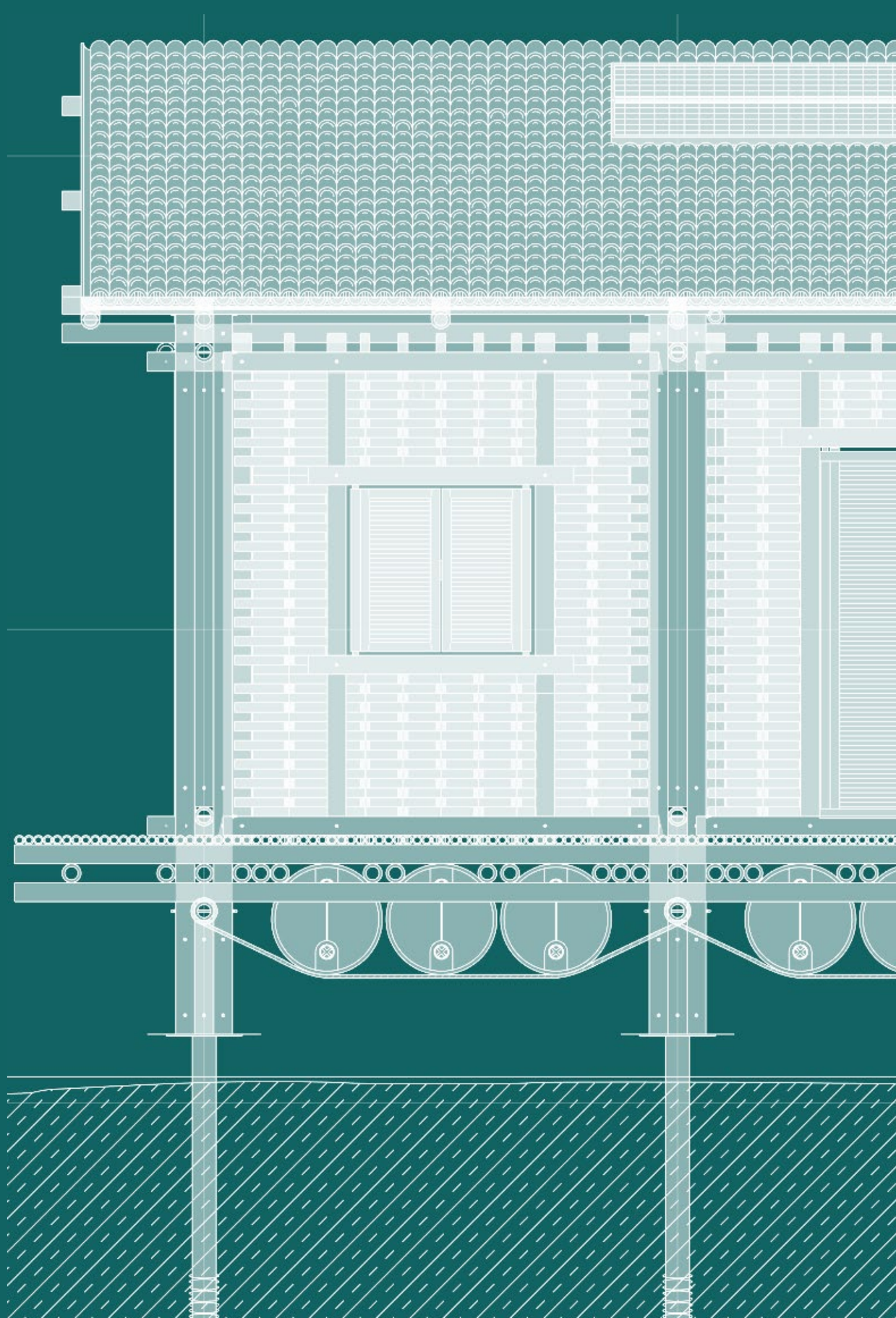
Floating on Invisible Waters

City of the Future - P5 Presentation

2024/2025

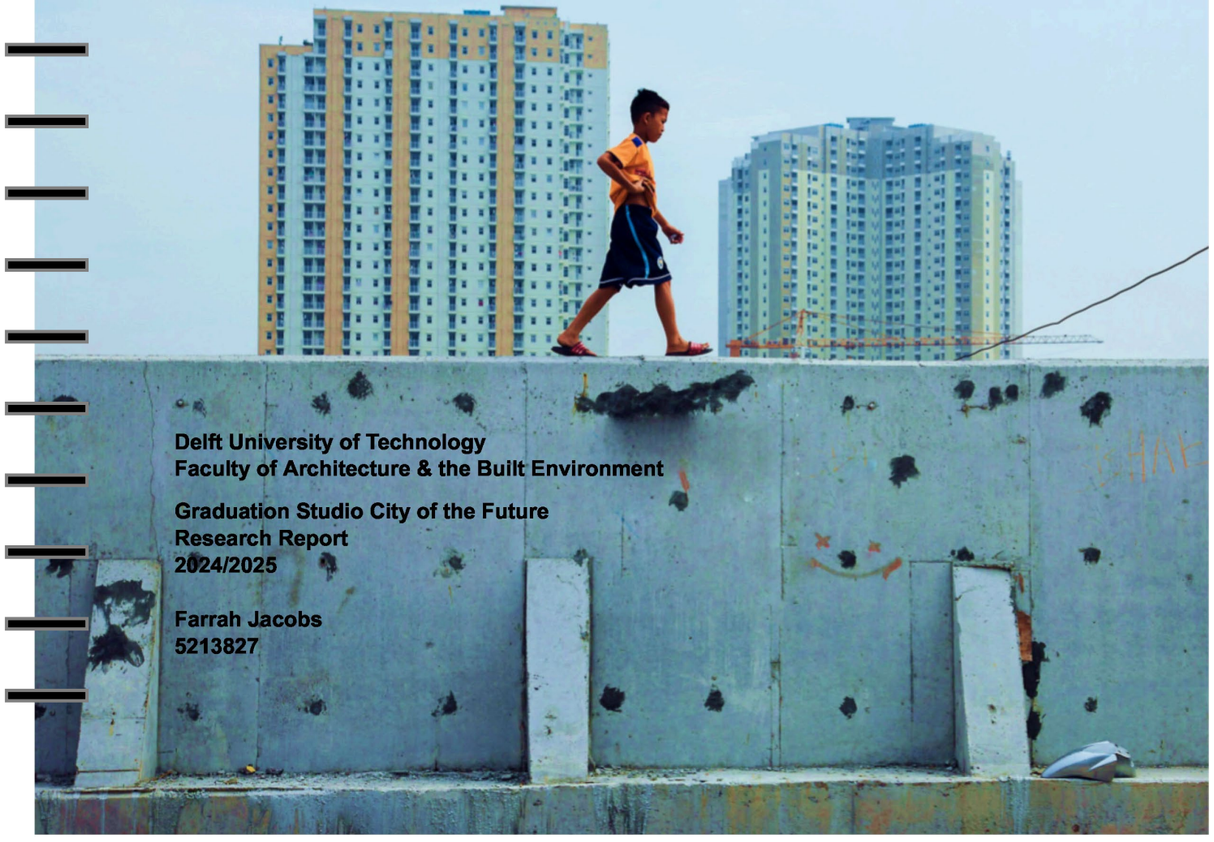
Farrah Jacobs

5213827



Invisible Waters in a Sinking City

Exploring Adaptive Strategies for Jakarta Amid Land Subsidence



Delft University of Technology
Faculty of Architecture & the Built Environment

Graduation Studio City of the Future
Research Report
2024/2025

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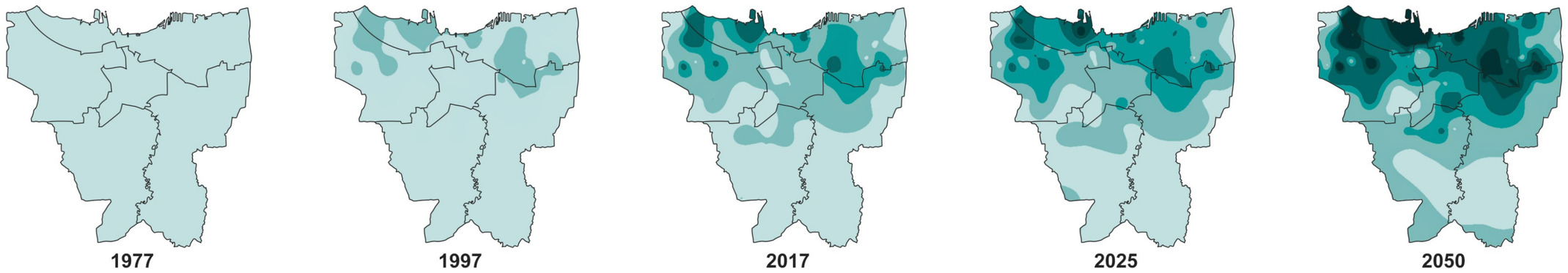
Jakarta is the fastest sinking city in the world



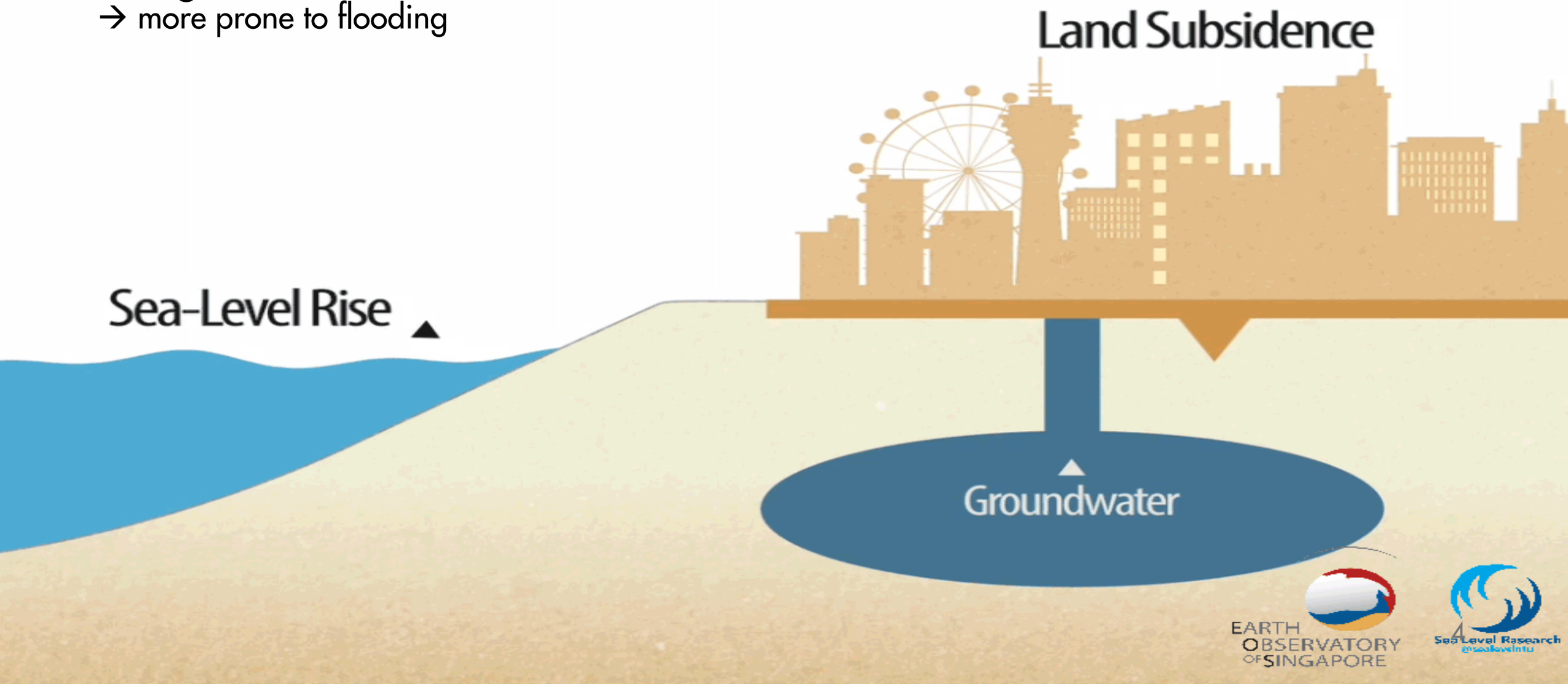
"(…) by 2050 about 95% of North Jakarta will be submerged."

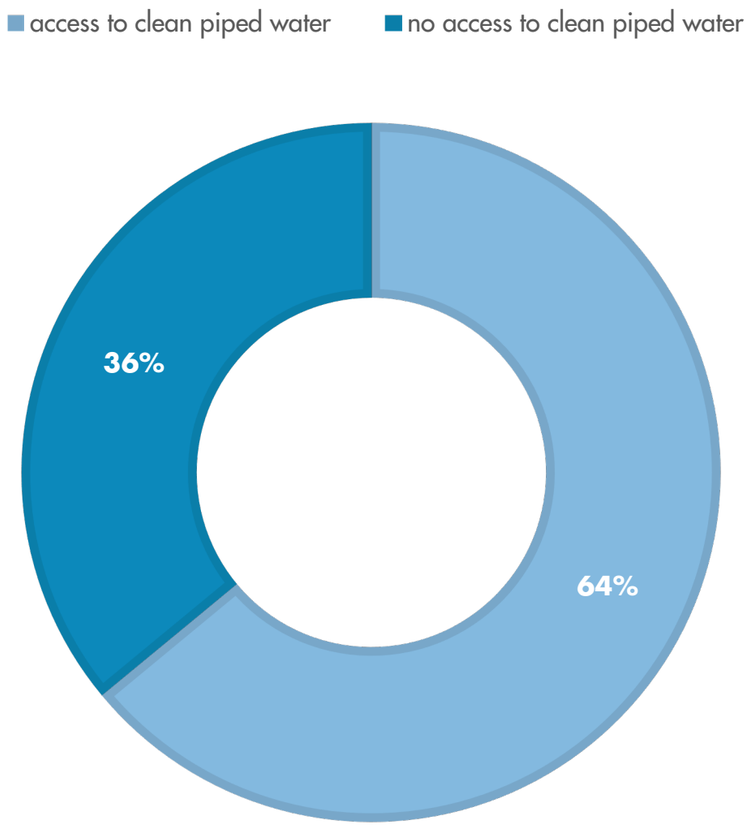
– Henri Andreas, Researcher from Bandung Institute of Technology

Land subsidence due to:

- (Illegal) Overextraction of groundwater
- Overurbanization
- Not enough water refilled in the aquifers due to poor drainage systems and overuse of concrete

Rising sea-levels
→ more prone to flooding





"Raw water sources in Jakarta, such as rivers, lakes, and ponds, cannot answer the supply for 36 percent of the people who have not been served," said PAM Jaya Service Director Syahrul Hasan.

PAM Jaya has targeted to expand the coverage to 100 percent by 2030. (TEMPO, 2022)


MDS

Studio: **City of the Future**

Uncertain future for the sinking city Jakarta

Who are most affected by this problem?

What is done to stop this now?

- *Current strategies*
- *Global strategies*

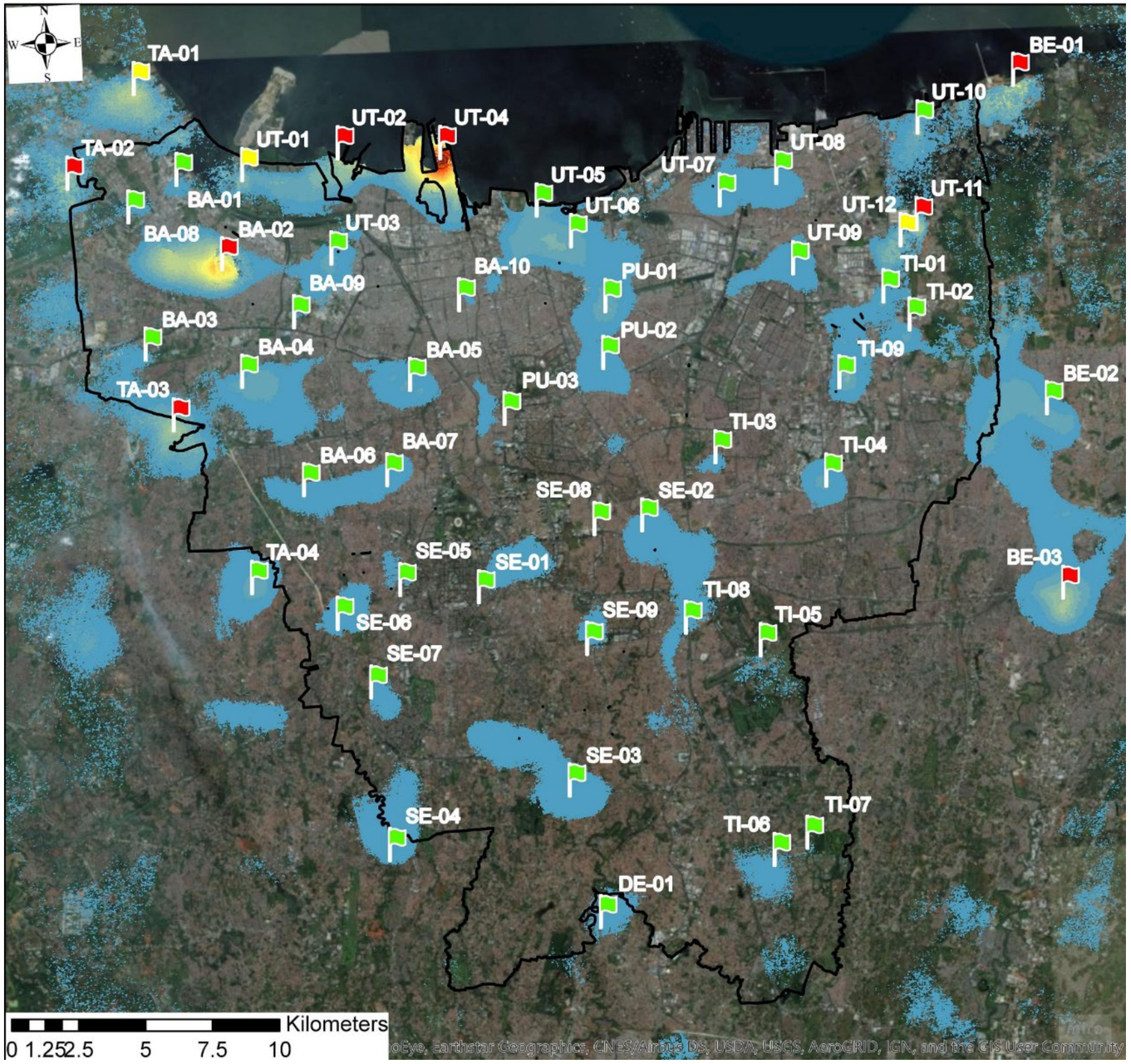
What can we do better?

- *Innovative solutions*
- *Speculative future*

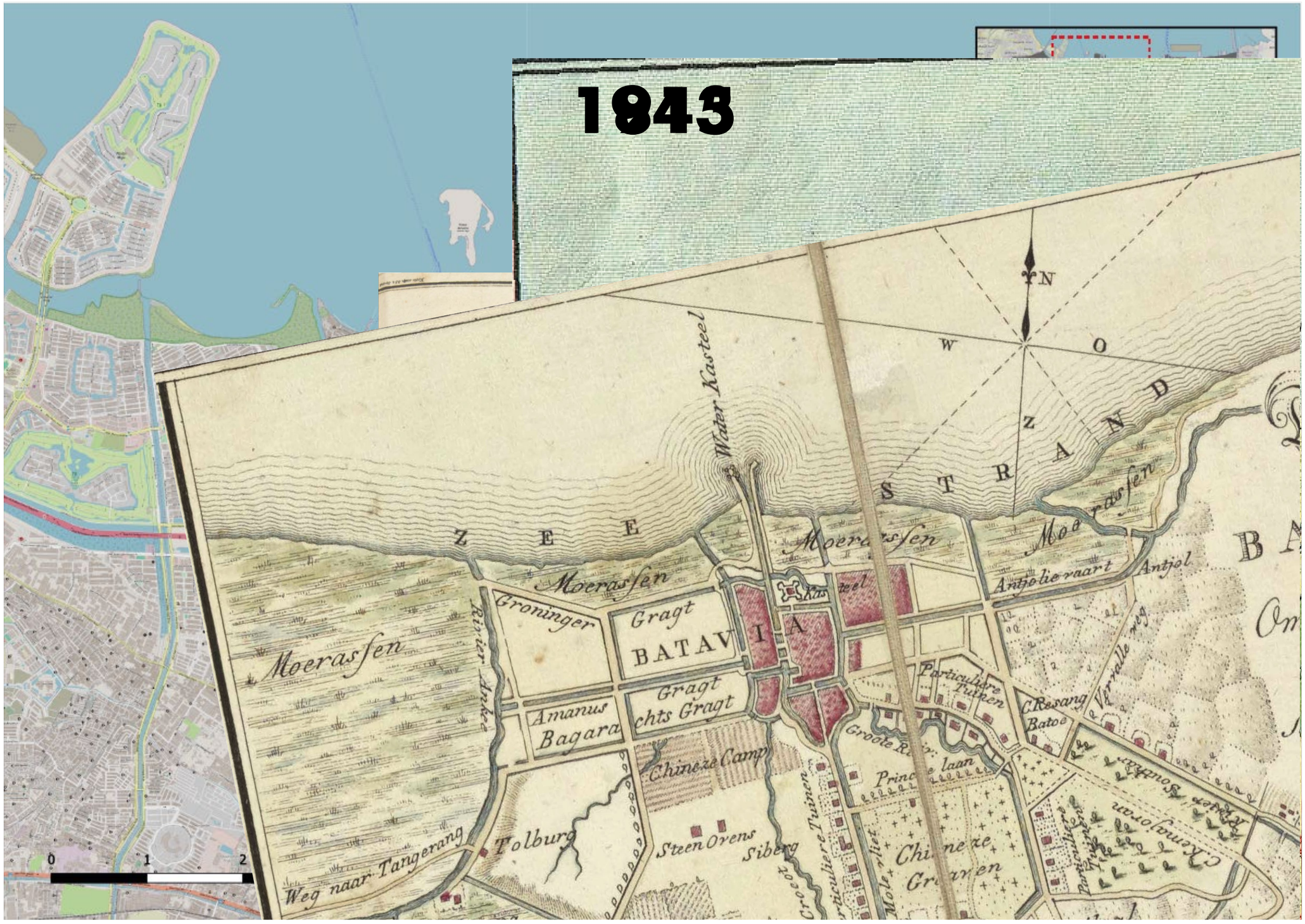
Most affected areas and communities

- Coastal region is most affected by land subsidence
    - Huge part of the coast is reclaimed land

- Low-income communities who are heavily reliant on groundwater extraction



Root cause of land subsidence (history)



Current strategies

Ineffective/temporarily effective

1. Capital Relocation

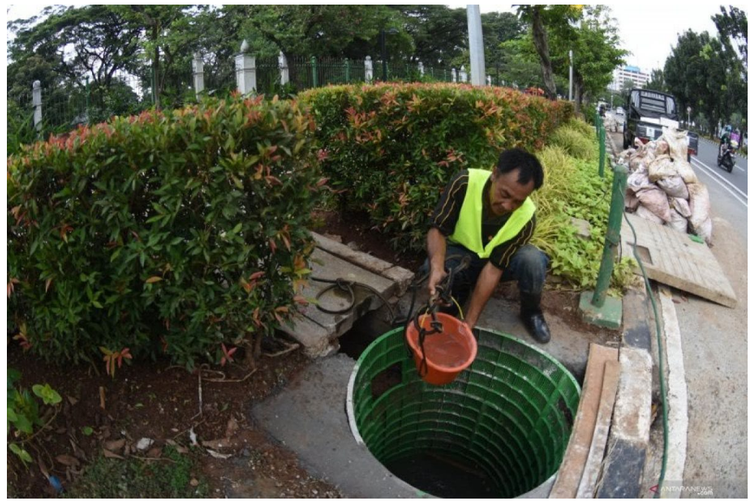
2. Giant Seawall

3. Policies and regulations

Current strategies

Not effective enough

4. Expanding piped water system



5. Groundwater recharge through infiltration wells

Current strategies

Effective enough

6. Mangrove reforestation

7. Flood-resilient houses

Reference project:
Muara Angke fishermen village

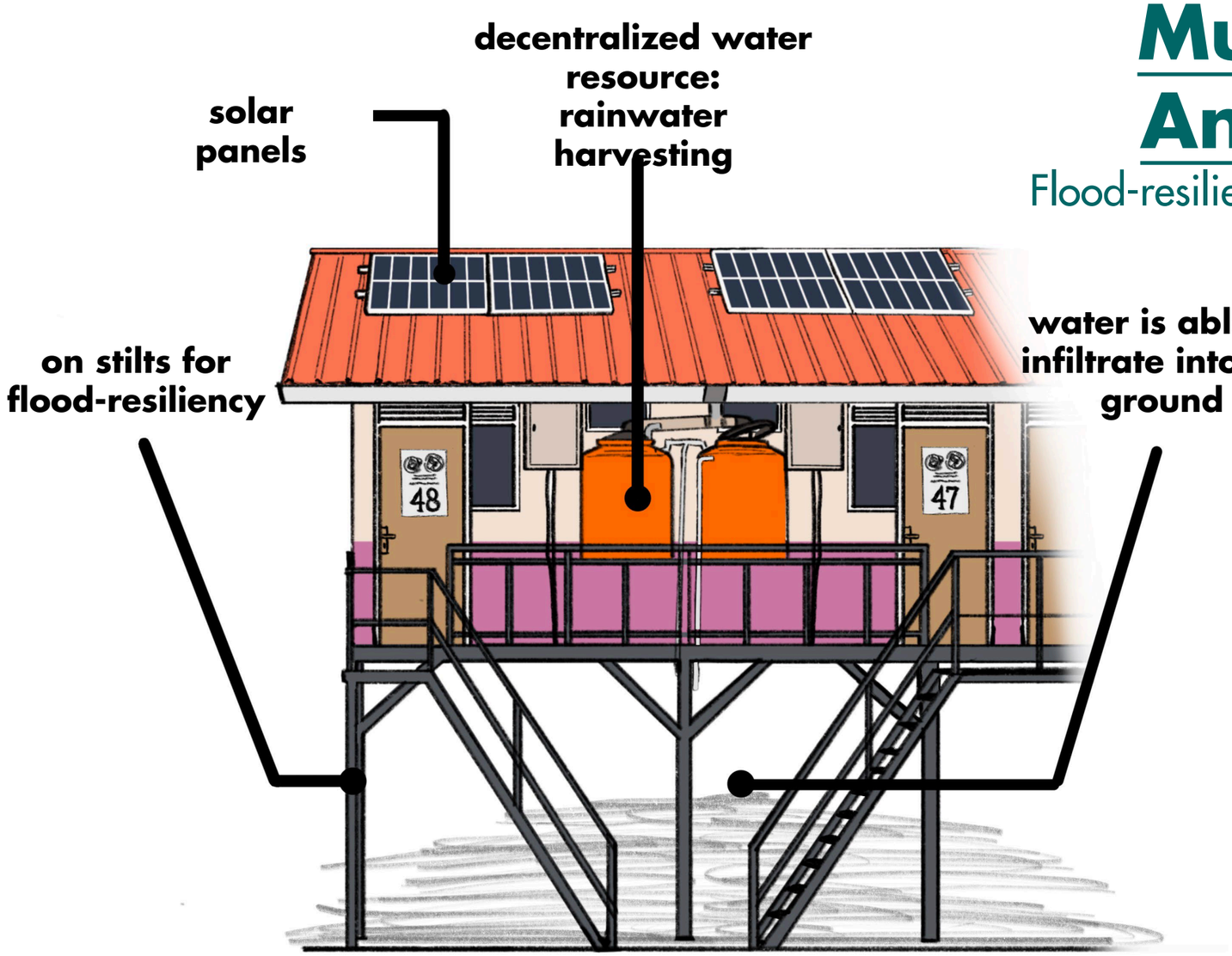

140
141
LUCKY
POLYTANK


KM.Alfal
CNBC
INDONESIA


03

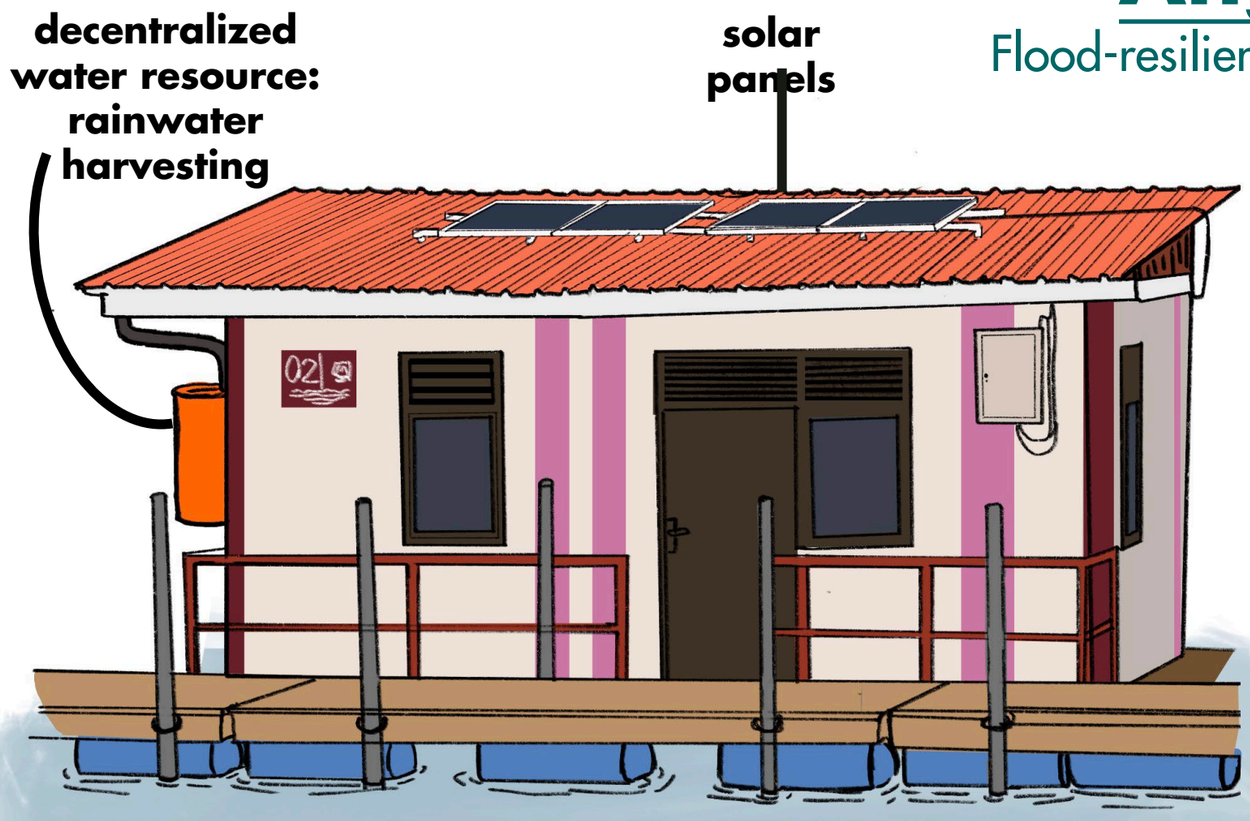
Muara Angke

Flood-resilient House Type 1



Muara Angke

Flood-resilient House Type 2



Conclusion

"While current strategies show a growing recognition of the crisis, many of the most visible solutions, such as the Giant Sea Wall or the planned capital relocation, ***risk repeating the same patterns of exclusion that contributed to the problem in the first place.*** *These large-scale interventions are often framed as ambitious, forward-looking projects, yet they rarely engage with the communities most affected by land subsidence or flooding. Without* ***inclusive planning and long-term commitment to social equity****, such projects may protect infrastructure or elite developments while leaving informal settlements and vulnerable neighborhoods even more exposed."*

Design goal

- **participatory, community-led approach** that is supported by organizations and grounded in local knowledge.

