Estelle Veron

THE DICHOTOMY OF RIVERBANKS

Paradox of wasted landscapes and housing redevelopment

Keane Bridge, Sylhet, BANGLADESH

TU Delft | MSc Architecture, Urbanism, and Building Sciences

Estelle Veron - 5864313

AR3AD105 Dwelling Graduation Studio : Global Housing
Architecture of Transition in the Bangladesh Delta

2023-2024

Ir. Rohan Varma
Ir. Rocio Sanchez
Prof. Marina Tabassum
Prof. André Mulder

TU Delft
Delft University of Technology
Faculty of Architecture
and the Built Environment

Preface

I would like to express my deepest gratitude to my supervisors, Marina Tabassum, Rohan Varma, Rocío Sanchez, Nelson Mota and Dick van Gameren, who have accompanied and guided me throughout this project with much expertise and availibility. Particularly Rohan and Rocío, who closely and actively followed the progress of this work, challenging and motivating me over the weeks. Also, I want to thank my friends in the studio, with whom we formed a great and supporting team during the year. Mille mercis Caspar for your indefectible support help and patience, particulary in stressful moments. A heartfelt thanks to my parents and to the helping hands at home and to the friends who assisted me – especially Charlotte and Bérénice. And lastely, all my thanks to the people in Bangladesh who provided me with valuable documents, exchanges, and information, essential for the completion of this work.

Introduction

Geography

Research

Design

Bibliography

INTRODUCTION

Introduction

In recent decades, Bangladesh has been facing a rapid spread of urbanization with significant growth of its population. As highlighted by Ahsan et al. (2023), the housing situation in metropolitan regions is under pressure due to a considerable increase in rural-to-urban migration and the growing concerns of climate change along the coastal strip. This has led to an increase in informal housing, overcrowding, and the establishment and growth of slums. With this urban development, challenges have emerged around health issues, environment, sustainability of cities, urban poverty, weak policy framework, housing market, unemployment, urban services, to name a few (Afroza et al., 2021).

A notable consequence among many of these challenges is the increase in waste, far from going unnoticed given the amount dumped on the riverbanks and on wasteland. Solid waste has become one of the most prominent environmental problem in developing countries (Alam et al., 2006), or as Connet (2007) puts it, "Waste is the evidence that we are doing something wrong. Landfills simply bury the evidence and incinerators (by whatever fancy name they are called) simply burn the evidence".

As the production of waste increases significantly in line with the grow in consumption, it becomes a tangible indicator of societal challenges. Research by Voukkali et al (2023) showed that, the higher the population density in a region, the greater the volume of garbage produced and, consequently, the infrastructure necessary for waste management.
Sylhet City, in the north-eastern part of Bangladesh, is one of those many cities facing this challenge. It is the most important town in the Surma River Valley (Britannica, 2023). Because of uncontrolled and unplanned rapid urbanization, the municipality is largely overwhelmed regarding the collection and disposal of increasing amounts of waste (Medina, 2005). Considering this is not an industrial city, the majority of the garbage that is produced here is from domestic, commercial, and clinical nature. According to the Sylhet City Corporation, about 100 tons waste per day were generated in 2004, increasing 2,5 times by 2017 (Sylhet City Corporation, 2018).

The consequences of this urban development, characterized by housing shortage and the escalating problem of solid waste disposal, emphasize a critical environmental concern in developing countries, shedding light on the intricate web of social and economic dynamics.

Problem Statement

Since the majority of current waste management systems and infrastructure face challenges in operating efficiently across various community types, including municipalities and informal settlements, the consequence is a detrimental effect on social, economic, health, and environmental aspects. This spans from pollution and environmental deterioration to a diminished quality of life for populations (Giusti, 2009). The rate of vulnerability is even higher in informal settlements, characterized as « an unofficial group of temporary residential structures, which can be of any size from one to several hundred structures, including tents, prefabs, and self-built shelter structures » (Unicef, 2011). The research on housing in the global south generally agrees that irregularity and illegality are the most frequent ways for the poor to populate and urbanize places. When formal housing is out of reach financially and public housing is insufficient, the poor are frequently left with little choice except to live irregularly and illegally in cities (Caldeira, 2017).

The Sweepers Colony and the Muslim community

One example among others is the informal settlement build on the southwest banks of the Surma River, next to the Keane Bridge in Sylhet. It is inhabited by a Hindu and a Muslim community, comprising approximately 380 families. A field trip to Sylhet, enabled to acquire information about this settlement, comprising a subset of 21 families primarily belonging to the Hindu community, and which are often referred to as the Sweepers Colony. They are part of the Dalit caste, the lowest stratum of the South Asian caste system, and are responsible of street and domestic cleaning in Sylhet (Un Women, 2018). Due to their caste position, they are assigned to low-paying tasks that are referred to as „dirty". Dalits experience poverty and marginalization, facing severe constraints in obtaining

Old Port, Dhaka, E.V.

education, employment, housing, healthcare, and public services. This is especially true for Dalit women, who experience injustice due to their caste, gender, and poor socio-economic status, even though gender equity is a concern for the whole Global South (IDSN, 2023; Nazneen, 2019). Discrimination and exclusion place the Dalit on the very fringes of Bangladeshi society, in slum areas.

Lacking land ownership, they might be compelled to reside on abandoned land or on government-owned property (IDSN, 2023). The government gave the land plot to the Sweepers Colony near Keane Bridge in exchange for utility and service fees, as is typically the case with most of the Sweepers Colonies in Bangladesh. Over time, their families developed, but the space in which they reside cannot expand (Mukhim, 2021; Hakim, 2022).

Moreover, the on-site visit gave an insight of the remaining Muslims who live in this slum. They do not belong to the cleaning community and, in contrast to the Hindus, are required to pay rent because the land is leased by someone else. They can continue to build more of these temporary dwellings, until the entire plot is fully occupied. Observations during the field trip revealed the rudimentary accommodation and the precarious conditions in which the community lives. No conflicts exist between the two groups inhabiting the slum area.

Solid waste management

Solid waste disposal is either ineffective, inadequate or non-existent in Sylhet city (Ahmed, 2014), despite the solid waste management program that has been established by Sylhet City Corporation. It includes the collection of waste by private companies. Households pay for the pick-up of the waste that is transferred to dumping stations and the city disposes of the waste.

The households that cannot afford to be part in this waste collection process, dump their garbage in open spaces, and it finally ends up in the drainage network (Pervin et al., 2020). The primary method of managing solid and liquid waste in Bangladesh involves the widespread practice of open-field dumping. Each day, various types of waste materials are directly disposed of into river water (Uddin et al., 2021). Urban solid waste management difficulties have been linked to various factors, including inadequate funding, a lack of community involvement, and a lack of implementation of proper laws (Al Mamun et al., 2018).

There is a need of necessary infrastructure for a sanitary and engineered dumping site to ensure safe disposal and there are transportation shortcomings since it does not provide full coverage of residential areas for the collection of household waste. Moreover, landfills are going to be completely filled up (Pervin et al., 2020 ; Ara et al., 2021) prompting perhaps a consideration of alternative waste disposal methods to replace the current practices, as they do not seem to be a sustainable solution. Due to the absence of a formal waste disposal site around Keane Bridge, the collected trash by the Sweepers Colony is simply discarded along the riverbanks. This dumping ground exists because of the open space the riverbank provides, and it is exacerbated by the high level of activity occurring in the area. The riverbanks and the river serve various daily domestic purposes, including bathing, washing, drying the laundry, fishing, transportation, shipping, cultivation, to name a few (Ferdous, 2017).

Public health and environmental issues

However, the unrestrained discharge of untreated waste has polluted the Surma River to an extent that endangers both water security and the health of individuals living and working along the riverbanks (Ferdous, 2017). Apart from the technical issues of waste management, the absence of a comprehensive effective waste disposal solution in Bangladesh entails a multitude of public health hazards as can be seen in the Keane Bridge area in Sylhet. Solid garbage clogs urban drainage systems and worsens urban flooding and waterlogging when it is dumped in canals and public areas, although those drainage canals are not sufficient to carry even moderate rainfall (Pervin et al., 2020 ; Islam et al., 2017). The southern side of the Surma River in the Keane Bridge area is low and becomes often flooded. Open dumps make the soil impermeable and increase the risk of flooding (Pervin et al., 2020). They may produce leachate, gas, stink, dust, and potential fire hazards, which can pollute the

Slum, Keane Bridge, Sylhet, E.V.

air, water, and soil (Hossain et al. 2018). Contamination of the groundwater aquifer and of the land is as well a major concern (Vasanthi et al., 2008). The risk for humans and animals of developing infectious diseases and physical disability rises when waste is dumped on open landfills, because of the pathogens and toxic elements that are proliferated by windblown dust, rats, insects, and rodents' droppings (Hossain et al. 2018).

Research questions

Sylhet City, overwhelmed by uncontrolled urbanization, faces a critical environmental concern marked by housing shortages and escalating waste problems. The inefficiencies in current waste management systems across various community types, have direct impacts on social, economic, health, and environmental aspects. Informal settlements, exemplified by the Sweepers Colony and the Muslim Community near Keane Bridge, present heightened vulnerability due to their socio-economic status and irregular housing practices. The Keane Bridge riverbank reflects only a fragment of a larger problem faced by Bangladesh and in general in South Asia. This research aims to gain a deeper understanding of the needs of riverine communities to preserve their activities and to explore how design and infrastructure interventions can improve people's living conditions on the riverbanks by addressing the following question :

What potential can a comprehensive urban housing redevelopment have for impacting human behaviour concerning waste management issues along the riverbanks of the Surma River in Sylhet ?

_Community - waste

What present activities and practices occurring along the riverbanks contribute to the challenges associated with waste management?

_Architecture - waste

How can sustainable design interventions convert the issue of waste management in Sylhet into an opportunity for improvement?

_Community - architecture

How can architecture shape socio-spatial relationships between individuals and their environment to promote a sense of responsibility for waste management in Sylhet City?

Methodology and replicability

_Field work

On-site observations serve as an initial method to gather visual data, including photographs and videos, along with note-taking. This approach aims to acquire insights into current waste management practices in Bangladesh, specifically centered around Keane Bridge. It also seeks to understand the living conditions of residents in various community types, including the Sweepers Colony and slums inhabited by Muslim communities, exploring the role of architecture in these domains. In person discussion with Willem Gees, Managing Director of Eco Home Solutions, provided information about alternative construction methods aimed at reducing the carbon footprint in the building sector. An interview was also conducted with Fahim Uddin, Managing Director of Garbageman, who is leading a project about building a clean and better Dhaka by providing an efficient waste management system for city dwellers and engaging them in the upcycling process of creating resources from waste.

_Mapping

It is essential for this research to map the different activities that take place along the riverbanks of the Keane Bridge, for example in a 0,5 kilometer radius, and to examine how people utilize this space. The aim is to understand the broader challenge of waste management in the area and illustrate its potential for improvement.

_Literature review

Drawing on literature sources is essential to gain knowledge about current waste practices in Sylhet City, addressing gaps left by the fieldwork. This review will also investigate the overall problem of the riverbank's pollution but also their potential, as the problem extend to a larger scale.

Children from the Muslim Community, slum, Sylhet, E.V.

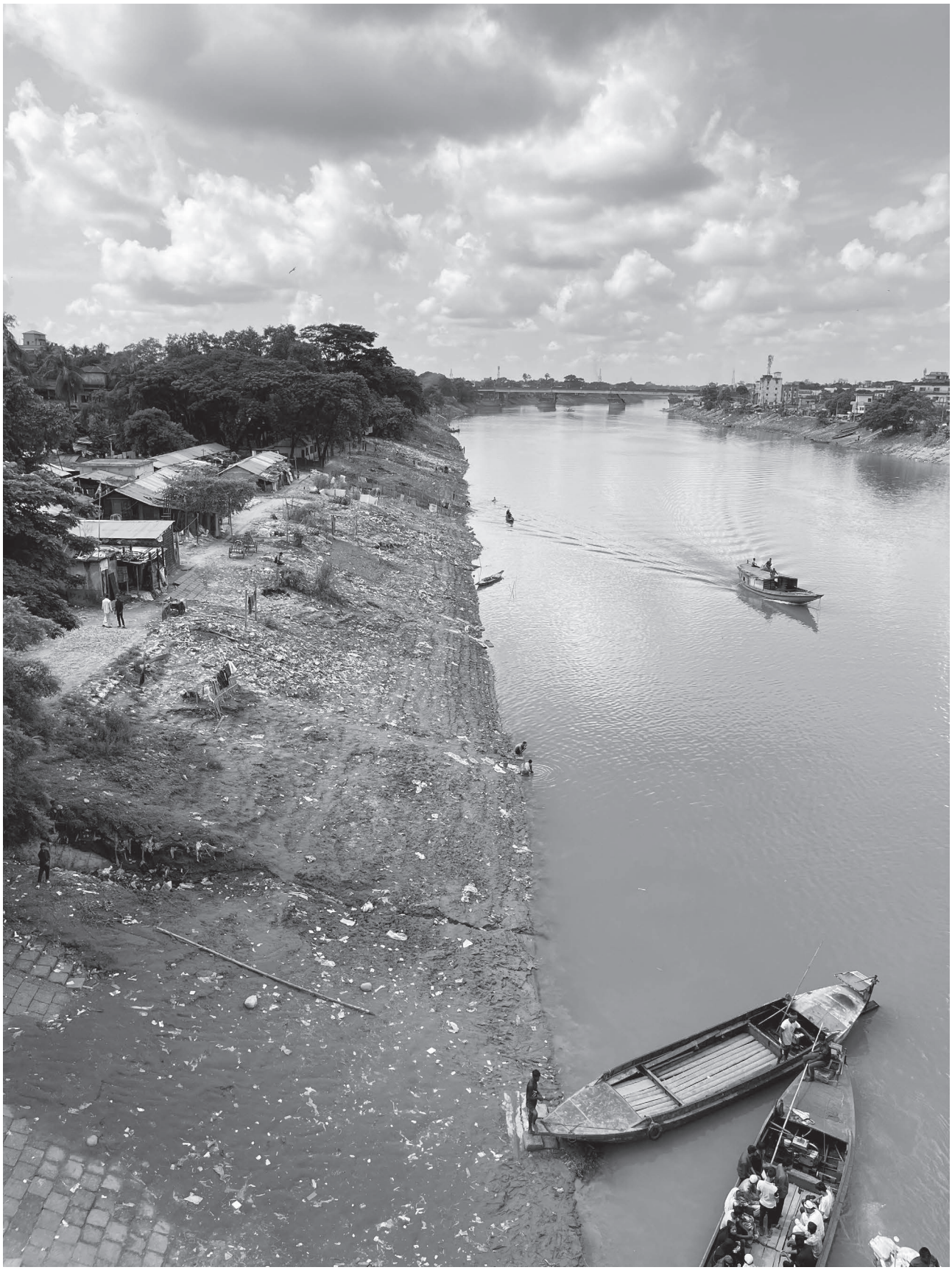
Research plan

_Questionnaire

A targeted questionnaire submitted to a Sylhet resident, Minhaz Vai, will enable the objective capture of lived experiences and provide information not accessible through other means. This approach enhances understanding of current waste management practices in the specific Sweepers Colony and Muslim community of the riverbank of the Keane Bridge.

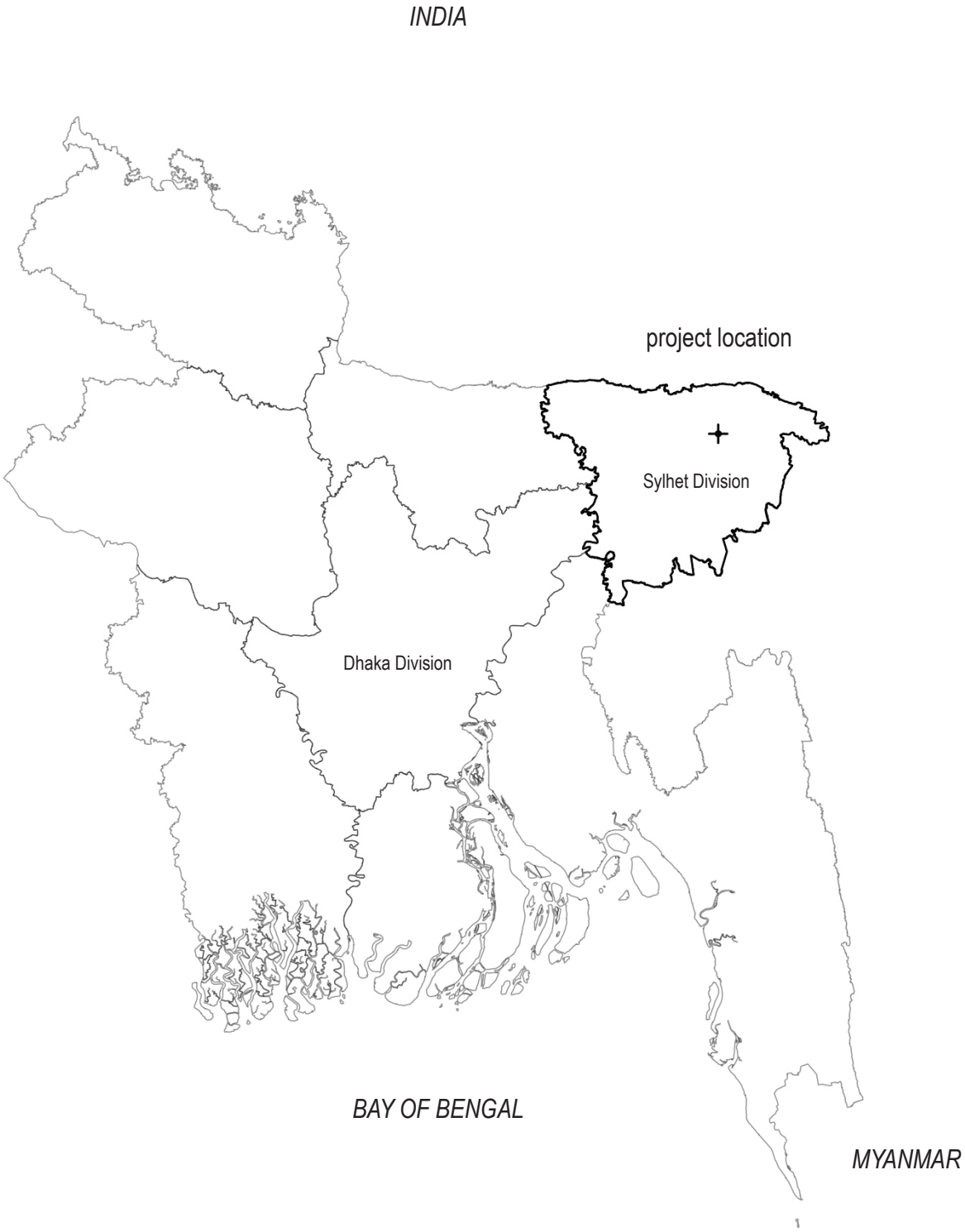
_ Comparative case study analysis

Analyzing and comparing precedents in the fields of architecture and waste in Bangladesh or similar contexts, with a specific focus on Sweepers colonies and slum inhabitants, allows to identify factors contributing to project success or failure. This analysis informs potential improvements and guides the project‘s direction.



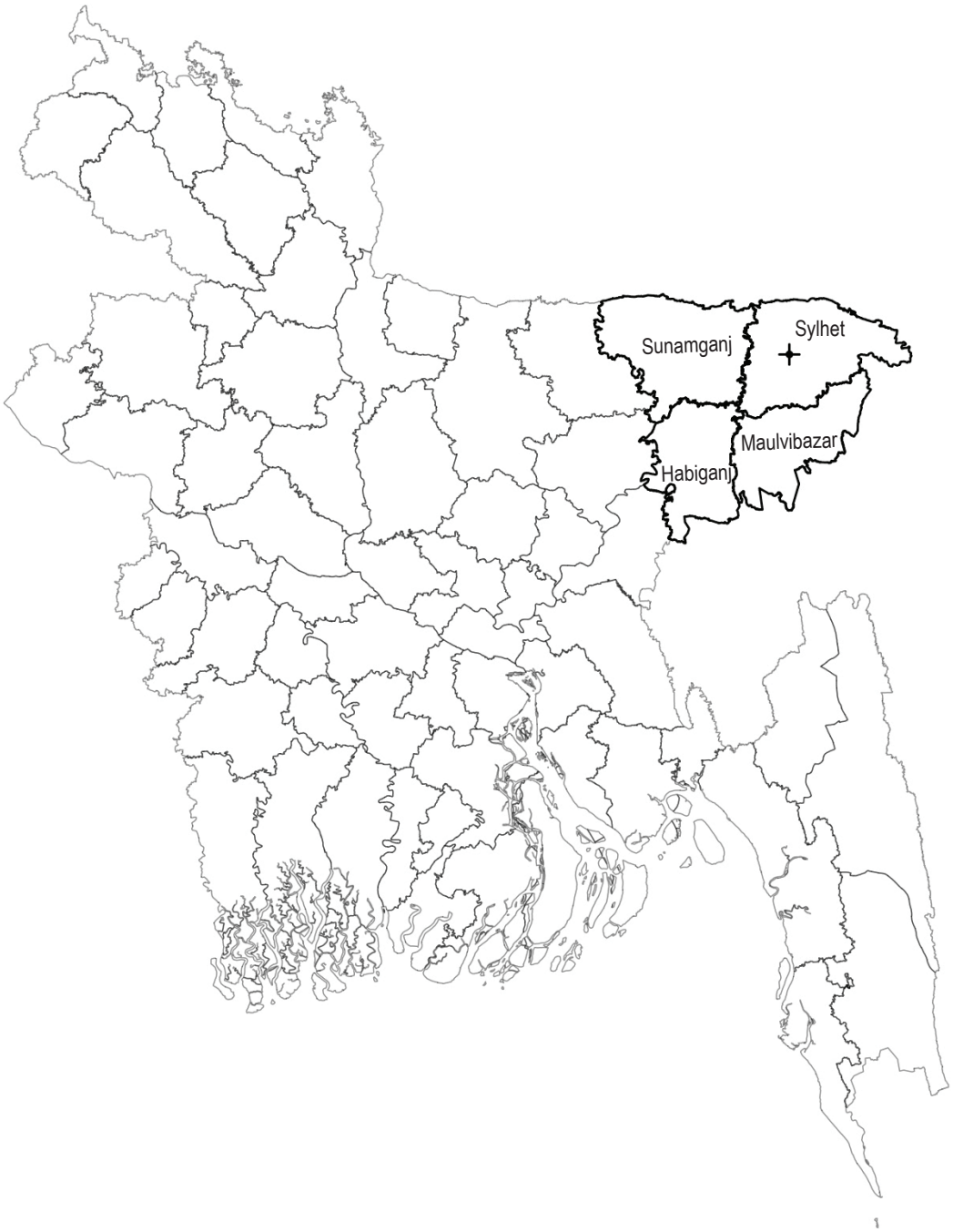
Southeast riverbank, slum, Keane Bridge, Sylhet, E.V.

GEOGRAPHY

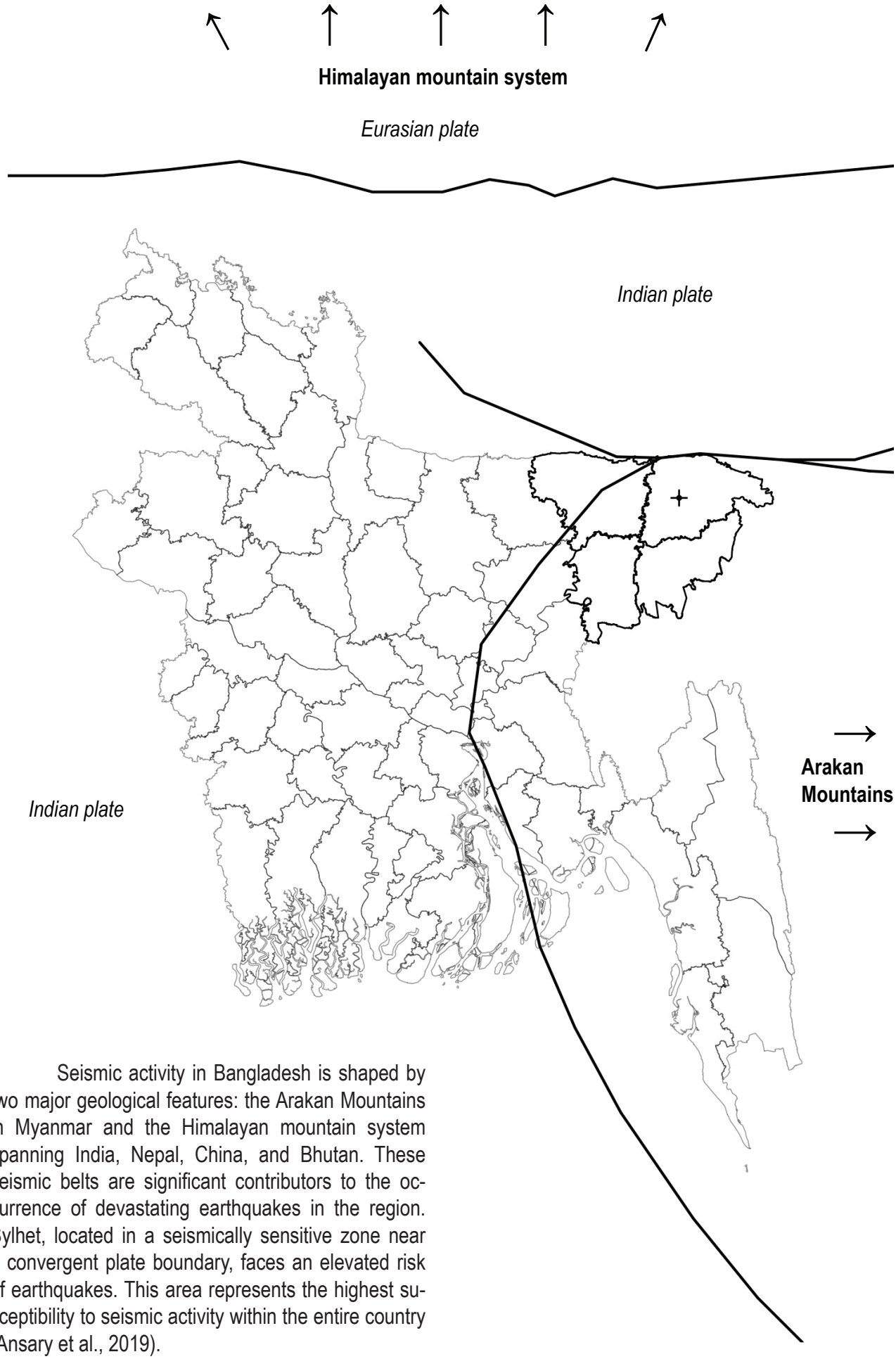


Situated in the Asian continent, Bangladesh shares land borders with India to the north, west, and east, and Myanmar to the southeast. The country covers approximately 145 000 km2 and is home to an estimated population of about 140 million people (Country Reports).

This chapter delves into three critical aspects of Bangladesh's geography, with a particular focus on the Sylhet Division. These factors - seismic activity, hydrology, and topography - significantly affect the livelihood of residents and must be carefully considered in urban redevelopment projects.



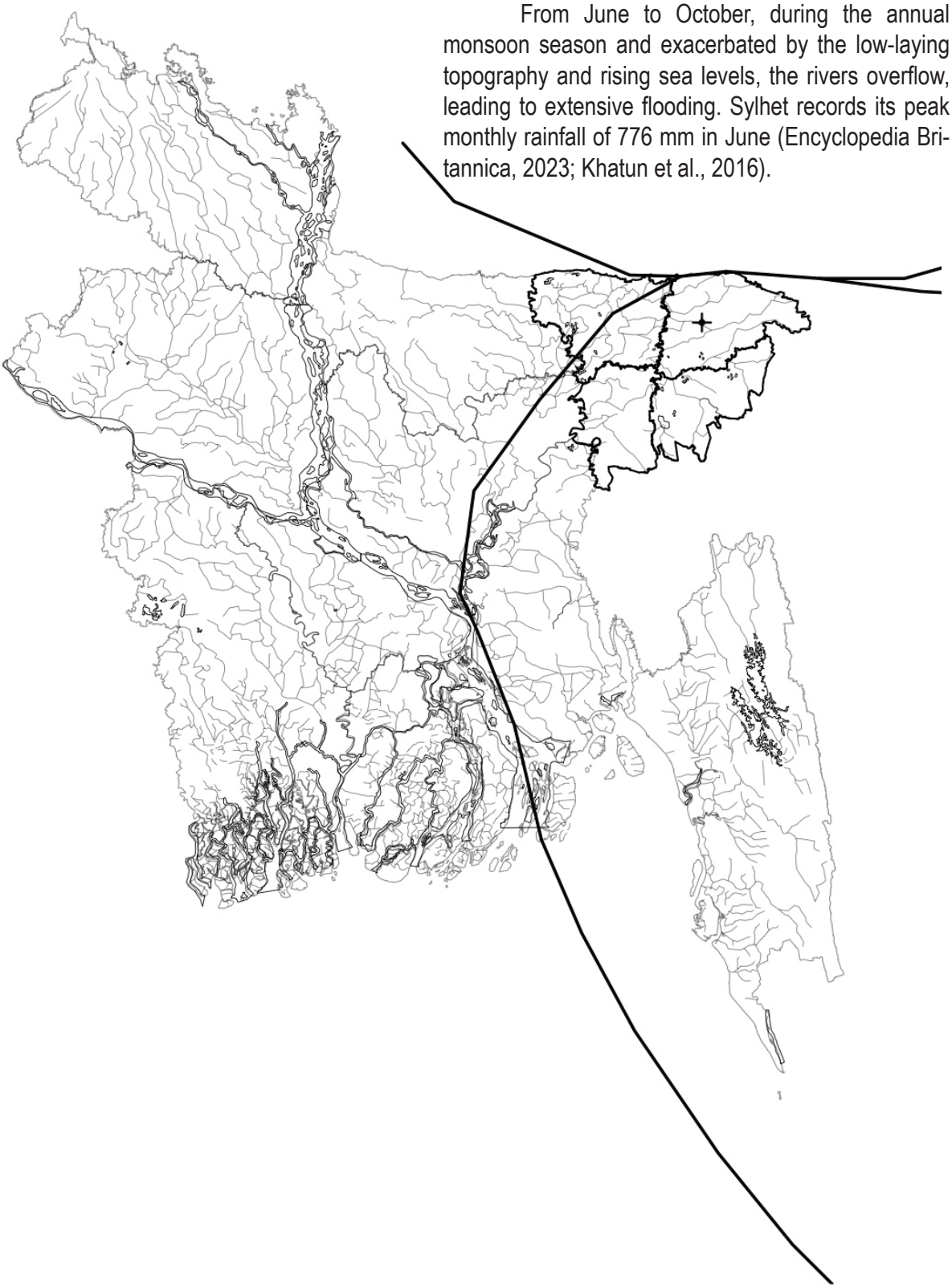
Seismic sensitive zone



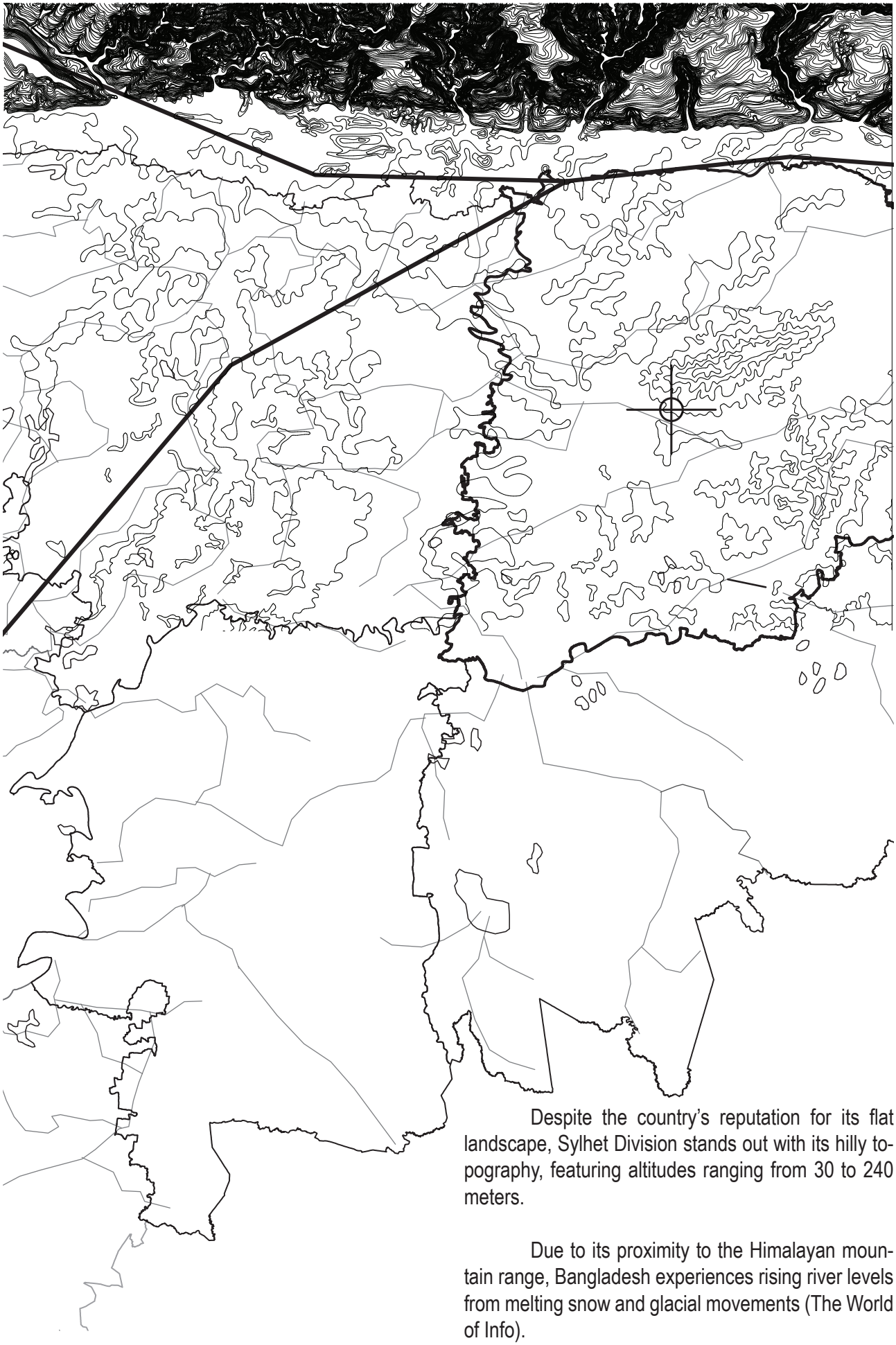
Seismic activity in Bangladesh is shaped by two major geological features: the Arakan Mountains in Myanmar and the Himalayan mountain system spanning India, Nepal, China, and Bhutan. These seismic belts are significant contributors to the occurrence of devastating earthquakes in the region. Sylhet, located in a seismically sensitive zone near a convergent plate boundary, faces an elevated risk of earthquakes. This area represents the highest susceptibility to seismic activity within the entire country (Ansary et al., 2019).

Bangladesh, one of the world's largest deltaic plain, is significantly shaped by its complex river network, constantly shifting patterns.

From June to October, during the annual monsoon season and exacerbated by the low-laying topography and rising sea levels, the rivers overflow, leading to extensive flooding. Sylhet records its peak monthly rainfall of 776 mm in June (Encyclopedia Britannica, 2023; Khatun et al., 2016).



