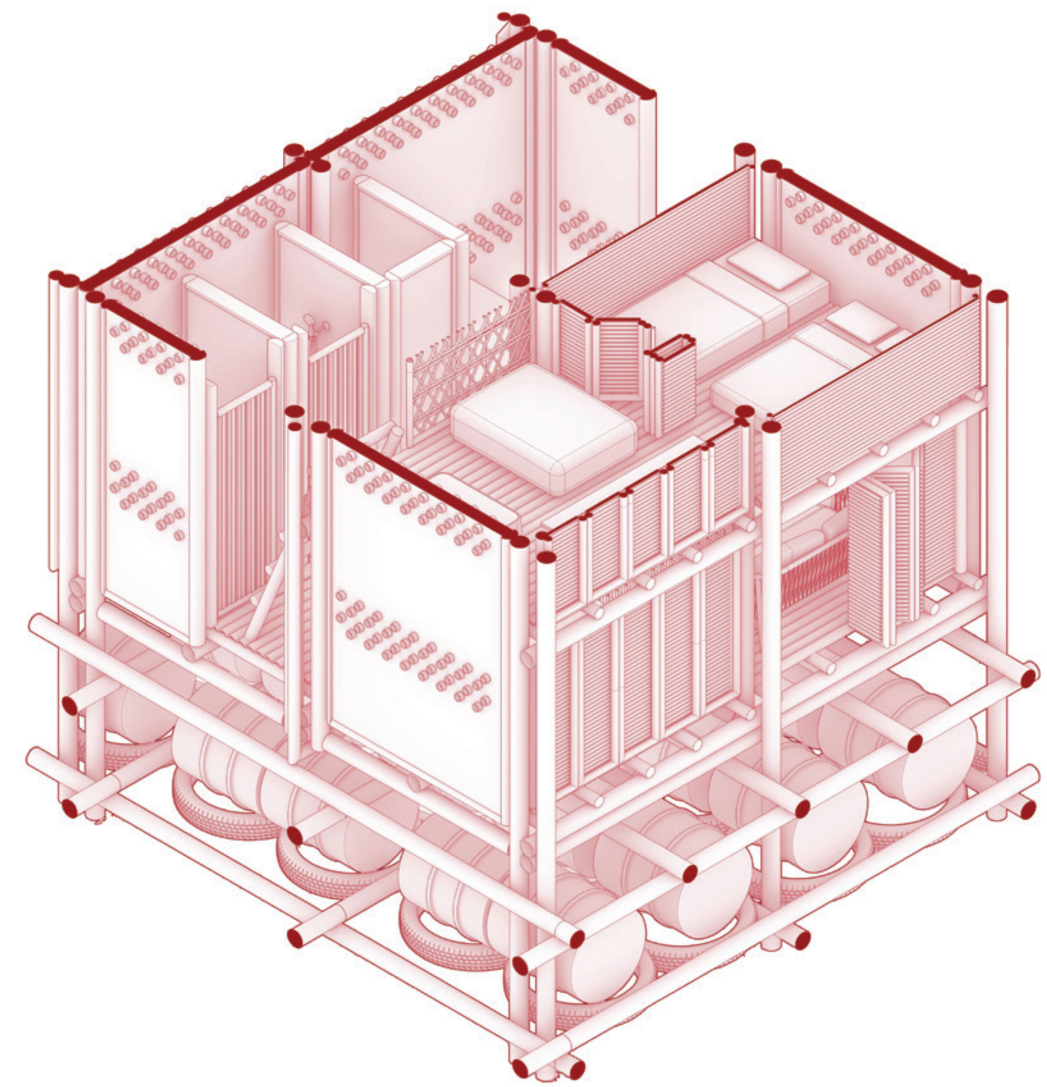


Dwelling Itiration
Type A

Dwelling - Option A
Second Floor

Dwelling A, has a mezzanine area that is made up of two grid squares, measuring 12.5 sq.m. The space is intended as spare bedrooms or storage spaces for the family

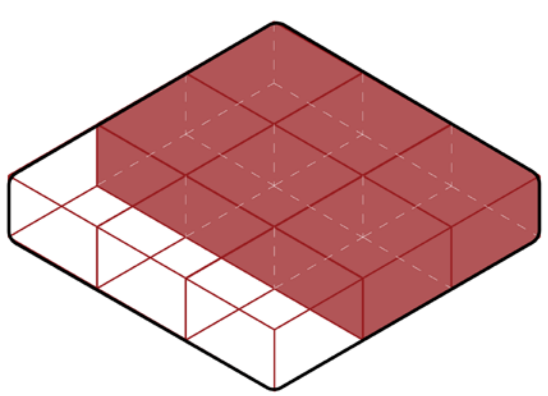


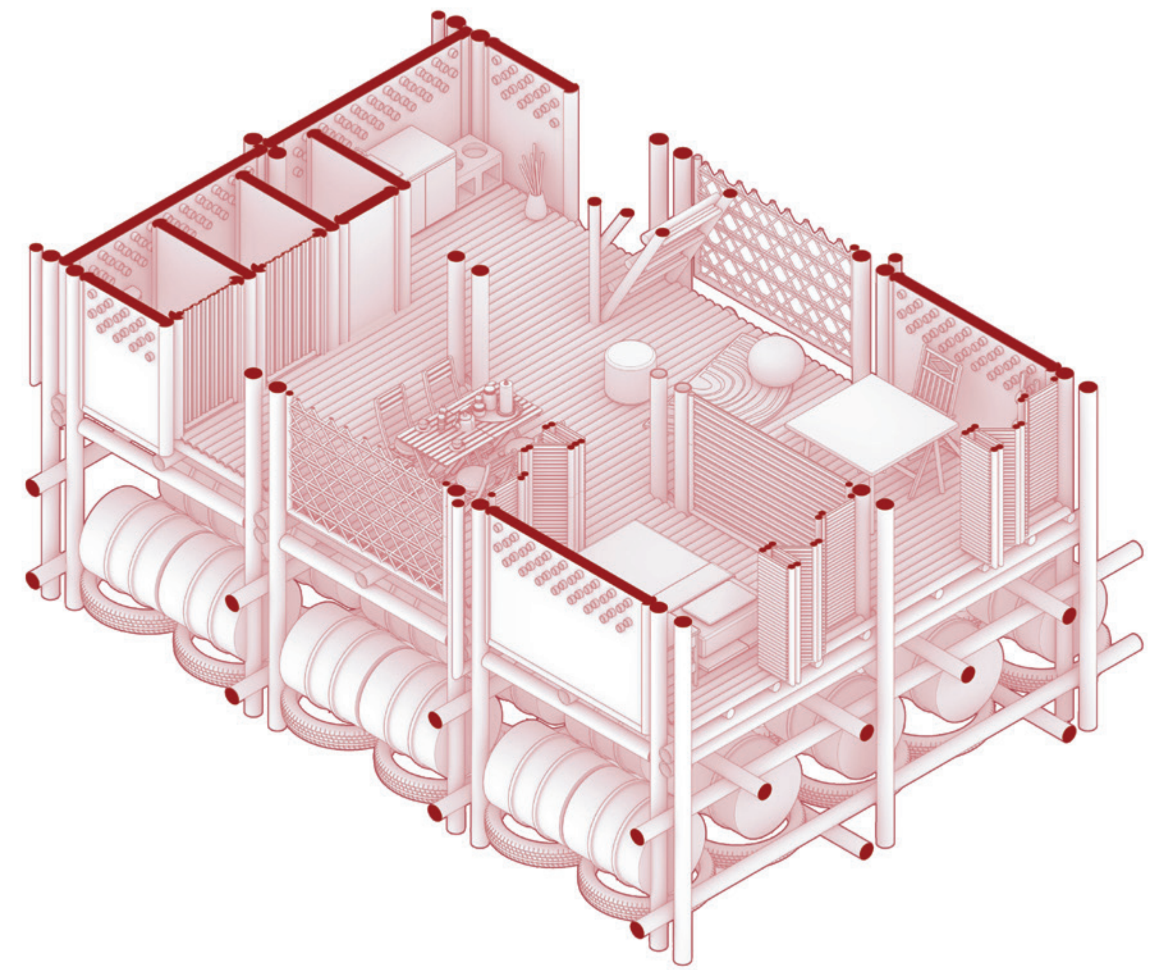


Dwelling Itiration
Type A

Dwelling - Option B
First Floor

Dwelling B, is the medium sized dwelling made up of 6 grid blocks, measuring 37.5 sq.m. The dwelling is meant for larger families of 6-8 people, with spaces for other programs to support the family economically



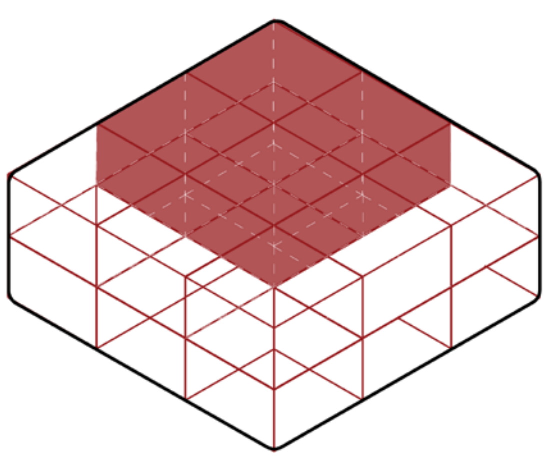


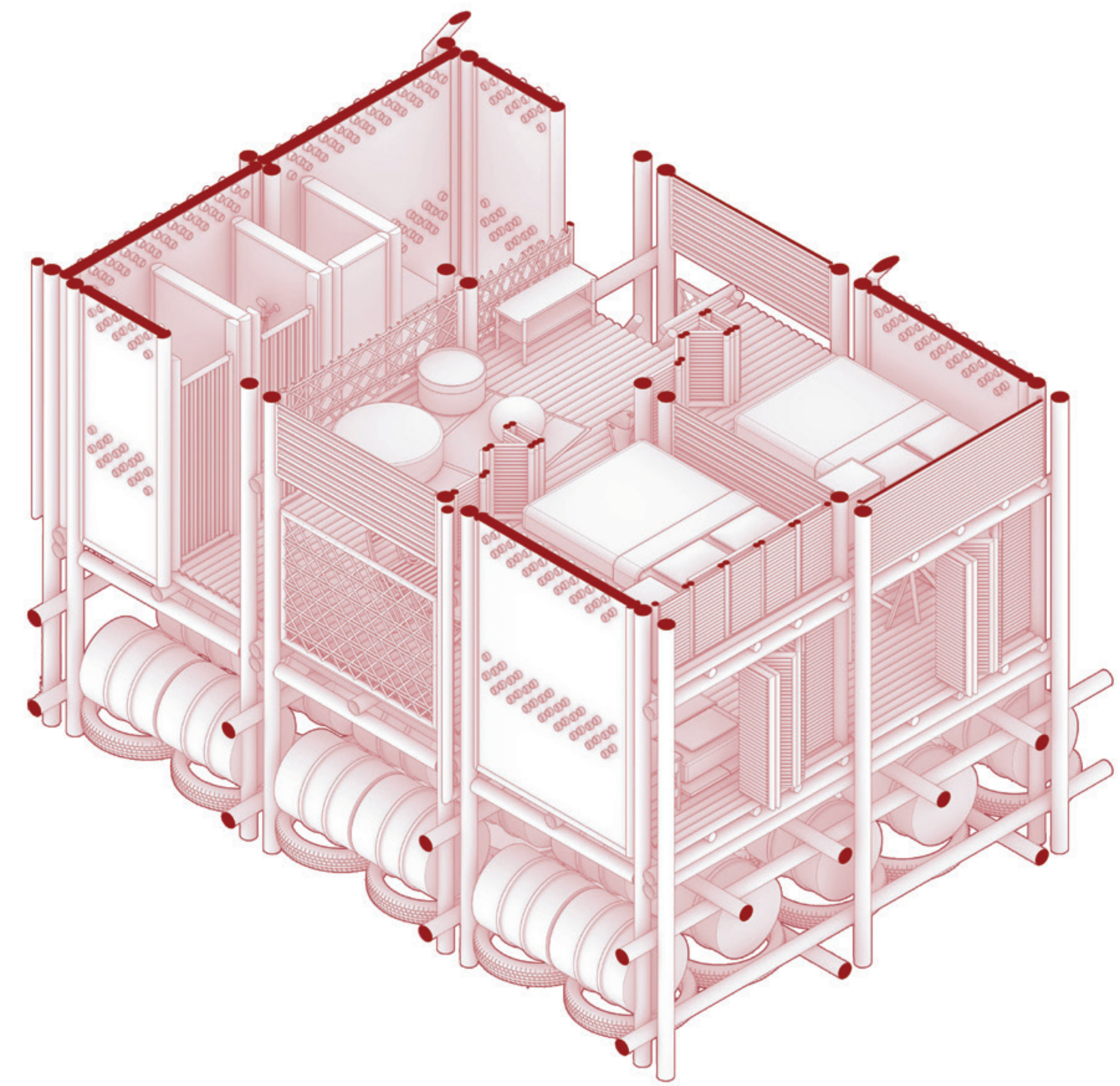
Dwelling Itiration
Type B

Dwelling - Option B

Second Floor

The upper floor of the dwelling is made up of four grid blocks, measuring 25sq.m. The space can be utilized for spare bedrooms and storage spaces and is accessible by stair



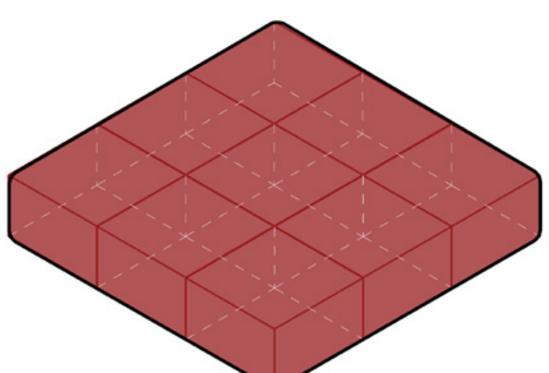


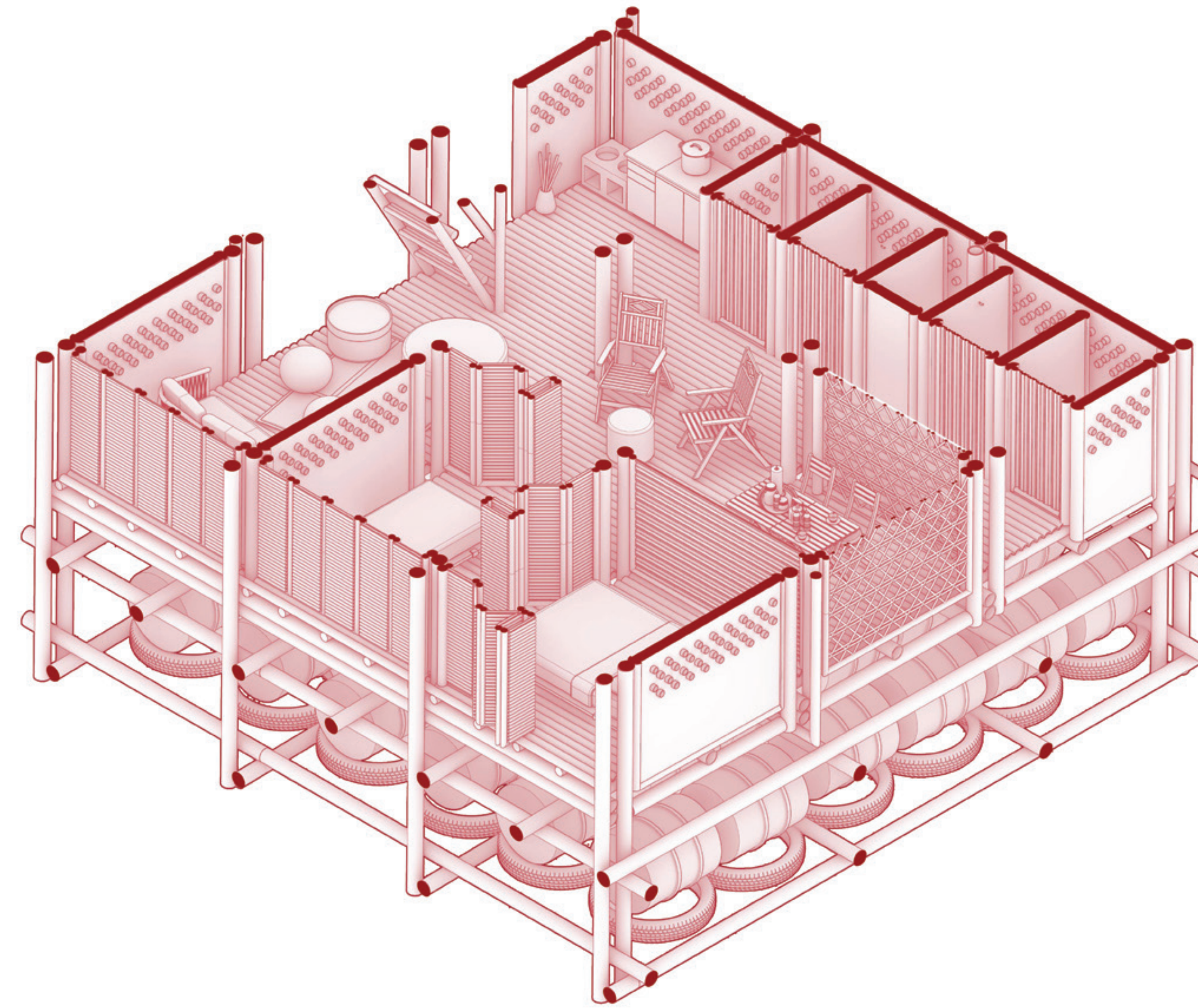
Dwelling Itiration

Type B

Dwelling - Option C
First Floor

Dwelling C, is the largest dwelling available to the community and is inspired by the traditional "Bari" in Bangladesh, meant for a generational family. The home allows for numerous families to reside within it and also allows for other programmatic functions. The dwelling consists of 9 grid blocks, measuring 56.25 sq.m



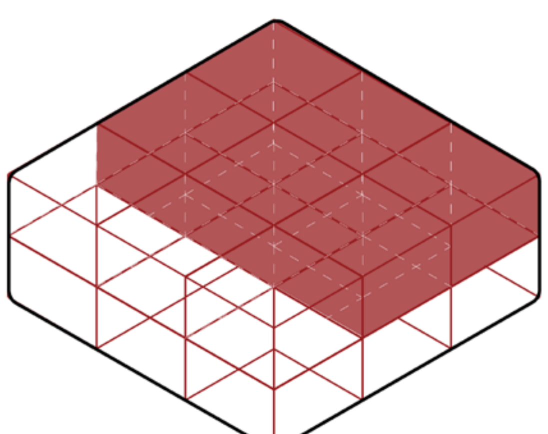


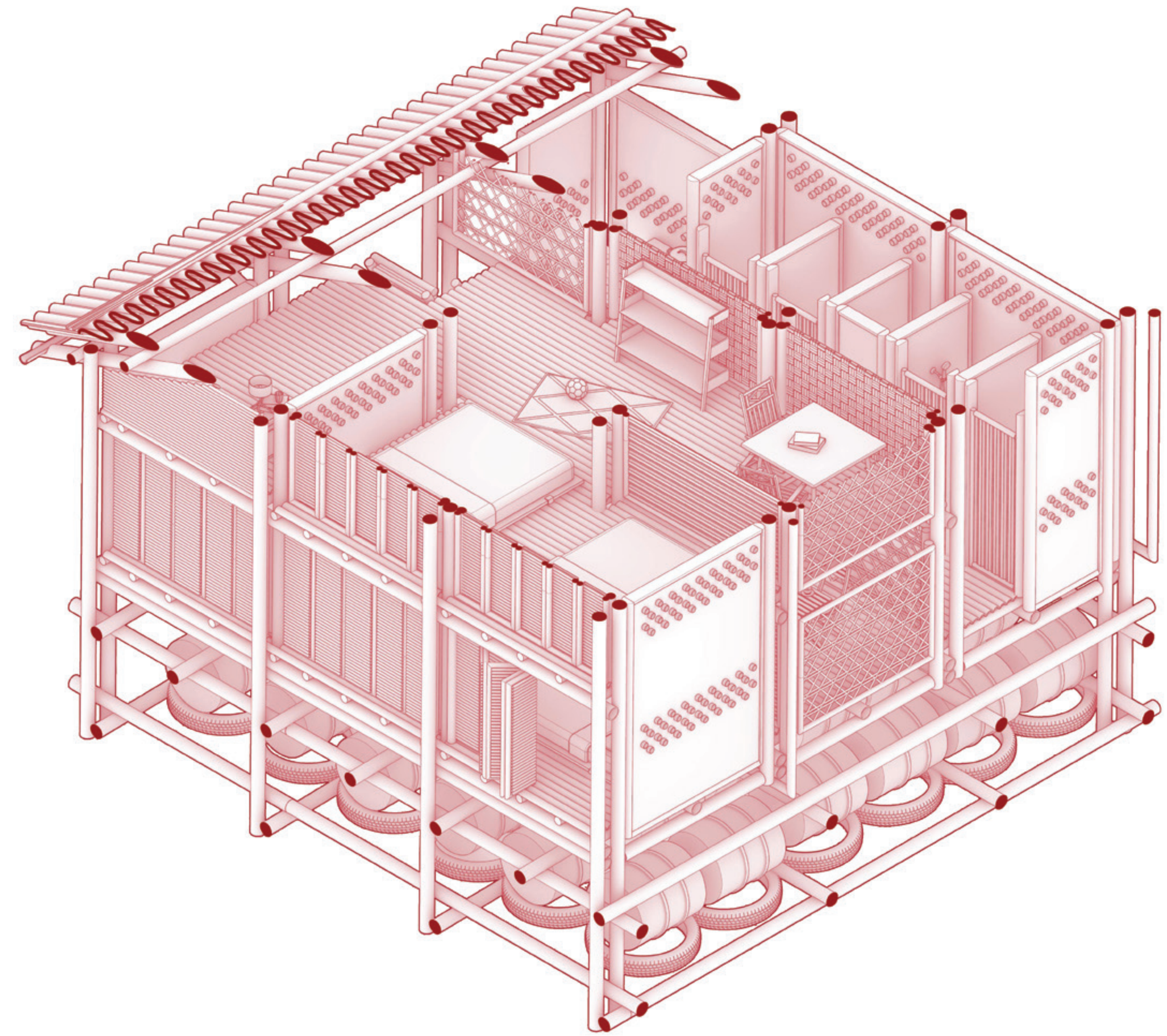
Dwelling Itiration
Type C

Dwelling - Option C

Second Floor

The upper floor of the dwelling is made up of six grid blocks, measuring 37.5 sq.m. The upper floor is intended for spare bedrooms and living areas, to allow for the ground floor to be more flexible based on the families needs





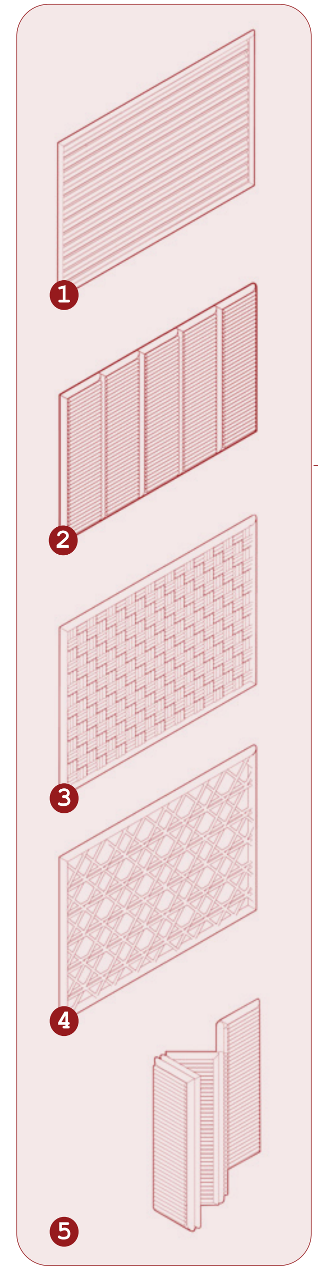
Dwelling Itiration

Type C

Kit of Parts

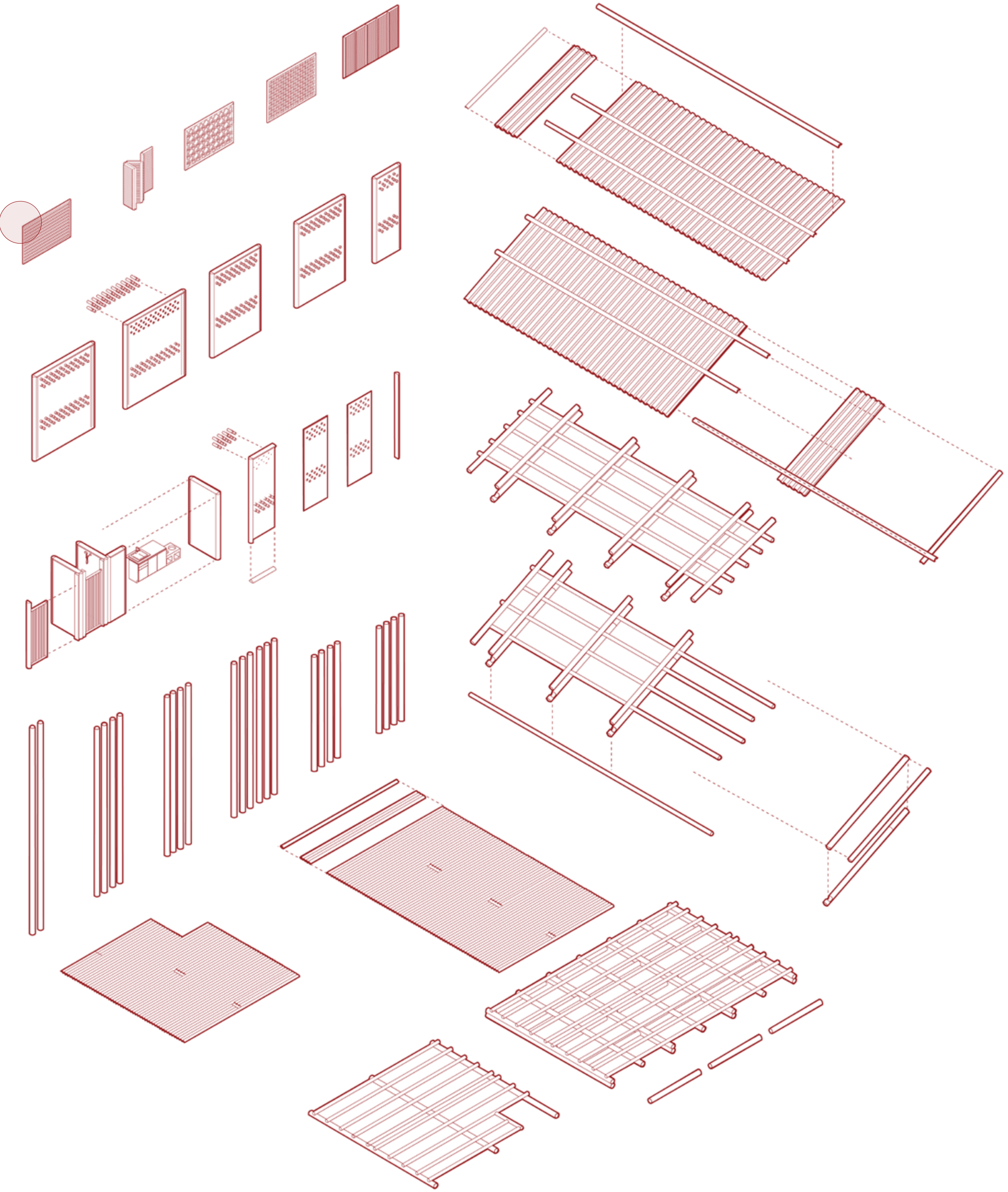
Dwelling B

Each dwelling is made up of a standard package, similar to the traditional typology of the Bangla Baton. Occupants are able to customize their dwellings based on a series of bamboo panels, that define the program of their spaces.