- create conditions for residents to shape their own responses by prioritizing **autonomy, adaptability, and ecological integration.**

- intention is not to design for the community, but to **work alongside** them in a collaborative process that fosters shared learning

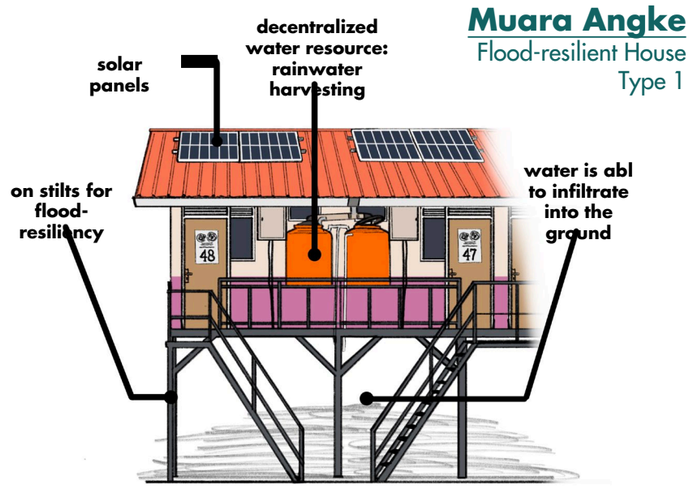
Community Research Center

A place where the local community can learn and explore about land subsidence, mangrove reforestation, and building flood-resilient houses/structures without having to wait around for top-down solutions

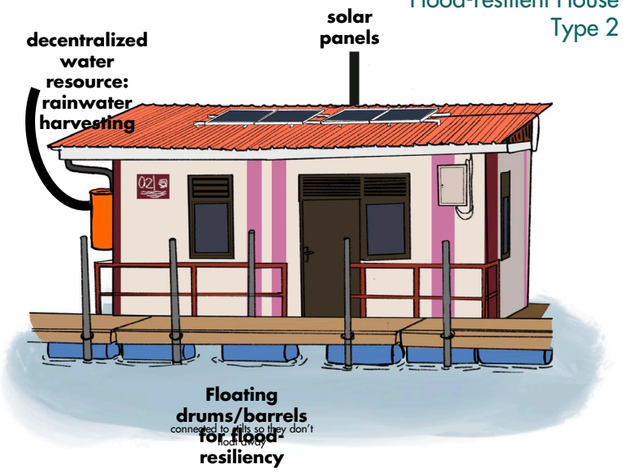
Design choices

- Flood-resilient structure
- Architectural style
- Material

Flood-resilient structure:
Amphibious



Muara Angke
Flood-resilient House
Type 1

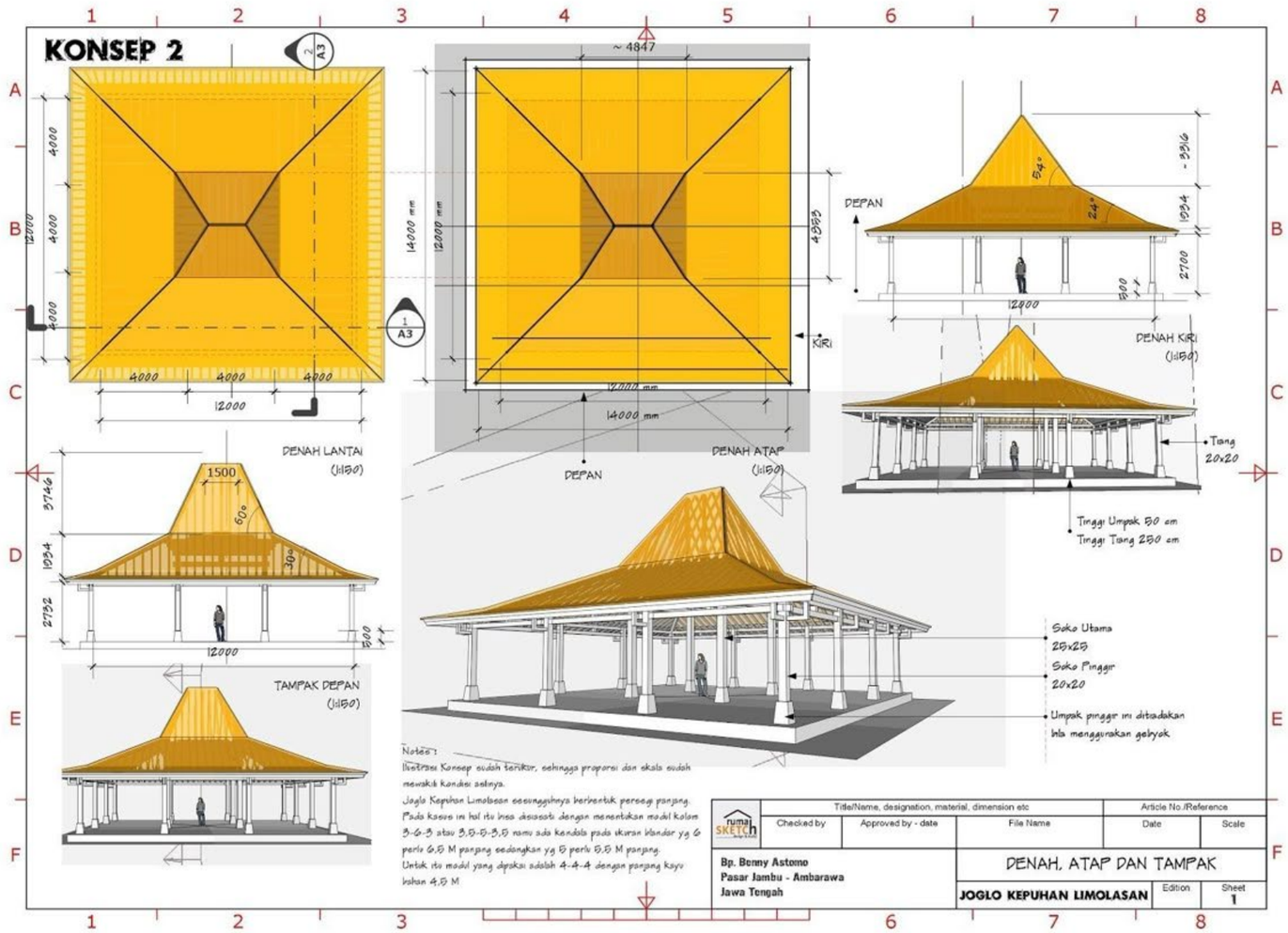


Muara Angke
Flood-resilient House
Type 2

Architecture:

based on local and traditional architecture *but make it modular*

Community Research Center as an example of building flood-resilient houses by having part of the construction be the same as a house that they learn to build in the center



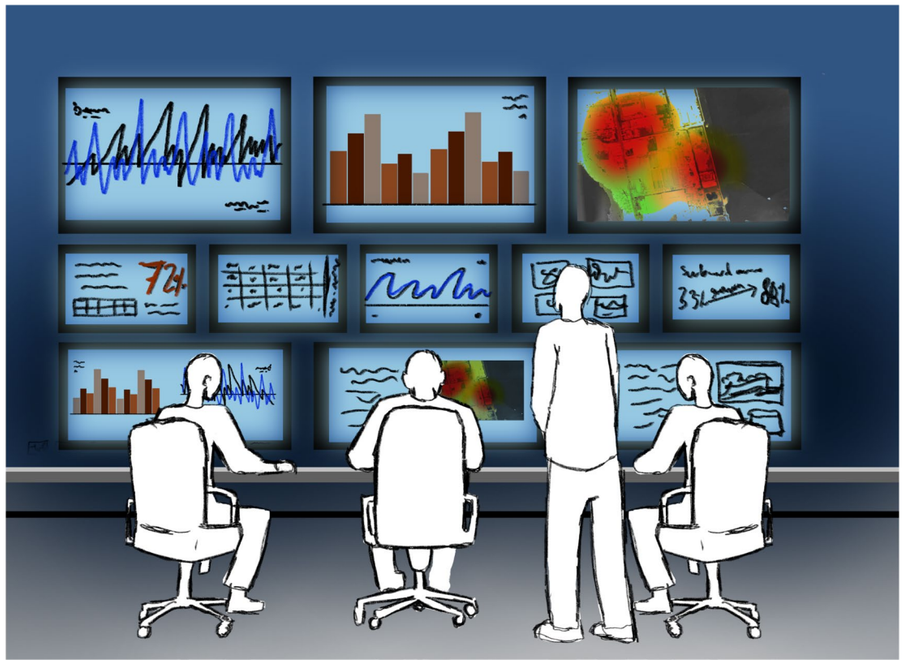
Main Material: Bamboo

- Sustainable
  - Regenerative
- Local
- Approachable building methods

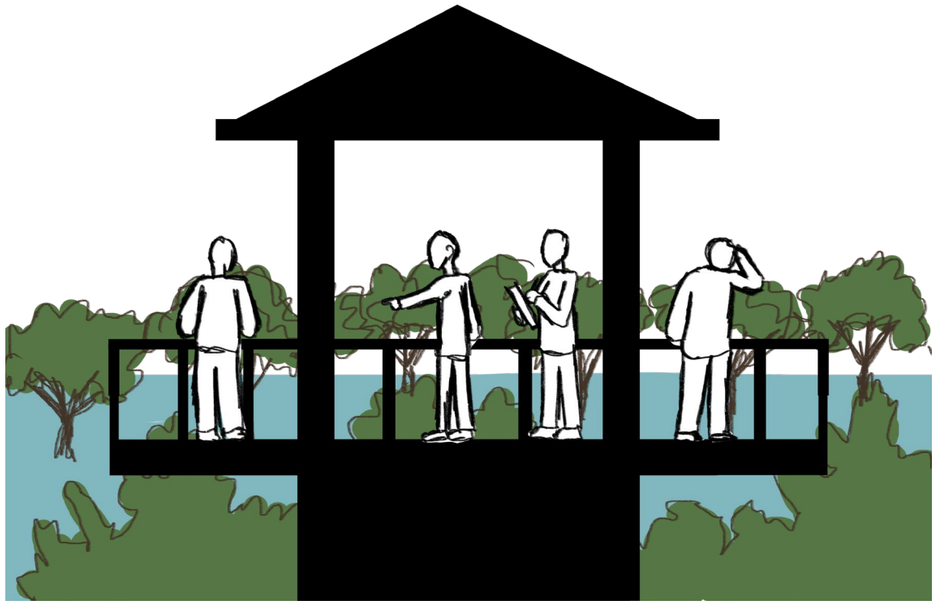
Program of requirements

Community Research Center

2. Research and Monitoring Facilities



Data Monitoring Center:
Facilities for tracking and analyzing land subsidence, sea levels, and flood patterns. Real-time displays of monitoring data from local sensors.

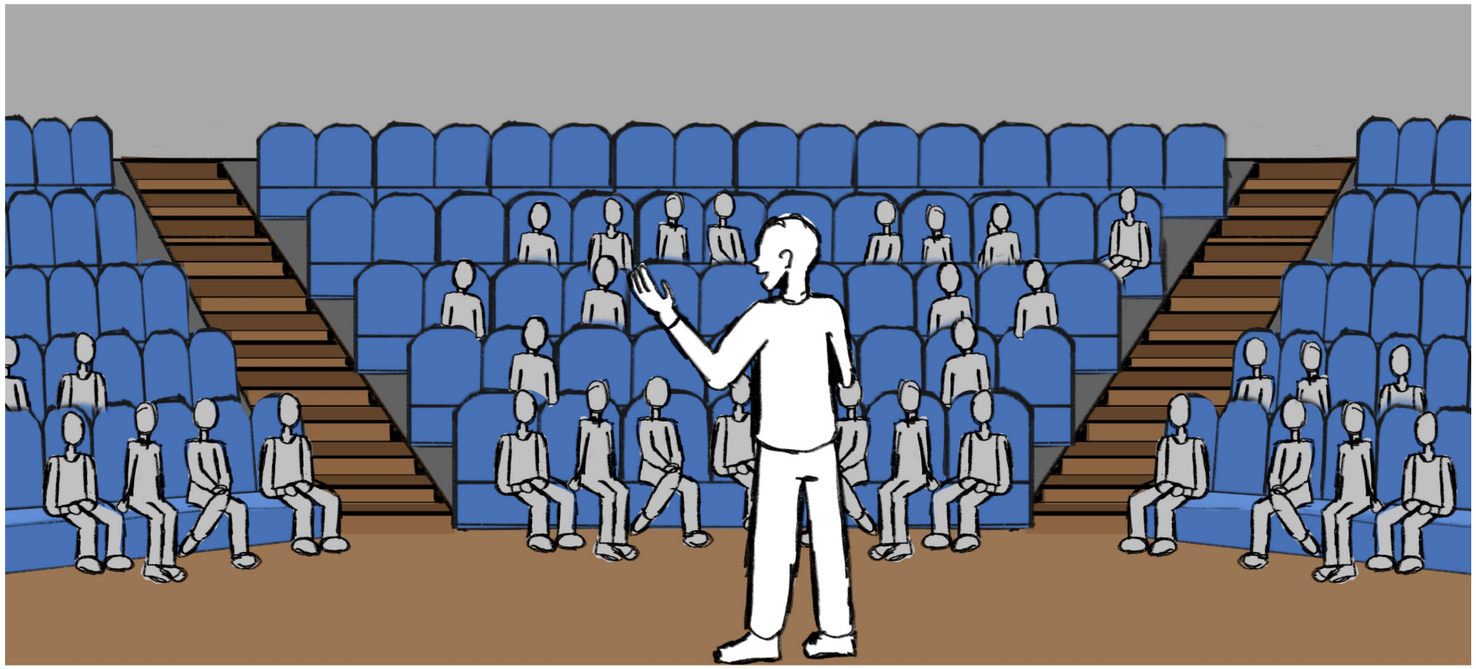


Observation Towers:
A viewing platform to observe mangrove forests and the surrounding coastal area. Integrated with sensors to monitor flooding and sea-level changes.

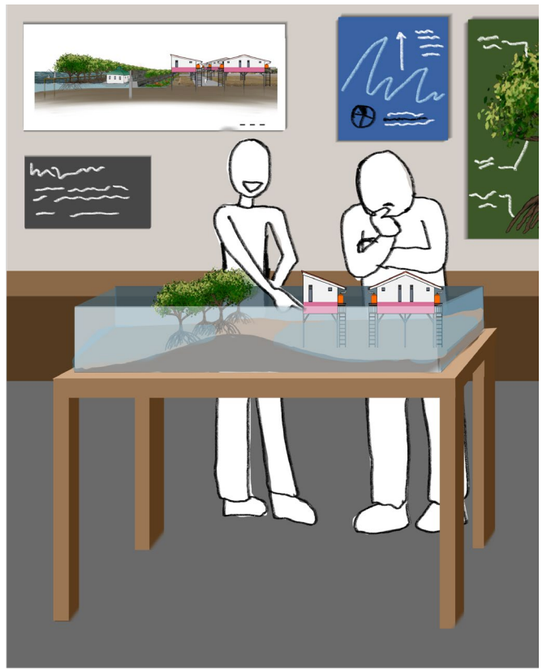
Program of requirements

Community Research Center

3. Educational Spaces:



Classrooms and/or Lecture Halls:
Flexible layouts for workshops, seminars, and lectures.

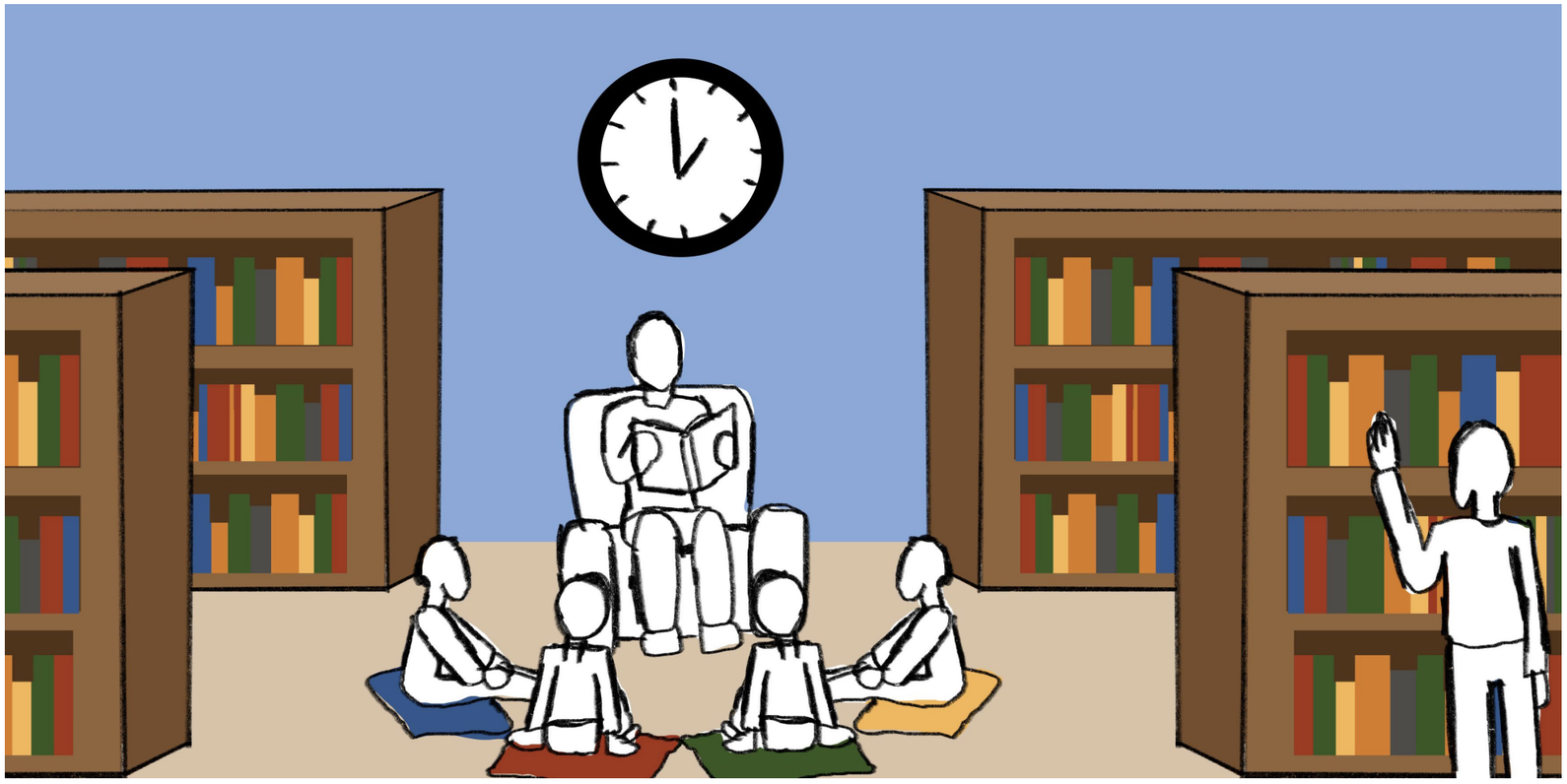


Exhibition space:
Exhibits on land subsidence, flooding, and mangrove ecosystems.
Models and simulations of flood-resilient structures and mangrove growth

Program of requirements

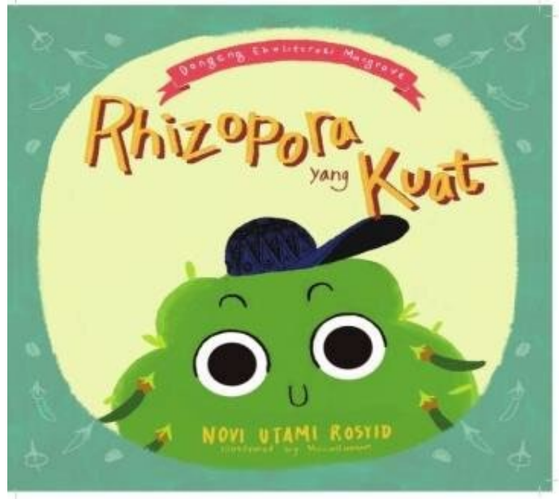
Community Research Center

4. Community Spaces:



Library

Digital and physical resources on land subsidence, flood management, and sustainable practices.
- accessible for all age groups.



Improving Coastal Children Eco-Literacy in Environmental Learning Through Mangroves Storytelling

NU Rosyid, B Budiaman, U Hasanah, International Journal of Psychosocial Rehabilitation 3 (24),1741-1749

Program of requirements

Community Research Center

Data & Monitoring center

Observation tower

Classrooms

Exhibition space

Library

Lecture / Community hall

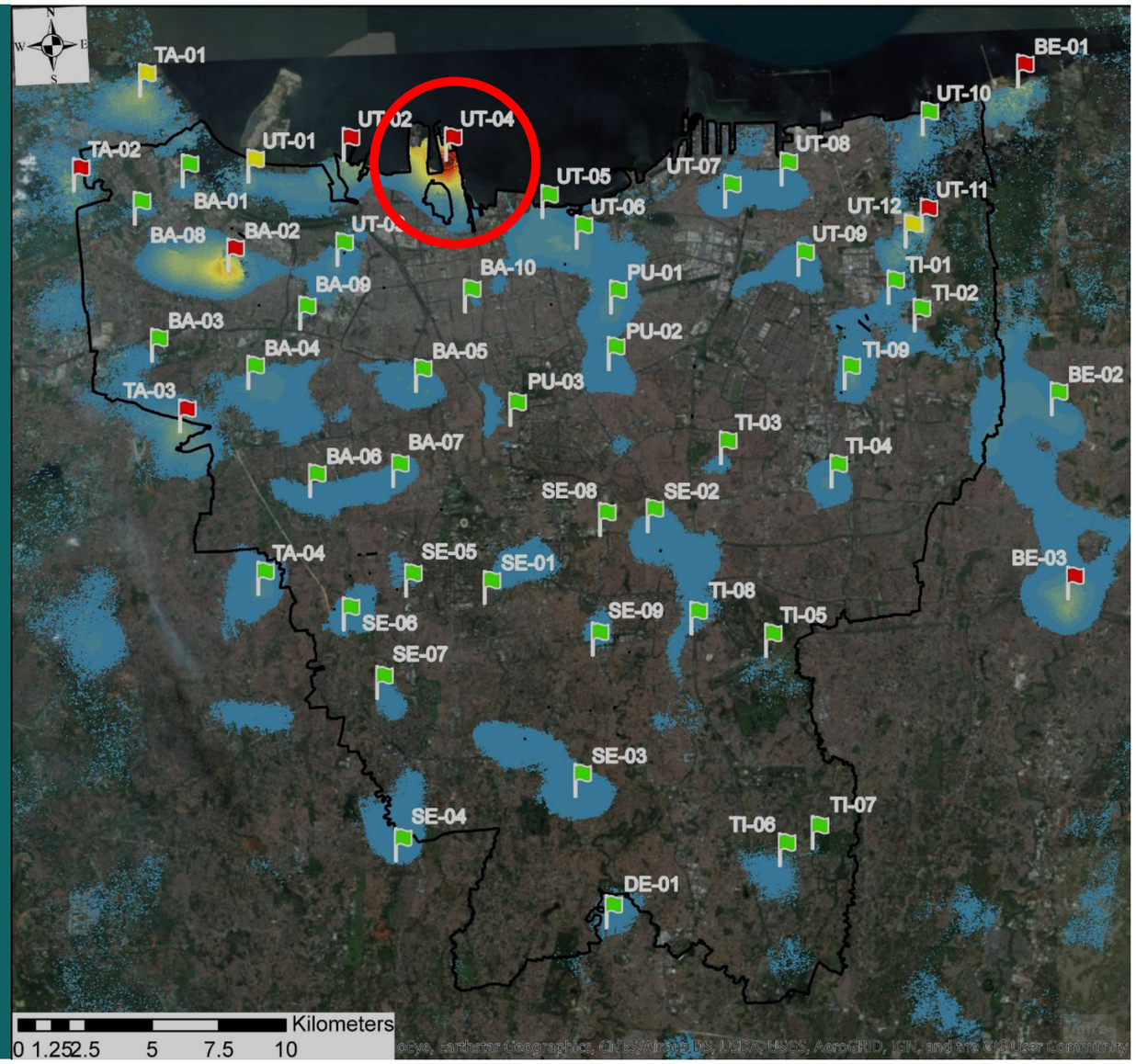
Outdoor demonstration zones

Workshops

Chosen design location:

Muara Baru

One of the fastest sinking areas of Jakarta where flooding often occurs



Chosen design location:

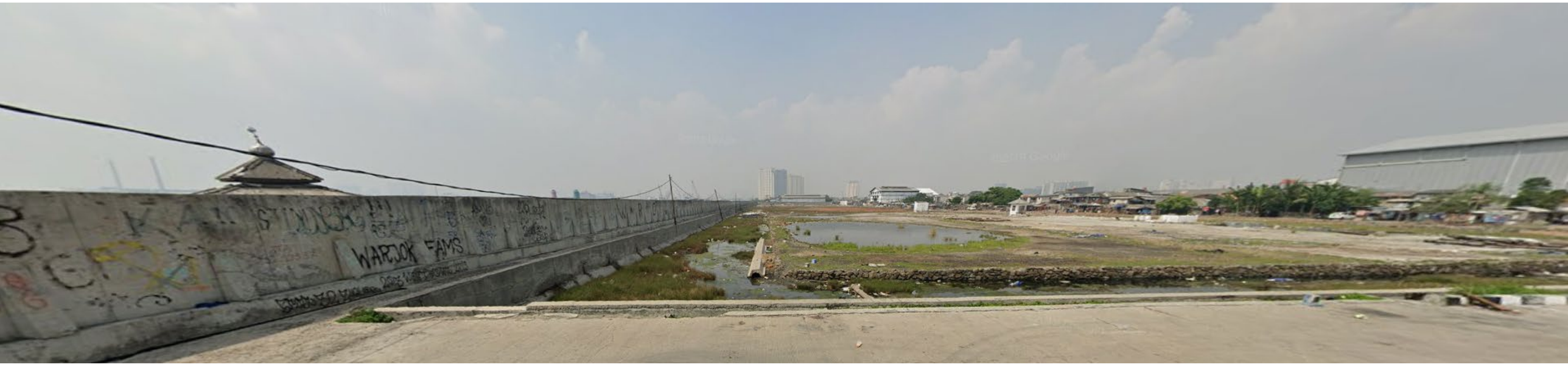
Muara Baru

Used to be one of the first and most important docks during the colonial era

Houses a large fishing community at risk of losing their source of income and living environment due to the impacts of land subsidence

Muara Baru, Jakarta

Specific site in Muara Baru



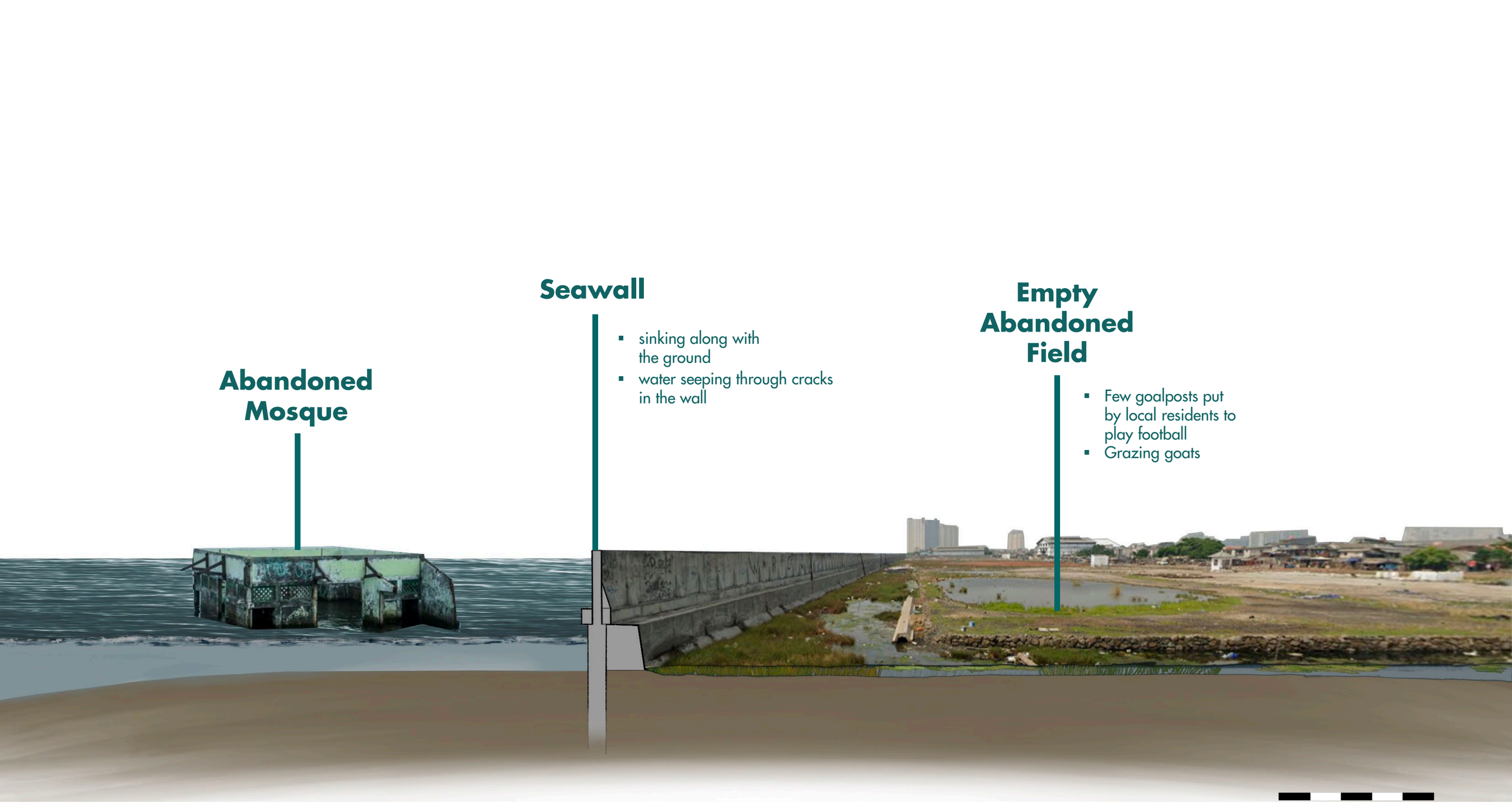
Abandoned Mosque

Seawall

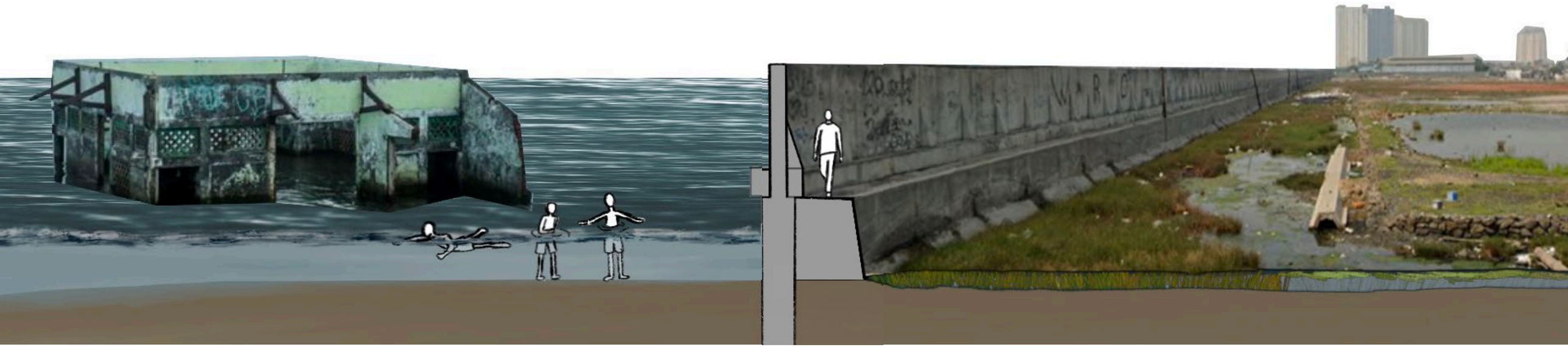
- sinking along with the ground
- water seeping through cracks in the wall

Empty Abandoned Field

- Few goalposts put by local residents to play football
- Grazing goats



Life among the Seawall



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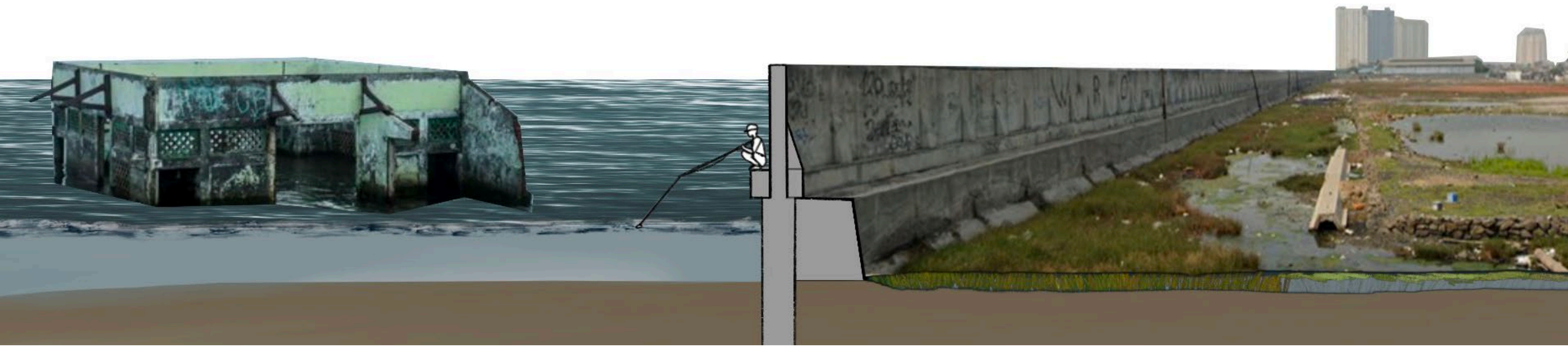
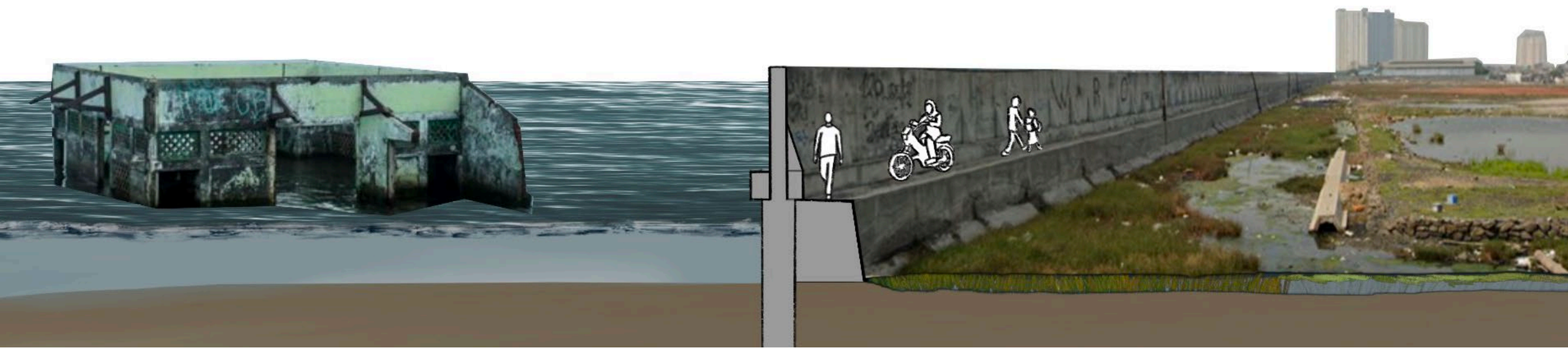
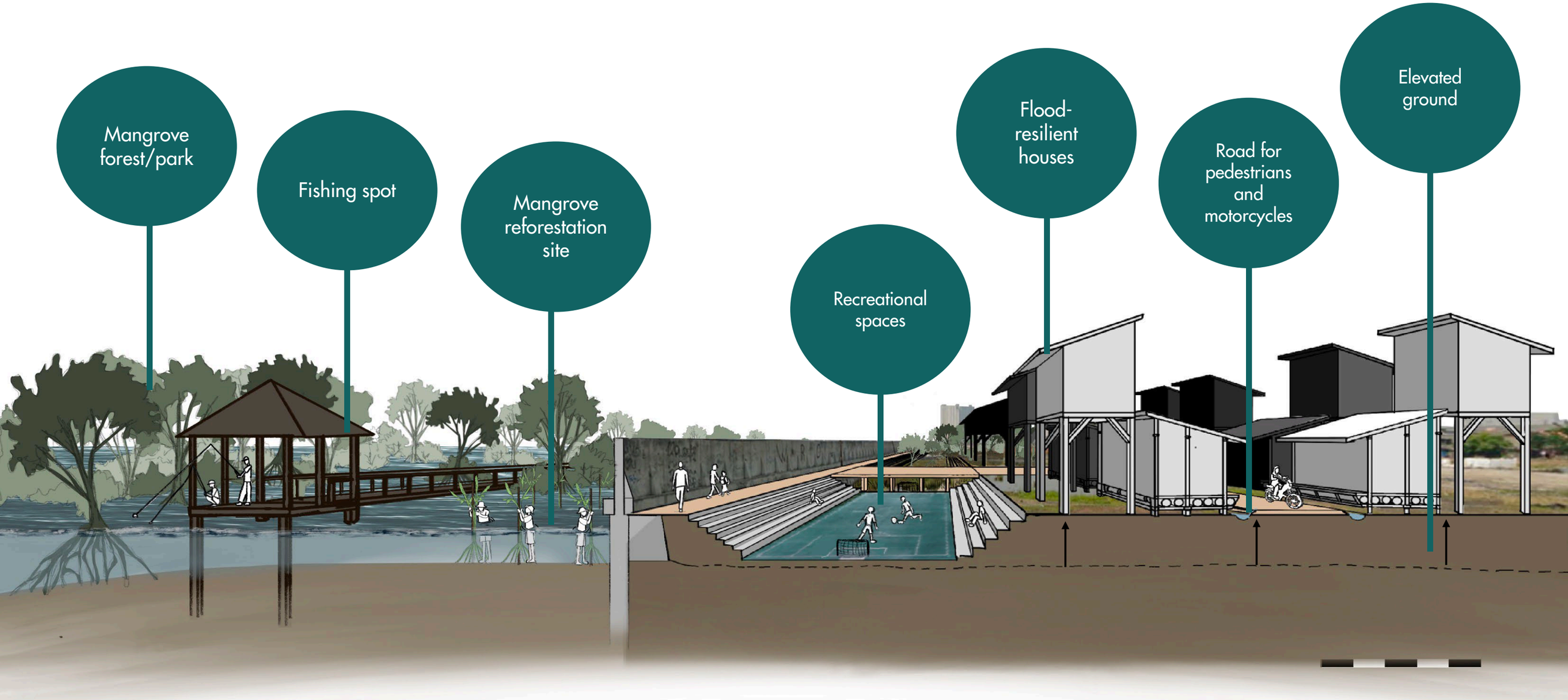


Life among the Seawall

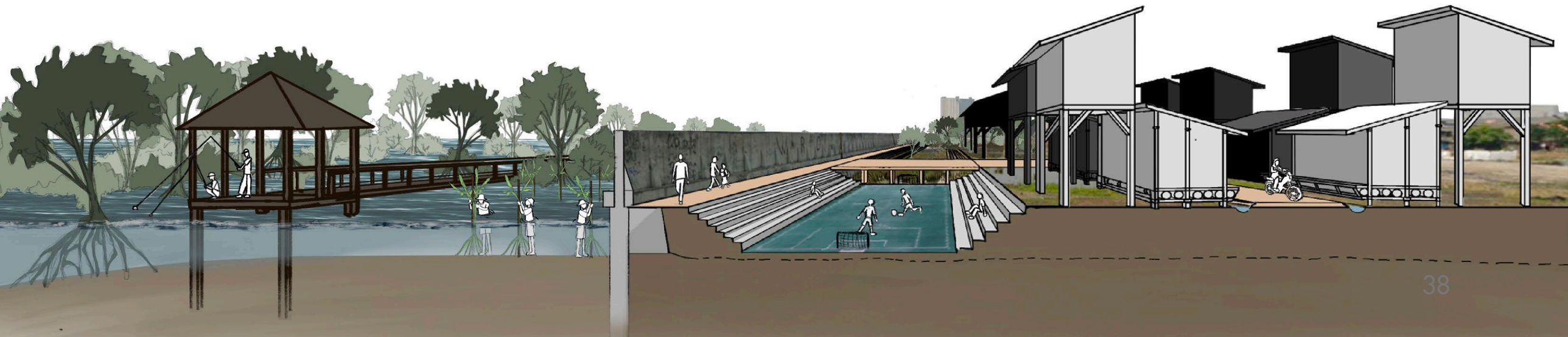


P2 Vision Muara Baru



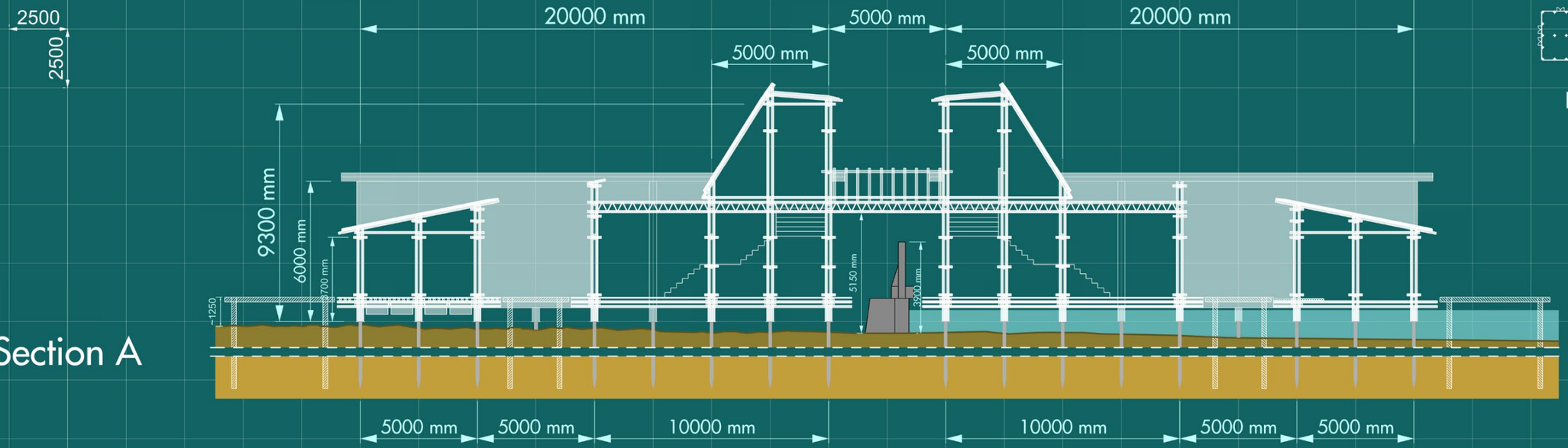
How can we bridge the border between land and sea?

Where will the Community Research Center be situated?