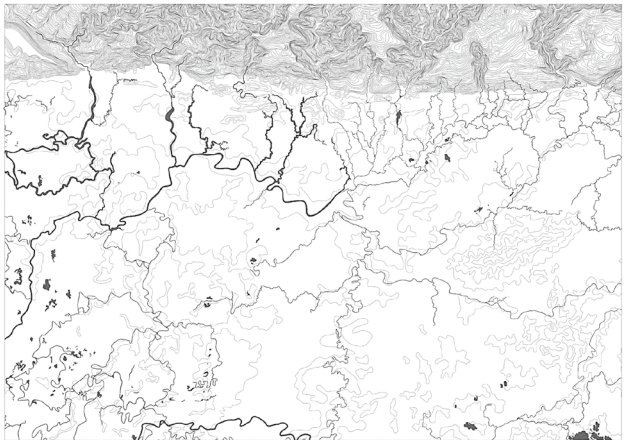
Topography

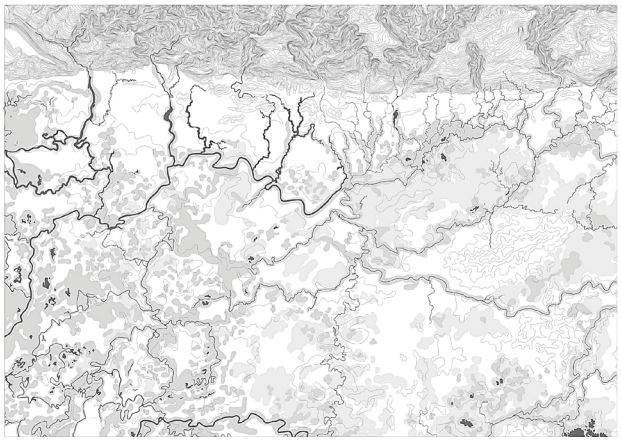


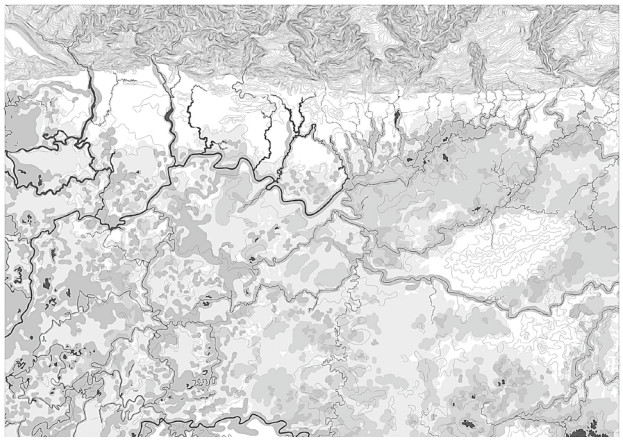
Despite the country's reputation for its flat landscape, Sylhet Division stands out with its hilly topography, featuring altitudes ranging from 30 to 240 meters.

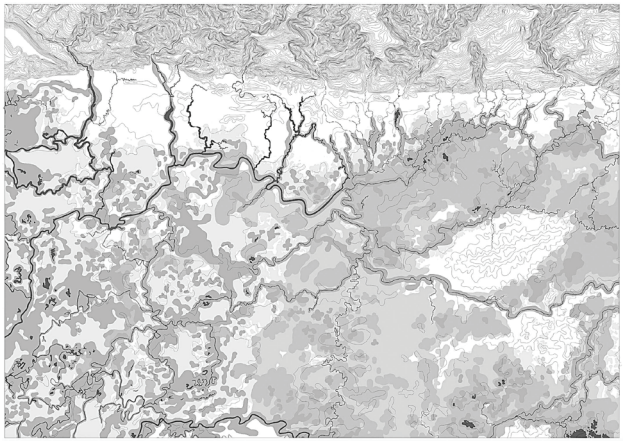
Due to its proximity to the Himalayan mountain range, Bangladesh experiences rising river levels from melting snow and glacial movements (The World of Info).

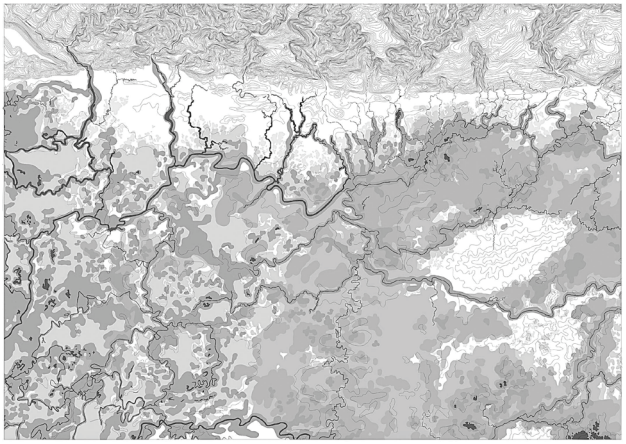
The maps show the river flows during the dry season and the growth of the flooded areas during the most heavy monsoon season in 2022. Over 71% of the yearly rainfall occurs in the monsoon period. On average, approximately 25% of Bangladesh's land is flooded each year. Climate change is expected to exacerbate these trends in the coming decades (Letsch et al., 2023; Shahid, 2010).











Felicitas Galle
Estelle Veron

Keane Bridge

Flood situation in Sylhet, Surma River overflows, 17/06/2022.

A monument of the city, Keane Bridge, Sylhet, Ariful Haque, 2008.

Surma River

The eastern part of Bangladesh experiences more than 4,400 mm of rainfall annually (Shahid, 2010).

Cherrapunji, located on the southern slope of India's Meghalaya Plateau is known as one of the wettest places on Earth. It receives exceptionally heavy rainfall, particularly during the monsoon season, with an annual average of 11,621 mm. The incessant rainfall in Cherrapunji has a substantial impact on flood risk in neighboring Bangladesh and contributes to the runoff that raises water levels downstream in Bangladesh, exacerbating the flooding situation (Murata, 2008).

The Surma River in Sylhet, located about 50 kilometers south of Cherrapunji, acts as a critical gauge for flood risk. From July 10 to July 31, during the height of the monsoon season, the Surma River consistently exceeded flood-danger levels in Sylhet (Murata, 2008).

The floods in Sylhet during 2022 began in May and persisted throughout the monsoon season, with the worst flooding occurring in June. The Surma river overflowed by 11 cm above danger levels. These measurements significantly exceeded typical annual flood levels (The Business Standard, 2022).

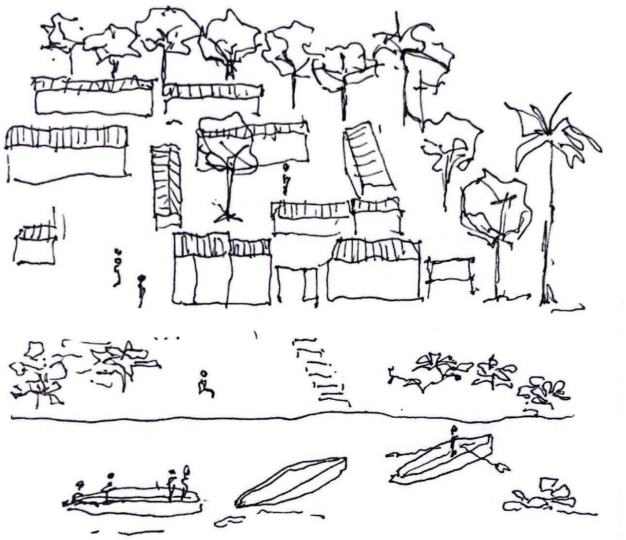
RESEARCH

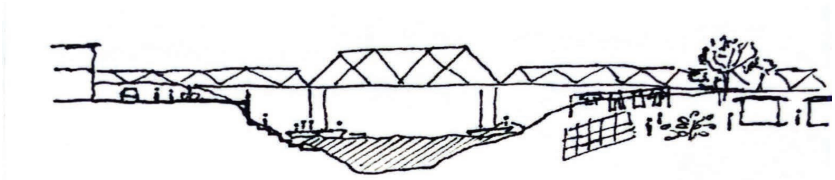
This section analyzes five factors concerning the project location, observed during the field trip in October 2023: slum, income generation, communities, riverbank activities, and solid waste management.

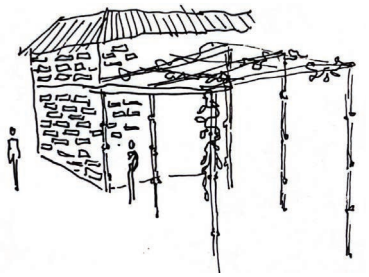
The project site is currently occupied by approximately 250 slum-dwelling families. As shown on page 30, the Muslim residences are constructed from repurposed materials such as bamboo, jute bags, and corrugated iron sheets. These houses are built directly on the ground, making them highly vulnerable to damage during river floods.

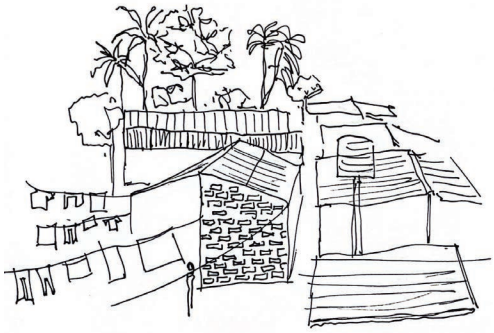
In contrast, the Hindu buildings, visible on page 31, are sturdily built with concrete and bricks, and roofed with corrugated iron sheets. These dwellings are elevated by at least 20cm on concrete plinths. The houses are painted in bright colors like green, pink, blue, and red, with shutters and doors in vivid tints that stand out against the walls.

Next to the construction methods, a notable difference between the two communities is cleanliness. The narrow streets and courtyards of the Hindu community are meticulously clean, swept, and tidy, providing a safe and healthy environment for residents and children to socialize and play. Conversely, the Muslim community's ground is littered with waste, where children play barefoot, and chickens, ducks, and dogs scavenge for food. This disparity in housing quality is explained in the «Community» section on page 35.





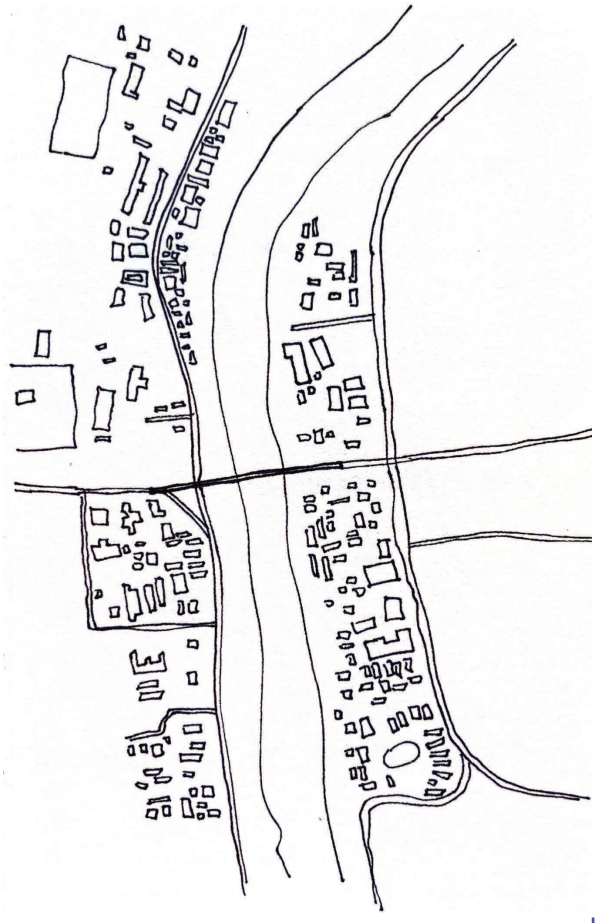




Slum

"lacking one or more of the following indicators: a durable housing structure; access to clean water; access to improved sanitation; sufficient living space (> 3 persons/room) ; and secure tenure (UN-Habitat, 2018)."

"theoretical potency that disrupts traditional understandings of modernity by showcasing the dysfunctionality of the city; from this view the increased visibility of the urban poor expands their capacity to make claims on the state (Rao, 2006)."



Adequate Housing Index

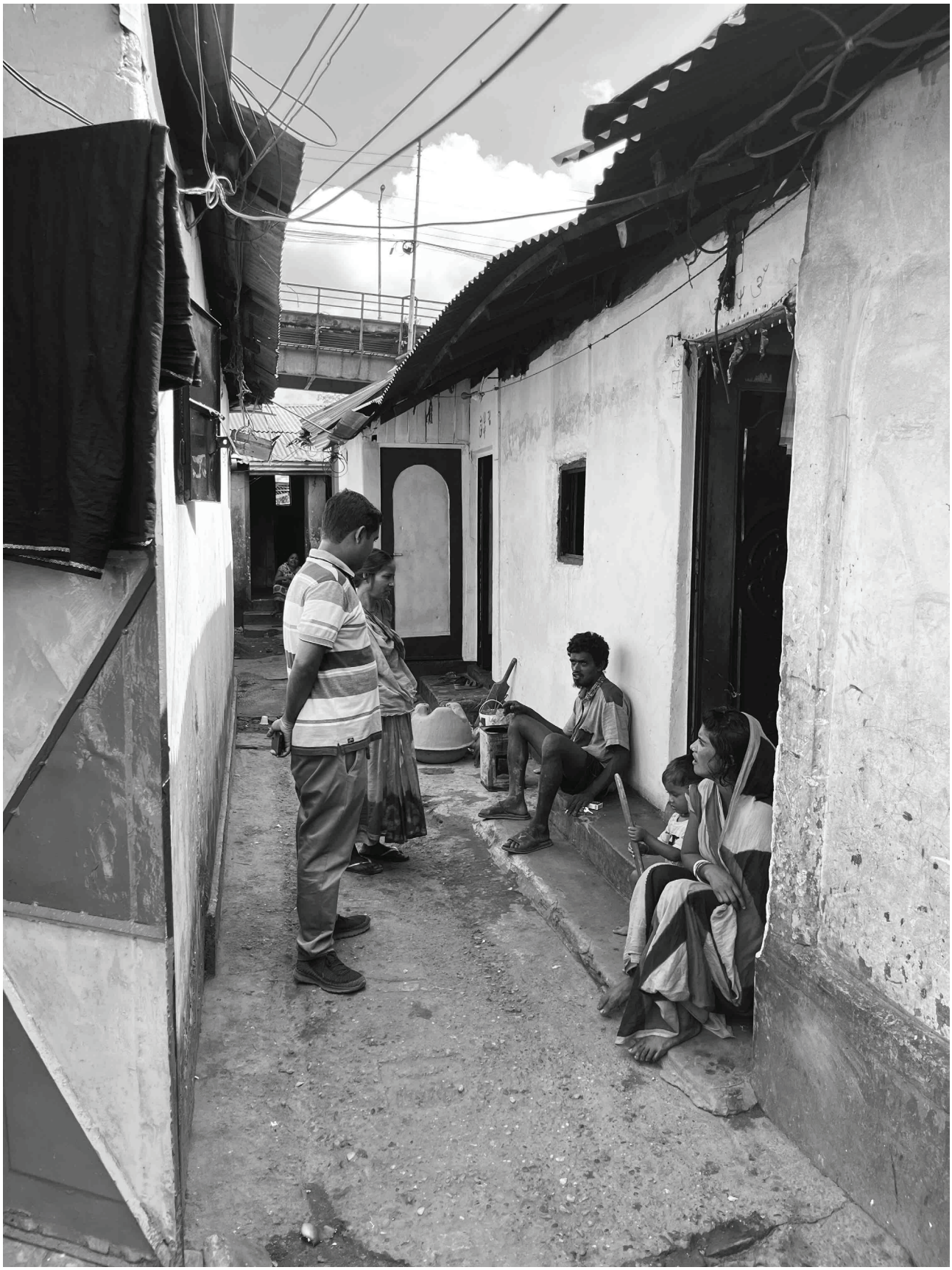
"Global standard for estimating the adequate housing deficit based on seven adequacy Criteria."

7 adequacy dimensions which have frequently been found to be a key determinant for socio-economic and health outcomes :

(1) access to improved water
(2) access to improved sanitation
(3) adequate living space
(4) durable material and good structural quality
(5) security of tenure
(6) access to electricity
(7) access to clean cooking

World Bank Group, 2021

Muslim settlement, E.V.



Hindu settlement, E.V.


hindu
muslim

Sylheti population : Muslims : 92,5%
Hindus : 7,3%

Under the Hindu community, some belong to the Dalit caste. From 1605 on, Dalits migrated, or were forced to relocate, from India to what was formerly East Bengal. During the British colonial period from 1835 to 1940, a significant number of Dalits were migrated to perform menial jobs such as sweeping, clearing sewage, work in tea plantations and railway stations.

They experience social and physical segregation, caste discrimination, restrictions and physical abuses. Dalits are perceived as untouchables, poor, marginalised, and have limit acces to education, employment, health, housing and public services (Islam et al., 2013).

Living conditions :

Housing → unsanitary and polluted areas
→ public housing or slums
→ 99% in 1-2 room houses
→ no landownership
(abandoned field or government land)

traditional **occupations** : "dirty jobs"
-sweepers
-washer men
-barbers
-blacksmiths
-fishermen
-oil-pressers

Since the 2001 United Nations World Conference against Racism, Racial Discrimination, Xenophobia, and Related Intolerance in Durban, South Africa, caste-based untouchability has emerged as a significant global concern. Despite its recent visibility, this form of discrimination is relatively new to the government, donors, and civil society in Bangladesh, demanding immediate attention and action (Islam et al., 2013).

On the vacant riverbank adjacent to Keane Bridge, concrete buildings were constructed to house the Sweepers Colony. Today, approximately 20 Hindu families reside there. In exchange for the government-provided housing, they are required to perform services such as street cleaning. They are not allowed to expand their dwellings, resulting in a high residential density.

Around 230 Muslim families have settled next to the Hindu community. According to several residents interviewed during the field trip in October 2023, the two communities coexist harmoniously.

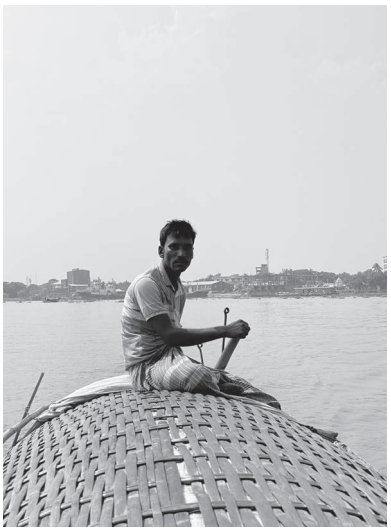
Hindu temple in the Sweepers Colony, E.V.

Bhartokhola Jaame Masjid Mosque next to Keane Bridge slum, Google street view.


school
administrative
mosque
medical
food market
hotel
store
housing



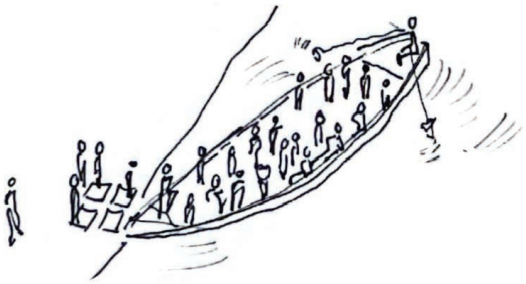


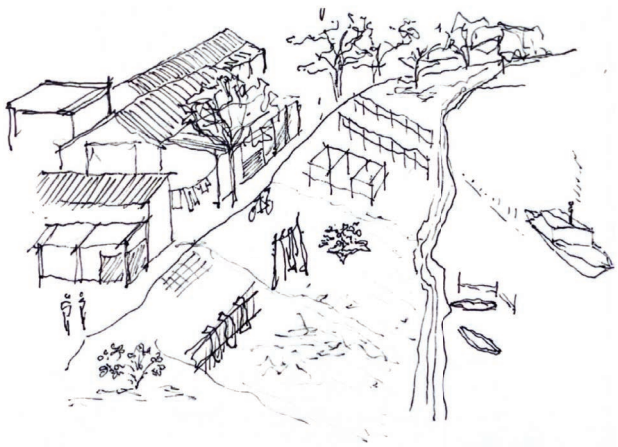



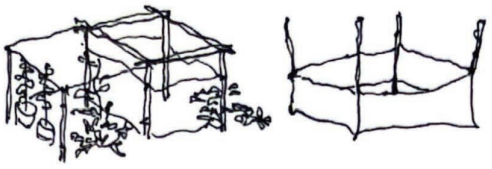

Low-income generating activities, E.V.

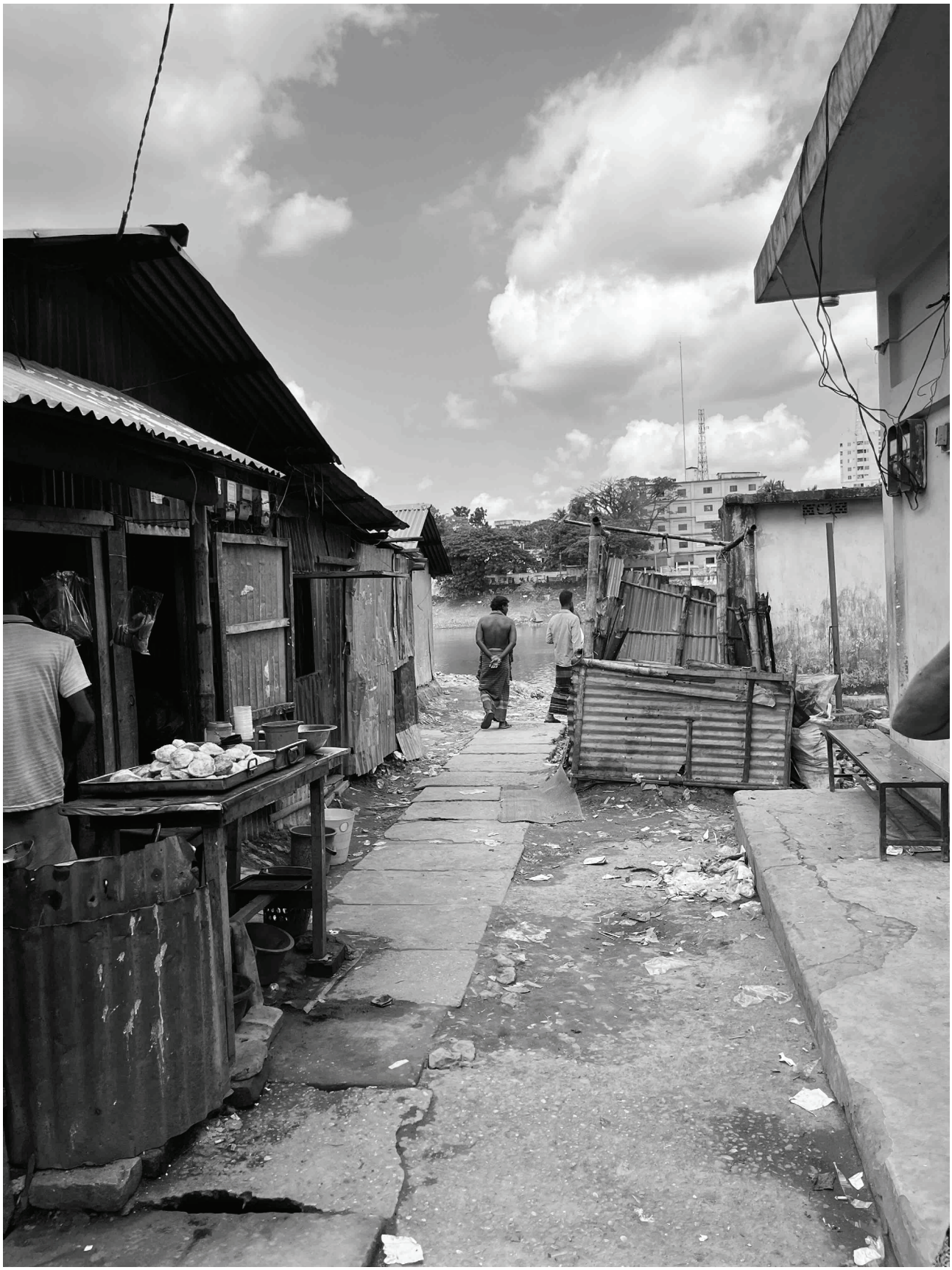
Riverbanks play a crucial role in the daily life of riverine communities. The southeastern riverbank of Keane Bridge is utilized by slum dwellers for river access and serves multiple purposes such as bathing, laundry, agriculture, fishing, and hosting food markets. The rich deposits of silt make it an ideal area for farming. Additionally, it is an important social interaction space.

Various types of riverbanks exist, such as pedestrian promenades or linear green spaces. Well-designed riverbanks hold great potential for enhancing community life. But the open space the banks provide is also subject to waste dumping.









Food shop in the Muslim slum part, E.V.

In developing countries, **MANAGING SOLID WASTE** is :

- one of the most **difficult environmental problem** in the urban centres.
- one of the most **costly** urban services, typically absorbing up to 20 to 40 per cent of municipal revenues.

In Sylhet City Corporation (SCC) 67% of the total generated waste are organic waste, 17% are plastic waste, 5% are paper waste, 3% are e-waste, 2% are medical waste and 1% are other waste.

Domestic waste

collection of the waste with vans

→ openspace / illegal dumping
→ street side dustbin
→ inadequate service : > 50% uncollected

gathering the waste in secondary transfer stations

transfering waste to landfill Lalmatia

→ no segregation
→ illegal collection & re-selling
→ open burning to reduce volume

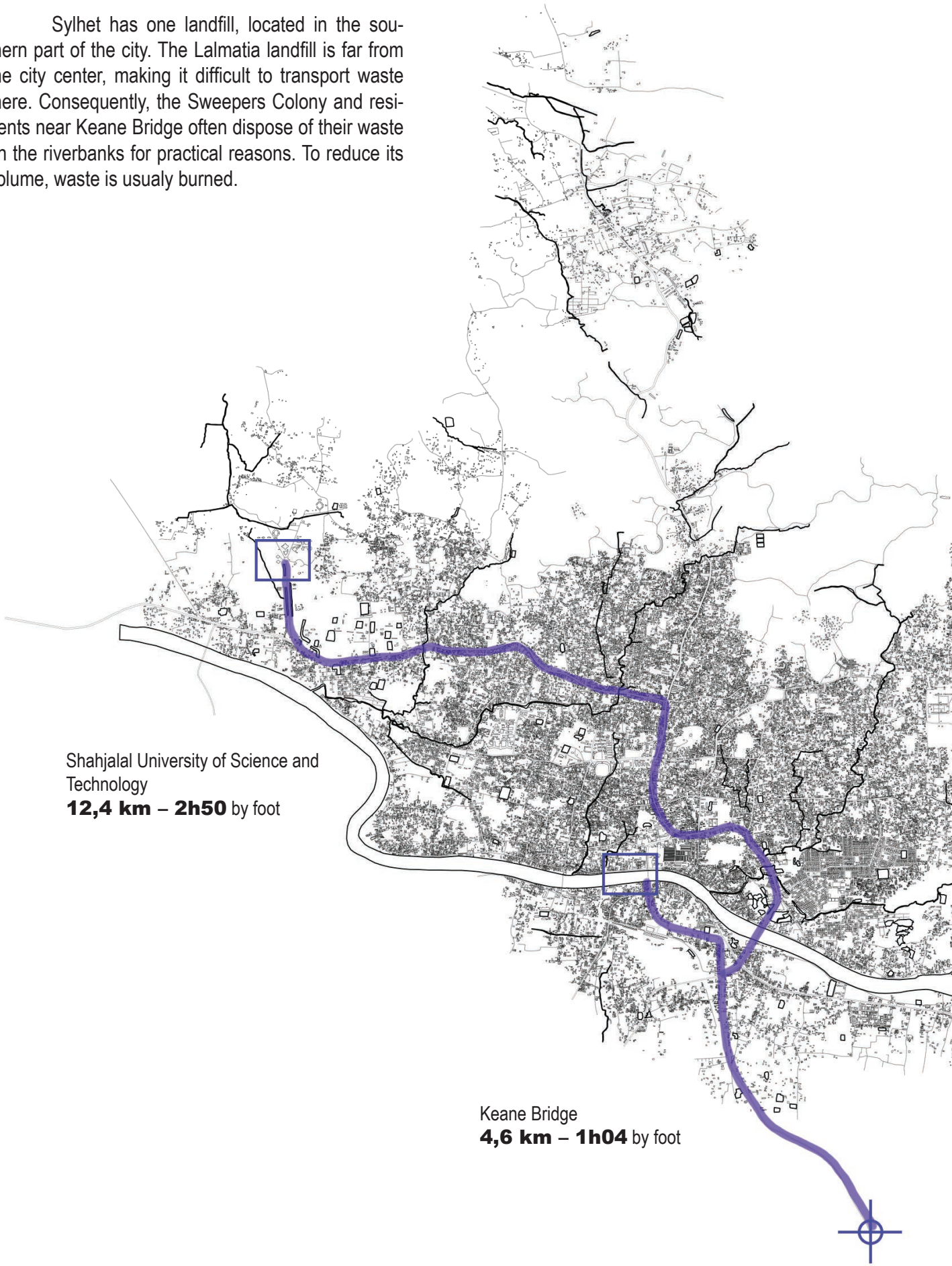
year	population (Sylhet)	solid waste (collected by SCC)
2002	29967	90 tons
2007	427265	120 tons
2012	552828	200 tons
2017	782646	260 tons

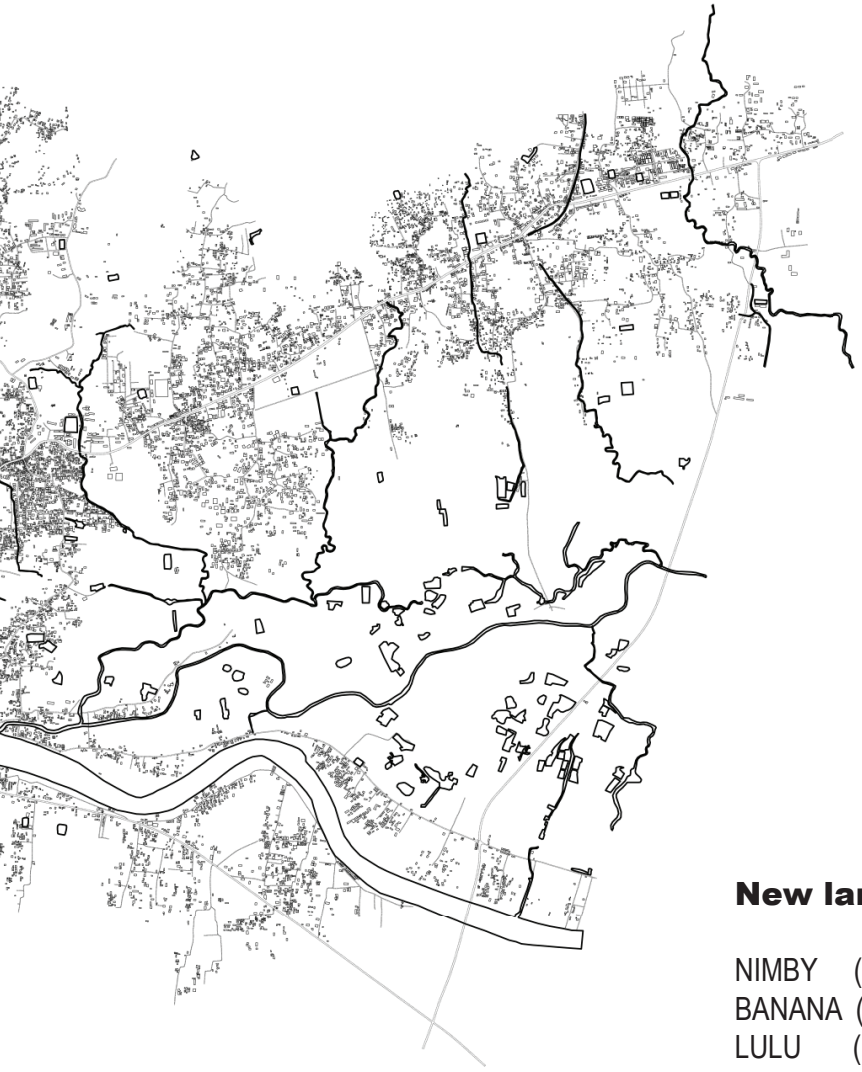
In 15 years : < x 2.5

International Journal of Engineering Applied Sciences and Technology, 2021.

Keane Bridge riverbank as an open dumping ground for waste, E.V.

Sylhet has one landfill, located in the southern part of the city. The Lalmatia landfill is far from the city center, making it difficult to transport waste there. Consequently, the Sweepers Colony and residents near Keane Bridge often dispose of their waste on the riverbanks for practical reasons. To reduce its volume, waste is usualy burned.





