P5 Presentation | aE Studio

# Eco Resilient Communities

HOUSING FOR LANDSLIDE-PRONE PRECIPITOUS TERRAIN IN BOGOTA'S INFORMAL SETTLEMENTS

Architectural Engineering Studio

Daniela Diaz Avila (5901553)

Faculty of Architecture & the Built Environment, Delft University of Technology

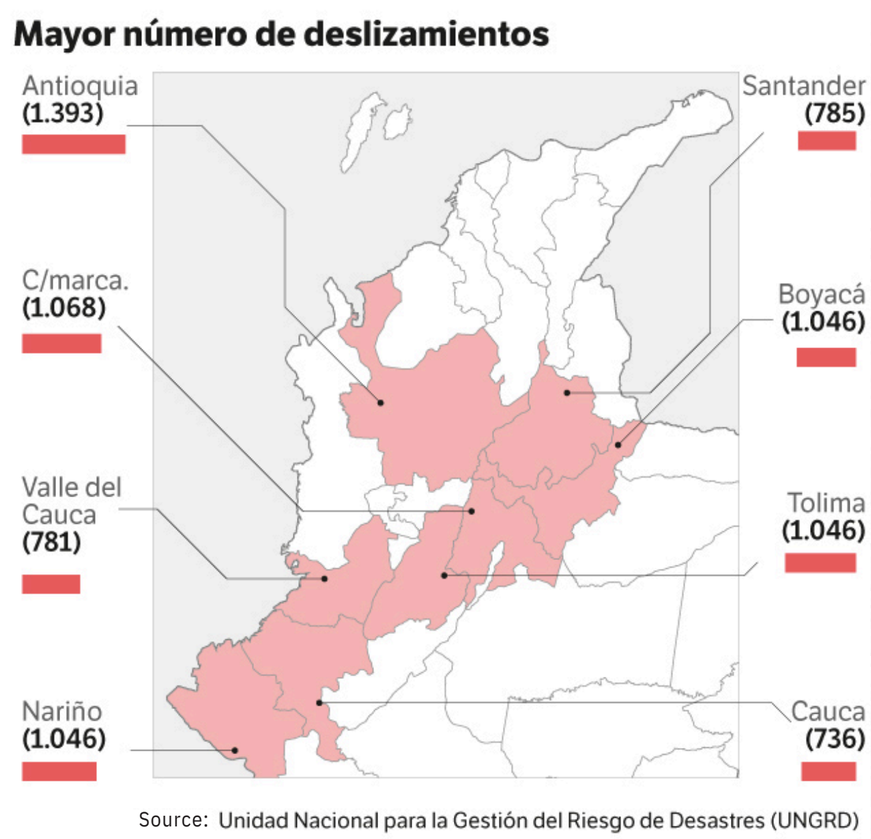
*2024*

# TABLE OF CONTENTS



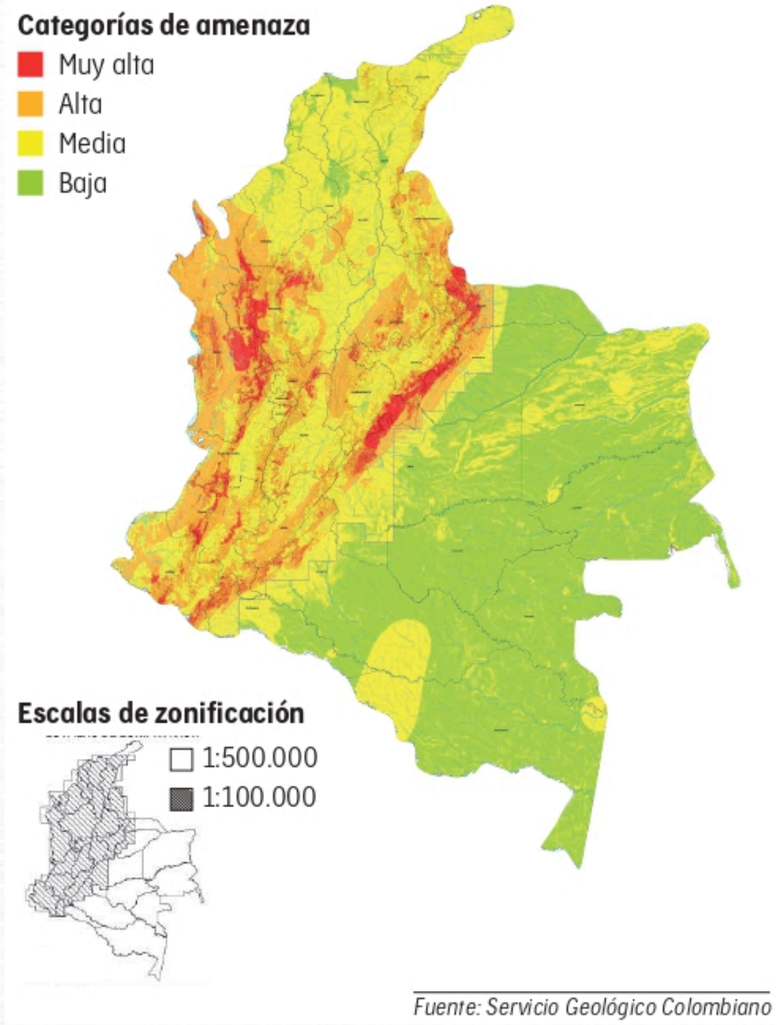
# INTRODUCTION

- 30,730 documented landslides, loss of 34,198 lives
- 25/32 departments are classified as, high- risk/red zone (GFDRR)




## Zones with most and least risk of landslides

The map assesses the risk of landslides in the country generated by climate and seismic activity

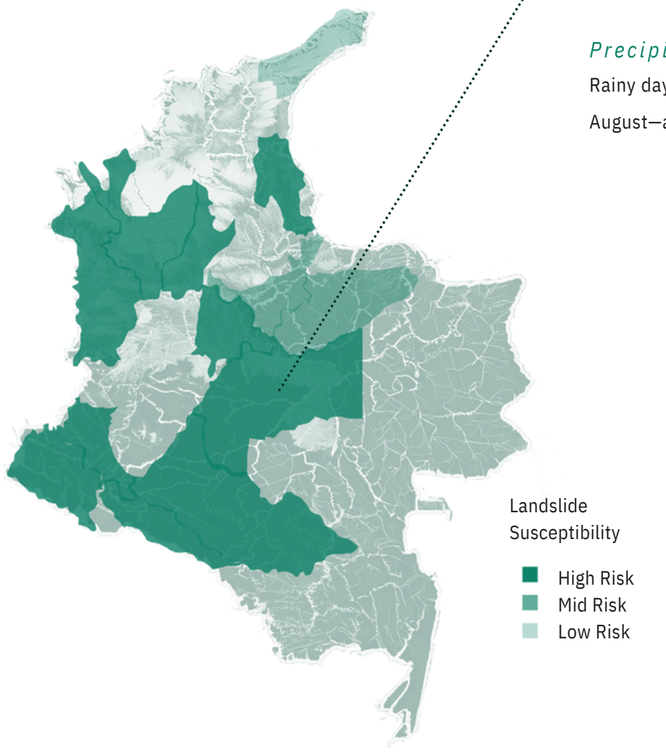



IDIGER
MAYOR
D.C.

# PROBLEM STATEMENT

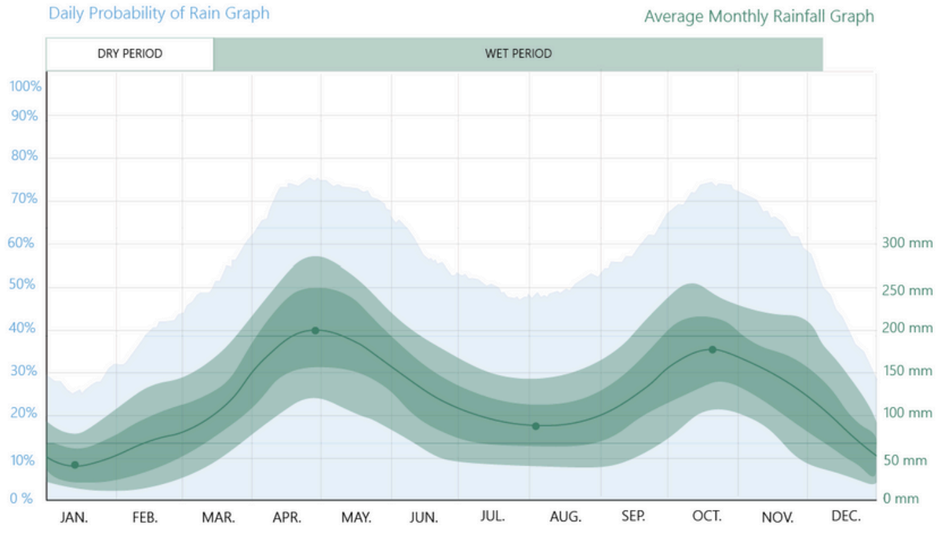
- Forced migration has contributed to the exodus of an estimated at 6.8 million internally displaced population as of the conclusion of 2022.
- Displaced individuals construct their own dwellings out of necessity,
- Socioeconomic constraints lead to the use of scavenged materials like plastic, sticks, and toxic asphalt resulting in poor structural integrity.
- This cycle leads to recurring devastation and flawed, reconstruction efforts.

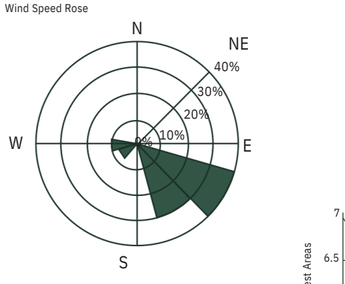

Image by Daniela Diaz- Brick factory located below the residential area right beside the Coal Factory. Causing air pollution.

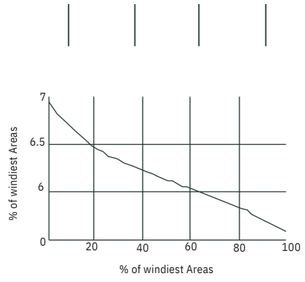


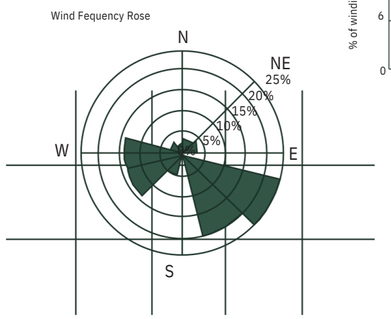

## *Precipitation*

Rainy days fluctuate significantly throughout the year, with the wet season encompassing April, May, and September to December. In contrast, the dry season is from January, February, July, and August—according to IDEAM. The highest rainfall occurs in April with a maximum amount of 200mm, while January tends to have the least precipitation.



Site Analysis

Site Analysis

Site Analysis

"We're still to some extent sleepwalking our way into disasters for the future which we know are going to happen, and not enough is being done to mitigate the damage."

—John Holmes, UN Under-Secretary-General for Humanitarian Affairs (Lynn 2009)

# DESIGN OBJECTIVE

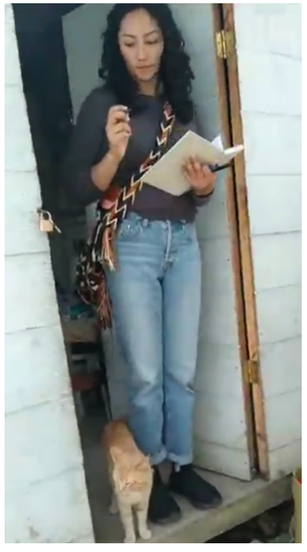
*Provide the community with landslide mitigation tchniques and a house design that will improve their life quality.*

- *showcasing passive strategies and housing diverse spatial characteristics* tailored to accommodate families of different sizes and needs, alongside communal/shared spaces.

Prioritizing:

- Community needs
- Cultural values
- structural Integrity
- Accessible Constructability
- Biobased and upcycled material

*Image by Daniela Diaz*



# *Relevance*

- Project acknowledges similarities with other localities
- Can offer a model for addressing similar challenges in other localities.
- Design concepts and strategies may benefit other countries facing similar issues.
- Improve quality of life and safety

*INCA- PERU*

## Settlement Layout

- Integrated with the Terrain
- Terracing and plantations
- Cluster Formation

*SHERPA'S- NEPAL*

## Climate Responsiveness

- Cross Ventilation
- Solar Orientation
- Insulation
- Rain Water Management
- Bio-Based Material

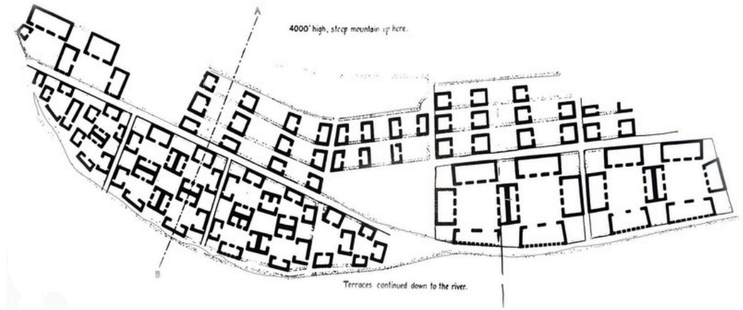
*EASTERN BLACK SEA REGION -TURKEY*

## Structural Elements

- Integrated foundations into the landscape
- Rain Water management in Architecture
- Interlocking Structure
- Rectangular & L-shape
- Parallel to slope
- Large Eaves

Settlement Layout → ANALYSIS

## *INCA- PERU*

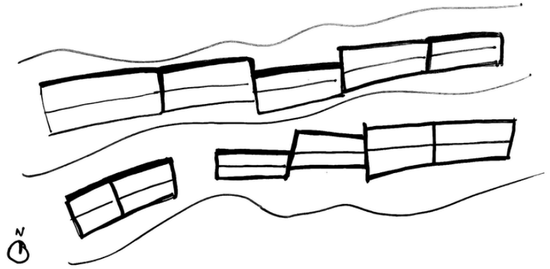



A plan of a *kancha* and other buildings following the natural contours of a mountain. Image drafted by Hiram Bingham in 1911.


A visualization of a *Kancha* unit with roofs. Image courtesy of En Peru Blog 2009. Annotation by author.

Terraces of Fortress Ollantaytambo view from the bottom looking up. Image taken by author.

## *SHERPA'S- NEPAL*

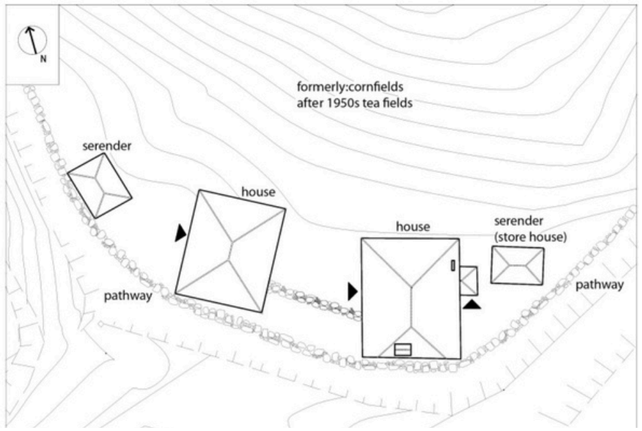



Drawing of Sherpa Village layout. Drawing by Author based on drawing by Manish 2015.

The Namche Bazaar in the Khumbu region. Images courtesy of Sherpa Village Lodge Trek.

Sherpa Settlements- Images courtesy of Valerio Sestini and Enzo Somigli

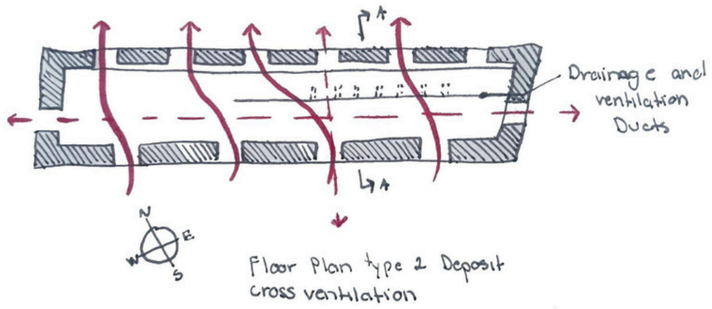
## *EASTERN BLACK SEA REGION -TURKEY*



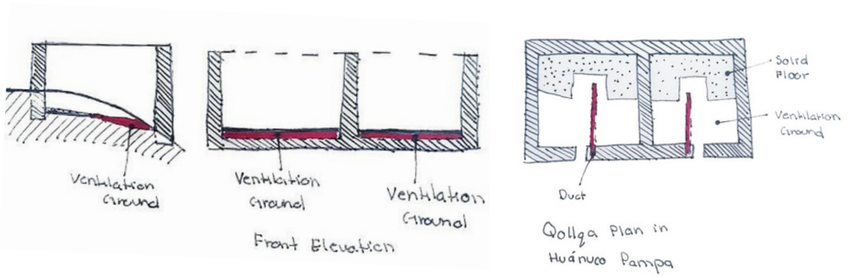

Settlement sample from Fındıklı, Rize (Güler, 2012).

Climate Responsiveness → ANALYSIS

## *INCA- PERU*

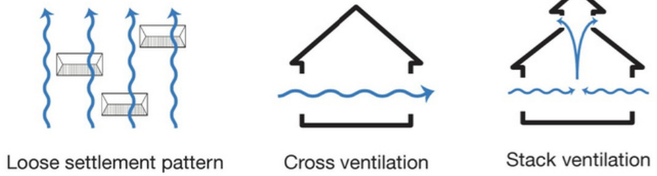



A plan of a rectangular type two *qollqa* in Ollantaytambo. Highlighting the cross ventilation and ducts. Drawing and annotation by the author, (redrawn from Jean-Pierre Protzen 2005, fig 5.19)




A plan of two rectangular *qollqa* in Huanuco Pampa. Highlighting the ventilation ducts as well as the entry doors. Drawing and annotation by the author, (redrawn from Morris and Thompson 1985 fig 18).