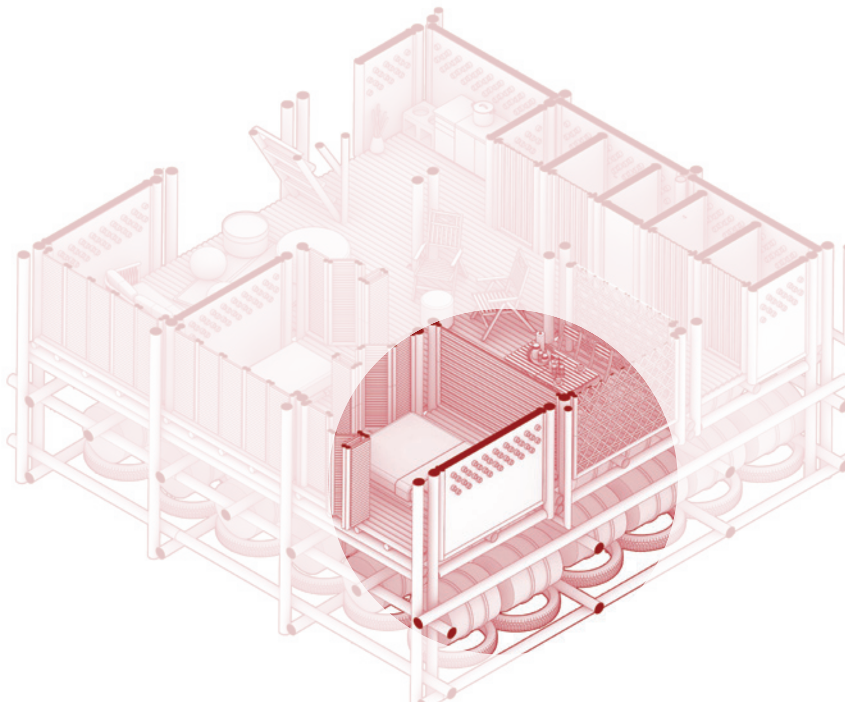
Bamboo Panels

1. Split Bamboo Panel
2. Bamboo Louvres
3. Woven Bamboo Panel
4. Ornate Bamboo Panel
5. Folding Panels



Kit of Parts

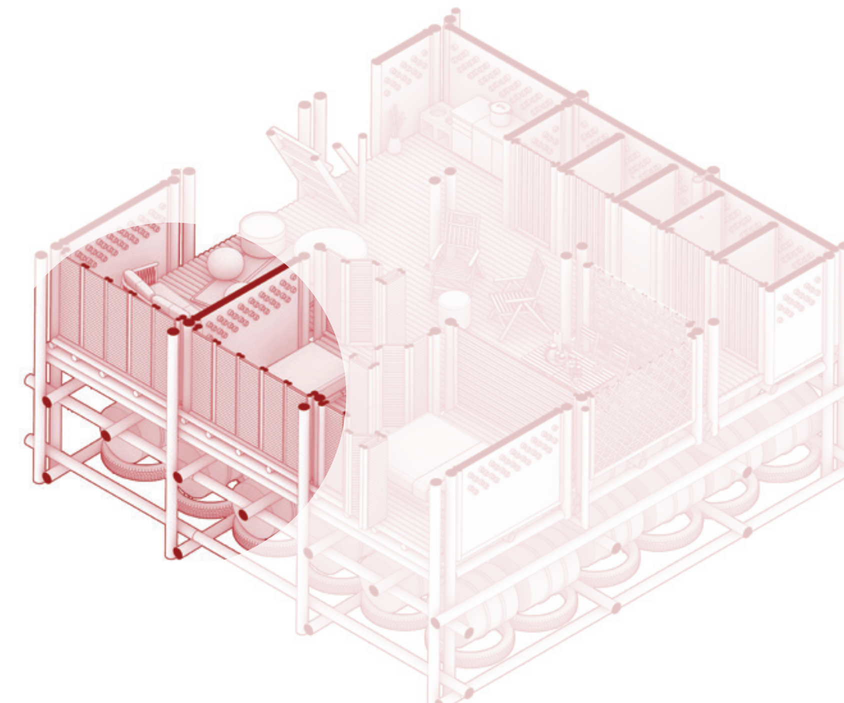
Dwelling Type B



Permanent Walls

Permanent Walls

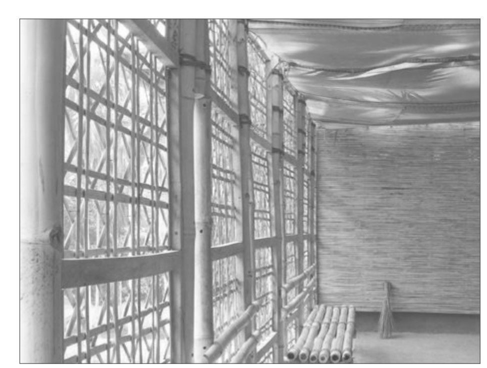
The permanent walls are made up of a woven bamboo, with mud and lime plaster. The permanent panels define the various zones of the dwelling



Non-Permanent

Wall Component

Five non permanent components are provided to the occupants. Each panel can be implemented to change the program of the space



Zone A

As is standard in original rural Bangladeshi architecture, the bathroom and kitchen are housed in separate parts of the building

Zone B

A central covered area separates the sercice area from the living accommodation. The covered area also provides an entertainment space from which women can retreat to maintain privacy.

Zone C

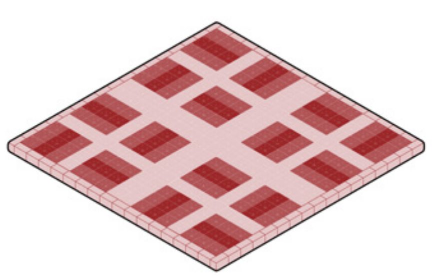
The living area is enclosed within mud walls, to provide adequate privacy to the occupants.

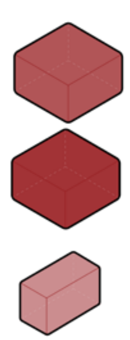
Base Dwelling

Ground Floor

Dwelling Type B

The dwelling is broken up into three zones. The service zone which makes up the kitchen and bathroom area, the semi-private zone which acts as a veranda area, and the private zone which is enclosed with permanent walls made up of mud and lime.

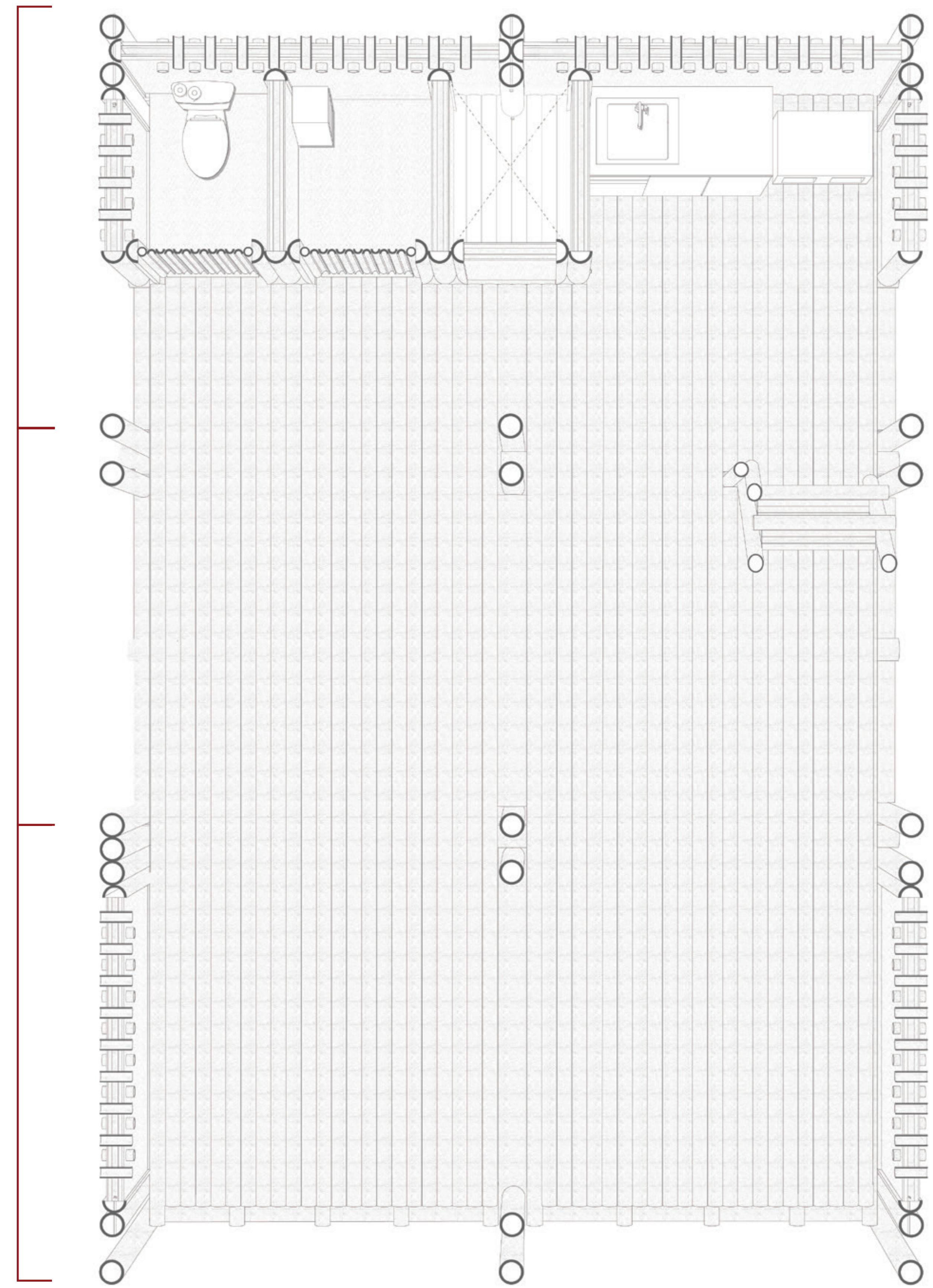




Closed Areas
Living and Service

Open Areas
Veranda

Paths



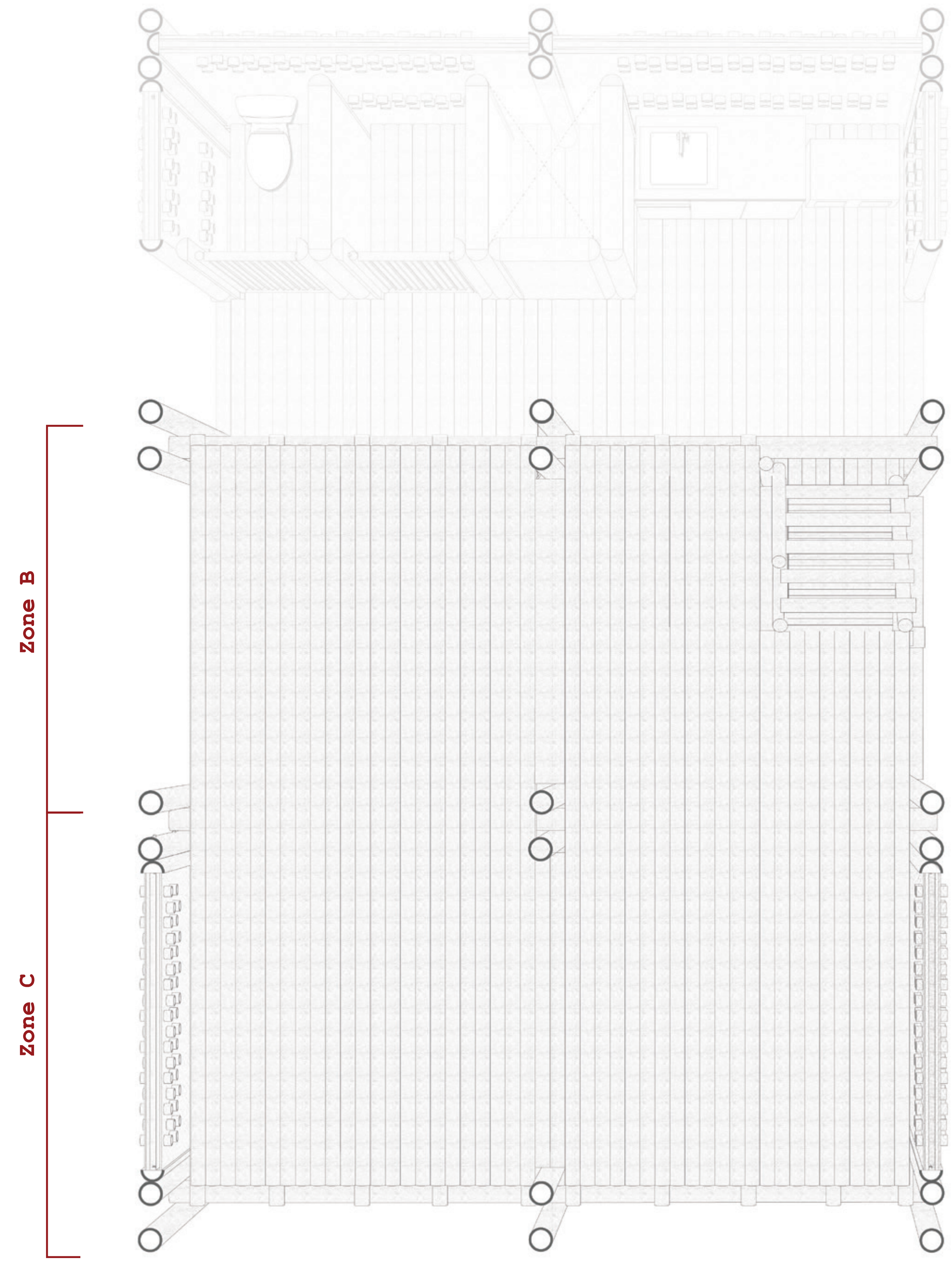
Base Dwelling
Scaled (1:20)

Base Dwelling

First Floor

Dwelling Type B

A upper level is also provided to increase the flexibility of the dwelling. The upper level is made up of four out of the six squares that make up the dwelling.



Base Dwelling
Scaled (1:20)

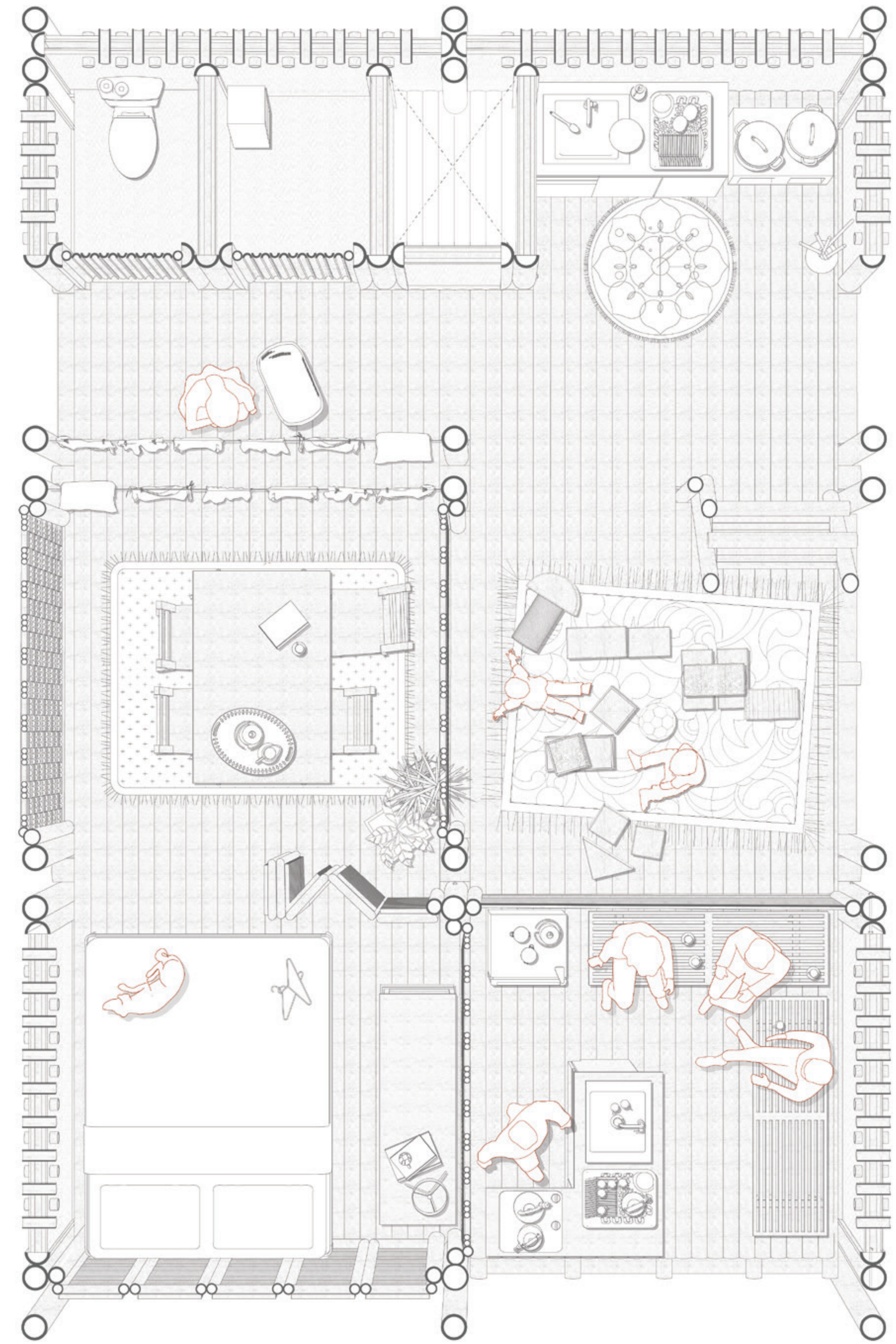
Dwelling Itirations

The Tea Shop

Dwelling Type B

Within Bangladesh, it is quite common for individuals to open up their own small tea shops within their homes or from small roadside setups.

These informal tea stalls are often called “tong” shops, and they can be found in both rural and urban areas. Sometimes they’re attached to someone’s home or run from a small shack in front of or beside the house.



Dwelling Iterations
Scaled (1:20)

Dwelling Itirations

The Work Shop

Dwelling Type B

Within Bangladesh, households operate workshops out of their homes, especially in rural areas and low-income urban neighborhoods.

These home-based workshops are often part of the informal economy and can take many forms, such as

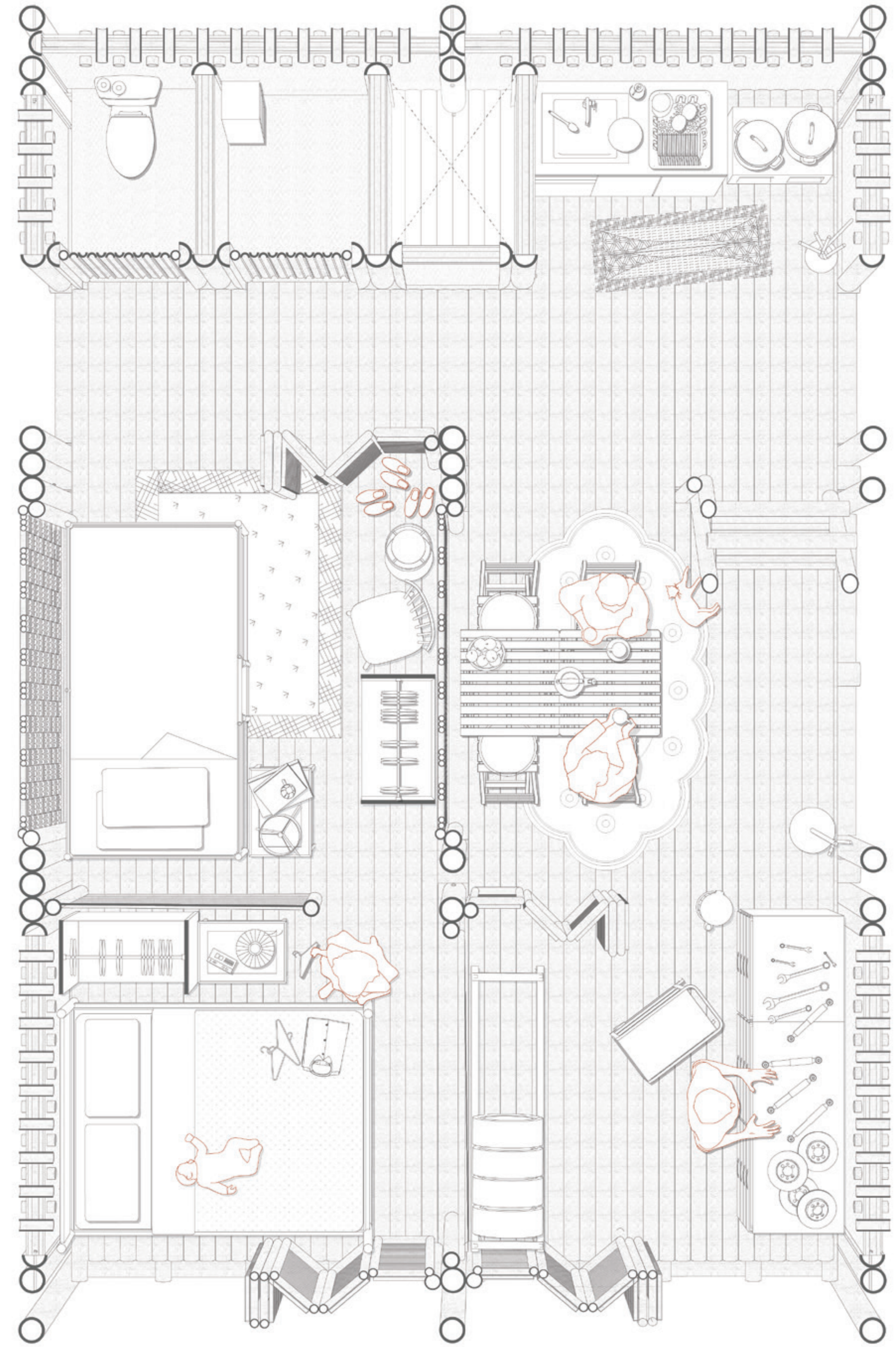
Tailoring and Sewing Shops - Small-scale garment work, including alterations, custom tailoring, or producing clothes for local markets or export subcontracts.

Handicrafts and Embroidery - Families may produce traditional crafts like nakshi kantha (embroidered quilts), pottery, or jute items.

Metalwork and Carpentry - Some households have small workshops for repairing or making tools, furniture, or household items.

Electronics or Bicycle Repair - Common in urban and semi-urban settings, often run from a room or a shed attached to the home.

Food Preparation - Some families prepare snacks or sweets (like samosas, pithas, or chanachur) to sell locally or supply to small shops.