New landfill site aquisition

NIMBY (not in my back yard)
BANANA (build absolutely nothing anywhere near anything)
LULU (locally unacceptable land use)
NOTE (not over there either)

DESIGN

Design hypothesis P1

Socio-environmental :

- Building strategy centered on circularity
- Diverse green public spaces for social mix
- Rainwater collection integrated in public space

Social :

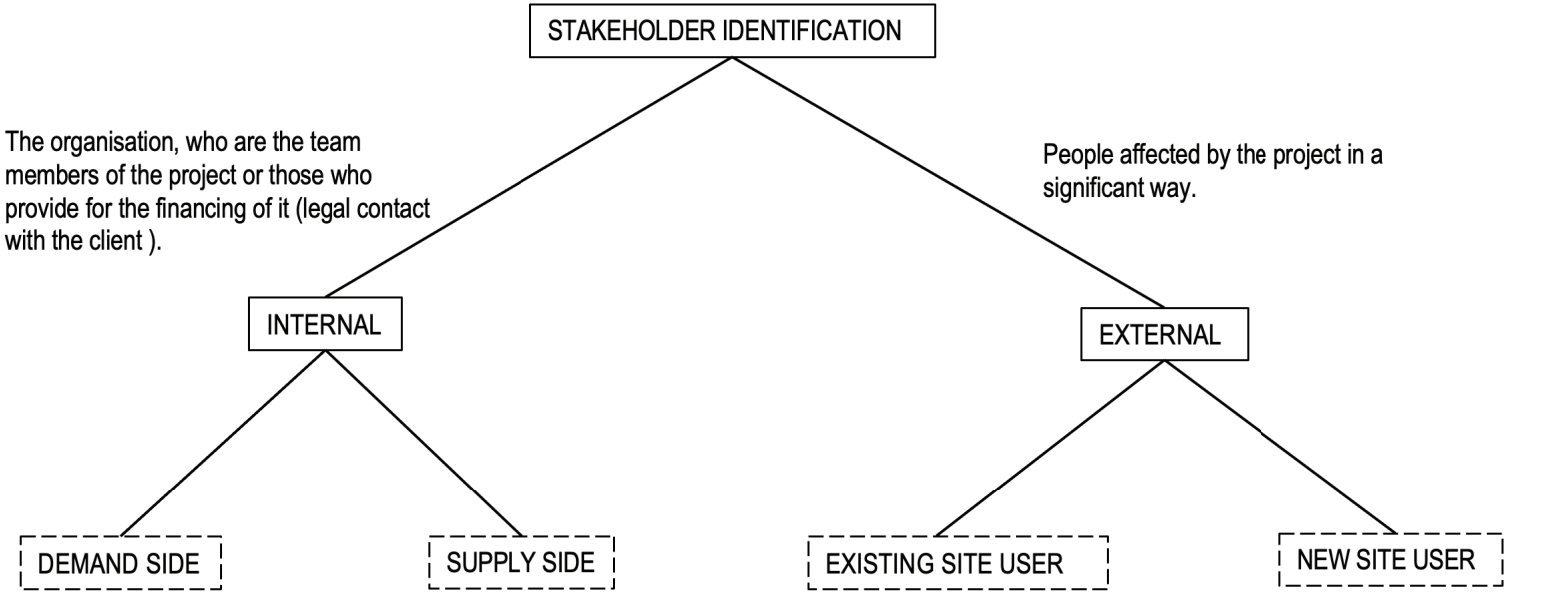
- Mixed income group
- Community clustering
- Equity in housing

Economical :

- Low-mid rise, high density
- FSI ≥ 2
- Inclusive financing system
- Local income generation (shops and recycling tower)

Environmental :

- Flood risk management
- Rainwater harvesting & recycling



- Sylhet City Corporation (SCC)
- Railway Company
- Developer
- bank

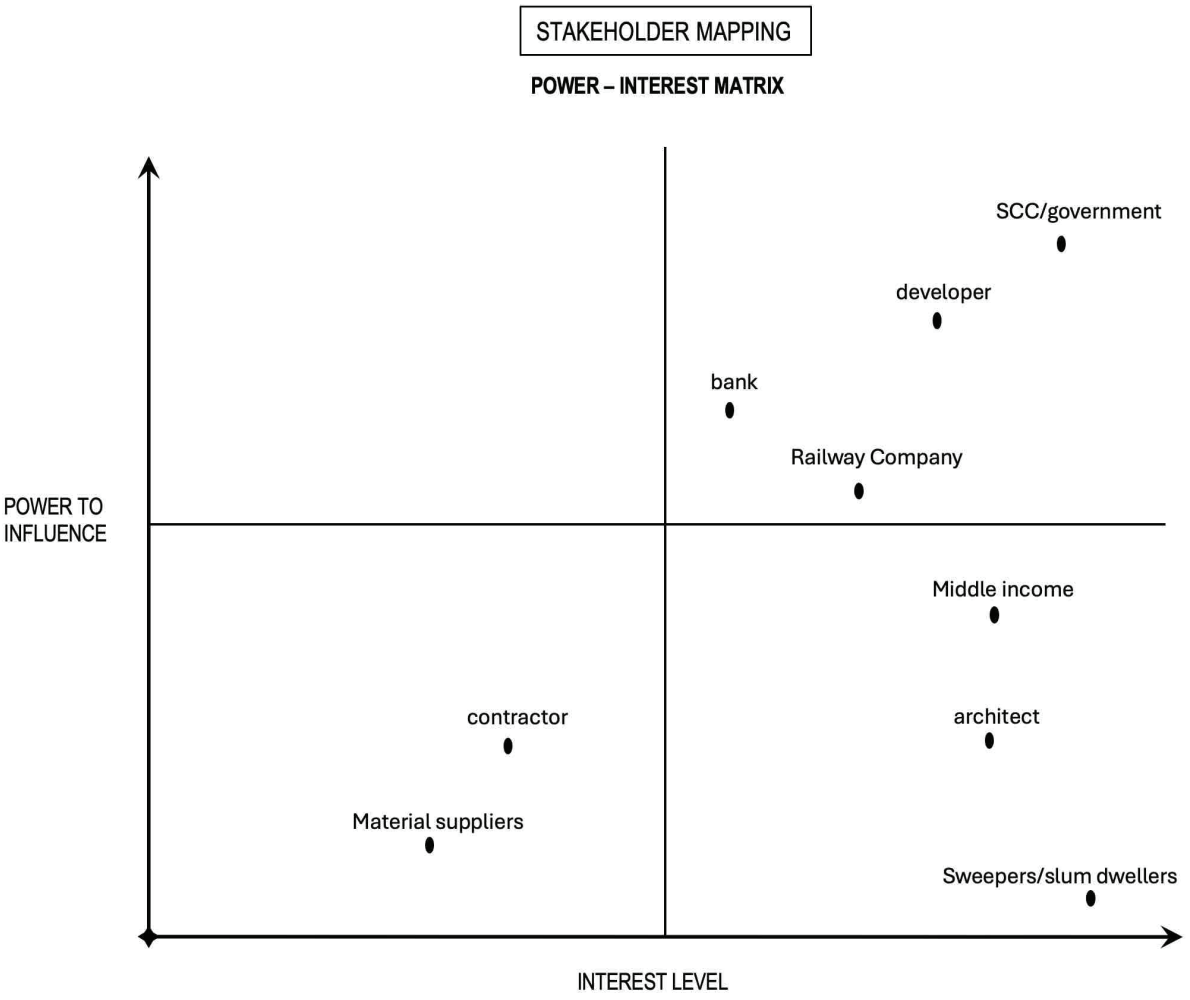
- architect
- Engineers
- Contractors
- Material suppliers

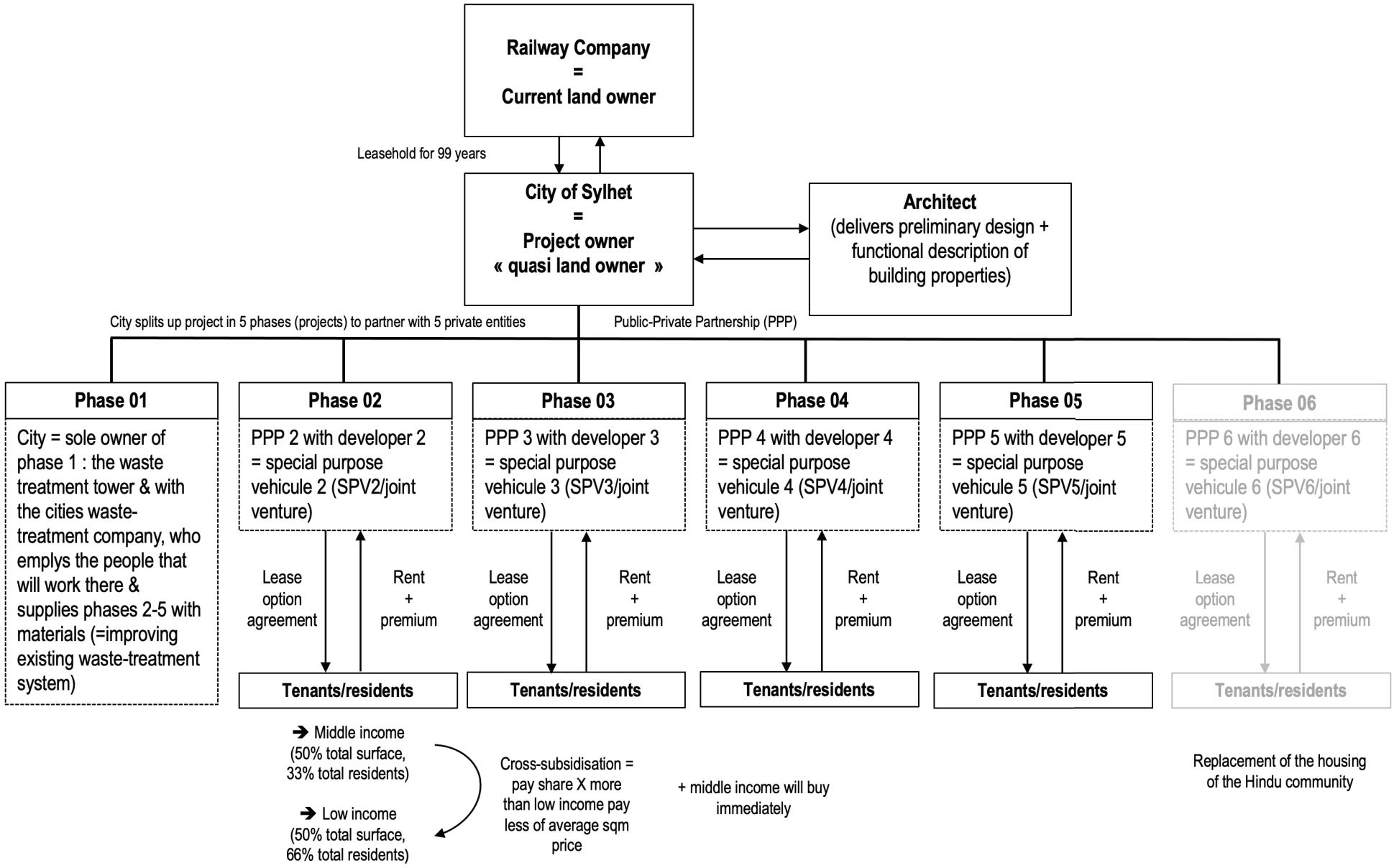
- Sweepers Colony
- Slum dwellers

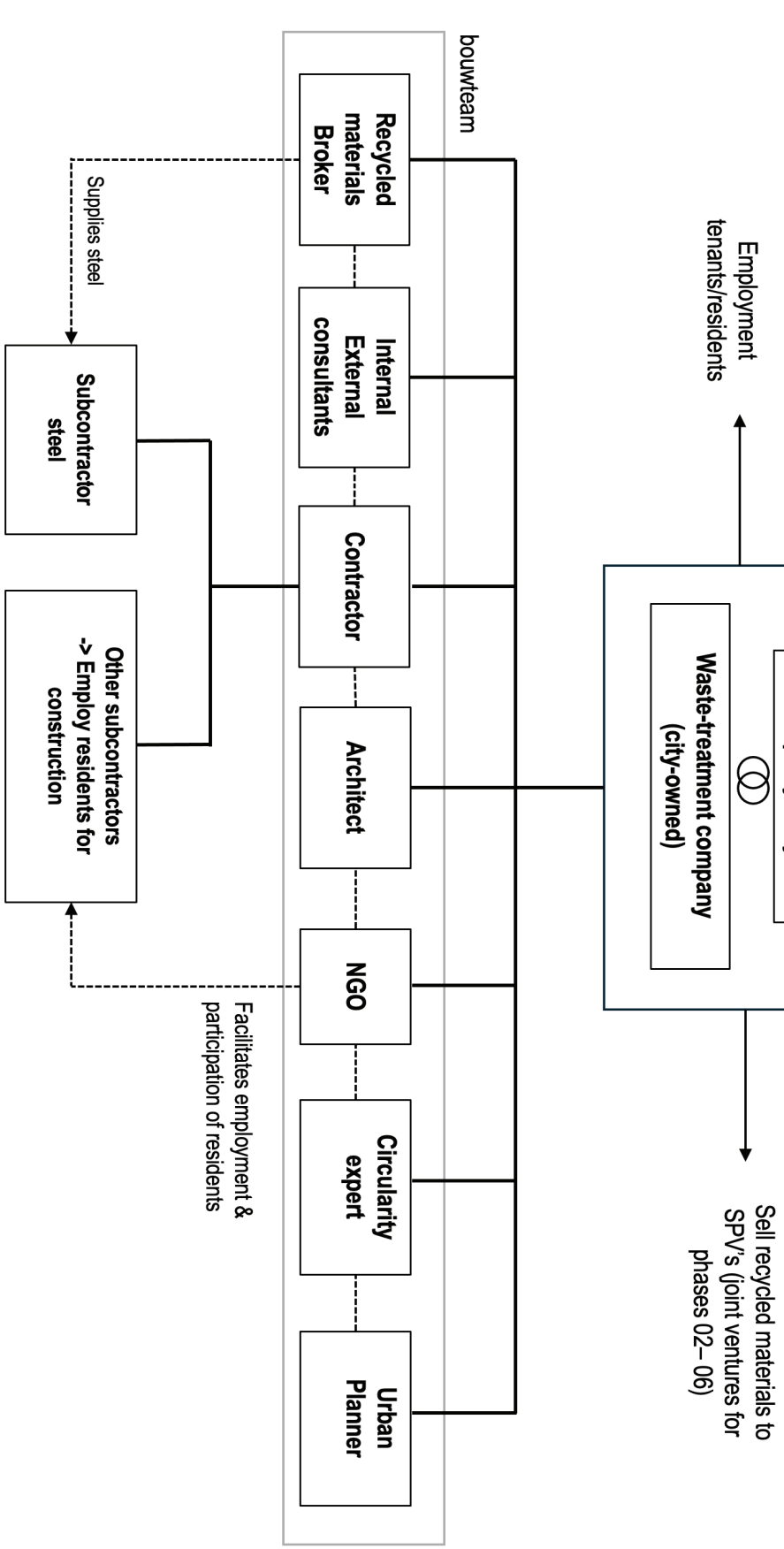
- Middle income residents

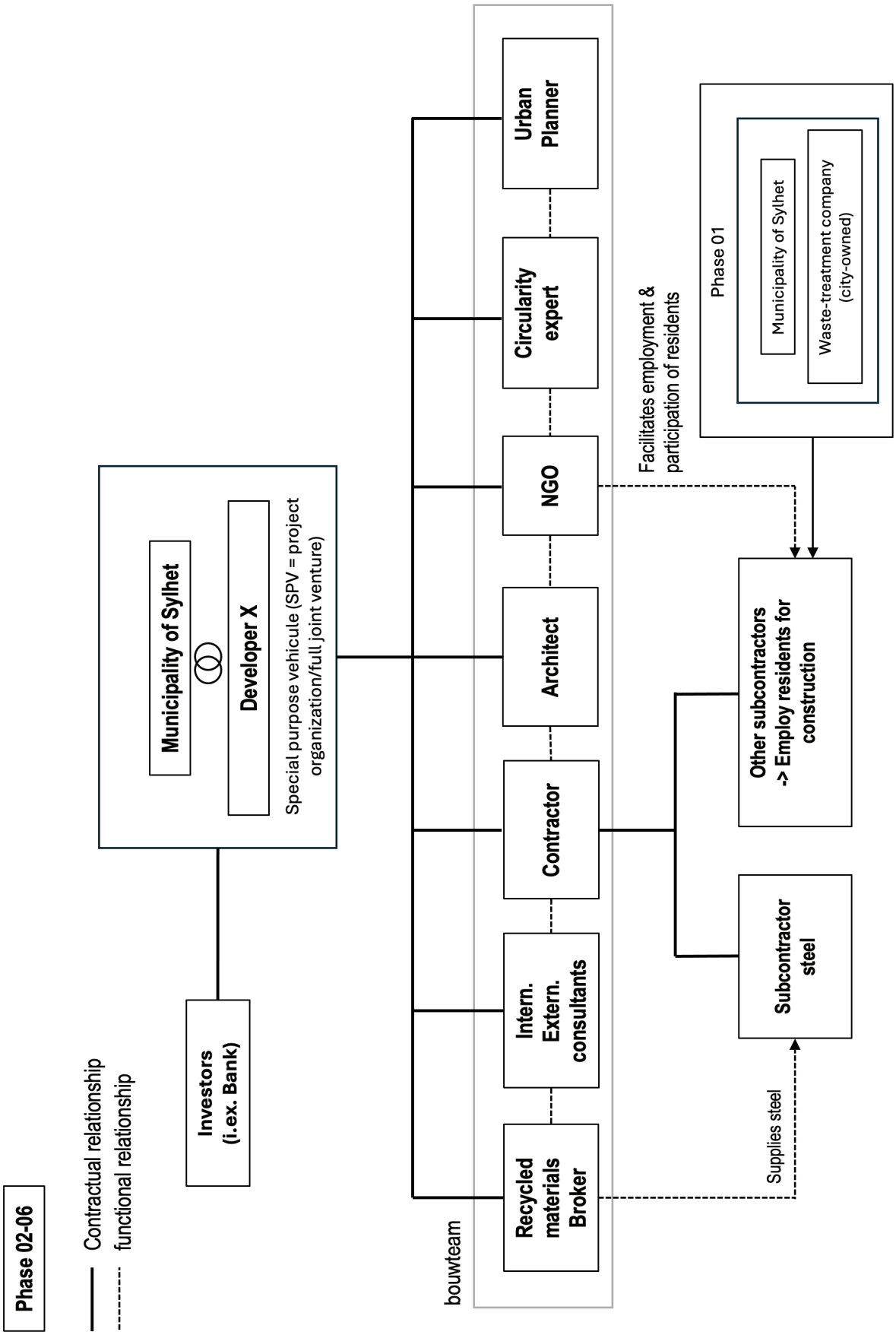
PUBLIC - PRIVATE PARTNERSHIP

	SCC	Railway Company	Developer	SweepersColony/ Slum dwellers	Middle income	Architect/engineer
ASPIRATIONS	- Housing - Densification (> FSI) - Solid waste management improvement - Good city image - Clean city & riverbanks - Rehouse slum dwellers (social interest)	- Site maintenance - Better land use - Social responsibility (house their employees)	- Return on investment - Make profit - Participate to a sustainable housing project	- Low cost housing - Rent-to-own housing - Rental housing - Better living conditions - Work opportunities	- Ownership - Pleasant living environment	- Money for the project - Participation from inhabitants
OFFERS	- Slum upgrading program - Income generation opportunities - Low incost housing - Subsidised rent for low income - Long term loan for stable income households	- Land	- Investment for project - On time & on budget delivery	- Labour - Money in the long term	- Investment for project : cross subsidisation	- Low cost housing design - Renewed image of city - Opportunities for income generation


STAKEHOLDER MAPPING
POWER – INTEREST MATRIX
SCC/government
developer
bank
Railway Company
POWER TO INFLUENCE
Middle income
contractor
architect
Material suppliers
Sweepers/slum dwellers
INTEREST LEVEL


Railway Company
=
Current land owner
Leasehold for 99 years
City of Sylhet
=
Project owner
« quasi land owner »
Architect
(delivers preliminary design + functional description of building properties)
City splits up project in 5 phases (projects) to partner with 5 private entities
Public-Private Partnership (PPP)
Phase 01
City = sole owner of phase 1 : the waste treatment tower & with the cities waste-treatment company, who emplys the people that will work there & supplies phases 2-5 with materials (=improving existing waste-treatment system)
Phase 02
PPP 2 with developer 2 = special purpose vehicule 2 (SPV2/joint venture)
Phase 03
PPP 3 with developer 3 = special purpose vehicule 3 (SPV3/joint venture)
Phase 04
PPP 4 with developer 4 = special purpose vehicule 4 (SPV4/joint venture)
Phase 05
PPP 5 with developer 5 = special purpose vehicule 5 (SPV5/joint venture)
Phase 06
PPP 6 with developer 6 = special purpose vehicule 6 (SPV6/joint venture)
Lease option agreement
Rent + premium
Tenants/residents
➔ Middle income (50% total surface, 33% total residents)
➔ Low income (50% total surface, 66% total residents)
Cross-subsidisation = pay share X more than low income pay less of average sqm price
+ middle income will buy immediately
Replacement of the housing of the Hindu community


Phase 01
Contractual relationship
functional relationship
Employment
tenants/residents
Municipality of Sylhet
Waste-treatment company
(city-owned)
Sell recycled materials to
SPV's (joint ventures for
phases 02– 06)
bouwteam
Recycled
materials
Broker
Internal
External
consultants
Contractor
Architect
NGO
Circularity
expert
Urban
Planner
Supplies steel
Subcontractor
steel
Other subcontractors
-> Employ residents for
construction
Facilitates employment &
participation of residents

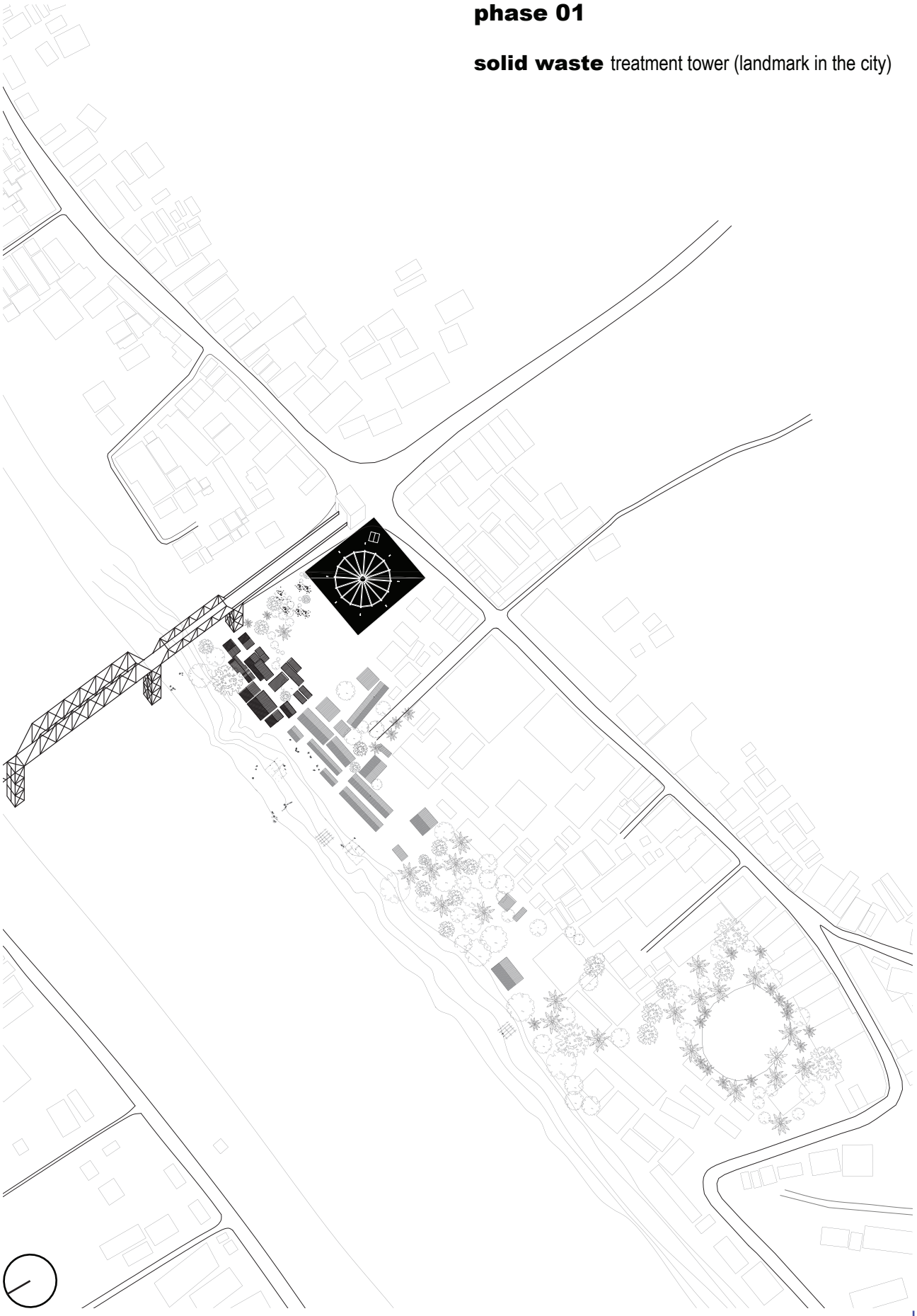

Phase 02-06
Contractual relationship
functional relationship
Investors (i.ex. Bank)
Municipality of Sylhet
Developer X
Special purpose vehicule (SPV = project organization/full joint venture)
bouwteam
Recycled materials Broker
Intern. Extern. consultants
Contractor
Architect
NGO
Circularity expert
Urban Planner
Facilitates employment & participation of residents
Phase 01
Municipality of Sylhet
Waste-treatment company (city-owned)
Other subcontractors -> Employ residents for construction
Subcontractor steel
Supplies steel

phase 0

existing low-income housing (Sweepers) : 20

phase 01

solid waste treatment tower (landmark in the city)



phase 02

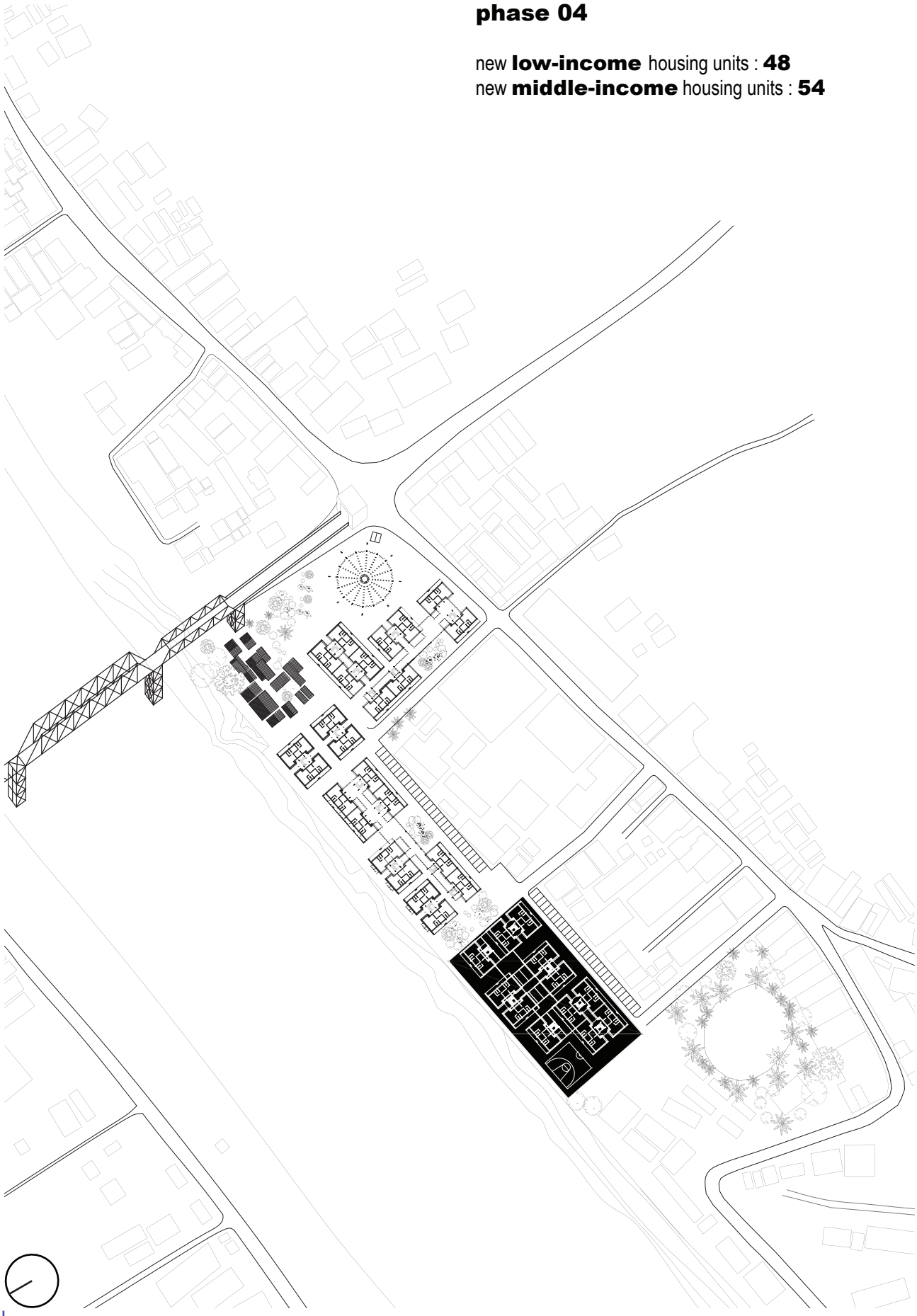
new **low-income** housing units : **128**
new **middle-income** housing units : **0**

phase 03

new **low-income** housing units : **40**
new **middle-income** housing units : **40**

phase 04

new **low-income** housing units : **48**
new **middle-income** housing units : **54**



phase 05

new **low-income** housing units : **40**
new **middle-income** housing units : **44**

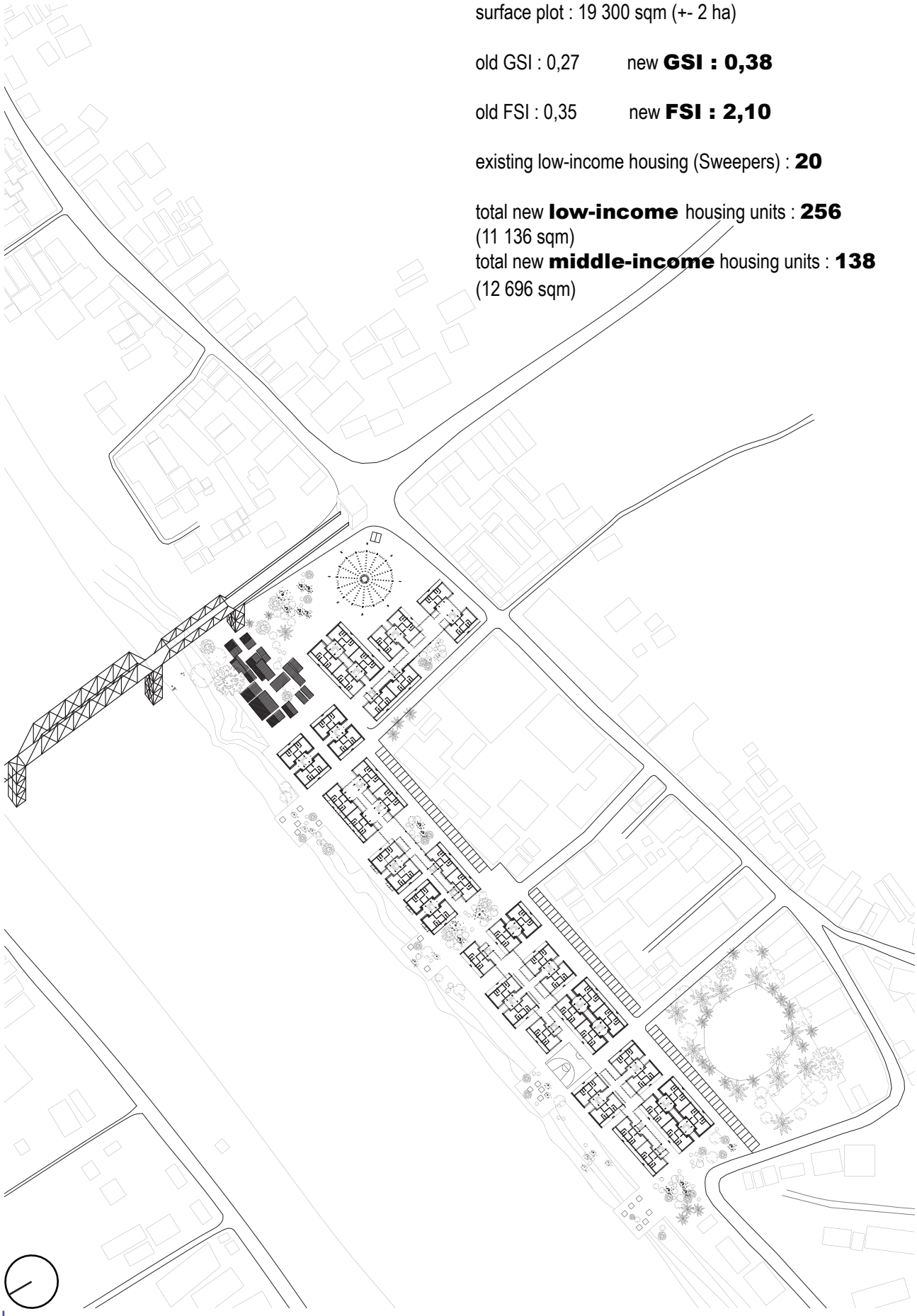
surface plot : 19 300 sqm (+- 2 ha)

old GSI : 0,27 new **GSI : 0,38**

old FSI : 0,35 new **FSI : 2,10**

existing low-income housing (Sweepers) : **20**

total new **low-income** housing units : **256**
(11 136 sqm)
total new **middle-income** housing units : **138**
(12 696 sqm)

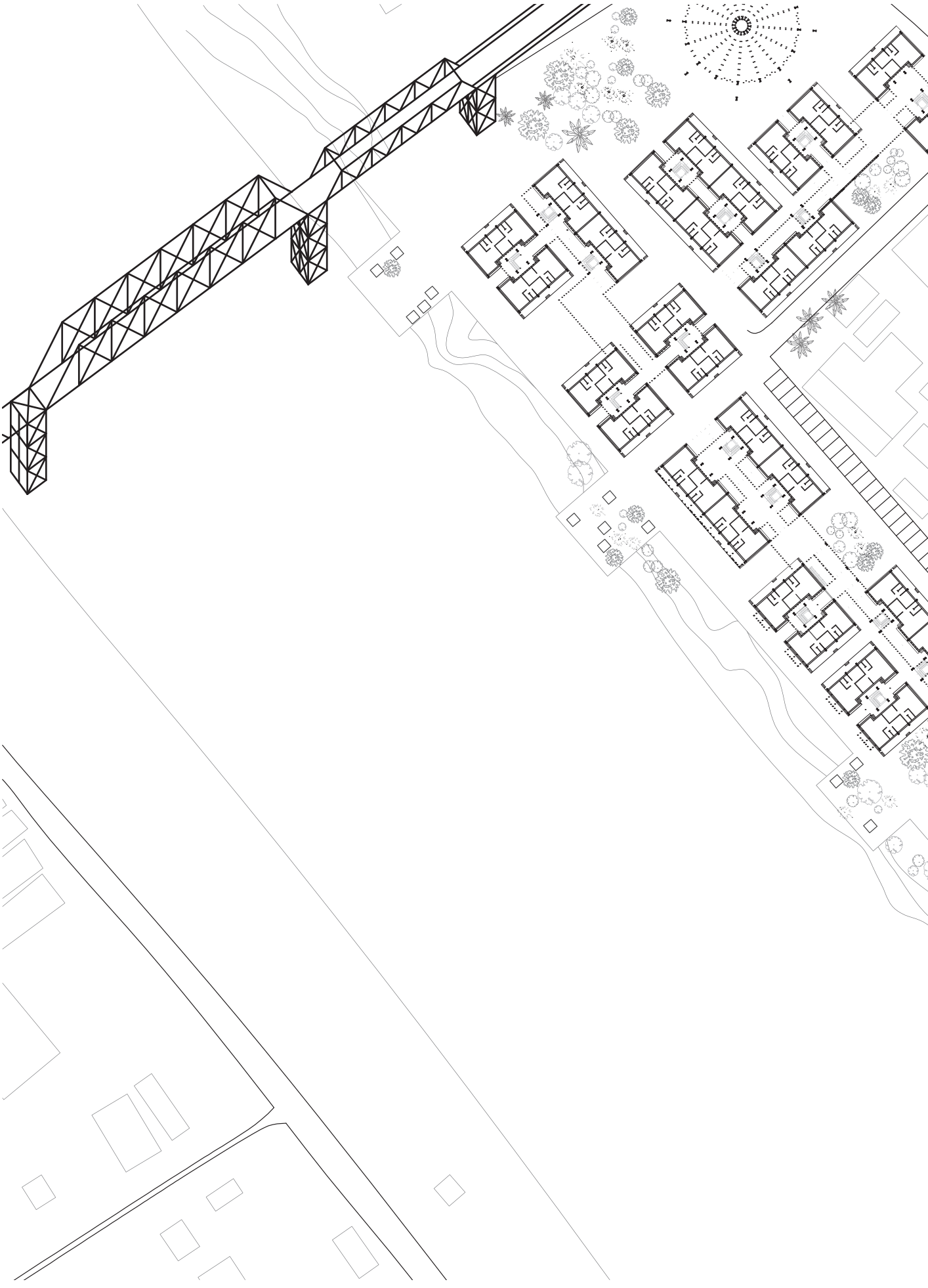


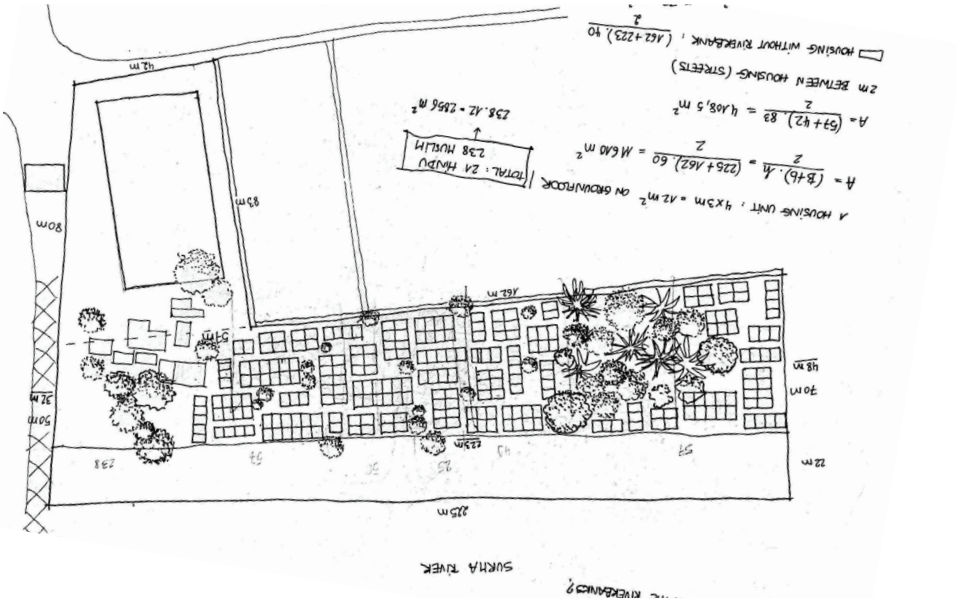
phase 06

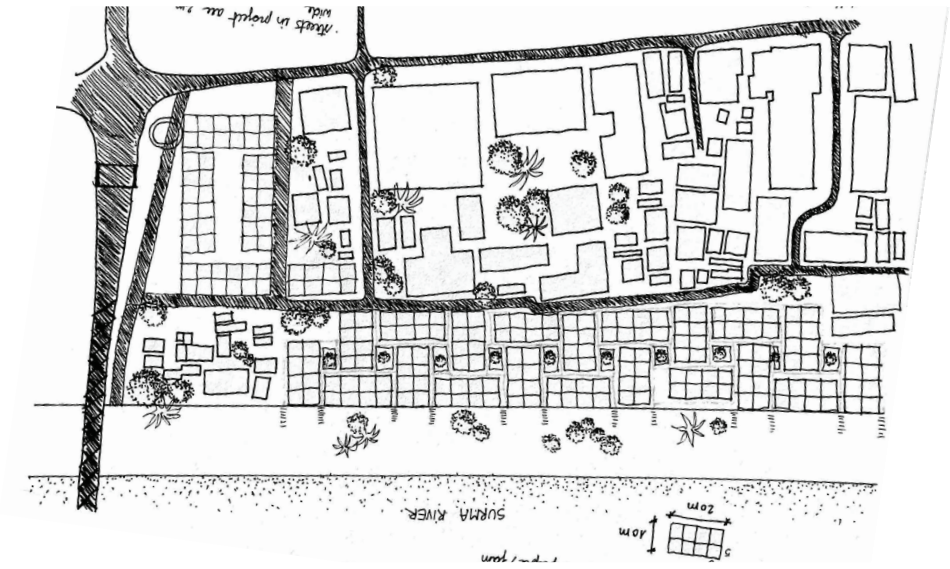
new **low-income** housing units : **36**

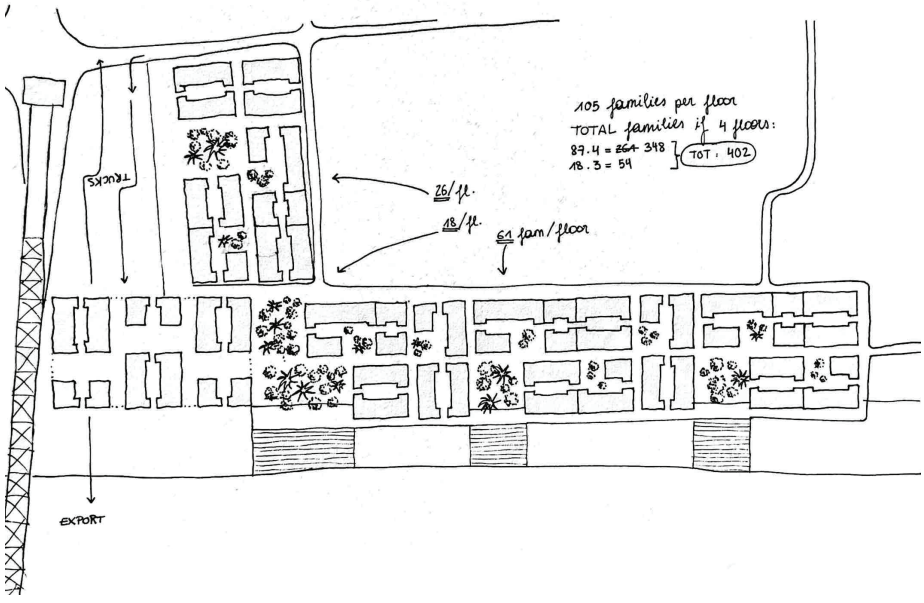
A sixth phase could be introduced in the future, focusing on replacing the current Sweepers Colony buildings to provide a better living environment.