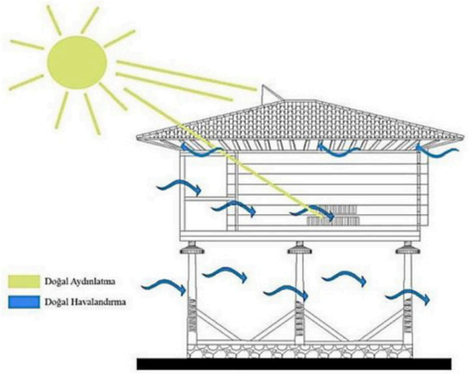
## *SHERPA'S- NEPAL*



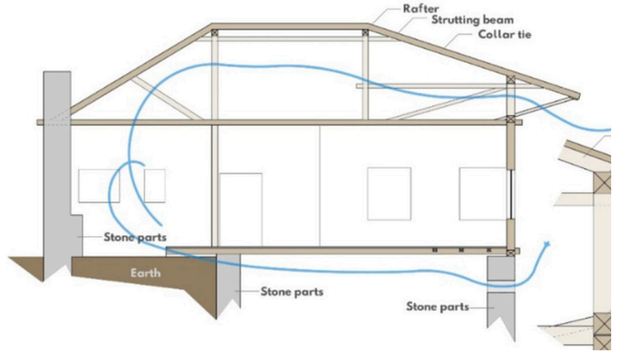


Diagrams courtesy of Bodach, S., Lang, W., Hamhaber, J.

## *EASTERN BLACK SEA REGION-TURKEY*



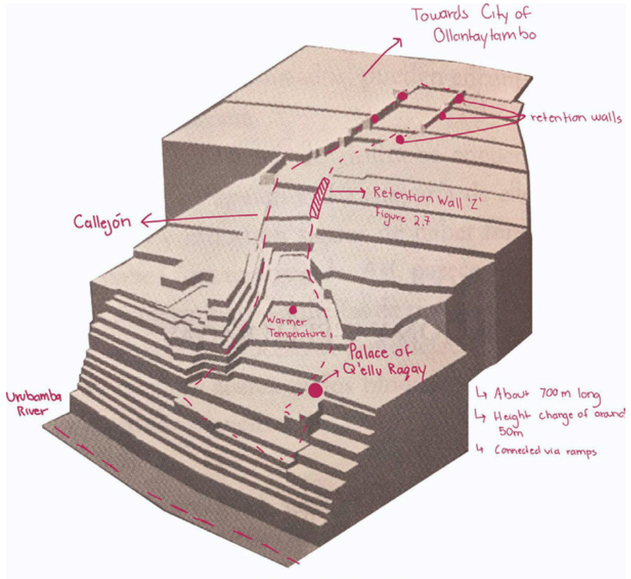

Climate Responsiveness of a Serender. Diagram courtesy of Selda Al Şensoy, Sibel Kukoglu




Air circulation and natural ventilation detail. Diagram courtesy of Burcu Salgın , Ömer F. Bayram, Atacan Akgün and Kofi Agyekum.

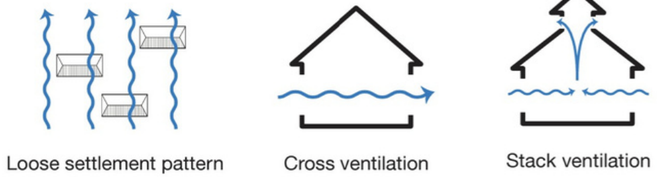
Climate Responsiveness → ANALYSIS

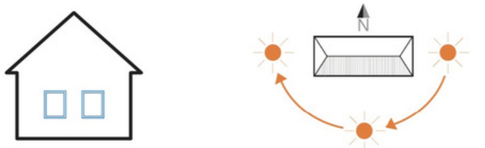
## *INCA- PERU*




3D model of terraces by Jean-Pierre Protzen annotated by Author.

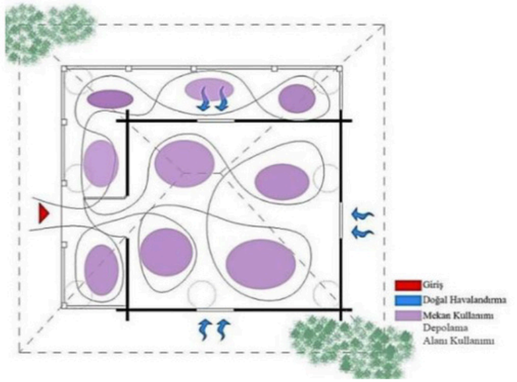
## *SHERPA'S- NEPAL*



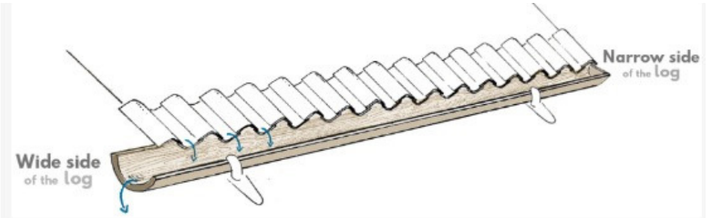




Diagrams courtesy of Bodach, S., Lang, W., Hamhaber, J.

## *EASTERN BLACK SEA REGION -TURKEY*




Climate Responsiveness of a Serender. Diagram courtesy of Selda Al Şensoy, Sibel Kukoglu




Rainspout made by pine or spruce log (re-illustrated from Özgüner (1970)).

Structural Elements

# STRUCTURAL SYSTEM &FOUNDATION

## *INCA- PERU*

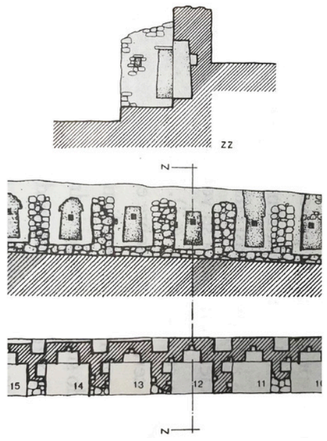
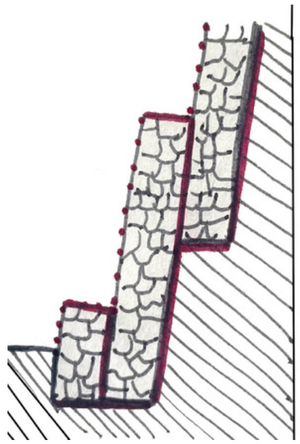
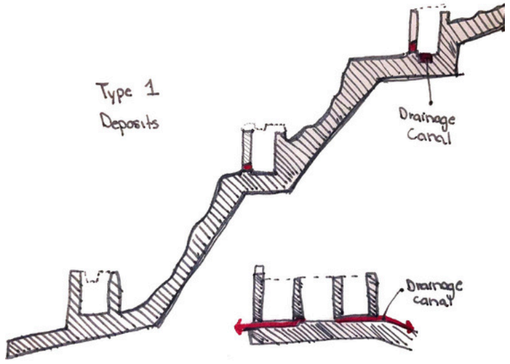



Figure 2.7 Retention wall ‘Z’ section by Jean P. Protzen

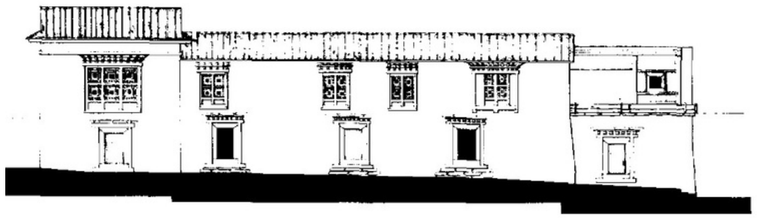


Staggered walls/foundation for greater stability. Drawing by the Author.



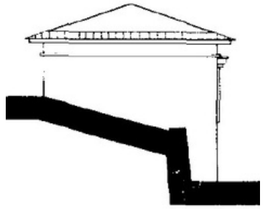

The drawing demonstrates a transversal section of the deposit type one structures, highlighting the drainage and ventilation canals. Drawing and annotation by the author (redrawn from Jean-Pierre Protzen 2005, fig 5.5)

## *SHERPA’S- NEPAL*

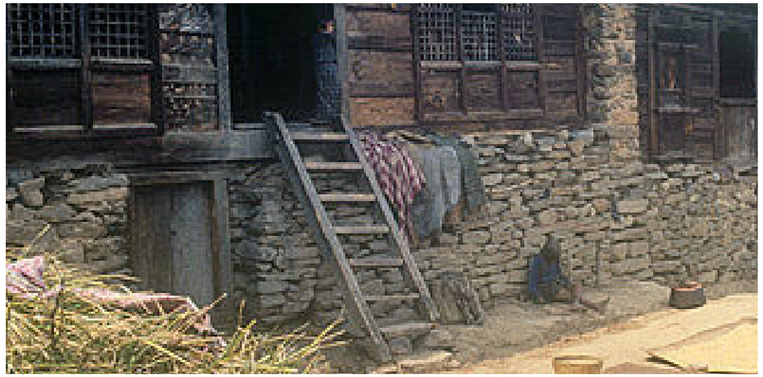


Front elevation

Elevations of a dwelling-house at Phortse. Drawings by Valerio Sestini and Enzo Somigli.

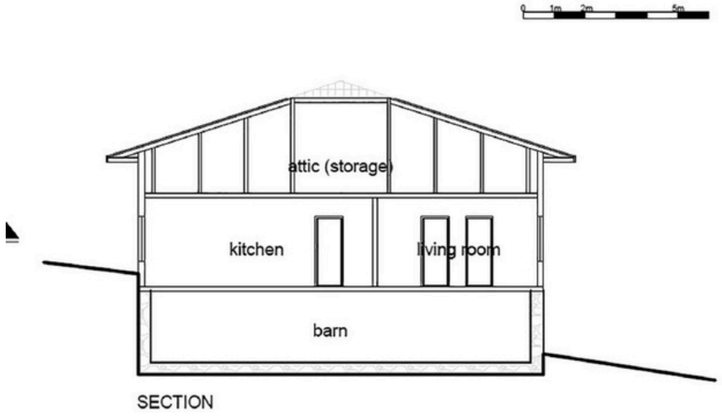


End elevation

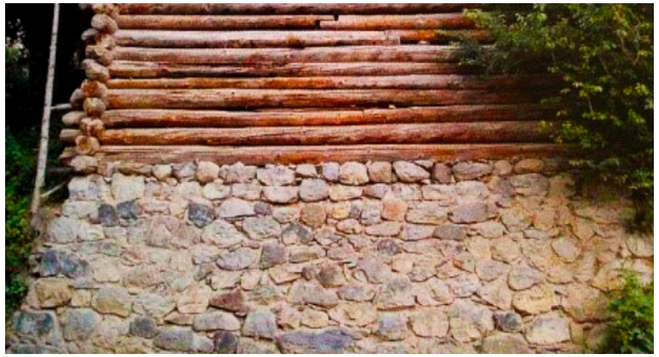


Sherpa village. Image by Sonia Halliday

## *EASTERN BLACK SEA REGION -TURKEY*



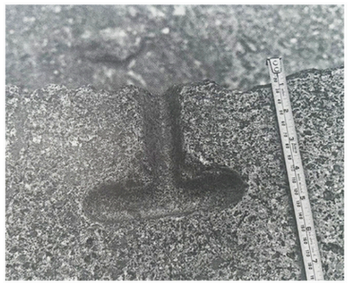

Plan and section drawing of building in the Eastern Black Sea Region. Drawing courtesy of Salih Ceylan.



House at Cevizli Village/Artvin at present (Gür and Batur 2005

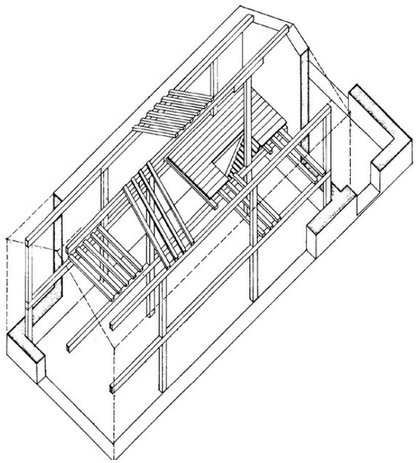
Structural Elements → WALLS

## *INCA- PERU*

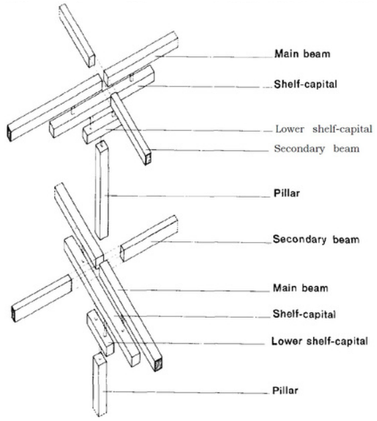



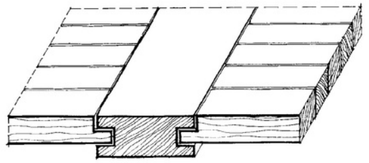
T-shape and U-shape notches in rocks found in Ollantaytambo. Image courtesy of Jean-Pierre Protzen.

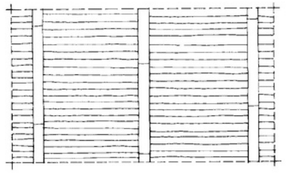
## *SHERPA'S- NEPAL*



Axonometric of Sherpa dwelling. Drawing by Valerio Sestini and Enzo Somigli.

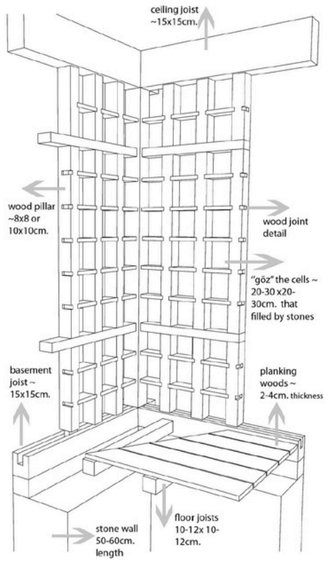


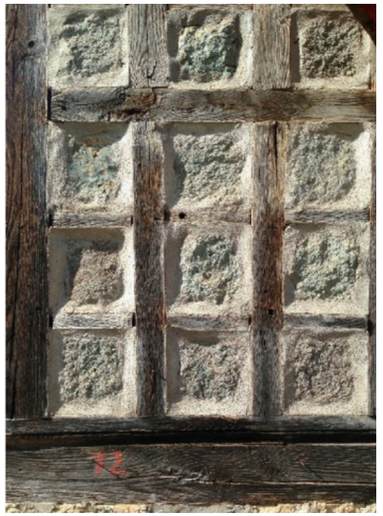


The first diagram is an axonometric of the main beams and shelfcapitals in a gompa.

## *EASTERN BLACK SEA REGION -TURKEY*



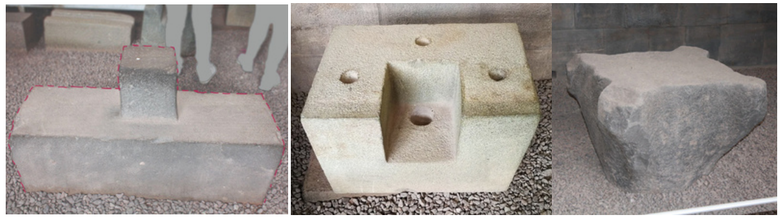

Perspective drawing of the construction of a timber frame structure with cell infilling system (Güler, 2013).



Structural Elements

# WALLS

## *INCA- PERU*



Figures 2.20 and 2.21 demonstrate two examples of the interlocking technique. Images and annotation by author.
Figure 2.22 courtesy of Atticus Drake

Figure 2.19 depicts the different interlocking techniques the Incas employed on the stones, similar to what in the modern day is known as Lego. Image by author.

## *SHERPA'S- NEPAL*

Image of a window in a Sherpa home. Image courtesy of Valerio Sestini and Enzo Somigli.

## *EASTERN BLACK SEA REGION -TURKEY*

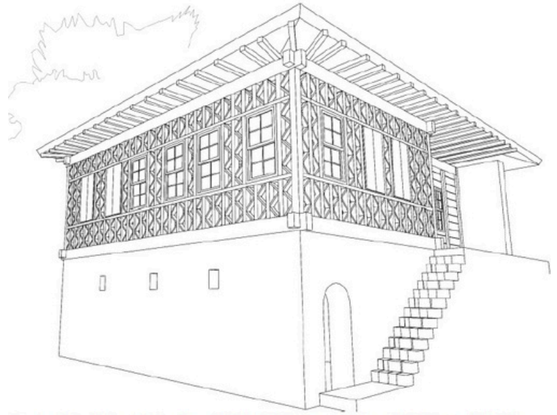
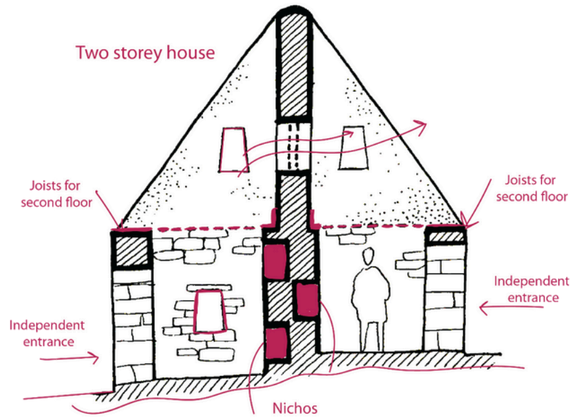


Figure 8. A model of amulet infilling system (Güler, 2013).

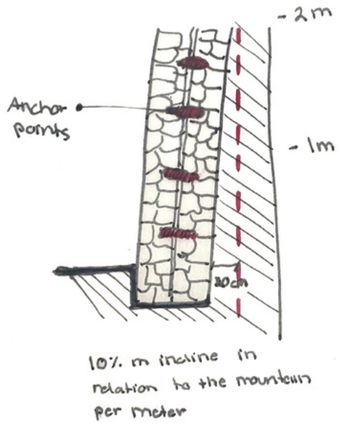
Image courtesy of Hamiyet Özen, Servet Keleş and Emre Engin

Structural Elements → WALLS

## *INCA- PERU*



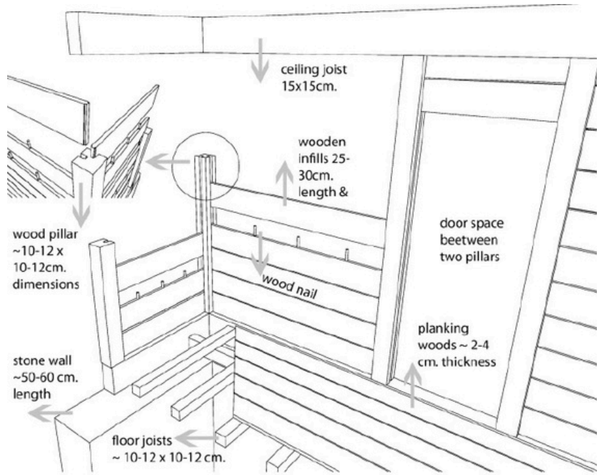

The drawing depicts a two-story house divided by a central wall with nichos, trapezoidal windows, and joists highlighted in red to support the second floor. Drawing by Gasparini & Margolies annotation by author.