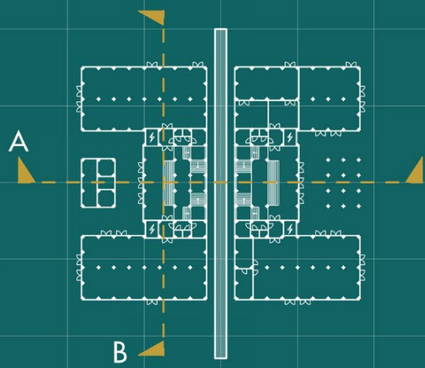


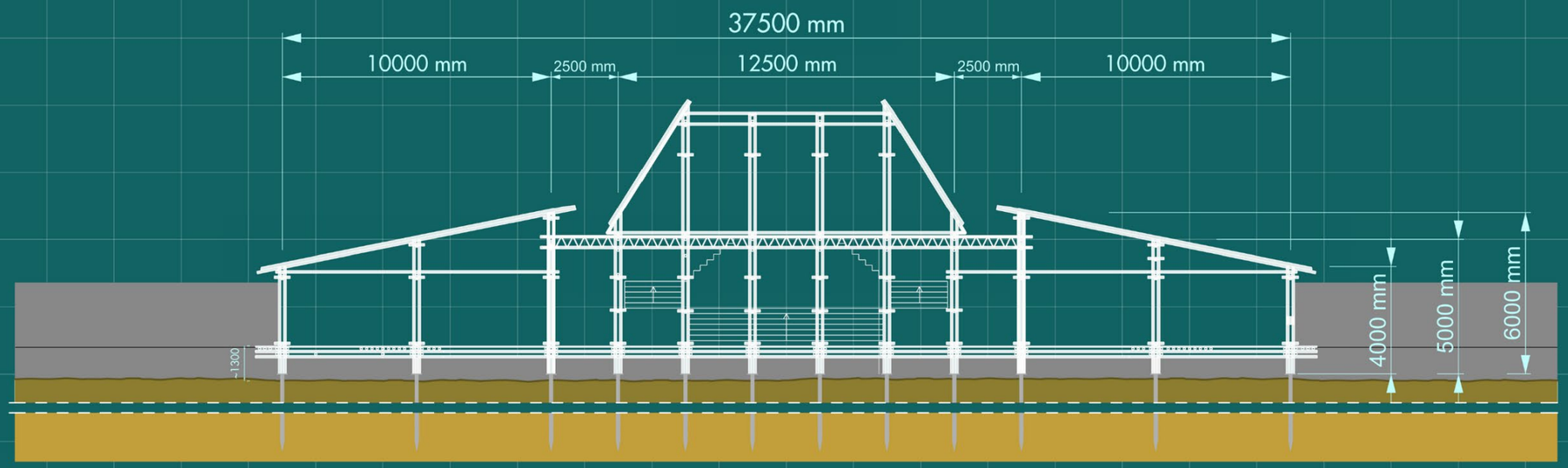
Community Research Center

Technical Sections



Section A





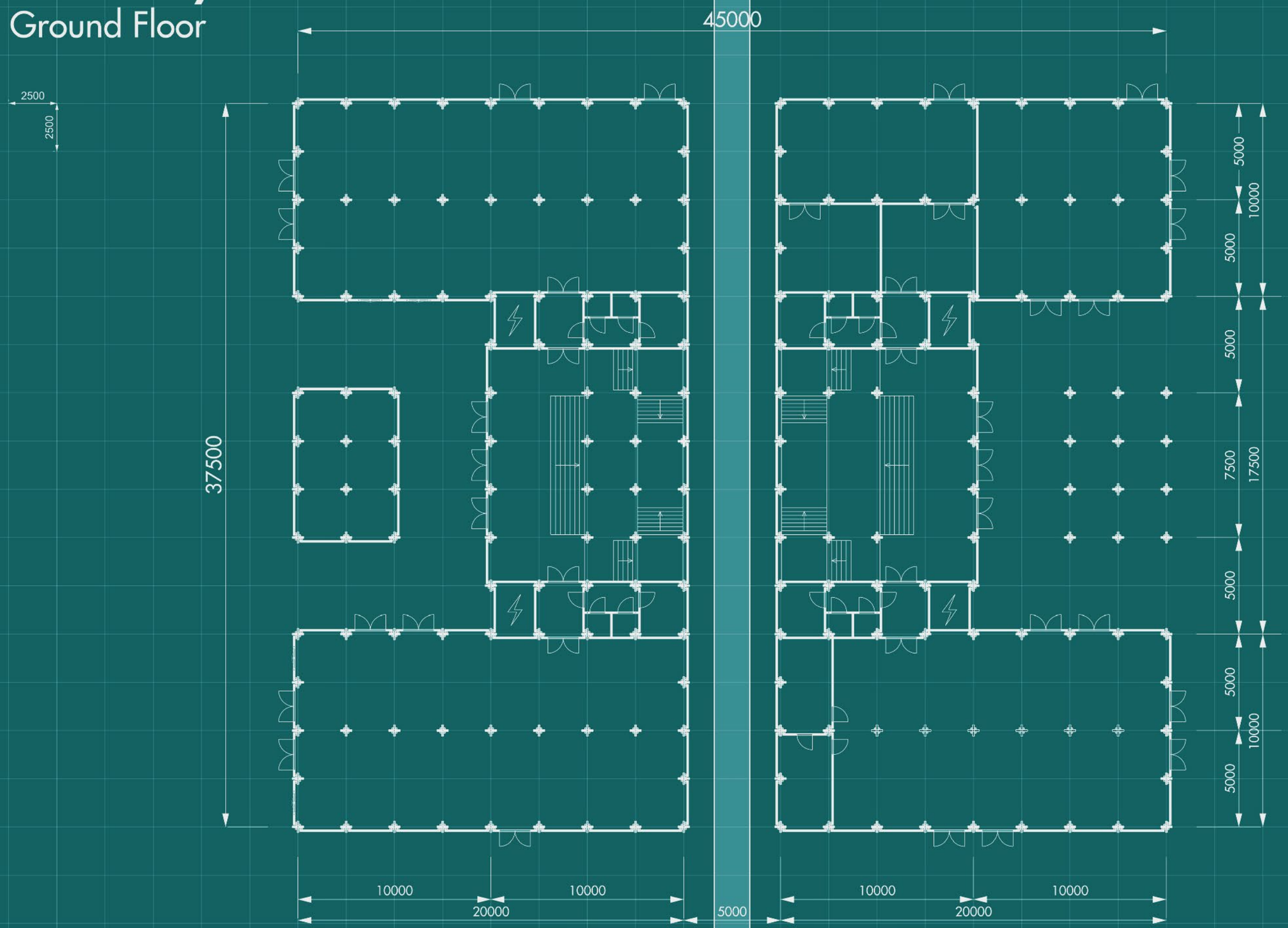
Section B

1:200

0 10 m

Community Research Center

Ground Floor



1:200

0 10 m

map of site in Muara Baru

miniature model of mangrove growth

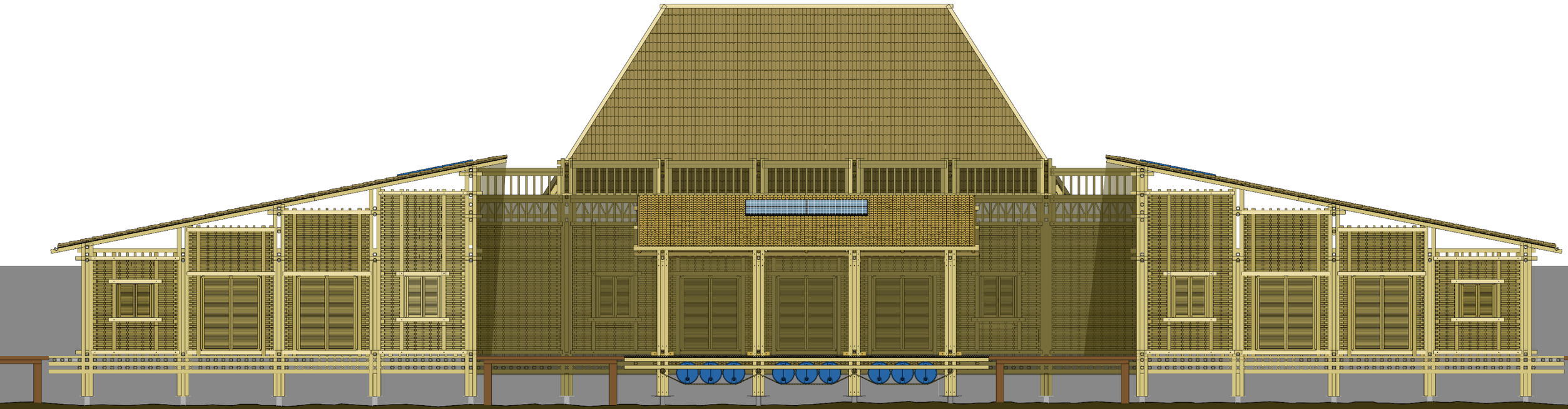
books on mangroves

0 10 m

1:200

Community Research Center

Elevation

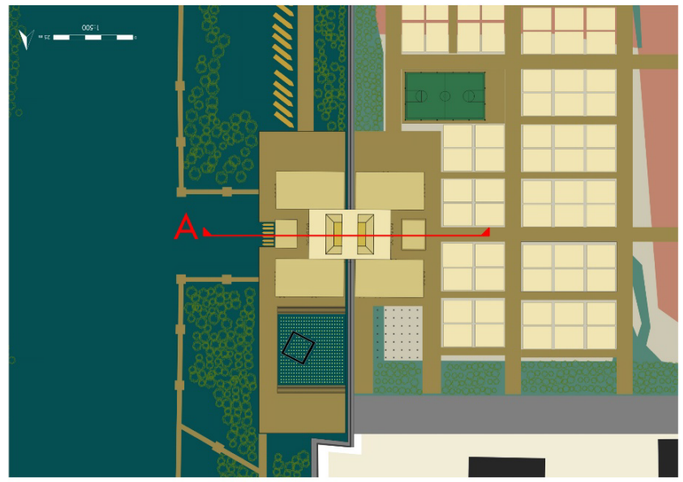


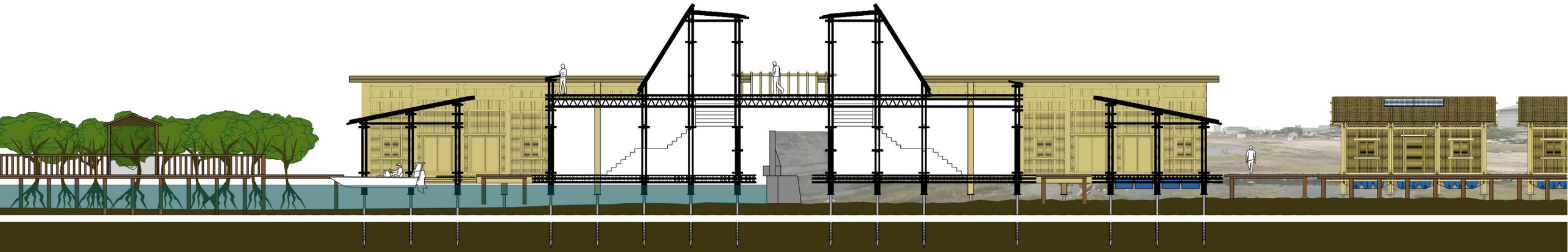
1:100

0 10 m

Community Research Center

Section A





1:200

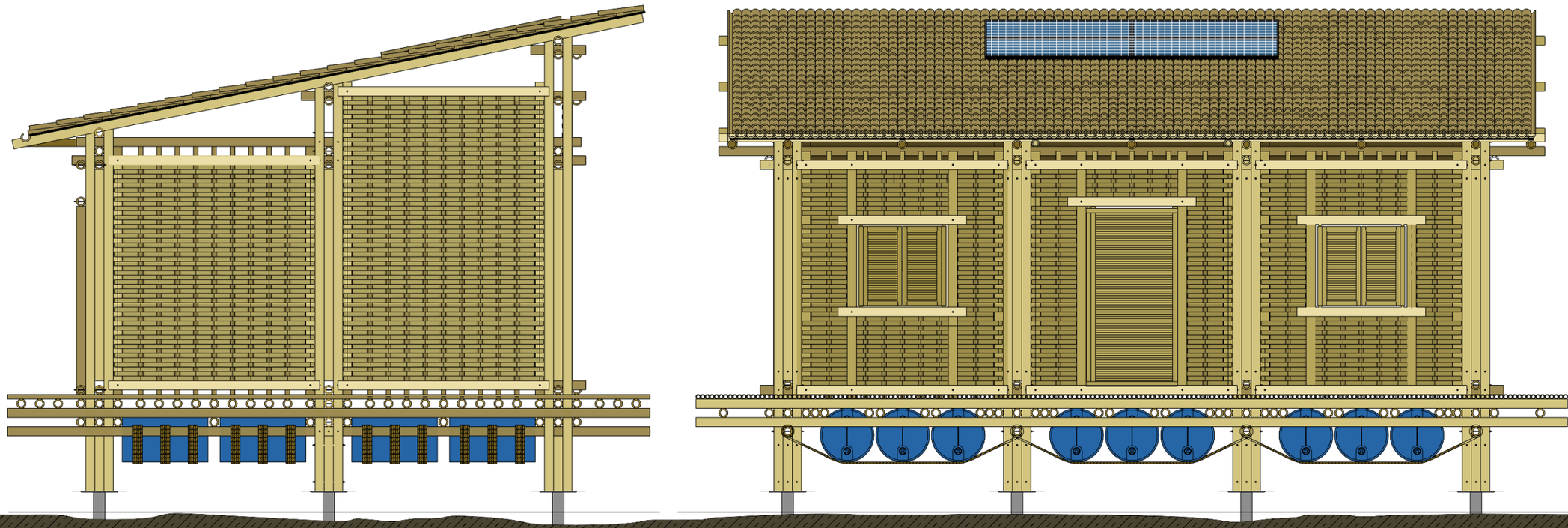
0 10 m

Housing Unit

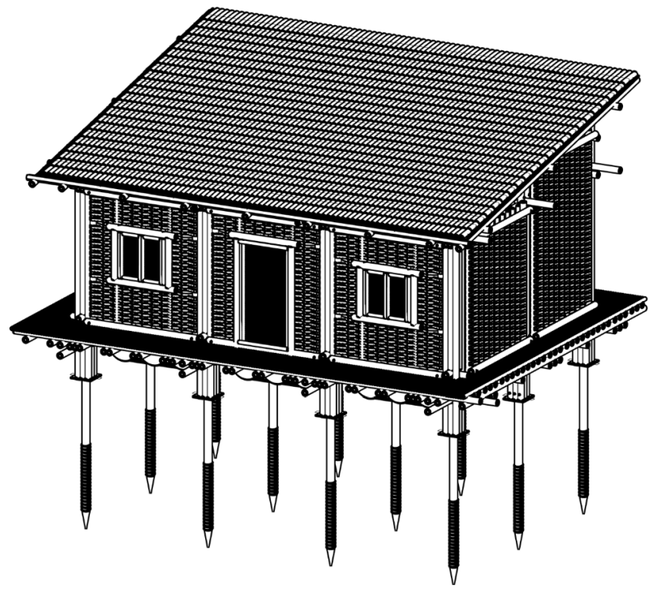
Elevations

1:50

0 5 m



AMPHIBIOUS BAMBOO HOUSE



Prototype Manual

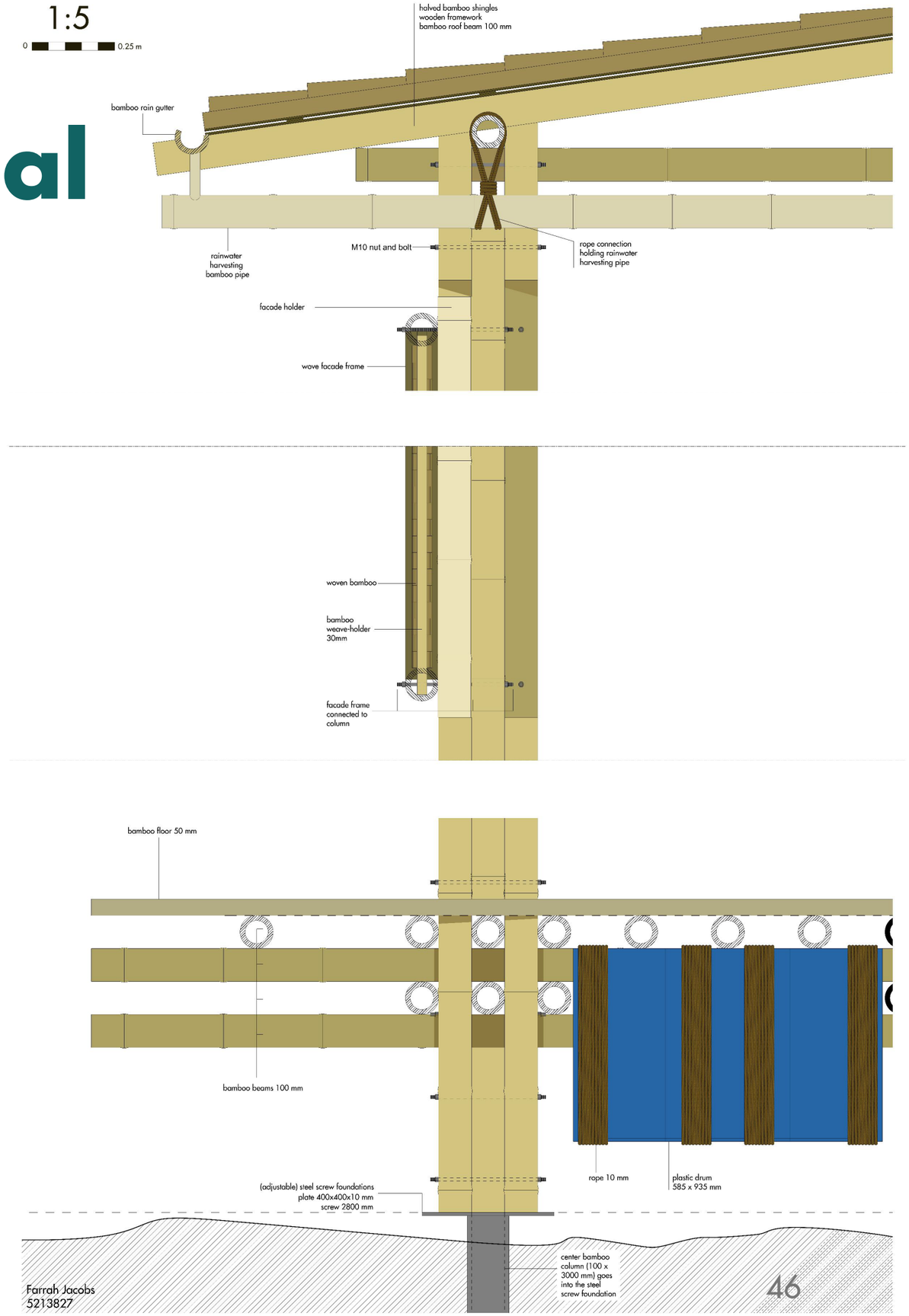
version 2

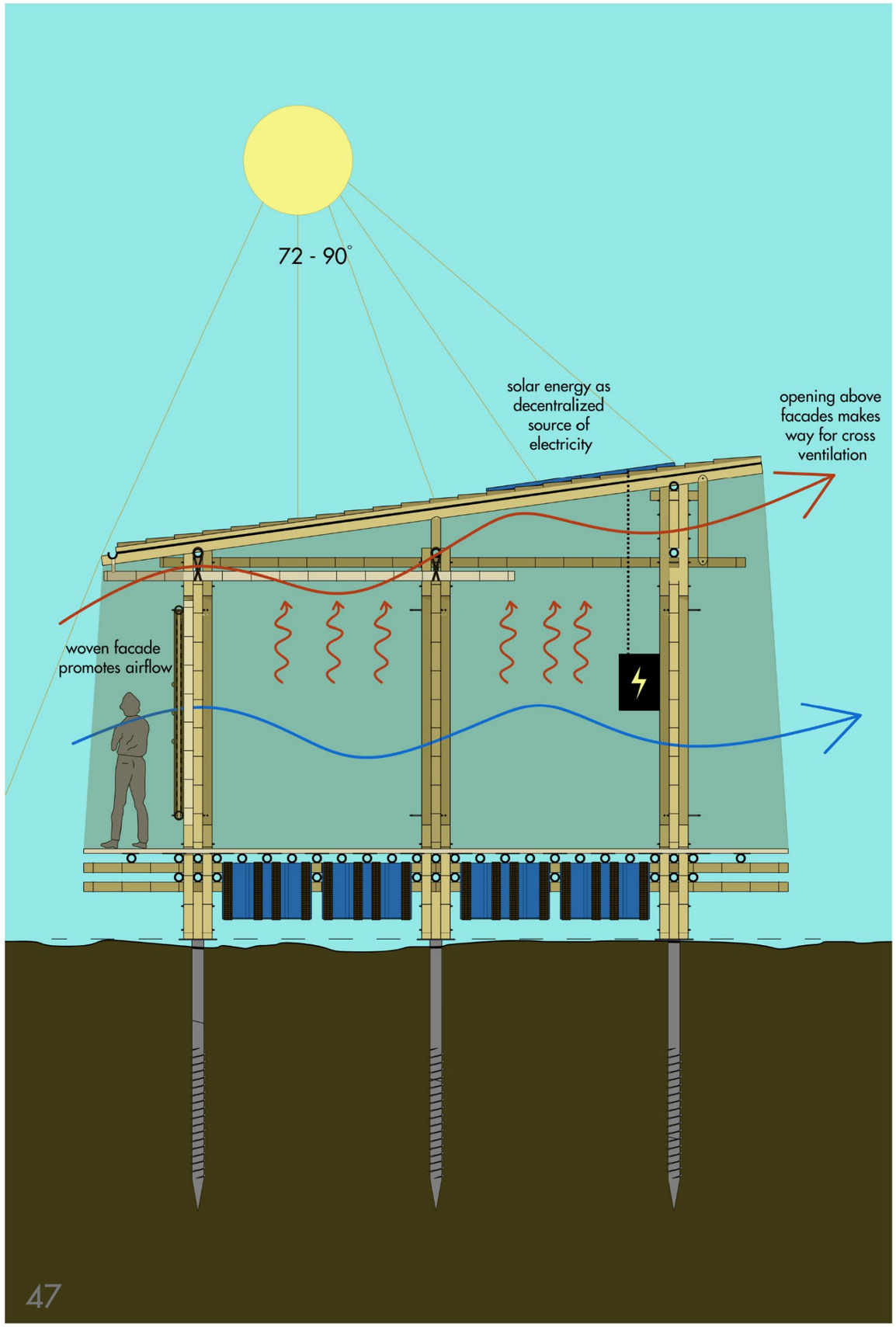
2025

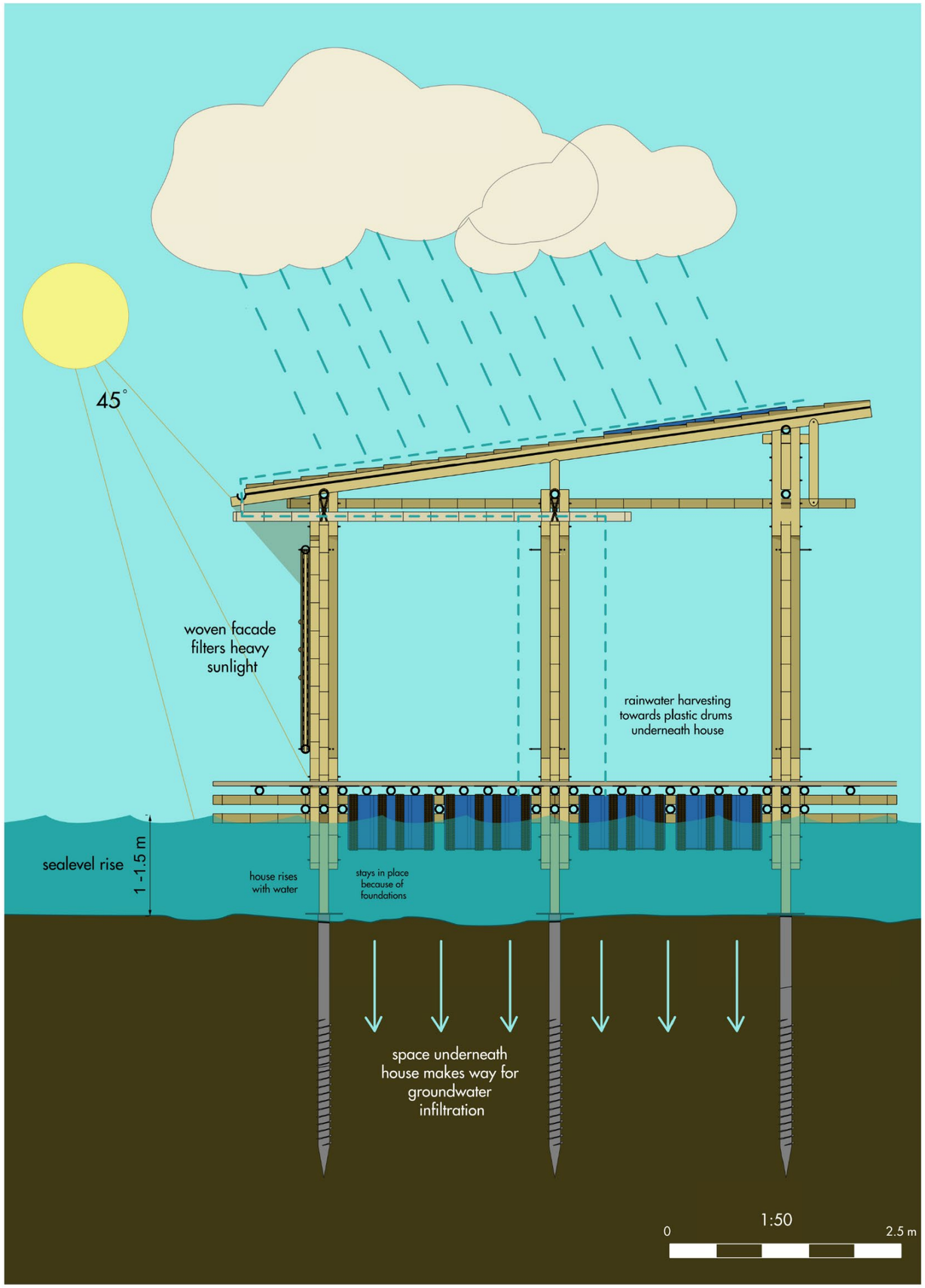
Construction Manual

Contents

1. Amphibious House
2. List of Materials
3. Foundation
4. Column
5. Floor
6. Roof
7. Walls
8. Building Order

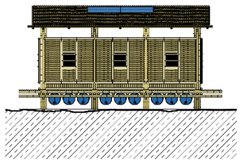



72 - 90°
solar energy as decentralized source of electricity
opening above facades makes way for cross ventilation
woven facade promotes airflow


45°
woven facade filters heavy sunlight
rainwater harvesting towards plastic drums underneath house
sealevel rise
1 -1.5 m
house rises with water
stays in place because of foundations
space underneath house makes way for groundwater infiltration
1:50
0
2.5 m

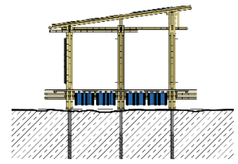
2. List of Materials

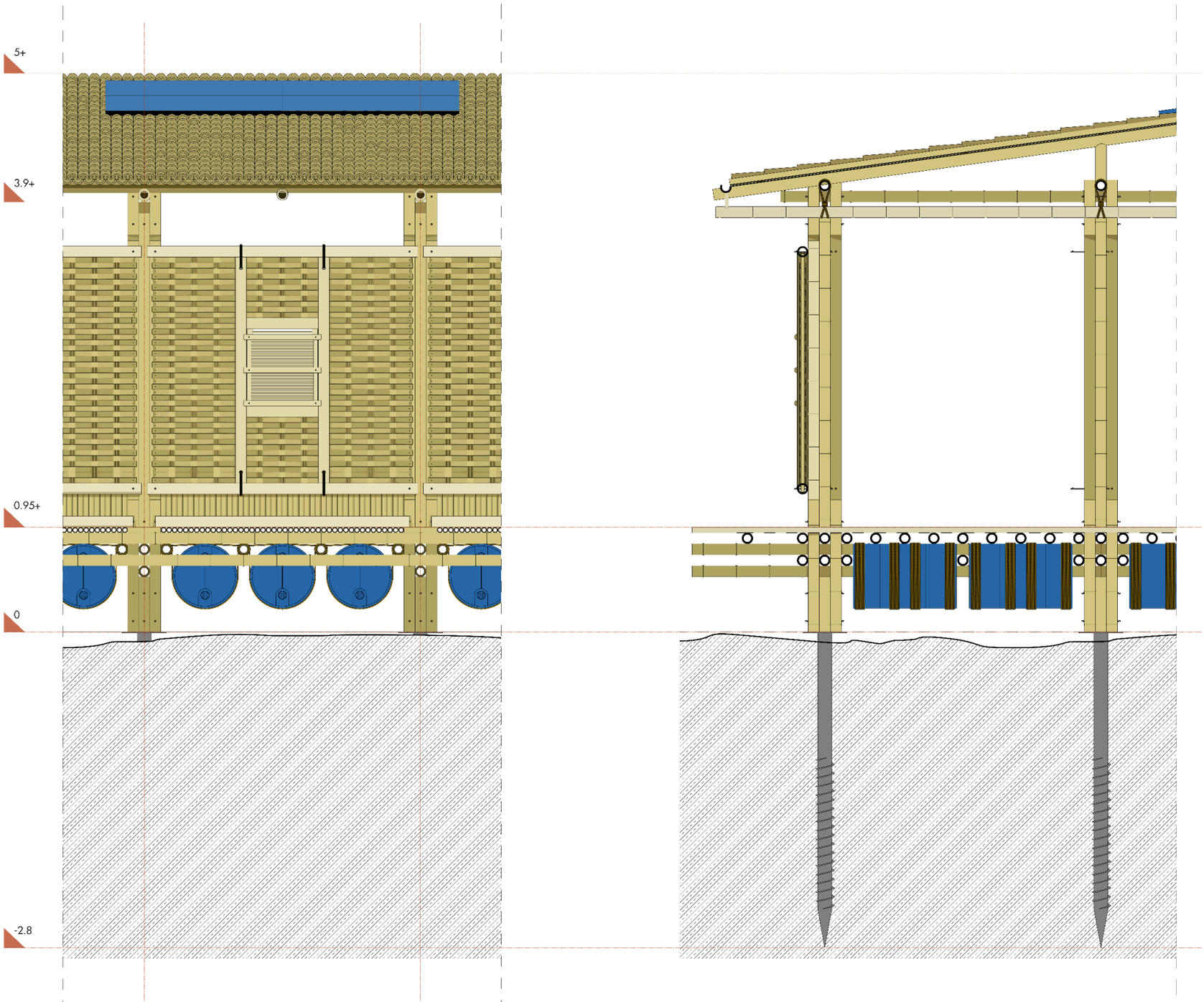
Material	Measurements	amount
Bamboo column stabilizers	100 x 600 mm	2 + 4 for short columns 3 + 4 for middle to tallest columns
Bamboo Columns	100 x 2300 mm	5 per column
	100 x 4000 mm 100 x 4500 mm 100 x 5000 mm	4 per column
Bamboo wall sticks for weaving	diameter: 30- 50 mm	
Bamboo floor	50 x 9500 mm 50 x 7000 mm	
Bamboo weaving strips	-	
Bamboo halved shingles	diameter: 100 mm length: 500 mm	
Wooden roof board	-	
drums	585 x 935 mm	36 per unit
rope	5 - 10 mm	-
steel bolts with washers and nuts	M10 or M12	
waterproofing membrane sheets	500 x 700 mm	

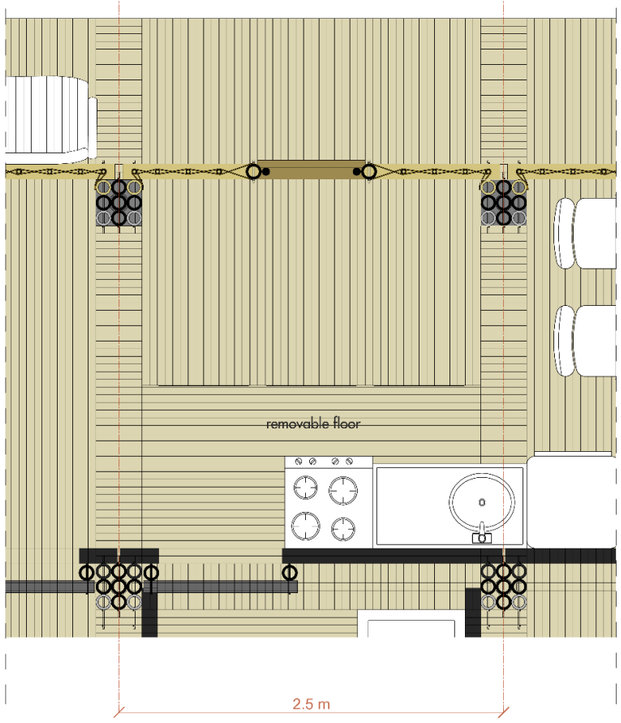


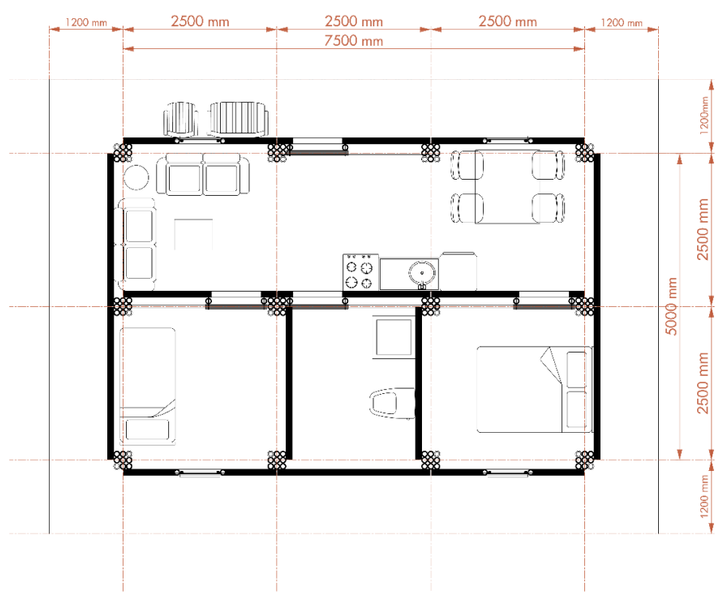
1:20 Housing Unit

0 1 m









1:50

0 2.5 m

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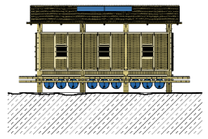
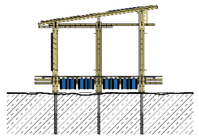
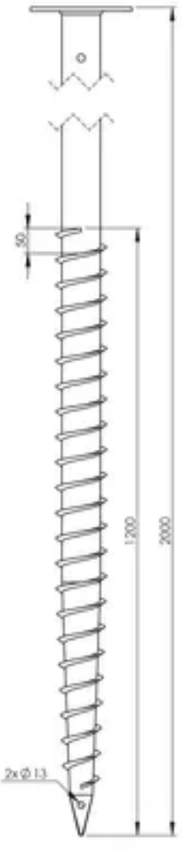
3. Foundation

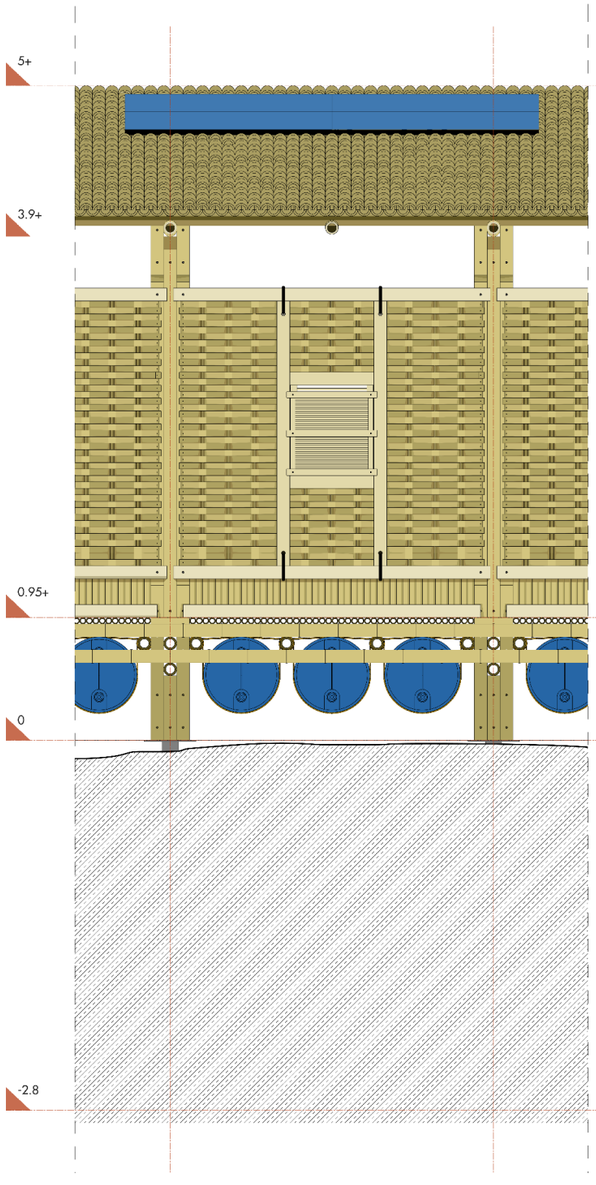


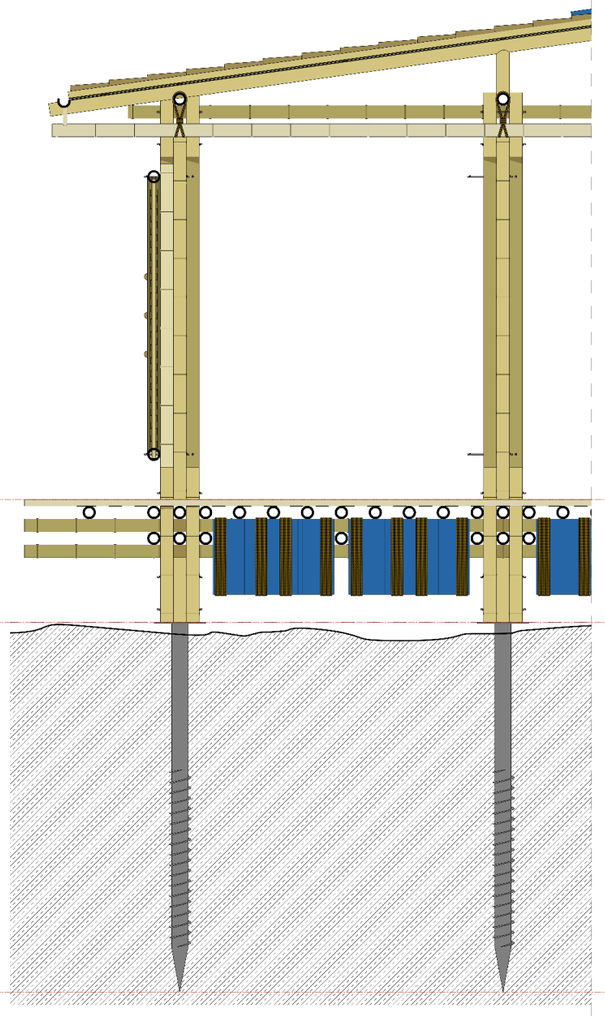
1:20 Housing Unit



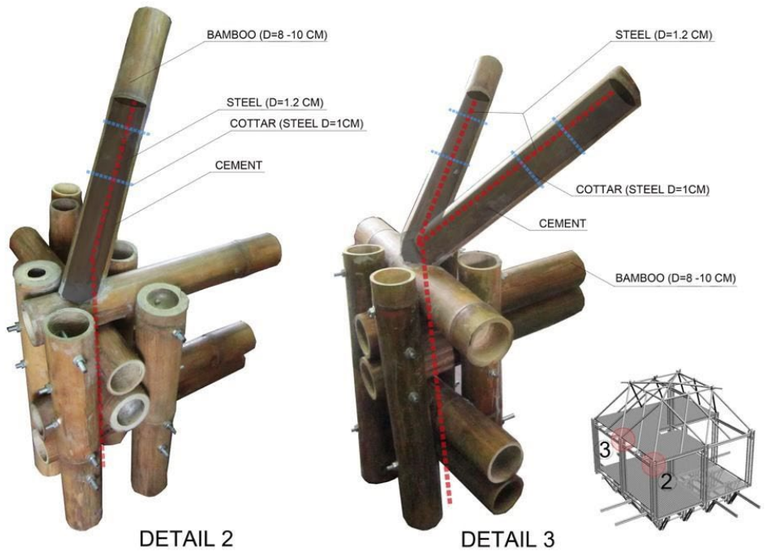
Screw foundation:
Residents can screw the foundation themselves into the ground. Because the ground is quite uneven, the foundation sometimes sticks out.