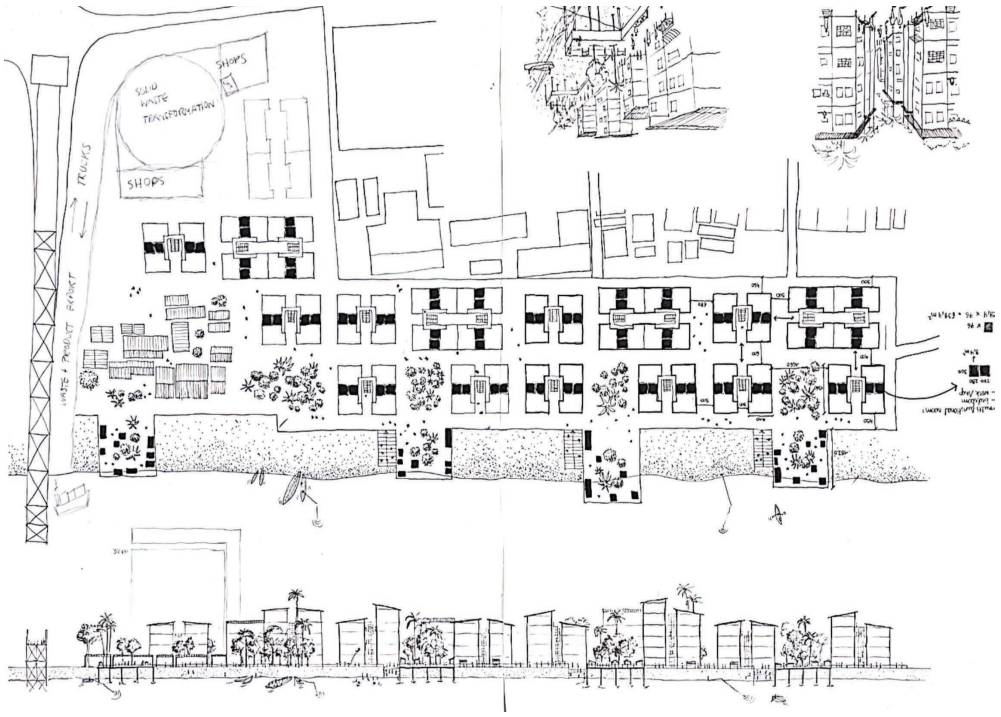
Phazing

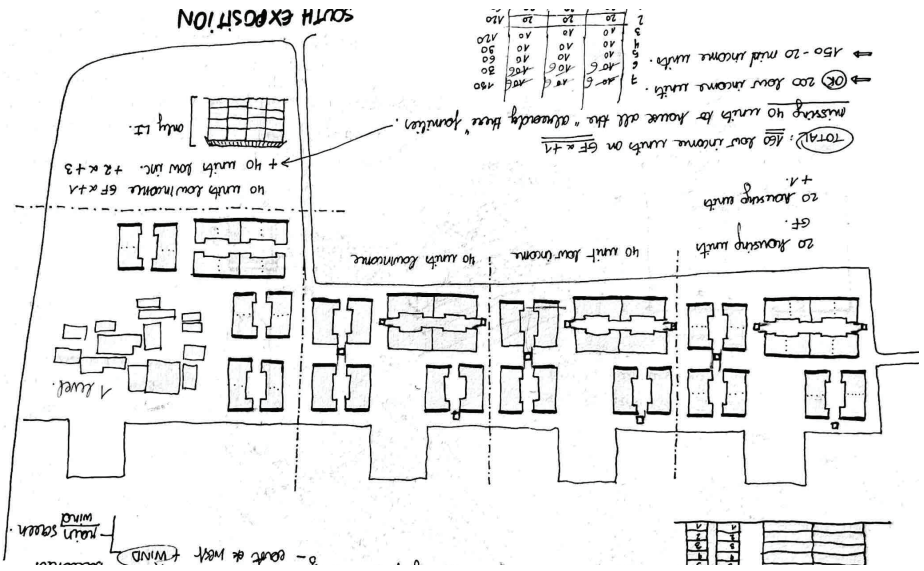



SURMA RIVER
TOTAL: 24 HOUSING
238 MUSLIM
238. 42 = 2856 m²
A HOUSING UNIT : 4x3m = 42 m² ON GROUNDFLOOR
HOUSING WITHOUT RIVERBANK : (462+223) 40 / 2
2m BETWEEN HOUSING (STREETS)


SURMA RIVER
20m
10m


105 families per floor
TOTAL families if 4 floors:
87.4 = 264 348
18.3 = 54
TOT: 402
76/11.
18/11.
61 fam/floor
TRUCKS
EXPORT

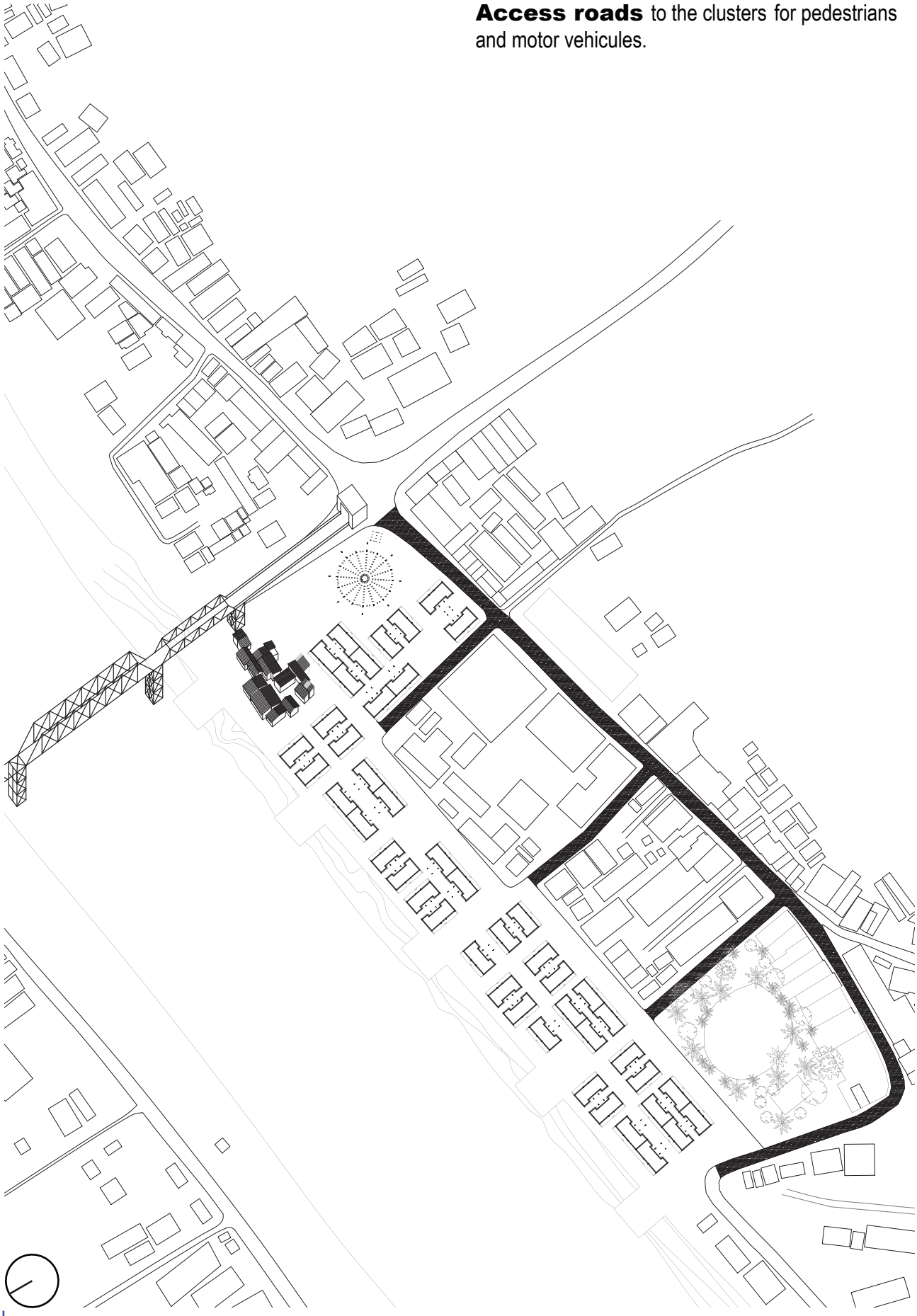




The building layout is inspired by the existing Hindu settlement, characterized by a series of narrow streets of varying widths, punctuated by courtyards. In that sense, the proposed project's buildings are intentionally not aligned, creating opportunities to use corners and recesses, fostering a sense of a dynamic and ever-changing pathway.

The sequence of hand drawings illustrates the design process. The first drawing presents a highly diverse, dense, and low-rise master plan with small living units (12m²). The second image depicts a more structured plan, featuring a pattern and larger housing units (24m²). Finally, the design evolves into well-defined clusters, maintaining a consistent building typology that is rotated to provide various access points from the internal street or smaller lateral streets, enhancing the village-like atmosphere.

Access roads to the clusters for pedestrians and motor vehicules.



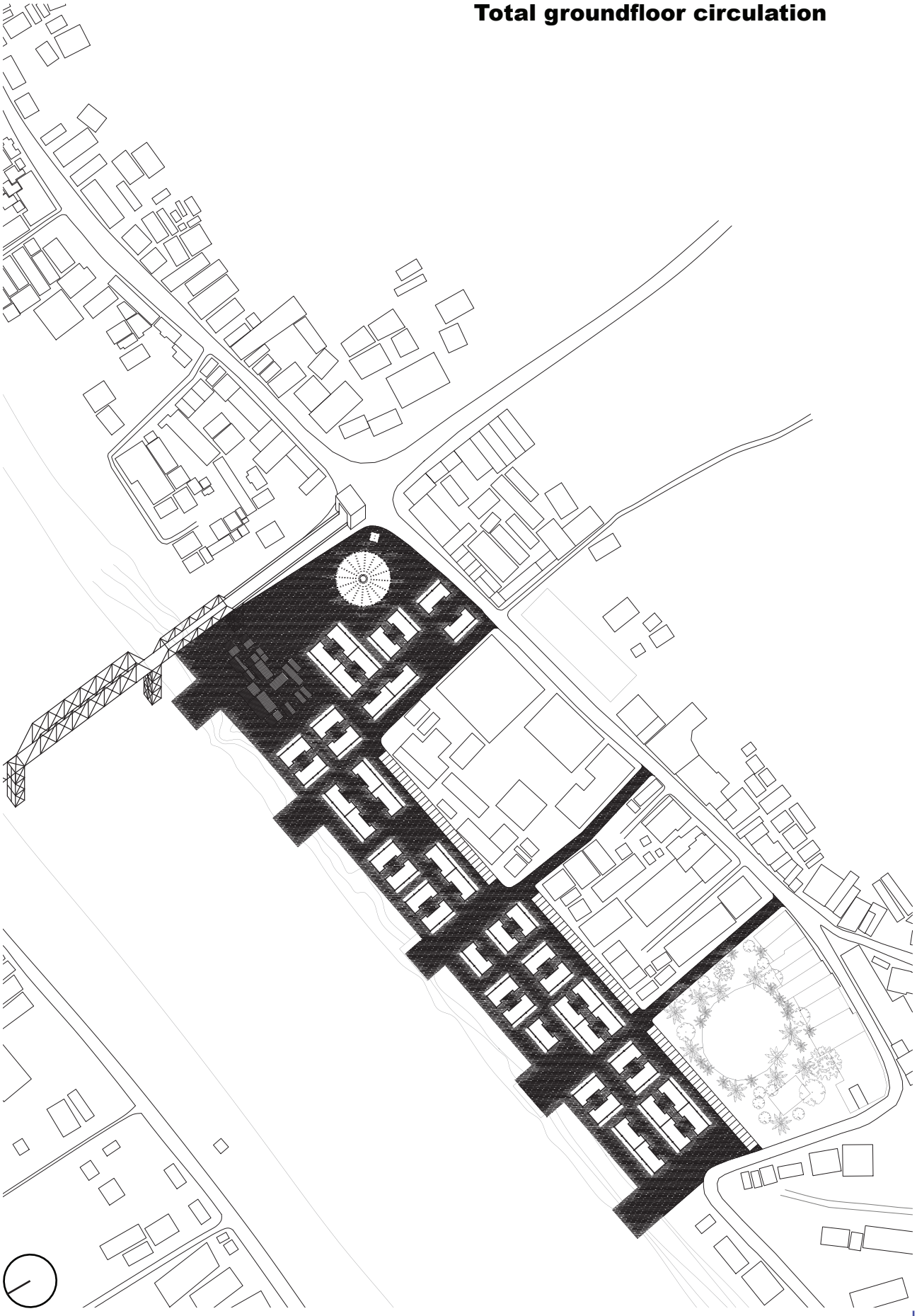
Car circulation with parking lots

Pedestrian street with shops. Mainly used by the residents themselves to access their housing.

Riverbank promenade with decks overlooking the river, inviting the public for recreational activities, providing a small harbor, open community spaces, food markets, access to the river, sport facilities, etc.

Platforms on the first floor, connecting the buildings to form a cluster. Those platforms provide the residents a transitional zone inbetween their dwelling and the dynamic street. It is an outdoor place providing enough space for people to hang out, play, and engage in their daily activities.

Total groundfloor circulation



The riverbank offers a diverse range of spaces for various activities. The promenade runs along the building facades and connects five decks that overhang the river. The axonometric views illustrate possible uses for these decks.

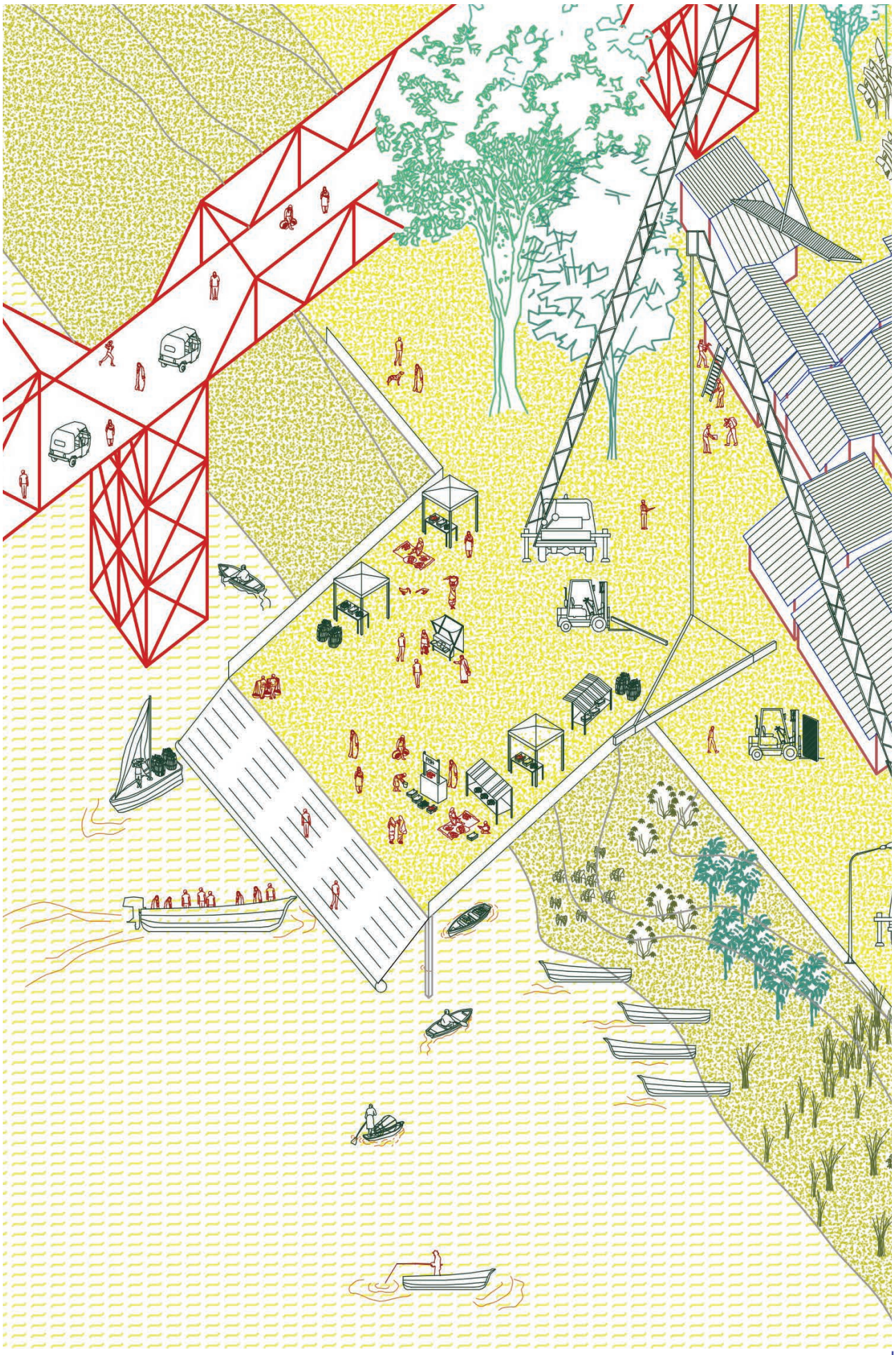
The deck closest to the bridge functions as a small harbor for fishers and taxi boats, facilitating river crossings and the export of organic waste. During construction phases, it can also serve as a point for receiving building materials by boat.

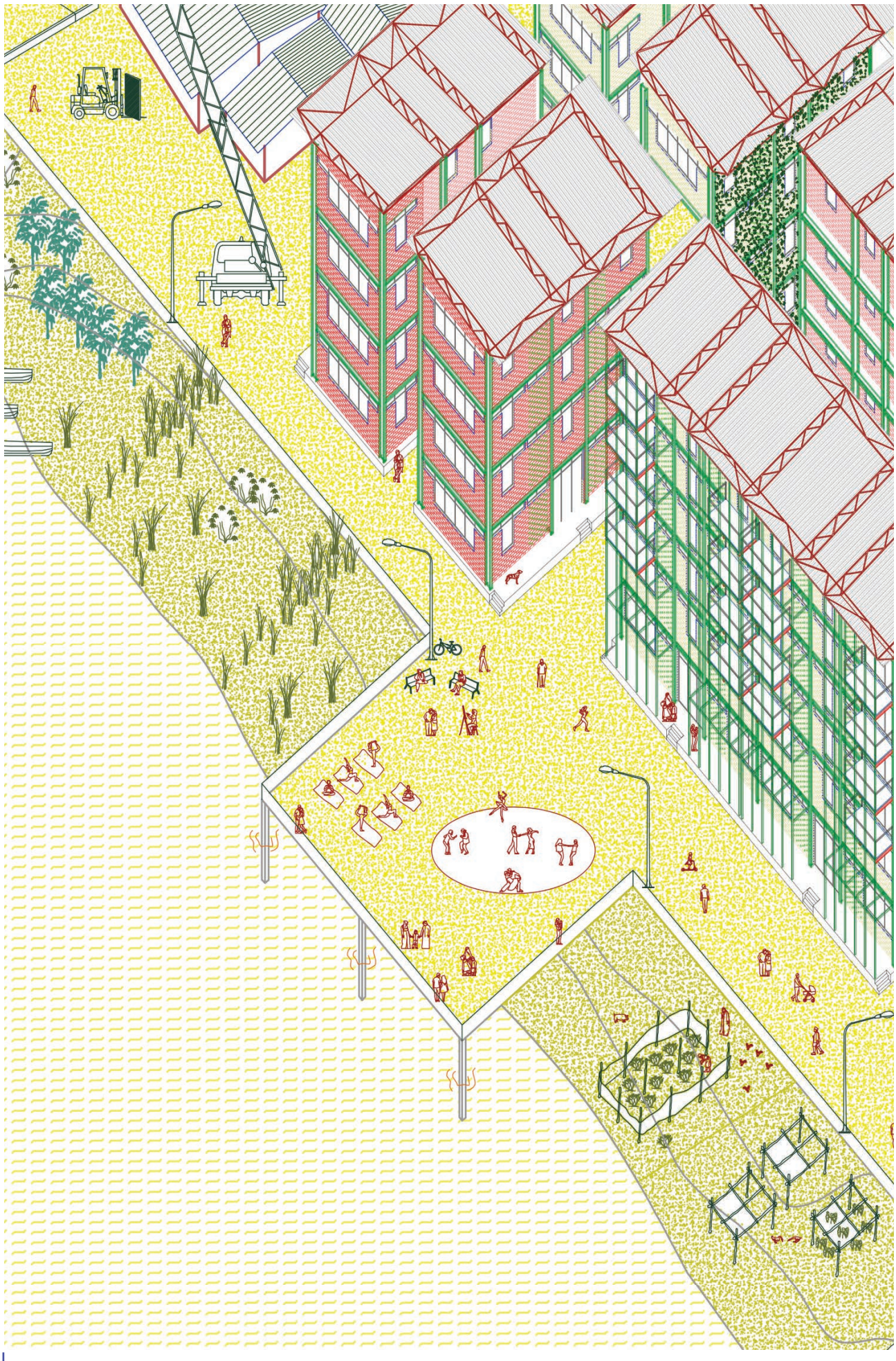
The second deck features a group of dancers practicing and a yoga class.

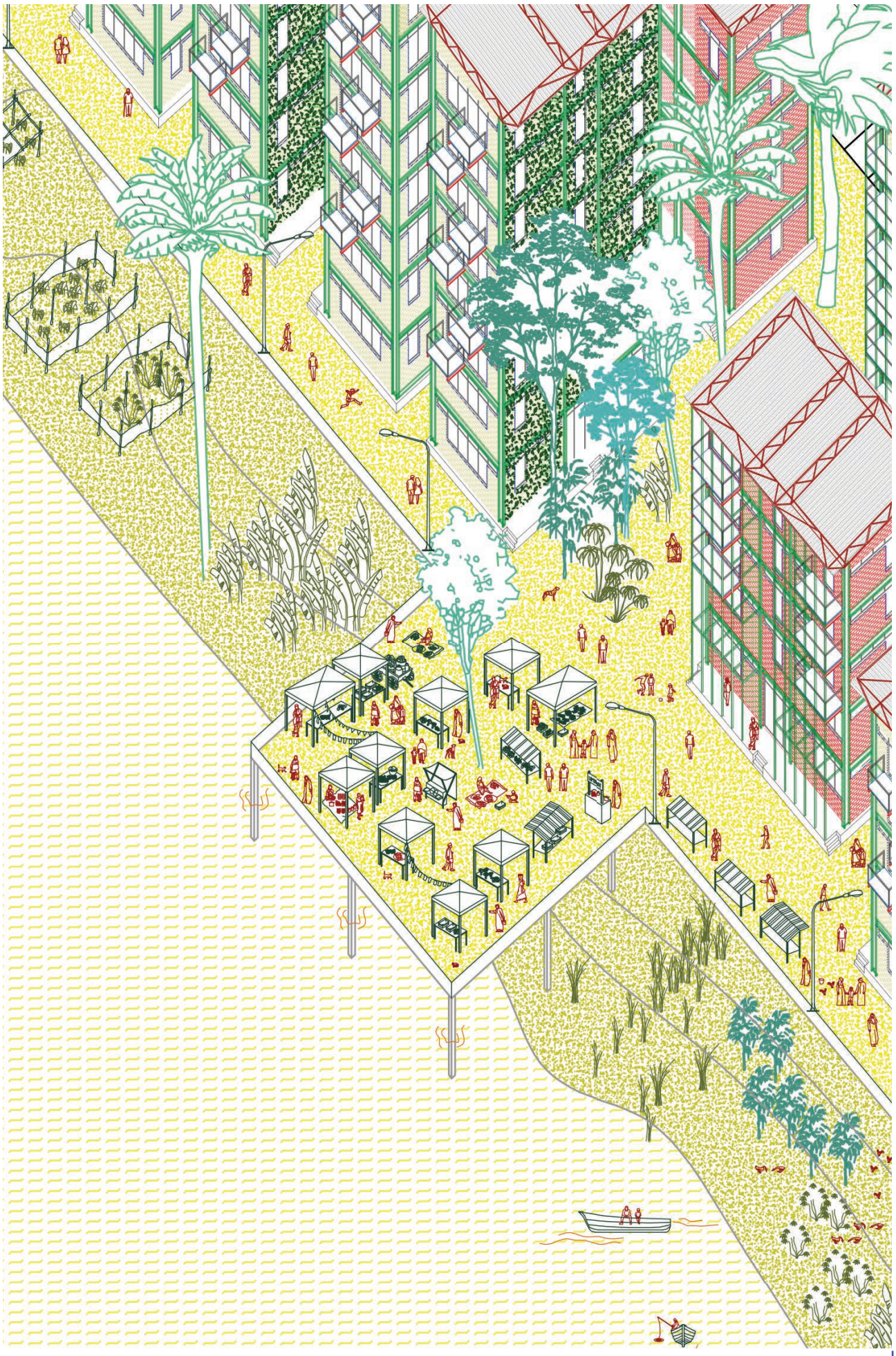
The third deck hosts a market where inhabitants can sell food, goods, and handcrafted items from the waste treatment tower.

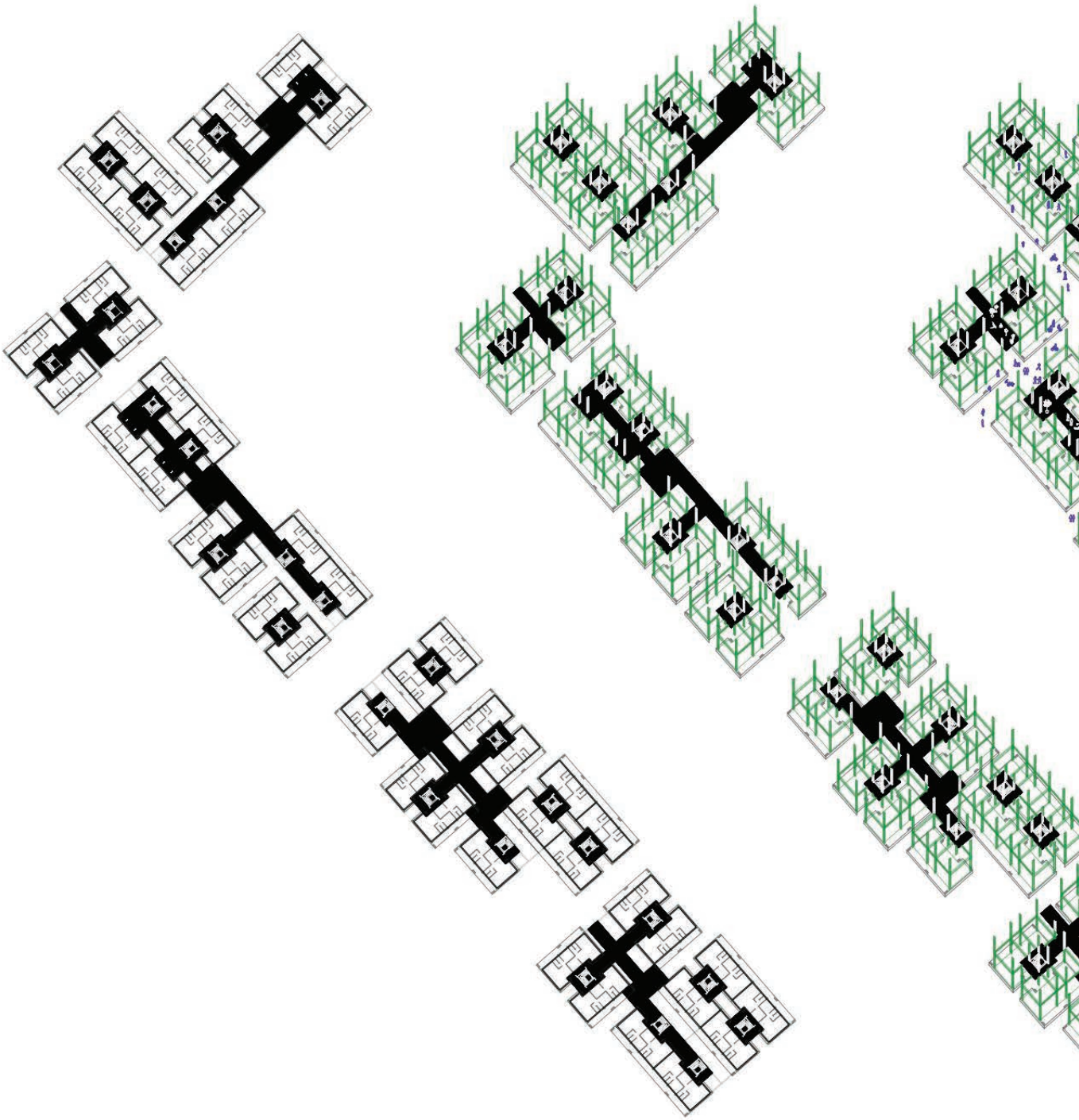
The fourth deck includes sport facilities and provides access to the water.

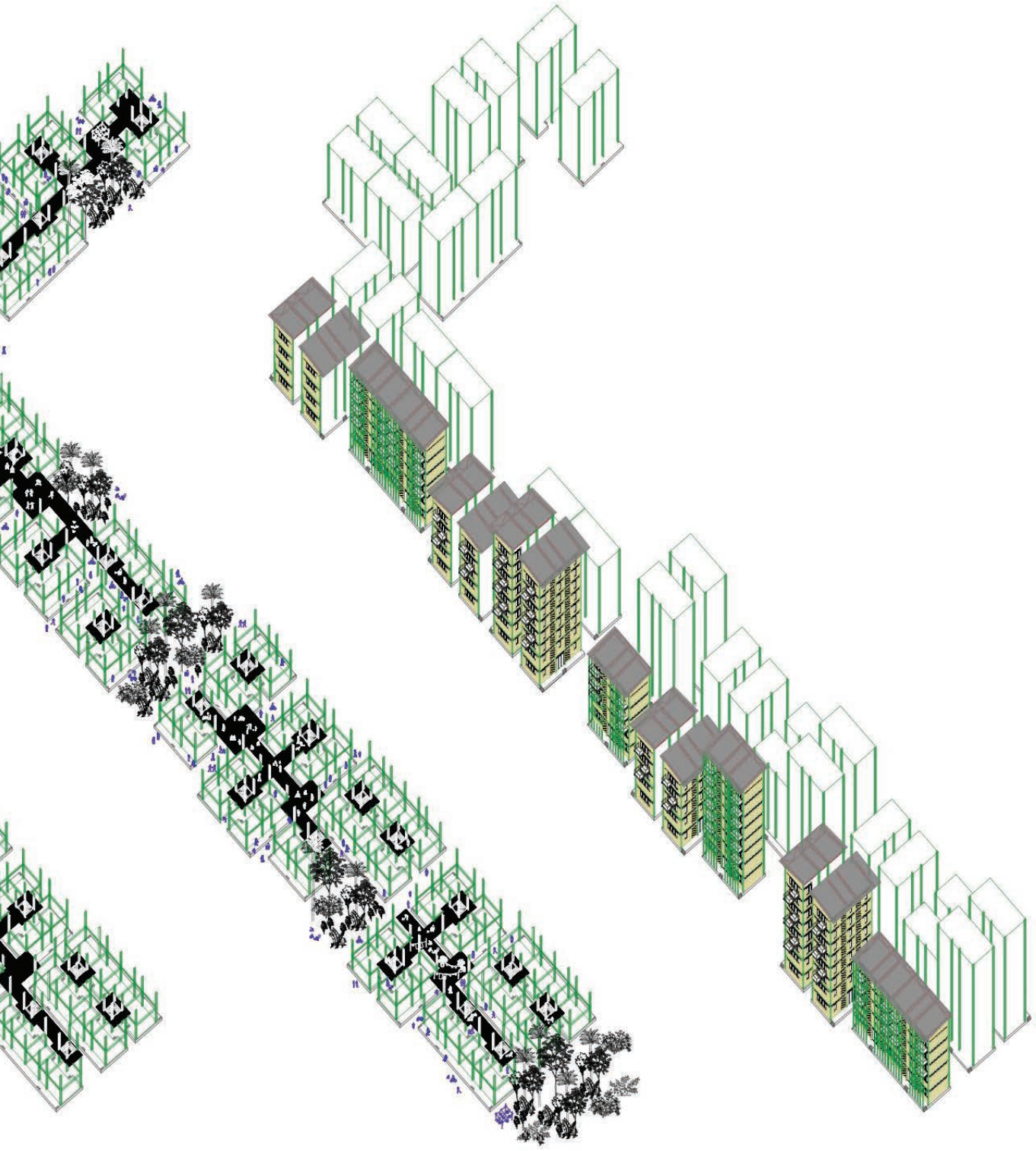
The fifth deck is shown hosting a religious event.