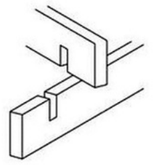


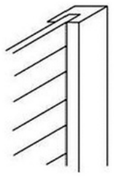

## *SHERPA'S- NEPAL*

Sherpa House courtesy of Photo Voyages. Steep roof, roof overhang on two levels , small windows, retaining wall made out of stone in back garden, along with trees and plants to prevent soil erosion.

## *EASTERN BLACK SEA REGION -TURKEY*





The wood infill structural system diagram. Retrieved from Elif Berna Var.

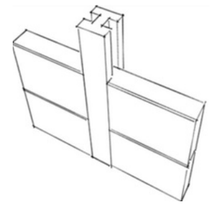
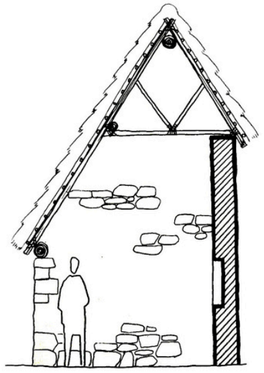


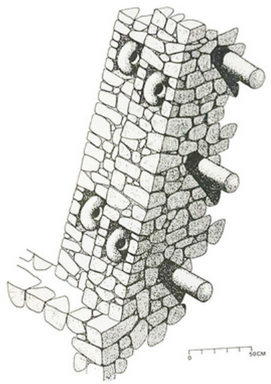
Diagram courtesy of Selda Al Şensoy, Sibel Kukoglu.

Structural Elements → ROOFS

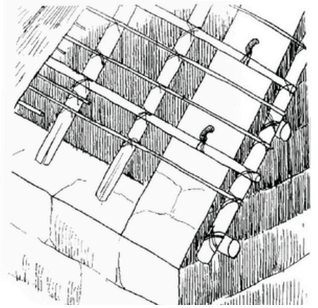
## *INCA- PERU*



Drawing of roof slopes and lengths by Gasparini & Margolies

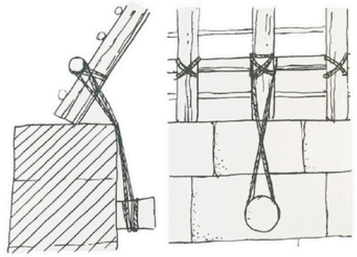


Possible stone peg and rings structural system



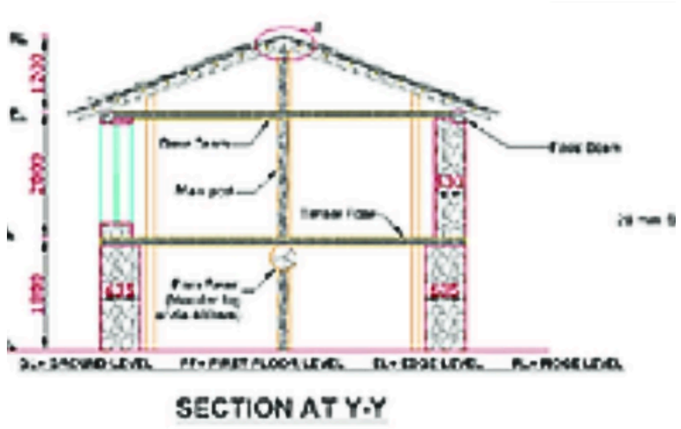
Drawing by Gasparini & Margolies, annotated by the author.

Possible method of tying the roof to pegs inside room



Drawing by Gasparini & Margolies annotation by the author.

## *SHERPA'S- NEPAL*




Khadka, Shyam & Acharya, Sabin & Acharya, Ayush & Veletzos, Marc. (2023).


Khadka, Shyam & Acharya, Sabin & Acharya, Ayush & Veletzos, Marc. (2023).

## *EASTERN BLACK SEA REGION -TURKEY*

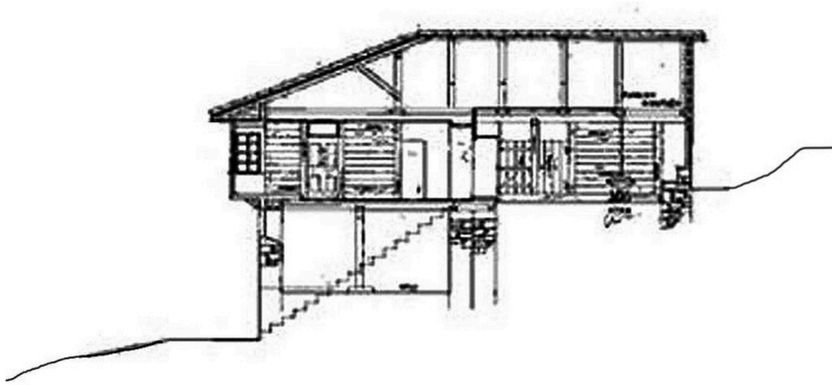
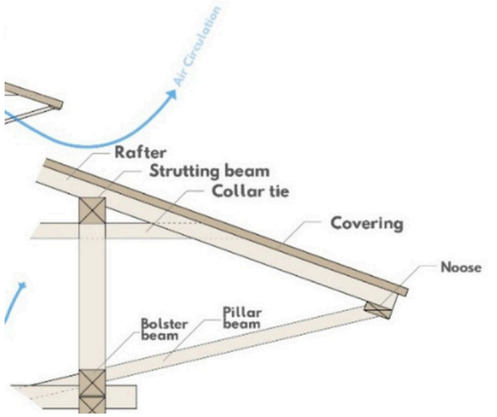


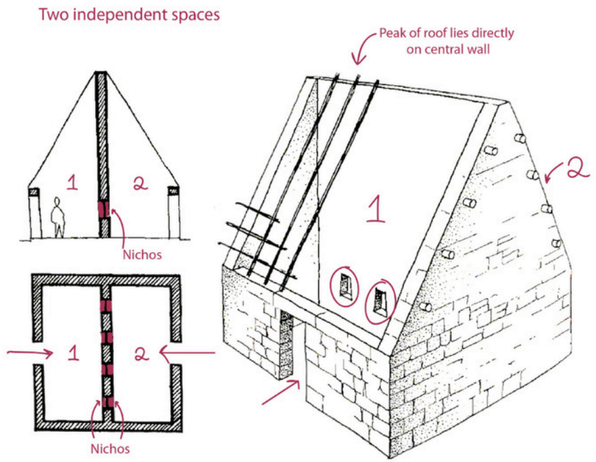
Figure 3.1- Cross sections of dwelling (Batur, 2005)




Detail of roof structure, diagram courtesy of Burcu Salgın , Ömer F. Bayram, Atacan Akgün and Kofi Agyekum.

Structural Elements → ROOFS

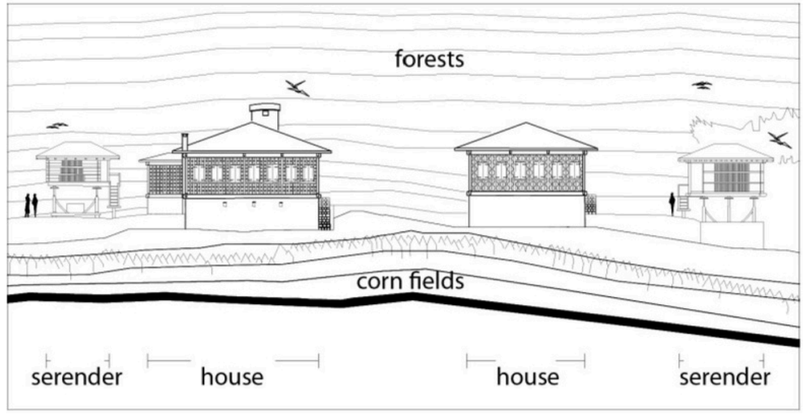
## *INCA- PERU*



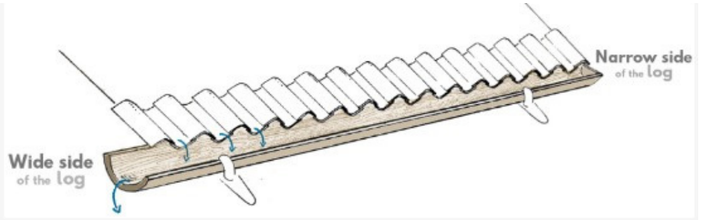

A housing typology with two independent spaces that are divided by a central wall where the peak of the roof lies. Drawing by Gasparini & Margolies annotation by author.

## *EASTERN BLACK SEA REGION -TURKEY*

Housing inbedded in the mountain. Surmener/ Trabzon. Image courtesy by Gur and Batur 2005.




Elevation of housing clusters and teh religious serender (Güler, 2013). Steep roofs as well.



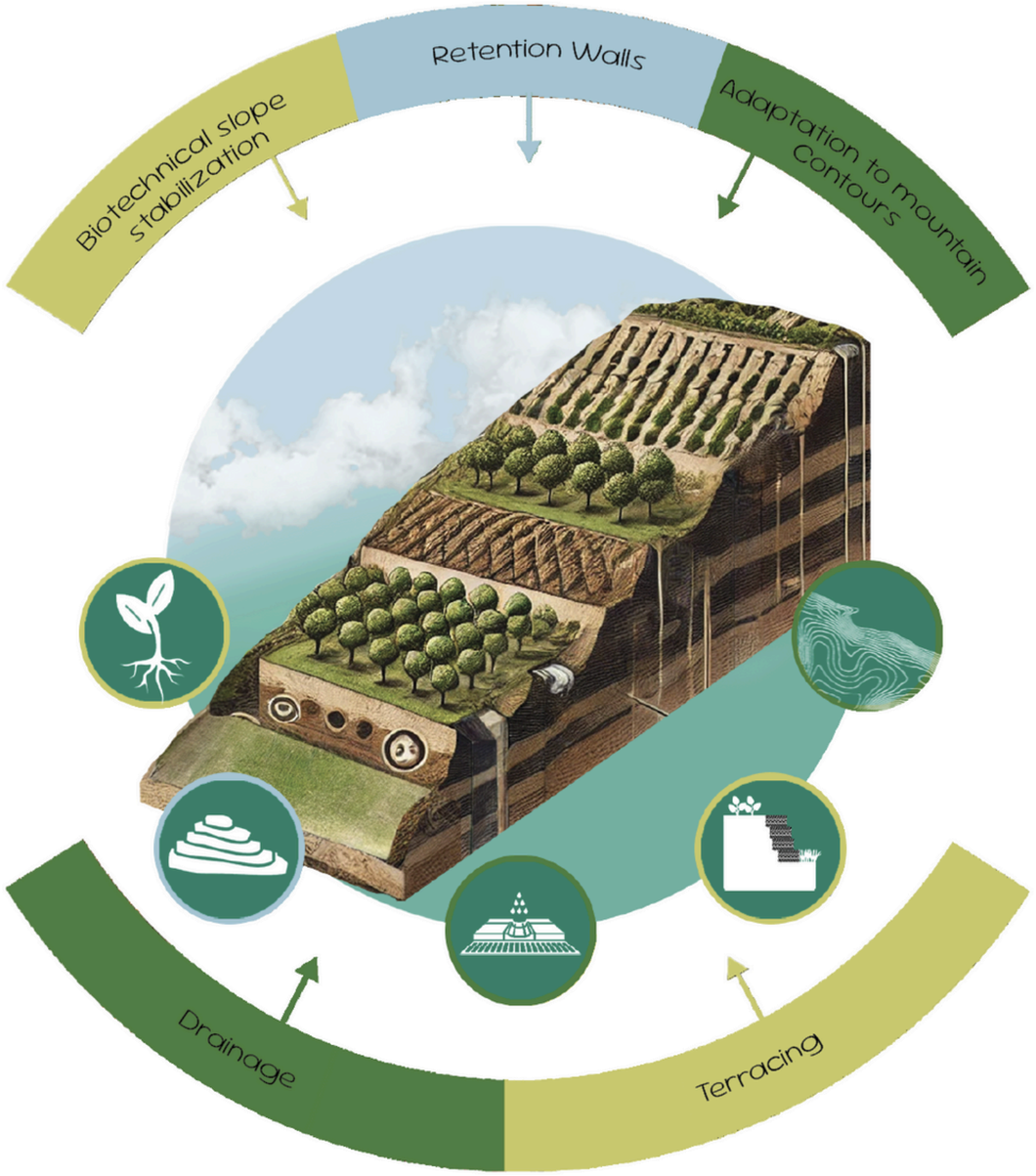

Rainspout made by pine or spruce log (re-illustrated from Özgüner (1970)).

# RESEARCH CONCLUSION

*Structure- Foundations- Walls- Roofs*

- Integrated foundations into the landscape and stilts for humid areas
- Rain Water management in Architecture
- Interlocking Structures
- Rectangular & L-shape building
- Parallel to slope
- Large Eaves

## Landslide Mitigation Techniques Derrived from Vernacular Engineering




## Design Principles Diagram

## *Environmental and Biodiversity*

Image by Daniela Diaz- One of the few remaining patches of vegetation in the area, which was once densely forested.