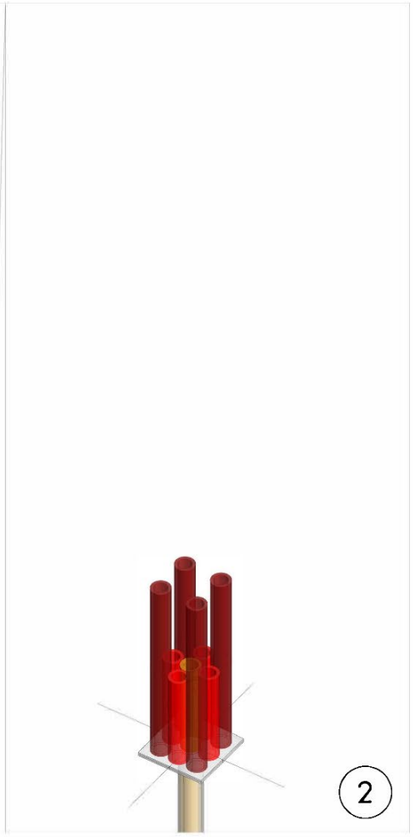


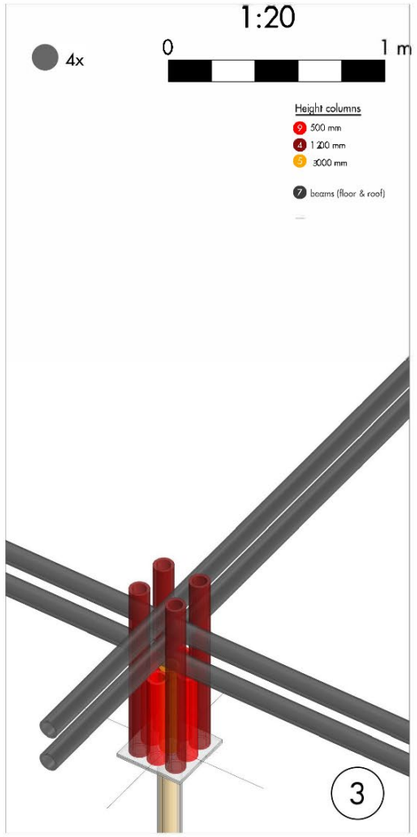


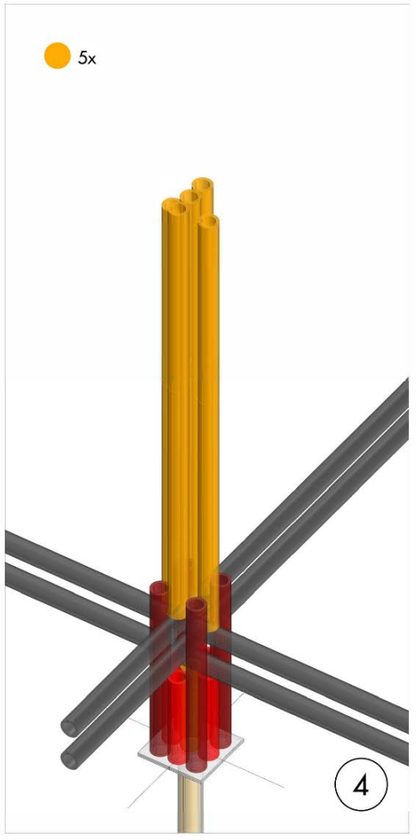
4. Columns
Prototype 1

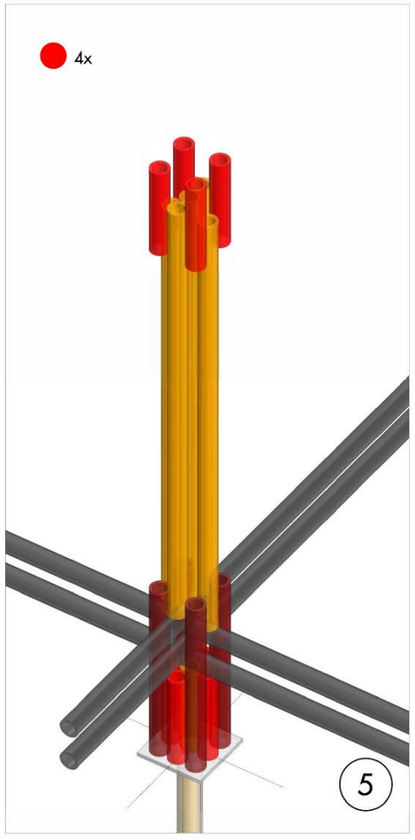


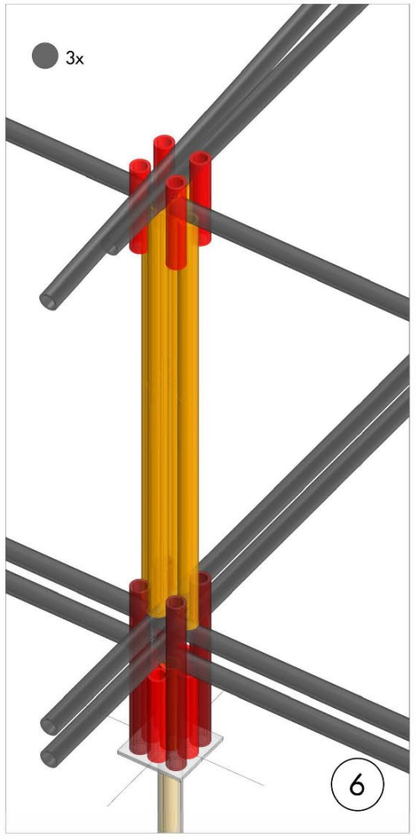
DETAIL 2 DETAIL 3





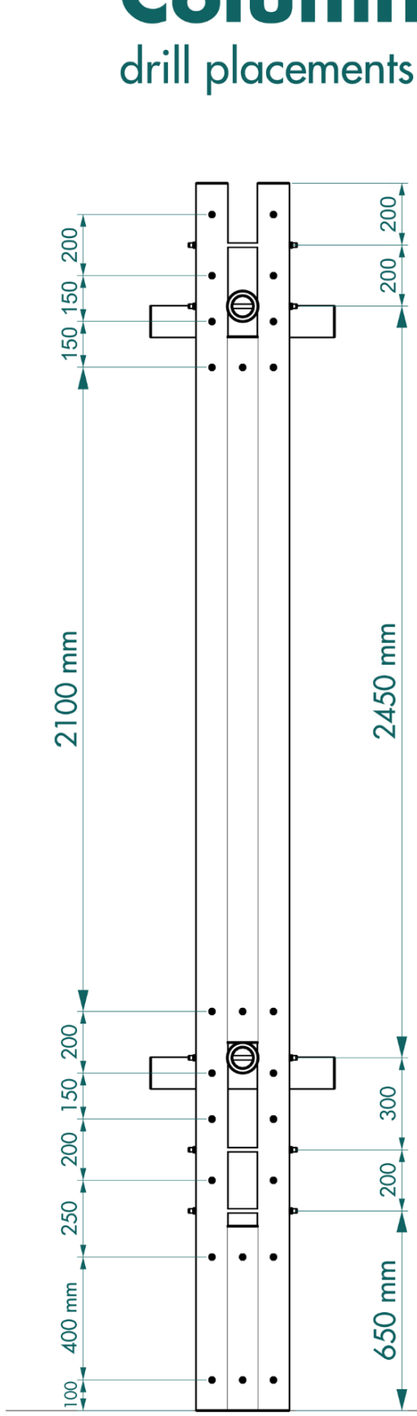


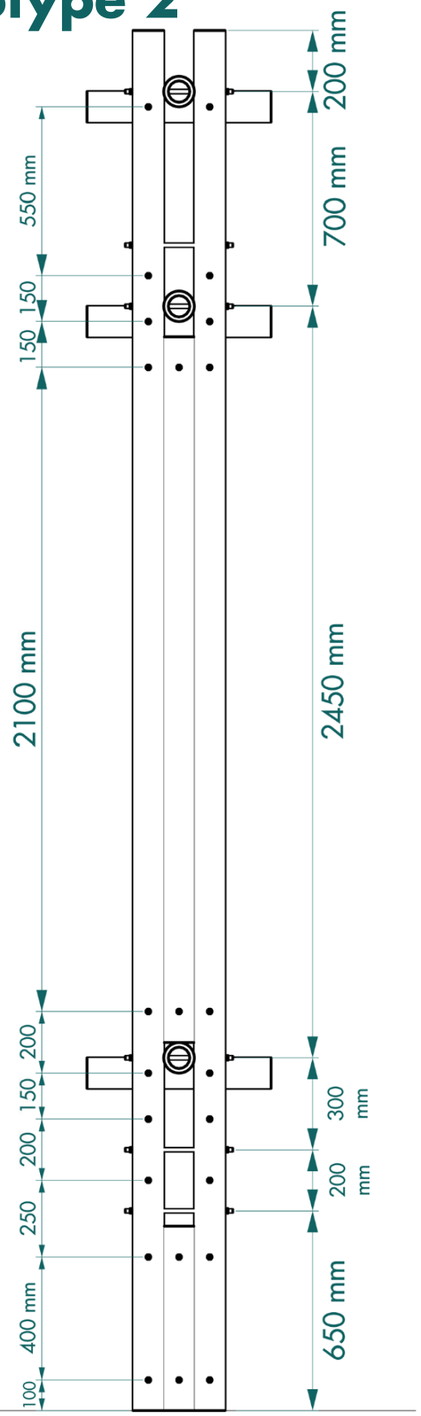




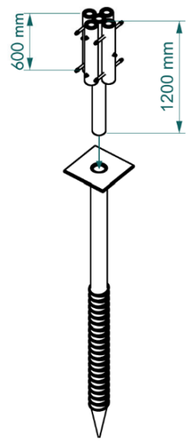
Columns - Prototype 2

drill placements

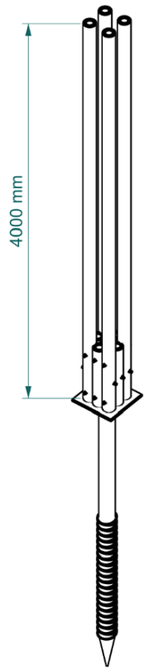




Column Build Order



1



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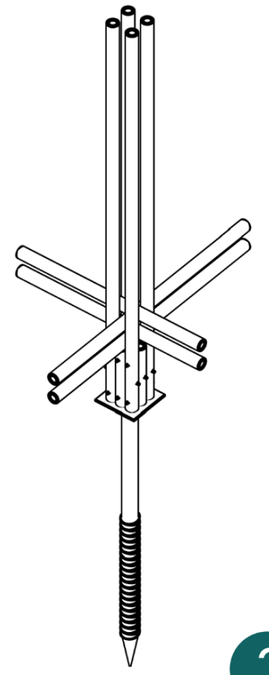

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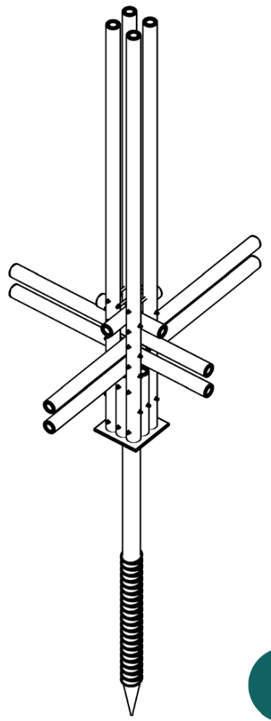

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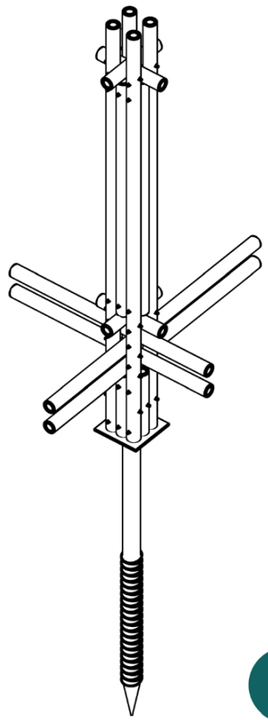

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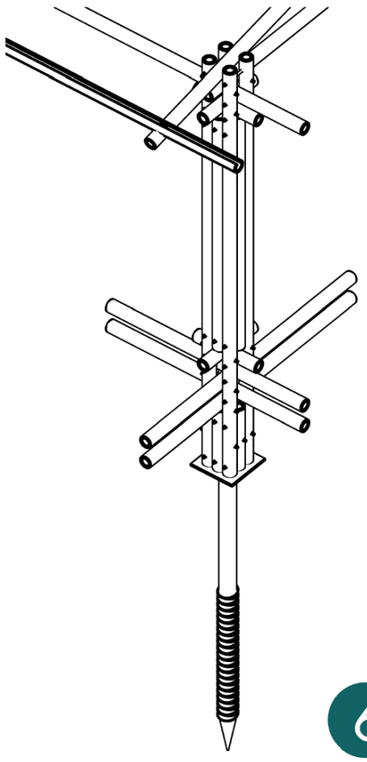
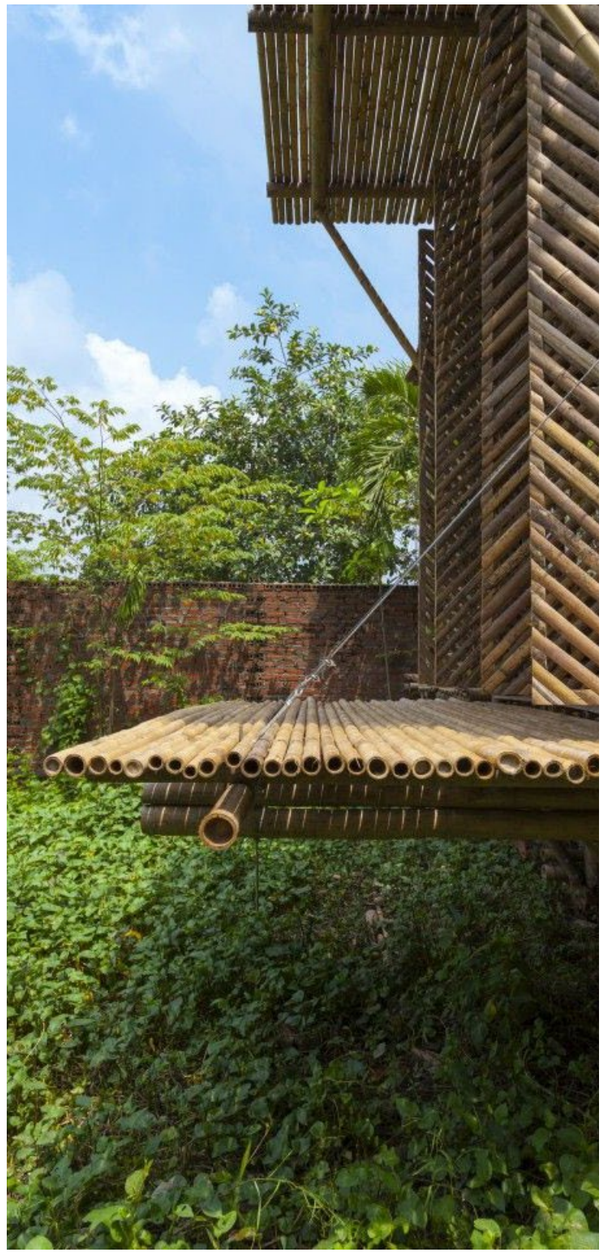
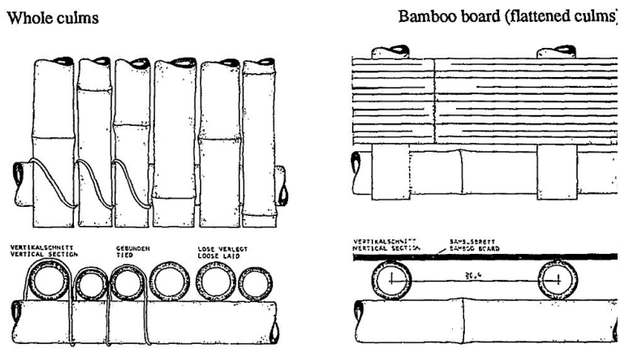
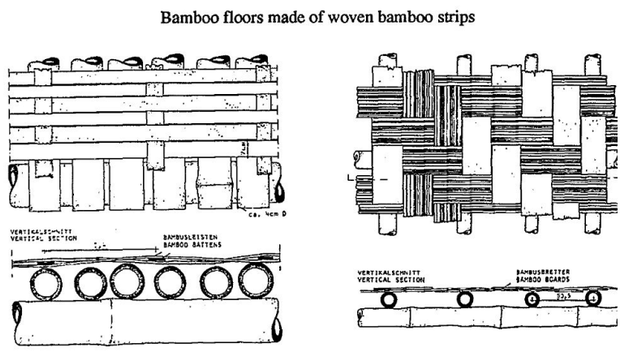


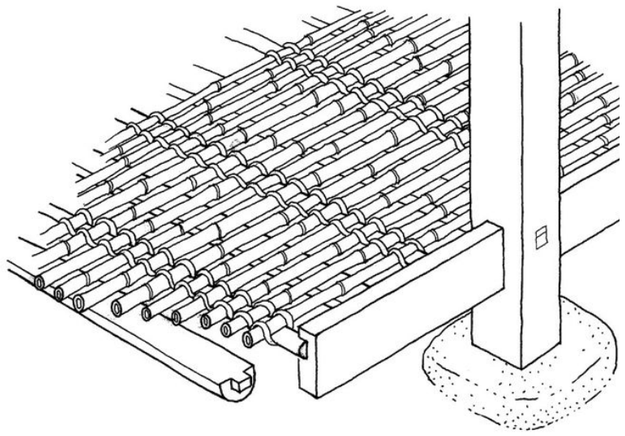
6

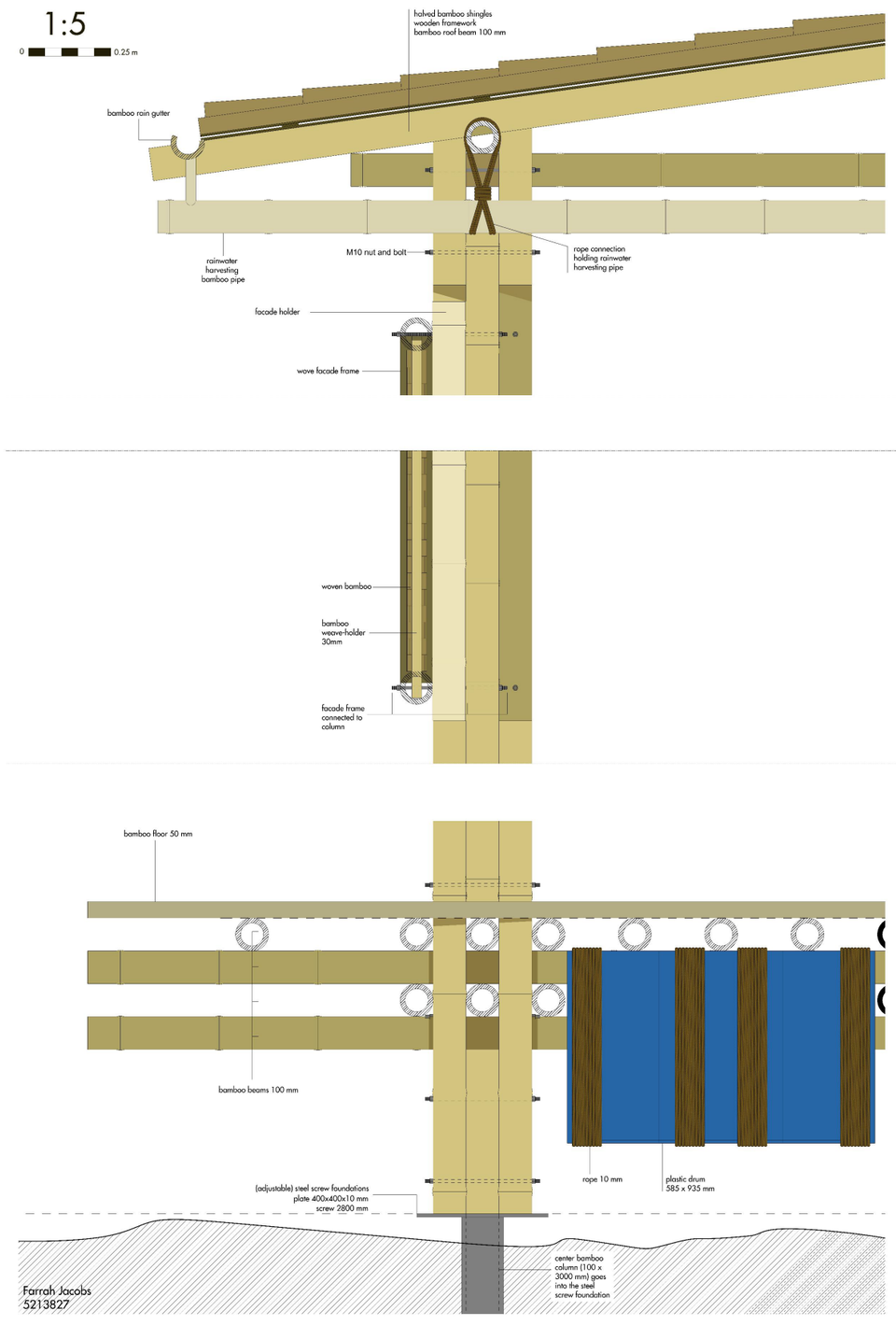
5. Floor



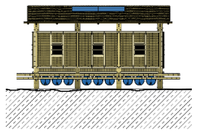

Whole culms
Bamboo board (flattened culms)
VERTIKALSCHNITT
VERTICAL SECTION
GEBUNDEN
TIED
LOSE VERLEGT
LOOSE LAID
VERTIKALSCHNITT
VERTICAL SECTION
BAMBUSBRETT
BAMBOO BOARD


Bamboo floors made of woven bamboo strips
VERTIKALSCHNITT
VERTICAL SECTION
BAMBUSLEISTEN
BAMBOO BATTENS
VERTIKALSCHNITT
VERTICAL SECTION
BAMBUSBRETTER
BAMBOO BOARDS



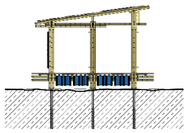

1:5
0
0.25 m
halved bamboo shingles
wooden framework
bamboo roof beam 100 mm
bamboo rain gutter
rainwater harvesting bamboo pipe
M10 nut and bolt
rope connection holding rainwater harvesting pipe
facade holder
wove facade frame
woven bamboo
bamboo weave-holder 30mm
facade frame connected to column
bamboo floor 50 mm
bamboo beams 100 mm
rope 10 mm
plastic drum 585 x 935 mm
(adjustable) steel screw foundations plate 400x400x10 mm screw 2800 mm
center bamboo column (100 x 3000 mm) goes into the steel screw foundation
Farrah Jacobs
5213827