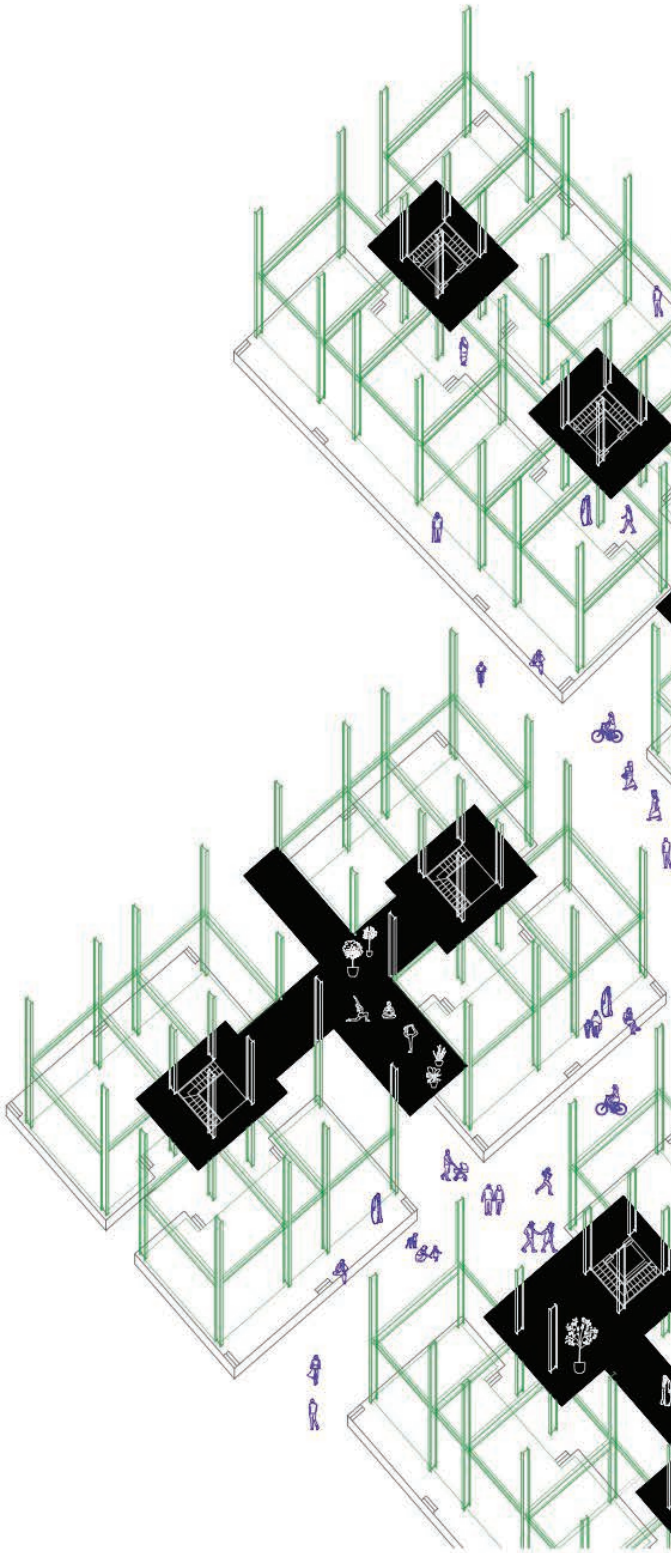


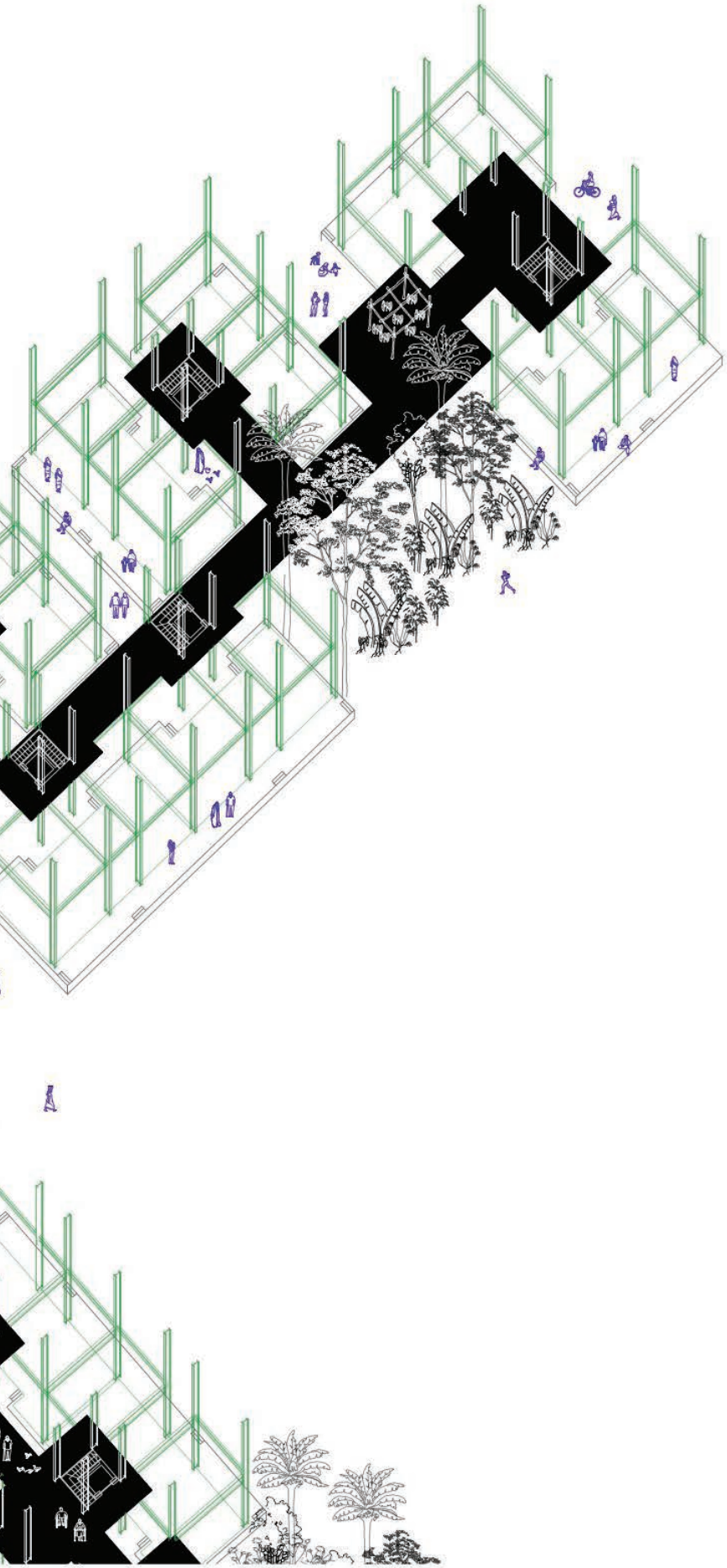


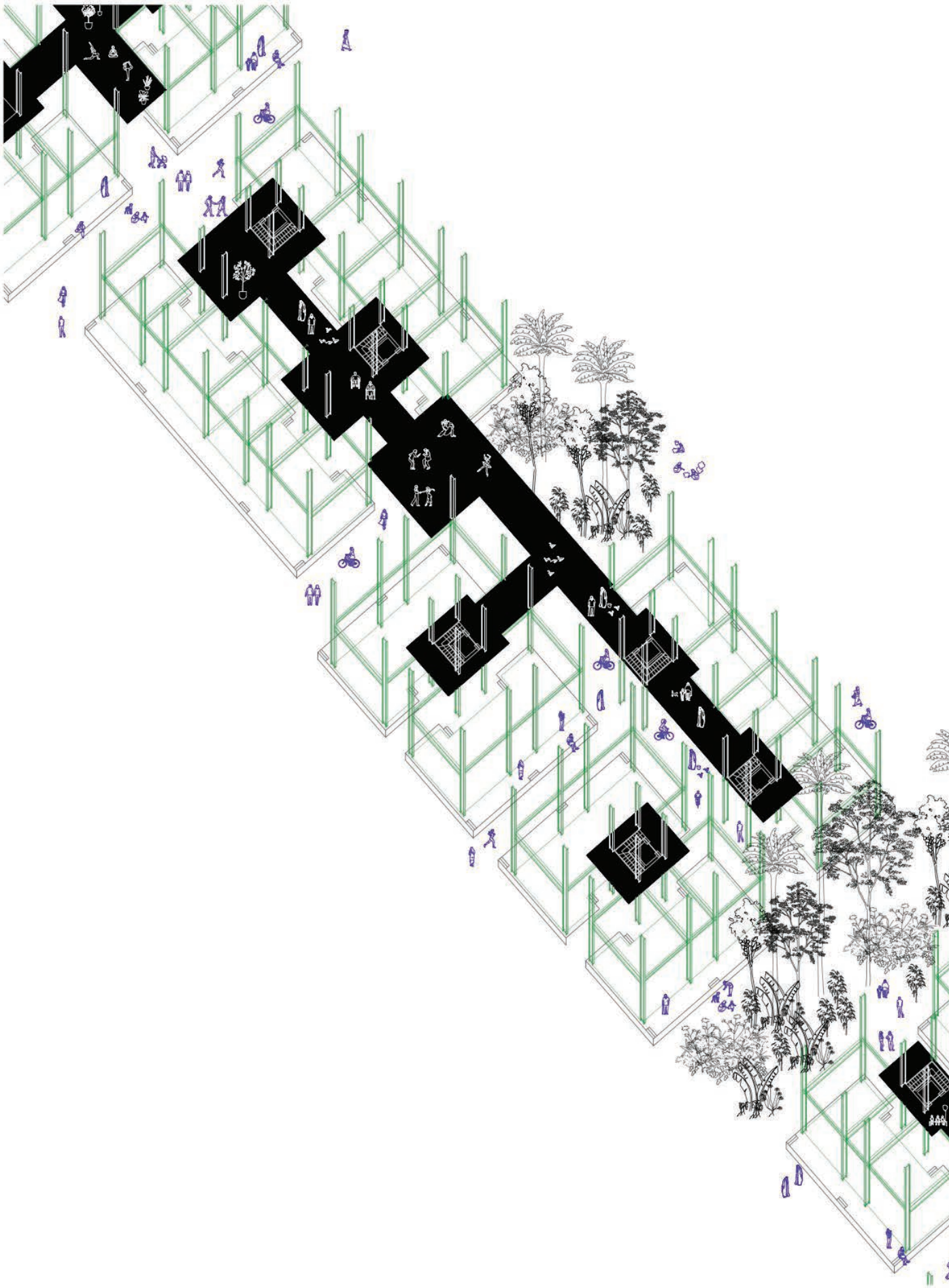


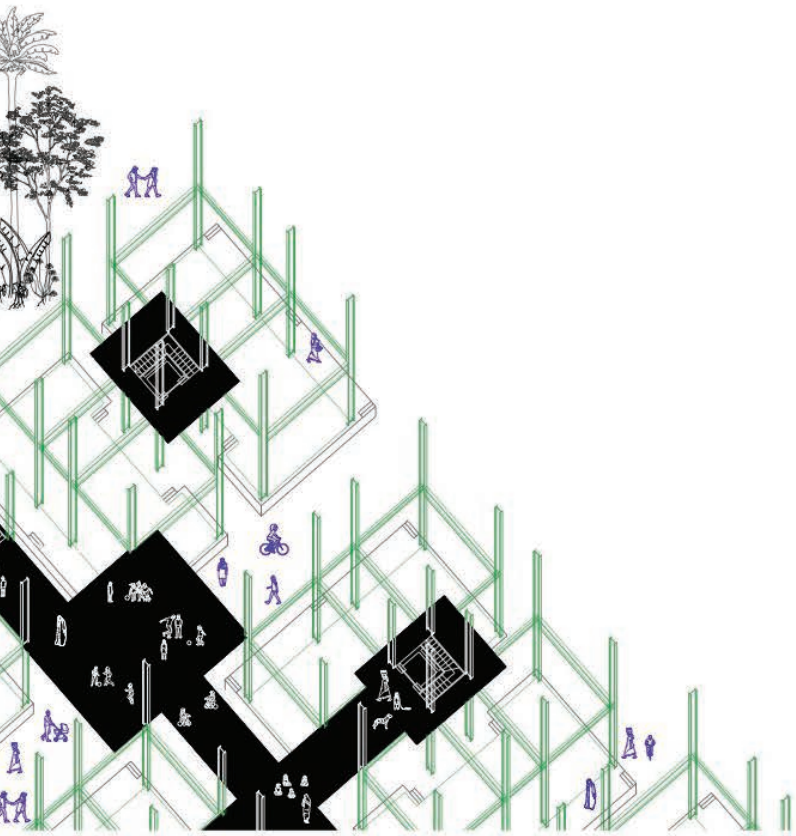
Cluster strategy

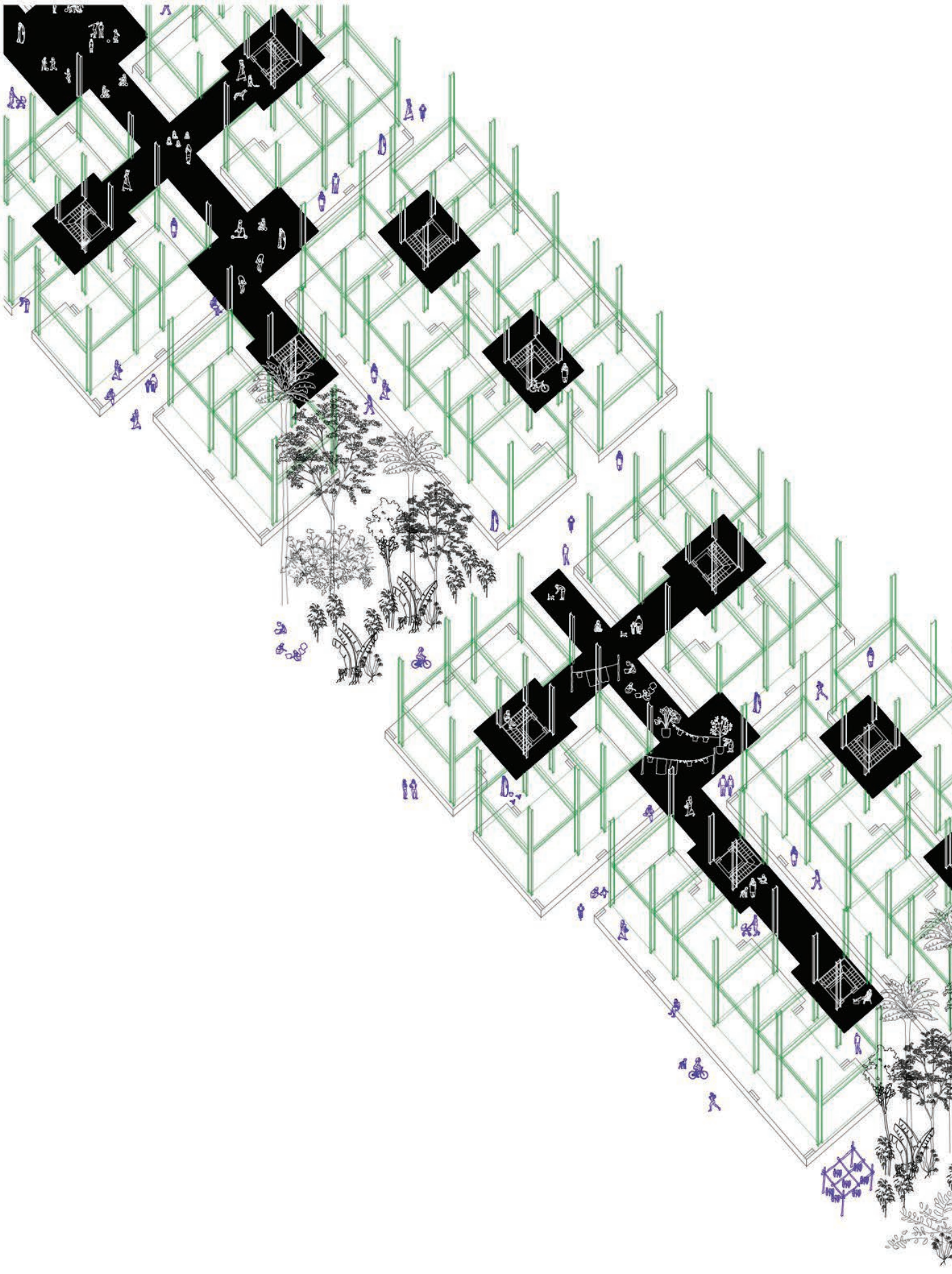
The decks can be used by all residents, regardless of income group. While the housing units on the ground and first floors are specifically allocated to low-income families, the platforms and courtyards in the clusters offer outdoor spaces to exerce the activities they used to practice while living in the slum (laundry, cooking, socializing, gardening, playing,etc.).

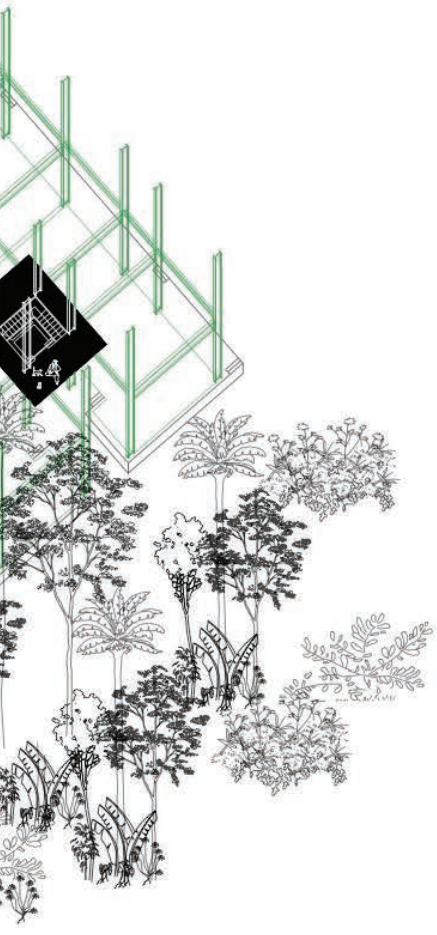






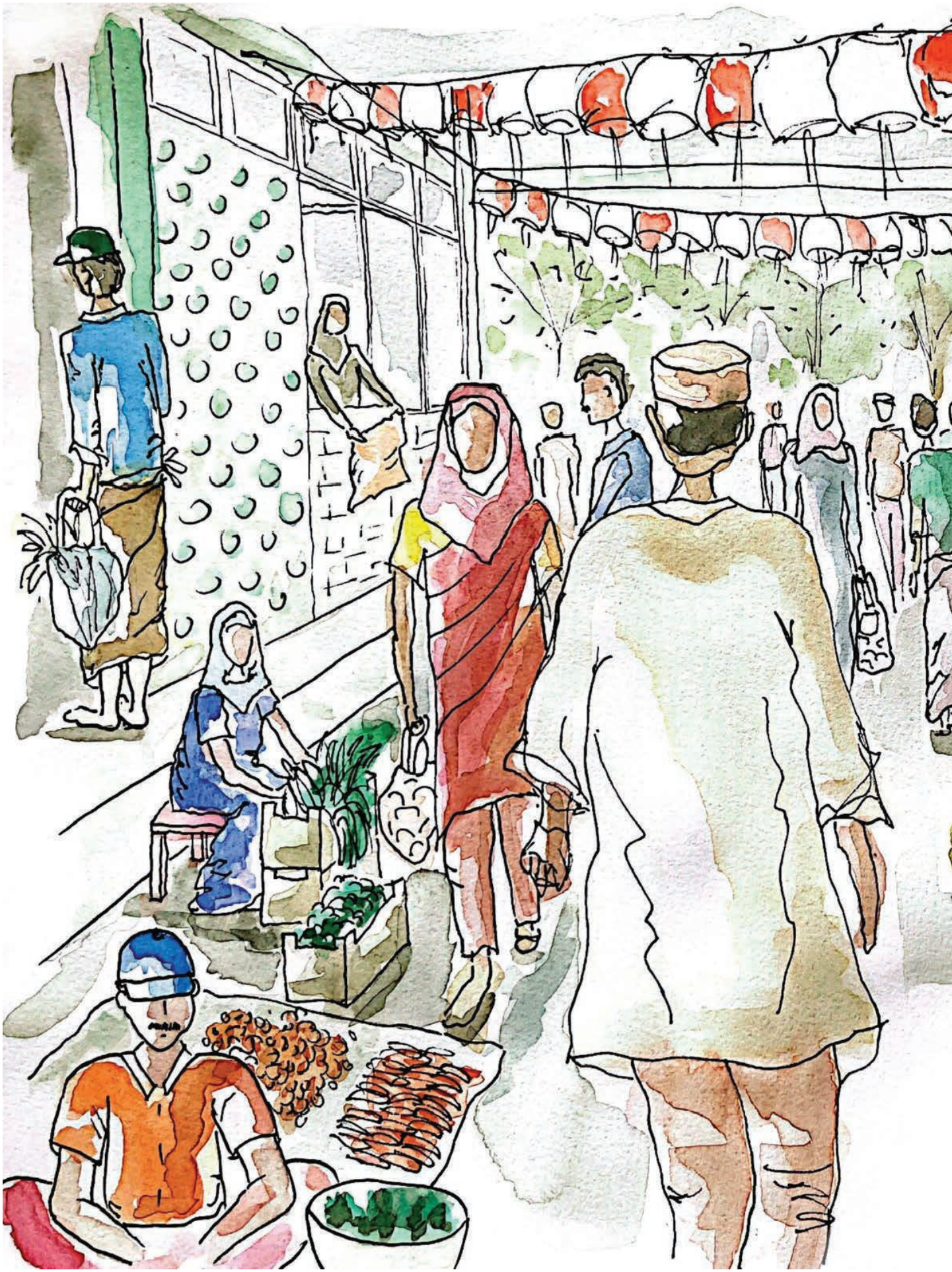







OIL

Life on the platfrom (first floor), E.V.



Street life under the platform, E.V.

Shop (black hatches)**, low-income** housing units - **first layer**

Low-income housing units - **second layer**

Middle-income housing units - **first layer**

Middle-income housing units - **second layer**

Middle-income housing units - **third layer**

Middle-income housing units - **fourth layer**

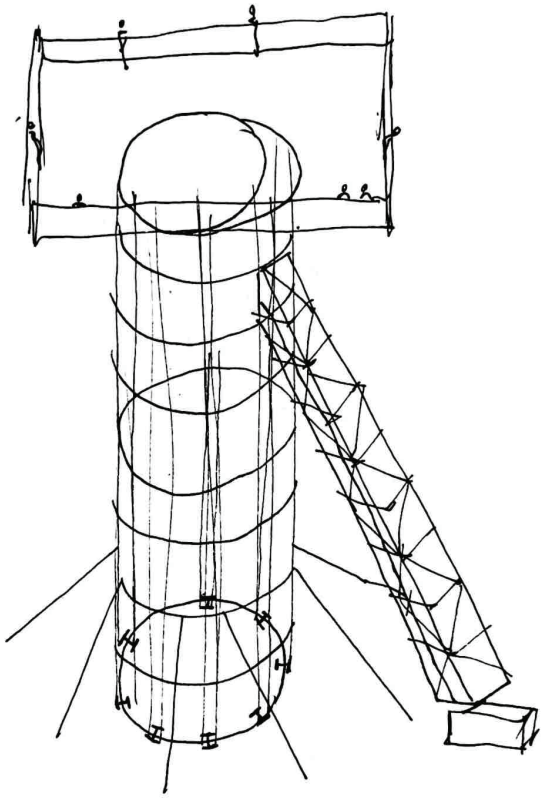
Middle-income housing units - **fifth layer**

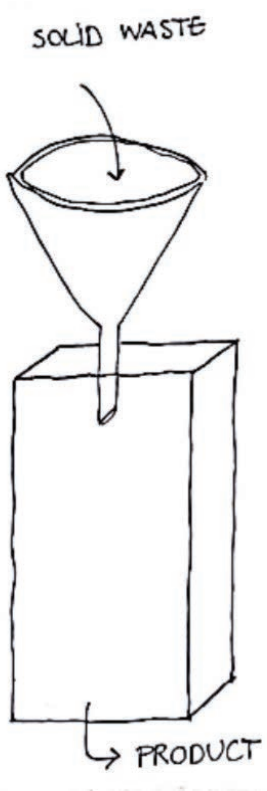
The building heights vary between four and eight storeys. This variation creates a dynamic skyline, allowing the buildings to stand out to distinguish them from one another.

number sqm low-income housing units
= sqm middle-income housing units

number of low-income housing units
= 2 times the number of middle-income housing units

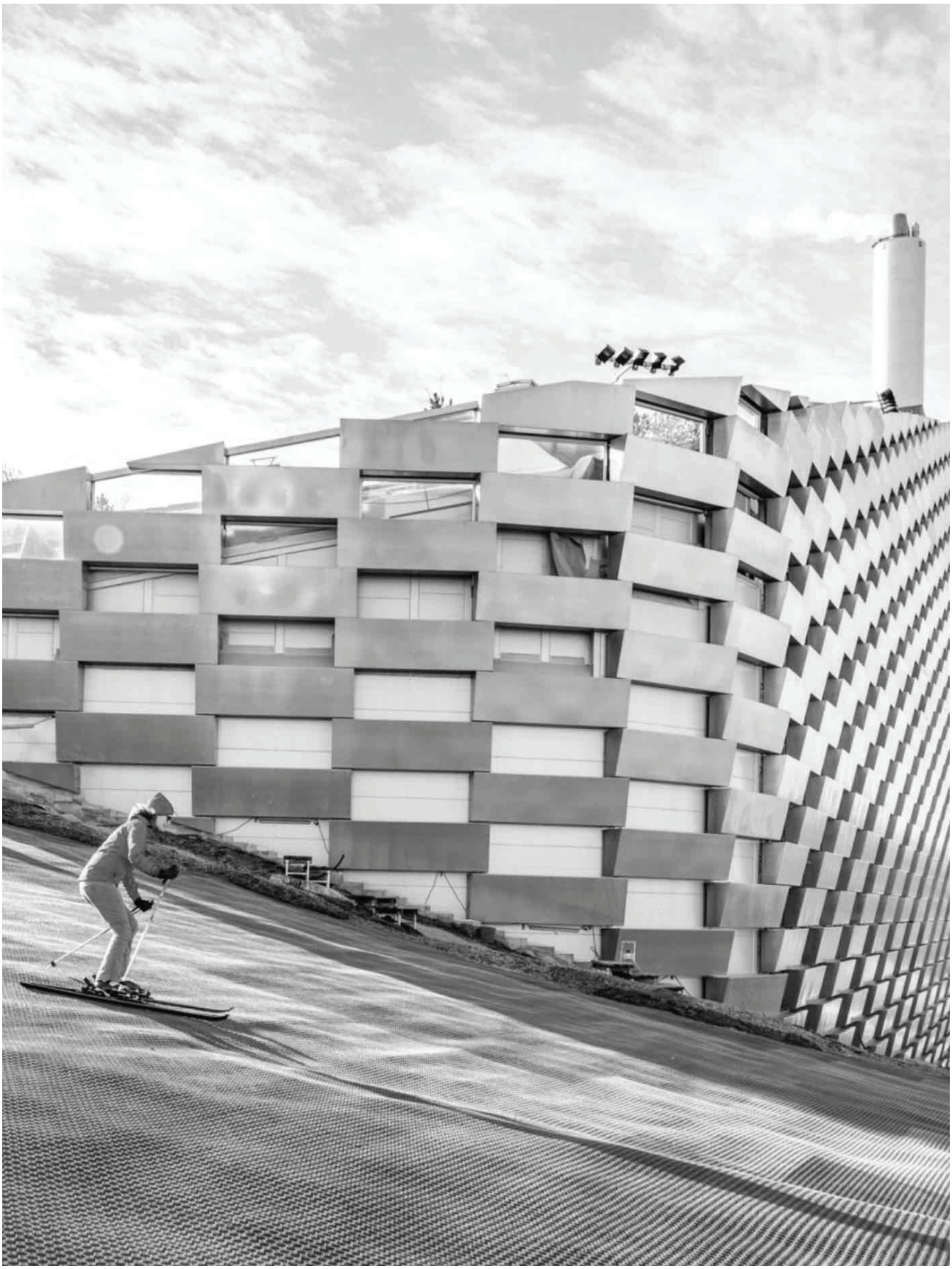
Solid waste treatment concept





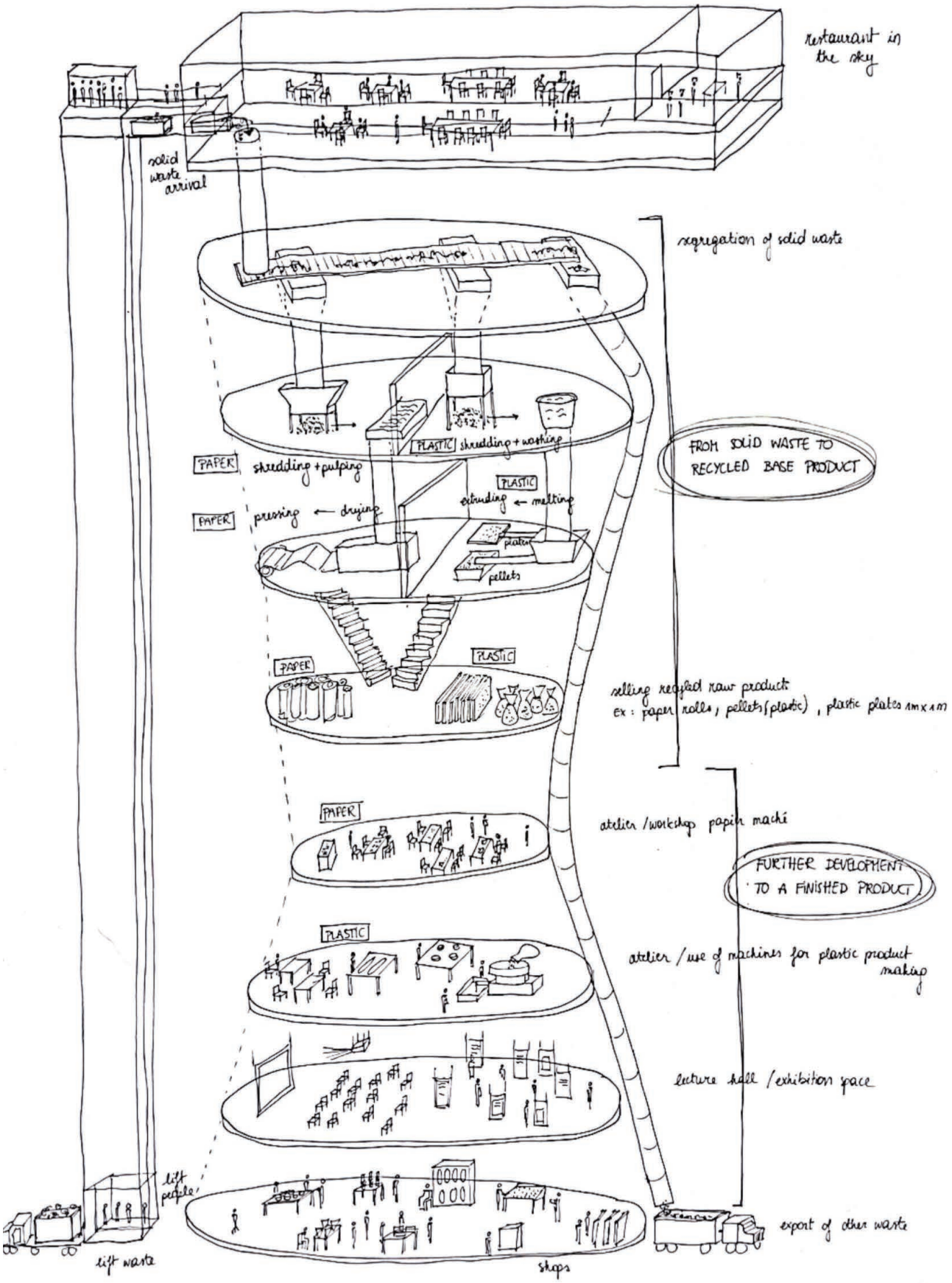
Currently, the Sylhet City Corporation's waste collection system transports waste to a landfill on the city's outskirts. This project proposes a different approach: treating garbage on-site. Instead of hiding the process, the factory will openly showcase the entire recycling operation in a clear and engaging manner. The waste treatment factory will be a prominent landmark in Sylhet landscape, similar to the CopenHill power plant in Copenhagen.

Solid waste will be brought to the top of the factory, which will function like a giant funnel. The factory will feature glazed sections, allowing people to observe the recycling process from the streets. The finished products will be available on the ground floor, demonstrating the simplicity and efficiency of the process. This design not only addresses waste management but also creates an educational and interactive experience for the community.

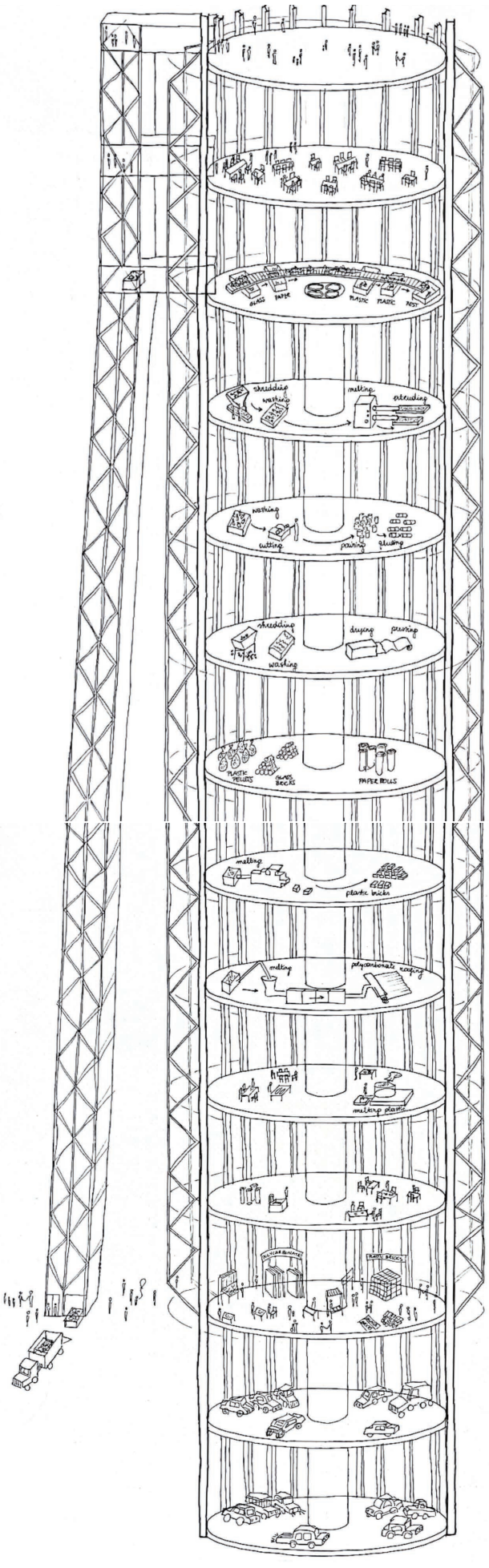


CopenHill power plant with rooftop ski slope in Copenhagen, BIG, 2017, Dezeen.

Preliminary design



Final design



observatoire 11

restaurant 10

arrival waste + segregation 09

plastic treatment 08

glass treatment 07

paper treatment 06

shop 05

plastic bricks 04

polycarbonate plates 03

plastic atelier 02

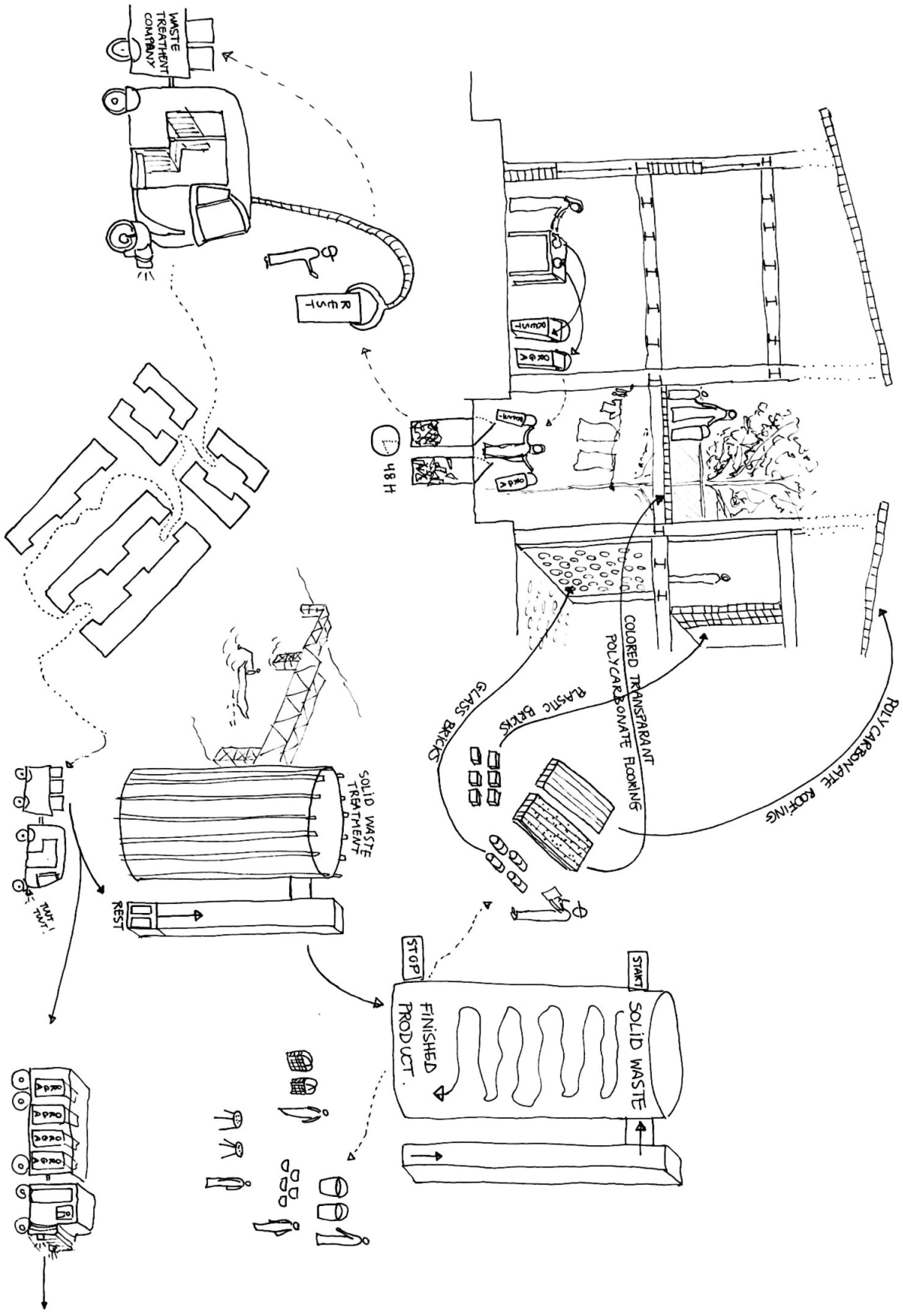
paper atelier 01

market - 0

parking - 01

parking - 02

Solid waste treatment concept



The scheme outlines the waste treatment process, from initial disposal at the dwelling to its conversion into building materials.

First, waste is segregated at home into two different bins: one for organic waste and one for solid waste.