## Agricultural Potential and Biotechnical Slope Stabilization

### Native Plants

*Chusquea - Bamboo*

*Giant cabuyá (Furcraea andina)*

*Yarumo (Cecropia spp.)*

*Encenillo (Weinmannia tomentosa)*

# Agricultural Potential and Biotechnical Slope Stabilization

## Fruits

*Uchuva (Physalis)*

*Blackberries (Rubus glaucus)*

*Lulo (Solanum quitoense)*

*Curuba (Passiflora tripartita)*

*Tomato*

## Vegetables

*Potatoes (Solanum tuberosum)*

*Carrots (Daucus carota)*

*Beets*

*Cabbage (Brassica spp.)*

*Onion*

*Lettuce*

*Coriander- Cilantro*

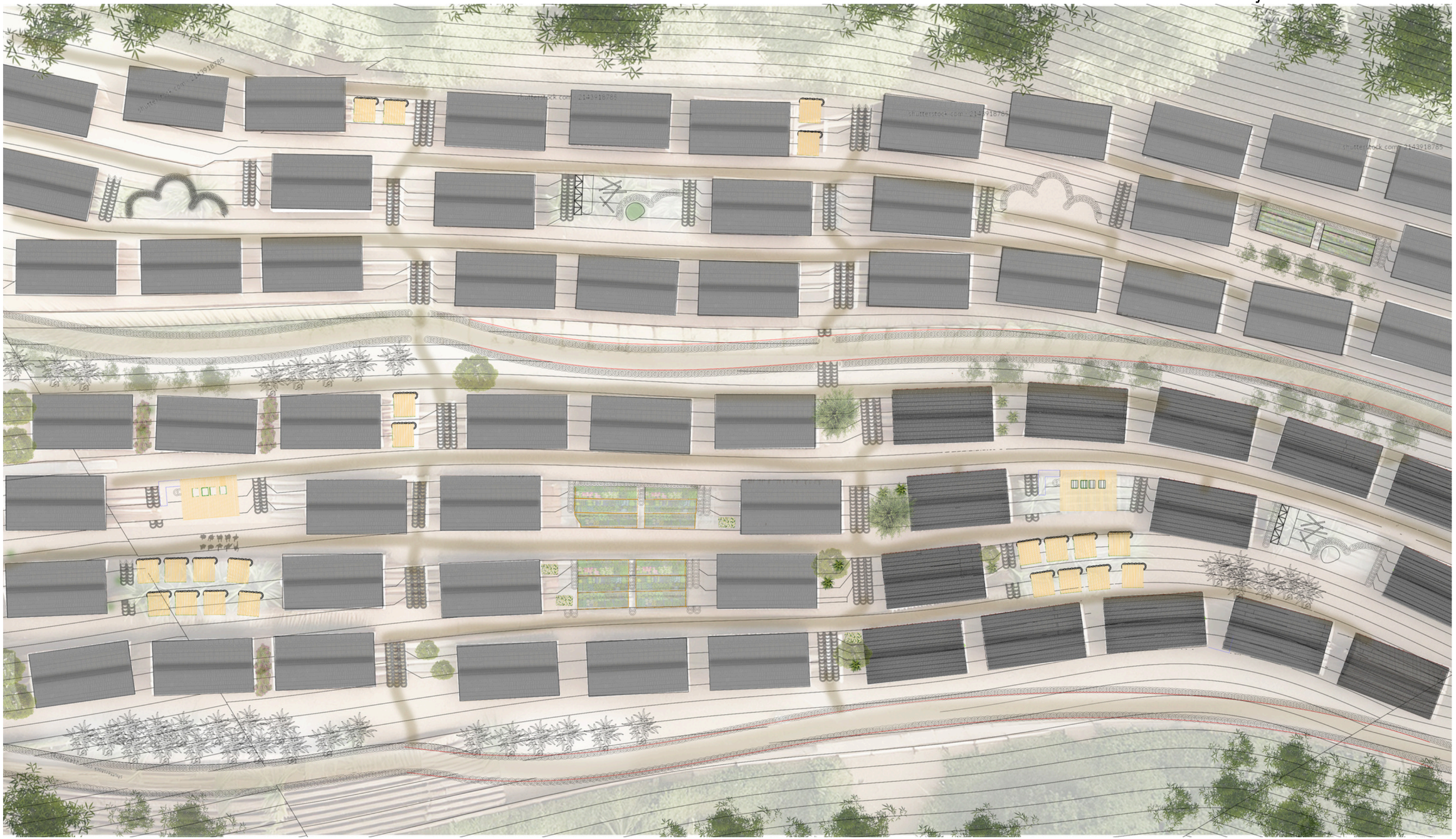
*Cammomile*

*Lemon Grass*

# Proposal

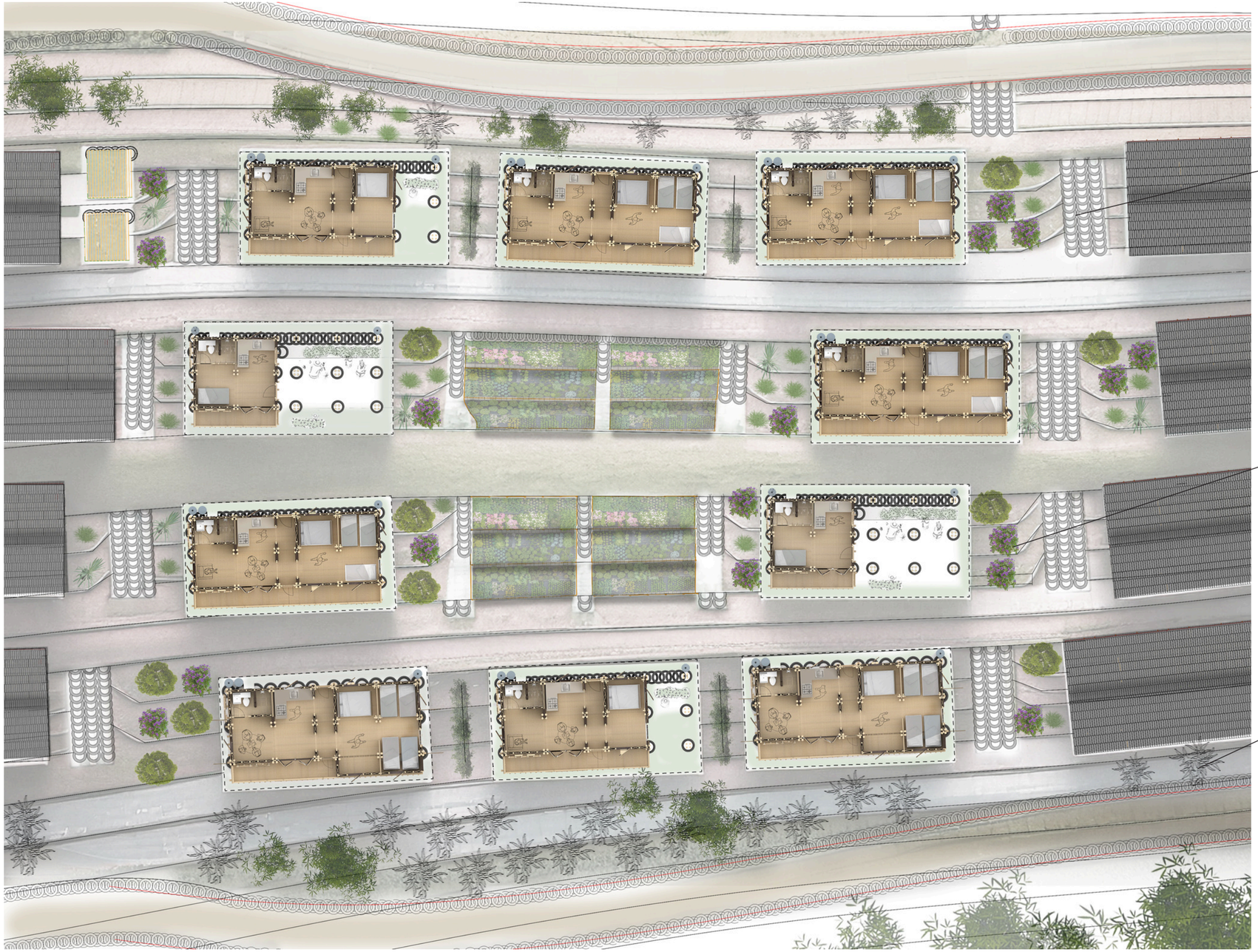
# Master Site Plan

Cluster Systems

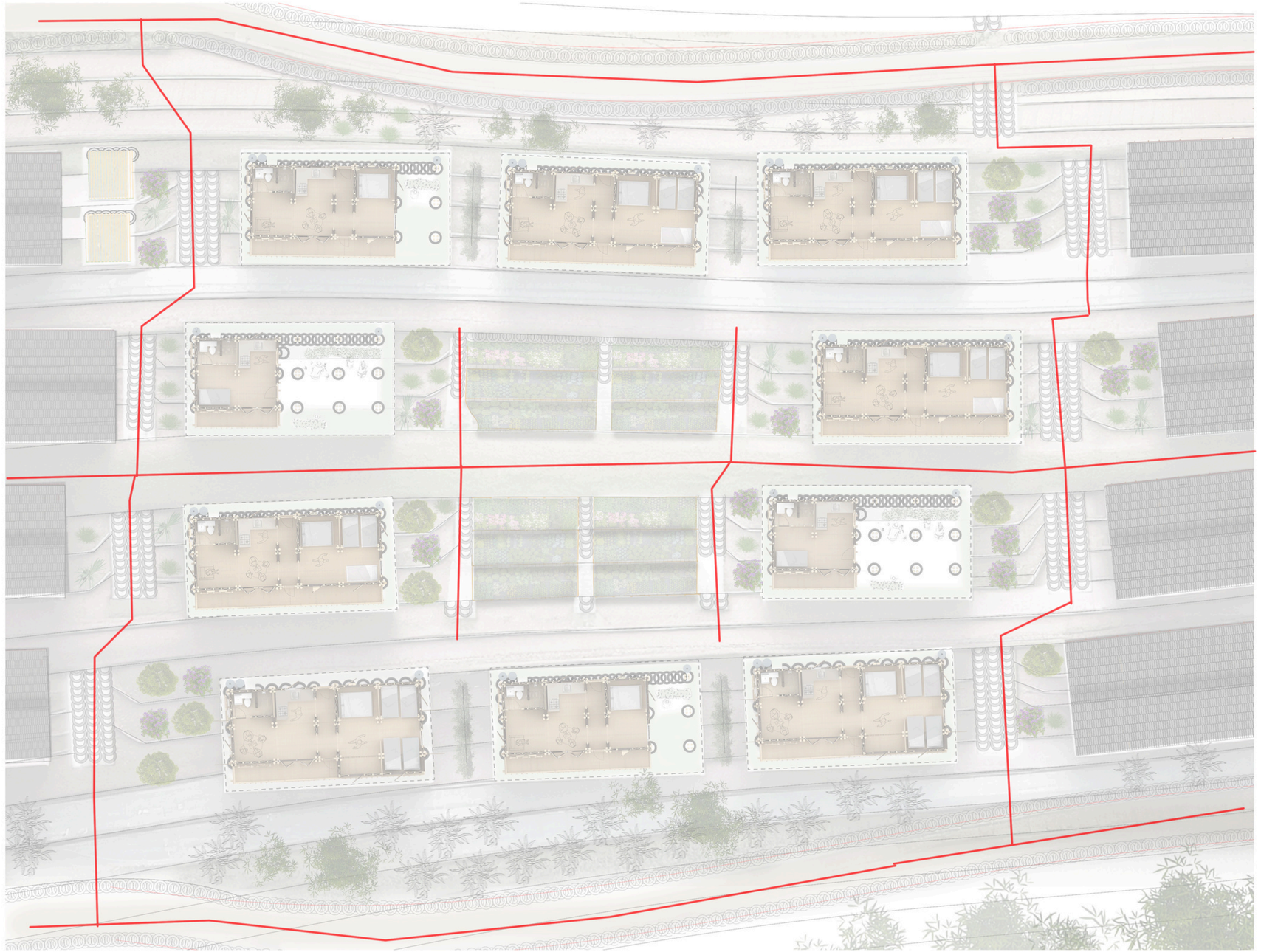


# Water Management- paths

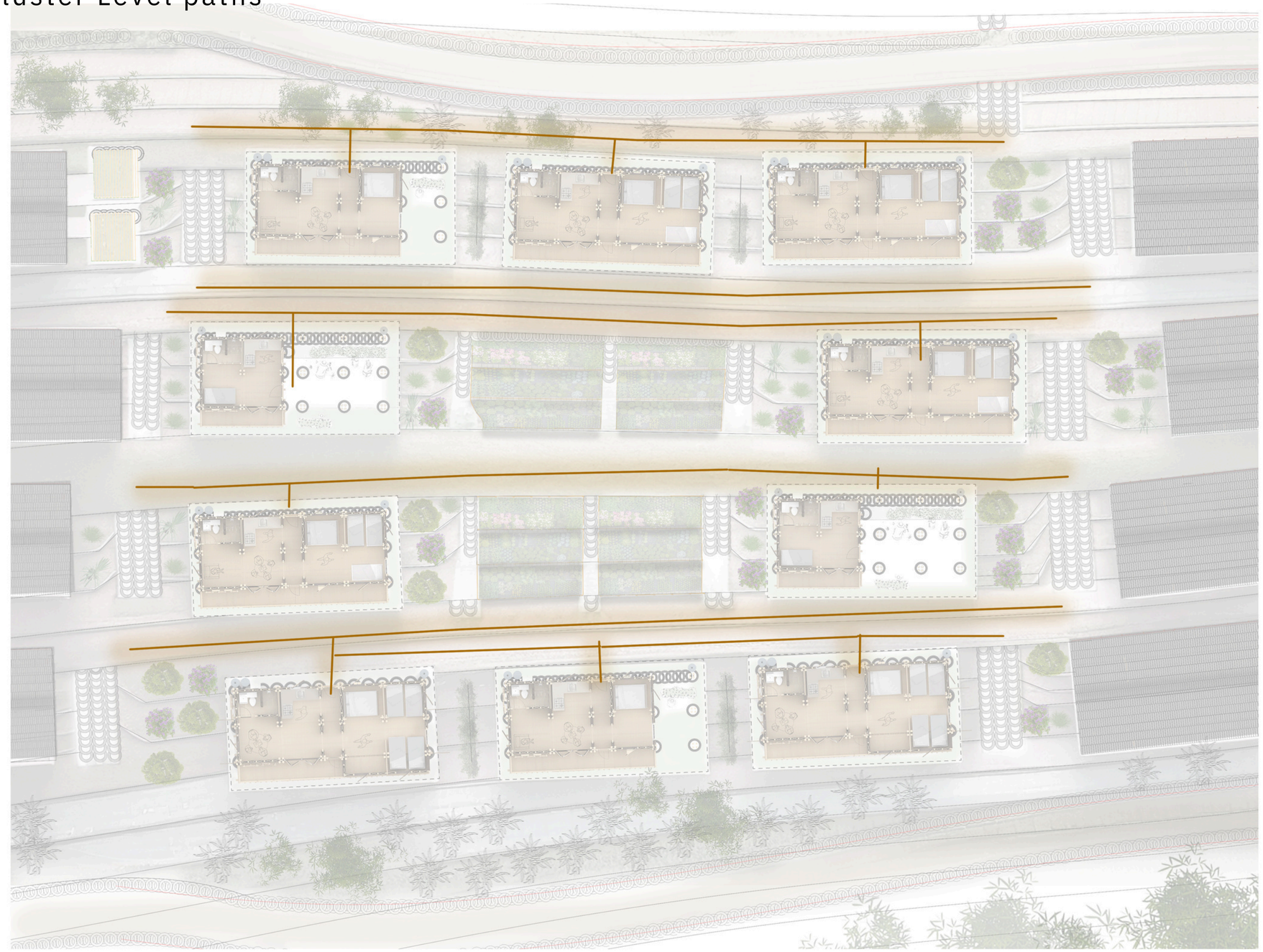
# Communal Garden Cluster Plan



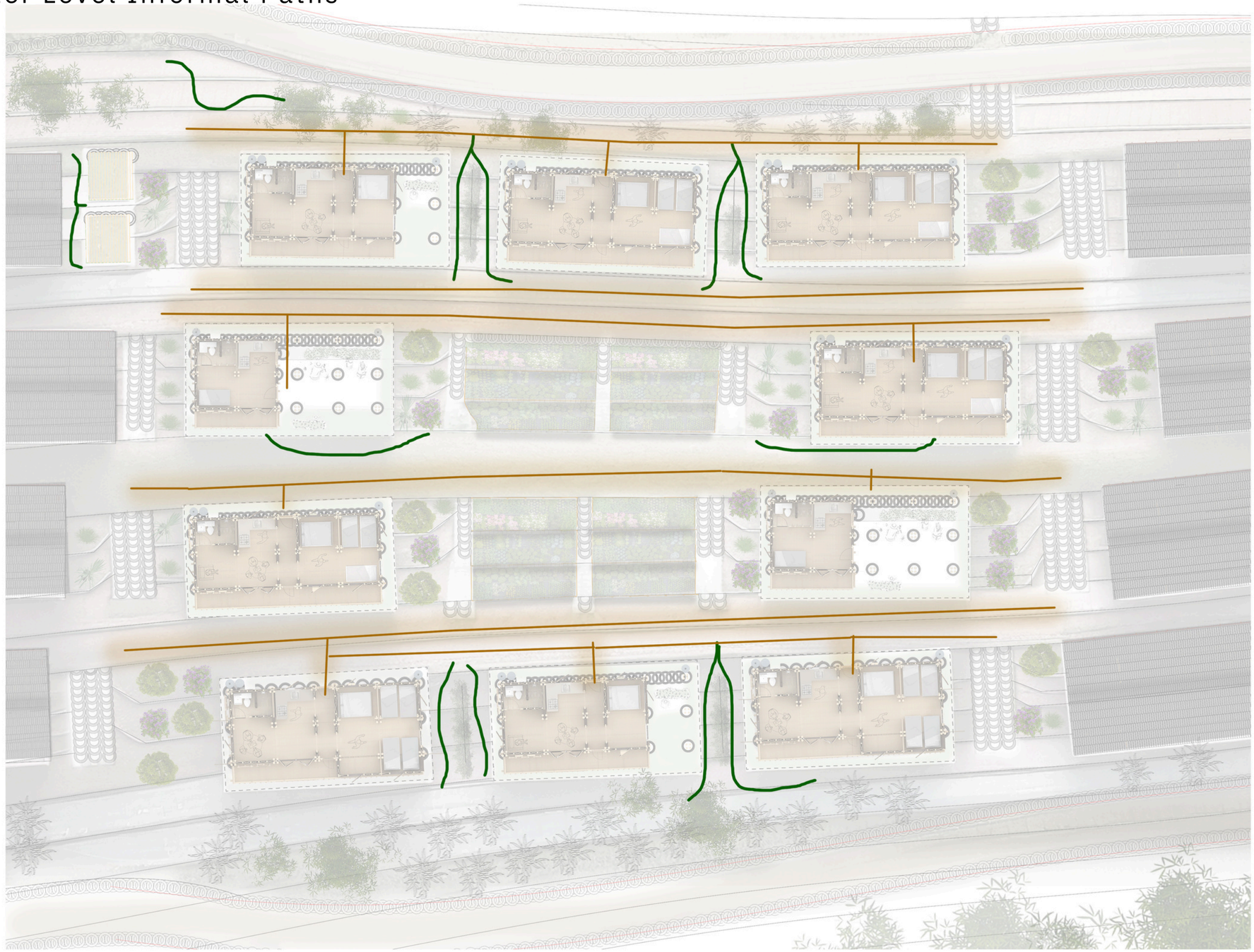
# Circulation- Main Pathways



# Circulation- Cluster Level paths



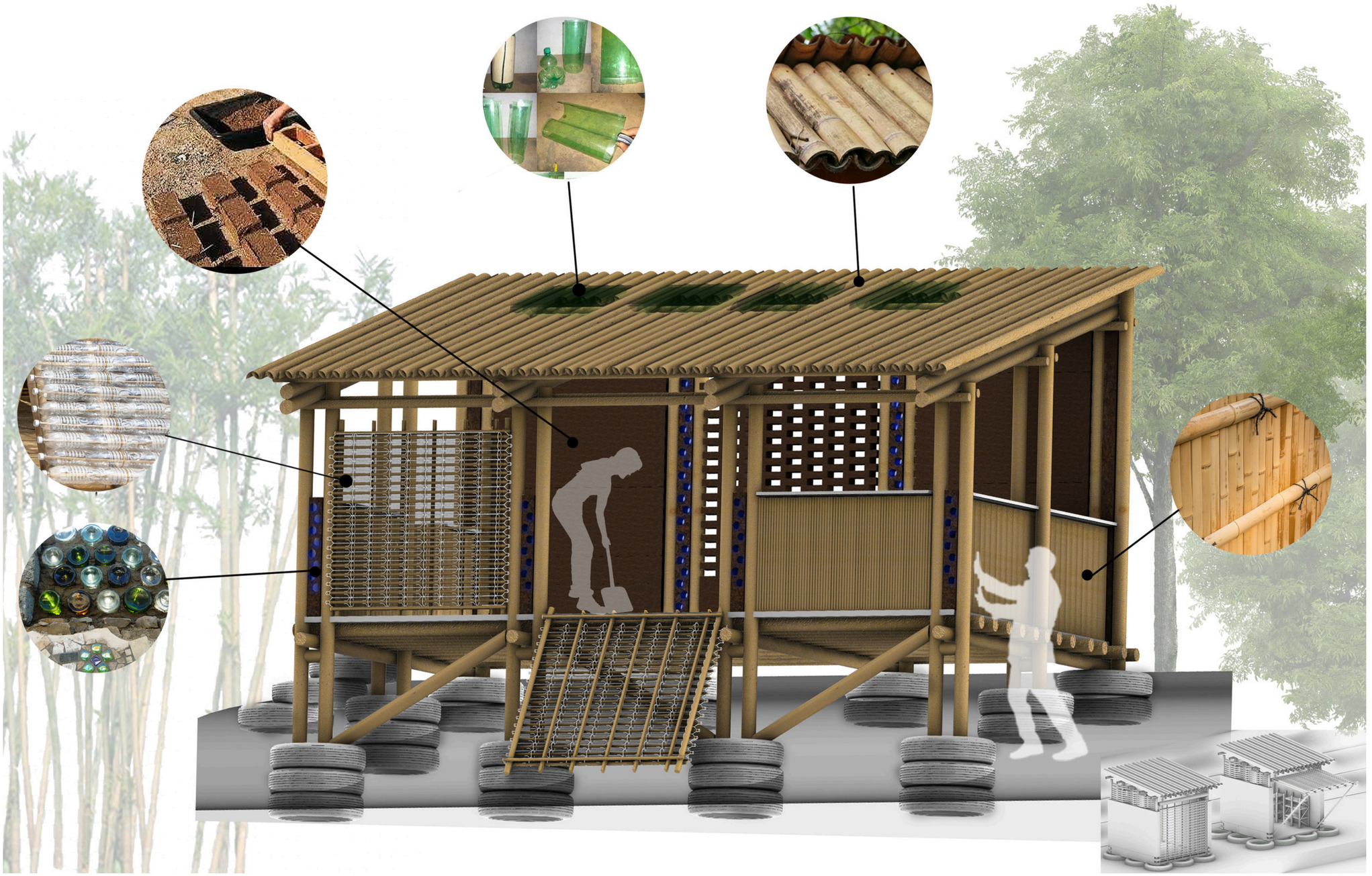
# Circulation- Cluster Level Informal Paths