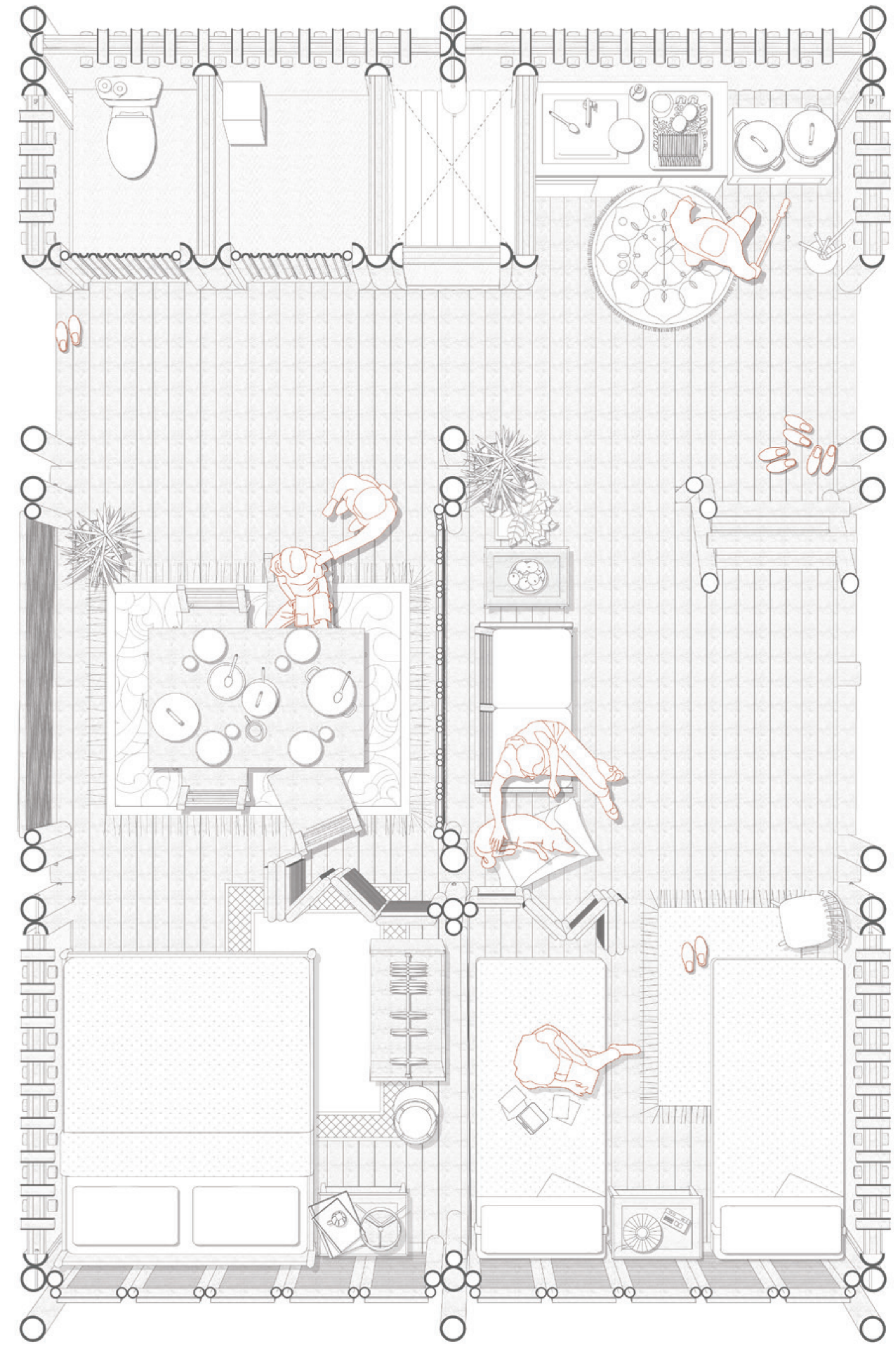
Dwelling Iterations
Scaled (1:20)

Dwelling Itirations

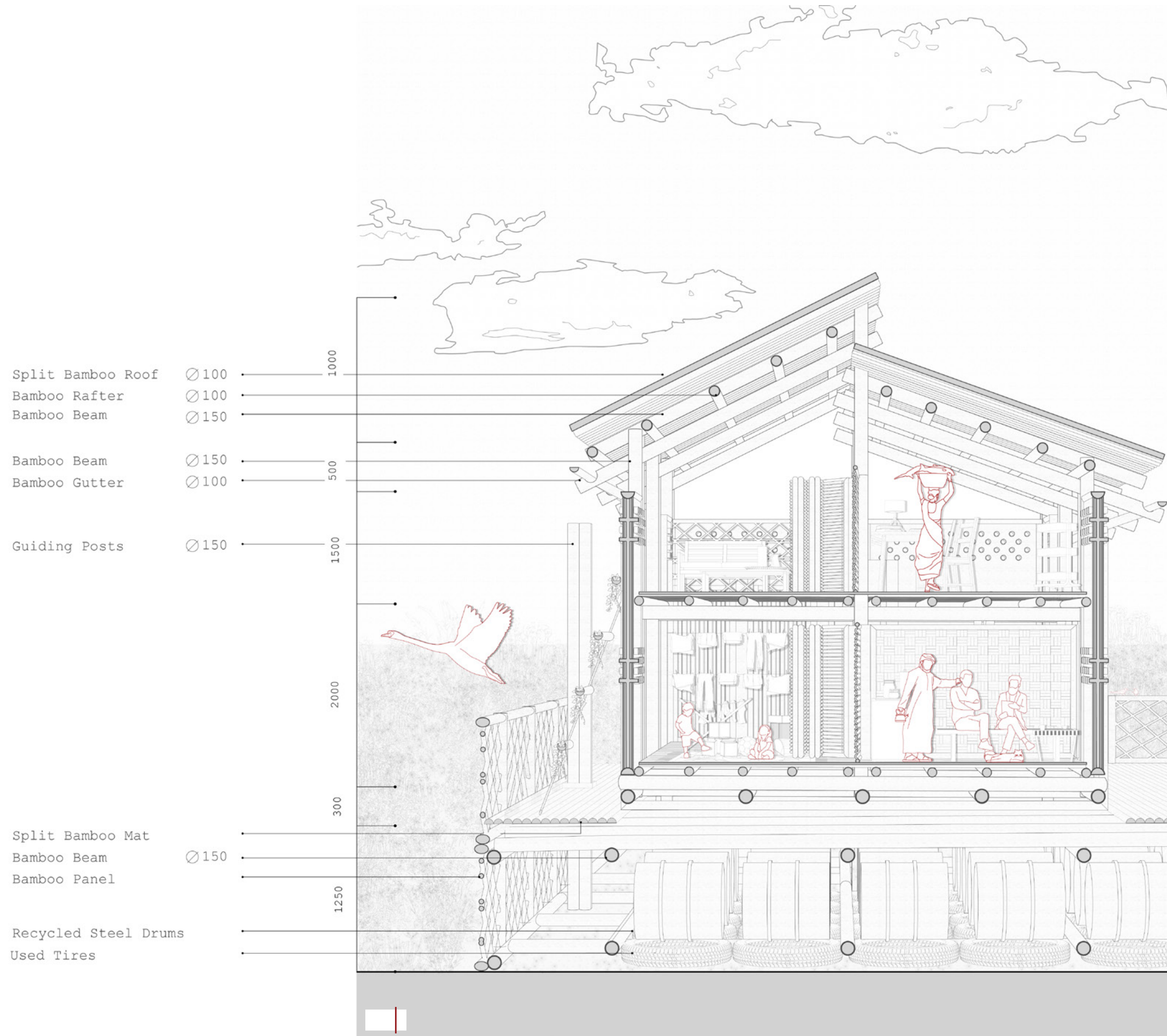
The Family Home

Dwelling Type B

The spaces can also be expanded to create more bedrooms for a growing family. The flexibility of the bamboo panels allows for various programmatic uses.



Dwelling Iterations
Scaled (1:20)



Dwelling Section

Dry Season

Dwelling Type B

The section portrays a dwelling for a family whose front of house was turned into a tea shop for extra income, with the rest of the dwelling utilized to raise their children.

Perspective Section

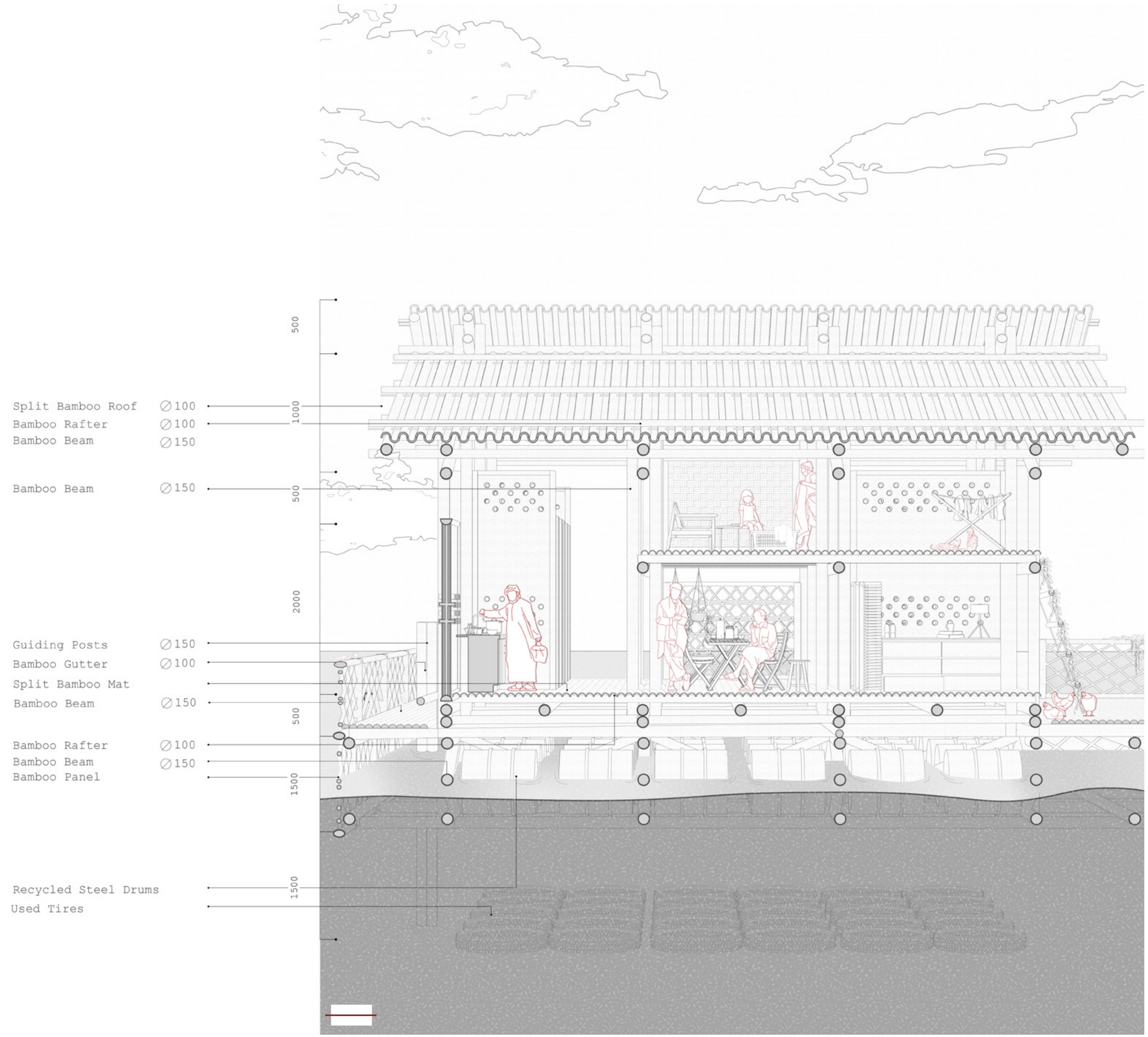
Scale 1:20

Dwelling Section

Monsoon Season

Dwelling Type B

The spaces can also be expanded to create more bedrooms for a growing family. The flexibility of the bamboo panels allows for various programmatic uses.



Perspective Section
Scaled (1:20)

Dwelling Visualization
Daily Life

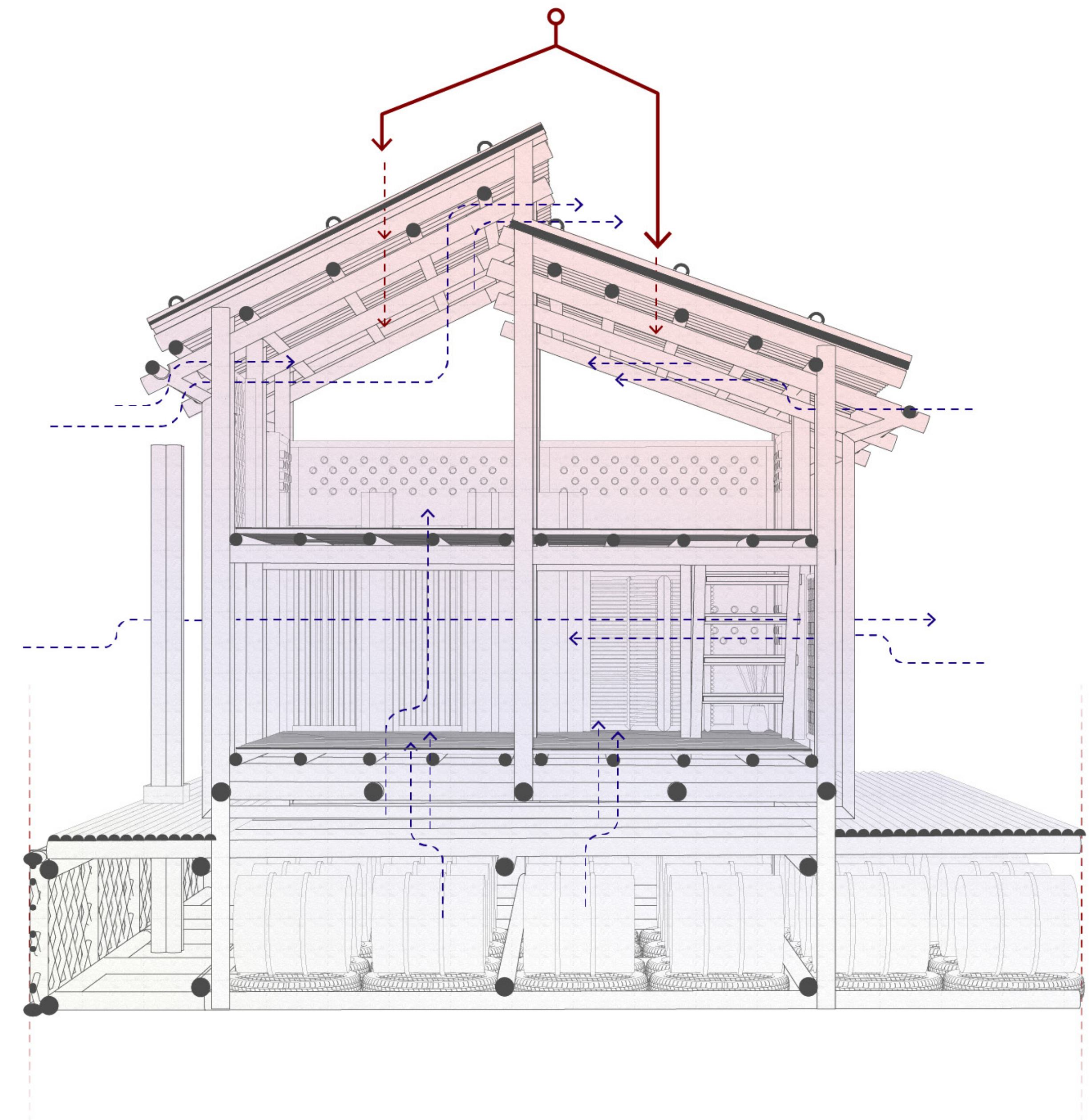
Communal Visualization
Daily Life

Clustering Visualization
Daily Life Visualization

Climate Principles
Heating and Cooling

> Humidity is very high from June to September (monsoon season), making it feel much hotter

Month	Outdoor Avg Temp (°C)	Indoor Avg Temp (°C)
January	18-22	17-20
February	20-24	19-22
March	24-28	23-26
April	27-32	26-30
May	28-33	27-31
June	29-32	28-30
July	29-31	28-30
August	29-31	28-30
September	28-31	27-29
October	26-30	25-28
November	22-27	21-25
December	19-24	18-22



The dwelling incorporates a passive cooling system that provides comfort in various weather conditions.

Climate Principles
Ventilation

Climate Principles
Water System

Bangladesh - 189 Rainy Days
10 Months a year
Approximately 16 days per month of rain

A typical family of five in Bangladesh needs approximately 100 to 150 liters of water each day for drinking, cooking, cleaning, and other household activities. However, this amount can vary based on factors such as weather conditions, access to water infrastructure, and personal usage habits

Rainy Season

May	*0.12 inches*	●○○
June	*0.41 inches*	●●●
July	*0.36 inches*	●●●
August	*0.22 inches*	●●○
September	*0.20 inches*	●●○
October	*0.13 inches*	●○○

Roof Area x Rainfall x 0.623 - *Amount of Water Collected*

Small Dwelling
26 sq.m Roof

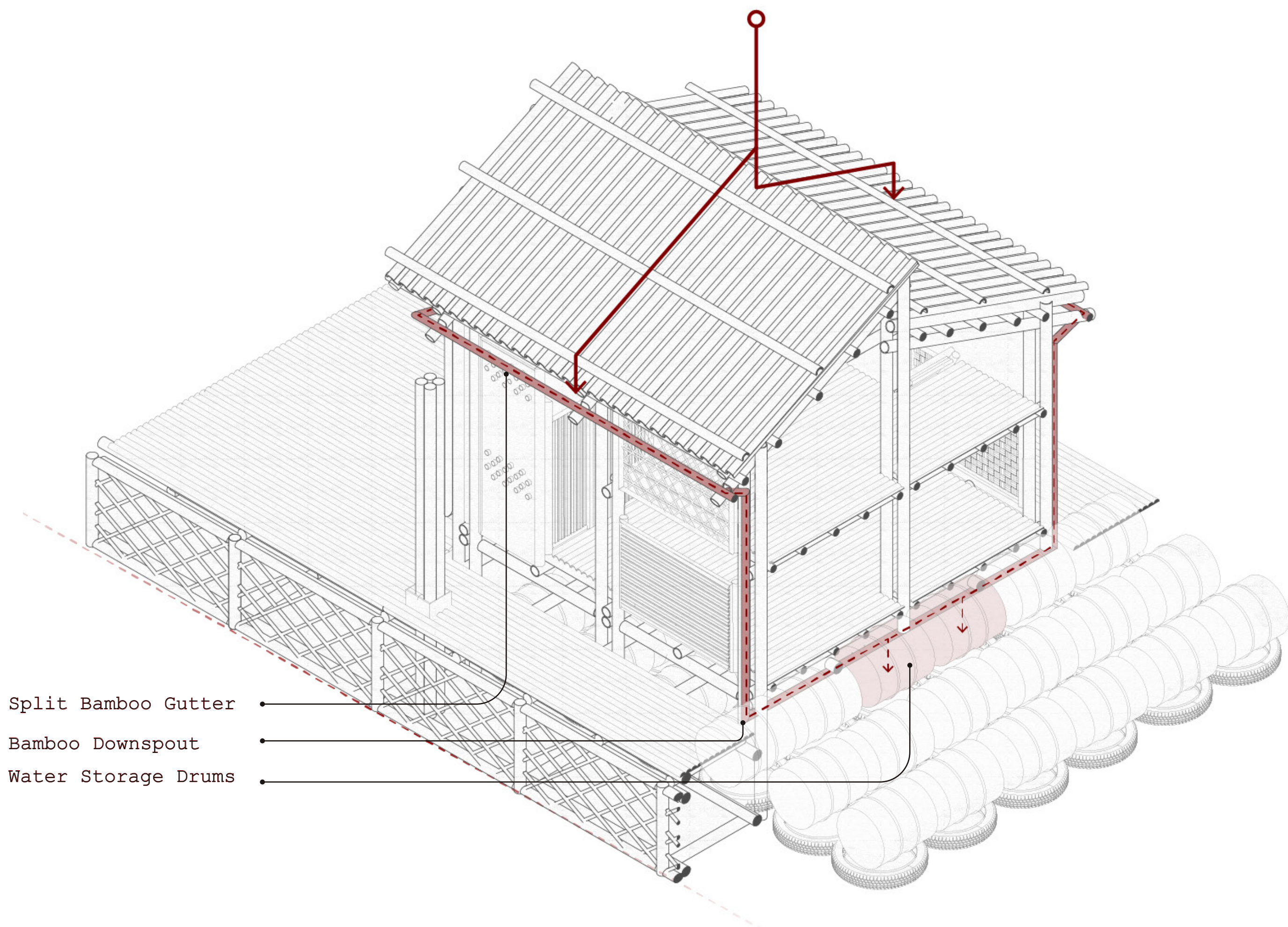
- 260 sq.ft x 0.41 (June) x 0.623
  - 66 Gallons of Water

Medium Dwelling
35 sq.m Roof

- 375 sq.ft x 0.41 (June) x 0.623
  - 96 Gallons of Water

Large Dwelling
70 sq.m Roof

- 750 sq.ft x 0.41 (June) x 0.623
  - 192 Gallons of Water



Three drums, with a total capacity of 630 liters, are installed within the dwelling to function as a ballast system. This arrangement ensures that the household maintains an adequate water supply for approximately one week.

Climate Principles

Septic Tank

The septic tank is utilized for grey water which is then ran through a helophyte filter. It is approximated that 4-10 liters of grey water are produced each day depending on the usage

Conservative Estimate

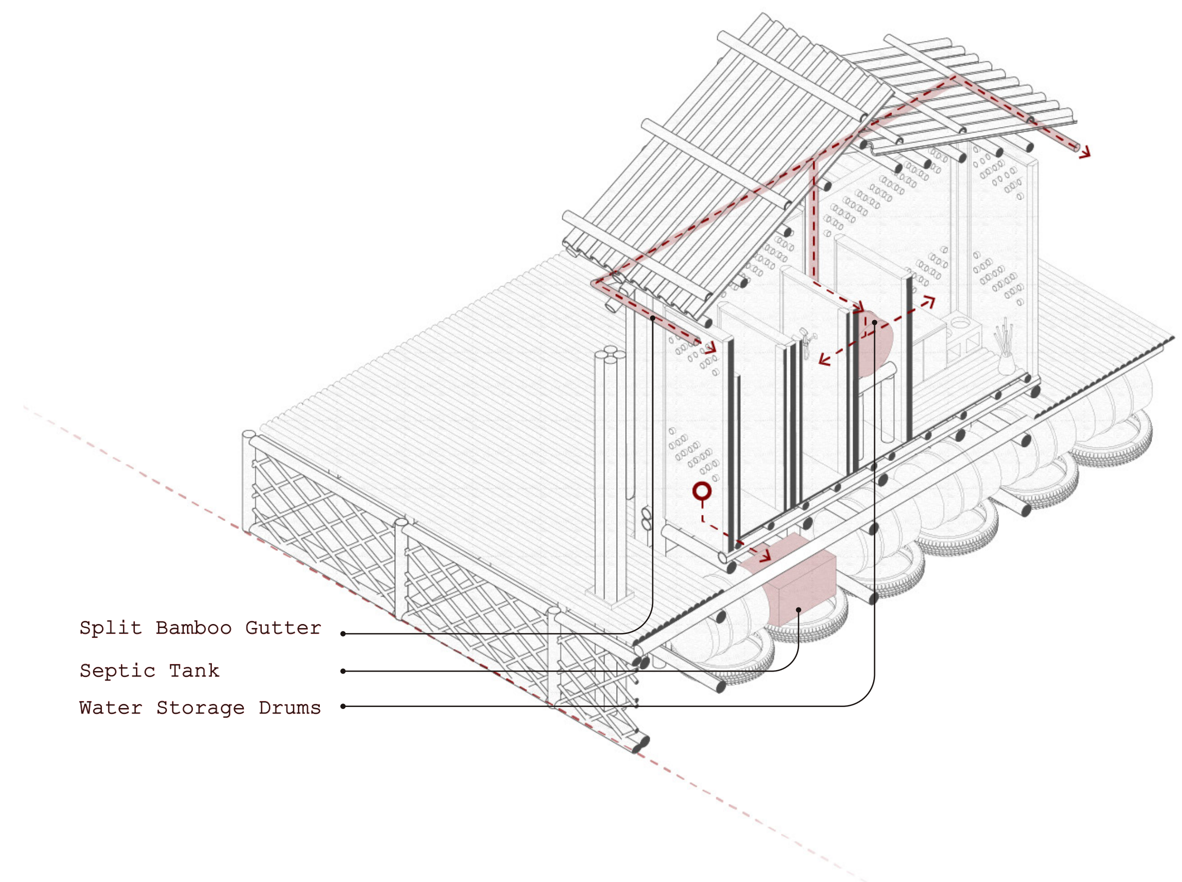
Family of 6

- 6 People x 5 Liters/Day
  - 30 Liters/Day
- Approximately 7 days

Real-World Adjustment

Family of 6

- 6 People x 7 Liters/Day
  - 42 Liters/Day
- Approximately 5 days

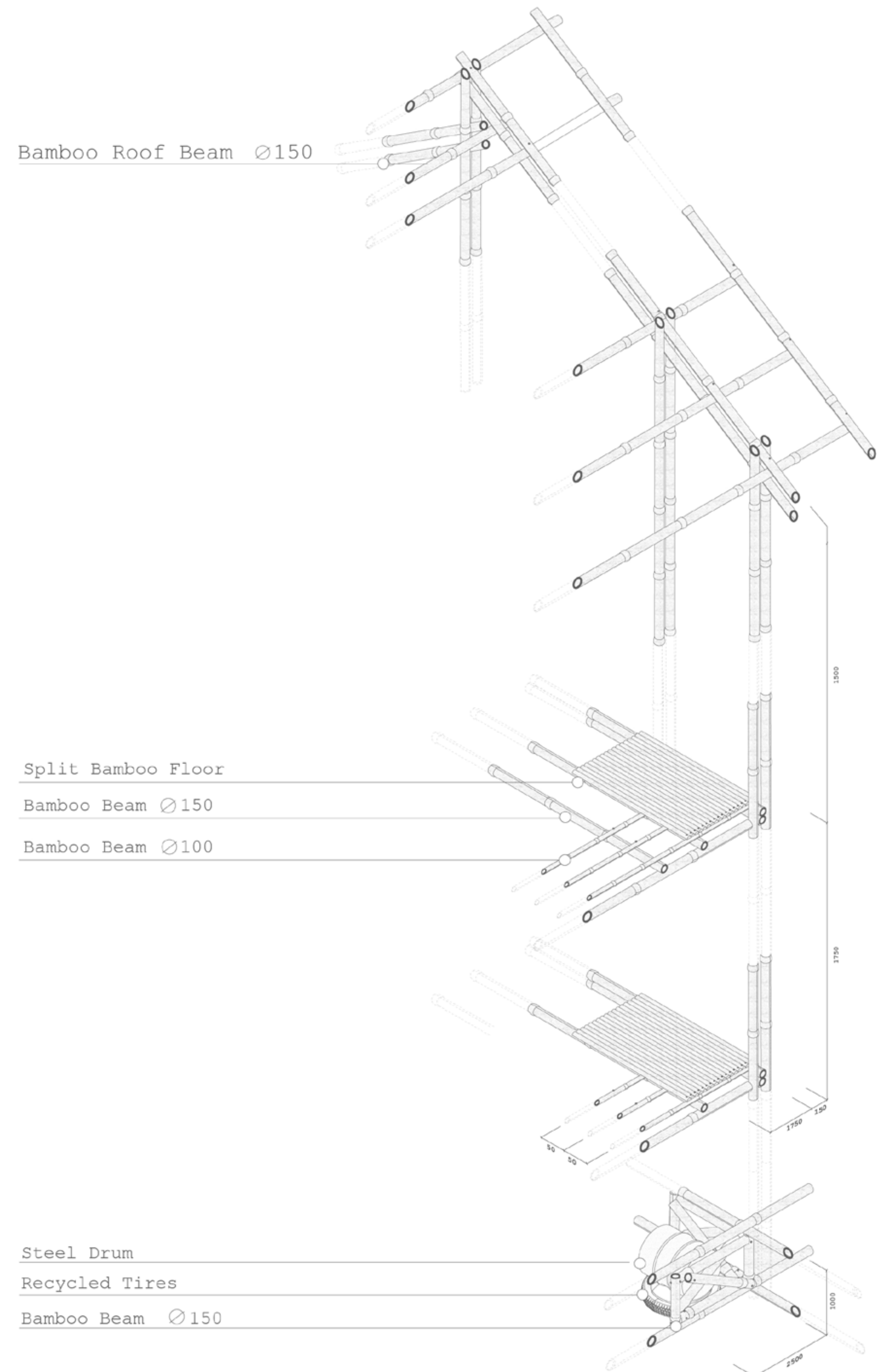


The septic tank replaces one of the metal drums within the raft. Each dwelling is equipped with one septic tank that is connected to a helophyte filter