When the bins are full, they are emptied into a container dug into the ground in the center of the cluster.

Every two days, waste pickers collect the waste from all the clusters. This process is also carried out in the neighborhood, where larger trucks are used for collection.

The waste is then transported to the waste treatment tower, where trucks await to transfer the organic waste to separate treatment facilities. The solid waste is lifted in a container by an elevator to the tenth floor of the tower.

Here, the transformation process begins, as detailed on page 101. Two types of end products are created from the solid waste : on the one hand handcrafted items made by residents using tools and small machinery in the workshop spaces within the tower, on the other hand building components, such as plastic bricks, polycarbonate plates for flooring and roofing, and glass bricks, to be used in the new housing project.

Solid waste treatment concept

Dweling strategy

Low-income

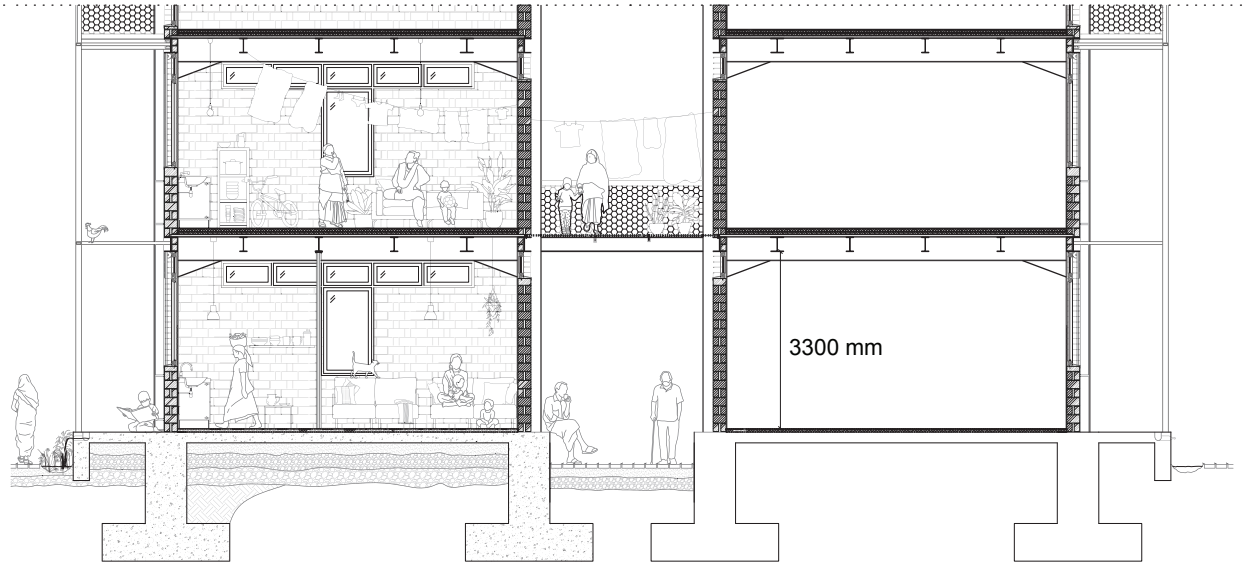
surface 1 housing unit : **43,5 sqm**

surface 1 housing unit + mezzanine : **48,5 sqm**

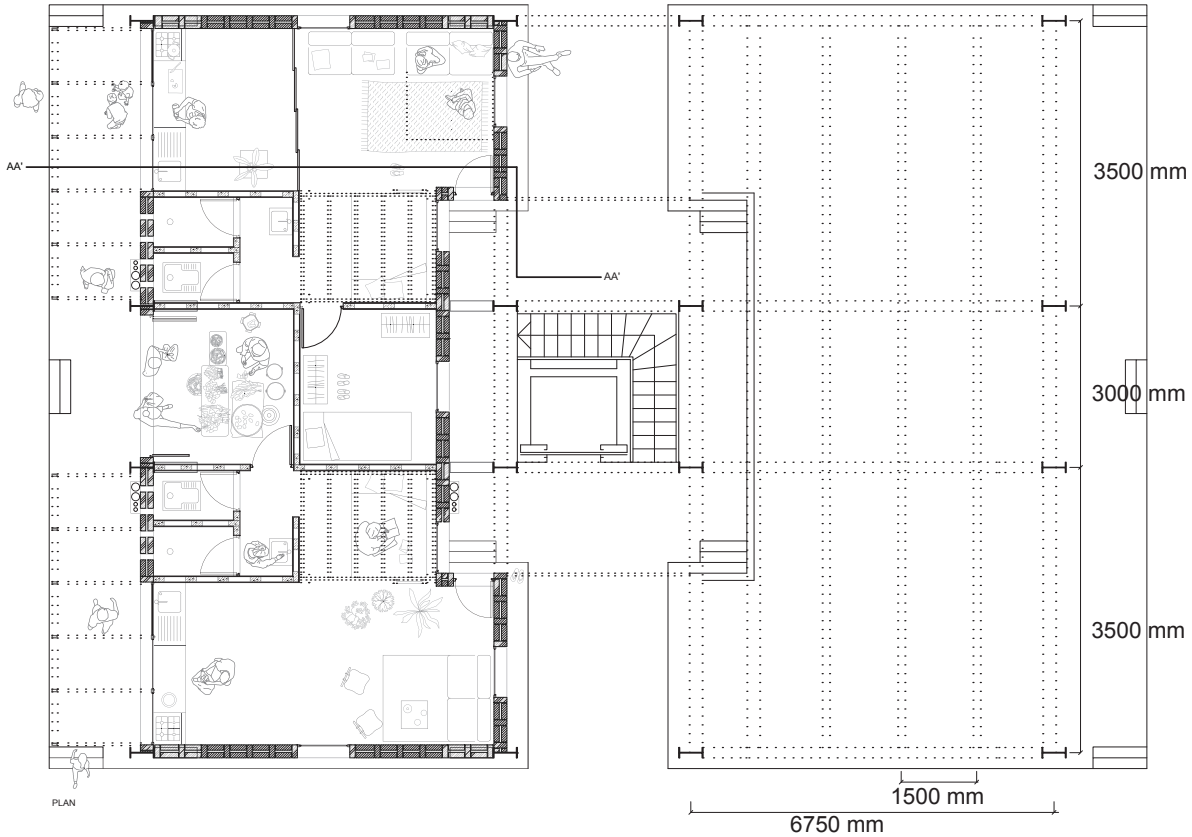
surface separated modular room : **9 sqm**

3 facades appartement

access : staircase



AA' SECTION



PLAN

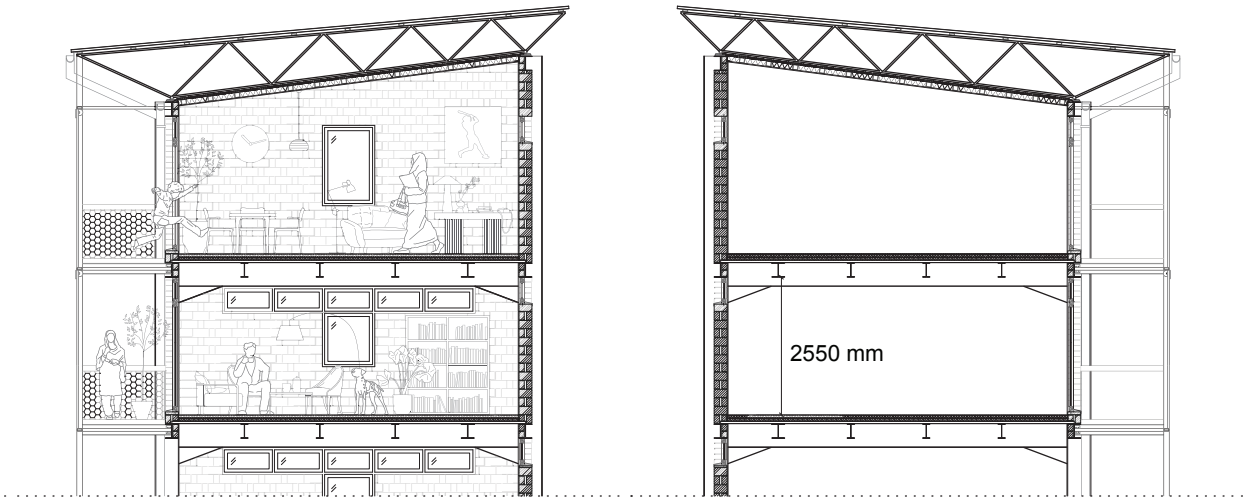
Middle-income

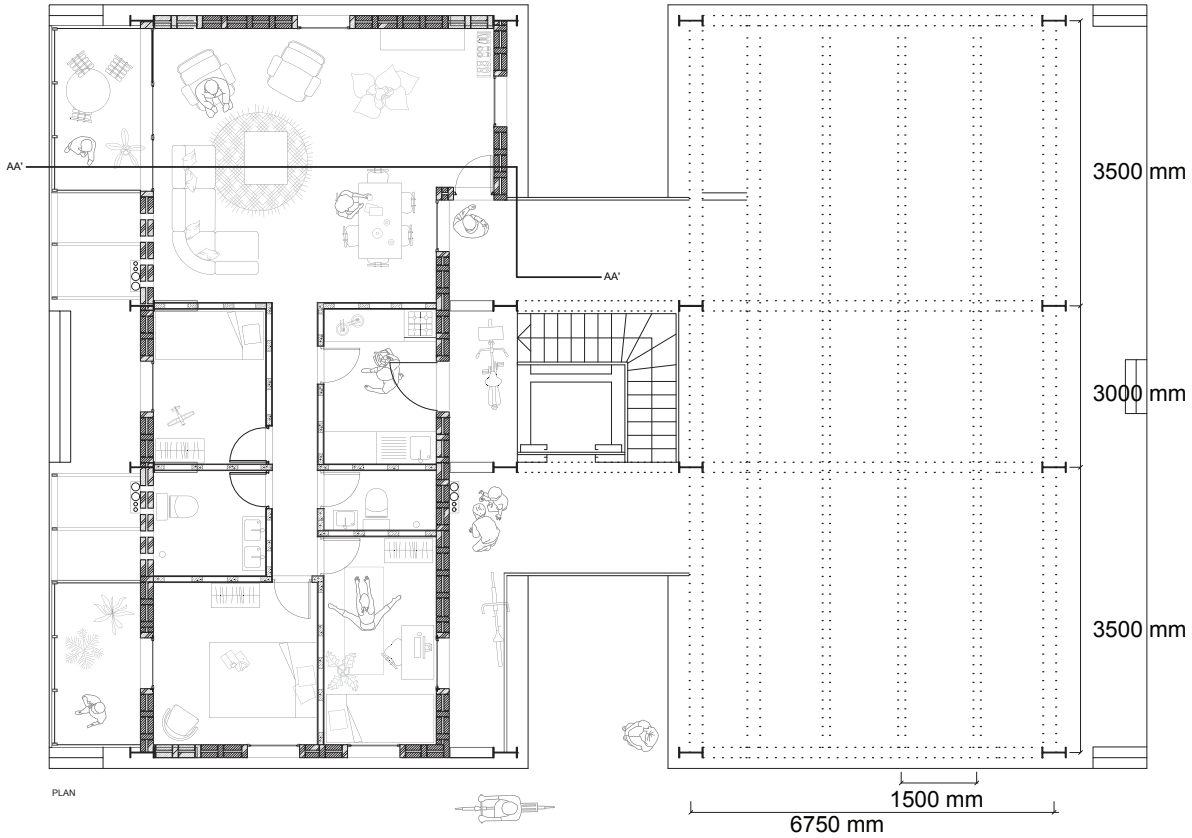
surface 1 housing unit : **92 sqm**

balcony and gallery

4 facades appartement

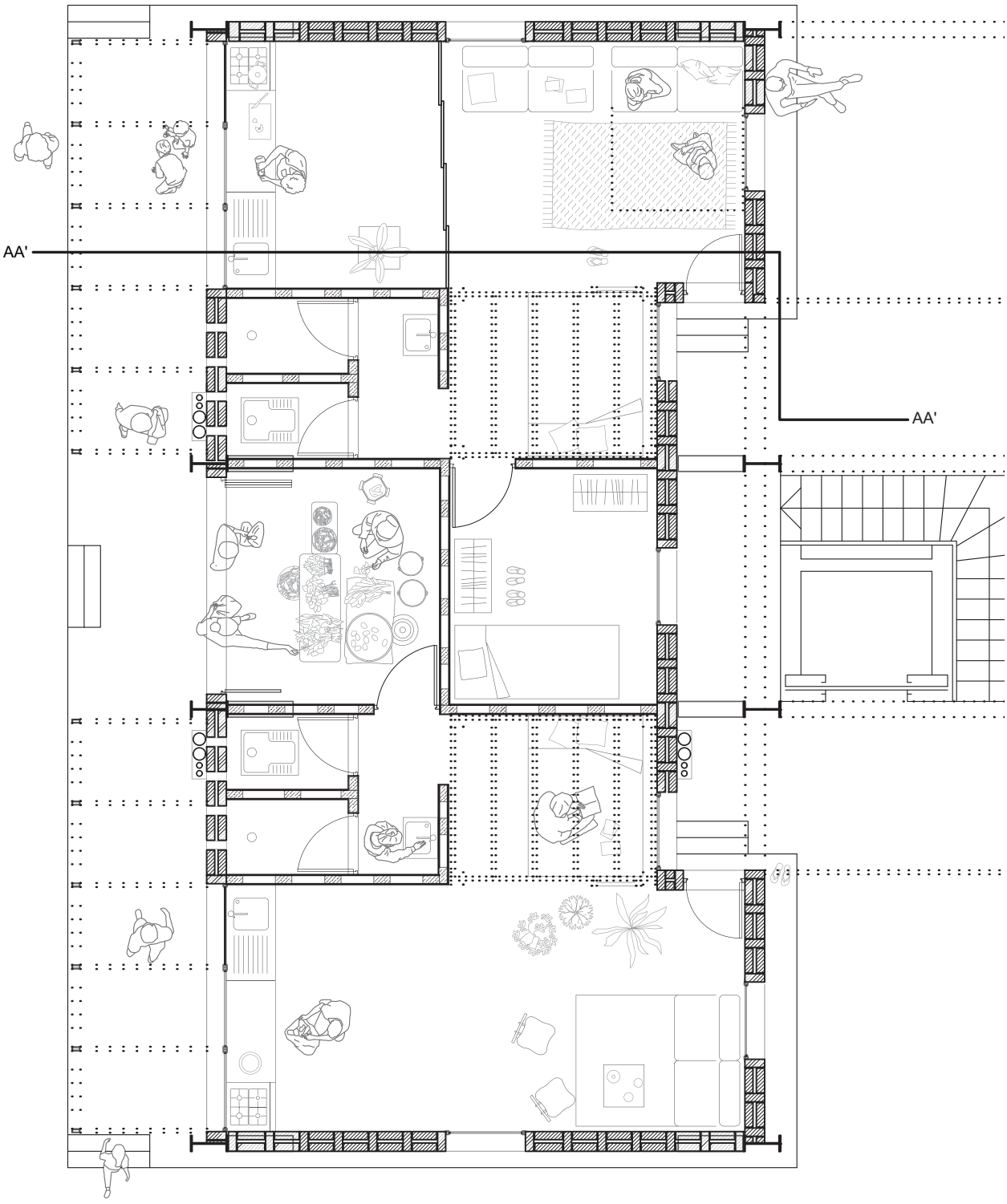
access : elevator/staircase





Low-income

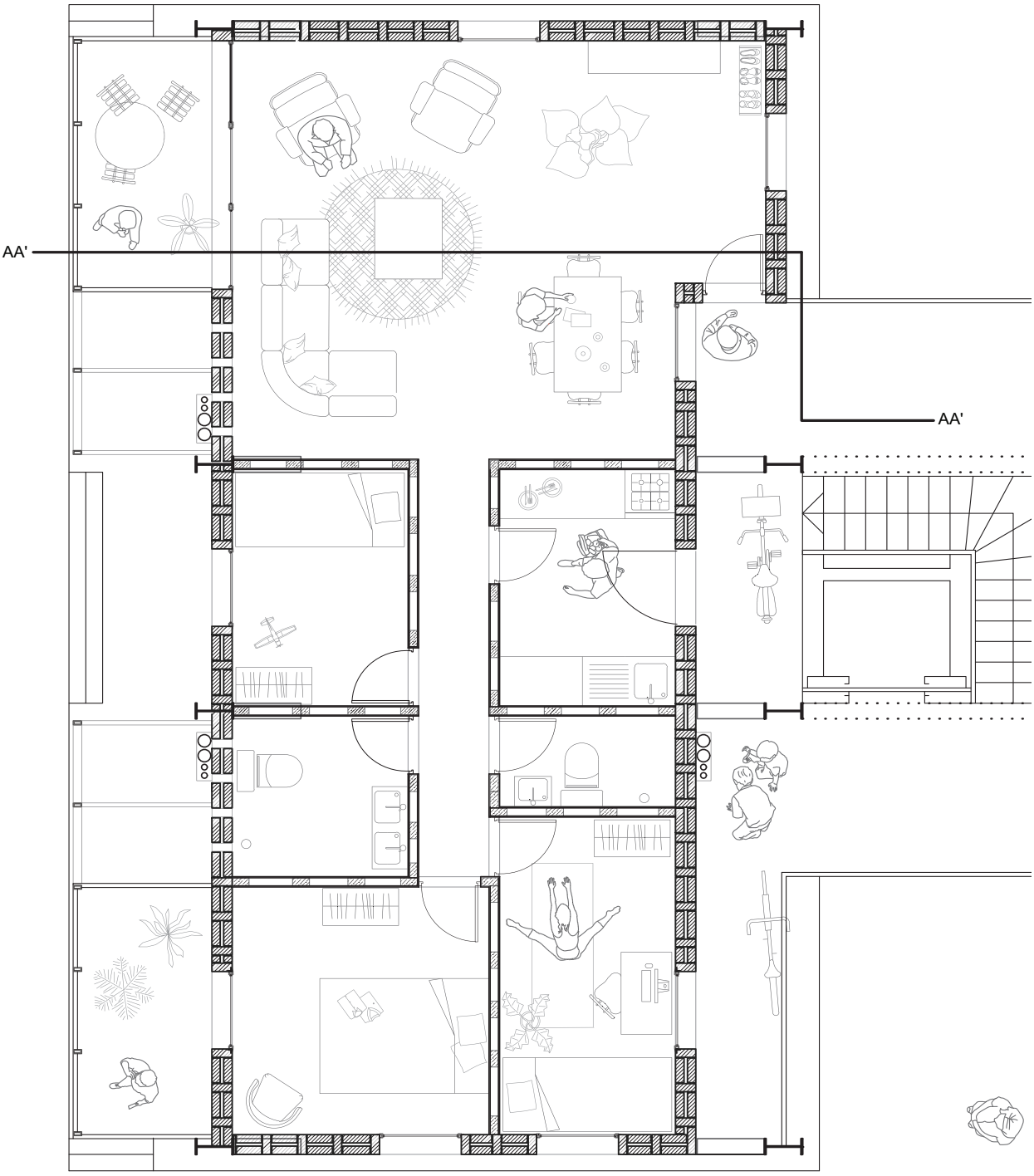
AA' SECTION



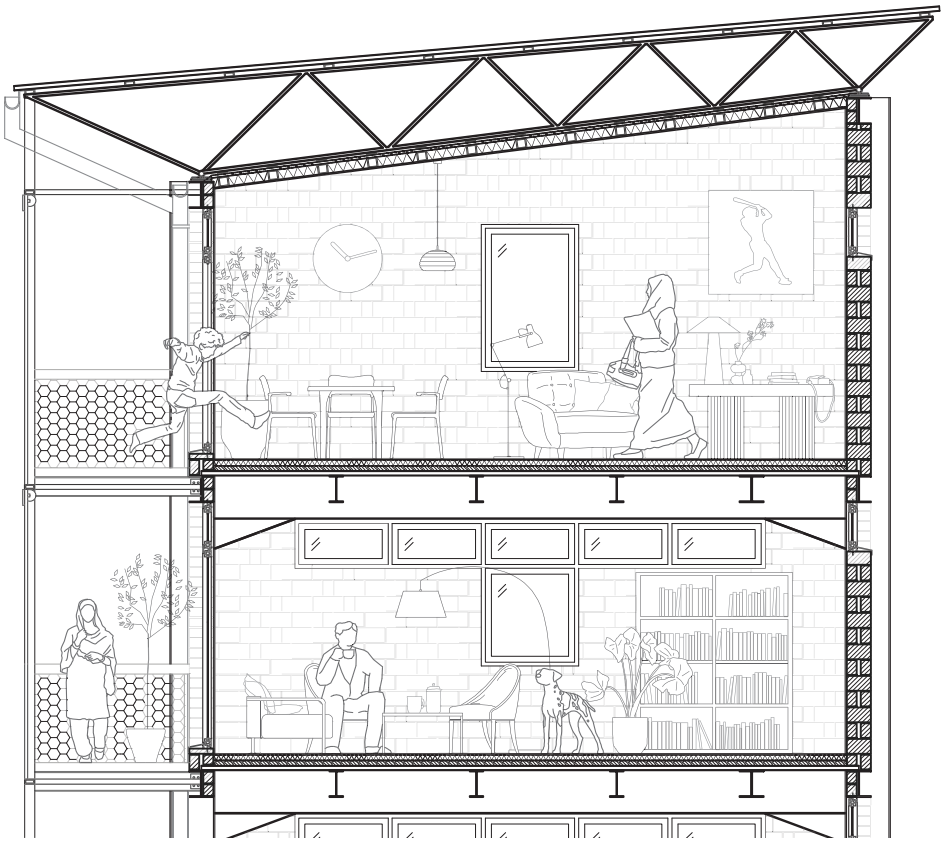
PLAN

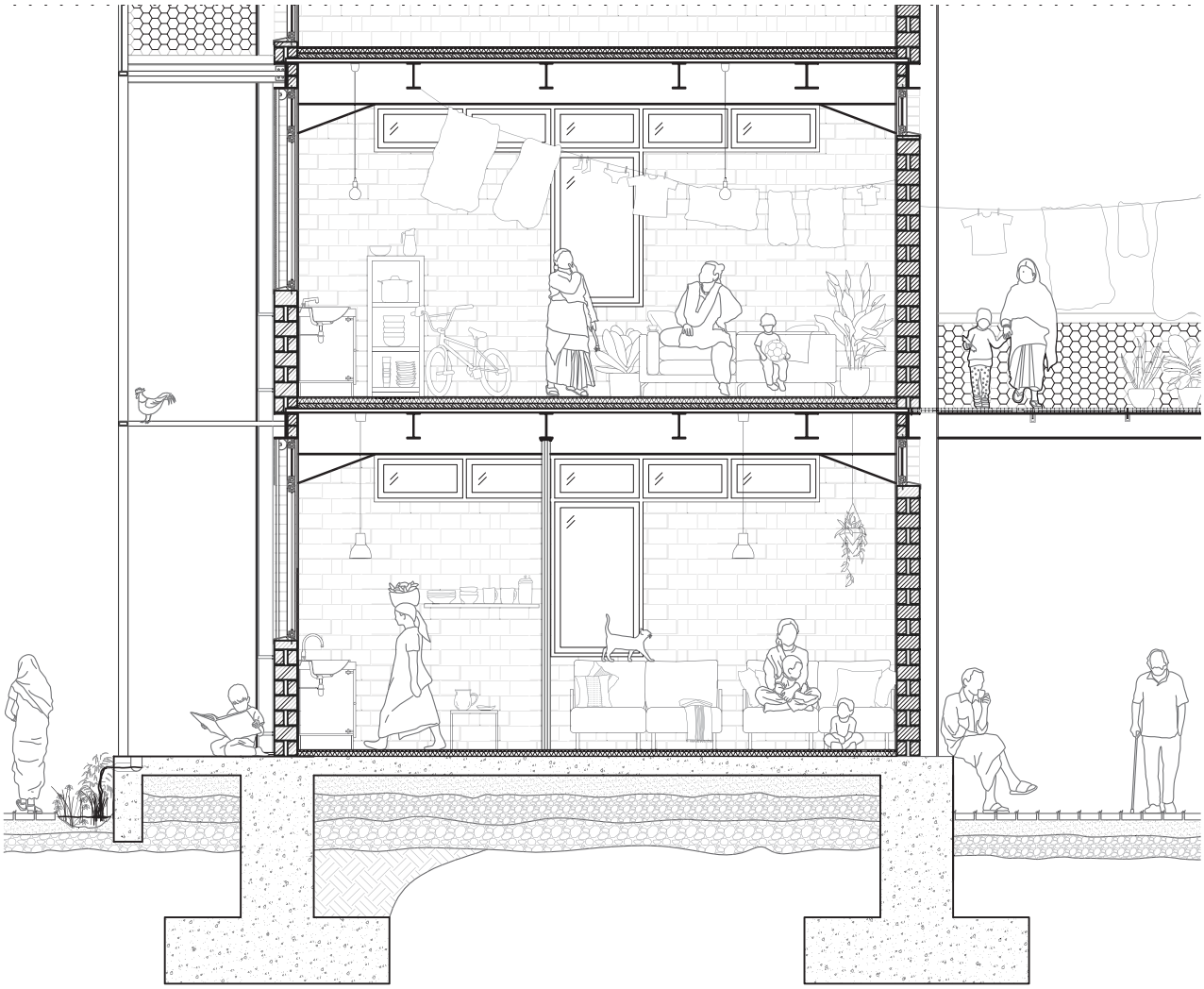
Middle-income

AA' SECTION



PLAN





The project proposes equal living space per income groups, regardless of household size, emphasizing equity in design. In *Housing and Urbanism published in 2000*, Charles Correa discusses this concept in the chapter *A Bill of Rights*:

« *But for us in India, there is one other advantage to this pattern of housing that may prove to be the most decisive of all, and that is : Equity. Today the amount of urban space one controls is directly proportional to one's status and/or income : it has no connection with actual family size. Poor people have families as large as rich people - in fact, larger. This space differential, therefore, cannot be justified in human terms, but only in economic ones (« Tell me how much urban space you can command and I'll tell you who you are».) In contrast, consider the cities of Australia, where almost every family has a quarter-acre lot - no more, no less. Australia is locked into equality - it can never become elitist. The exact opposite is true of most to the Developing World. Despite all our rhetoric about social justice and equal opportunity, we are locked into inequality. Our cities make sure of that.»*

The project aligns with this vision of equity. Although there is an economic imperative that is difficulat to derogate from because of the project's viability with the implementation of cross subsidization. The real progress lies in the radical change in housing for low-income households, where residents now have access to quality housing constructed with the same standards and materials as those for higher-income groups. This ensures that all residents, regardless of income, benefit from equal quality living conditions.

To further promote equity, the project offers the same dwelling size within each income group, regardless of the number of occupants. Each low-income family unit includes a nine-square-meters separate room between two housing units, adaptable for various uses. For large families, this room can serve as an additional bedroom. If the main dwelling and mezzanine provide sufficient space, the room can be used for economic activities such as a shop, storage, or workshop, or rented out to another family. This modular approach allows families to tailor their living space to their needs.

Moreover, the project offers multiple outdoor spaces for residents' daily use, extending beyond the individual dwellings. Charles Correa, in his 1985 book *The New Landscape*, states regarding low-cost urban housing:

« Urban living involves more than just the use of a small room of 10 square meters. The room, the cell, is only one element in a whole system of spaces that people need. This system is hierarchical. For us, under Indian conditions, it appears to have four major elements:

Firstly, the space needed by the family for exclusively private use, such as cooking, sleeping, storage and so forth;

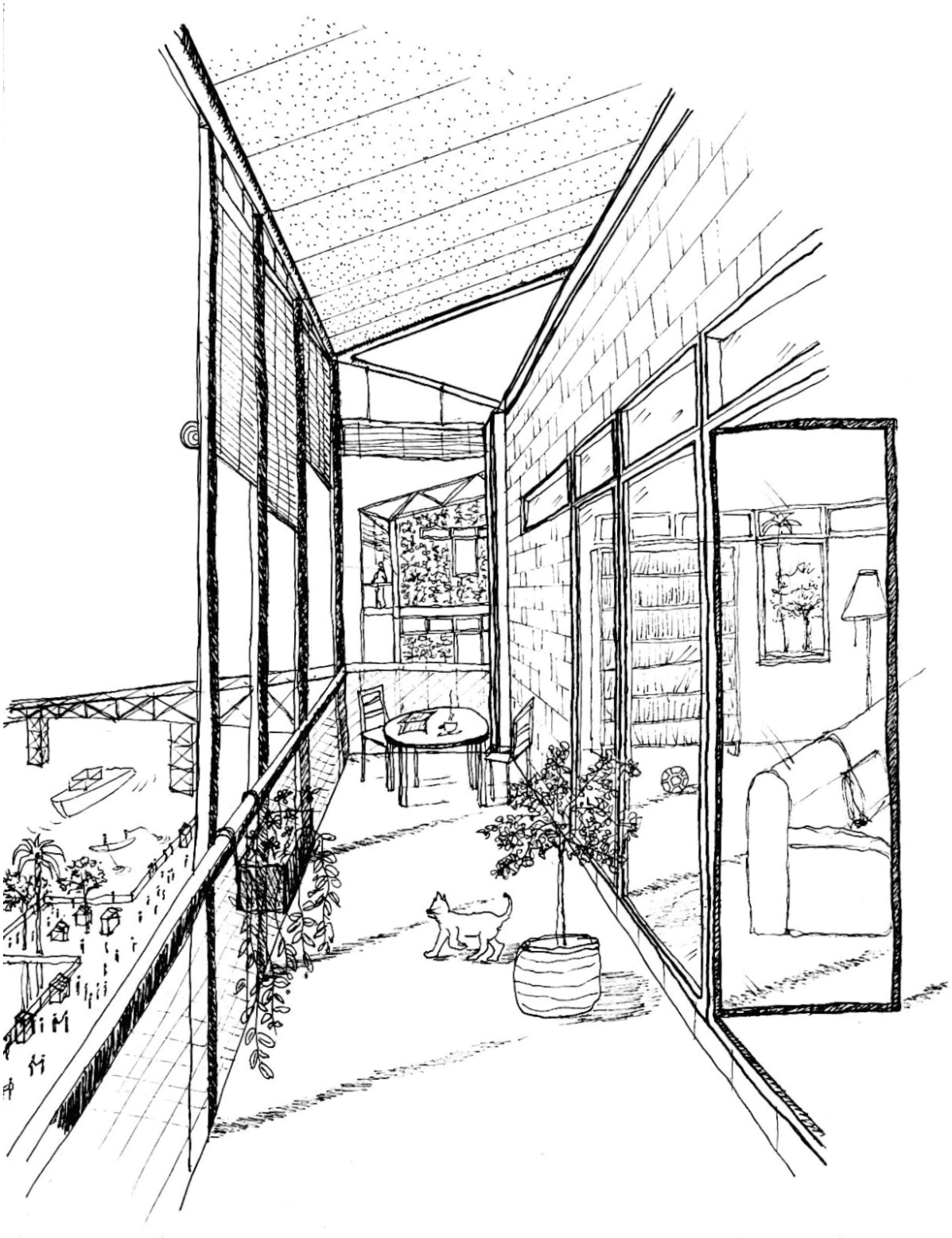
Secondly, the areas of intimate contact, i.e. the front doorstep where children play, you chat with your neighbour.

Thirdly, the neighbourhood meeting places (e.g. the city water tap or the village well) where you become part of your community;

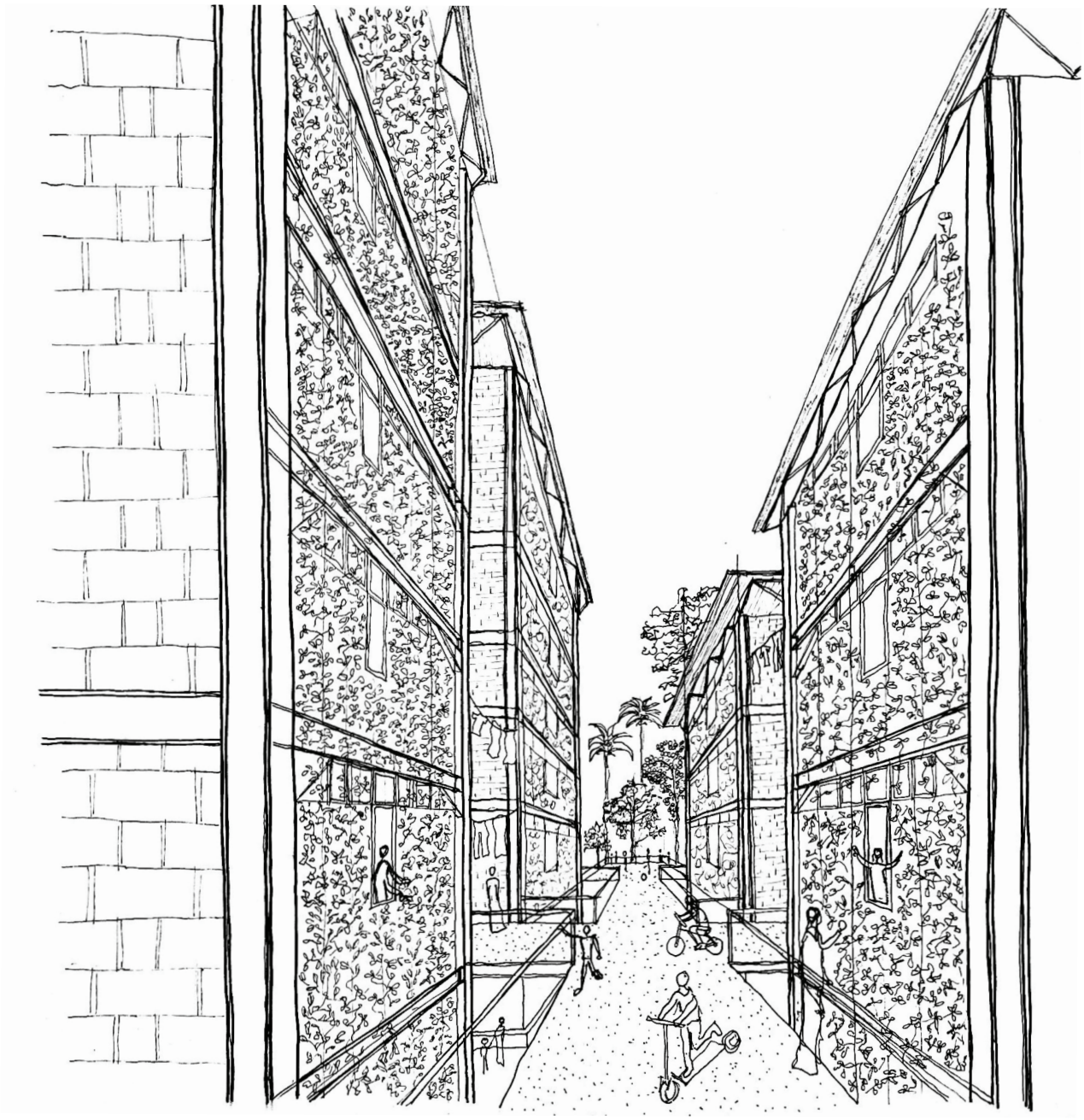
Finally, the principal urban area - e.g. the maidan - used by the whole city.»