# Section through Garden Cluster

# Cluster Growth- Workshop & Storage

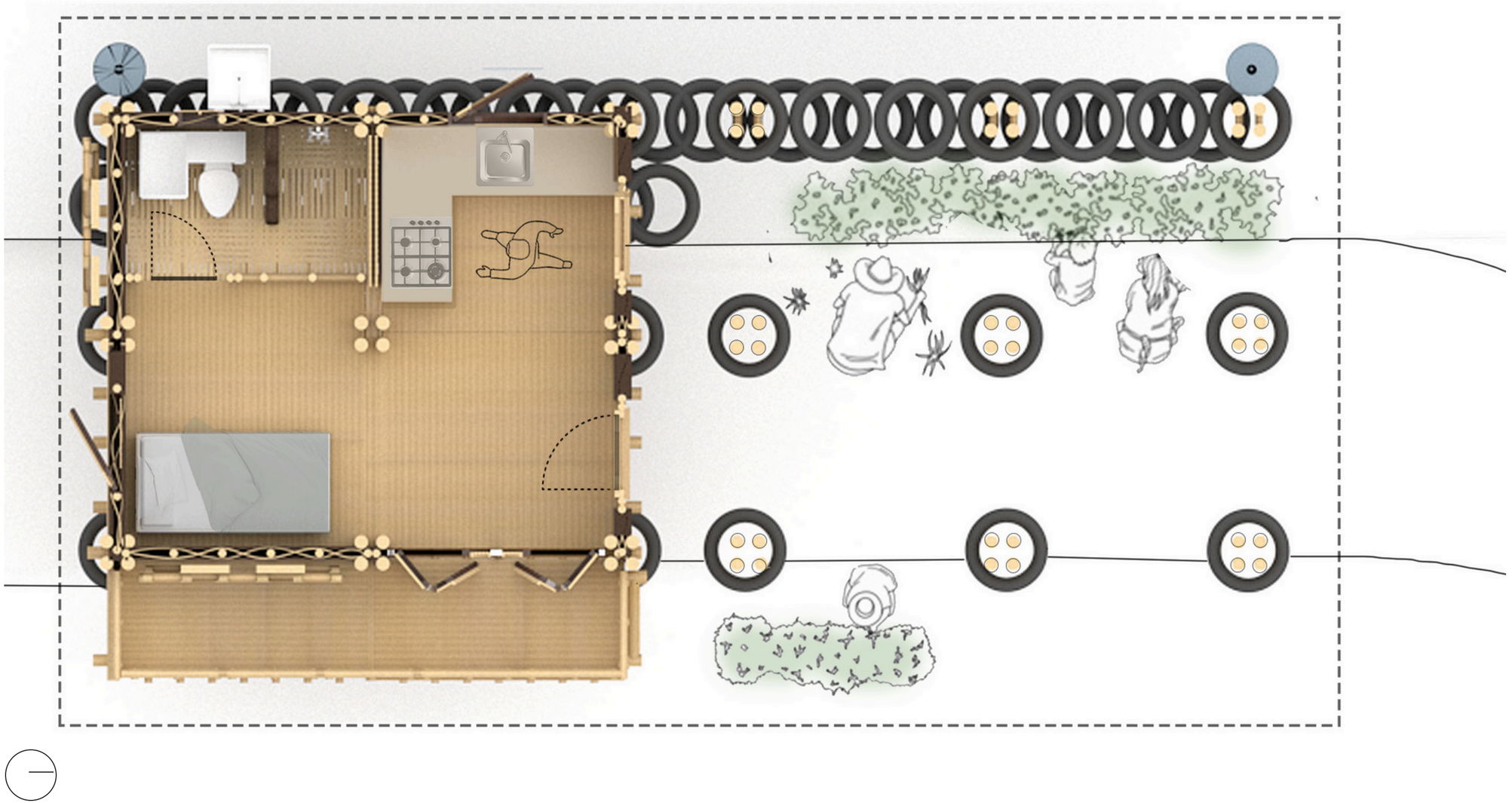
# Workshop & Storage



# Housing Proposal

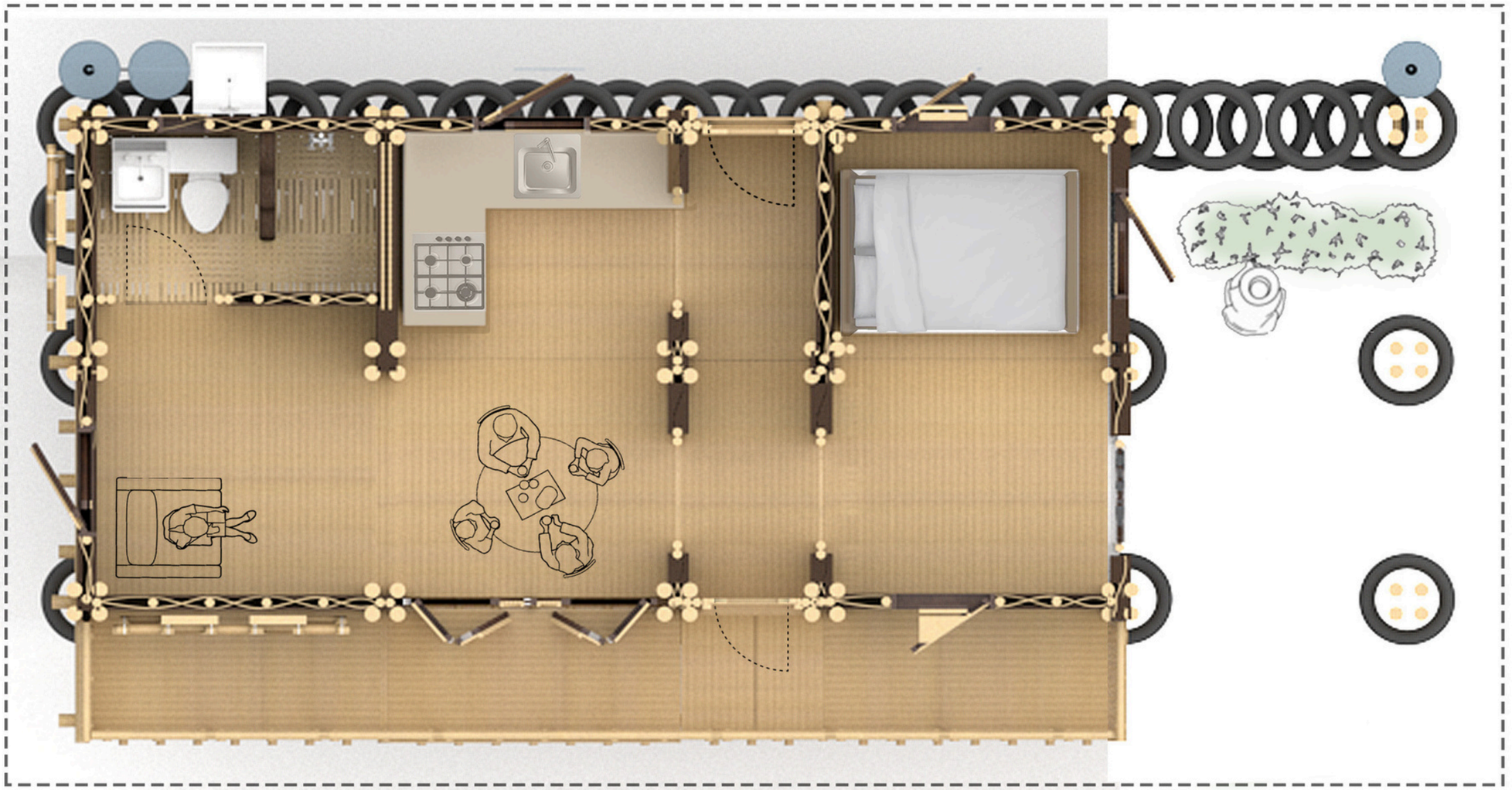
# Phase 1- House

# Phase 1-Floor Plan



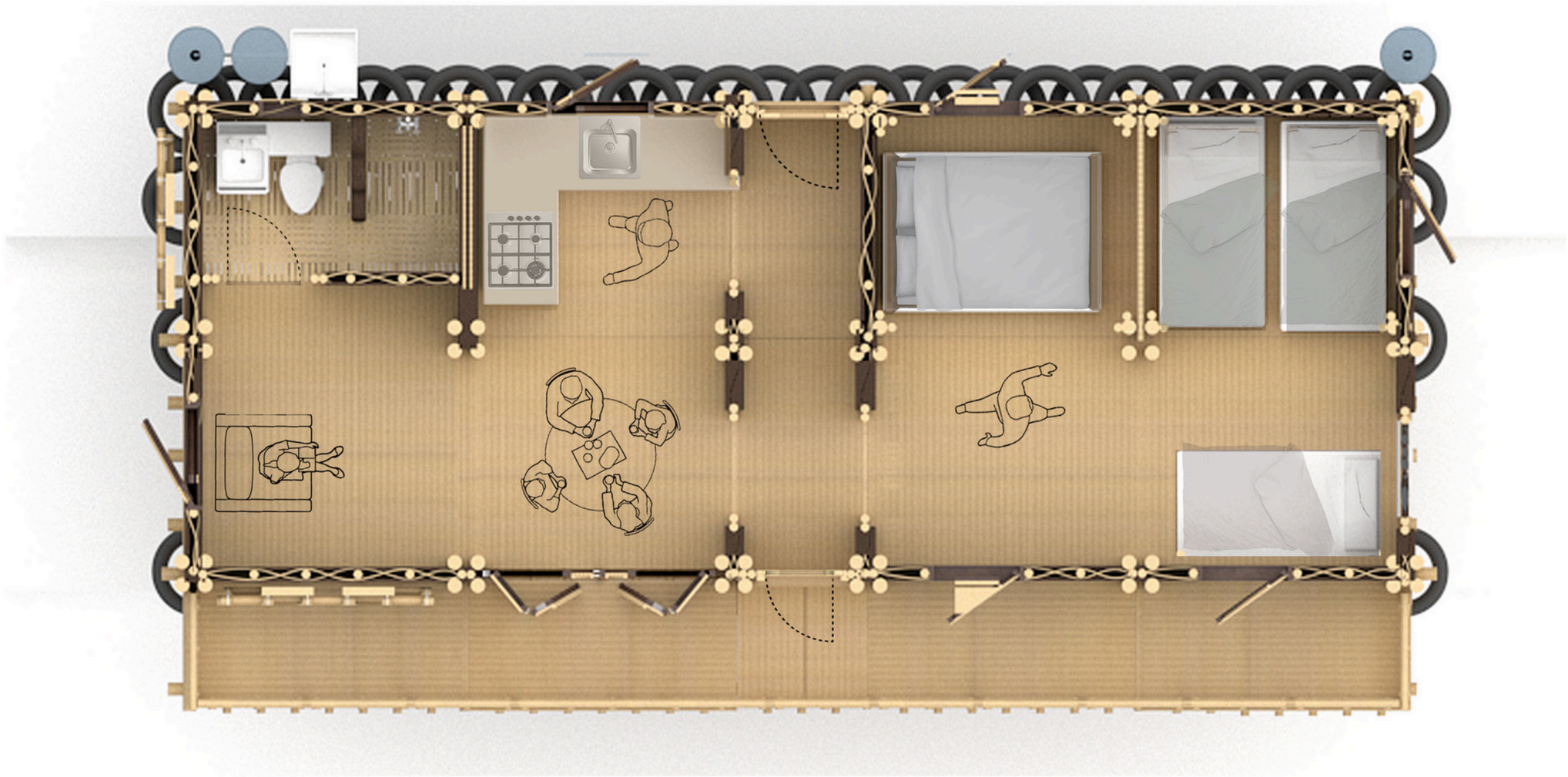
Phase 2- House

# Phase 2-Floor Plan



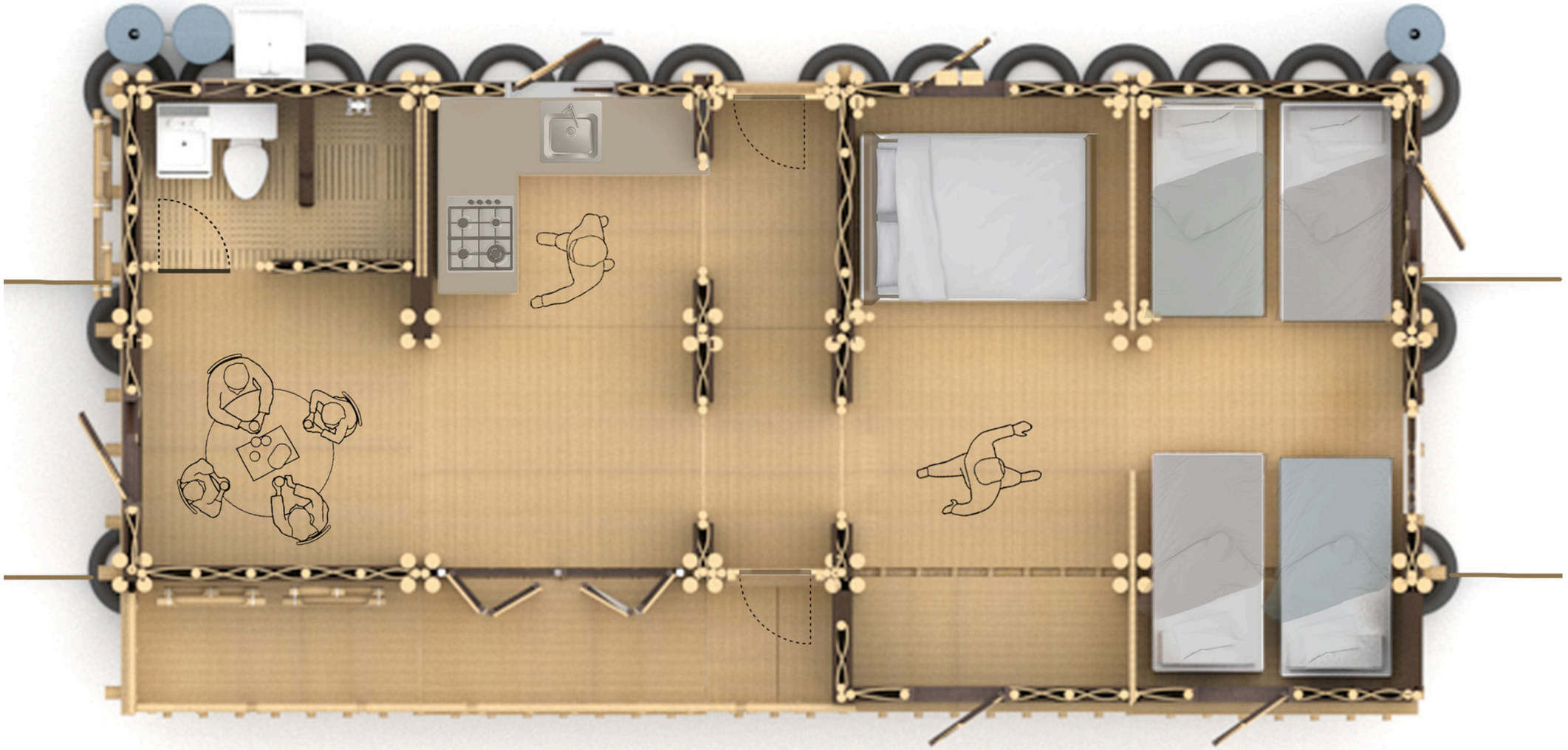
# Phase 3- House

# Phase 3-Floor Plan

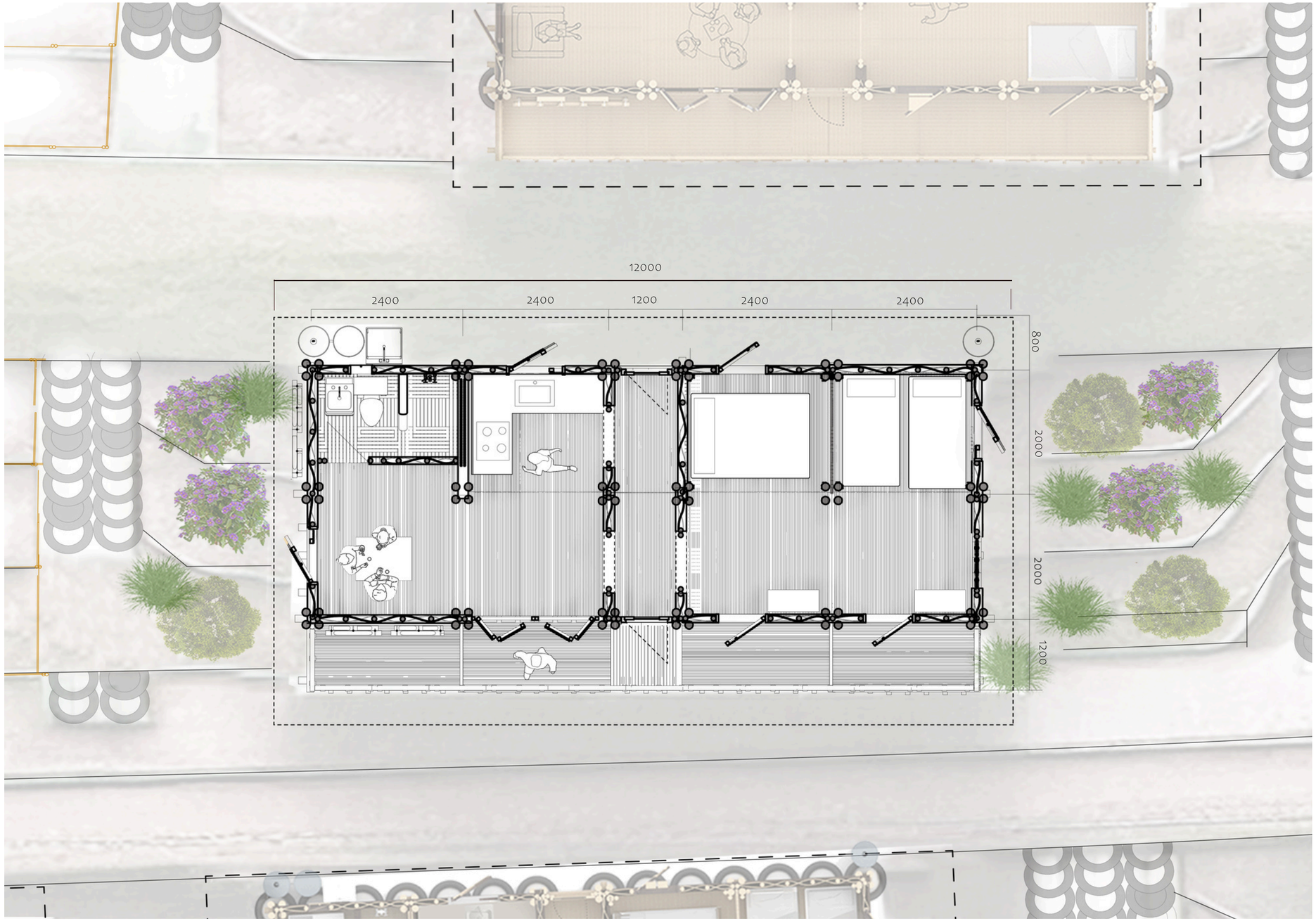


# Phase4- House

# Phase 4-Floor Plan



# Floor Plan

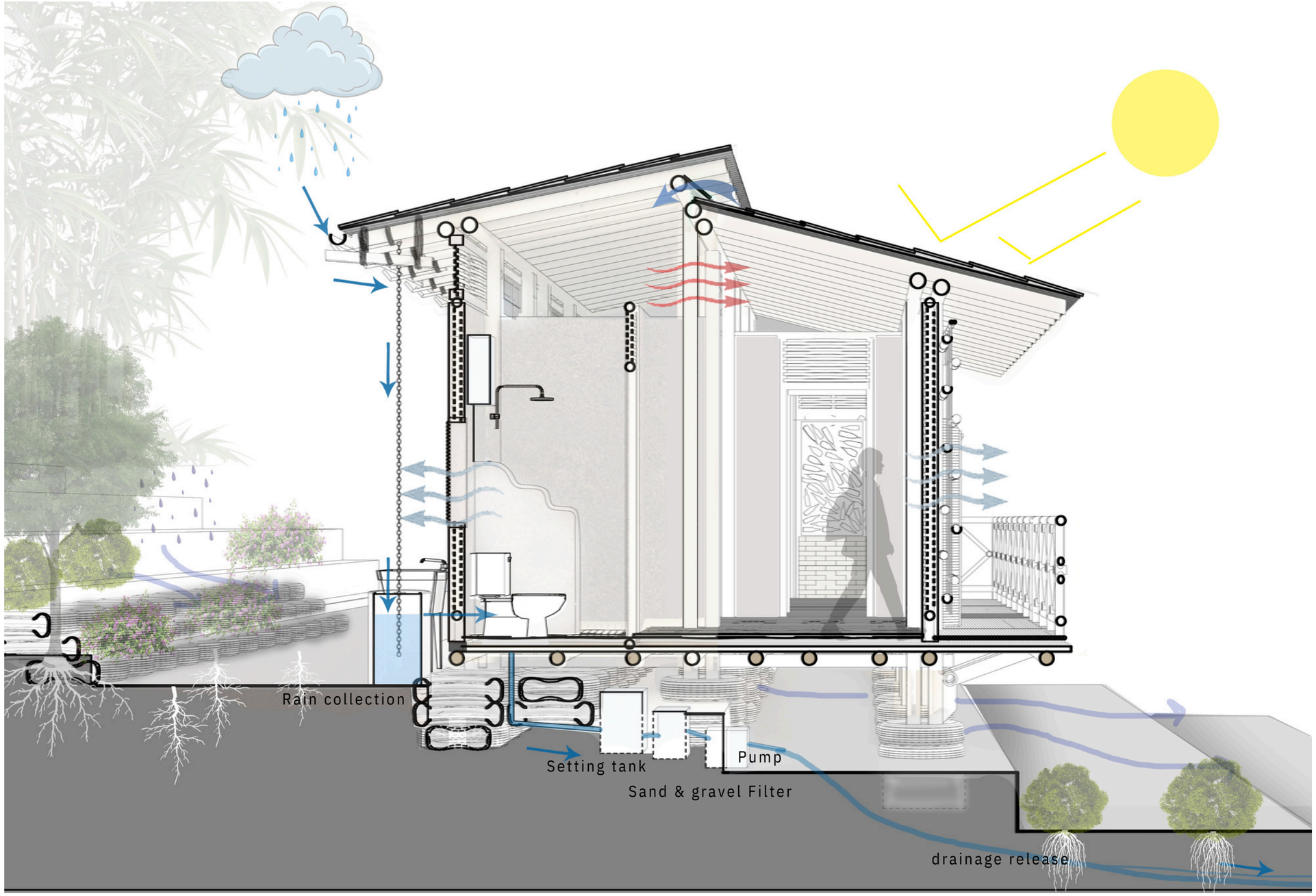


# East Elevation

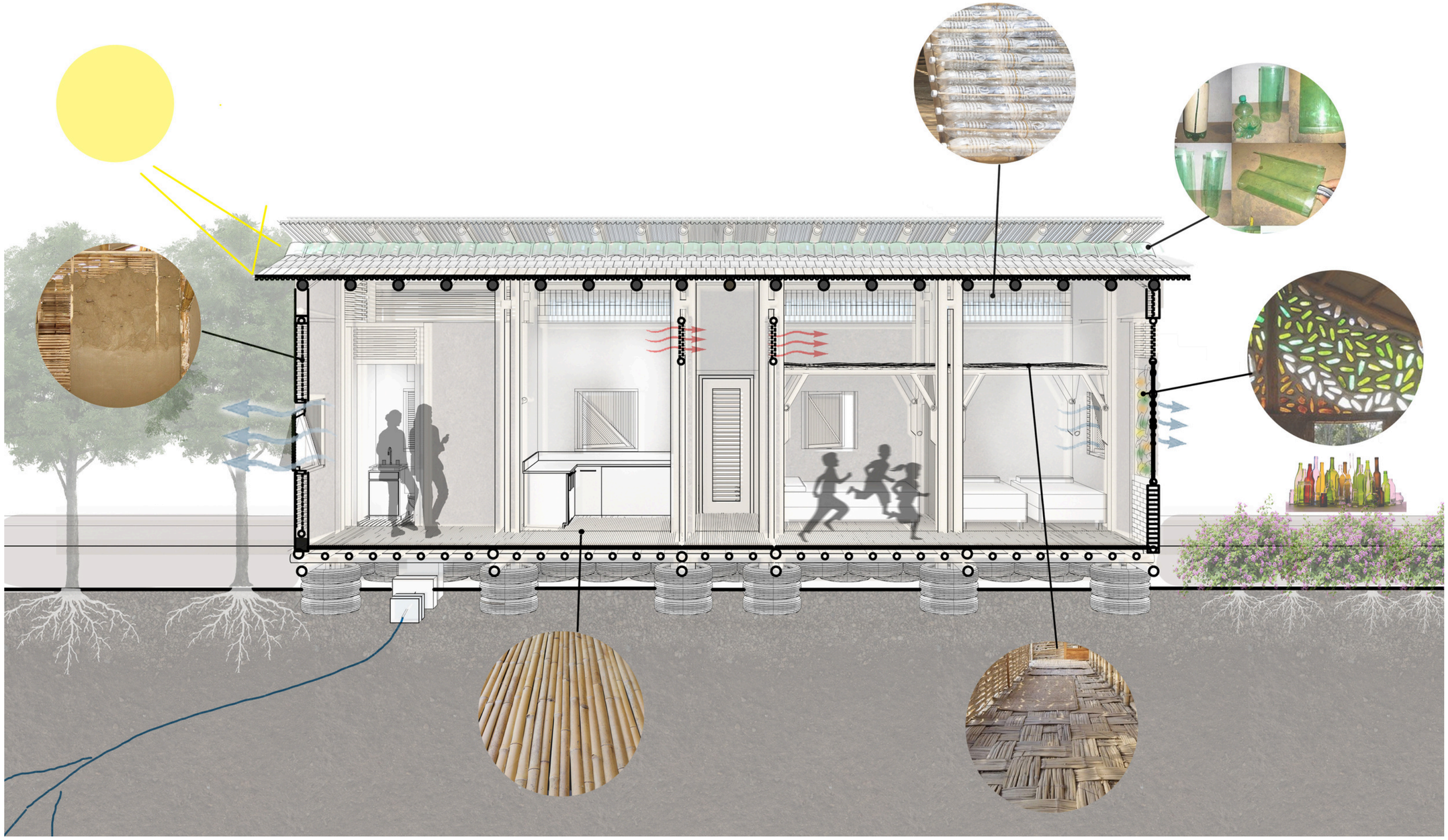
# West Elevation

# North Elevation

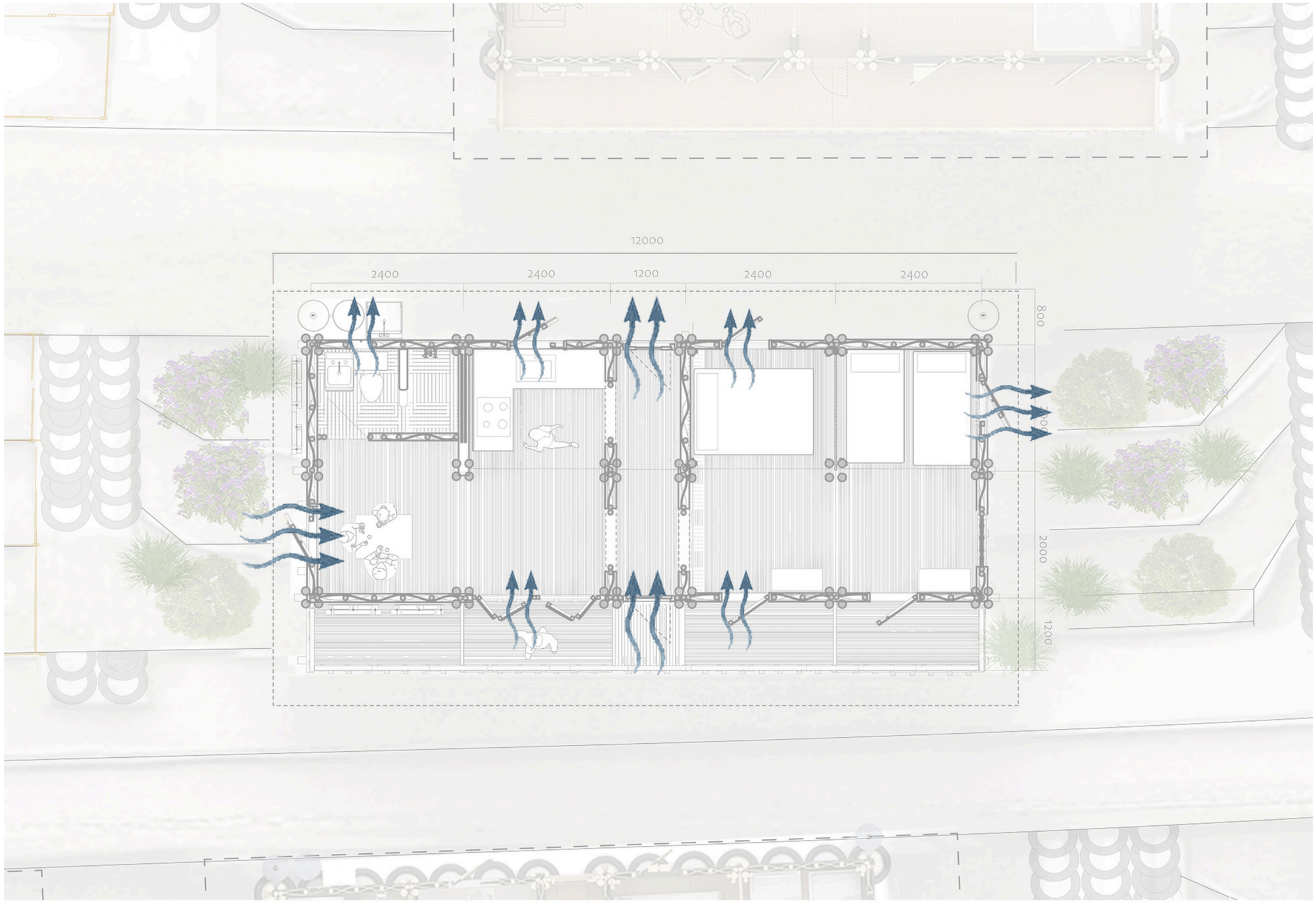
# Transversal Section



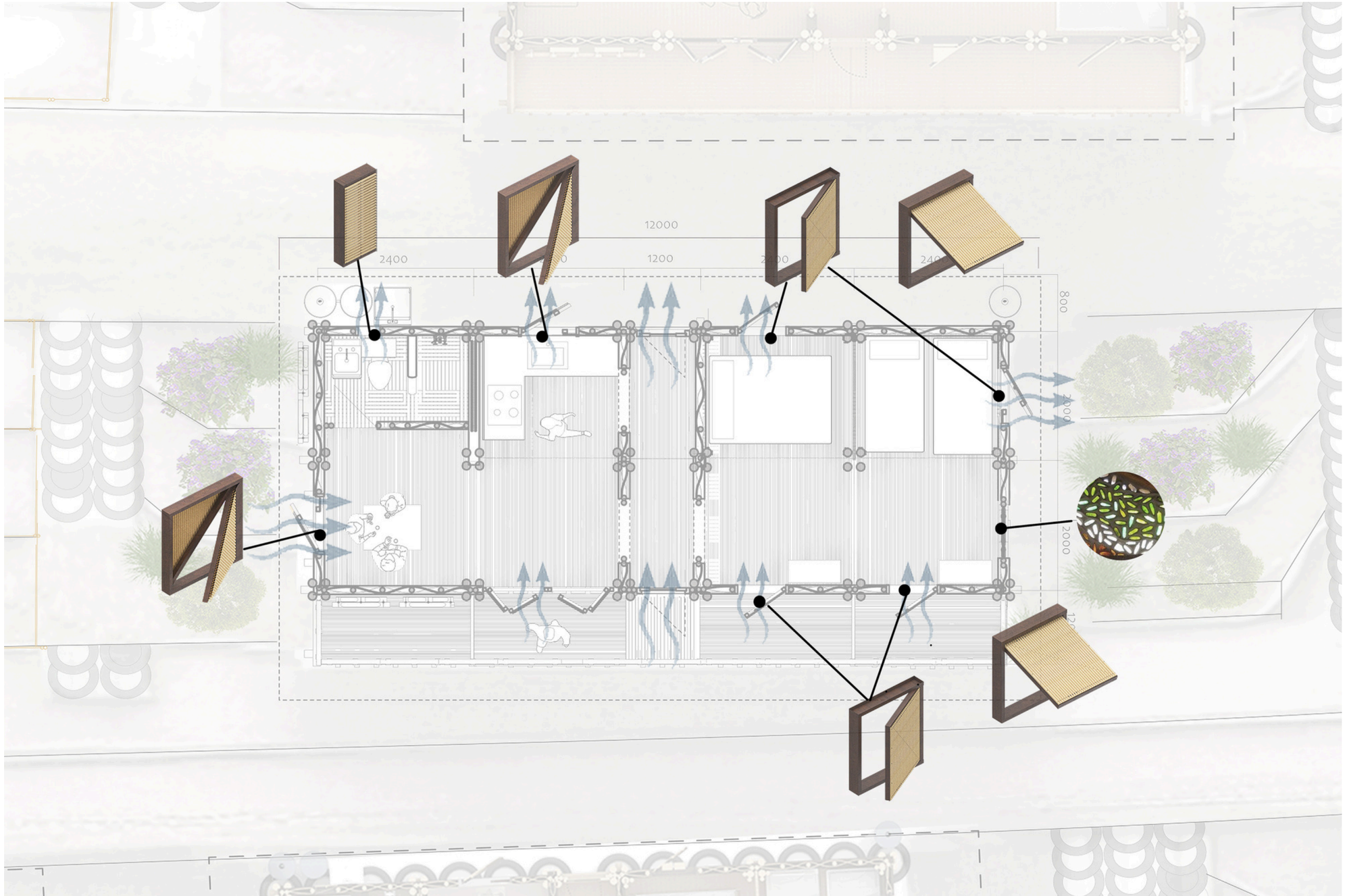
# Longitudinal Section



# Cross ventilation Recommendation

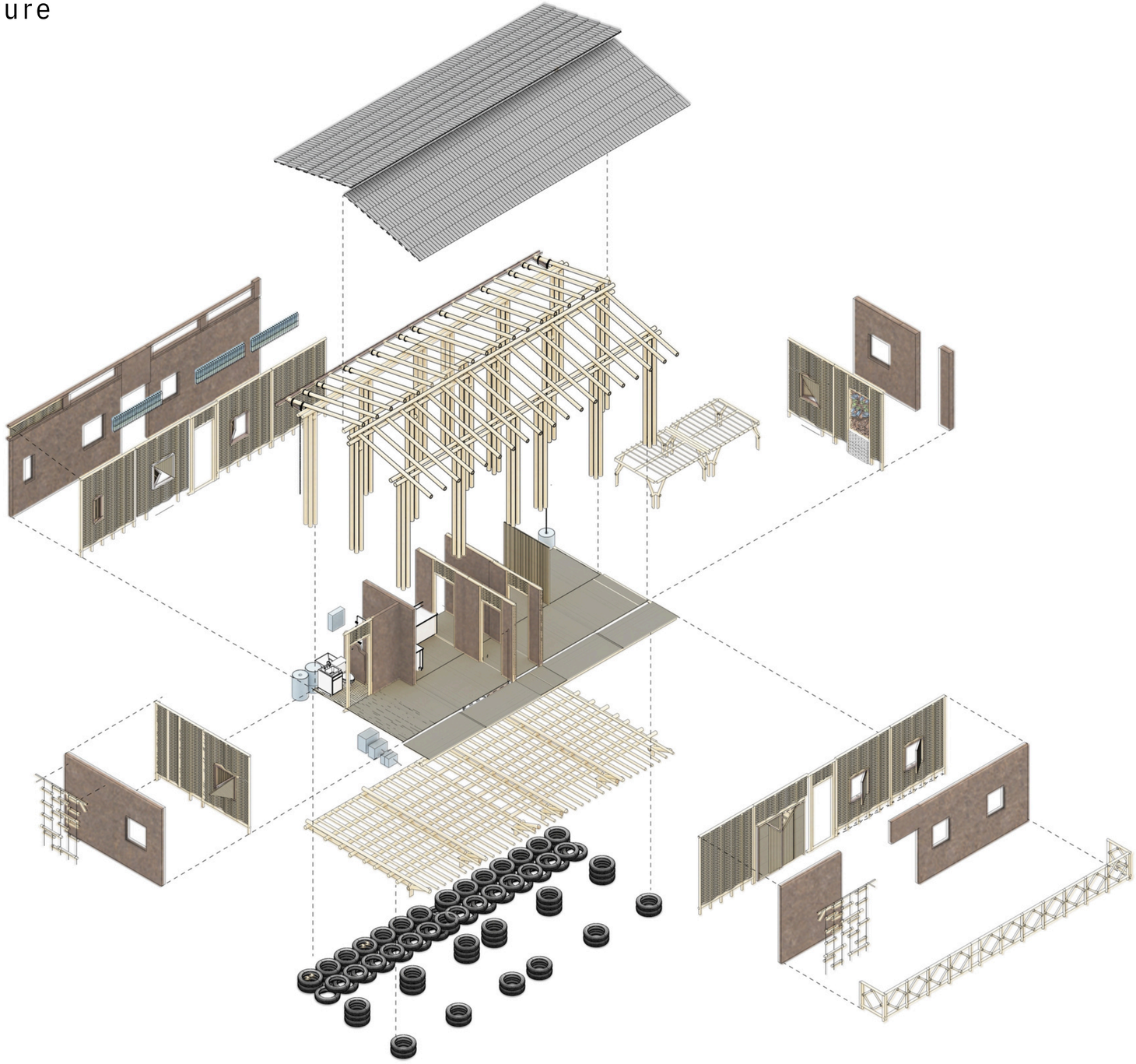