Structural System

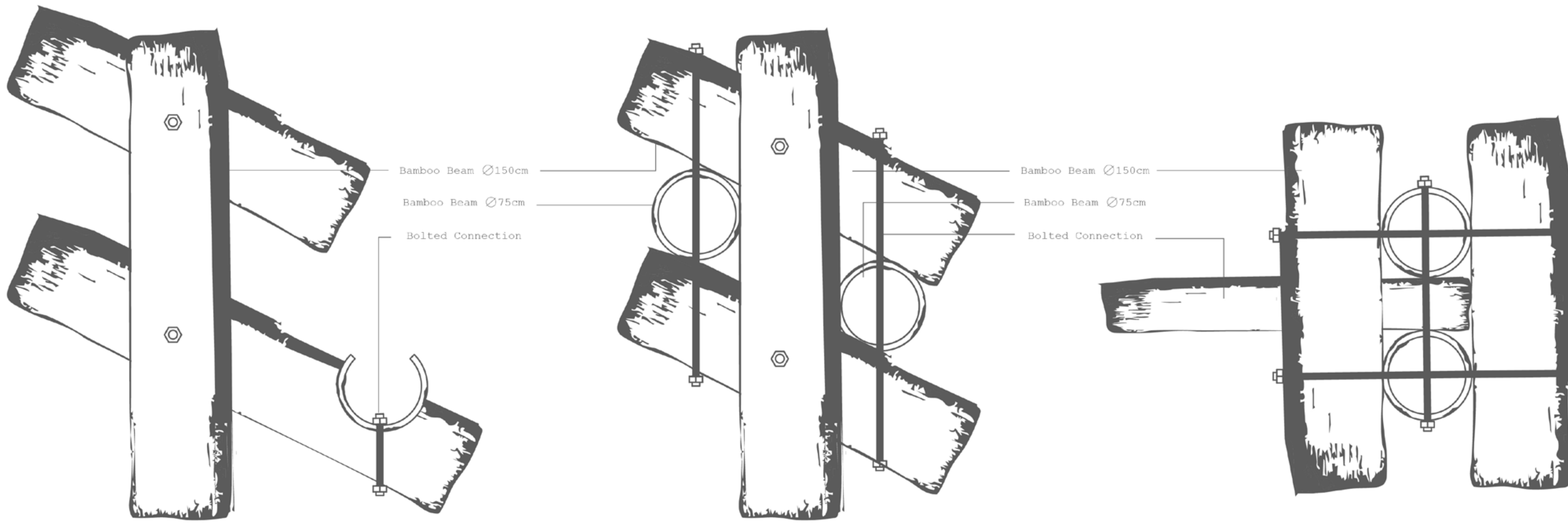
Dwelling Type B

> The intent to utilize bolted connections was the ease of assembling and disassembling the structure. The flexibility aids to the projects overall goal of having the community built the project themselves



Structural System

Scale 1:20



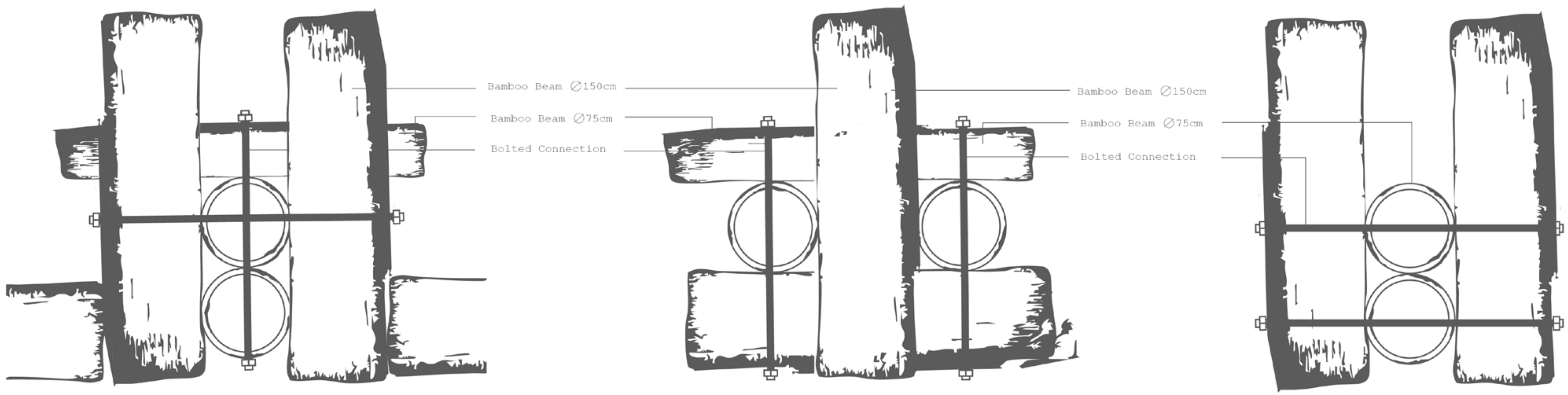
Joint A
Roof Joint

Joint B
Roof Joint

Joint c
Roof Joint

Structural Systems
Bamboo Joints

The diagrams above showcase the floor bamboo joints.



Joint D
Floor Joint

Joint E
Floor Joint

Joint F
Roof Joint

Structural System
Bamboo Joints

The diagrams above showcase the floor bamboo joints.

Dwelling

Interior Visualizations

The images aim to convey the environemnt that is created within the dwelling units, creating a warm atmosphere through the use of materiality and spacial organization

Bedroom Area
Dwelling B

Split View
Dwelling B

Split View
Dwelling C

Construction Sequence

Phasing

The construction of the raft is dependent on a few key points. The harvesting of the local materials and the use of community engagement for the actual assembly.

Phasing of Rafts

Four Rafts per year

- Assuming 50 Culms per mature clump
- 8,000 Culms (2,000 per raft) / 50 Culms per Clump - 160 Clumps Needed
- Assuming each clump requires 25 sq.m of space

Area Required for Project

Four Rafts per year

- 160 Clumps x 25 sq.m - - 4,000 sq.m
- 4,000 sq.m - Approximately 1 acre

One time Harvest

Four Rafts per year

- Require one acre of land

Sustainable Harvesting

Four Rafts per year

- Harvesting only 20-30% each year
- Requires 3-4 acres of land
- Allowing for healthy clumps, providing a steady supply of Bamboo

Harvesting

Four Rafts per year

- Harvest takes place during the dry season
- The project will require 4-5 years to be completed with the master plan showcased

Growing
Each raft requires approximately 2,000 bamboo culms made up of three different varieties

Harvesting
To ensure an ongoing productive farm only 25-30% of the bamboo should be harvested each year

Waterproofing
The bamboo culms are chemically treated by applying a liquid made by boiling local Gaab fruits. This traditional Bangladeshi method waterproofs bamboo (1-2 Mature fruits are needed per culm)

Transportation
Bamboo is harvested in the Sylhet and Chittagong Divisions, and transported to the site

Preparation
The bamboo is dimensioned into pieces that would require approximately 4-8 individuals to transport the largest pieces

Assembly
The project is designed to not require large machinery to assemble

Construction Sequence
Vertical Elements

Mounting vertical structural
Bamboo elements per dwelling specifications.

The main dwelling structure is composed of Bambusa Balcooa and Steel Connections

Bambusa Balcooa - *Small*
- 7.5m x 4
- 6m x 4
- 5.5 x 4
- 4m x 4
- 3.5m x 4

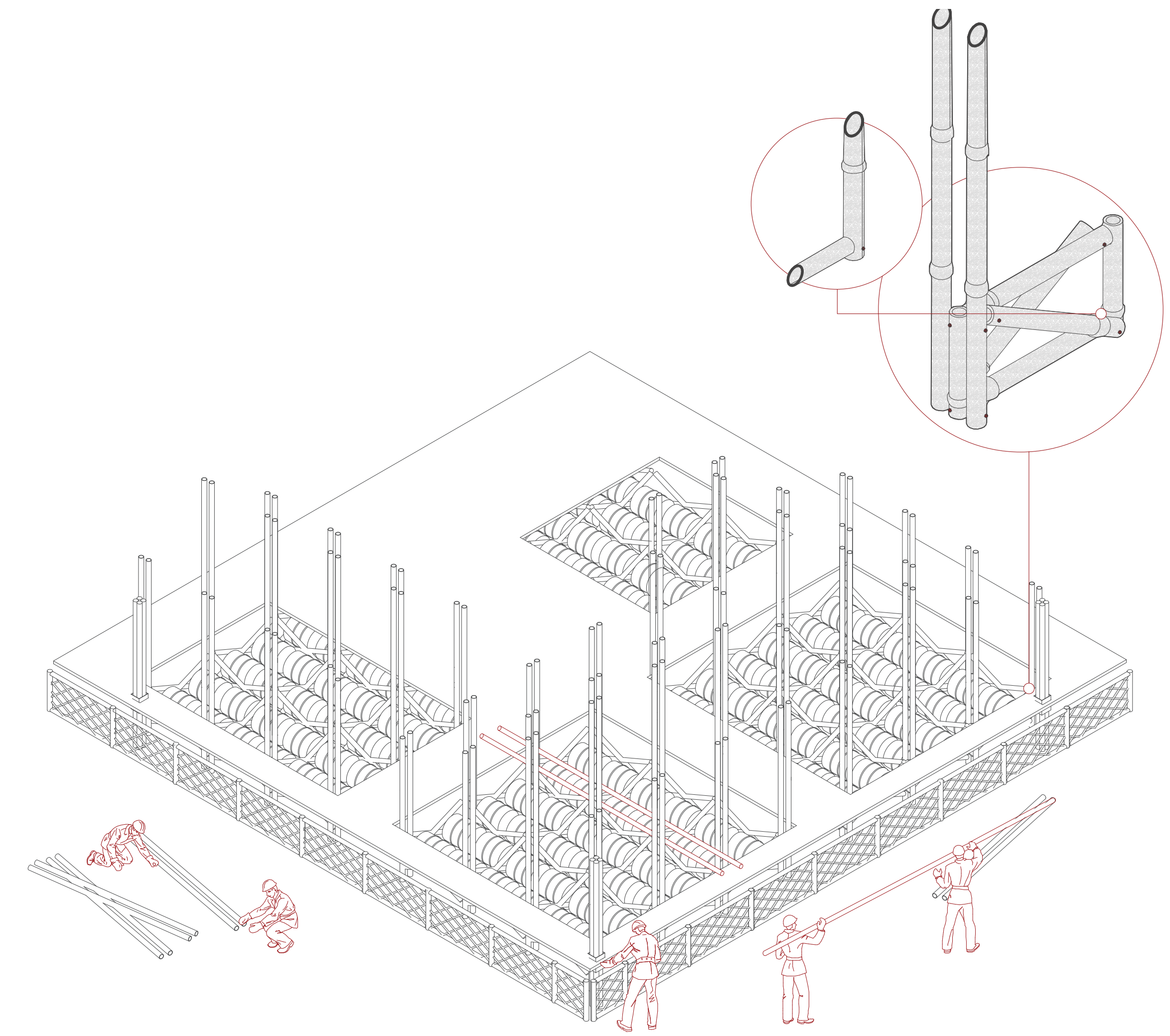
◦ Total of 96m of Bamboo
- 4.8 Bamboo Culms

Bambusa Balcooa - *Medium*
- 7.5m x 4
- 6m x 4
- 5.5 x 8
- 4m x 4
- 3.5m x 4

◦ Total of 128m of Bamboo
- 6.4 Bamboo Culms

Bambusa Balcooa - *Large*
- 7.5m x 4
- 6m x 4
- 5.5 x 8
- 4m x 4
- 3.5m x 4
- 3m x 4

◦ Total of 151m of Bamboo
•8 Bamboo Culms



The vertical structural elements of the dwelling are bolted with the rafts cross bracing to ensure the stability of the project

Construction Sequence
Horizontal Elements

Mounting horizontal structural bamboo elements per dwelling specifications.

The horizontal structure is composed of Bambusa Balcooa, Dendrocalamus Longispathus and Steel Connections

Bambusa Balcooa - *Small*
• 5m x 10 • 2.5m x 10

◦ Total of 75m of Bamboo
• 3.75 Bamboo Culms

Dendrocalamus Longispathus - *Small*
• 5m x 10 • 2.5m x 10

◦ Total of 75m of Bamboo
• 5 Bamboo Culms

Bambusa Balcooa - *Medium*
• 5m x 14 • 2.5m x 15

◦ Total of 142.5m of Bamboo
• 7 Bamboo Culms

Dendrocalamus Longispathus - *Medium*
• 7.5m x 10 • 2.5m x 8

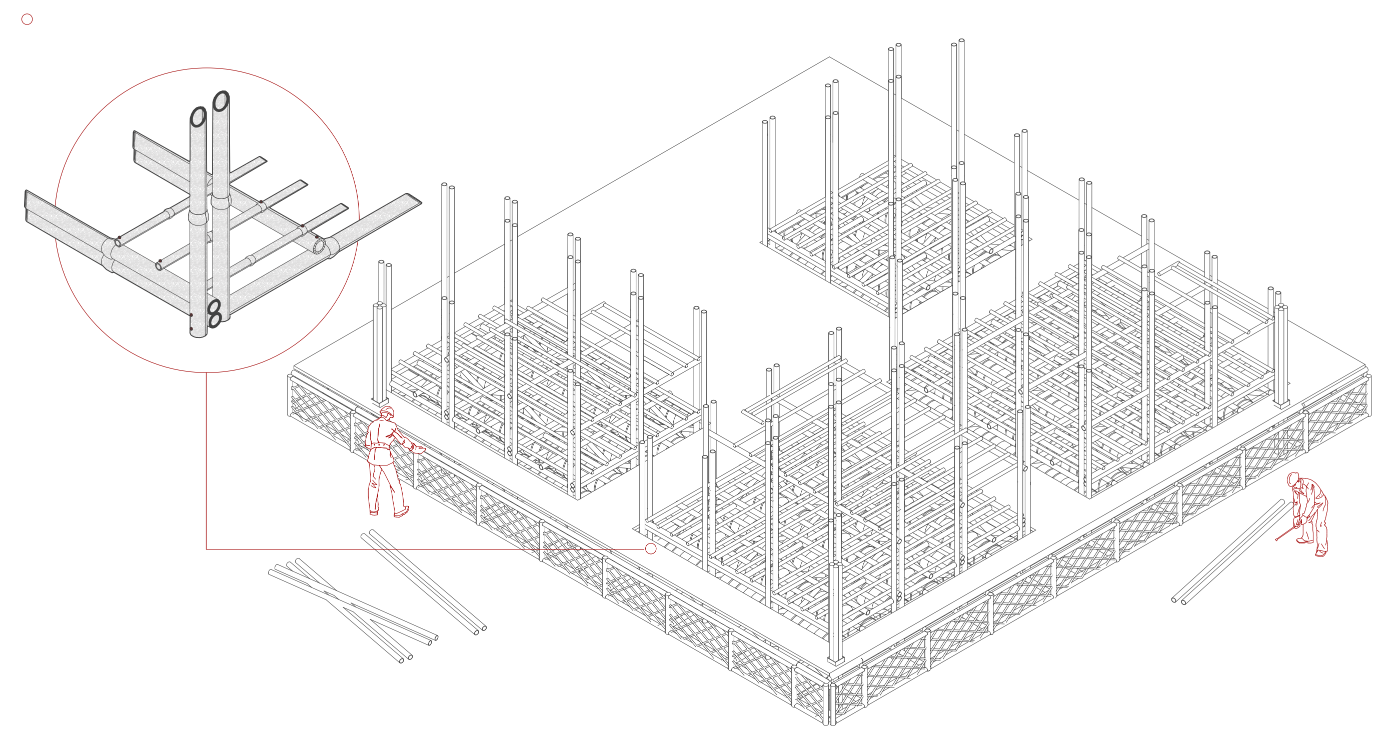
◦ Total of 120m of Bamboo
• 8 Bamboo Culms

Bambusa Balcooa - *Large*
• 7.5m x 14 • 2.5m x 21

◦ Total of 158m of Bamboo
• 7.8 Bamboo Culms

Dendrocalamus Longispathus - *Large*
• 7.5m x 10 • 2.5m x 8

◦ Total of 182.5m of Bamboo
• 12 Bamboo Culms



The horizontal structural elements are interlocked and bolted with the vertical structural elements

Construction Sequence
Roof Elements

> Mounting the roof structural
> Bamboo elements per dwelling specifications.
>
> *The roof structure is composed of Bambusa Balcooa, Dendrocalamus Longispathus and Steel Connections*

Bambusa Balcooa - *Small*
• 3.75m x 10 • 3.5m x 8

◦ Total of 65.5m of Bamboo
• 3.2 Bamboo Culms

Dendrocalamus Longispathus - *Small*
• 7.5m x 10

◦ Total of 75m of Bamboo
• 5 Bamboo Culms

Bambusa Balcooa - *Medium*
• 3.75m x 12 • 3.5m x 8

◦ Total of 73m of Bamboo
• 3.6 Bamboo Culms

Dendrocalamus Longispathus - *Medium*
• 10m x 10

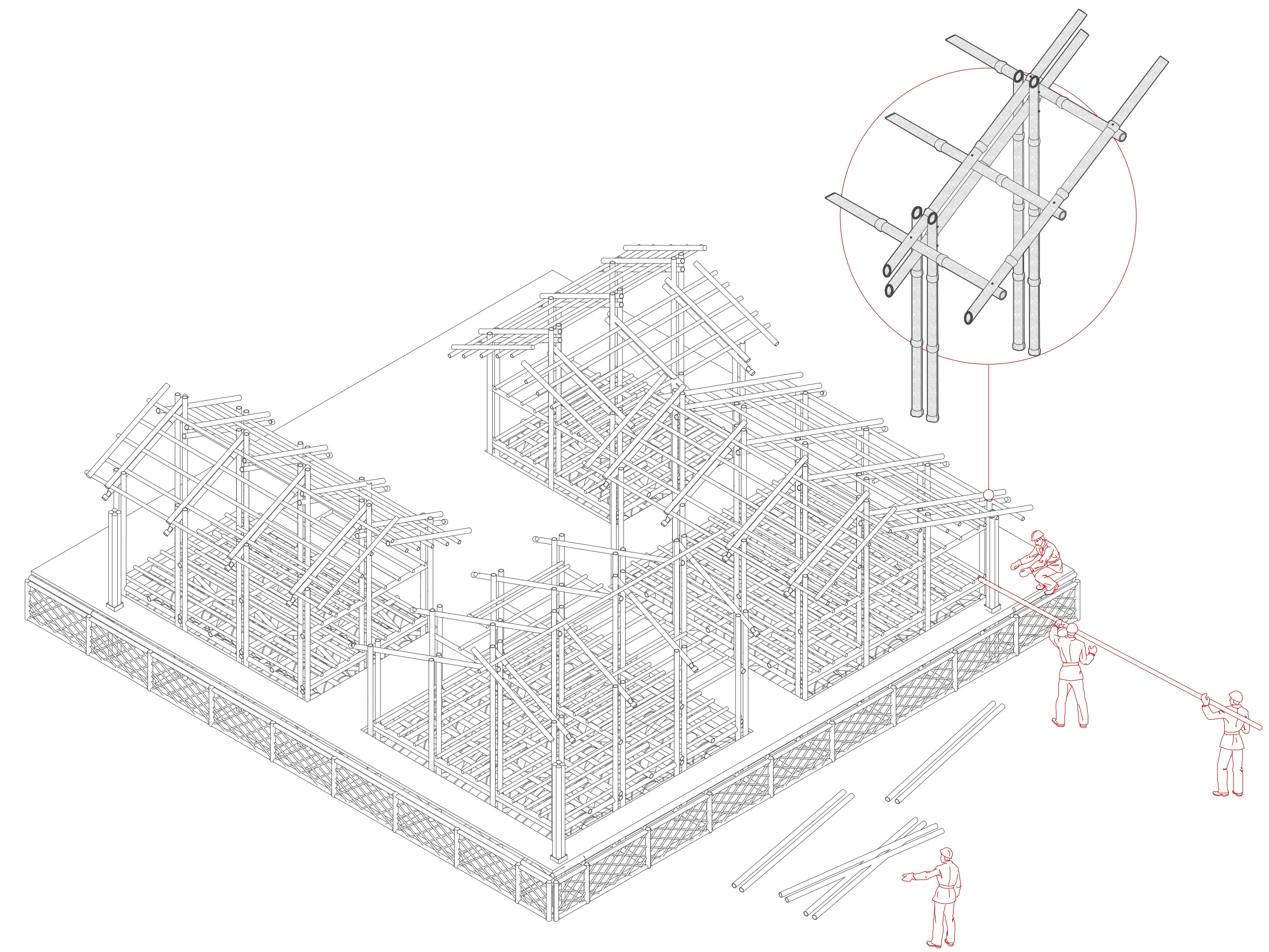
◦ Total of 100m of Bamboo
• 6.6 Bamboo Culms

Bambusa Balcooa - *Large*
• 6.75m x 4 • 3.75m x 4
• 6.5 x 6 • 3.5m x 6

◦ Total of 102m of Bamboo
• 5 Bamboo Culms

Dendrocalamus Longispathus - *Large*
• 10m x 13

◦ Total of 130m of Bamboo
• 8.6 Bamboo Culms



The roof elements are interlocked and bolted with the vertical structural elements

Construction Sequence

Split Bamboo Flooring

> Mounting the split bamboo flooring per dwelling
>
> *The dwelling floor is composed of Dendrocalamus Longispathus and Steel Connections*

Dendrocalamus Longispathus - *Small*
• 5m x75

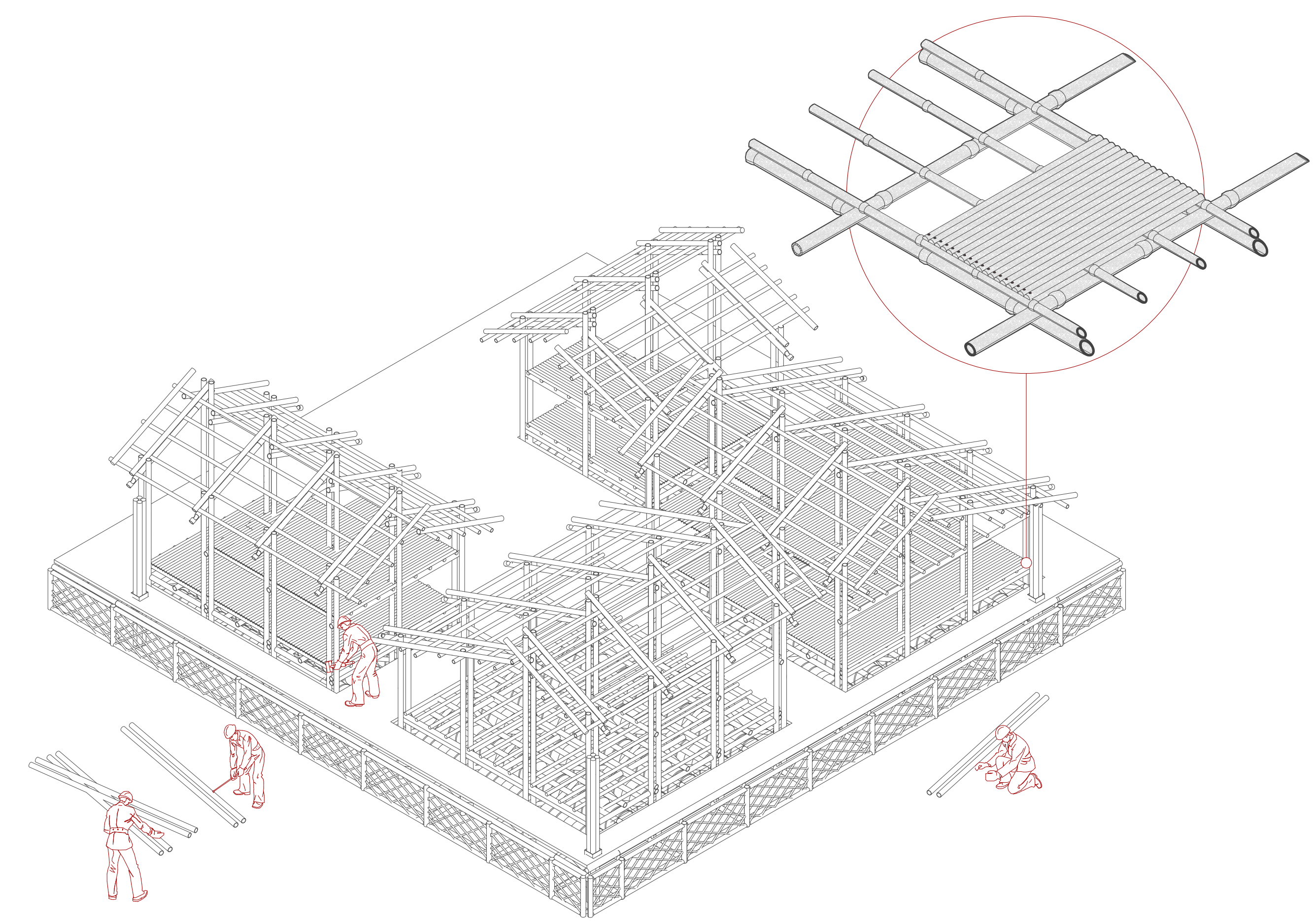
◦ Total of 375m of Bamboo
• 25 Bamboo Culms

Dendrocalamus Longispathus - *Medium*
• 5m x125

◦ Total of 625m of Bamboo
• 42 Bamboo Culms

Dendrocalamus Longispathus - *Large*
• 7.5m x125

◦ Total of 938m of Bamboo
• 62.5 Bamboo Culms



The split bamboo flooring is placed perpendicular to the horizontal structural elements and bolted into place

Construction Sequence

Split Bamboo Roofing

The split bamboo roof and gutter system are mounted

The roof is composed of Dendrocalamus Longispathus and Steel Connections

Dendrocalamus Longispathus - *Small*
- 3m x150

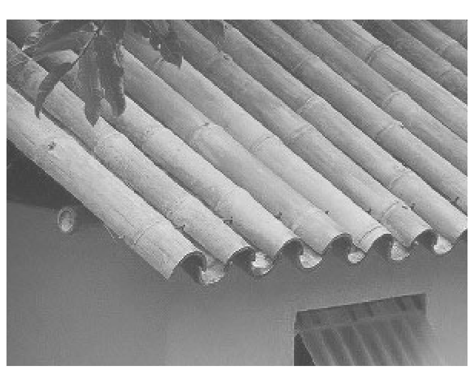
◦ Total of 525m of Bamboo
- 35 Bamboo Culms