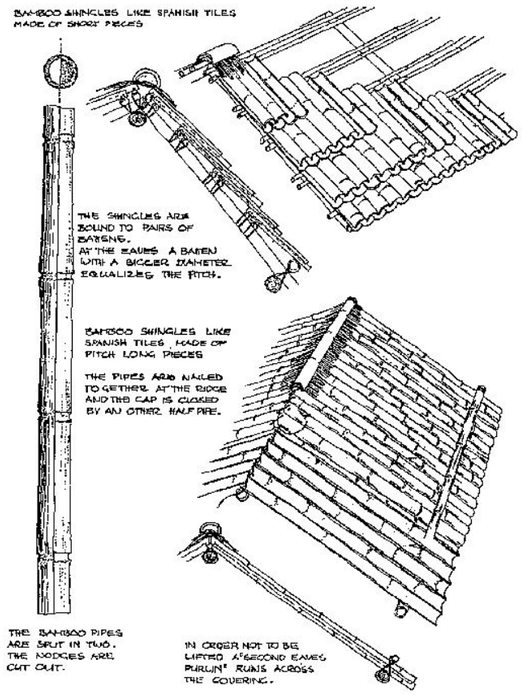
6. Roof

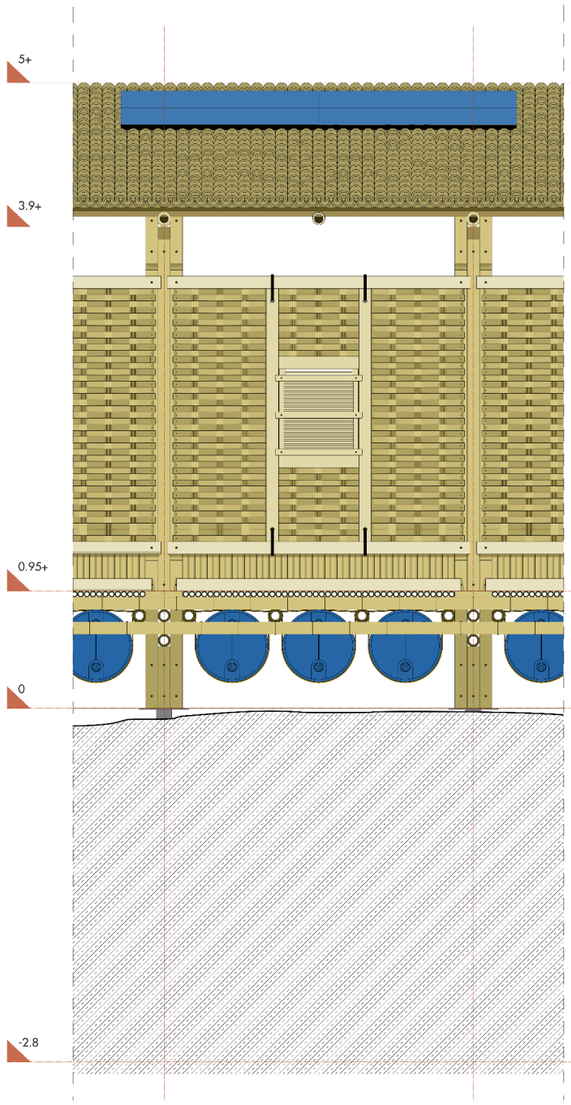


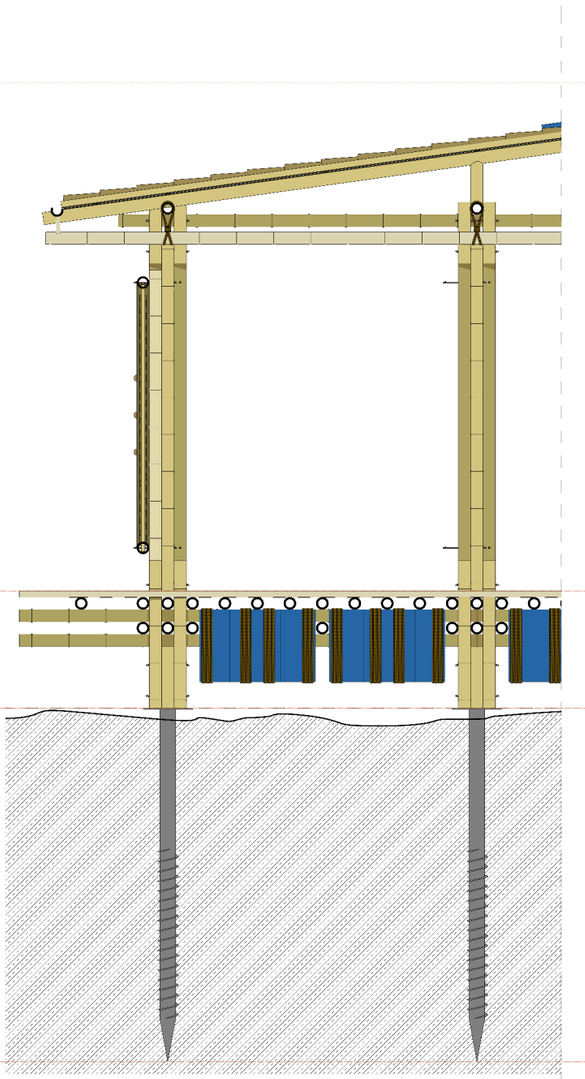
1:20 Housing Unit

0 1 m



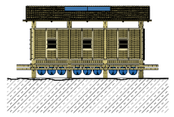






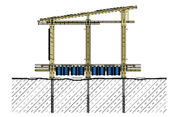
7. Walls

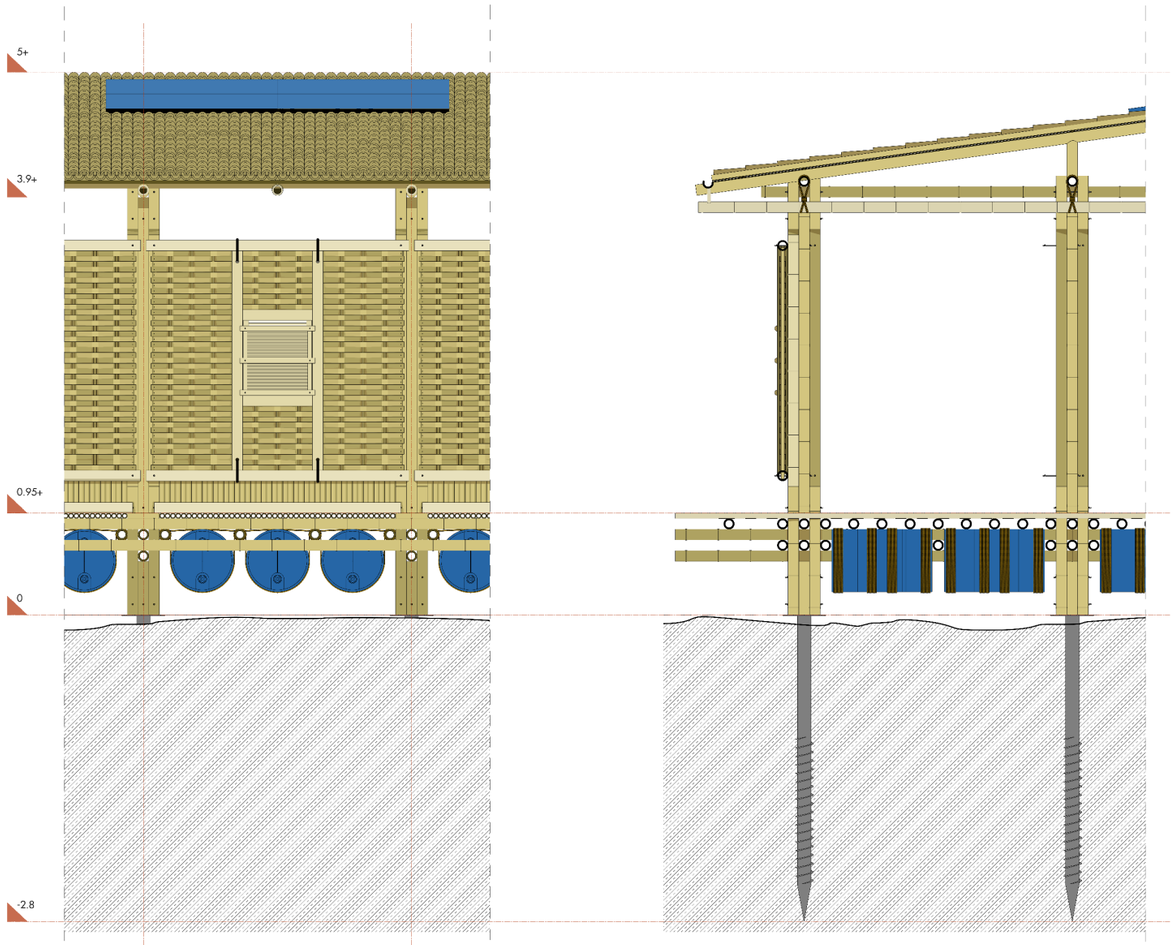
Facade / innerwalls

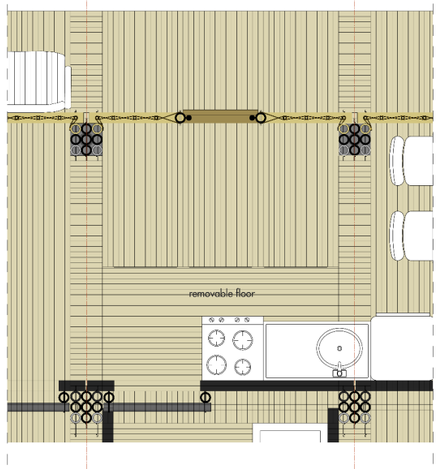


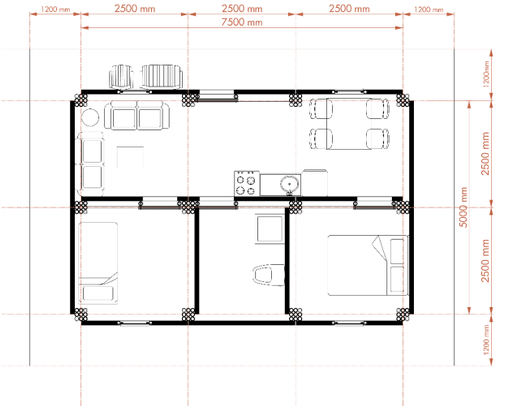
1:20 Housing Unit

0 1 m







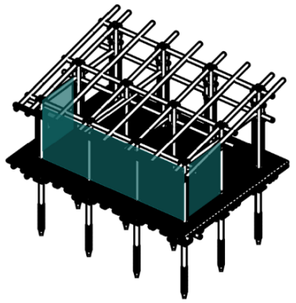


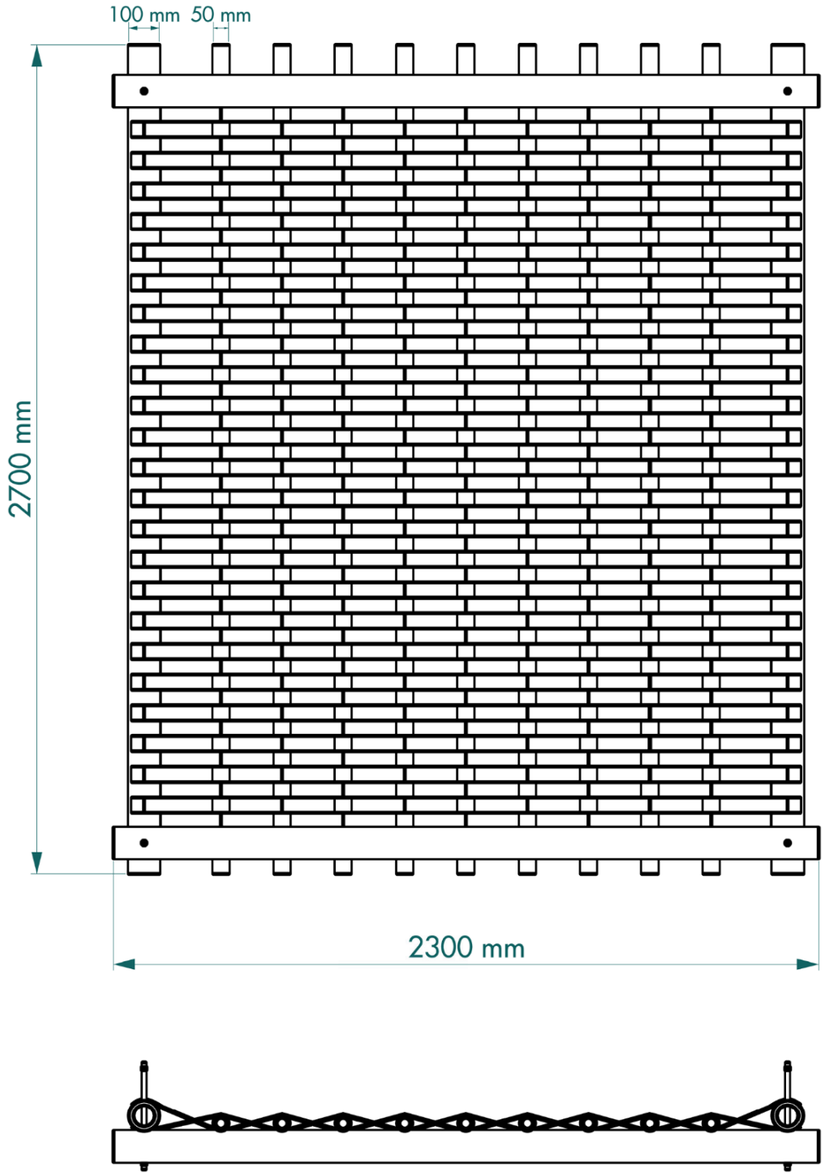
1:50

0 2.5 m

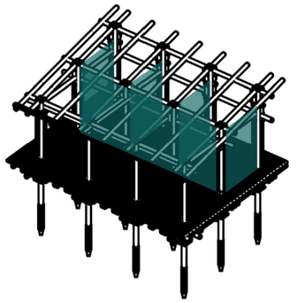
Farrah Jacobs
5213827

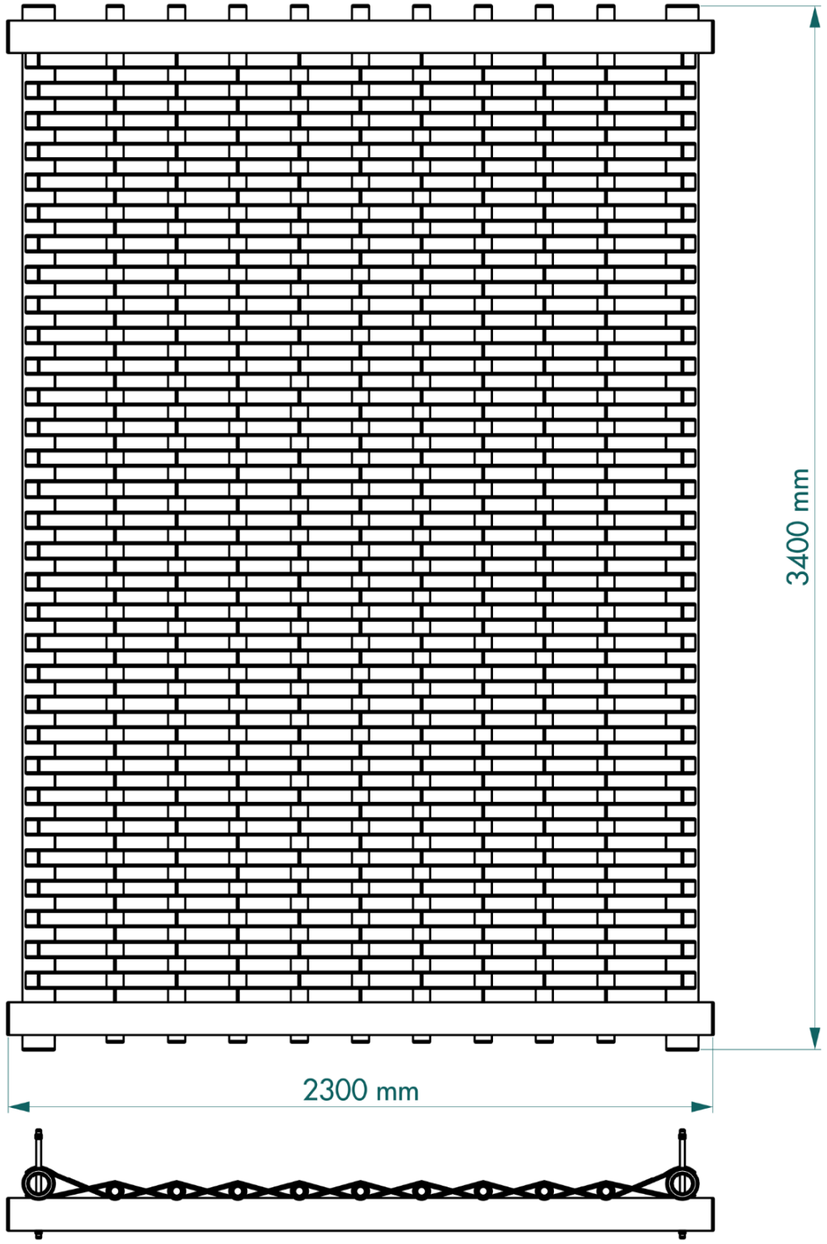
Wall 1
closed



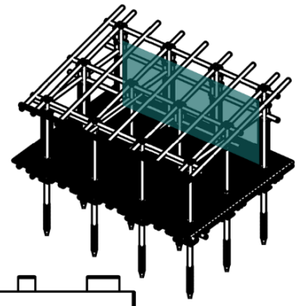


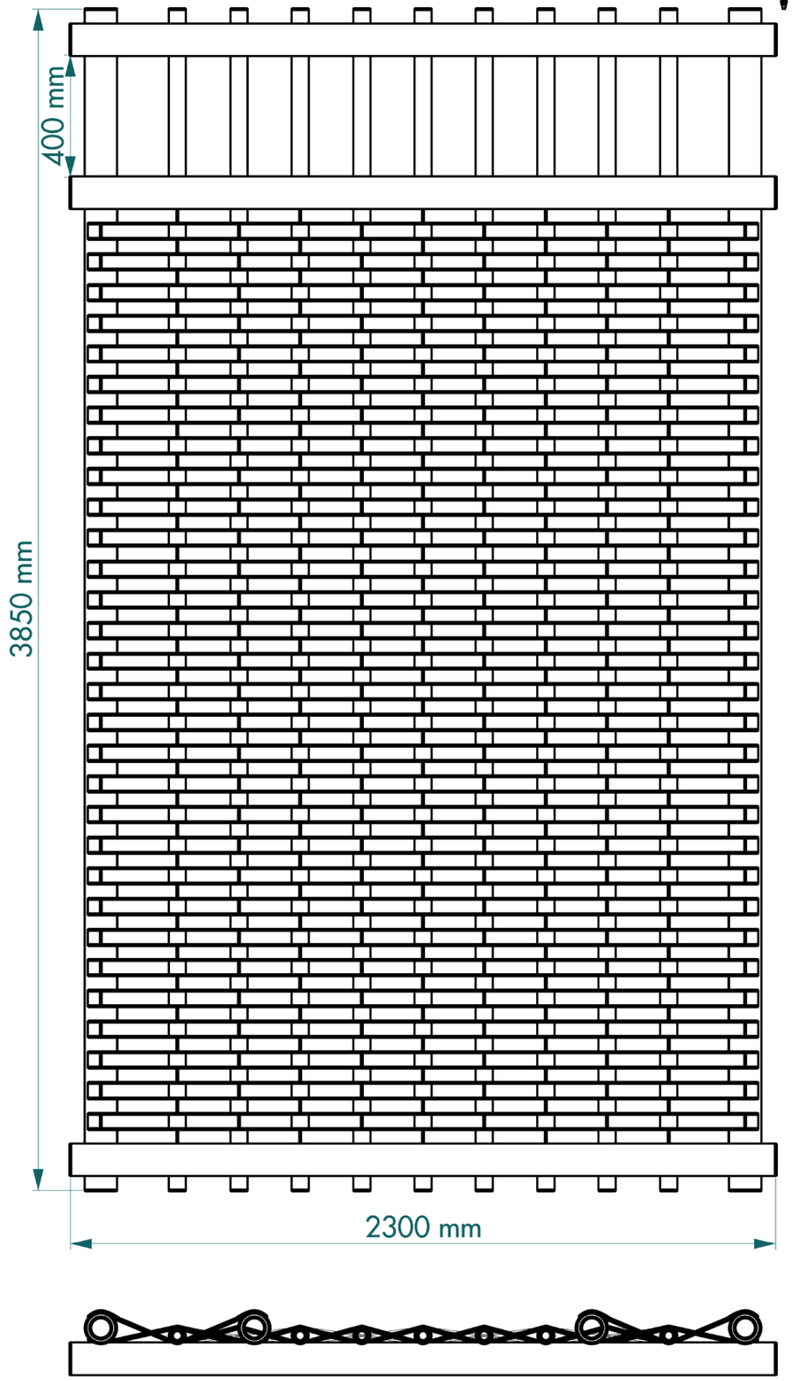
Wall 2
closed

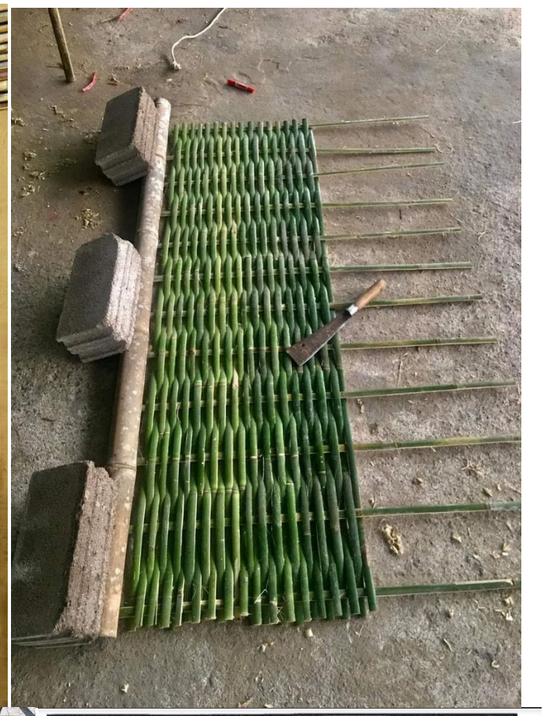


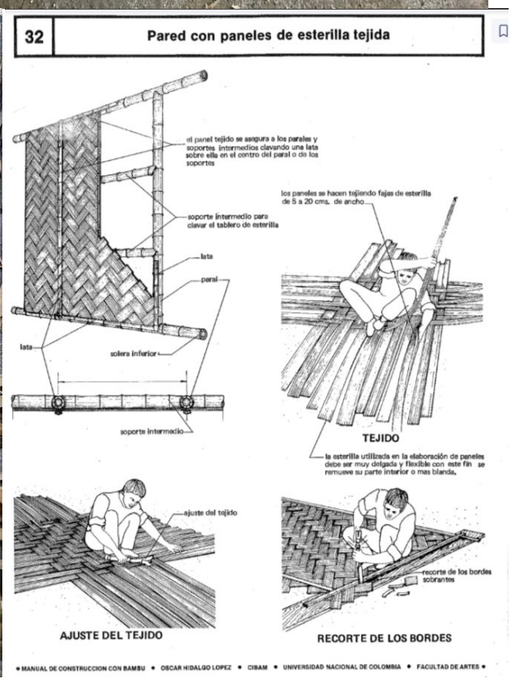


Wall 3
back




400 mm
3850 mm
2300 mm




32
Pared con paneles de esterilla tejida
el panel tejido se asegura a los parales y soportes intermedios clavando una lata sobre ella en el centro del paral o de los soportes
soporte intermedio para clavar el tablero de esterilla
los paneles se hacen tejiendo fajas de esterilla de 5 a 20 cms. de ancho
lata
paral
lata
solera inferior
soporte intermedio
TEJIDO
la esterilla utilizada en la elaboración de paneles debe ser muy delgada y flexible con este fin se remueve su parte interior o mas blanda.
ajuste del tejido
recorte de los bordes sobrantes
AJUSTE DEL TEJIDO
RECORTE DE LOS BORDES
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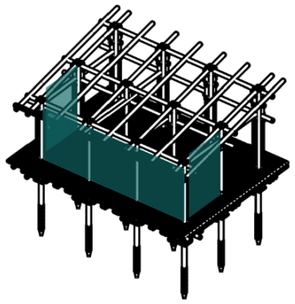
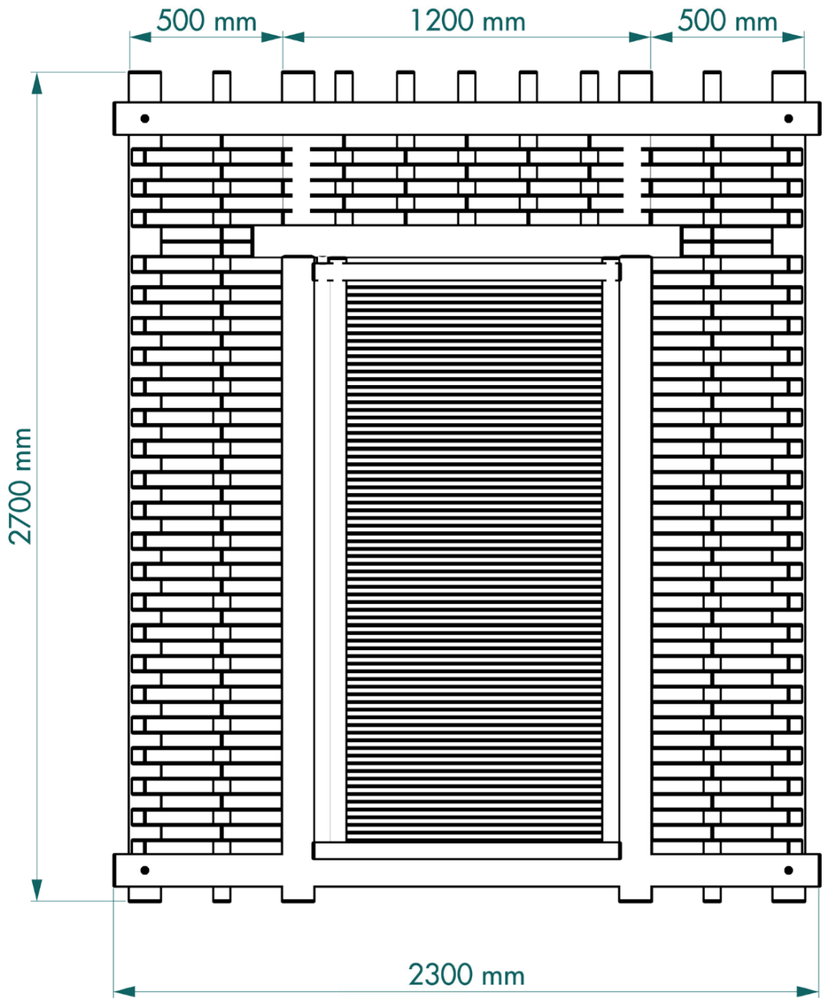
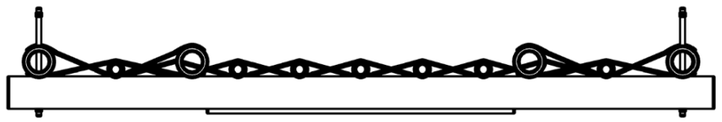
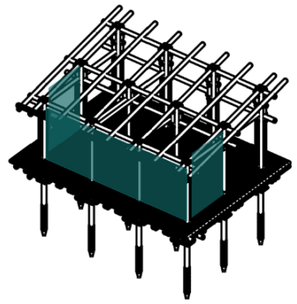
Wall 1
door

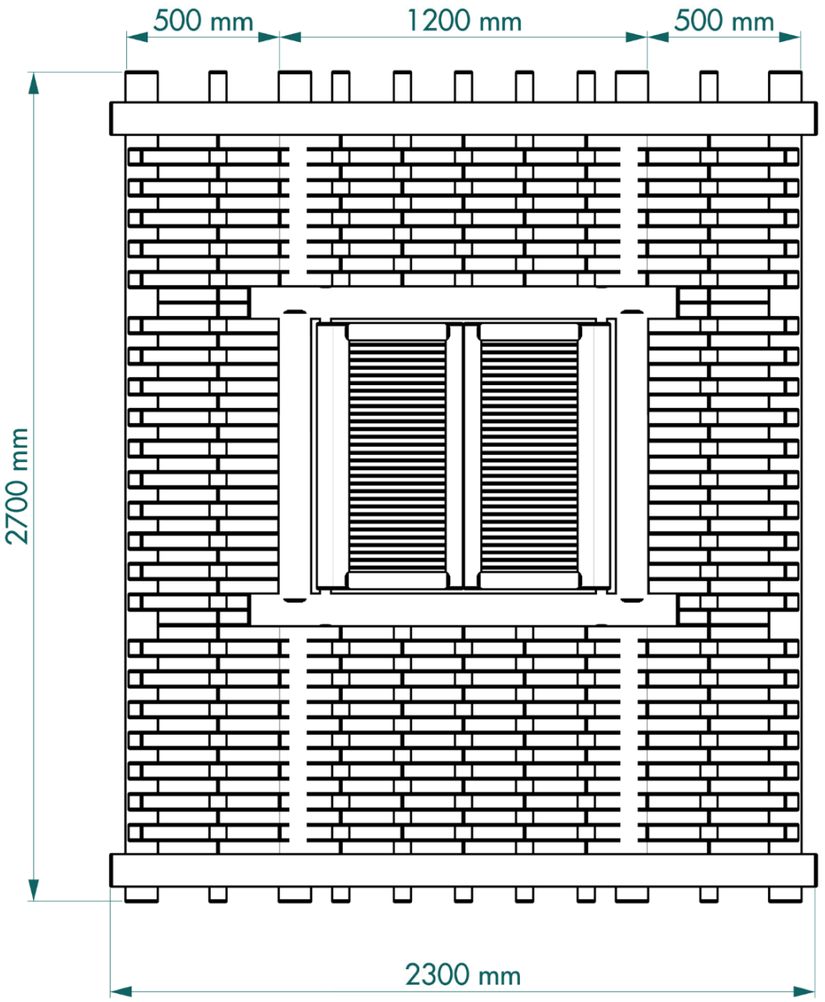




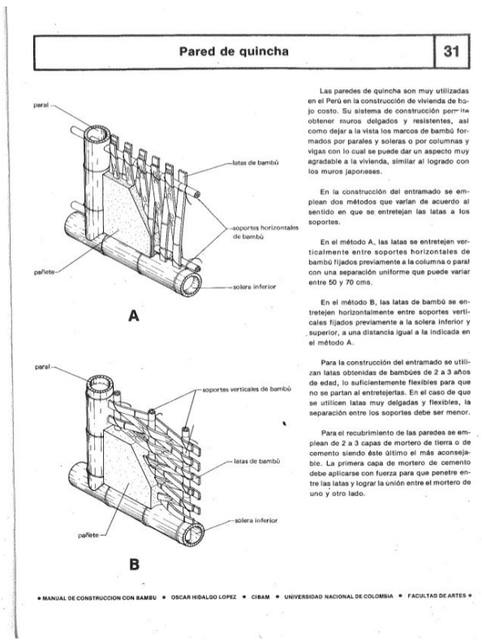


Wall 1
window





7. Walls Bathroom wal



Pared de quincha 31

paral

latas de bambú

soportes horizontales de bambú

pañete

solera inferior

A

paral

soportes verticales de bambú

latas de bambú

pañete

solera inferior

B

Las paredes de quincha son muy utilizadas en el Perú en la construcción de vivienda de bajo costo. Su sistema de construcción permite obtener muros delgados y resistentes, así como dejar a la vista los marcos de bambú formados por parales y soleras o por columnas y vigas con lo cual se puede dar un aspecto muy agradable a la vivienda, similar al logrado con los muros japoneses.

En la construcción del entramado se emplean dos métodos que varían de acuerdo al sentido en que se entretejan las latas a los soportes.