# Window recommendation

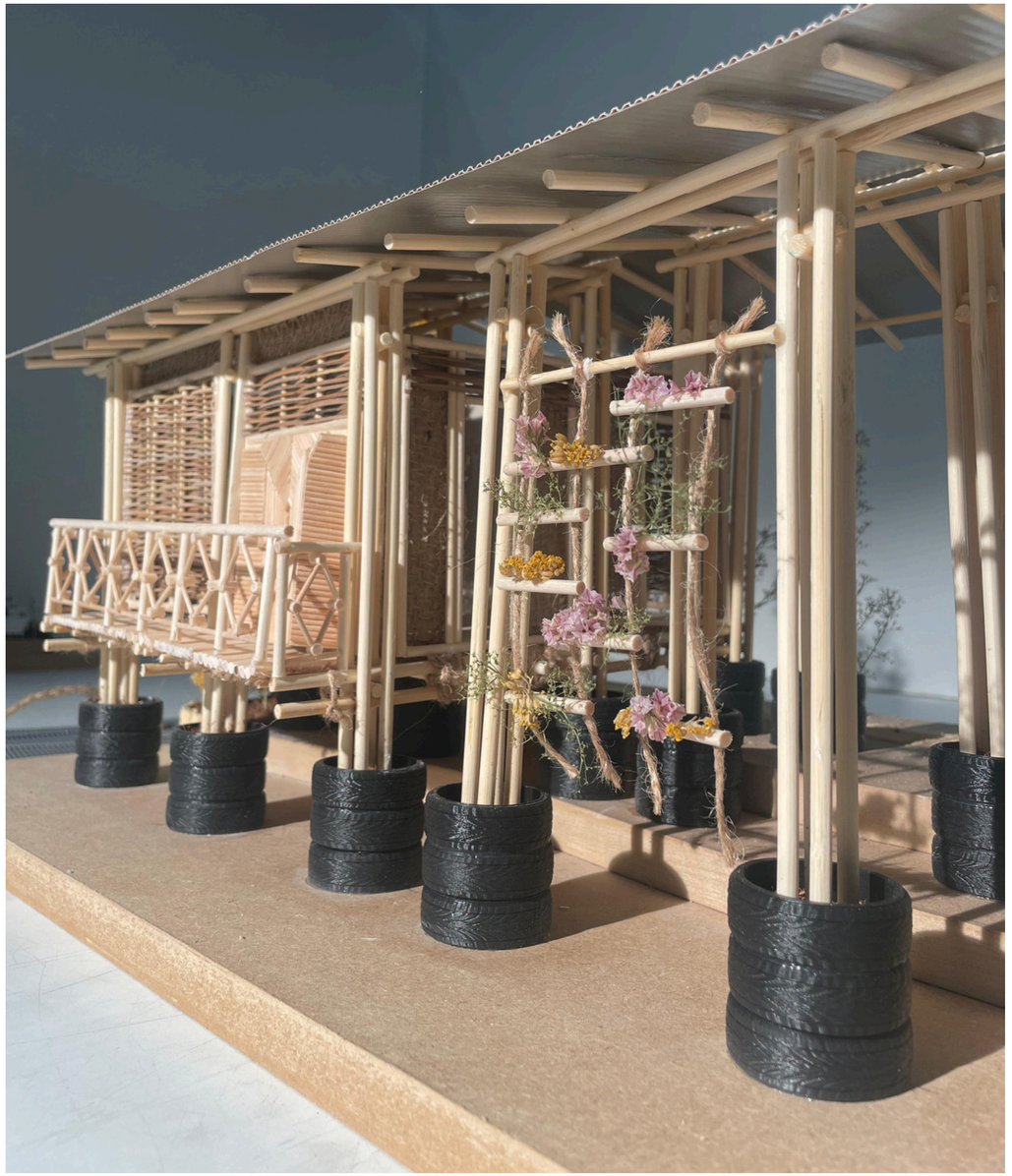


Interior Render
Bedrooms

# Exploded Axonometric- structure

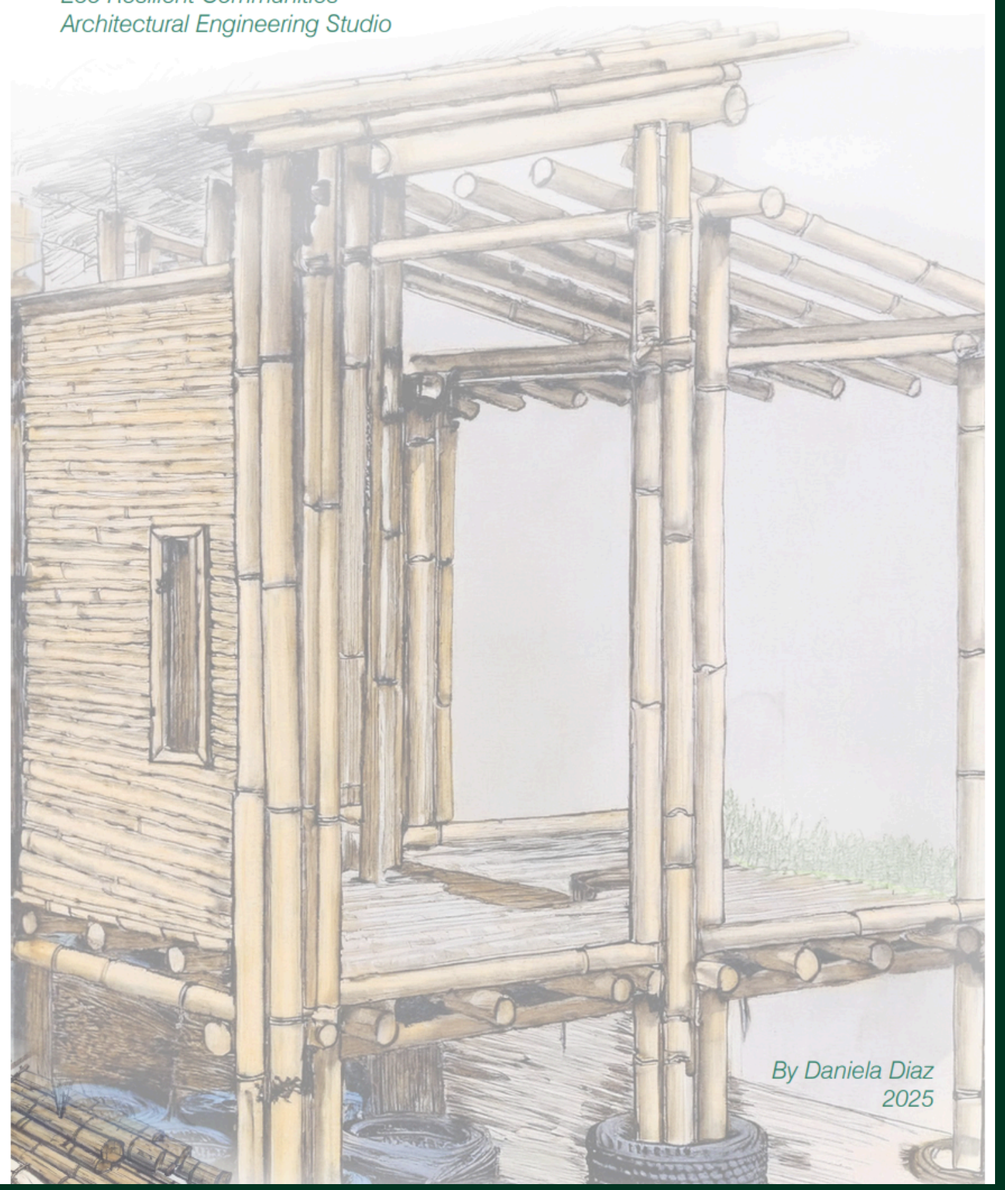


Model 1:25



# Construction Manual

*Eco Resilient Communities*
*Architectural Engineering Studio*



*By Daniela Diaz*
*2025*

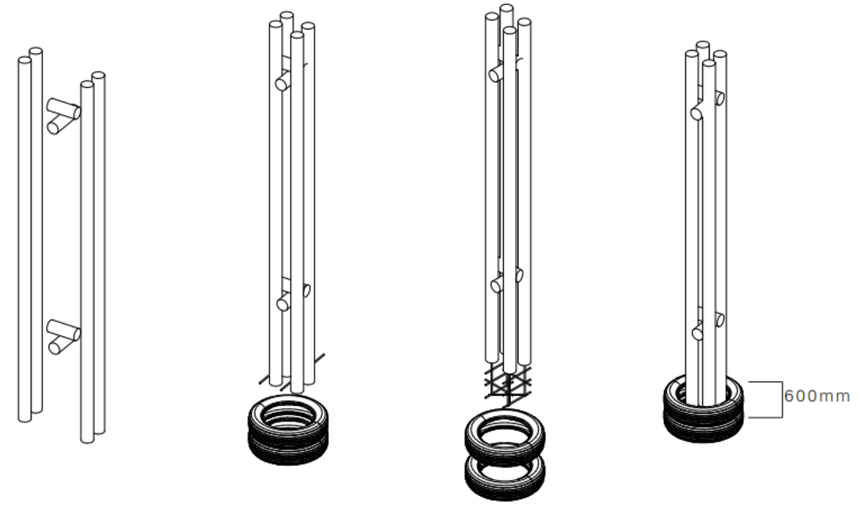


## Columns

Columnas y Estructura

- Install prefabricated vertical Bamboo Columns
- Infill Tires with a mix of soil and comcrete
- Ensure Columns are firmly anchored in Foundation. (Should be minimum about 1.5-2 tires deep of 600mm)

- Instalar columnas verticales prefabricadas de bambú
- Rellenar los neumáticos con una mezcla de tierra y cemento
- Asegurarse de que las columnas estén firmemente ancladas a la base (deben tener una profundidad minima de aproximadamente 1,5-2 neumáticos de 600 mm)



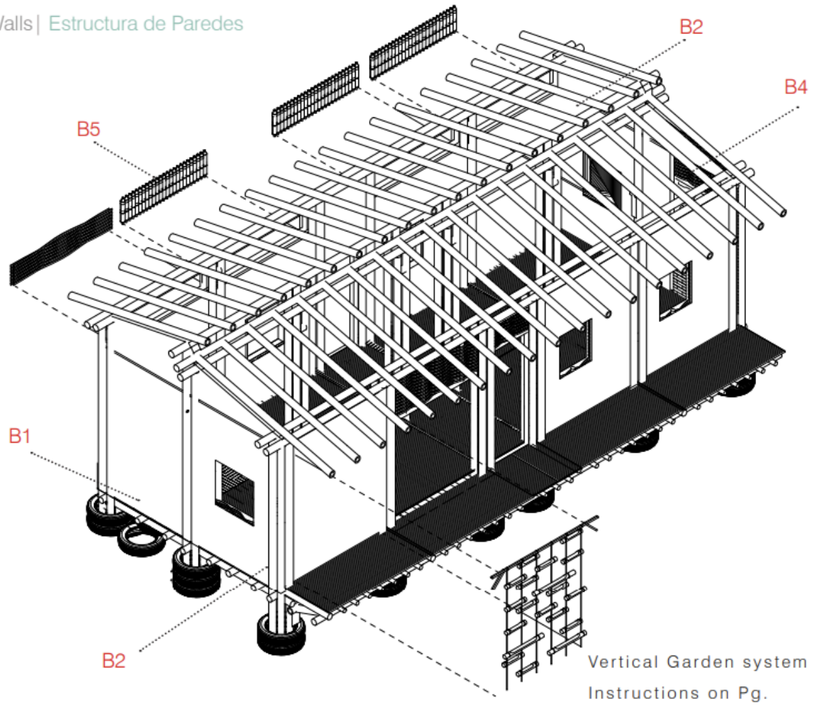