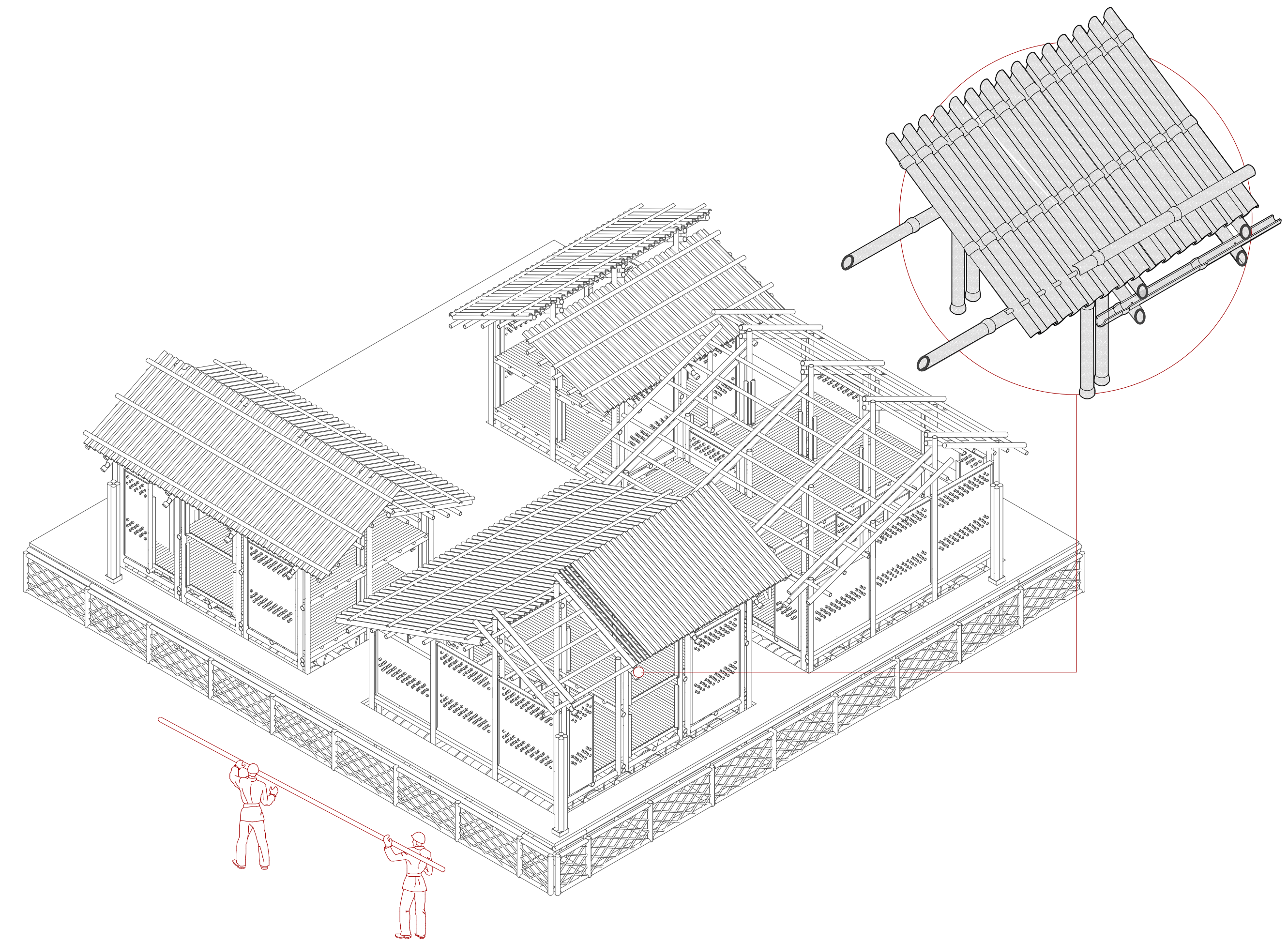
Dendrocalamus Longispathus - *Medium*
- 3.5m x200

◦ Total of 700m of Bamboo
- 46.6 Bamboo Culms

Dendrocalamus Longispathus - *Large*
- 3.5m x100
- 6.25m x100

◦ Total of 975m of Bamboo
- 65 Bamboo Culms





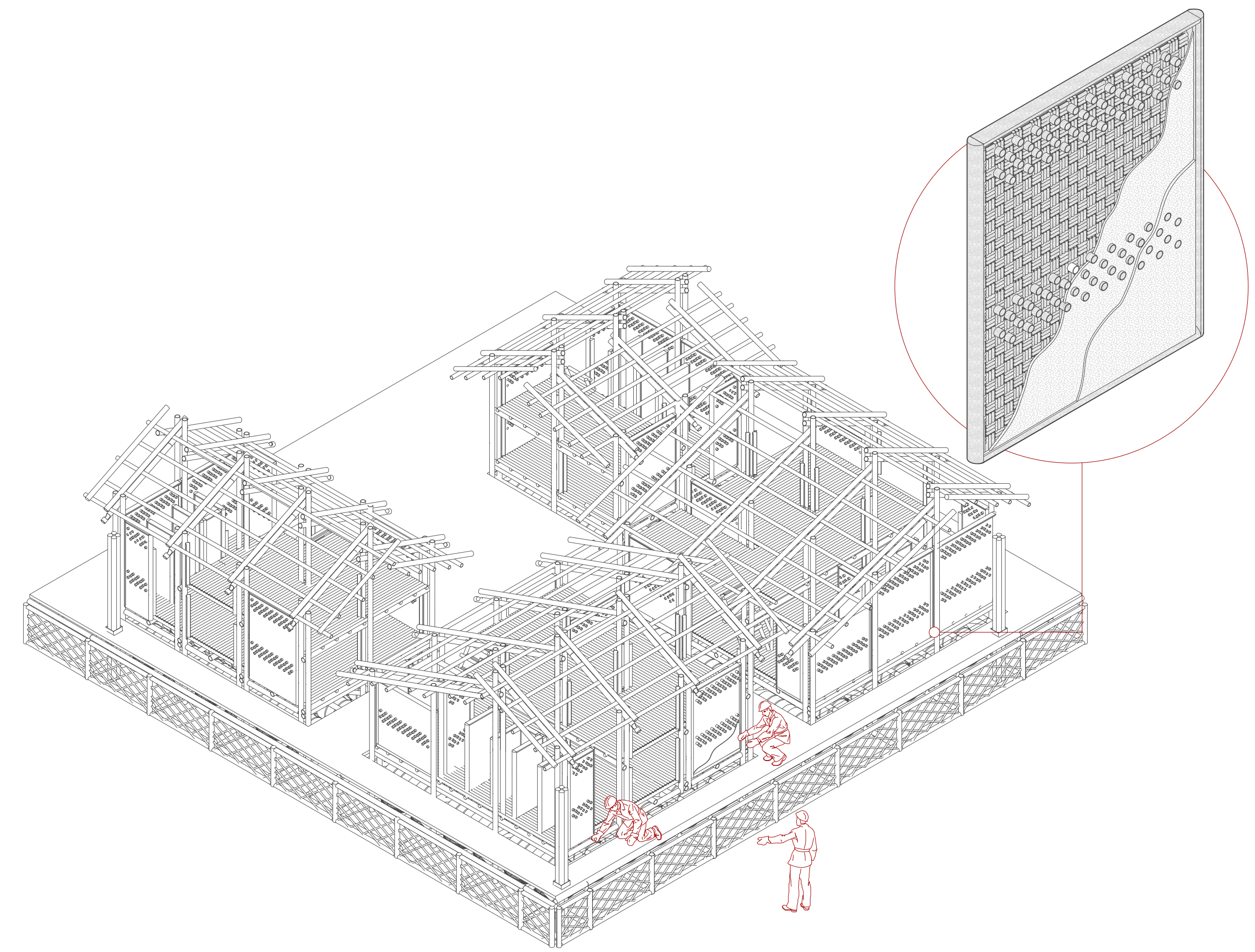
The split bamboo roof is designed with water collection in mind. A bamboo element runs through the culms and above to secure them in place

Construction Sequence
Mud and Lime Walls

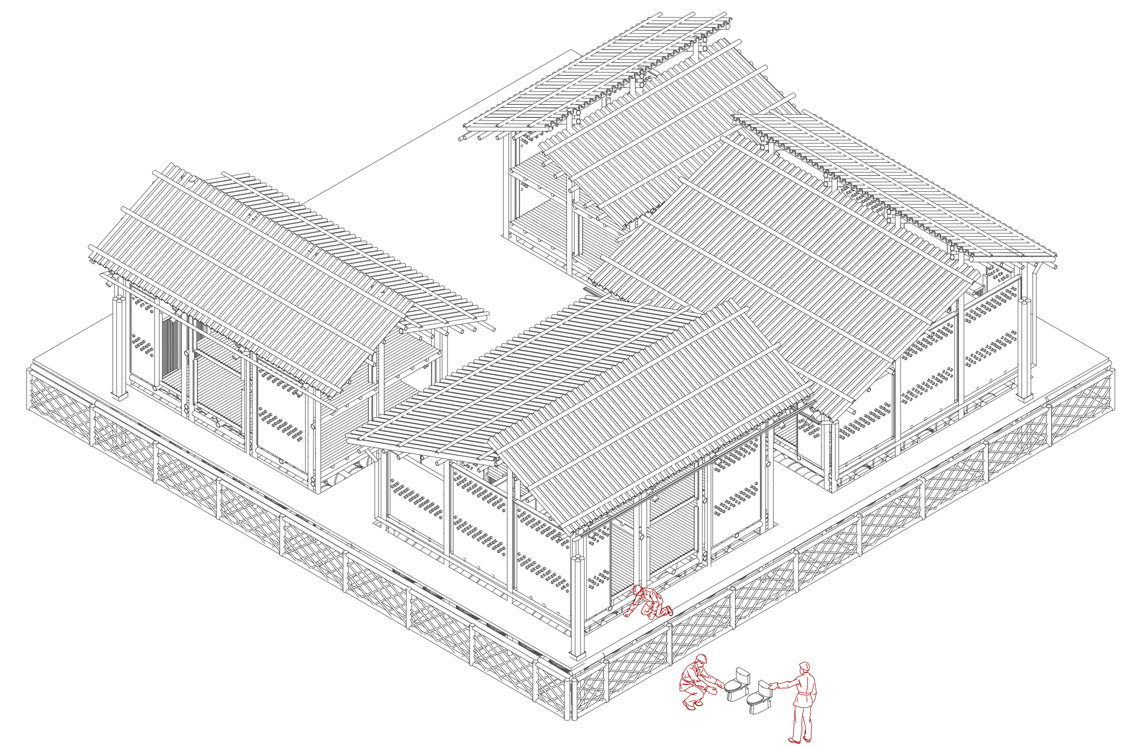
The woven bamboo panels are placed and plastered

The permanent walls within the dwellings are made up of the following components

- Woven Bamboo Panel
- Mud Plaster
- Lime Coating



The traditional mud wall encapsulates the cultural, social, and environmental fabric of the country



The services provided are based on our conversations with the Shonatola Community

Construction Sequence

Services

The services provided within each dwelling are implemented

Each dwelling is equipped with basic services

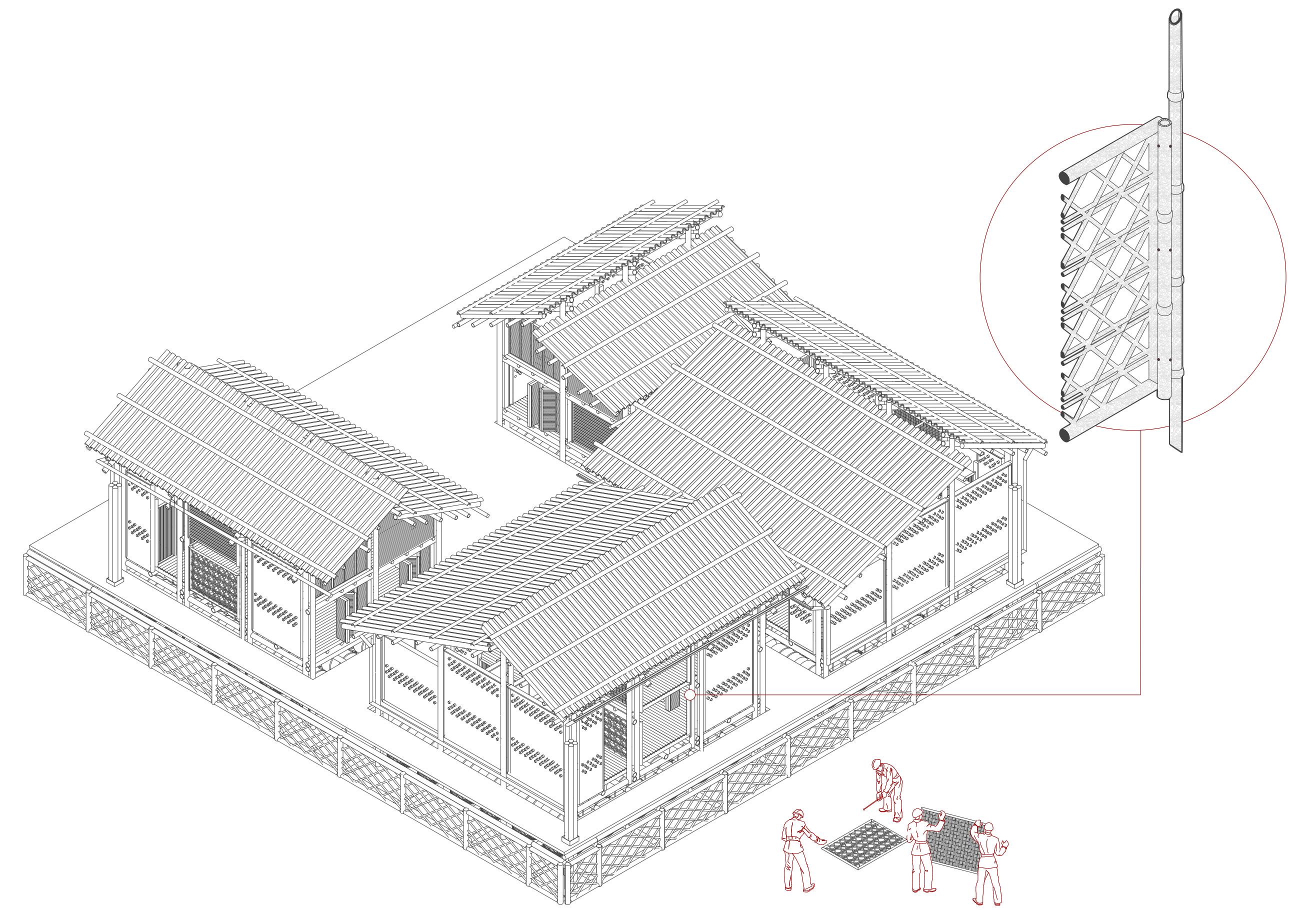
- Toilet
- Shower
- Kitchen

Construction Sequence
Bamboo Panels

The flexible bamboo panels are mounted based on the needs of the occupant

The panels are composed of Melocanna Baccifera and Steel Connections





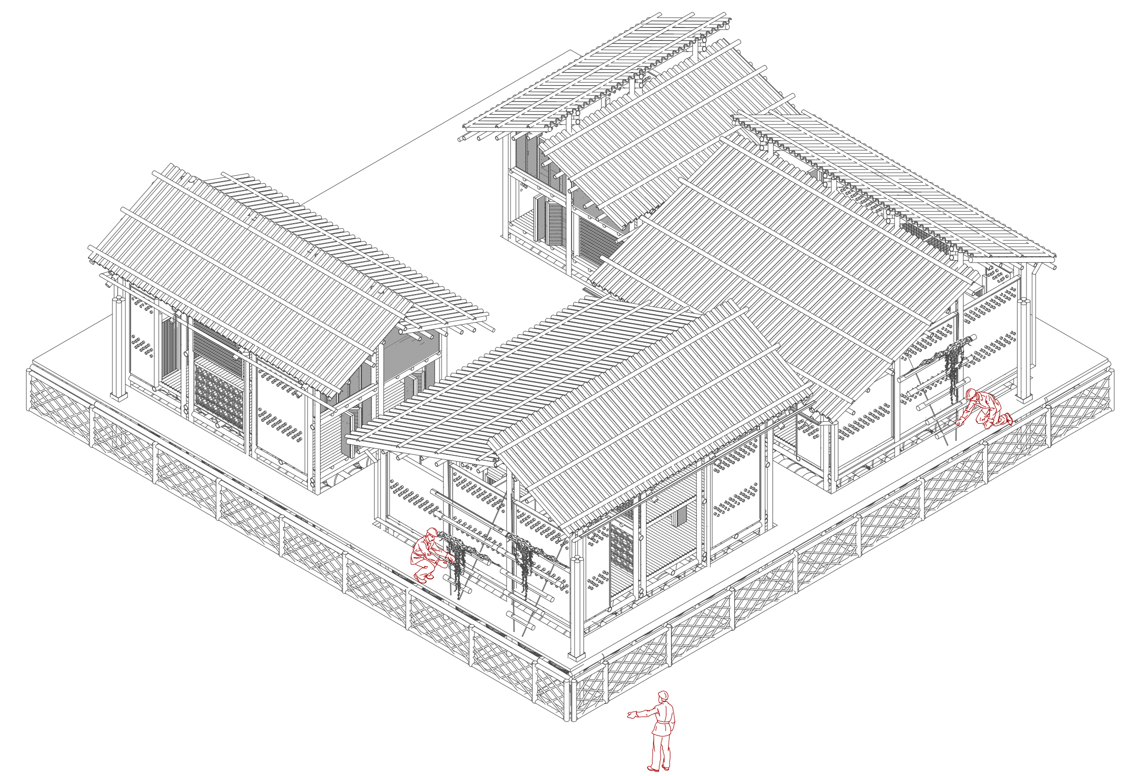
A series of bamboo panels have been designed to serve a series of functions within each dwelling

Construction Sequence
Personal Gardens

A series of climbing greenery walls are implemented within the dwellings

Inspiration for the construction of the planters is taken from the project below by H&P Architects





The vertical gardens encourage the purifying of the air, regulating the temperature and promotes biodiversity within the community

03C The Masterplan

Community Development

The community is granted agency in directing the urban development of their settlements through a modular system of interconnected rafts forming an integrated whole. The density, spatial organization, and other fundamental aspects of the masterplan are calibrated in response to the unique needs and priorities of the specific community where the prototype is deployed.

Program Requirements

Key Characteristics

The creation of self reliant communities is at the forefront of the proposal. As climatic situations worsen, the dependency on existing infrastructure is unstable

Community Spaces

Encourage social engagement within the entire community

Market Spaces

Spaces to foster and support the production and distribution of local goods

Education Spaces

A new educational facility will meet the needs of the current and future community

Food Source

Floating farms provide a viable solution for the community

Waste Management System

Helophyte filters are implemented within the overall design to aid the community

Water Supply and Sanitation

A rain water collection system is incorporated within the design

Masterplan Variations

The Shonatola Community

A set of rules are set to maintain the quality of the masterplan as well as maintain the sites relationship to water

Spacing

Rafts must be placed at least 5m apart horizontally and 10m apart verticallyto allow for water flow

Communal Spaces

Communal spaces to be placed in the center of the amphibious typology, creating a connection between the existing and future village

Circulation

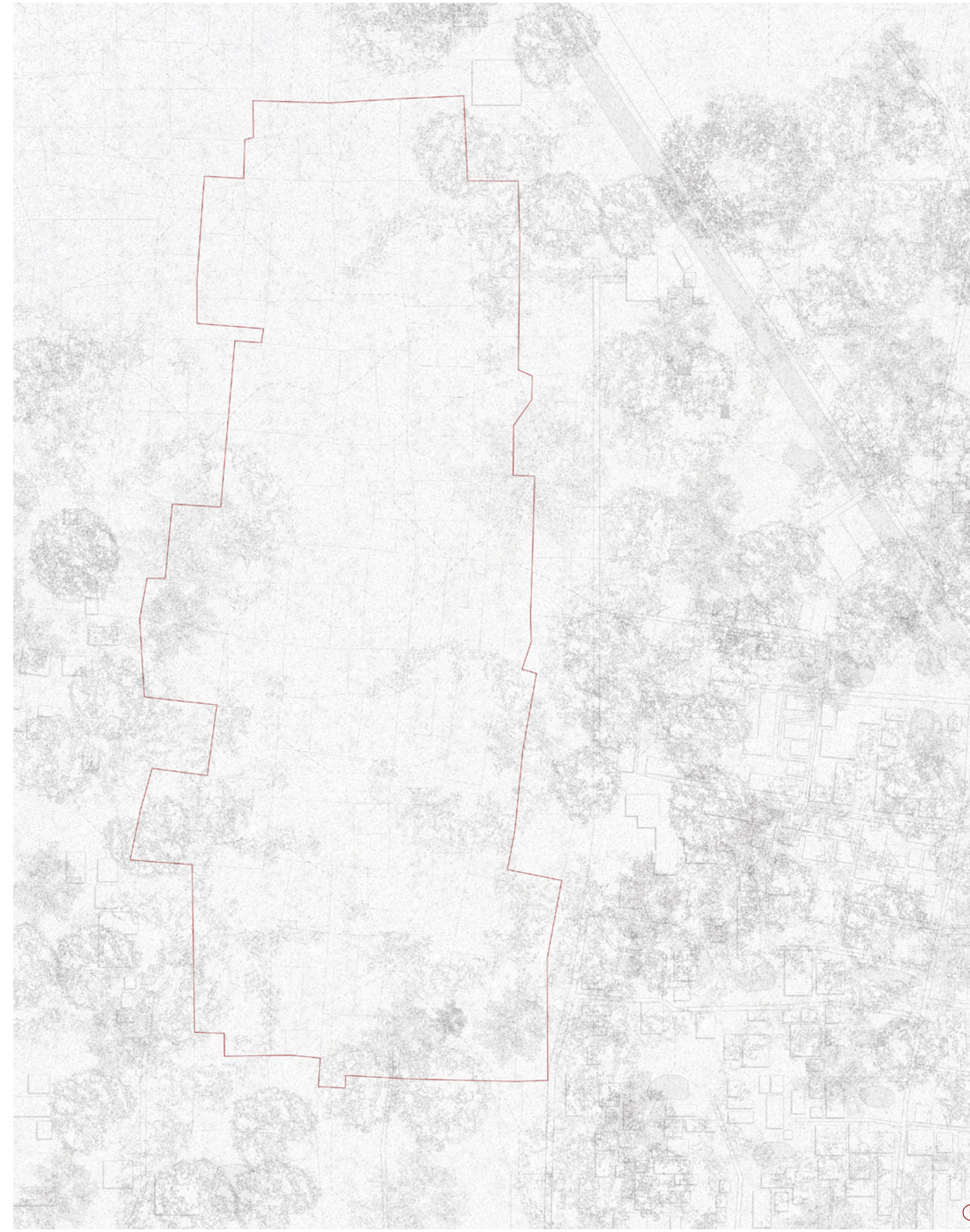
Each “Raft” must be accessible both by bridge and stair, as well as be connected to the larger bridge system

Farming

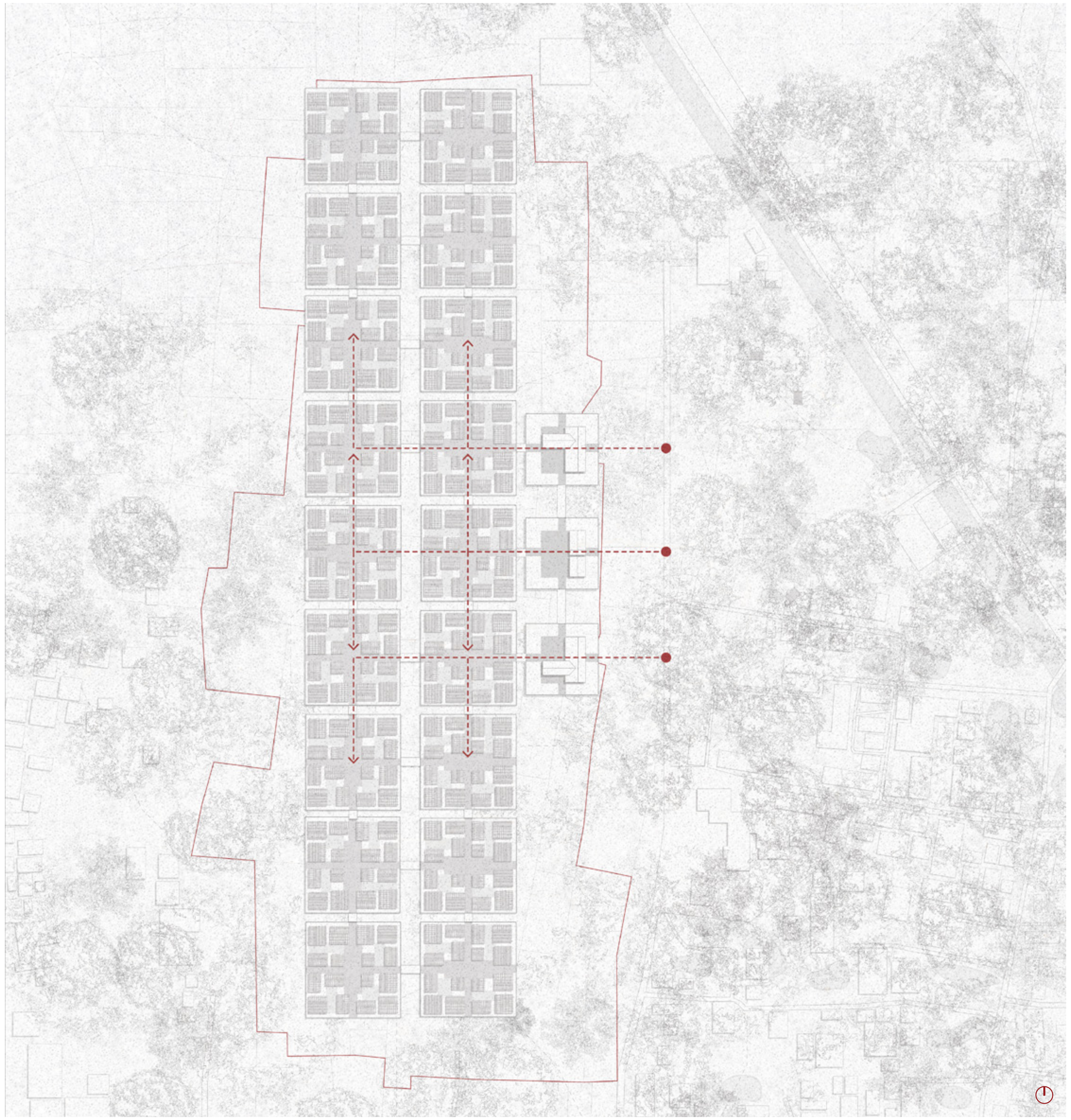
Designated spaces for farming must be allocated for each raft to be self sufficient

Sanitation

Each raft must be accompanied by a small helophyte filter, or a larger helophyte filter for a grouping of rafts



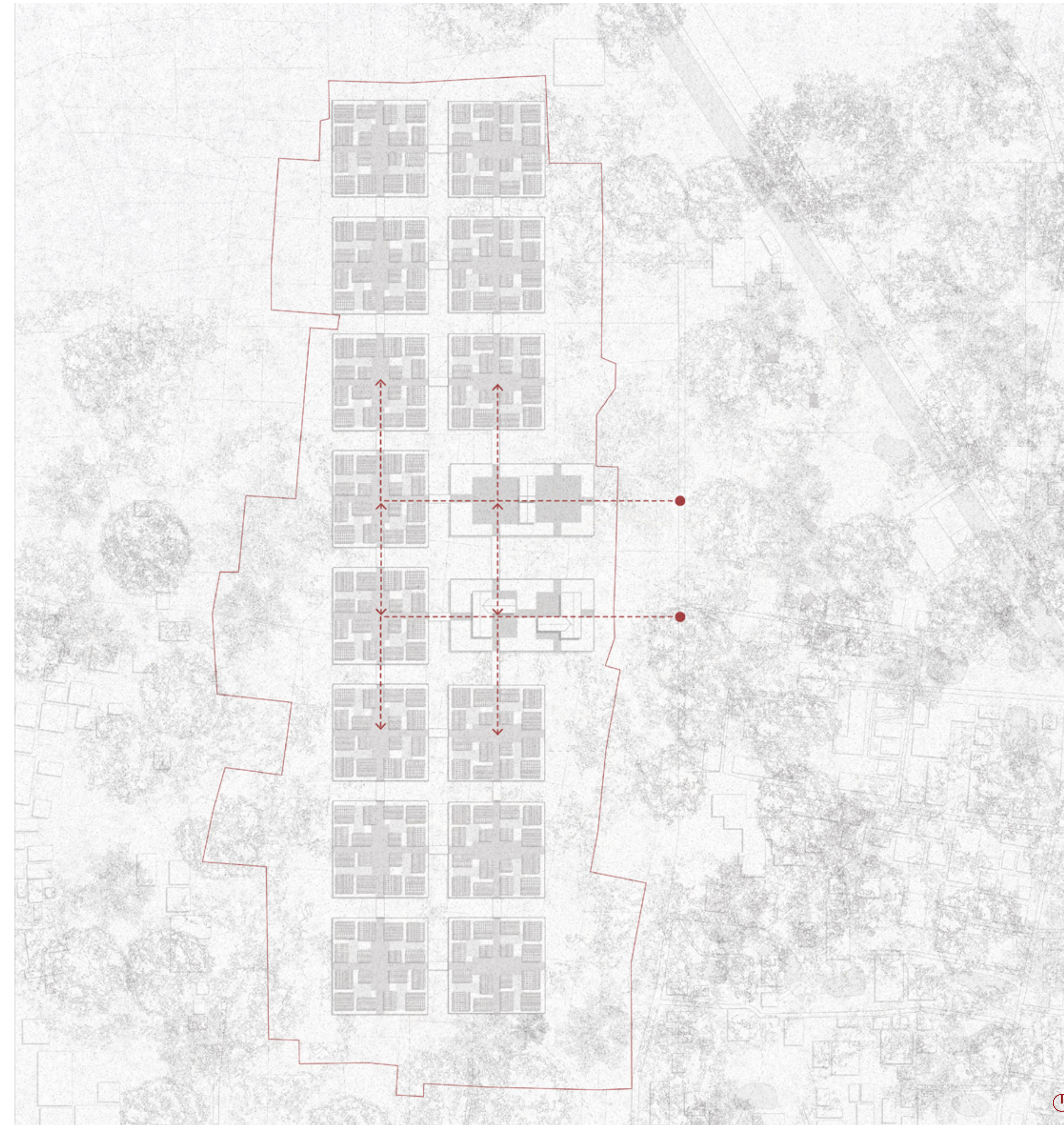
Site Boundary
Scaled (1:1000)



Masterplan Variations
Option A

Plot Area	40,000sq.m
FSI	0.81
GSI	0.81
DPH	1,080

The calculation is based per raft as the dwelling variation of each raft will be dependent on the user.