En el método A, las latas se entretejen verticalmente entre soportes horizontales de bambú fijados previamente a la columna o paral con una separación uniforme que puede variar entre 50 y 70 cms.

En el método B, las latas de bambú se entretejen horizontalmente entre soportes verticales fijados previamente a la solera inferior y superior, a una distancia igual a la indicada en el método A.

Para la construcción del entramado se utilizan latas obtenidas de bambúes de 2 a 3 años de edad, lo suficientemente flexibles para que no se partan al entretejerlas. En el caso de que se utilicen latas muy delgadas y flexibles, la separación entre los soportes debe ser menor.

Para el recubrimiento de las paredes se emplean de 2 a 3 capas de mortero de tierra o de cemento siendo éste último el más aconsejable. La primera capa de mortero de cemento debe aplicarse con fuerza para que penetre entre las latas y lograr la unión entre el mortero de uno y otro lado.

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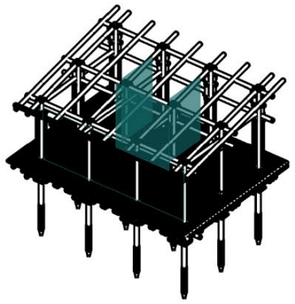
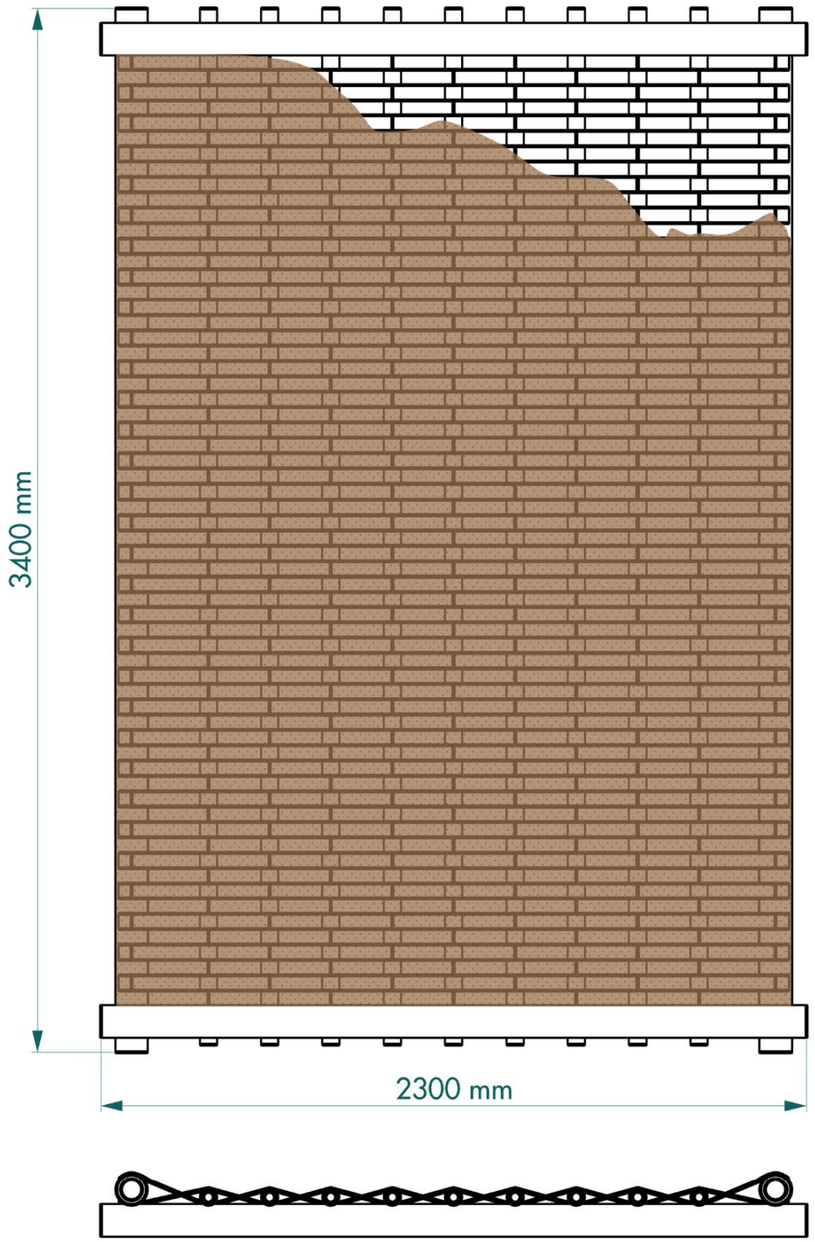
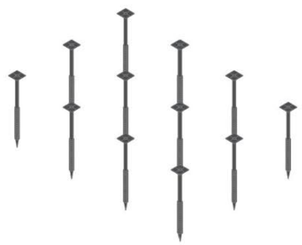
Wall 2
bathroom