A. 4450mm (x24) ∅ 130mm

B. 5000mm (x12)

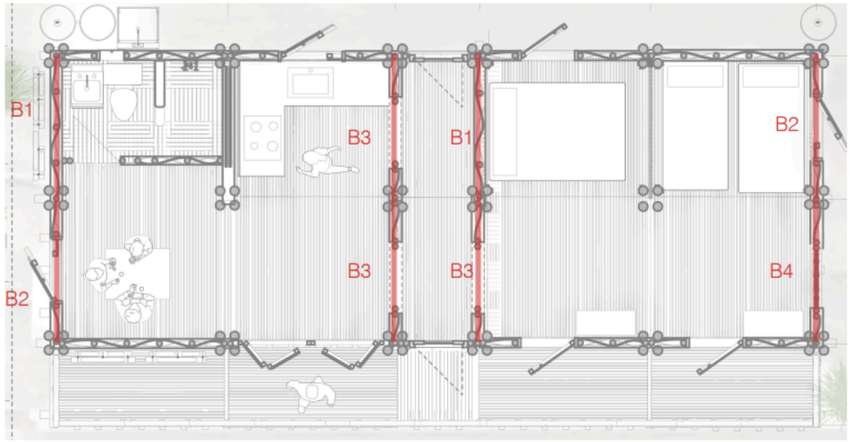
C. 4700mm (x36)

Total Bamboo Poles: 72 to create 18 Columns

Total de postes de bambú: 72 para crear 18 columnas



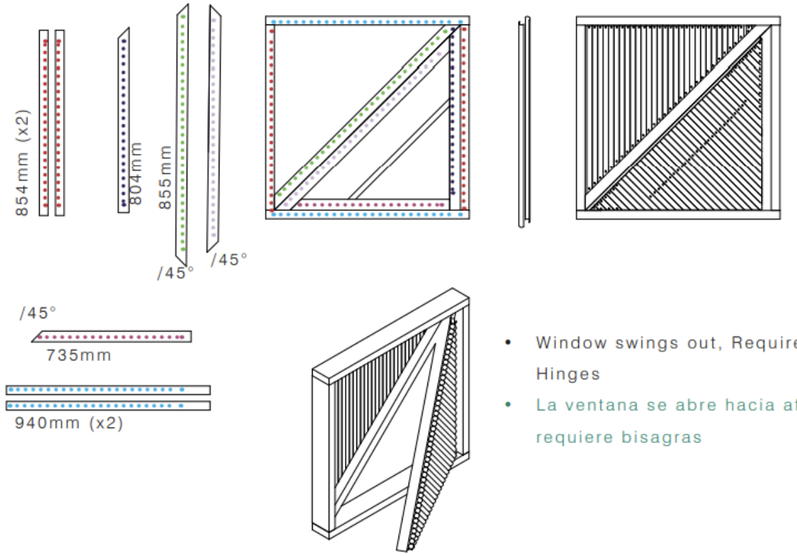

Vertical Garden system
Instructions on Pg.





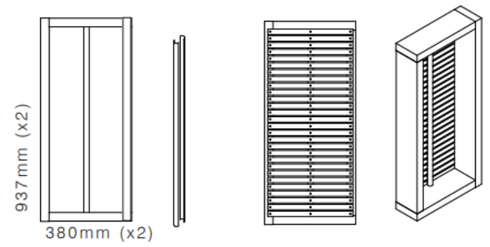



W3



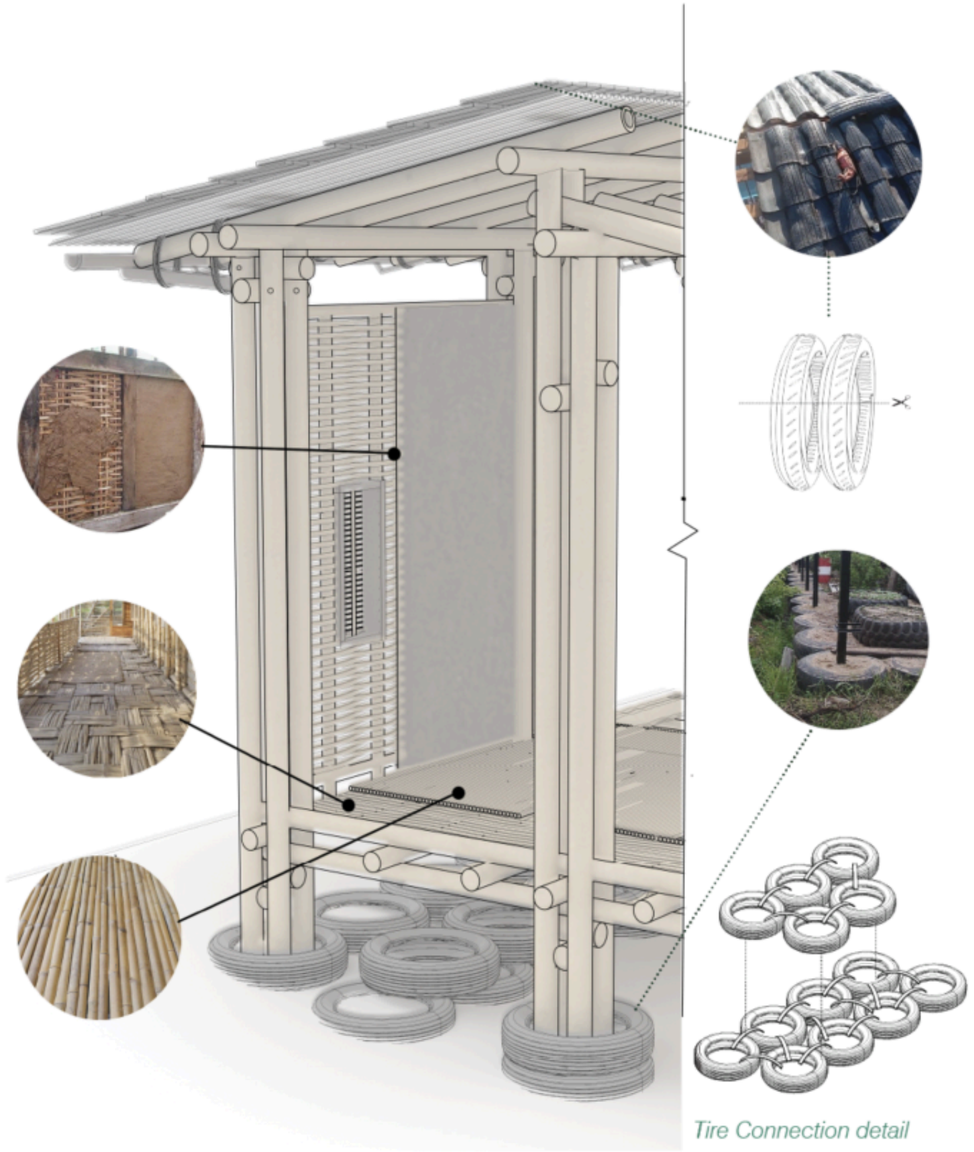

- Window swings out, Requires Hinges
- La ventana se abre hacia afuera, requiere bisagras

W4




- The frame should already be built. Cut small bamboo pole in half and attach to frame with small nails. Leave some space inbetween each bamboo stick for ventilation
- El marco ya debería estar construido. Corte una vara de bambú pequeña por la mitad y fíjela al marco con clavos pequeños. Deje algo de espacio entre cada vara de bambú para que haya ventilación.