Masterplan Variations
Option B

Plot Area	40,000sq.m
FSI	0.65
GSI	0.65
DPH	896

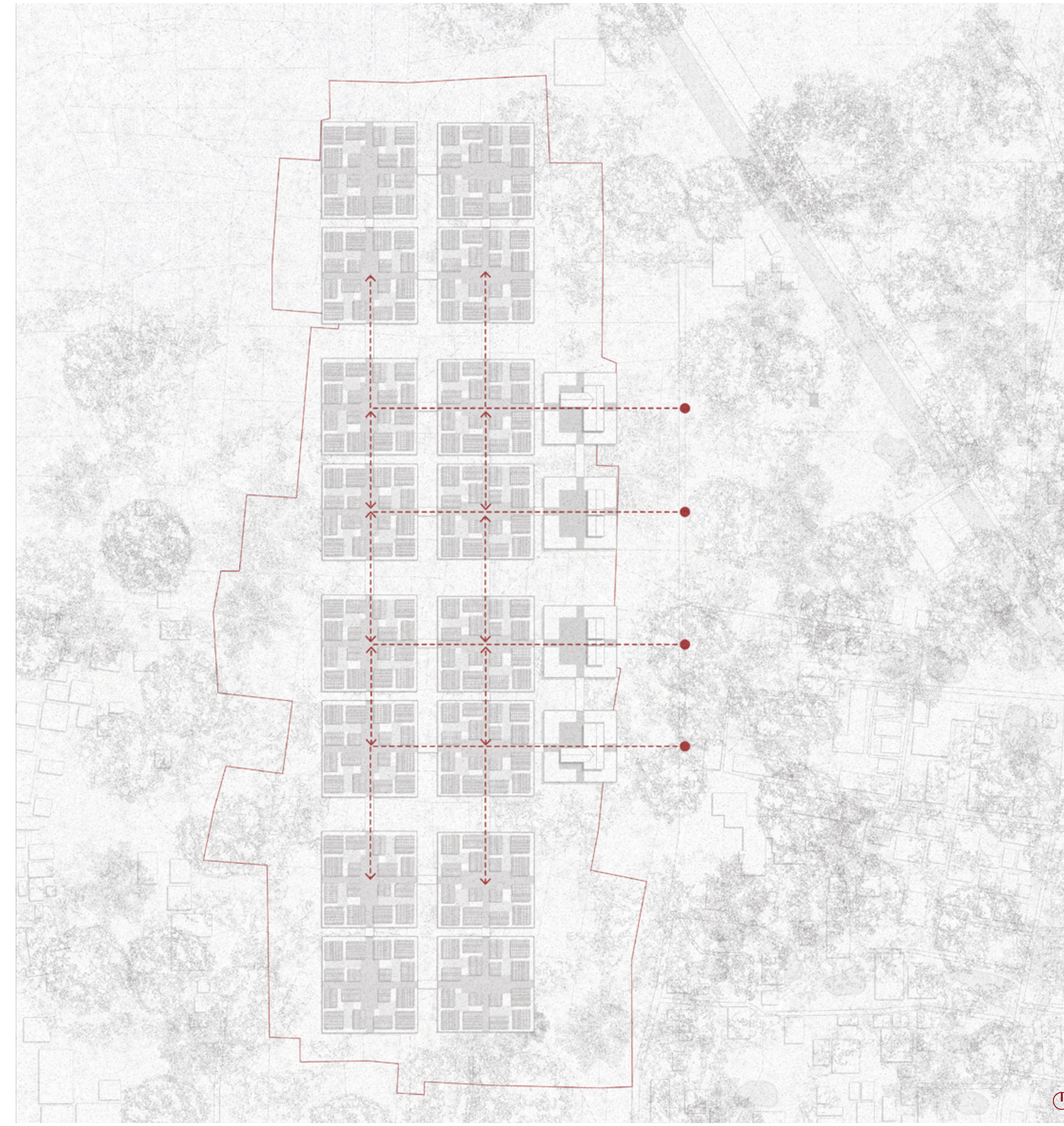
The calculation is based per raft as the dwelling variation of each raft will be dependent on the user.

Masterplan Variations

Option C

Plot Area	40,000sq.m
FSI	0.65
GSI	0.65
DPH	896

The calculation is based per raft as the dwelling variation of each raft will be dependent on the user.



Masterplan Variations

Option D

Plot Area	40,000sq.m
FSI	0.72
GSI	0.72
DPH	1,024

The calculation is based per raft as the dwelling variation of each raft will be dependent on the user.

Masterplan Variations

Dry Situation

During the dry season, the rafts are accesible by stair and bridge systems. The connection to the existing village is through stairs embedded within terraced farming, as well as two main bridge access points. During the dry season, daily life involves tending to cattle and farming the surrounding land

Master Plan

Scaled (1:1000)

Masterplan Variations
Flash Floods

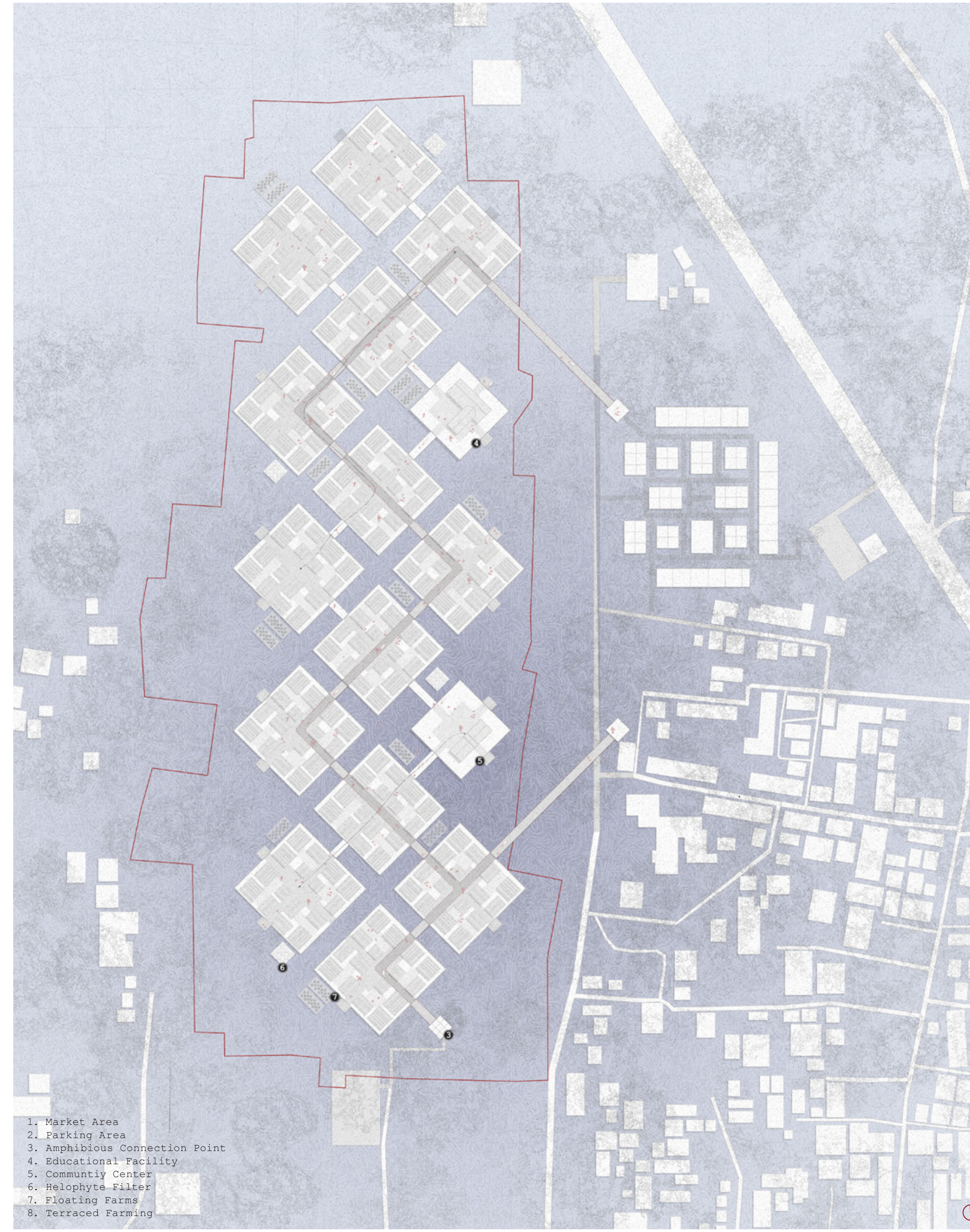
Water enters the site from the north and rashes to the lowest point of the site, in this case the retention area. The angled nature of the rafts acts to slowl down the flow of water into the amphibious community and guide it towards the retention area

Master Plan
Scaled (1:1000)

Masterplan Variations

Monsoon Situation

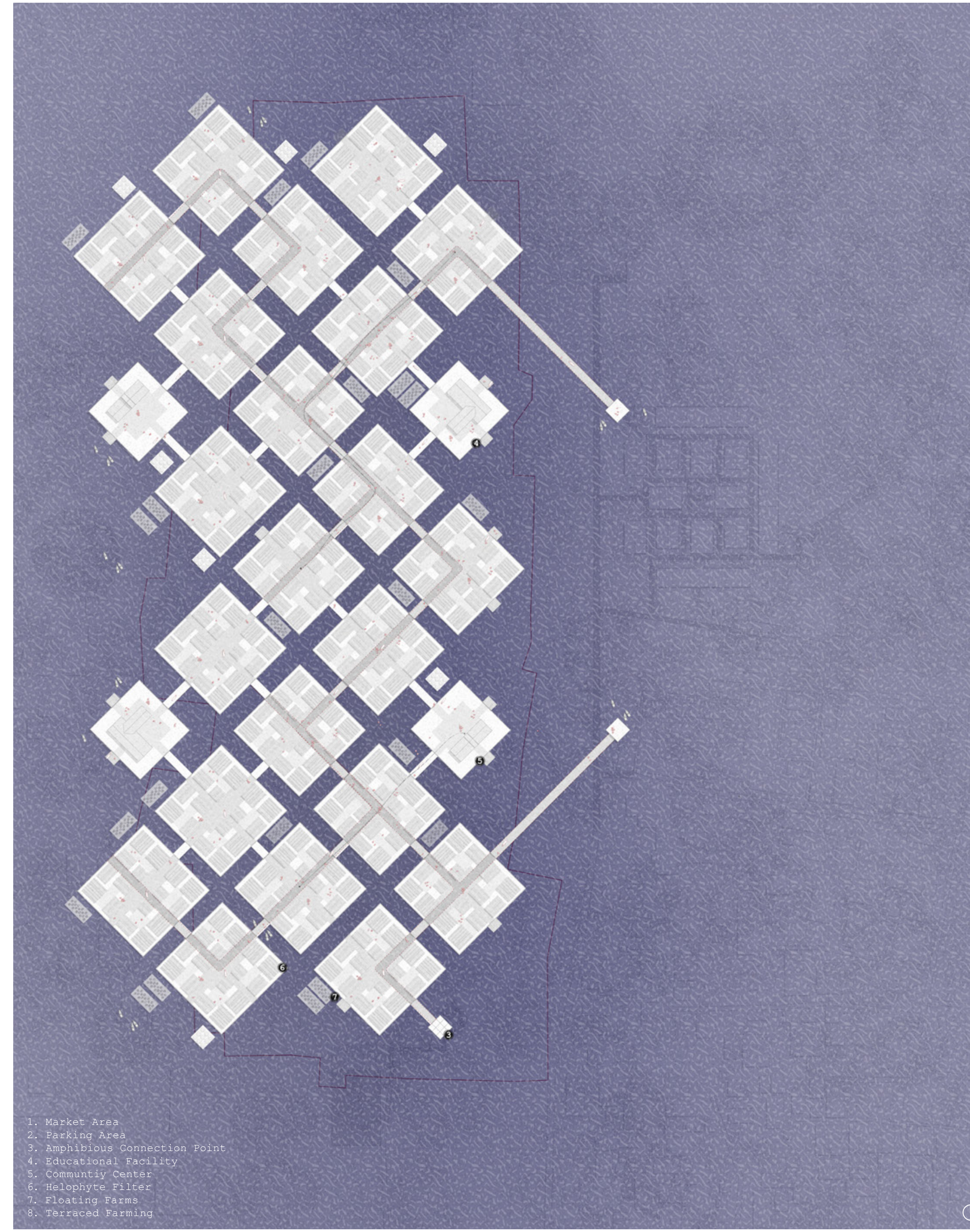
During the monsoon season the rafts are accessible by bridge systems. The existing stairs which are on a hinge, float up based on the water level and act as boat docks. During the monsoon season, daily life involves tending to the floating farms while daily operations such as markets or small shops remain open



Master Plan
Scaled (1:1000)

Masterplan Variations
Extreme Situation

It is predicted that at some point in the near future, the village could be permanently under water, which would result in additional rafts being constructed. The situation conveys the flexibility of the plan to continue to expand as need grows



Master Plan
Scaled (1:1000)

Construction Sequence
Phasing

Phasing of Rafts
Four Rafts per year

- Assuming 50 Culms per mature clump
- 8,000 Culms (2,000 per raft) / 50 Culms per Clump - 160 Clumps Needed
- Assuming each clump requires 25 sq.m of space

Area Required for Project
Four Rafts per year

- 160 Clumps x 25 sq.m - - 4,000 sq.m
- 4,000 sq.m - Approximately 1 acre

One time Harvest
Four Rafts per year

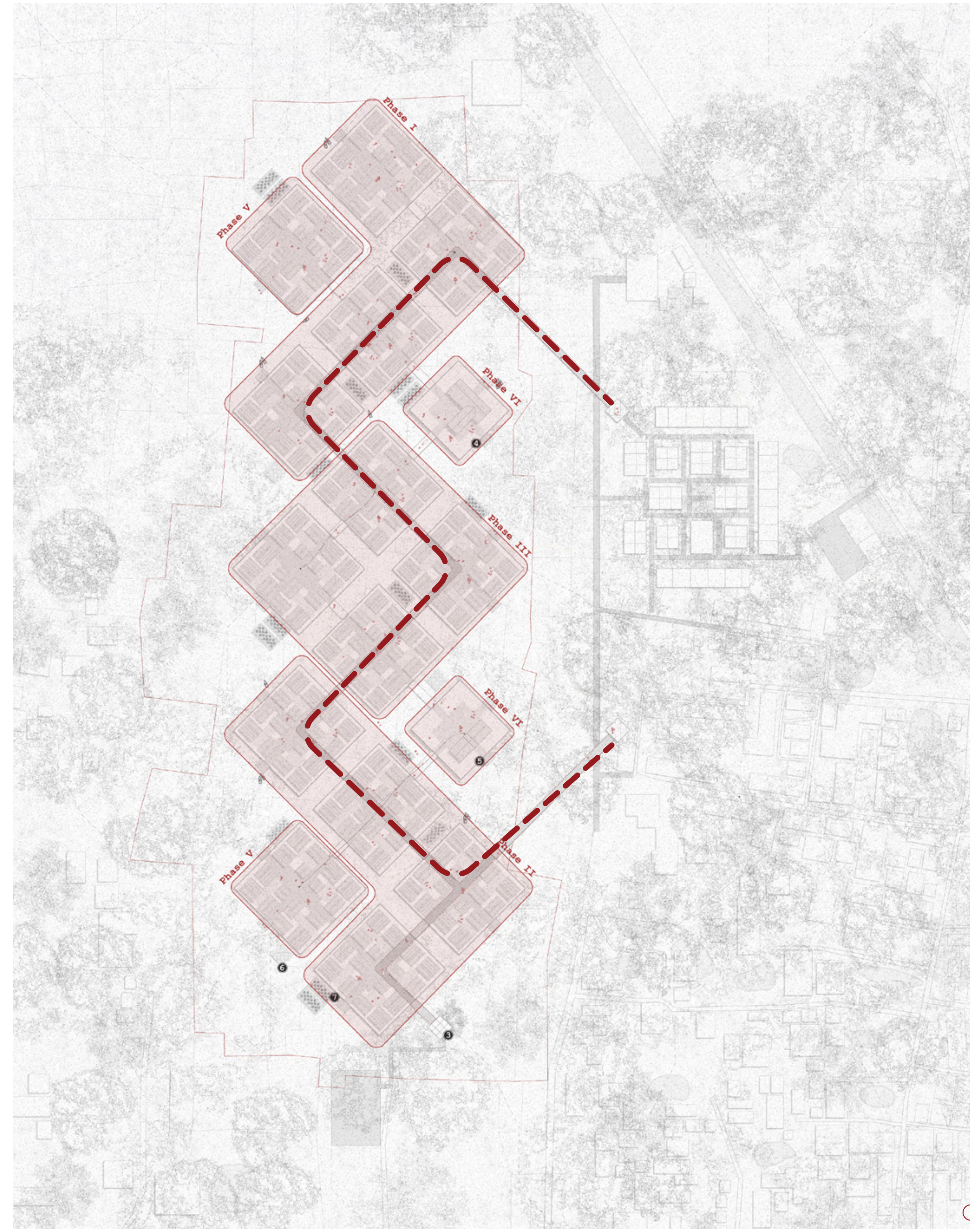
- Require one acre of land

Sustainable Harvesting
Four Rafts per year

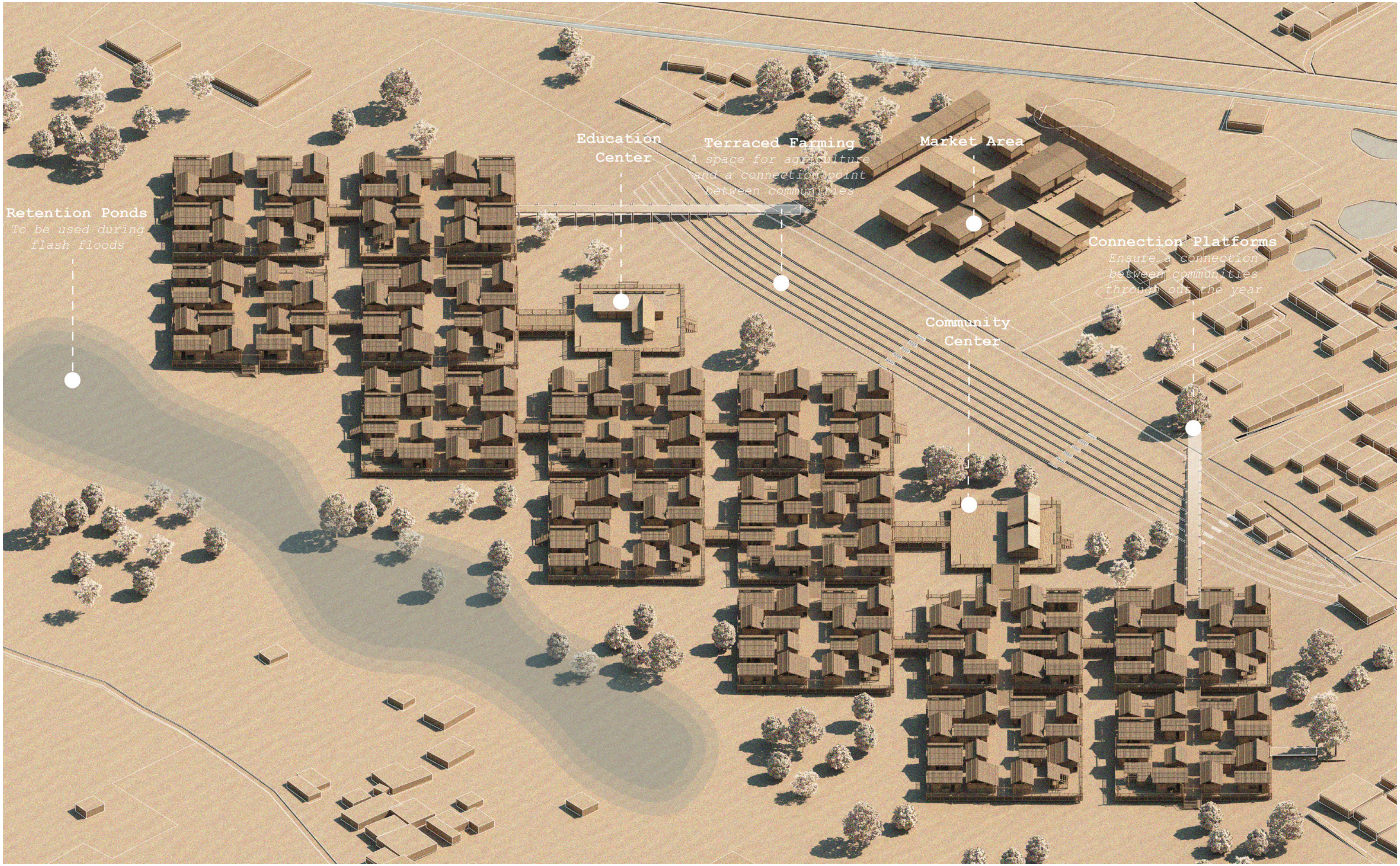
- Harvesting only 20-30% each year
- Requires 3-4 acres of land
- Allowing for healthy clumps, providing a steady supply of Bamboo

Harvesting
Four Rafts per year

- Harvest takes place during the dry season
- The project will require 4-5 years to be completed with the master plan showcased