Following that idea, the project proposes a similar sequence of spaces (see pages 112 to 115), from the private to the public :

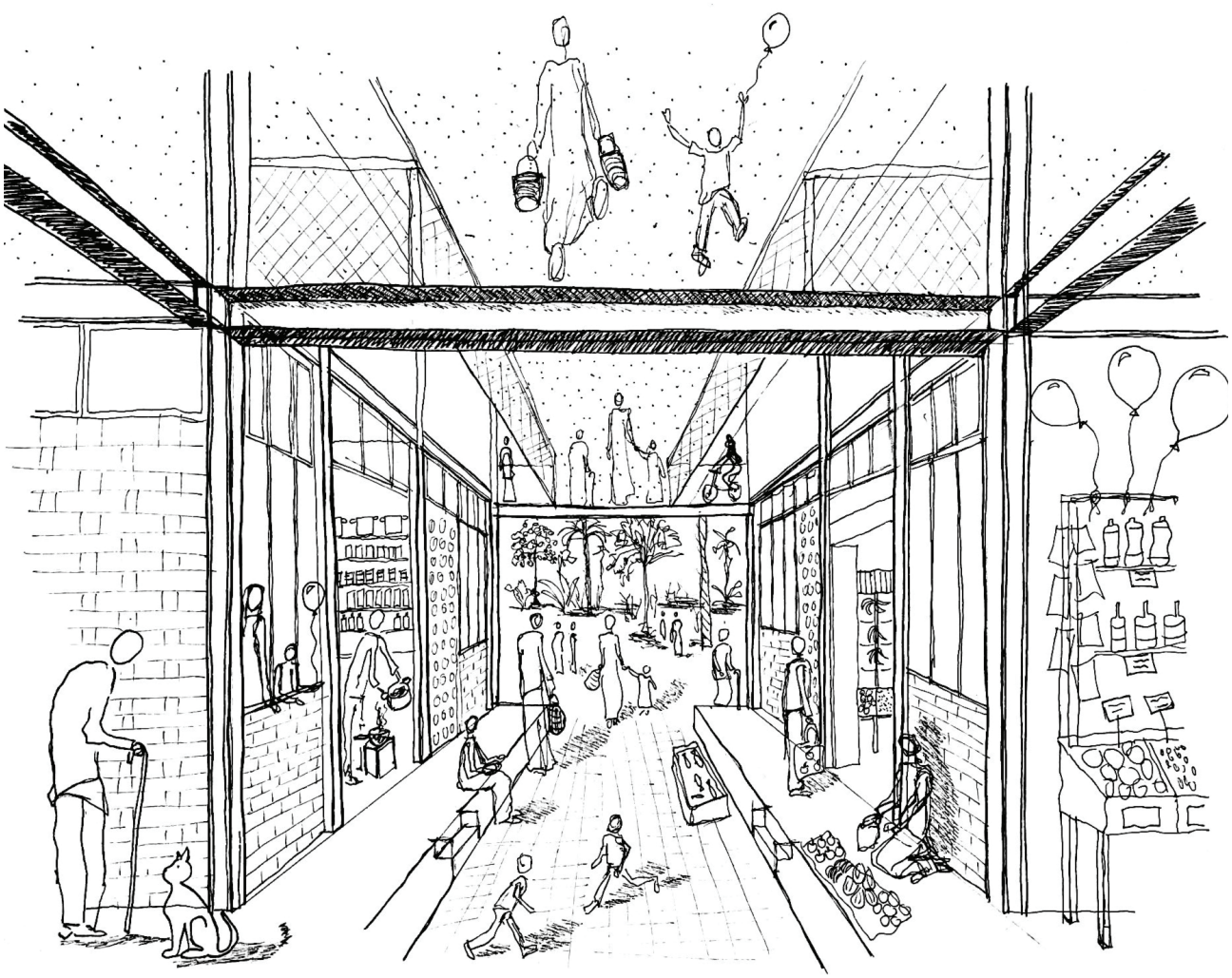
1. the dwelling with its balcony
2. the platform on the first floor, connecting the buildings to eachother, a transitional zone
3. the main street with the shops
4. the riverbank with the decks



Private - balcony



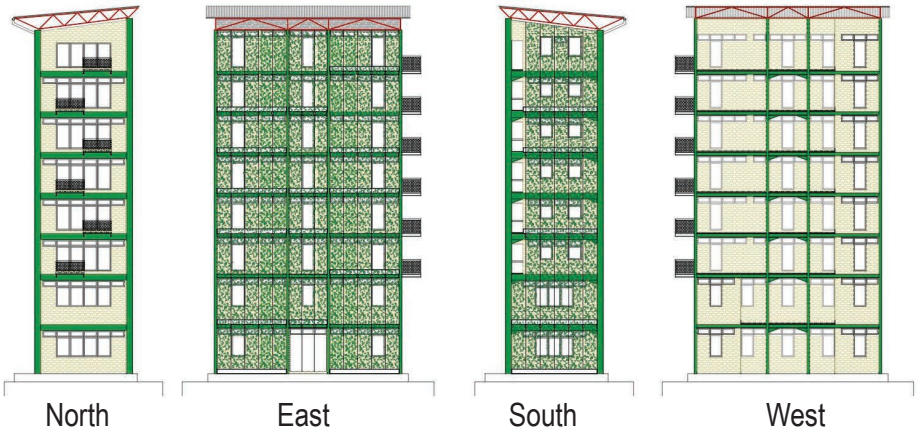
Semi-private - platform

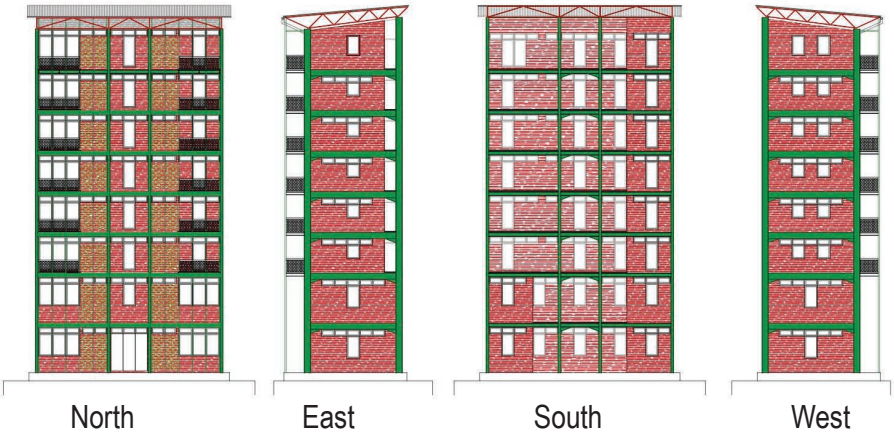


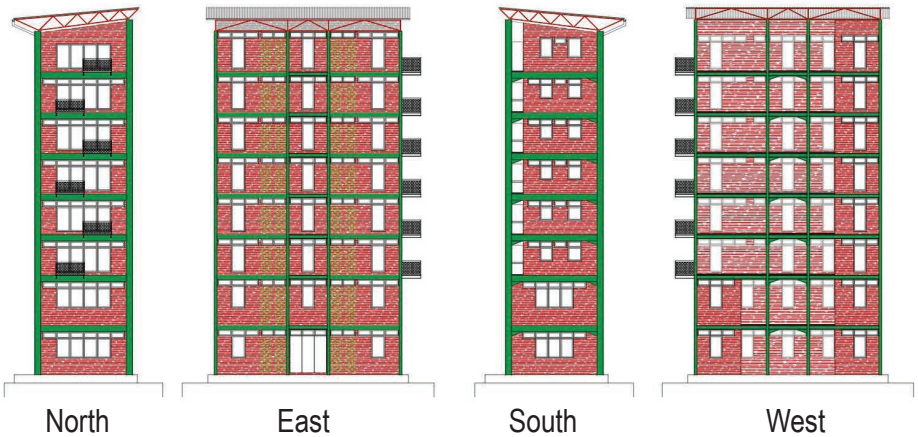
Semi-public - internal shopping street

Public - riverbank promenade


North
East
South
West


North
East
South
West


North
East
South
West

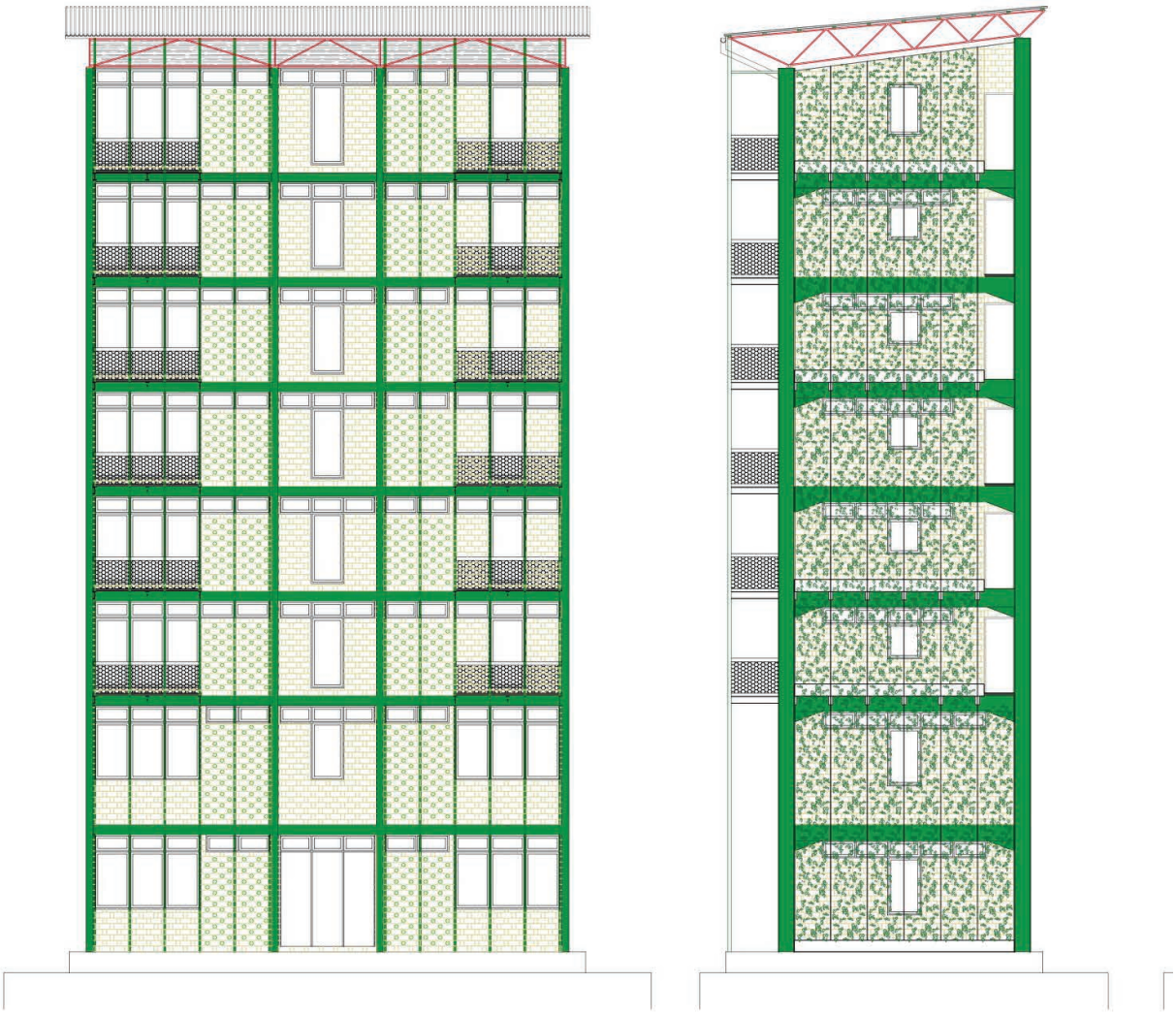

North
East
South
West

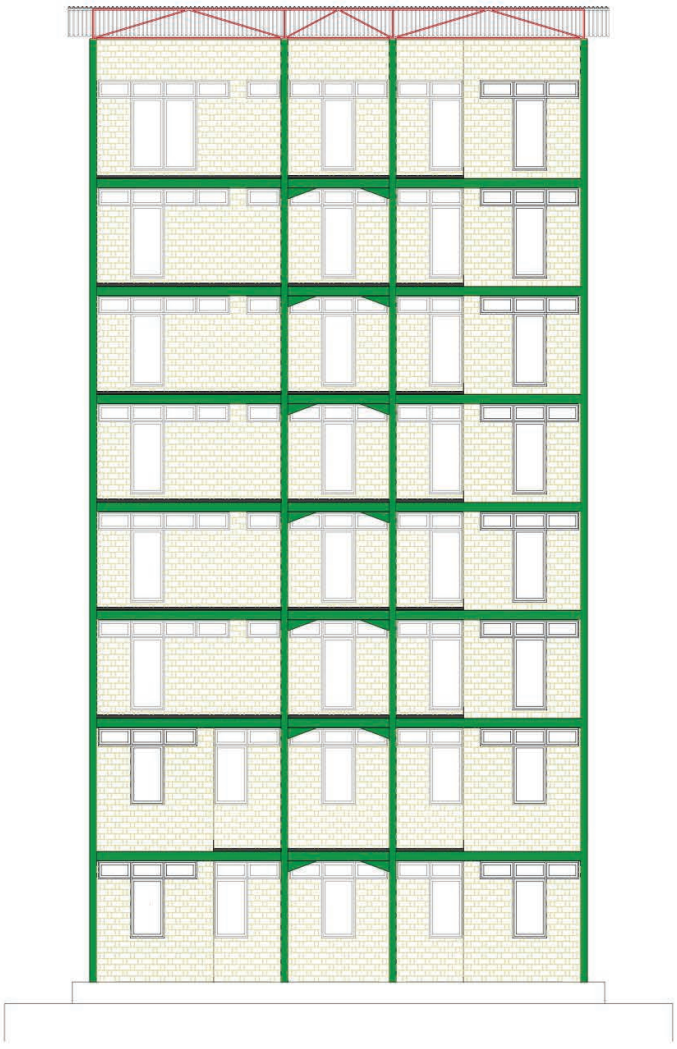
Rain protection and sun shading

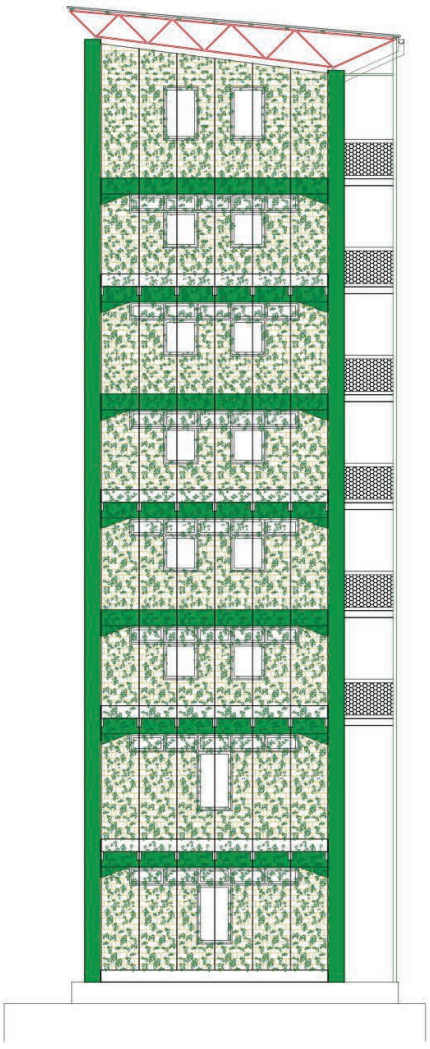
The facade incorporates Compressed Stabilised Earth Blocks (CSEBs) within a steel structure. These locally produced blocks offer a sustainable and cost-effective alternative to conventional bricks, composed of compressed soil, sand, and stabilisers like cement or lime. CSEBs are known for their excellent thermal insulation, durability, and environmental sustainability (Khushi Jha, 2023). Due to their porous nature, they require protection from heavy rains, particularly those from a more horizontal angle.

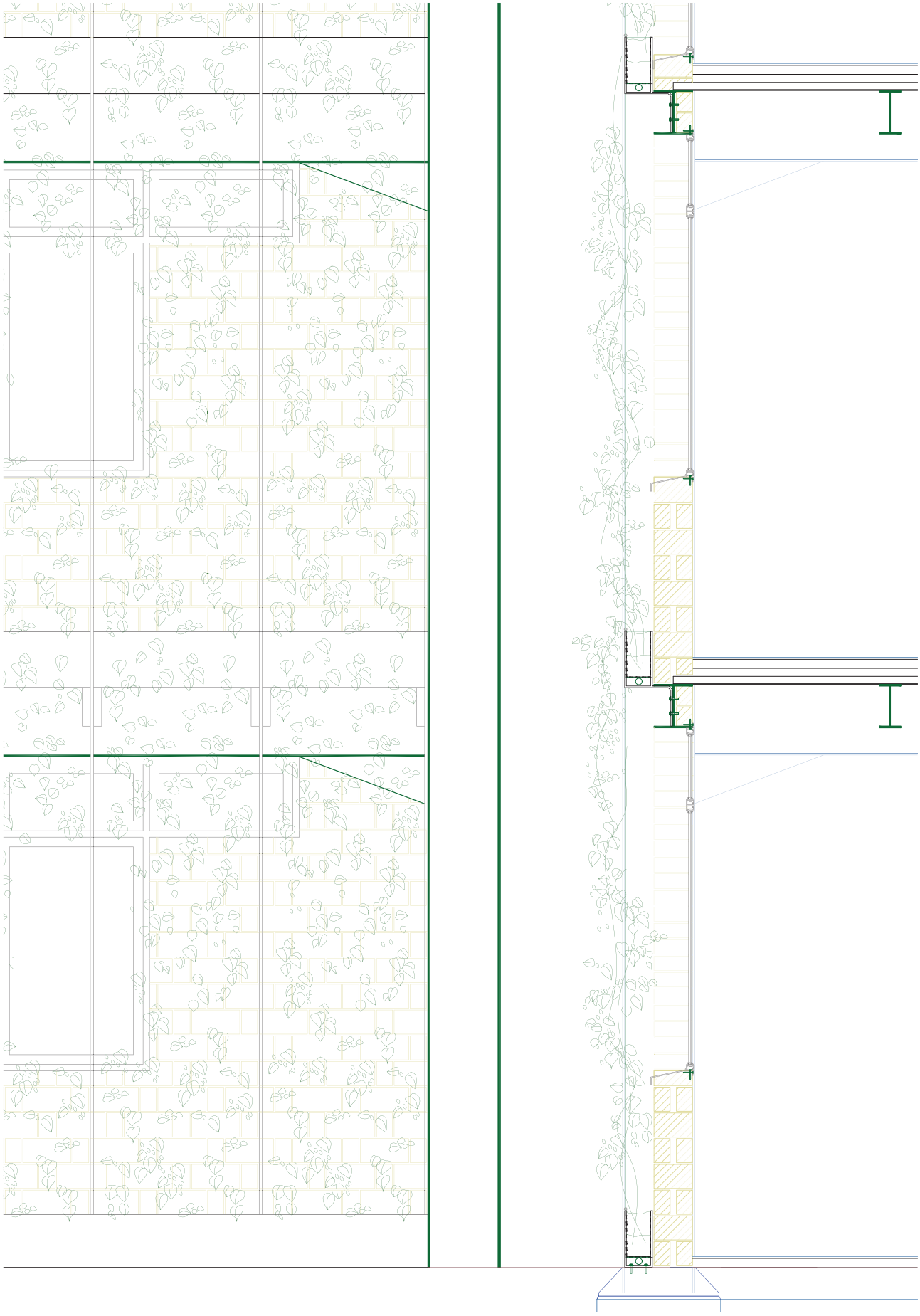
Various techniques are employed to safeguard the CSEBs in the project. On the north side of the first and third unfolded facades (as seen on page 116), a secondary structure serves as a second skin to the building, supporting sunscreens (see axonometry on page 121). Each window is equipped with Venetian blinds, a simple and replaceable sunscreen solution. Additionally, balconies and outdoor galleries provide protection for the facades, particularly those in the central cluster. Other facades feature vegetation, which not only shields but also helps cool the buildings.

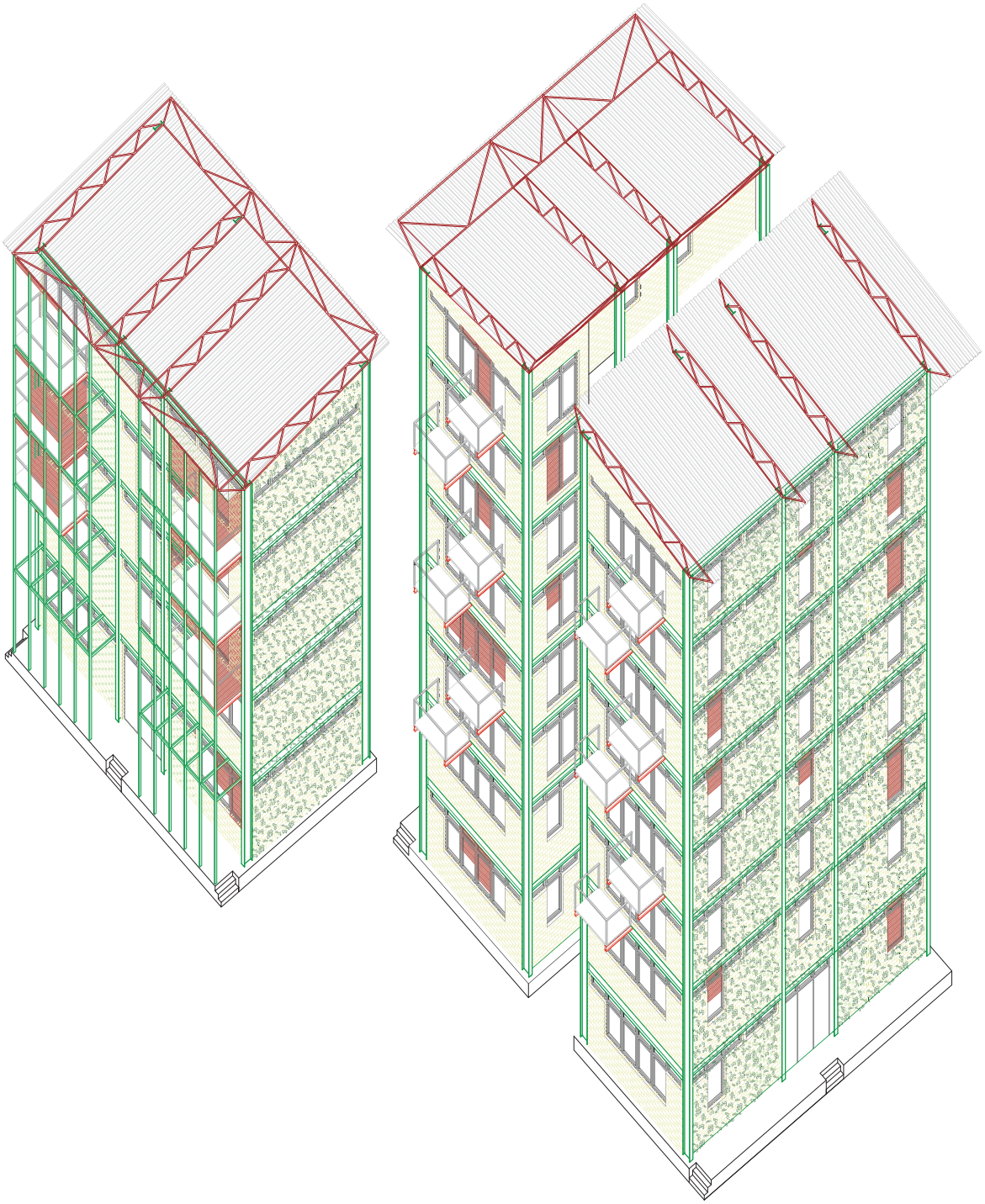
To enhance architectural diversity and protect the CSEBs, some buildings are plastered with lime coating tinted in red, reminiscent of the iconic Keane Bridge.









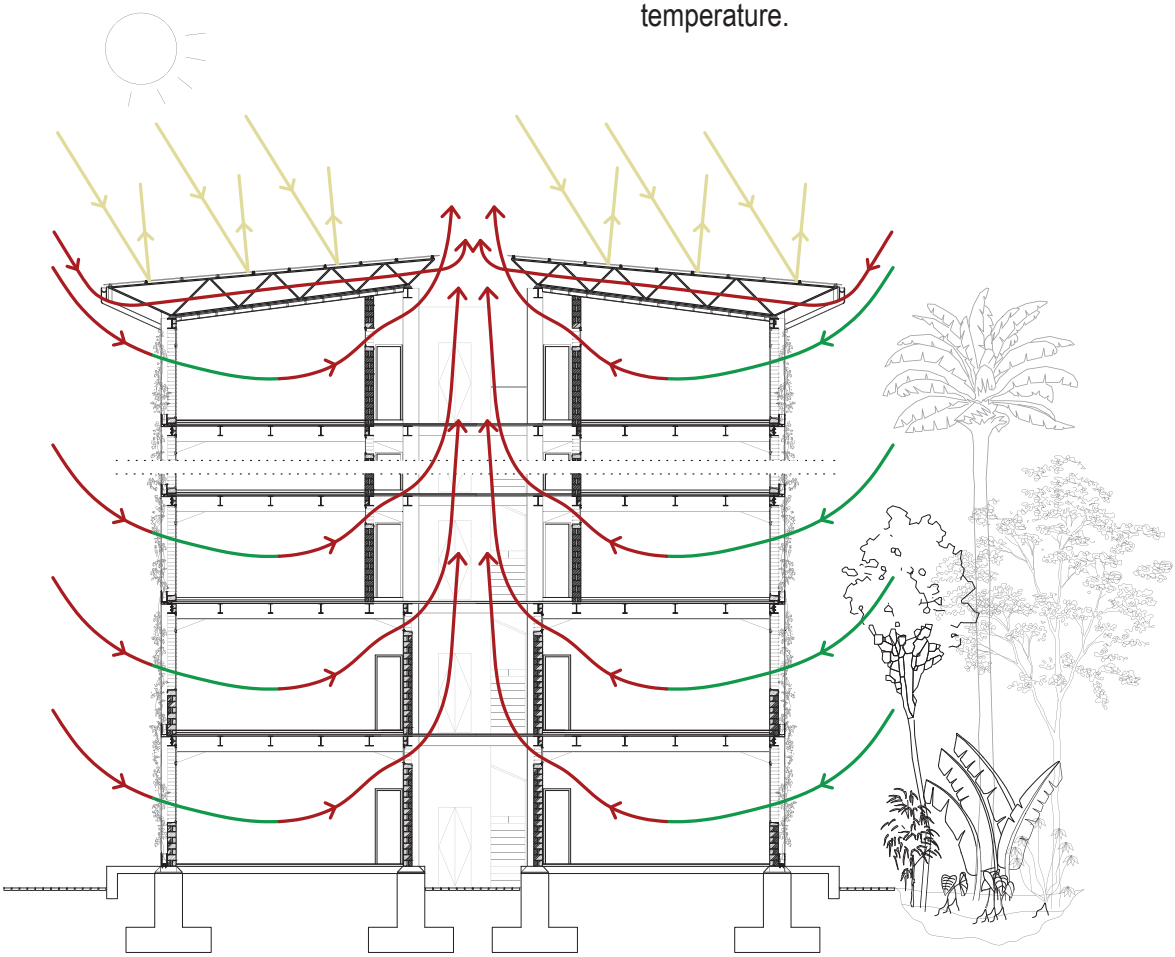


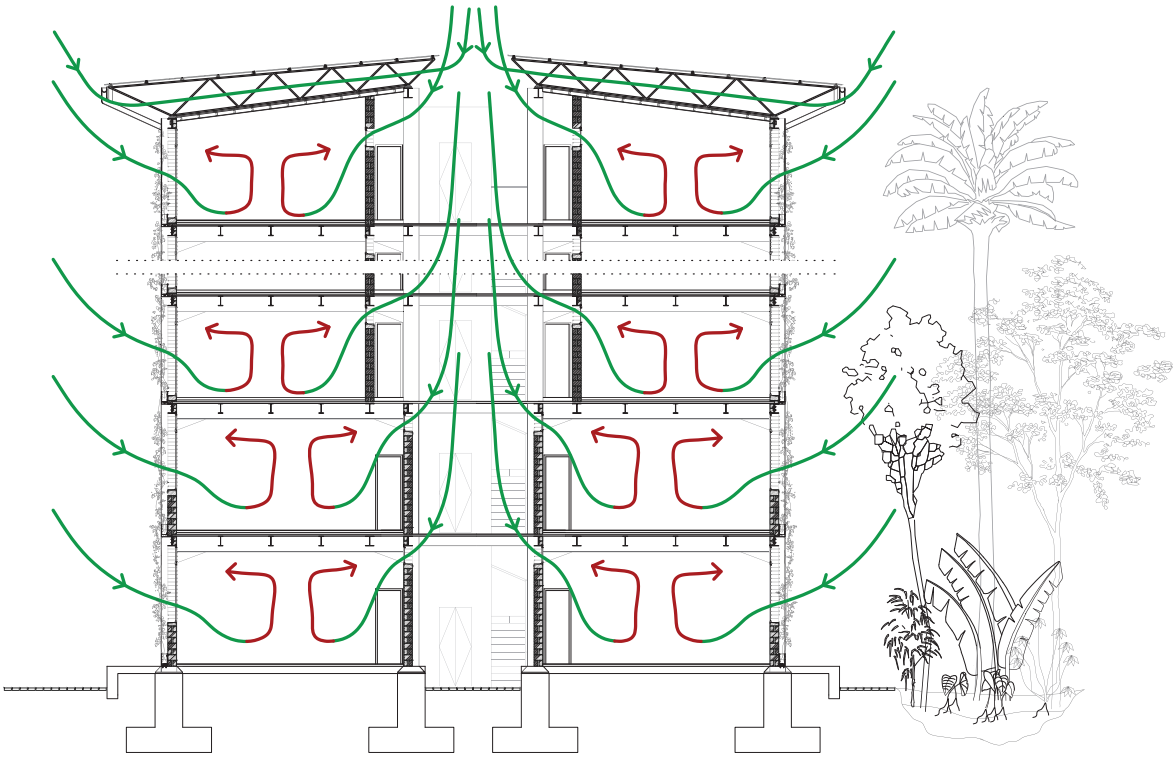
Visible on page 120, the system for vegetation growth consists of mild steel containers affixed to the horizontal steel structure. These containers are naturally irrigated by rainwater.

Natural ventilation - over day

The exterior air is cooled by the vegetation on the facade and in the rain gardens before entering the building through the windows. Once inside, it mixes with the indoor air, warms up, rises, and exits the dwelling through high-placed bandeau windows, to finally escape the cluster through a cheminey effect.

The detached polycarbonate roofing with UV protection, supported by a steel truss, provides ventilation underneath the roof to prevent overheating on the top floor. Simultaneously, the transparent roofing panels allow light to penetrate the cluster, enhancing illumination while maintaining a comfortable indoor temperature.

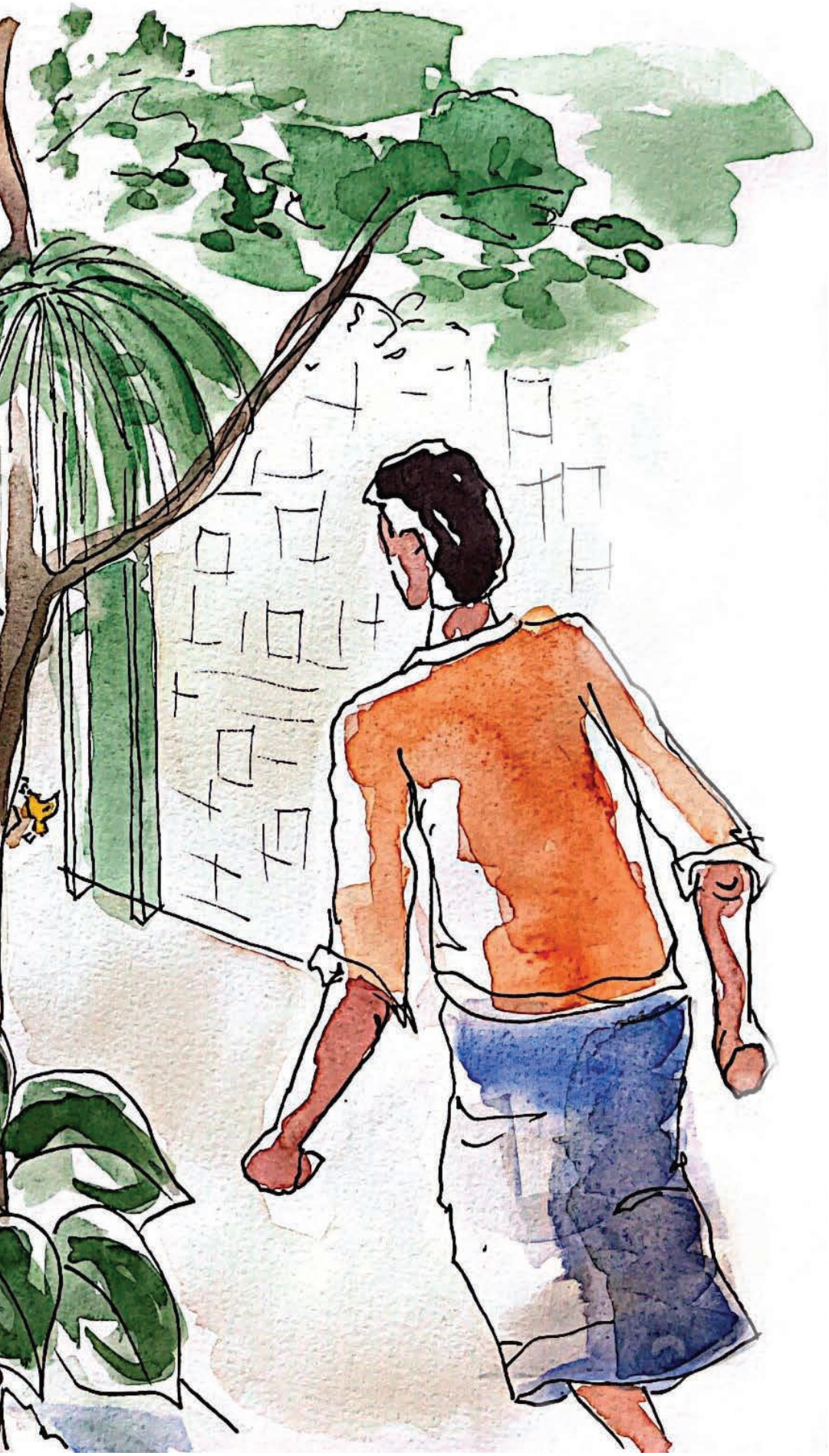




Natural ventilation - over night

Cool air enters the building through open windows and via the central area of the cluster. Inside, it lowers the ambient temperature, while warmer air exits through the bandeau windows.

Raingarden, collective space, E.V.



Circular supply chain

The connection between the solid waste treatment tower and the housing project lies in the building components produced in the tower for the residential units. This approach utilizes waste materials in a straightforward manner, repurposing resources that would otherwise be burned or buried.