## Façade Fragment and materiality

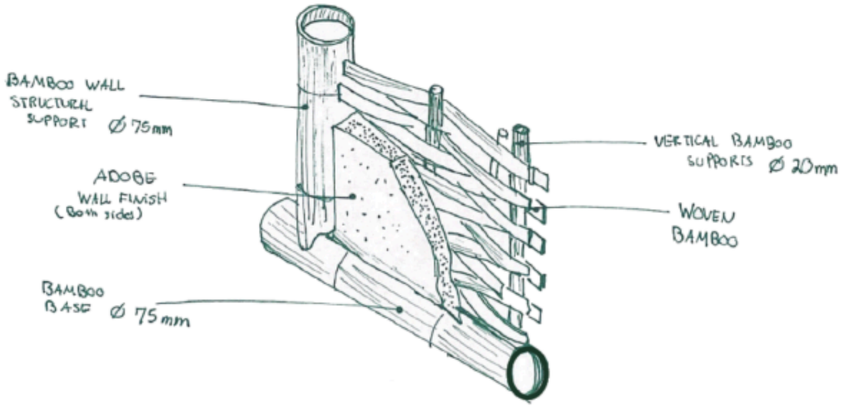


*Tire Connection detail*

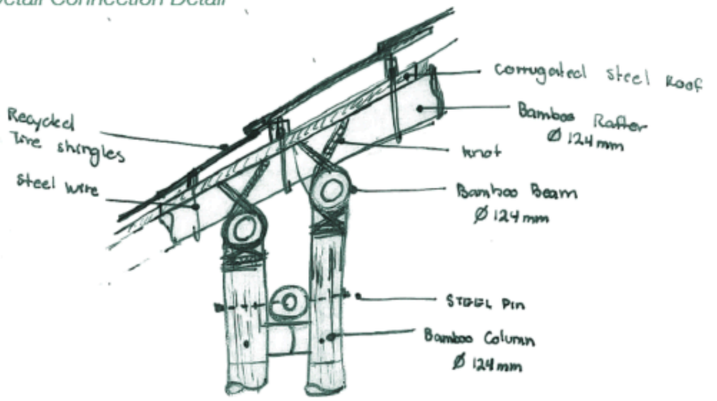
Architectural Proposal

## Details and Connections

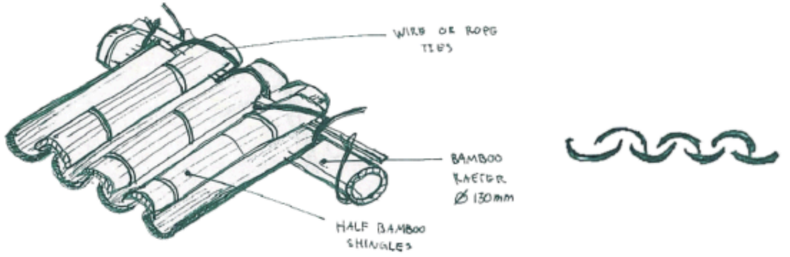
*Wall Structure Detail*




*Roof Detail Connection Detail*

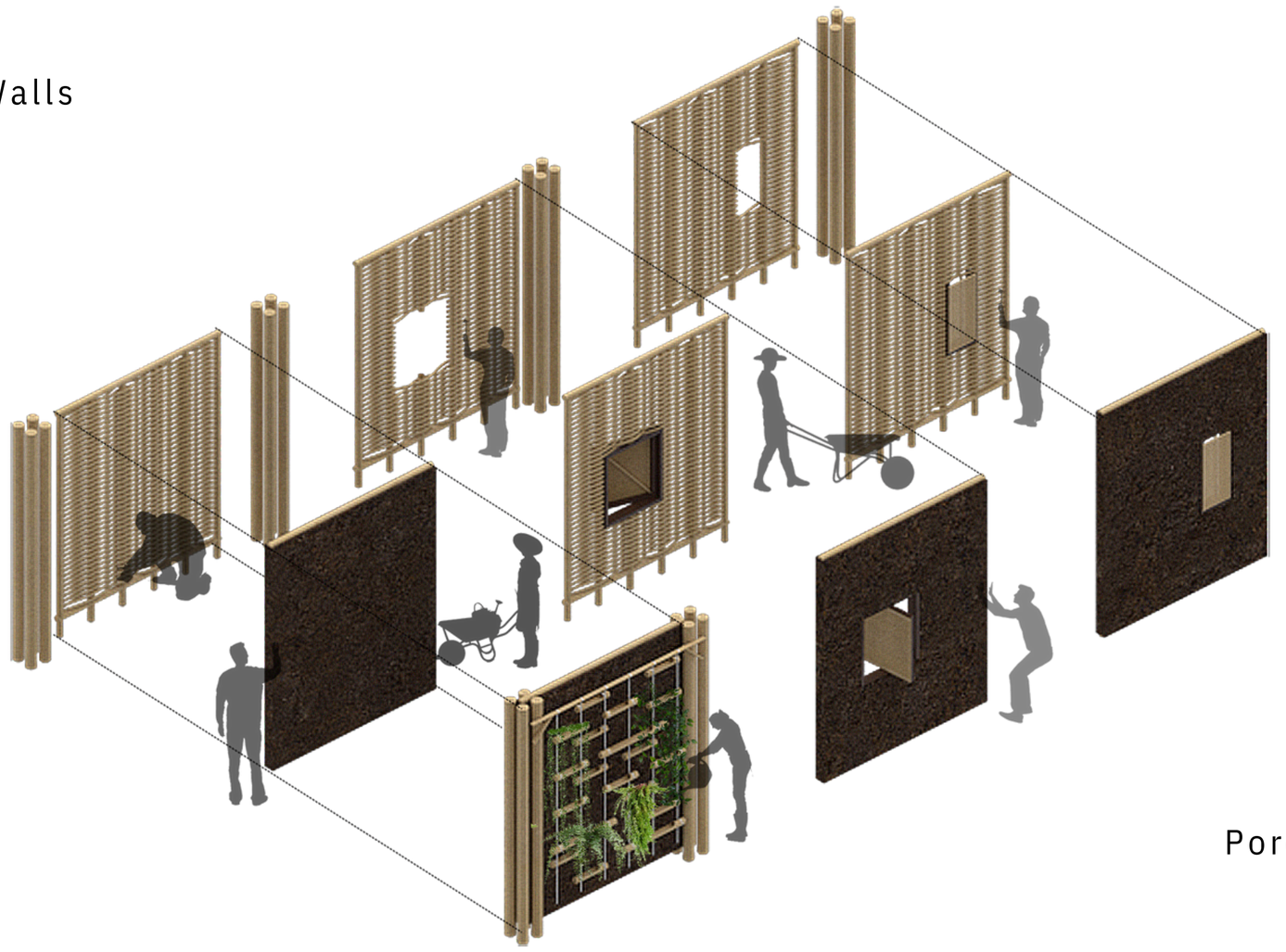



*Alternate Bamboo Roof Detail*



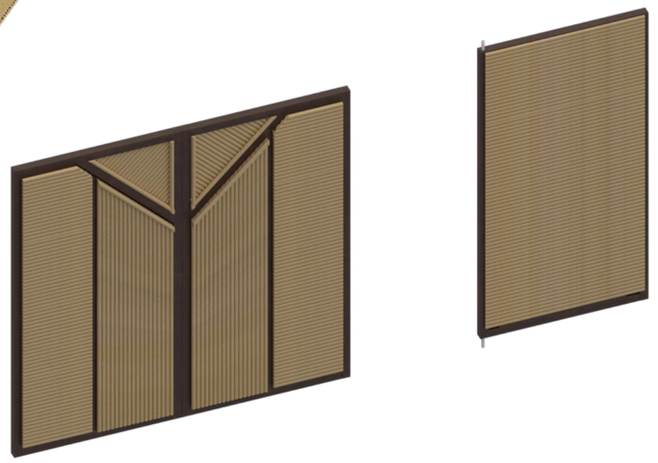
# Typologies

## Walls



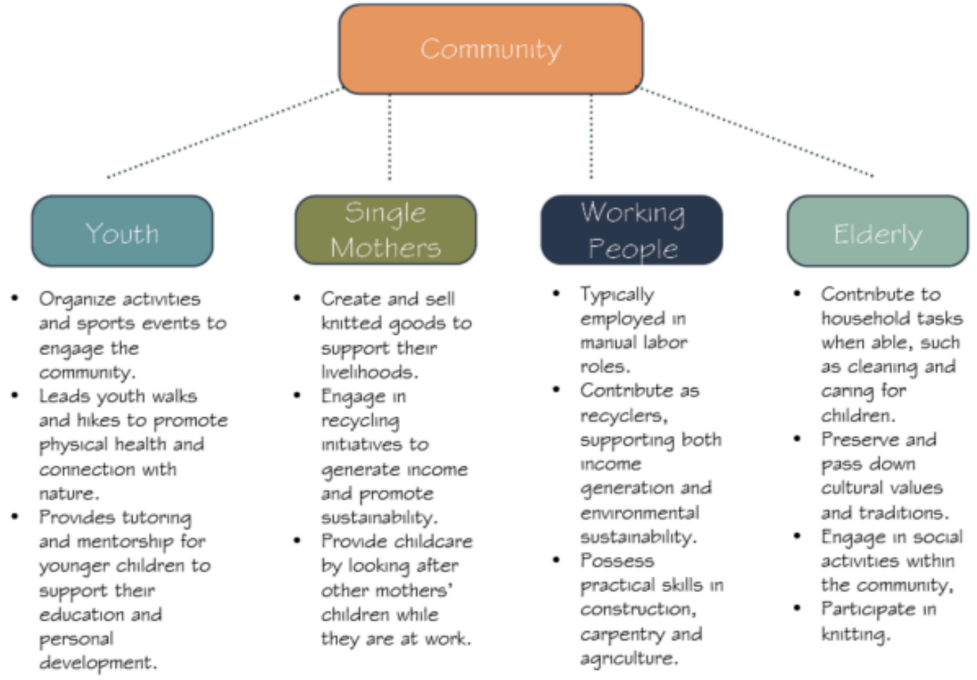
## Windows

## Doors



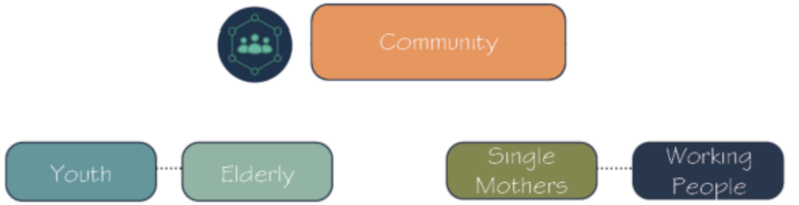
## Porch Railings

# Stakeholders


## Proposed Project Community Organization

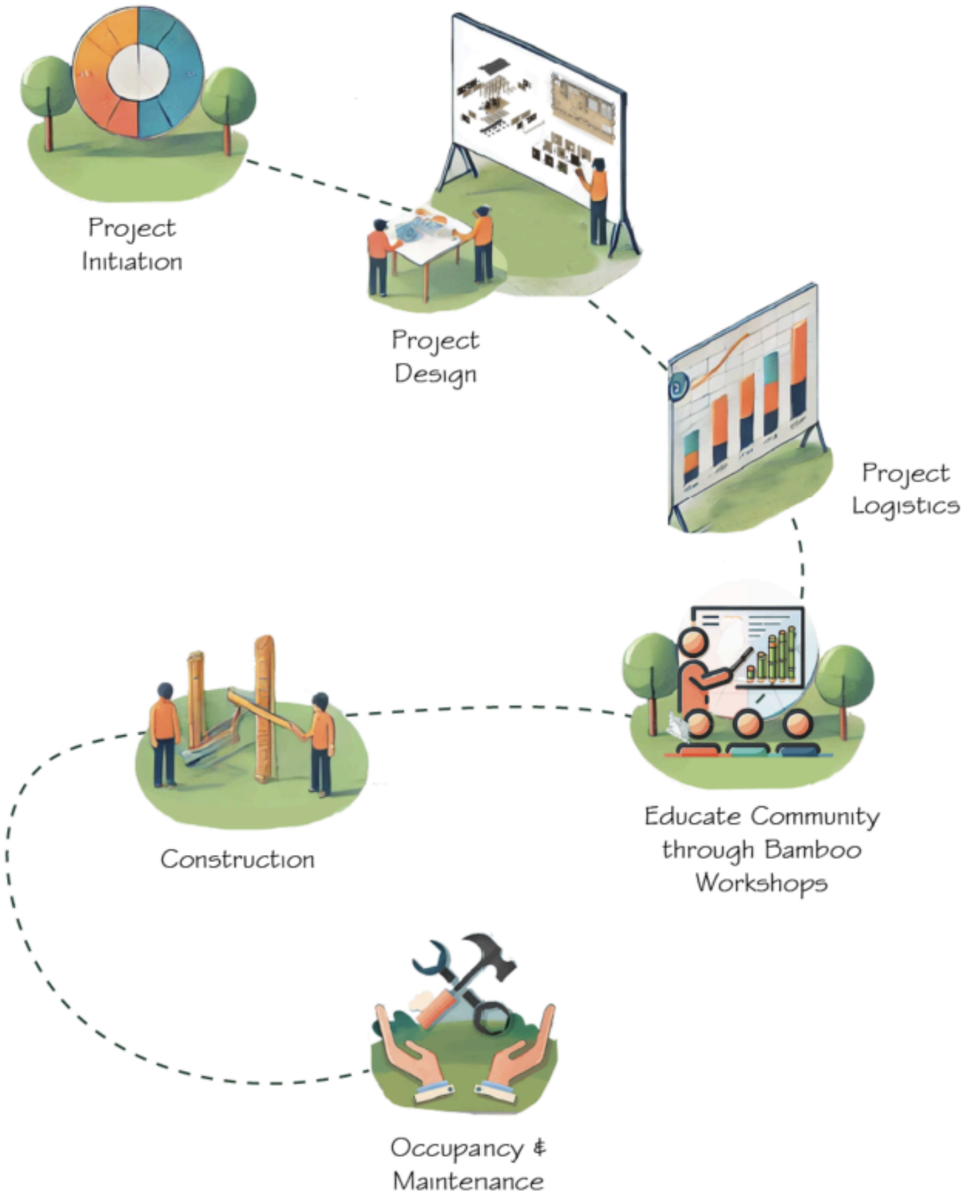

- Coordinates between community groups, identifying where individuals best fit to maximize their contributions.
- Builds relationships with foundations and NGOs to secure recognition and funding for community initiatives.
- Guides cultural sensitivity efforts, ensuring the preservation of the community's unique identity and traditions.
- Maintains trust by fostering strong relationships within the community and with external stakeholders.

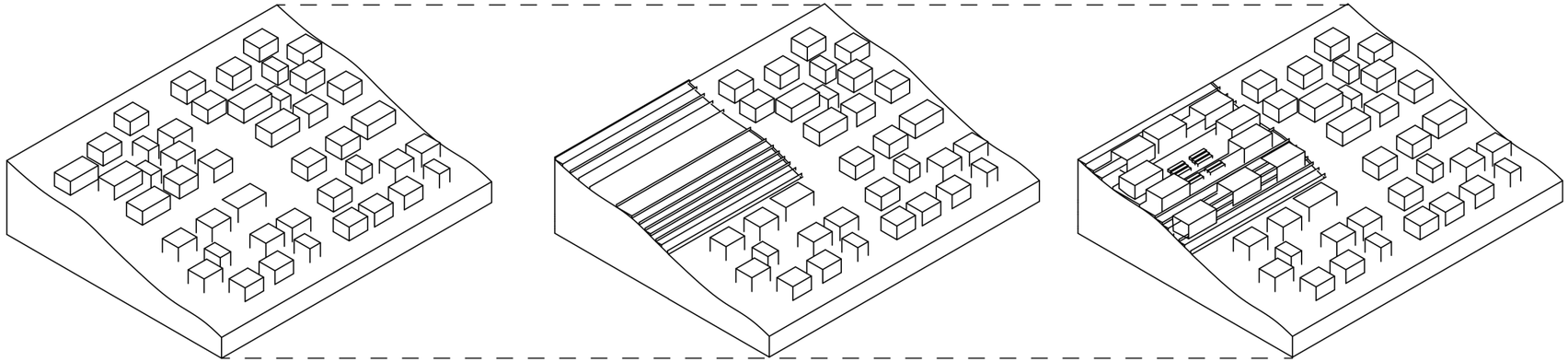


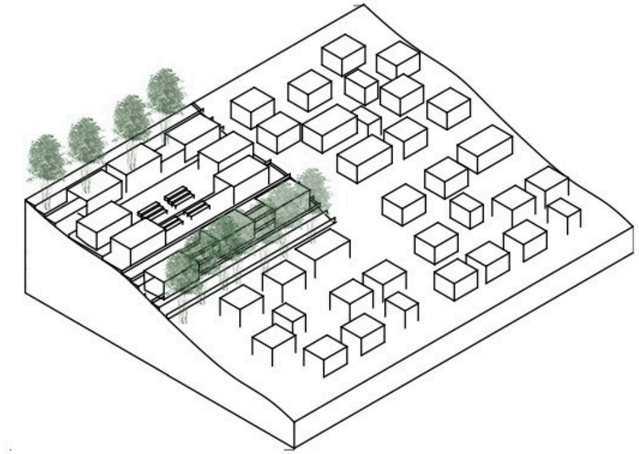

- The elderly share agricultural knowledge, advising on which plants can be planted together and which should not.
- Both the elderly and children assist with gathering and carrying small, lightweight bamboo pieces.
- They participate in designing or decorating the structure, adding creative touches such as painting or embellishing panels.
- Contribute to weaving bamboo panels for walls and flooring, combining creativity with hands-on work.
- Prepare the bamboo and rope for vertical gardens.

- Single mothers can help coordinate materials, manage tools, and prepare meals and drinks to support workers on-site.
- Single mothers can also provide care for children during work hours, ensuring their safety and allowing others to focus on construction tasks.
- Working people can build structural elements, assemble bamboo pieces, and install walls and floors.
- They can also dig and add the tire foundations.
- Work to prepare materials and prefabricate elements.

# Project Development







## *Project construction Phases*

1. The houses within the perimeter of the new cluster space must be cleared, with all functioning doors and materials salvaged for reuse in the new project. Any remaining unusable materials should be recycled to minimize waste.
2. The area should then be terraced to ensure landslide mitigation techniques. Should be done