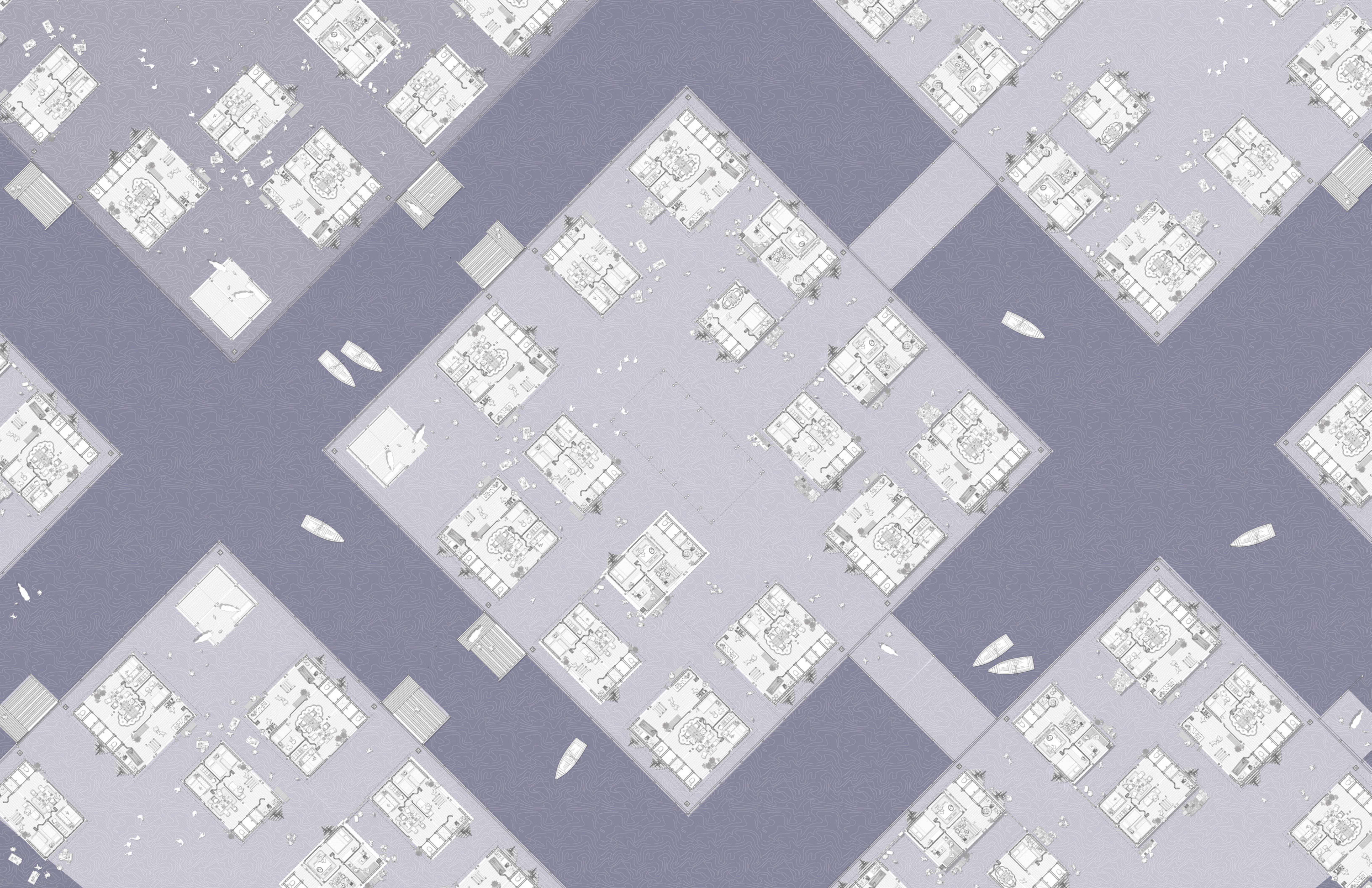


Master Plan
Scaled (1:1000)


Retention Ponds
To be used during
flash floods
Education
Center
Terraced Farming
A space for agriculture
and a connection point
between communities
Market Area
Connection Platforms
Ensure a connection
between communities
through out the year
Community
Center

Cluster
Dry Situation

During the dry season the rafts rest on the agricultural land and daily activities take place



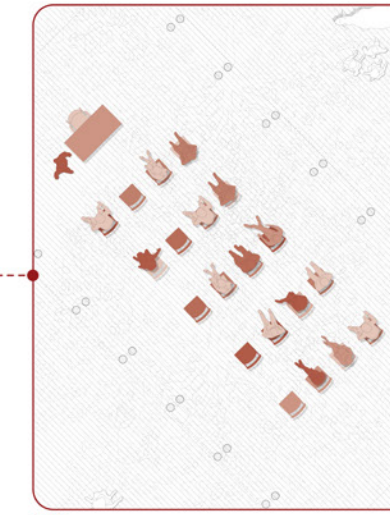
Cluster

Day in the Life

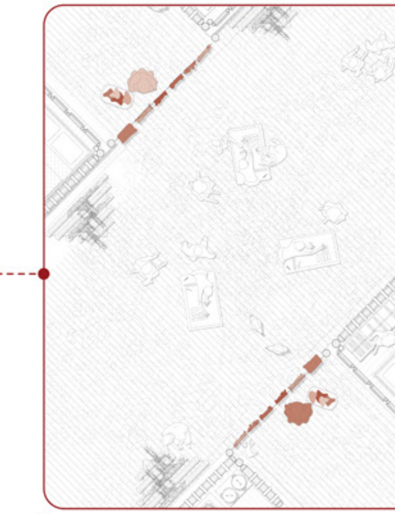
The drawing depicts the daily life of families living within the raft. Various activities take place through out the day from household to household. The drawings aims to convey the community engagement that the raft aims to foster on various social scales

6am
Breakfast

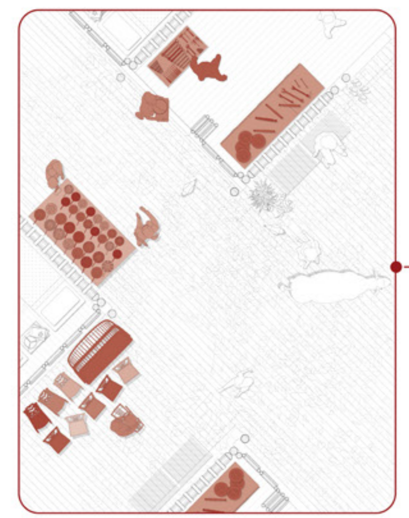
8am
Agricultural Work



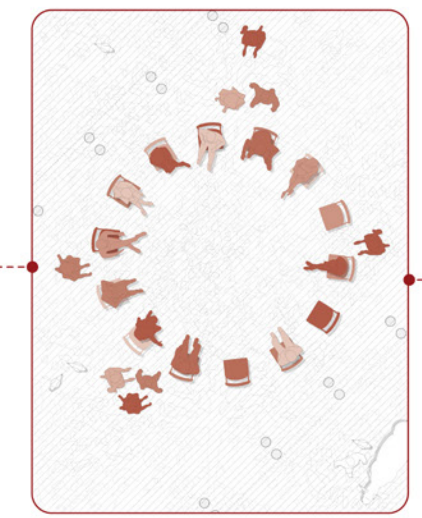
8am
Children attend school



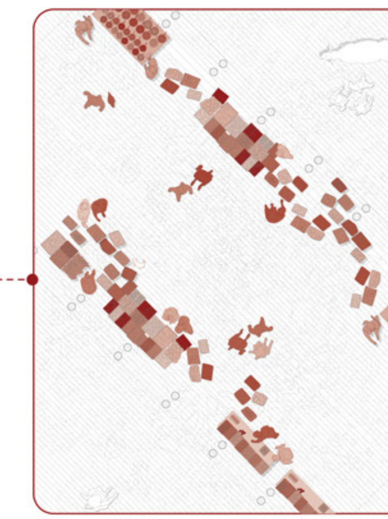
8am
House Work



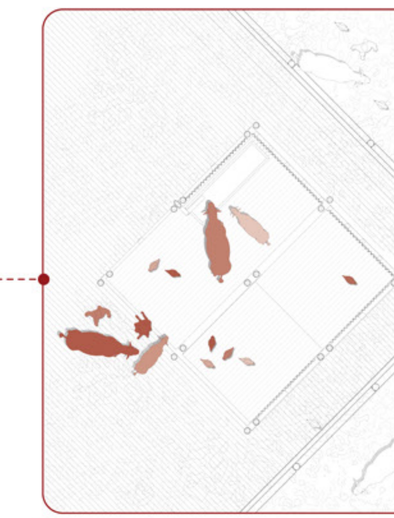
10am
Errands



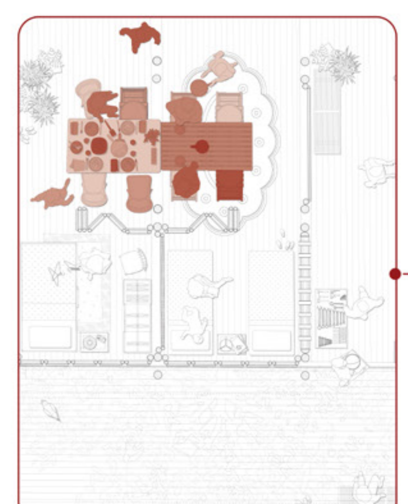
12pm
Community Meeting



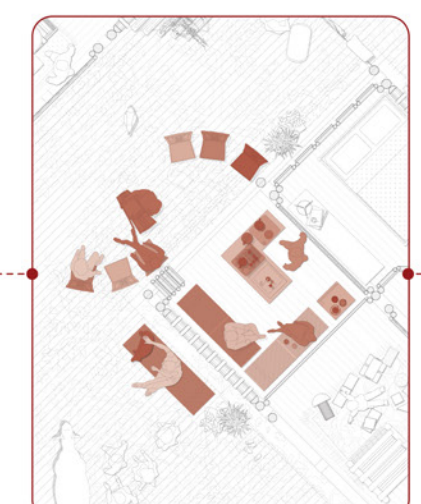
1pm
Lunch



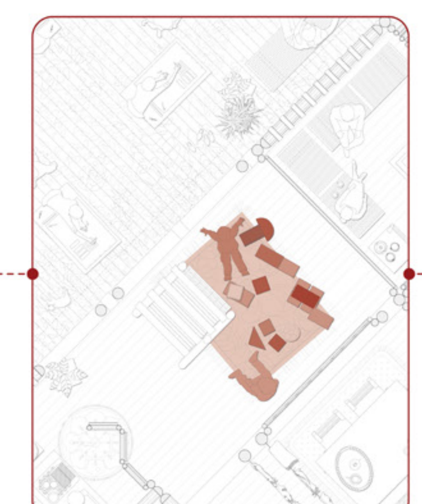
5pm
Livestock Pen



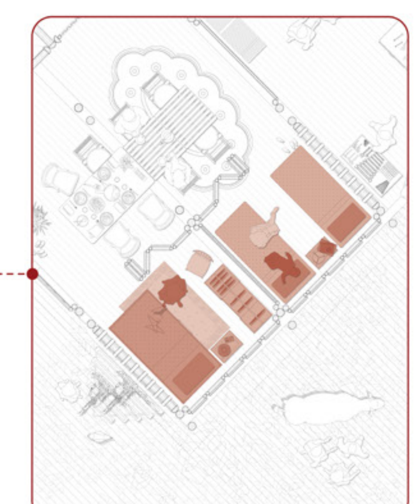
6pm
Supper



7pm
Tea Shop



7pm
Play Time



10pm
Wind Down


Urban Visualization
Dry Season

Urban Visualization
Monsoon Season

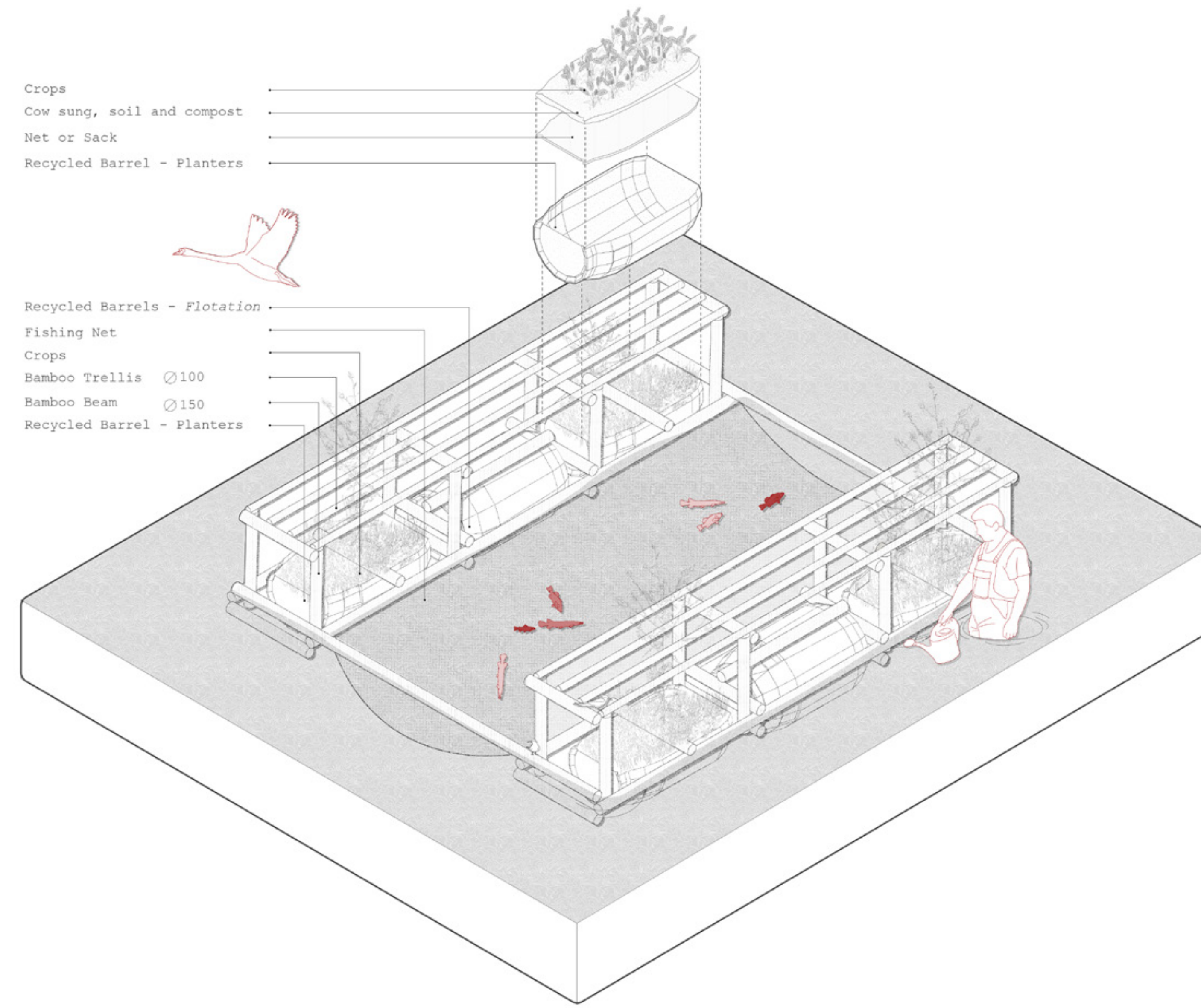
03D Smaller Intervention

Amphibious Solutions

The chapter below introduces a few options provided to the community to enhance their day to day life both culturally and economically. The interventions are to be adopted by the community as seen fit to meet their needs

Farming
Amphibious

A sustainable farming solution is proposed to support the community's continued harvesting and fishing activities throughout both dry and flood seasons



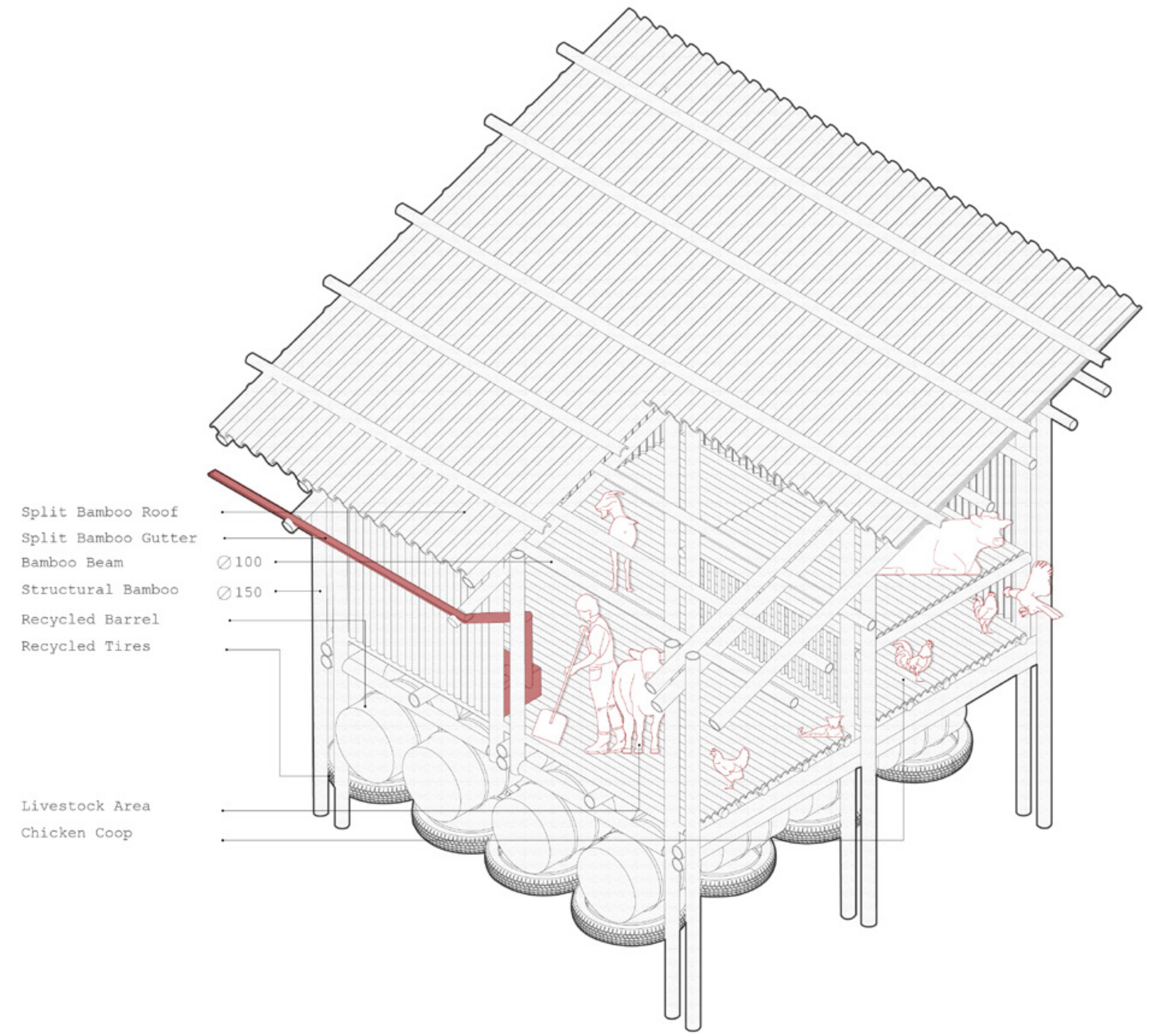
The amphibious garden design combines the primary materials utilized within the raft design to create viable solution for the community during all seasons

Farming
Option

Livestock Pen

Amphibious

Within each raft a livestock pen, through observations of the Shonatola village the livestock pen was a crucial part of the communities livelihood



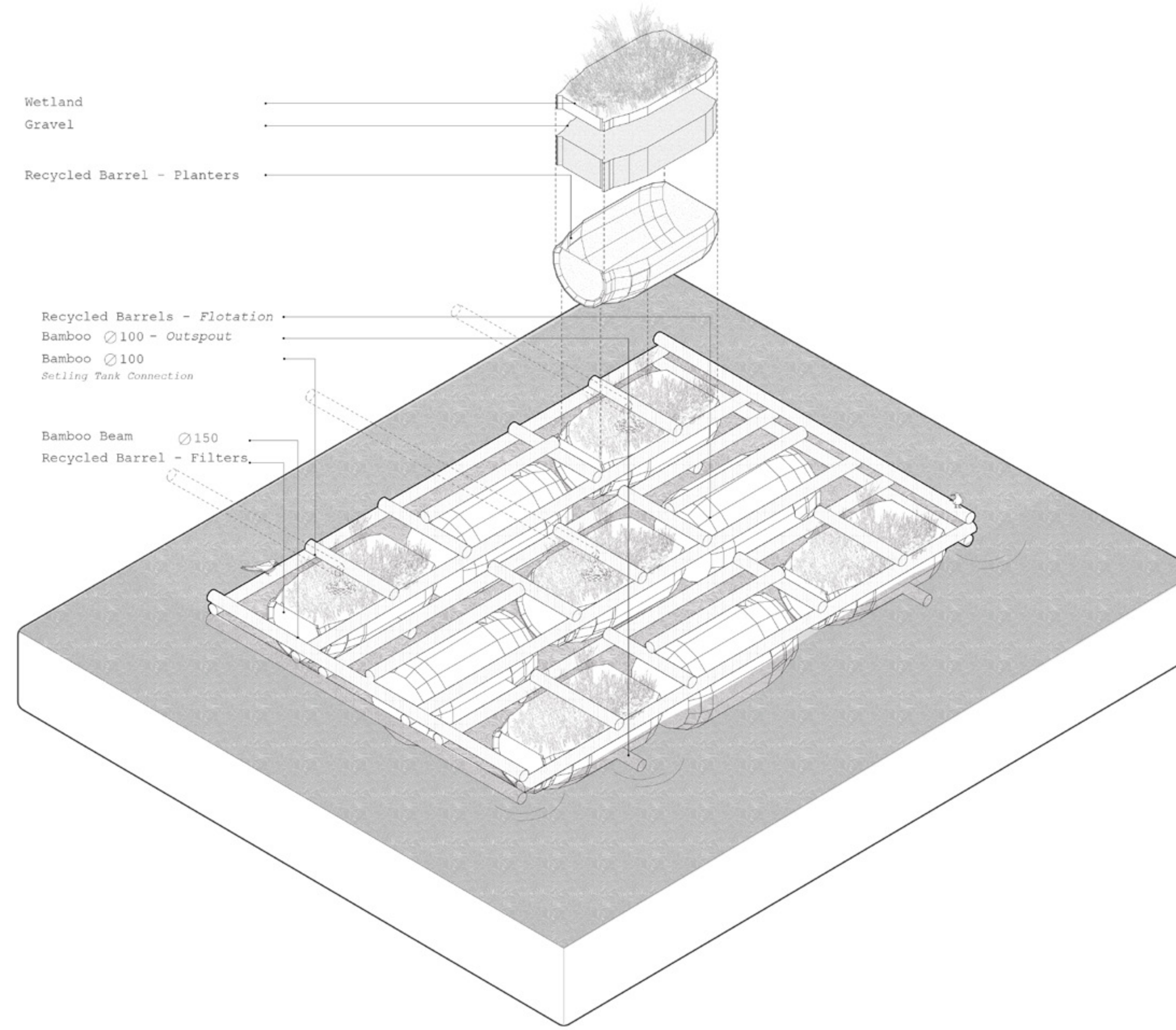
Agriculture is at the heart of most of the villages in Bangladesh. Among these, smallholder mixed farming systems, where rice production combines with small ruminants particularly goats and dairy cows, stand tall

Livestock Pen
Option

Helophyte Filter

Amphibious

The implementation of the helophyte filters aims to purify water using a combination of plants, bacteria, and nutrient adsorbents. These filters are designed to efficiently remove pollutants and improve water quality



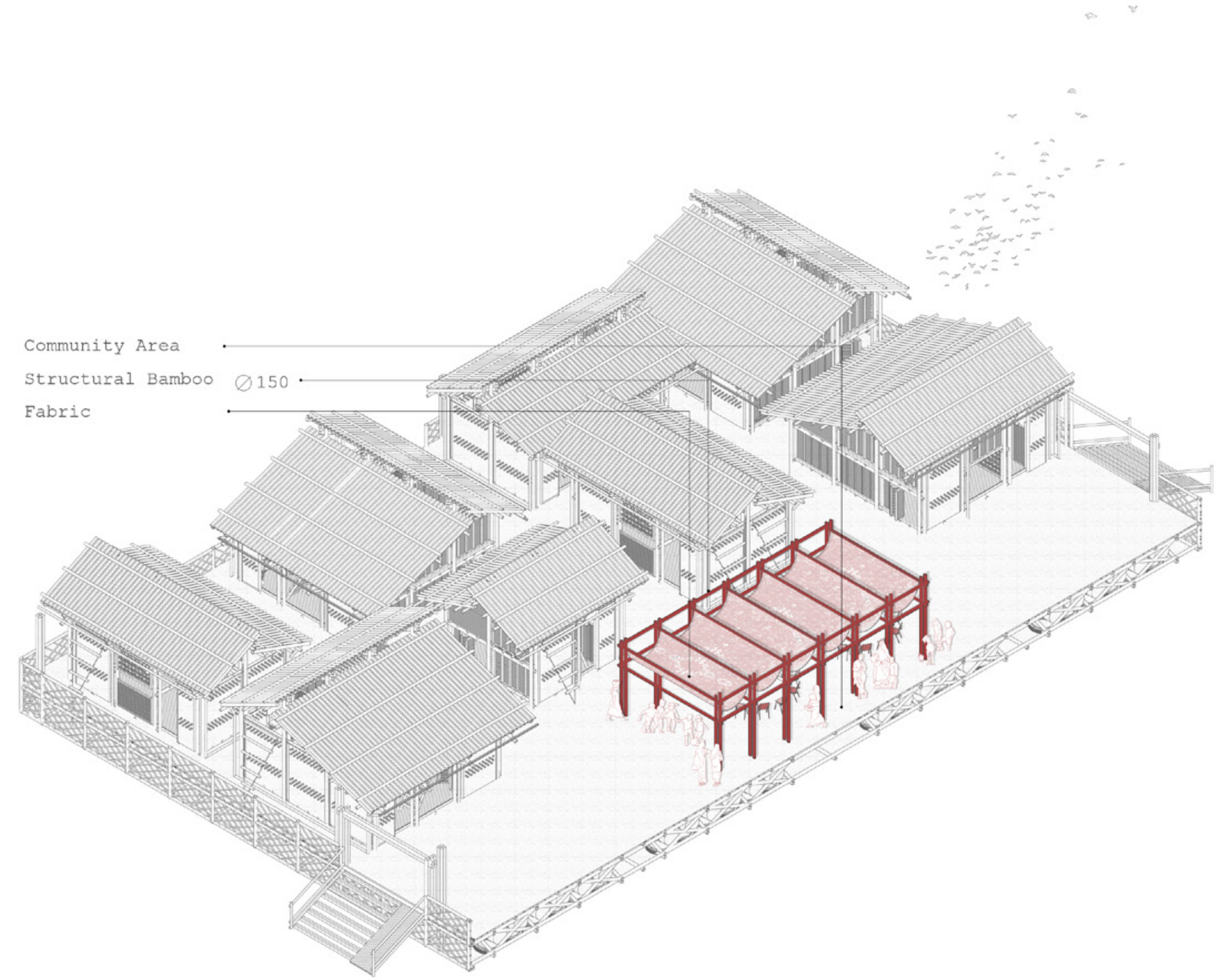
During the monsoon season, the raft rises with the rising water levelsalongside the helophyte filter. This adaptive system ensures that treated water is safely discharged into the surrounding environment

Helophyte Filter
Option

Pavilion
Raft Addition

The aim of the pavilion is to provide a non permanent structure that can activate the large communal area of the raft. The space can be used for a variety of activities by the community.