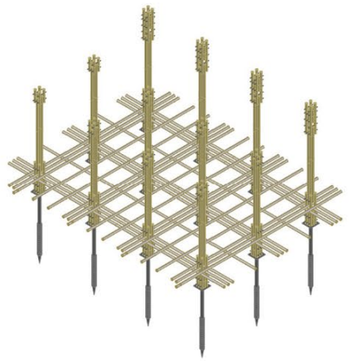


8. Building Order prototype 1

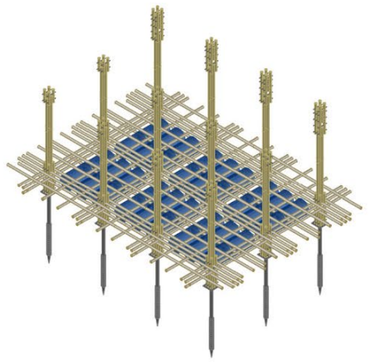
1. screw foundations



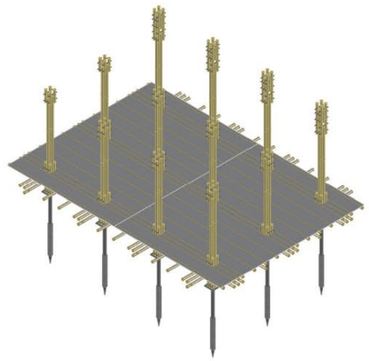
2. columns and floor beams



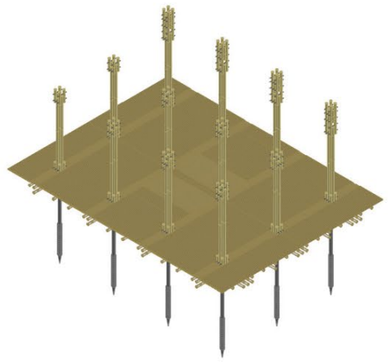
3. plastic drums and top floor beams



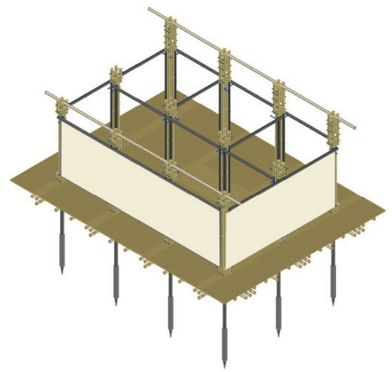
4. waterproofing membrane



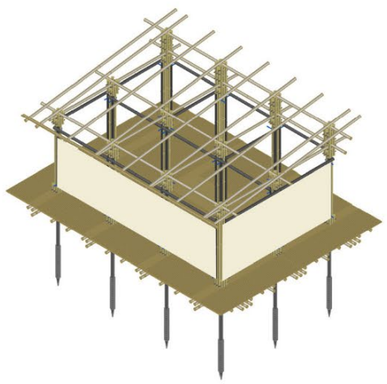
5. floor covering



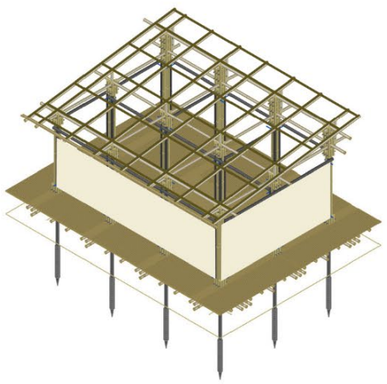
6. facades and innerwalls



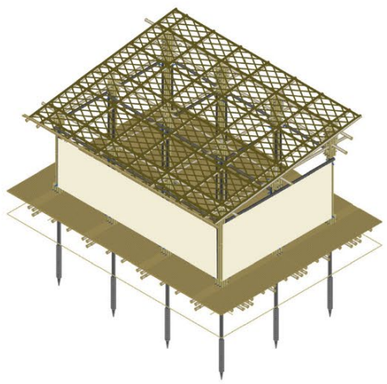
7. roof beams



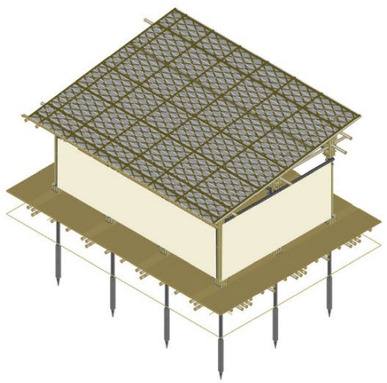
8. wooden framework



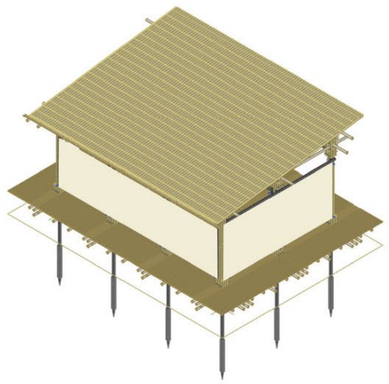
9. wood cross lattice



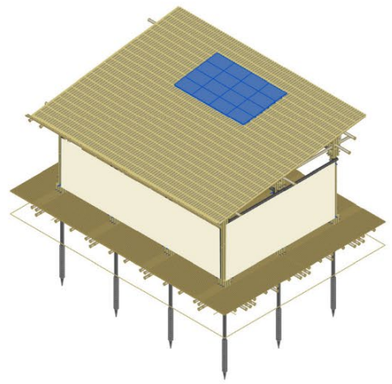
10. waterproofing membrane



11. halved bamboo shingles



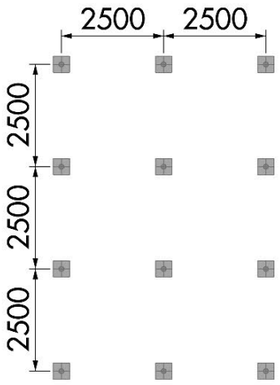
12. PV-panels



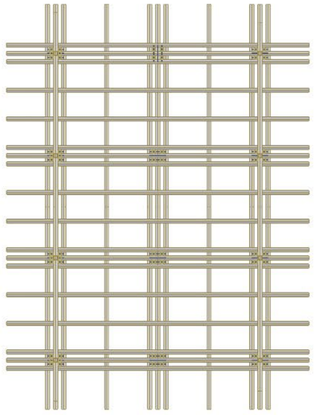
1:200

0 10 m

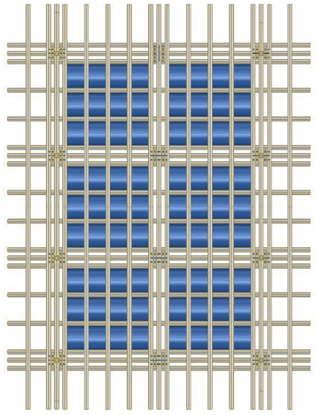
1. screw foundations



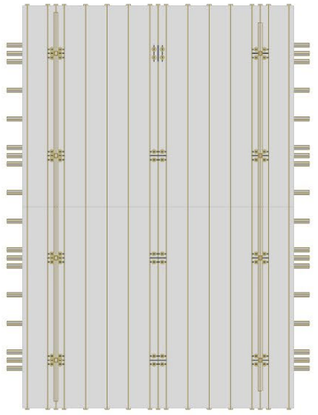
2. columns and floor beams



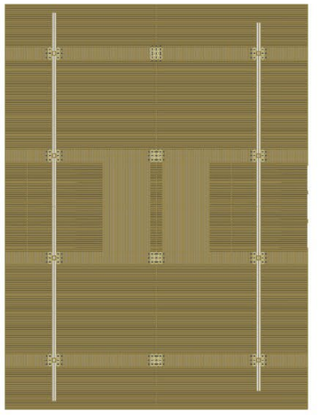
3. plastic drums and top floor beams



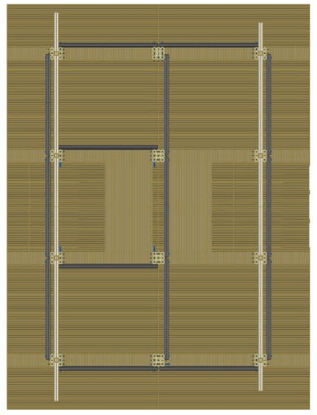
4. waterproofing membrane



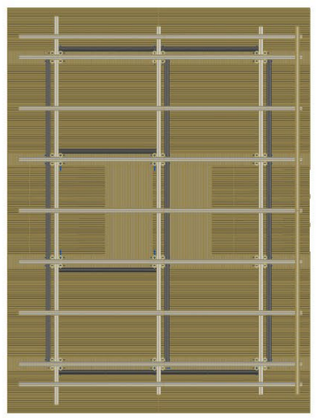
5. floor covering



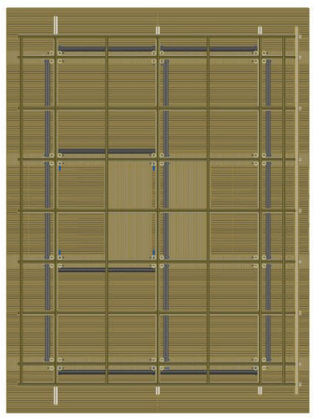
6. facades and innerwalls



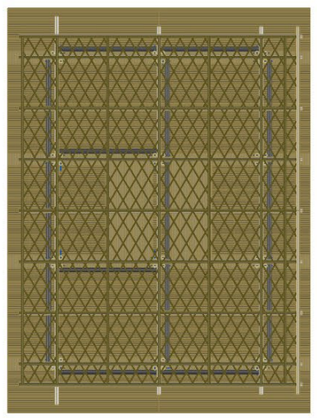
7. roof beams



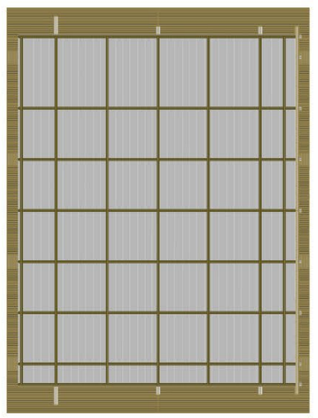
8. wooden framework



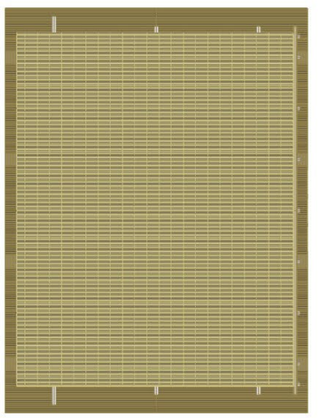
9. wood cross lattice



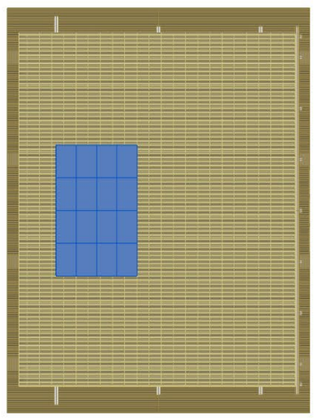
10. waterproofing membrane



11. halved bamboo shingles



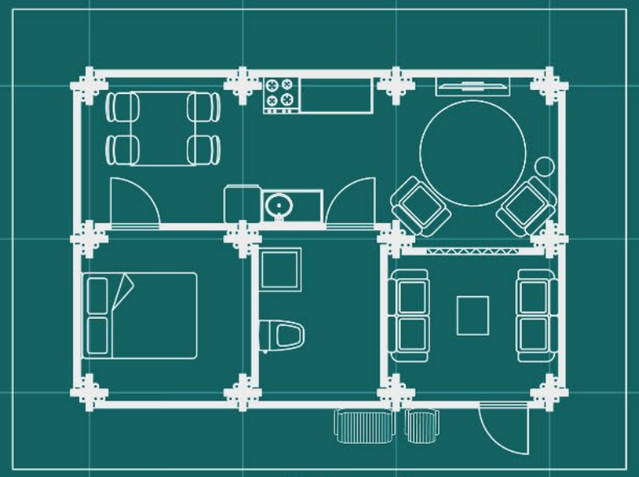
12. PV-panels



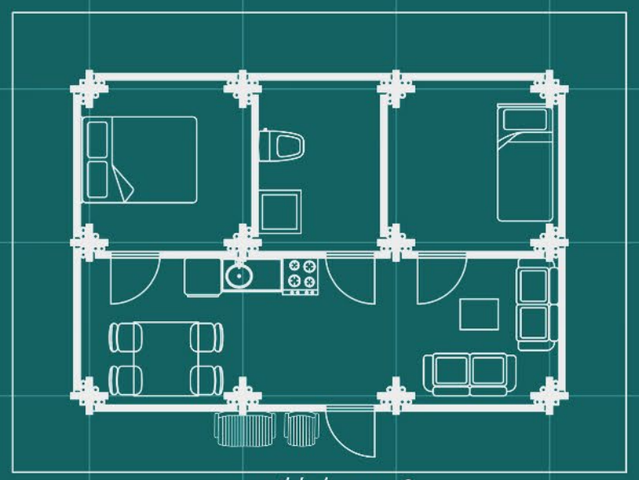
1:150

0 7.5 m

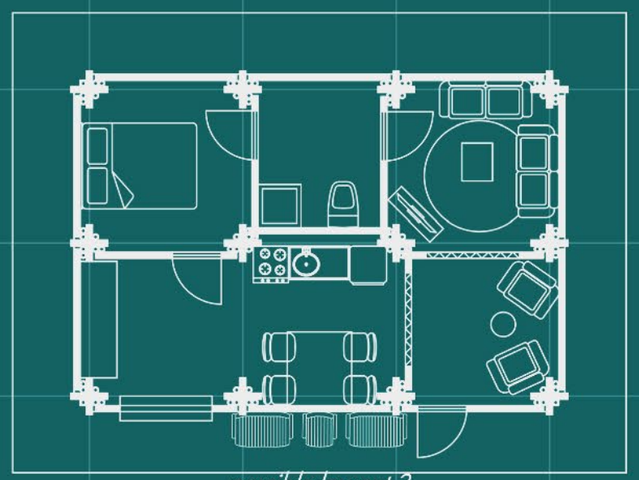
Housing Unit
Lay-out Variations



possible lay-out 1



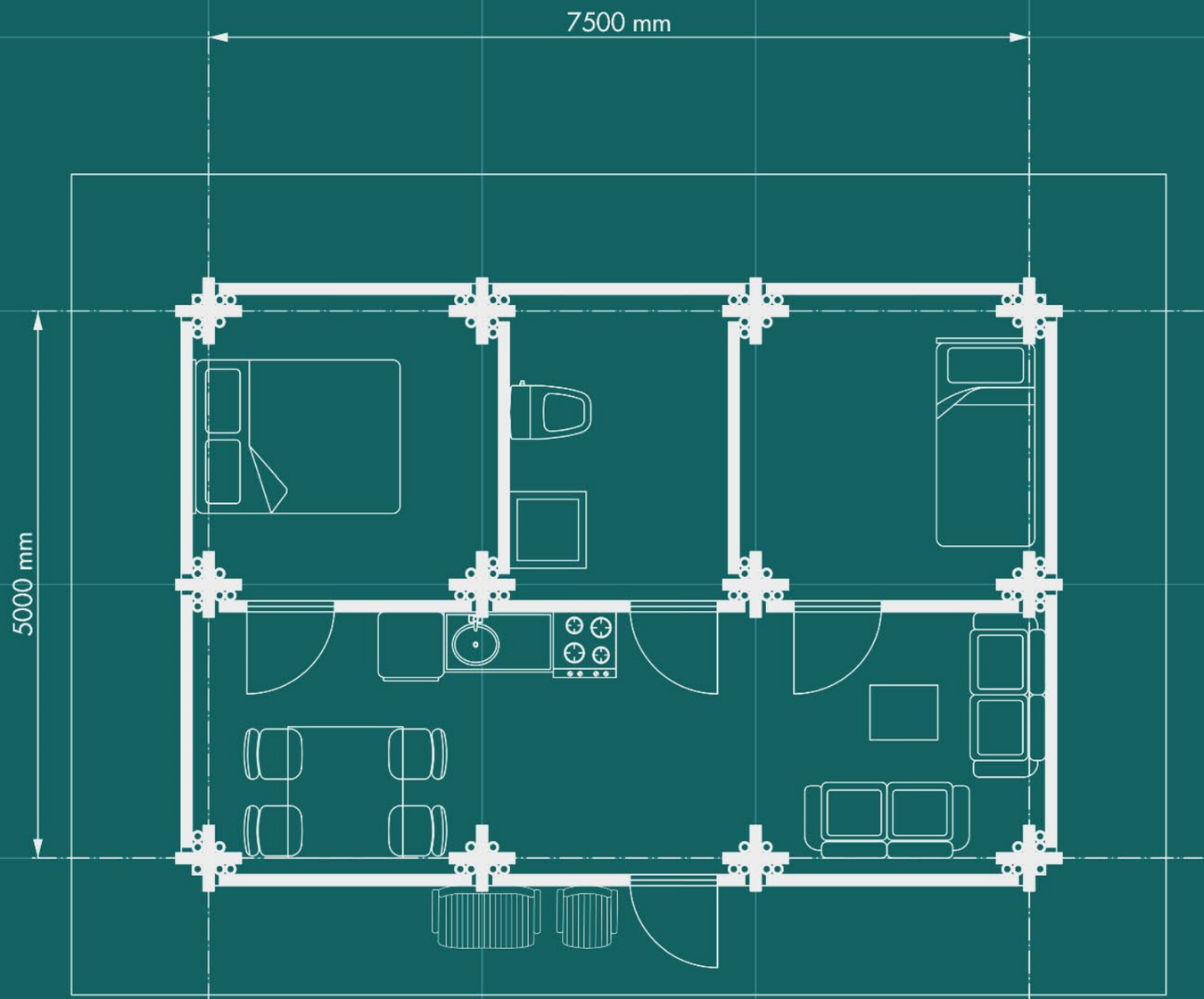
possible lay-out 2



possible lay-out 3

1:100

5 m 0



1:50

0 2.5 m

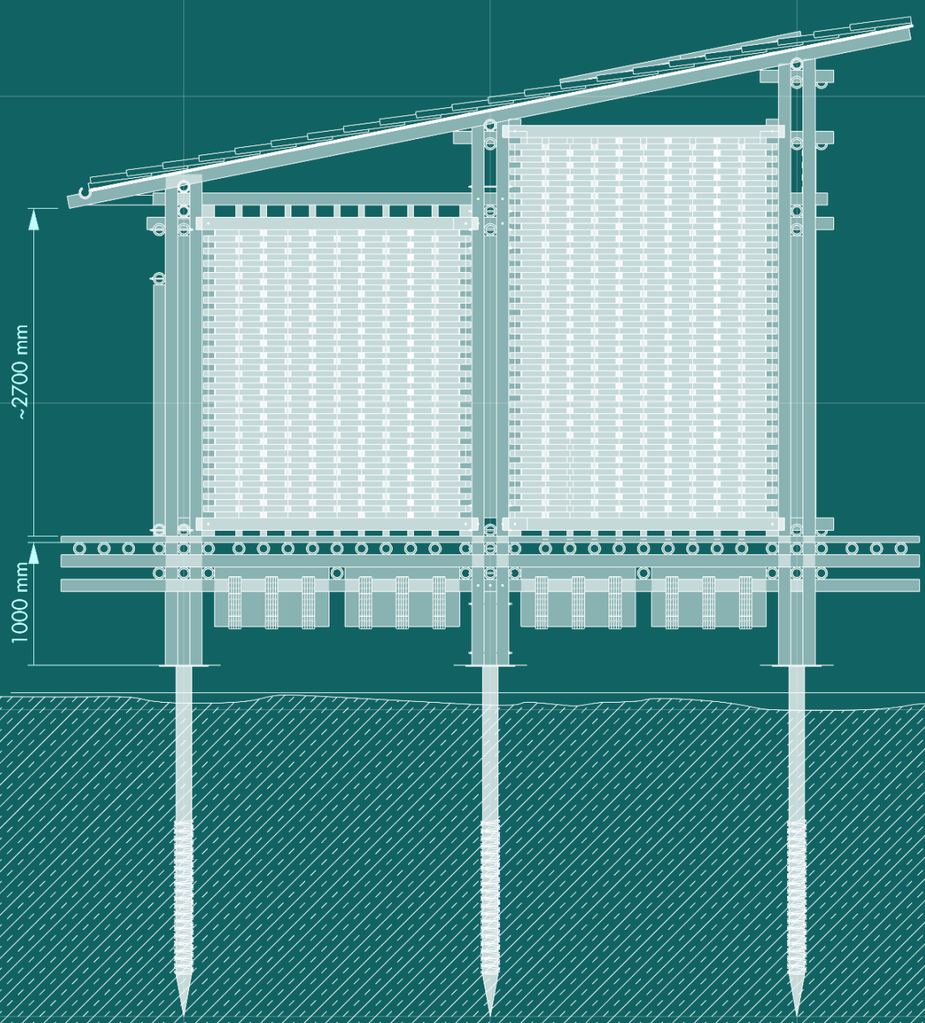
Housing Unit
Elevations

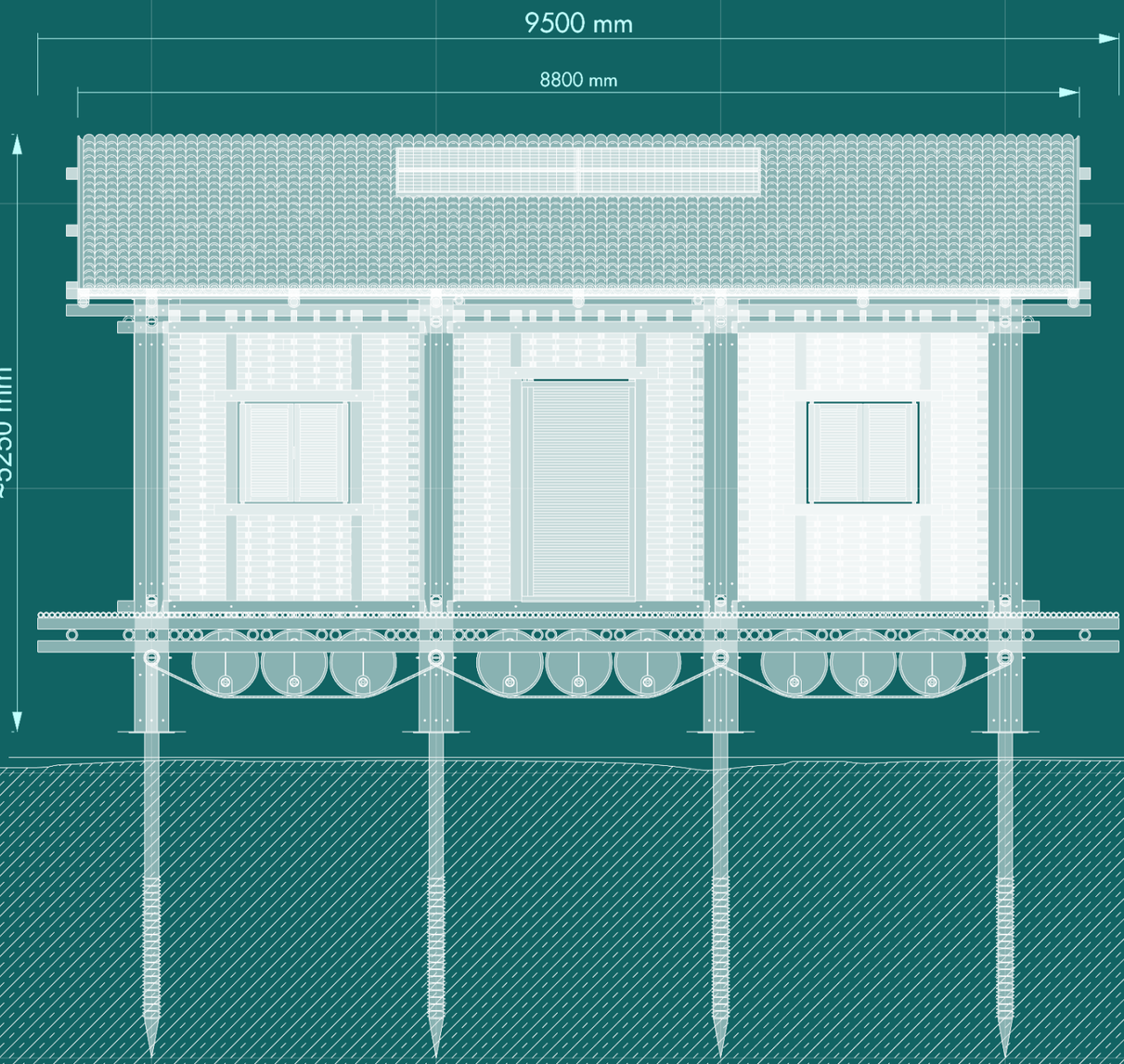
2500 mm

2500 mm

1:50

0 5 m



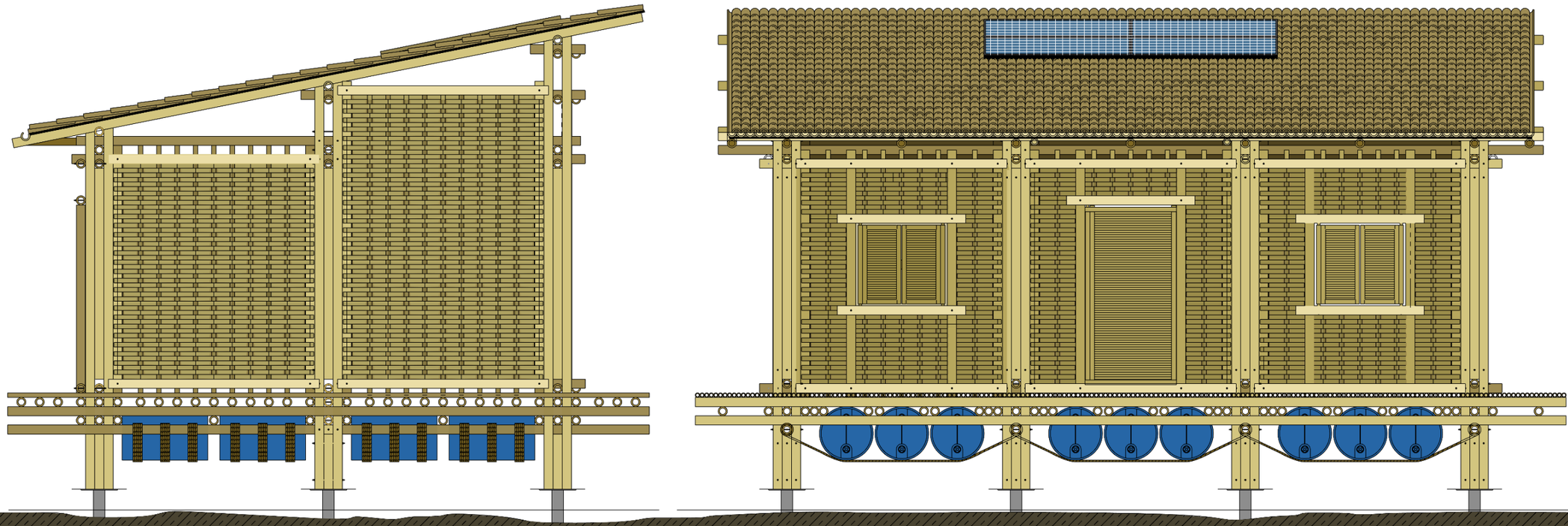


Housing Unit

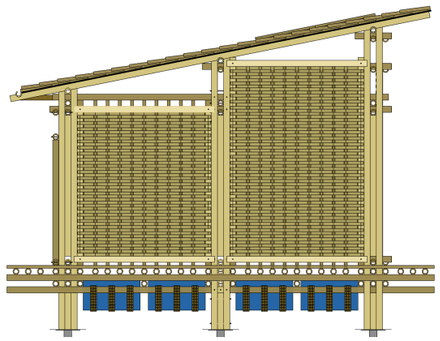
Elevations

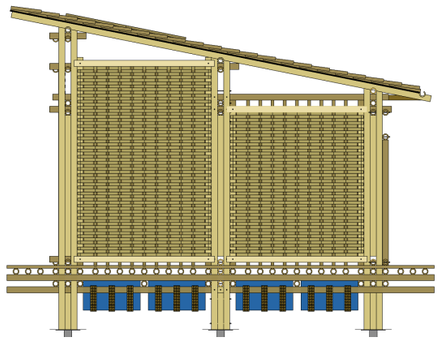
1:50

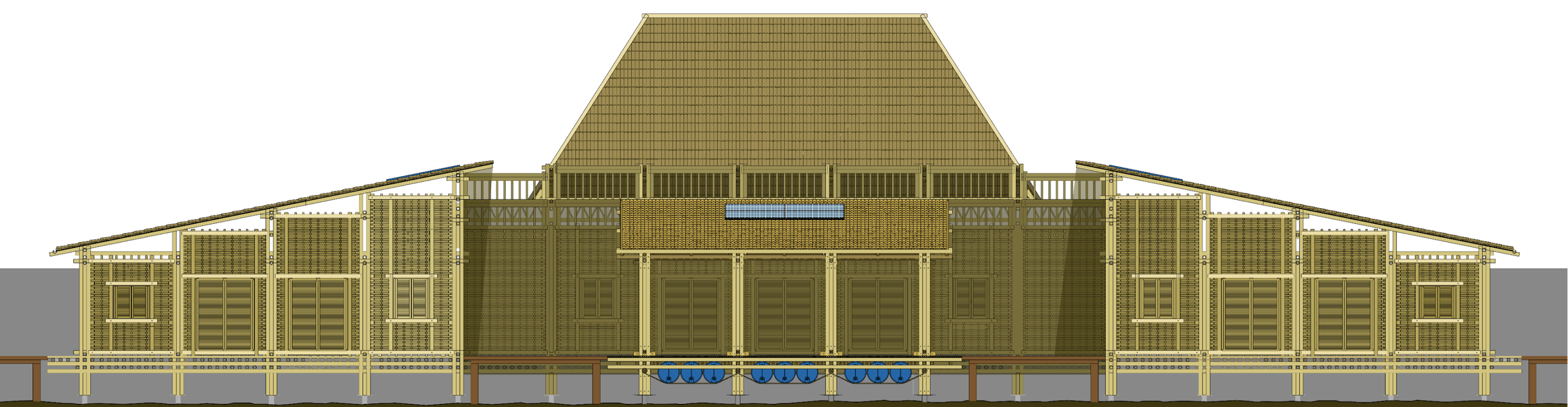
0 5 m



Community Research Center
Elevation





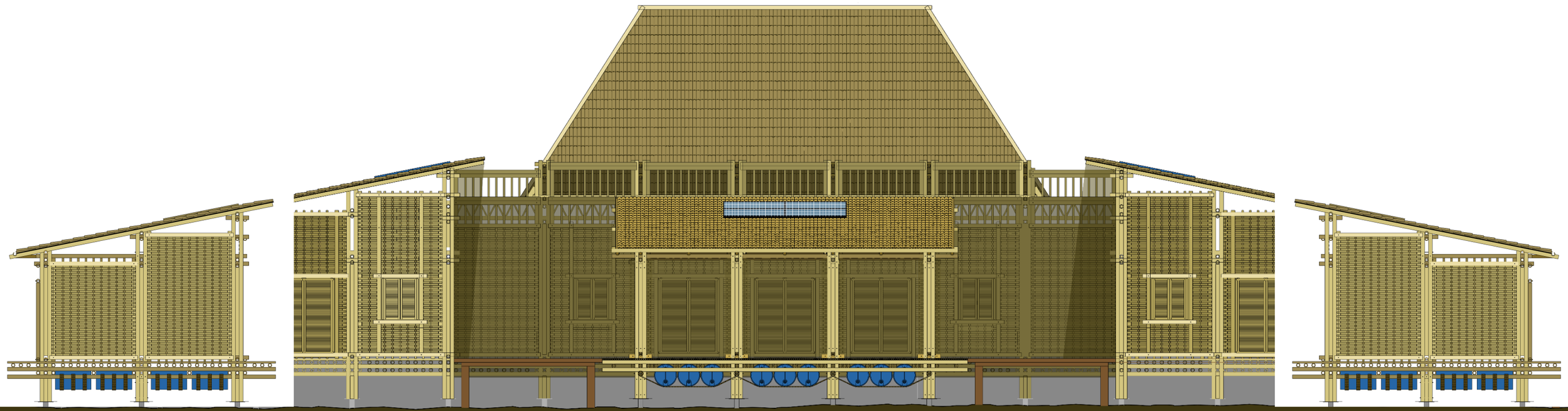


1:100

0 10 m

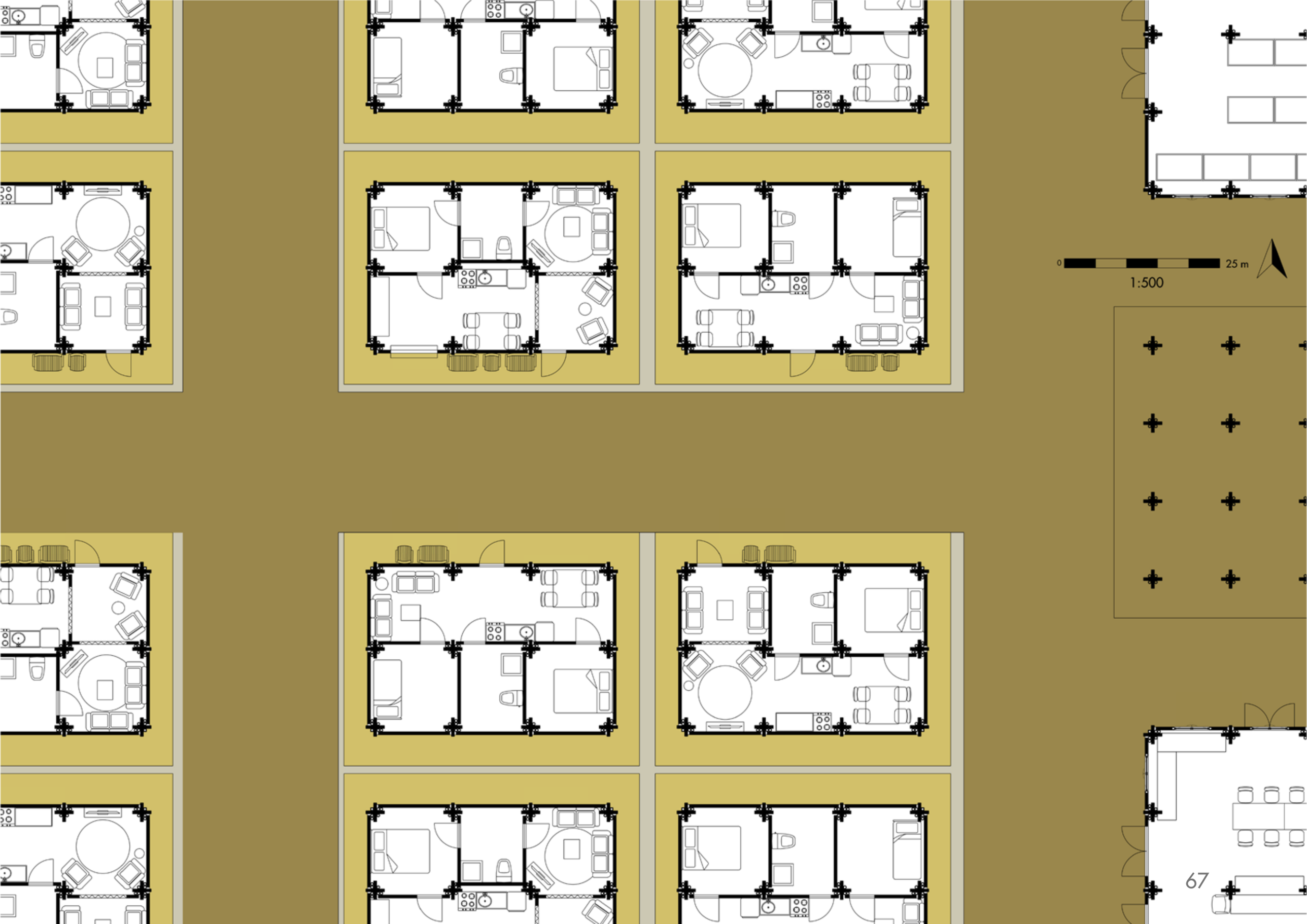
Community Research Center

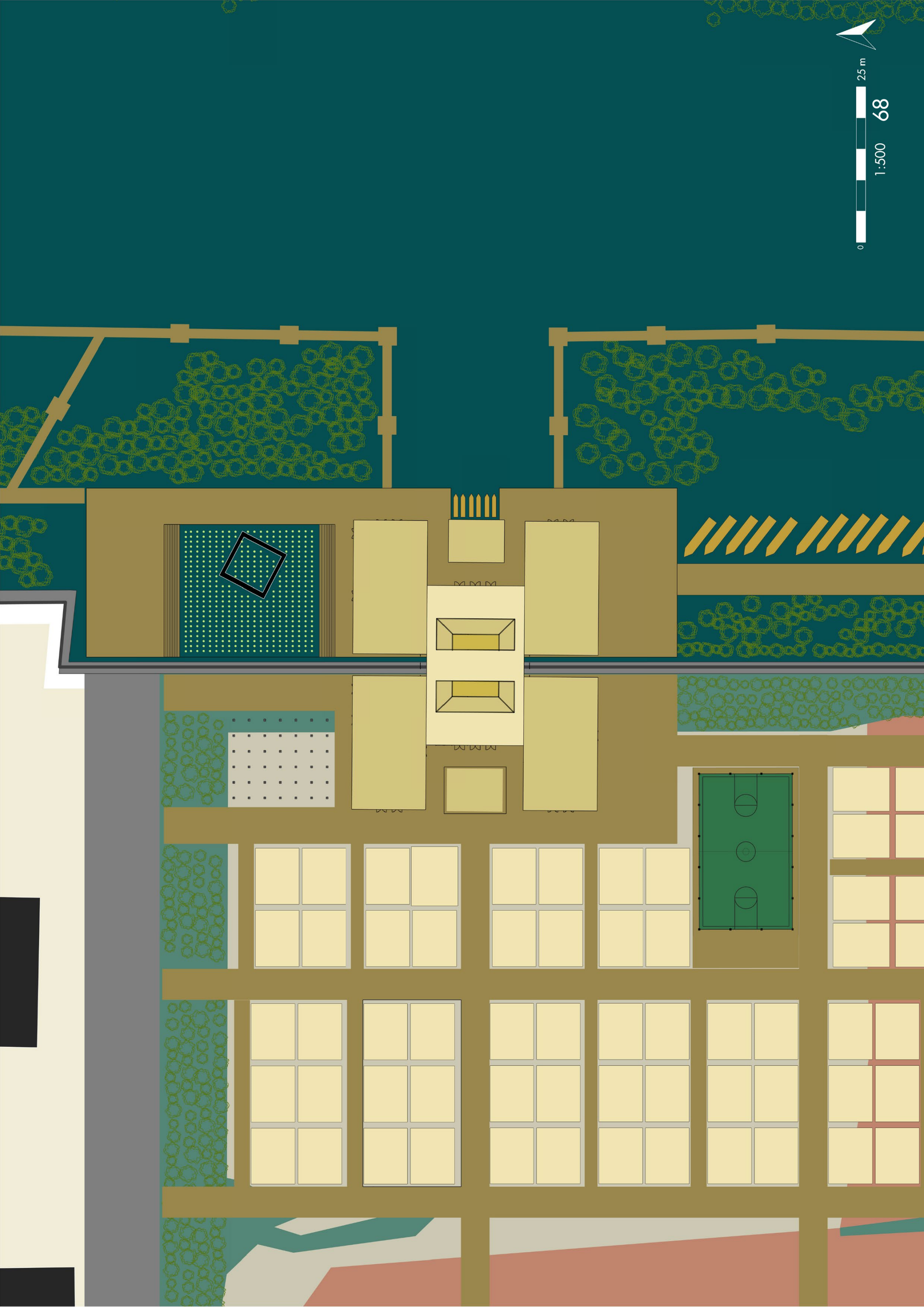
Elevation



1:100

0 10 m


0
25 m
1:500


25 m
0
1:500
68

Phasing strategy (2025-2050)

How will this plan develop over the years?

0 100 m

1:2000

greenery/trees

buildings

wet ground

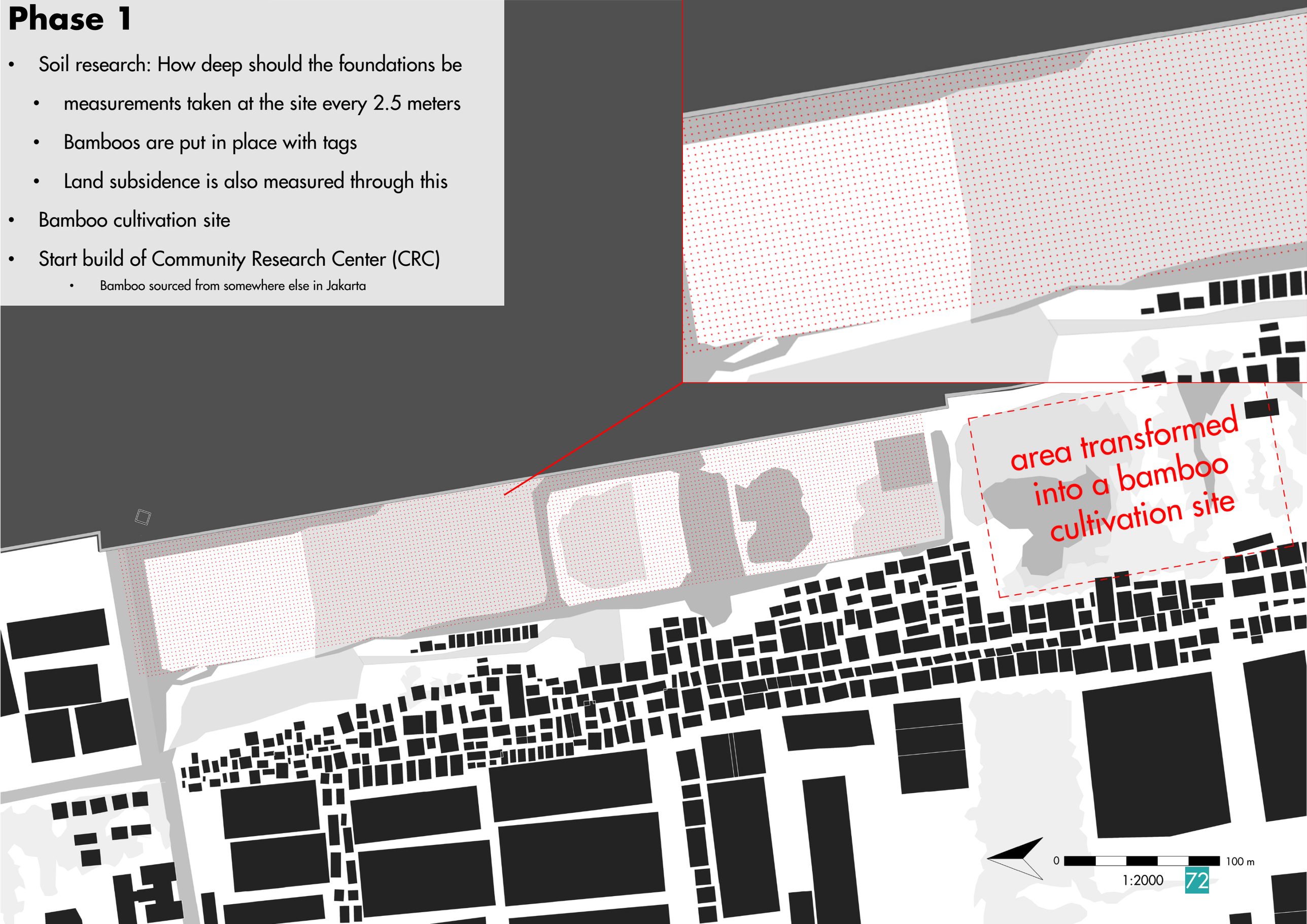
soft soil

semi-hard soil


0
100 m
1:2000

Phase 1

- Soil research: How deep should the foundations be
  - measurements taken at the site every 2.5 meters
  - Bamboos are put in place with tags
  - Land subsidence is also measured through this
- Bamboo cultivation site
- Start build of Community Research Center (CRC)
  - Bamboo sourced from somewhere else in Jakarta

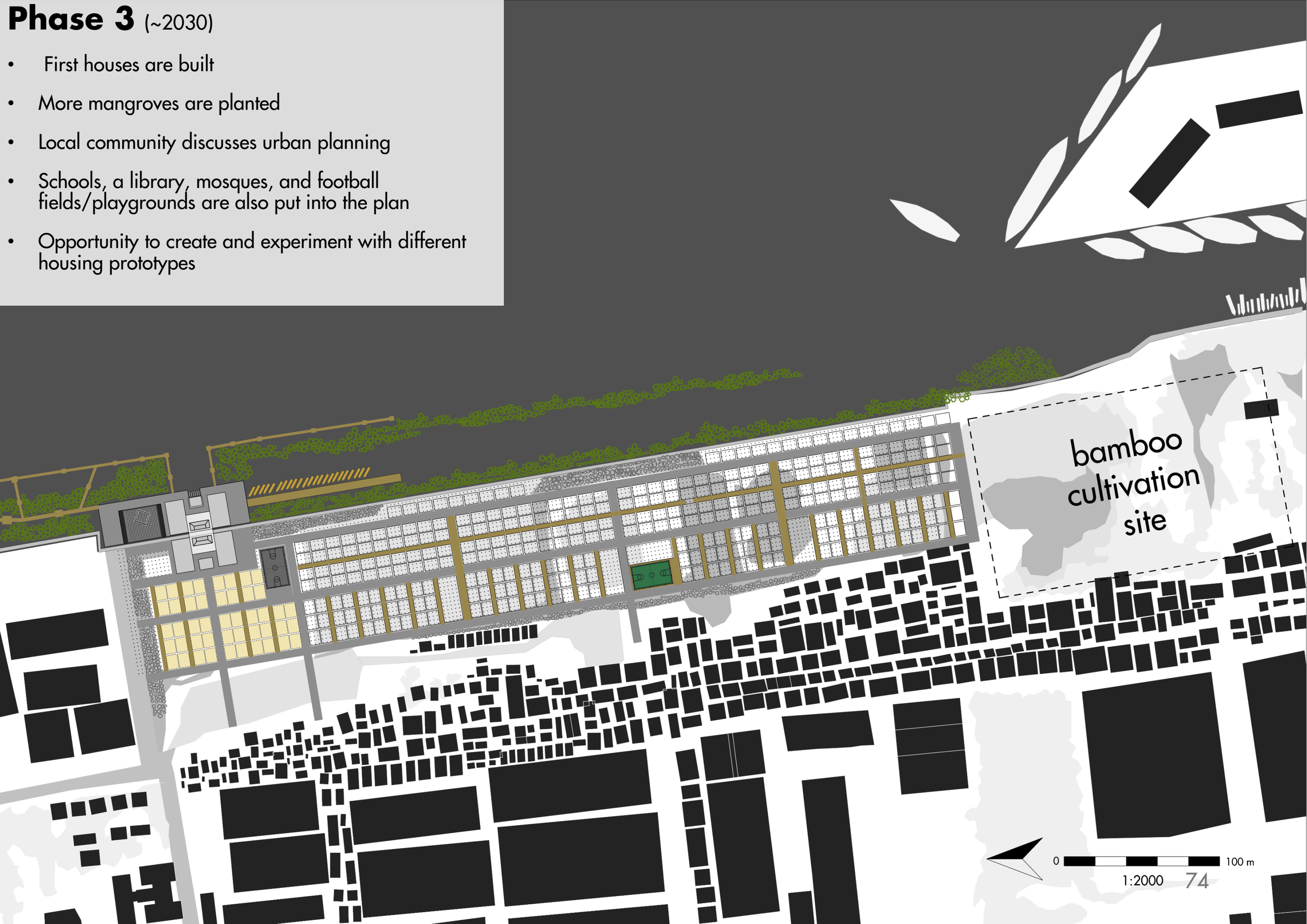


Phase 2 (1-2 years after first phase ~2027)

- CRC finished
- First mangroves are planted (behind the wall)
- Amphibious football field built next to CRC to attract local community
- Local community learns about building amphibious houses and mangrove forestation
- Road decks are constructed

Phase 3 (~2030)

- First houses are built
- More mangroves are planted
- Local community discusses urban planning
- Schools, a library, mosques, and football fields/playgrounds are also put into the plan
- Opportunity to create and experiment with different housing prototypes



Phase 4 (~2040)

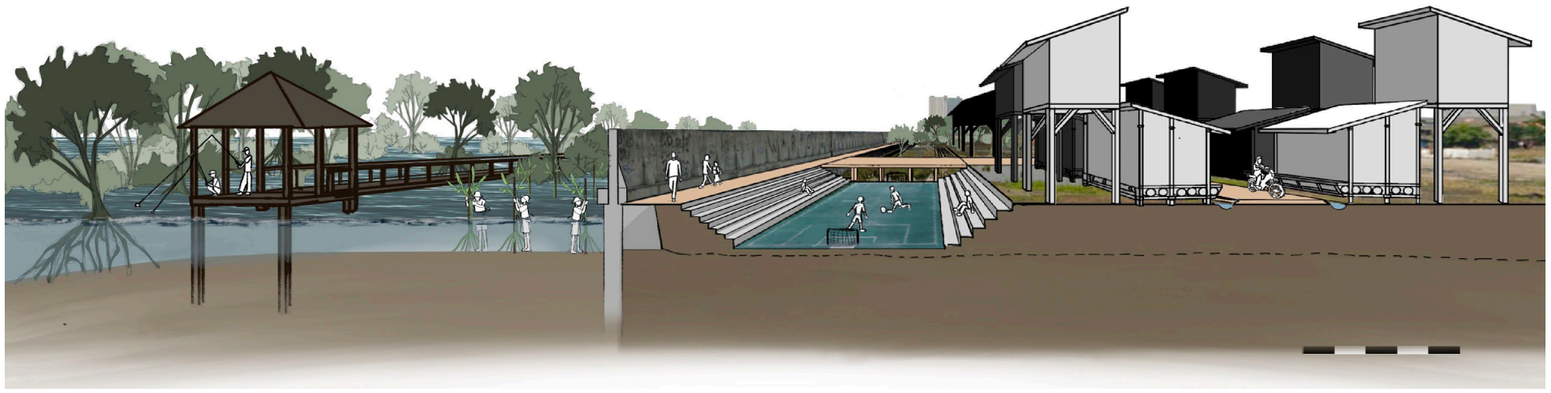
- The site is fully built
- Mangroves have fully matured
- Community Learning Center and Houses are inspected in case replacements are needed
- Knowledge is passed on to other coastal communities

Phase 5 (2050)

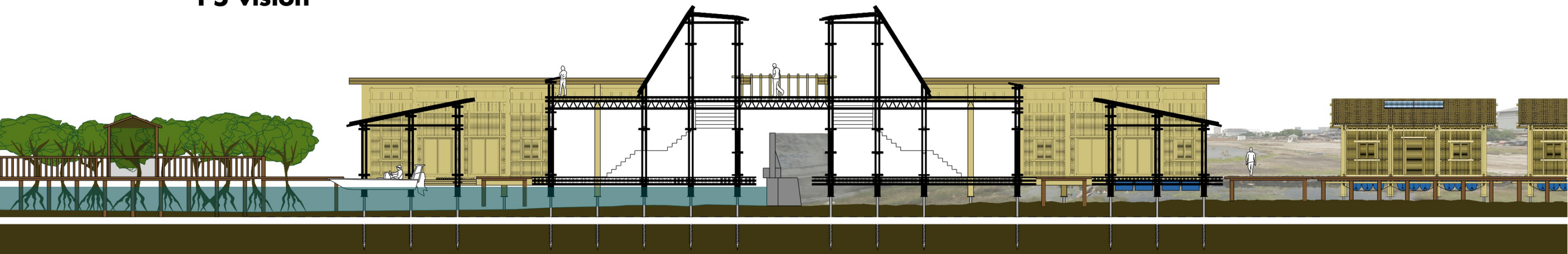
- Seawall has completely sunk or deteriorated
- The site has become a tidal zone
- A bridge on the ground floor between the two sides of the community research center is made

Current situation

P2 vision



P5 vision



1:200

0 10 m

Questions?