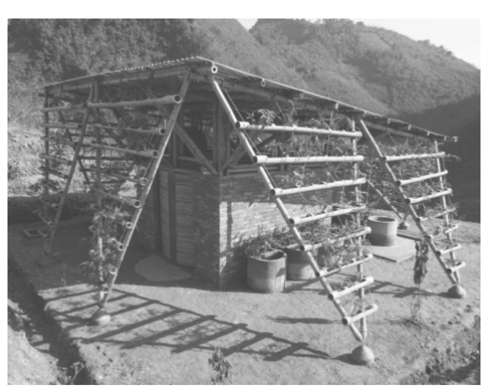
During the monsoon seasons the pavilion can be utilized as a covered area for teaching as the neighbouring schools tent to flood. The space can also be utilied year round for community meetings, workshops and other activities

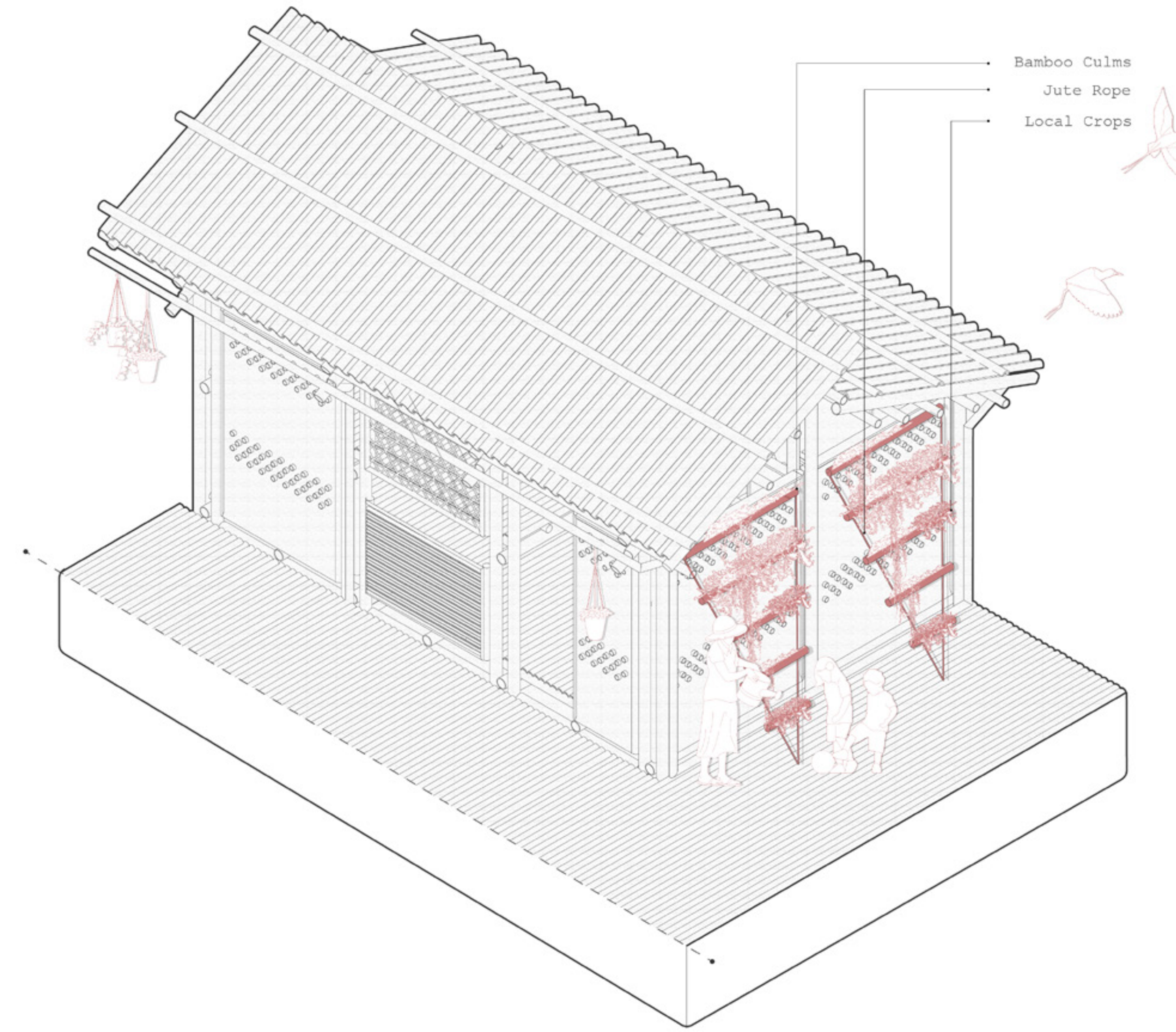
Pavilion
Option

House Gardens

Dwelling Addition

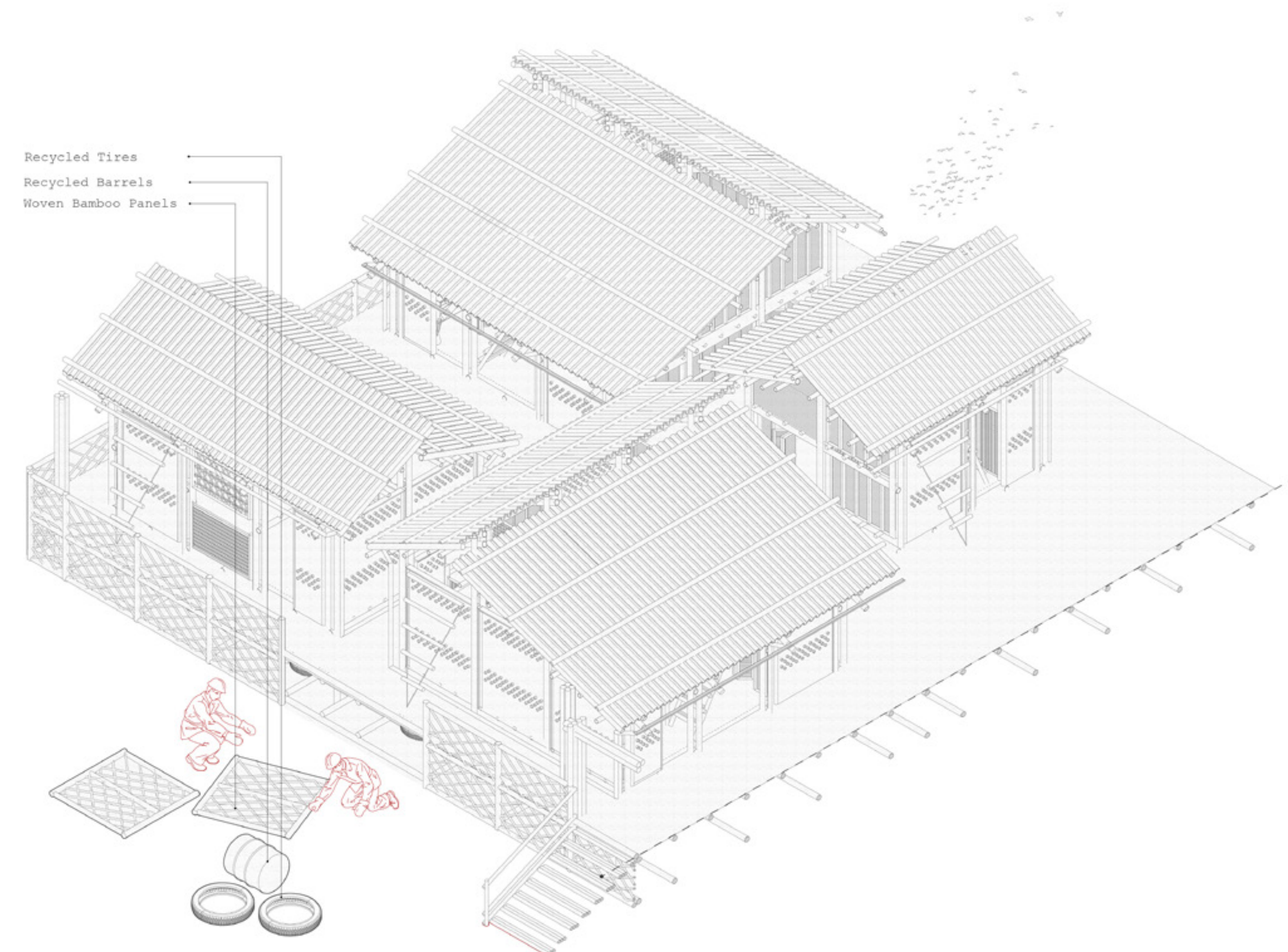
A small hanging garden is design to adorn the exterior of the dwellings. The aim is to provide green areas on the dwelling and provide a small space for crop production





Home gardens are found in both rural and urban areas in predominantly small-scale subsistence agricultural systems

Gardens
Option



The community will be able to replace any portions of the raft necessary due to the ease of the bolted connections

Raft Maintenance

Tire & Barrel

The tires and barrels have a shorter lifespan than the bamboo. As such through out the rafts lifespan of 25 years, certain parts of the amphibious structure will have to be replaced. The tires and barrels utilized in the project have a life span of a few years depending on the environmental conditions

Maintenance
Tires and Barrels

Built on Shape Shifting Land

A Transition towards Amphibious Living

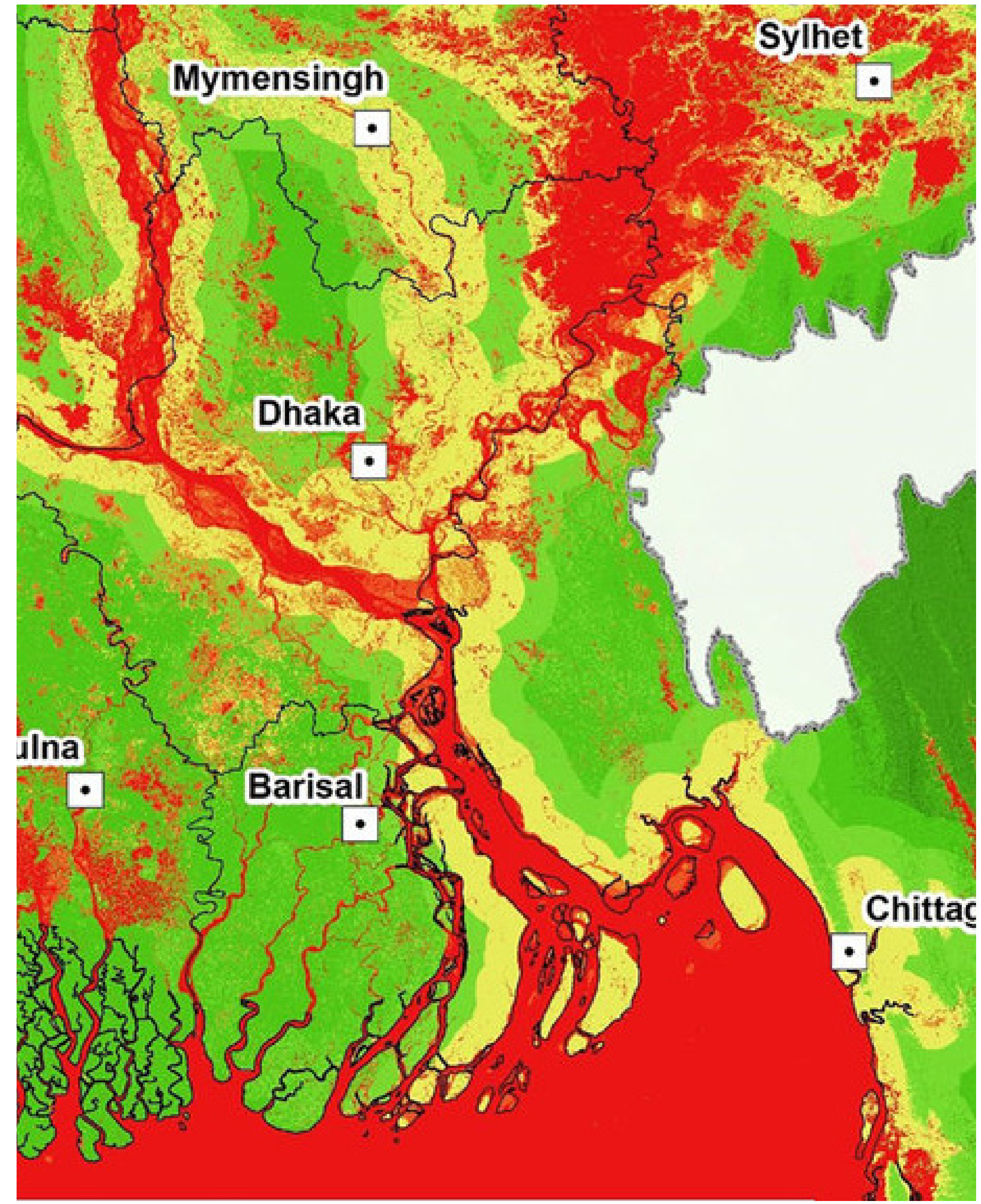
01 Research
Contextual Analysis

A series of mapping exercises was undertaken to visualize flood risks in Bangladesh and the threats posed by rising sea levels. Additionally, the site-specific relationship with water was analyzed to better understand its environmental and spatial dynamics

Flood Prone Areas
Bangladesh

Data published by UNOSAT (United Nations Satellite Centre)

- Very Low
- Low
- Low Medium
- Medium
- High Medium
- High
- Very High
- Extremely High

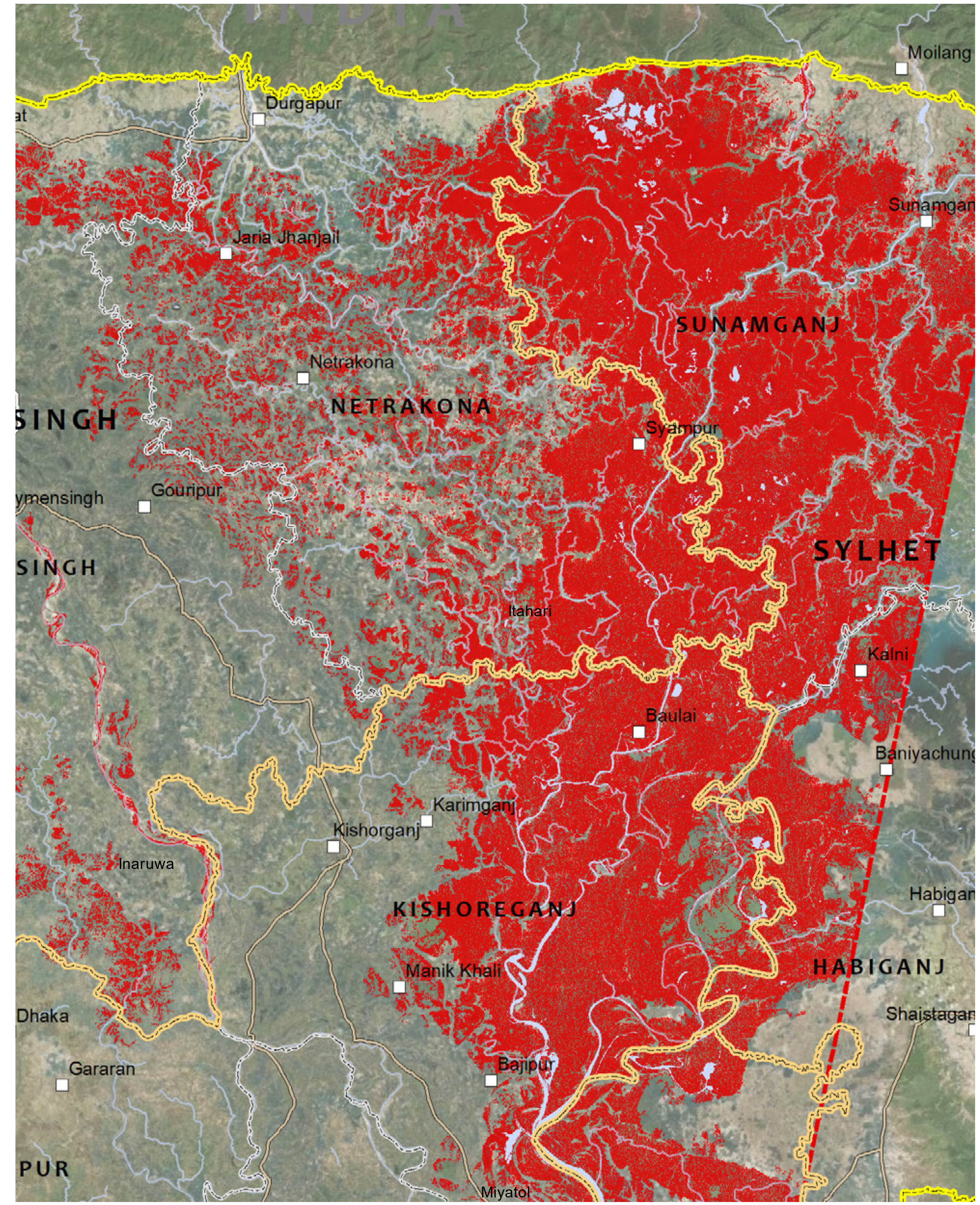


Sylhet Flooding
2020

Data published by UNOSAT (*United Nations Satellite Centre)*

- Sylhet 45% under Water
- Maulvibazar 21% under Water
- Habiganj 41% under Water
- Sunamganj 72% under Water



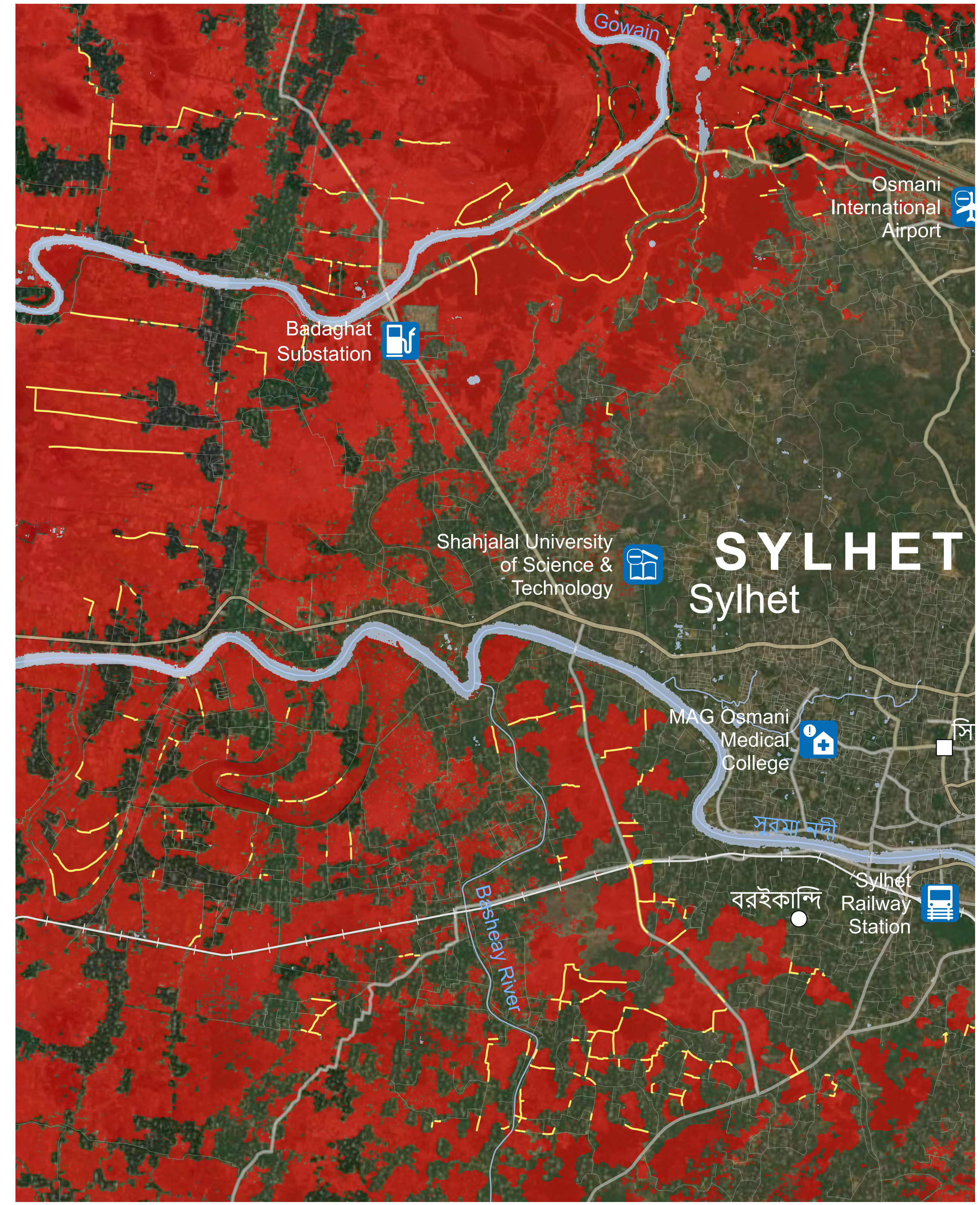


Flooded Areas

Sylhet Flooding
2022

Data published by UNOSAT (*United Nations Satellite Centre)*

- *Sylhet* *72% under Water*
- *Maulvibazar* *50% under Water*
- *Habiganj* *70% under Water*
- *Sunamganj* *80% under Water*

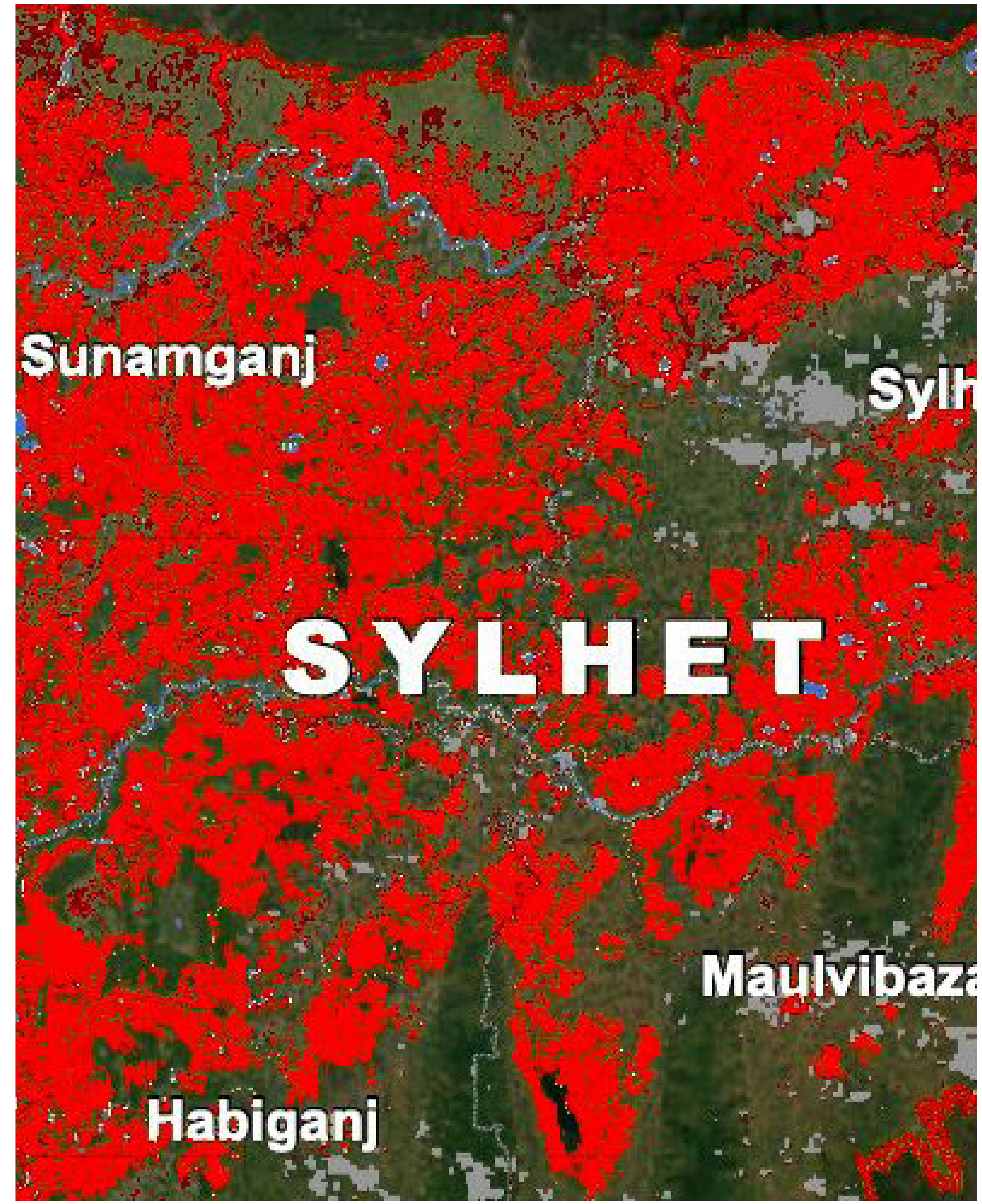


Flooded Areas

Sylhet Flooding
2024

Data published by UNOSAT (*United Nations Satellite Centre)*

- • *Sylhet* *53% under Water*
- • *Maulvibazar* *16% under Water*
- • *Habiganj* *15% under Water*
- • *Sunamganj* *48% under Water*



● Flooded Areas

Aid
Flooding 2020

Flooded Homes
Flooding 2020

Refuge Point
Flooding 2020

Seeking Refuge
Flooding 2022

Flooded Homes
Flooding 2022

Flooded Streets
Flooding 2022

Flooded Neighbourhoods
Flooding 2024

Seeking Refuge
Flooding 2024

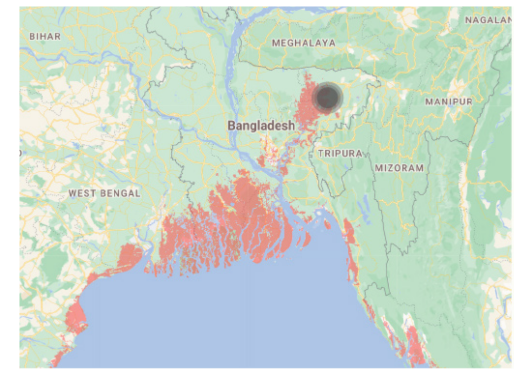
Fleeing Homes
Flooding 2024

Sea Level Rise

Bangladesh

Predictions made through ClimateChange.org are based on the following criteria

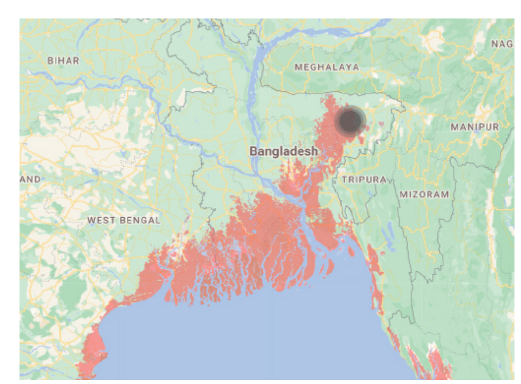
- Projection Type - Sea level rise + Annual flood
- Pollution Pathway or Sea Level Scenario - Current Trajectory
- Luck - Medium



2030
Sea Level Rise

2040
Sea Level Rise

2050
Sea Level Rise



2100
Sea Level Rise