Benefits of repurposing waste into construction materials:

Environmental Conservation:
- Preserves natural resources
- Reduces CO2 emissions
- Minimizes landfill use

Cost-Effectiveness:
- Saves money on raw materials

Energy Efficiency:
- Requires less energy during manufacturing

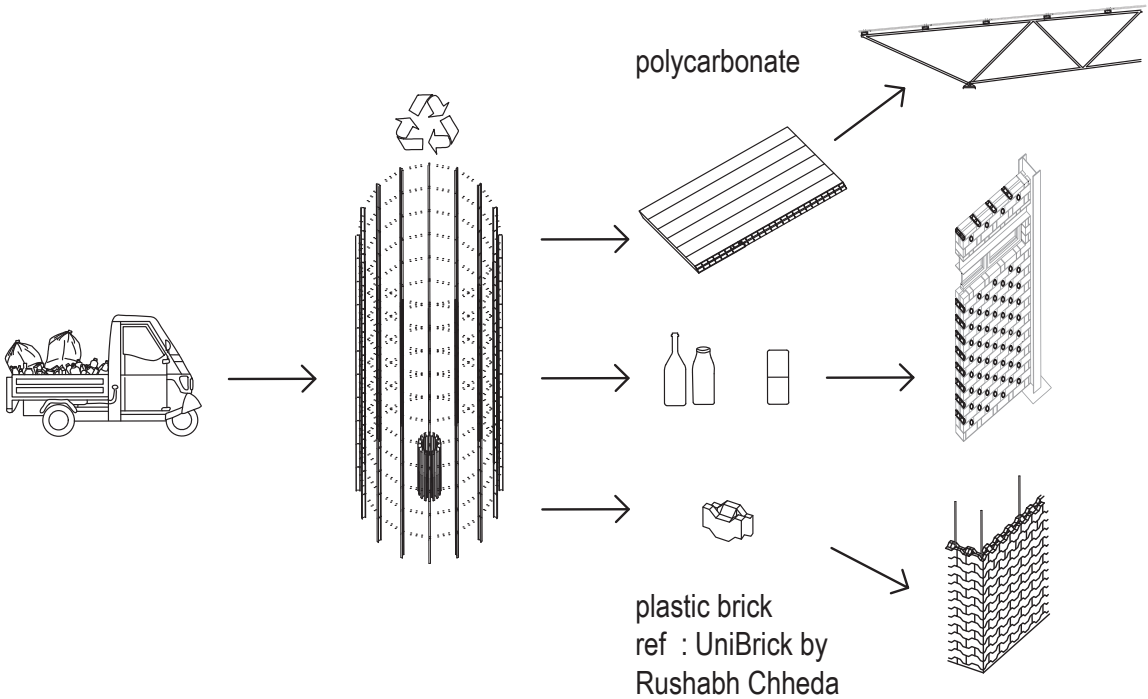
Circular Economy:
- Extends the lifespan of materials
- Reduces waste generation

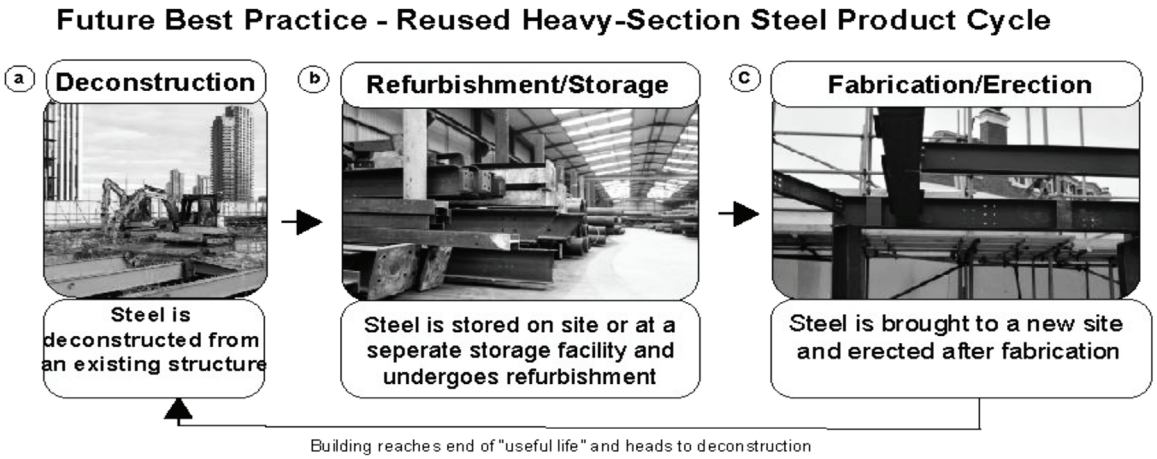
Economic Opportunities:
- Generates new economic prospects for the residents

Transforming waste into building materials:

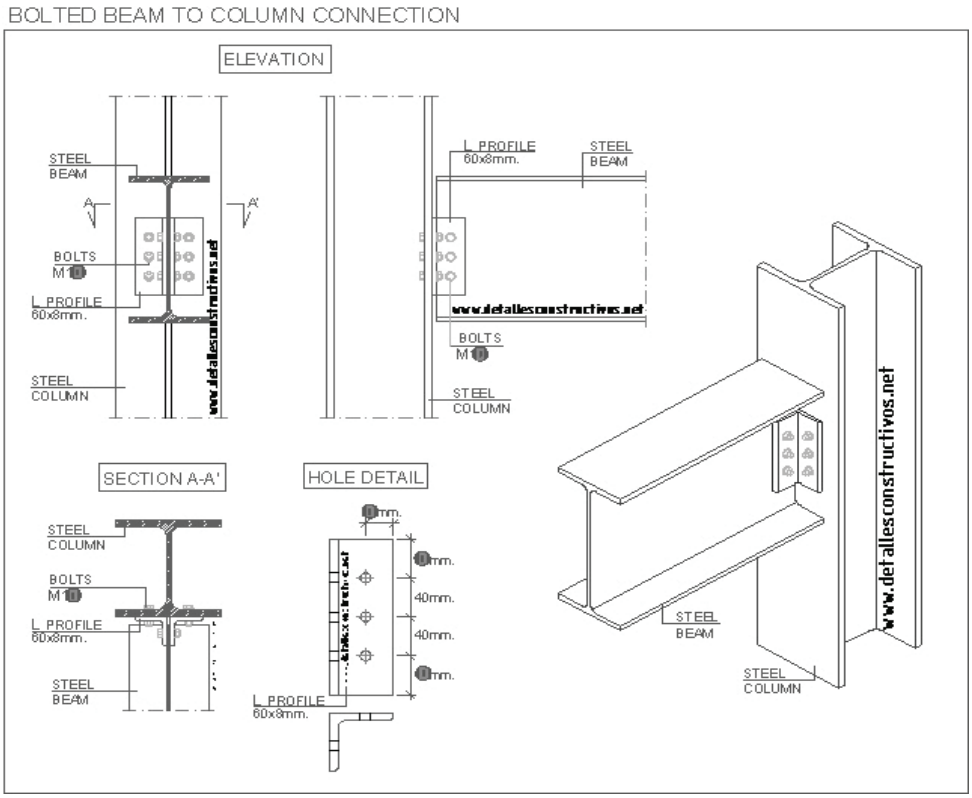
plastic bricks and **polycarbonate plates** properties:

- lightweight
- excellent thermal insulators
- UV resistant
- waterproof
- high strength
- easy to mold





Holbein Gardens: Delivering a low-carbon structure with reclaimed steel, Mills, 2023.



Construction Details Cad Blocks Steel Beams, Steel - Bolted Beam To Column Connection, PngKey, 2024.

Standardized I and H beams are used for the structural framework of the project buildings. These beams are not welded but assembled using dry connections, specifically bolted, allowing for easy disassembly and reuse in the future. This approach ensures that building materials can be efficiently reused, supporting the principles of the circular economy by reducing waste and conserving resources.

Building materials	**Kg CO_2/kg**
Steel virgin (stainless)	2,80
Steel recycled (stainless) : reduce airpolution 86%, waterpolution 76%	0,47
Steel profile hot galvanized	1,85
Concrete 55 MPa	0,14
Concrete 25 MPa	0,09
Light concrete (600-900 kg/m^3)	0,27
Light concrete with 20% fly ash	0,24
Light concrete with 20% fly ash and 85% fossil free aggrgates	0,14
timber	0,35
Cross laminated timber (CLT) 489 kg/m^3	0,51
Laminated wood, plywood, chipboard 507 kg/m^3	0,52
Gypsum plaster board 630 kg/m^3	0,23
Brick 1800 kg/m^3	0,23
Glass 3 mm 2500 kg/m^3	1,37
cement	0,9
Aluminium profile	10,93
Mineral wool	1,6
Foam plastic PE	6,13

1000 km ship deep sea container	0,008
1000 km ship short sea	0,016
1000 km barge	0,031
1000 km rail	0,022
1000 km road	0,0
1000 km air	

CO_2 emissions per 2020 from materials including a full life cycle with : production, transport, building, application, demolition, removal. Technical Universiwty of Denmark - Department Civil engineering, 2016.

School kids, Manav Sadhna Community Centre, Ramapir No Tekdo, Ahmedabad, The Potty Projects, 2010.

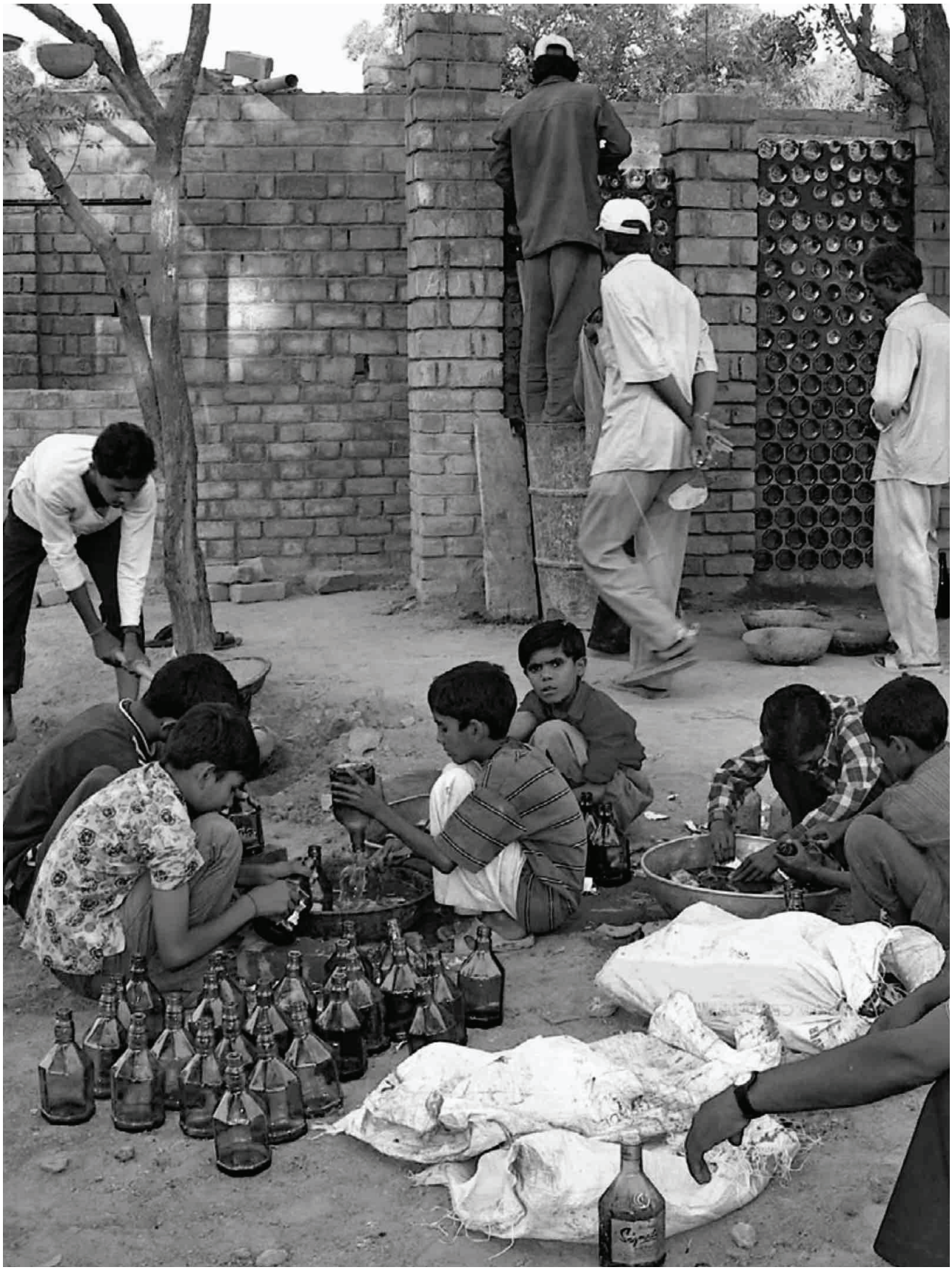
Reference

Ahmadabad, with a population of around 4 million, is the center of Gujarat, a prosperous region in western India. Squatter settlements can be found all around the city, even in affluent neighborhoods where a large number of recent immigrants work as domestic helpers.

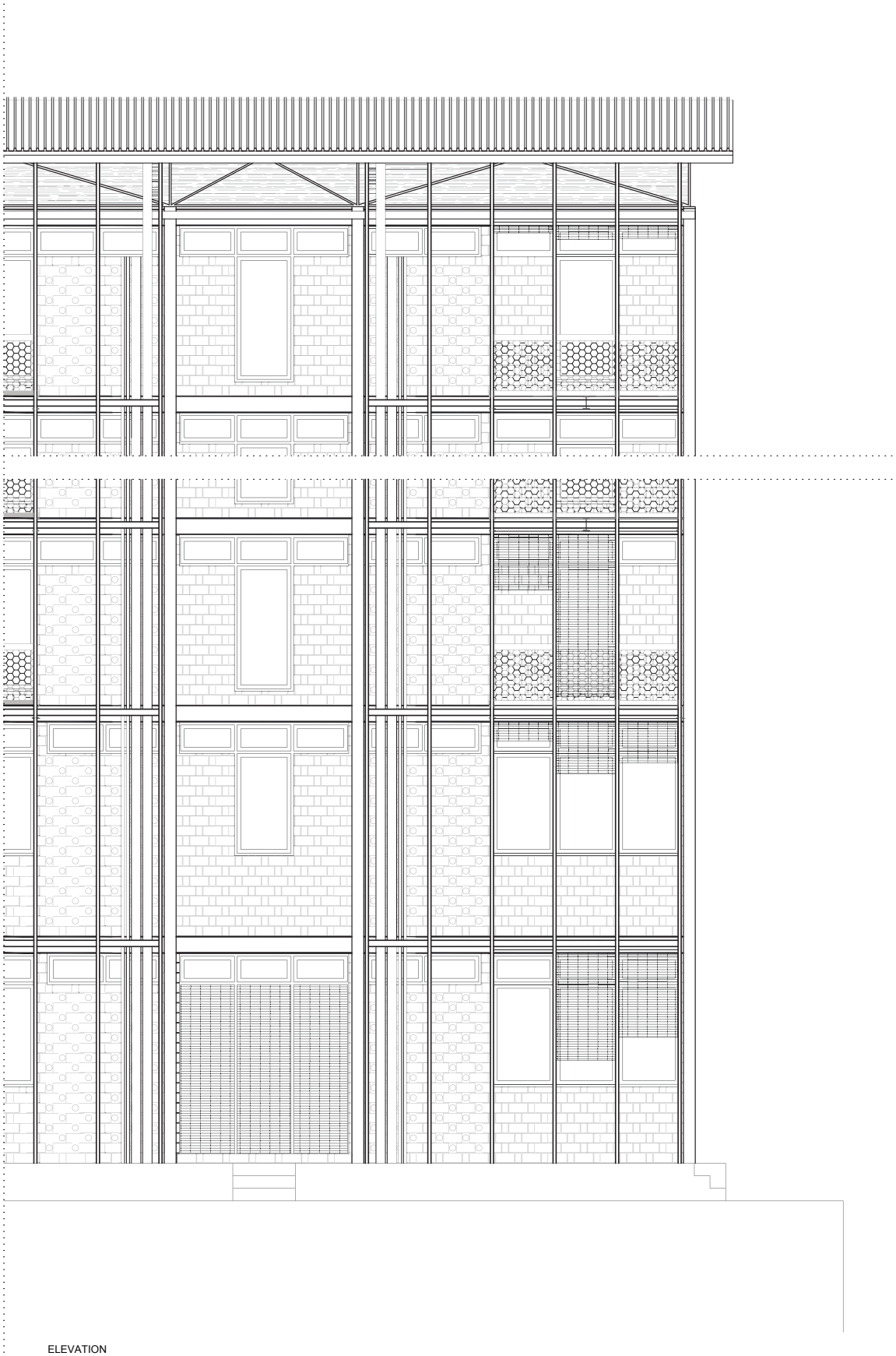
In these settlements, residents construct their own housing using any available materials, such as plastic sheeting or sacks, which have both a market and a price. A significant portion of the materials comes from the careful dismantling of old houses, with the components then sorted, cleaned, and resold.

A notable feature of India is the interplay between informal recycling systems and official waste management structures. Ragpickers collect about 25 percent of usable waste from the streets, while the formal urban refuse system handles the remainder, typically burning it without recycling. This dual system operates independently yet complements each other, reflecting the distinct social and economic separation between the two (Knippers, 2008).

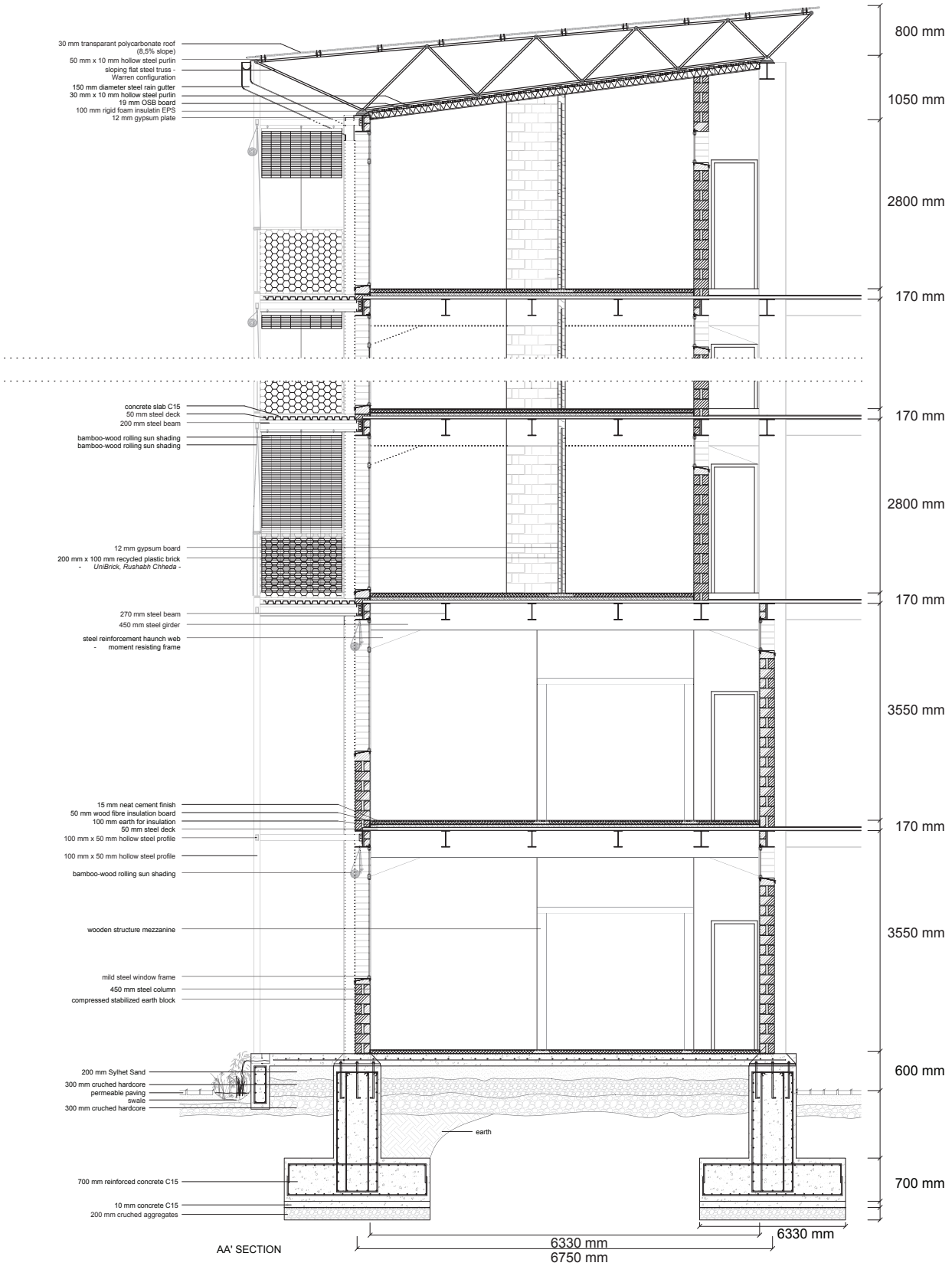
The Manav Sadhna Activity Centre, designed in 2008 by the architect Yatin Pandya, is located amidst the largest squatter settlement of Ahmedabad. It contains spaces for school classes and community craft activities. It was built by the slum inhabitants themselves, who not only earned a little money in the process but who were also able to acquaint themselves with the use of new, low-cost materials. The centre is an good example of sustainable design using recycled waste as building components. The project has demonstrated the application of nearly twenty types of recycled waste. Waste such as fly ash, dump fill site waste, crate packaging, plastic water bottles, glass bottles, rags, wrappers, metal scrap, broken ceramic wares, compact discs, and electronic hardware have been transformed into walling, roofing, flooring, and fenestration elements. The architecture thus creatively demonstrates environmental concern by reducing pollution and energy through the recycling of waste, empowers the poor economically by generating economic opportunities through value addition processes, and improves their quality of life by developing affordable and durable alternative building products for their homes (Knippers, 2008).

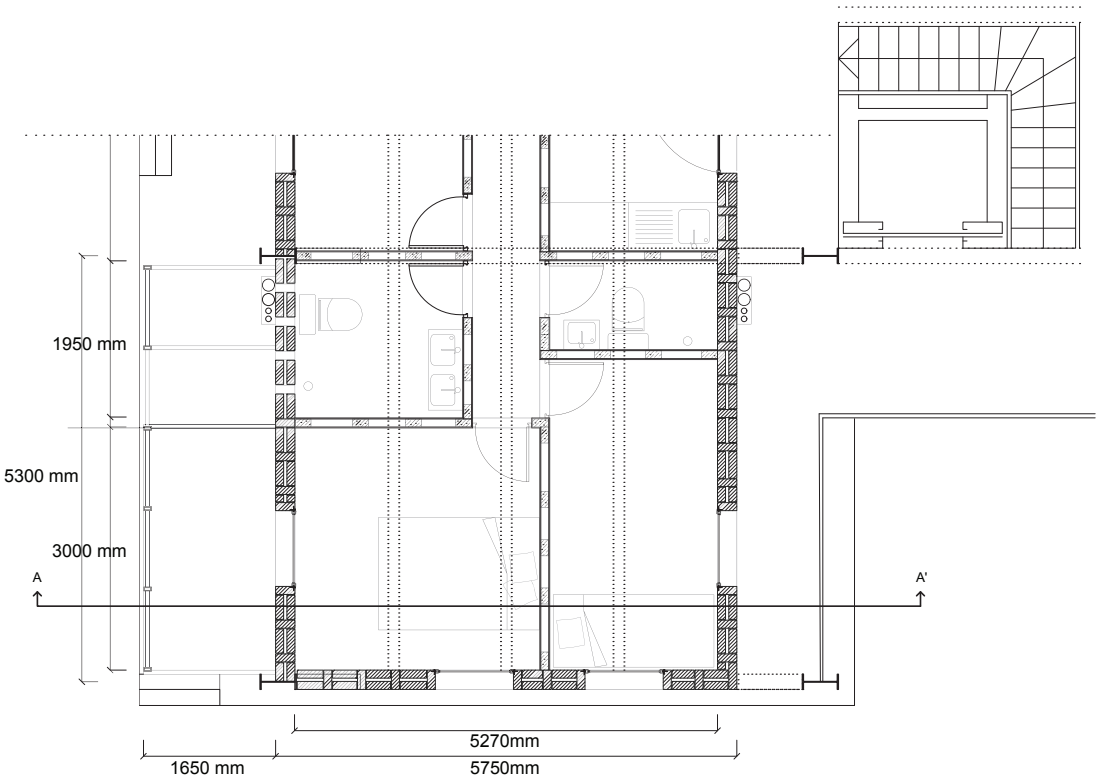


Manav Sadhna Activity Centre, Ahmadabad, New Building Products from Waste Materials in India, Jan Knippers, DE-TAIL, 2008.

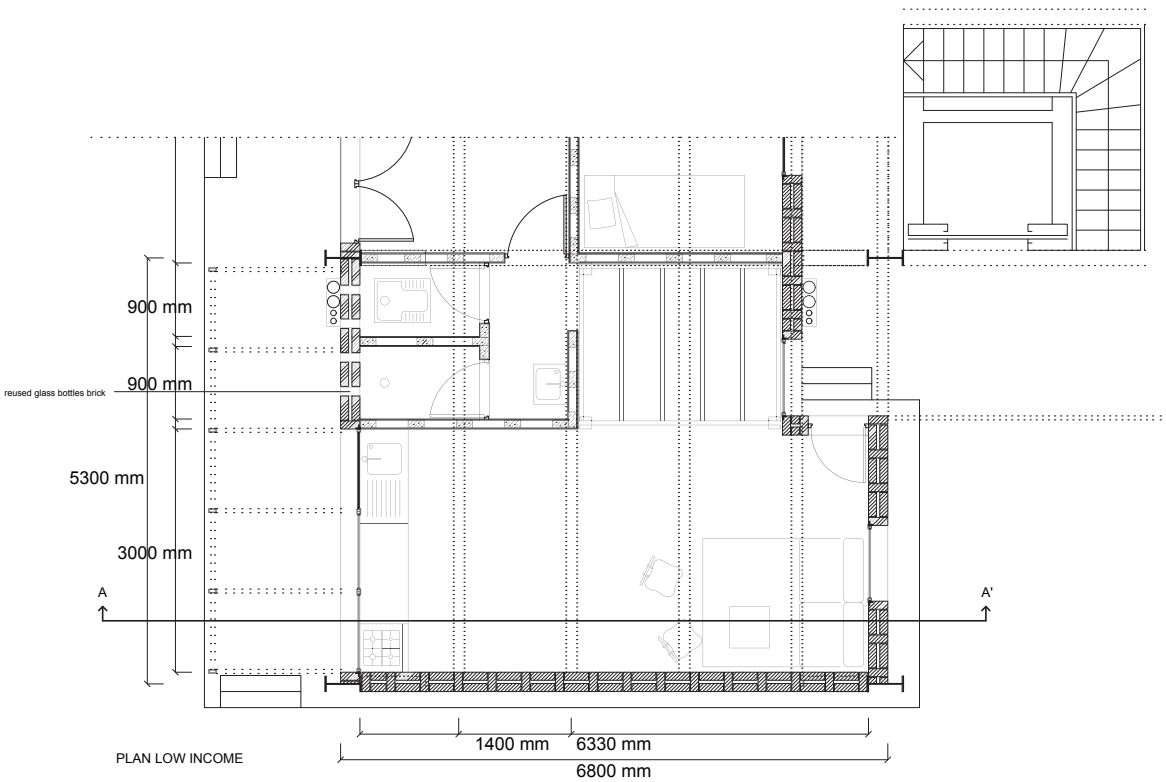


ELEVATION

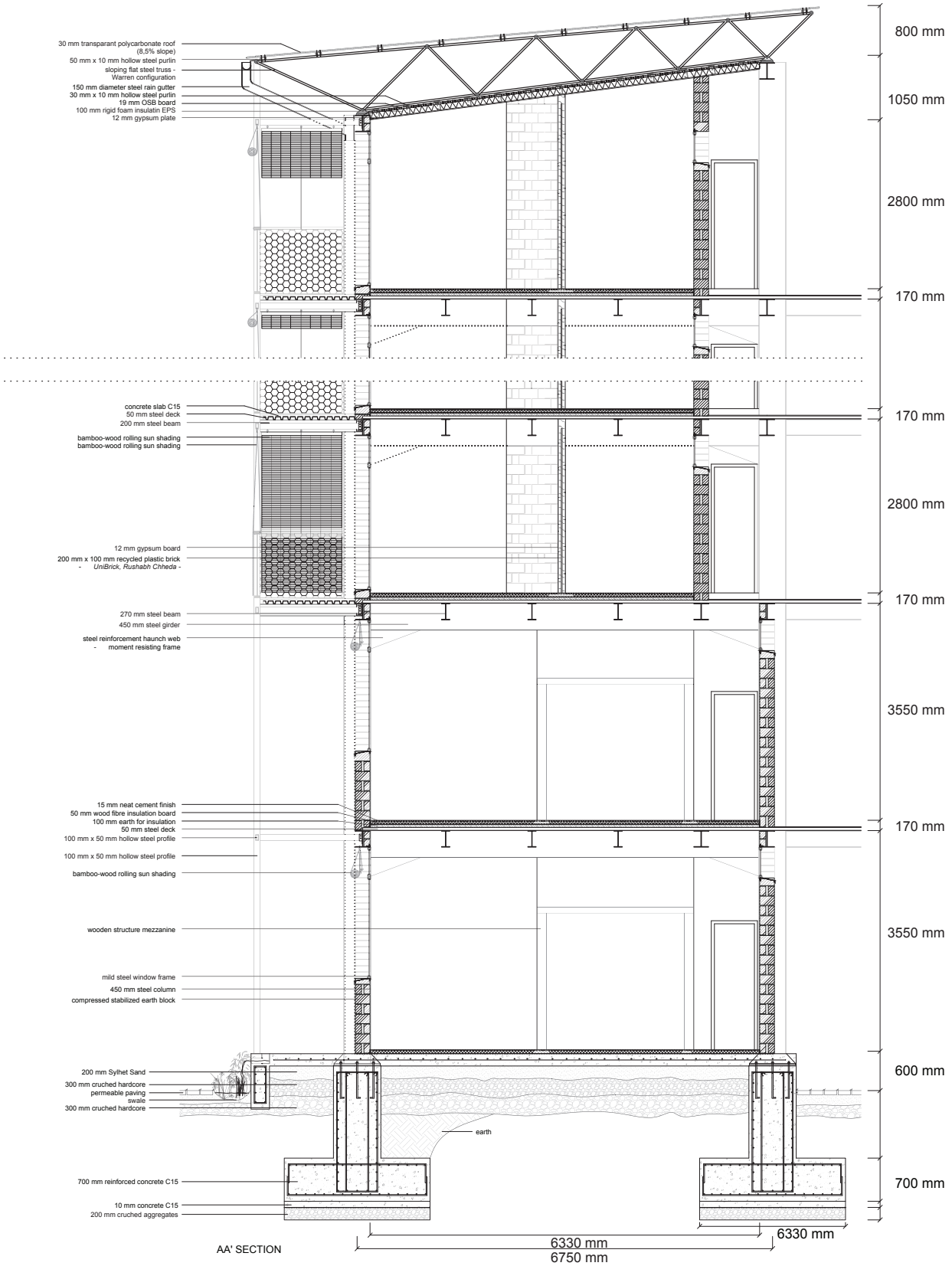

30 mm transparant polycarbonate roof (8,5% slope)
50 mm x 10 mm hollow steel purlin
sloping flat steel truss - Warren configuration
150 mm diameter steel rain gutter
30 mm x 10 mm hollow steel purlin
19 mm OSB board
100 mm rigid foam insulatin EPS
12 mm gypsum plate
800 mm
1050 mm
2800 mm
170 mm
concrete slab C15
50 mm steel deck
200 mm steel beam
bamboo-wood rolling sun shading
bamboo-wood rolling sun shading
170 mm
2800 mm
12 mm gypsum board
200 mm x 100 mm recycled plastic brick - UniBrick, Rushabh Chheda -
270 mm steel beam
450 mm steel girder
steel reinforcement haunch web - moment resisting frame
170 mm
3550 mm
15 mm neat cement finish
50 mm wood fibre insulation board
100 mm earth for insulation
50 mm steel deck
100 mm x 50 mm hollow steel profile
100 mm x 50 mm hollow steel profile
bamboo-wood rolling sun shading
170 mm
wooden structure mezzanine
3550 mm
mild steel window frame
450 mm steel column
compressed stabilized earth block
200 mm Sylhet Sand
300 mm cruched hardcore
permeable paving
swale
300 mm cruched hardcore
earth
600 mm
700 mm reinforced concrete C15
10 mm concrete C15
200 mm cruched aggregates
700 mm
6330 mm
6330 mm
6750 mm
AA' SECTION

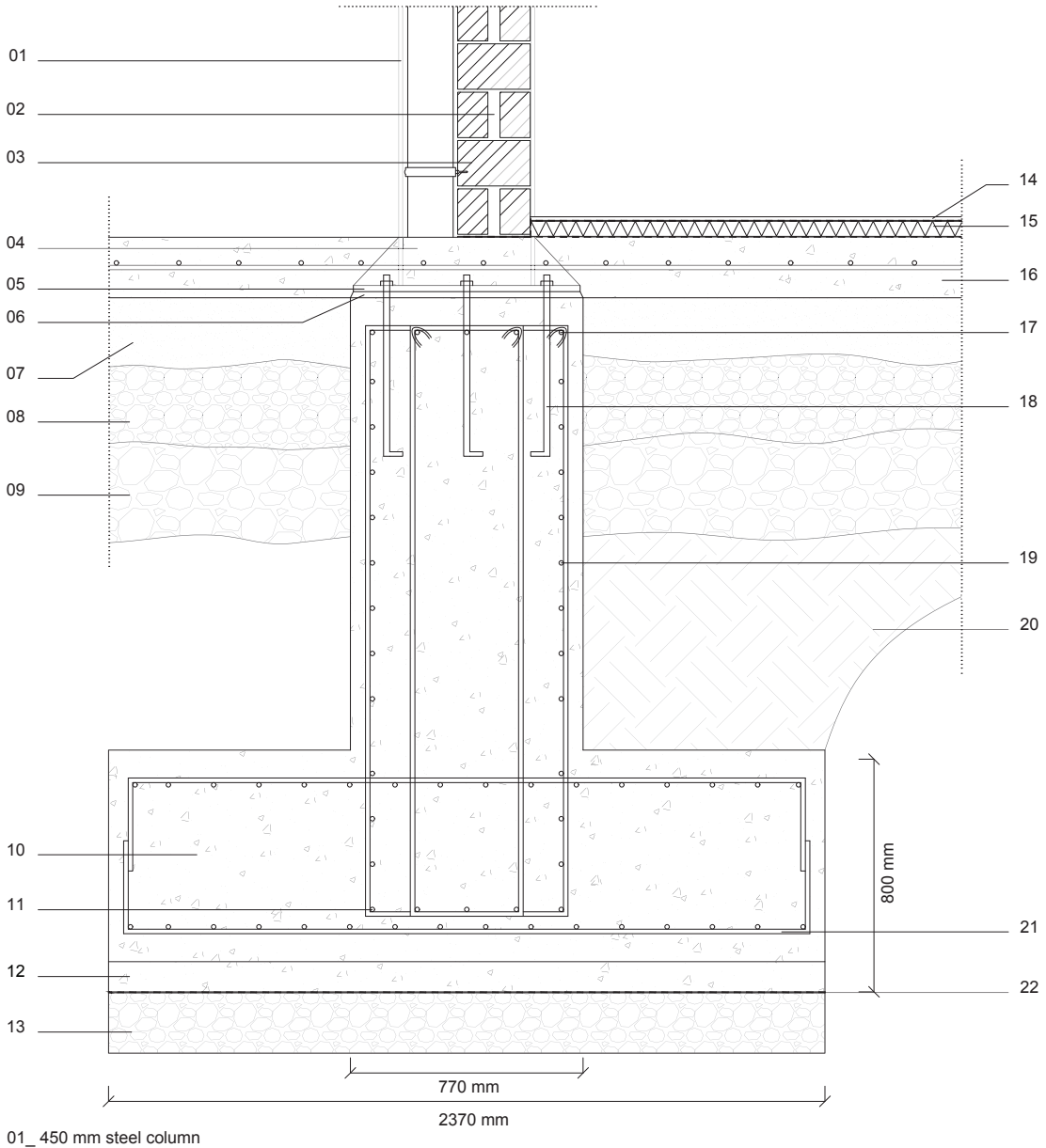


PLAN MIDDLE INCOME

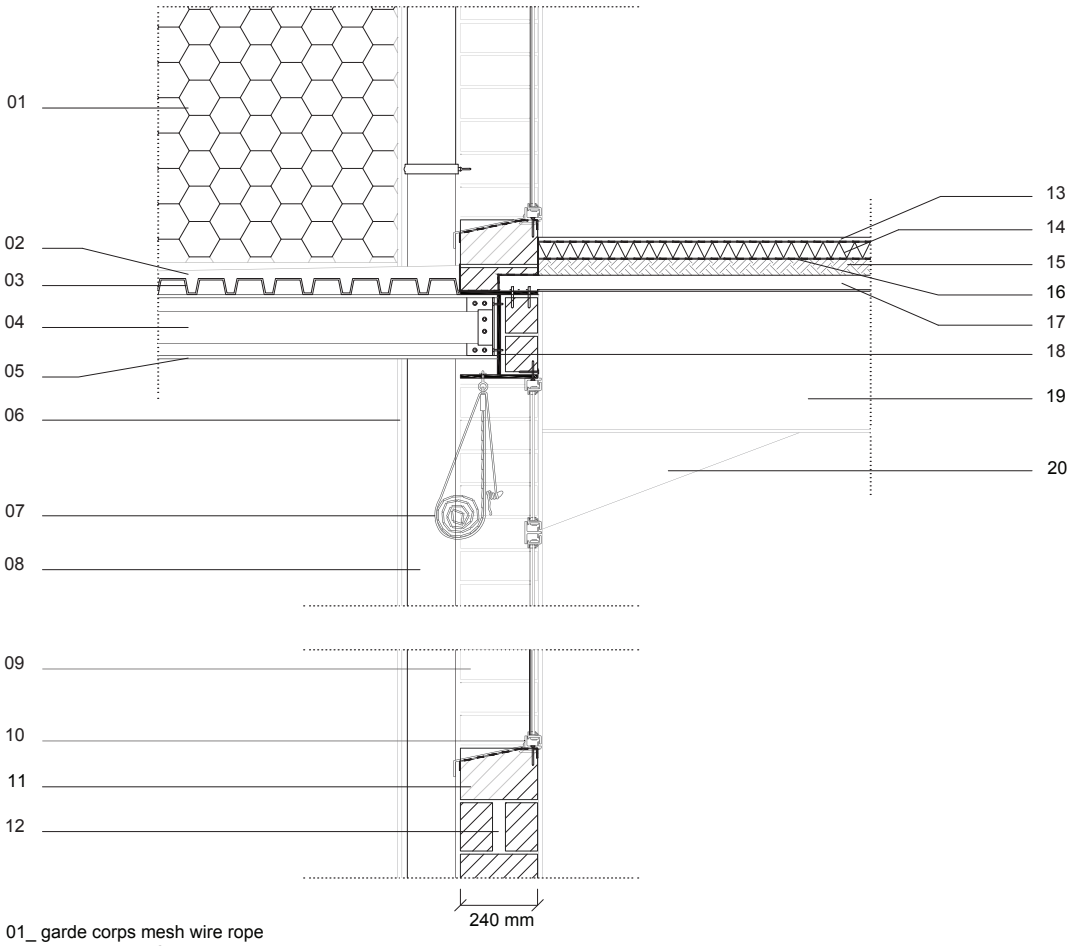


PLAN LOW INCOME

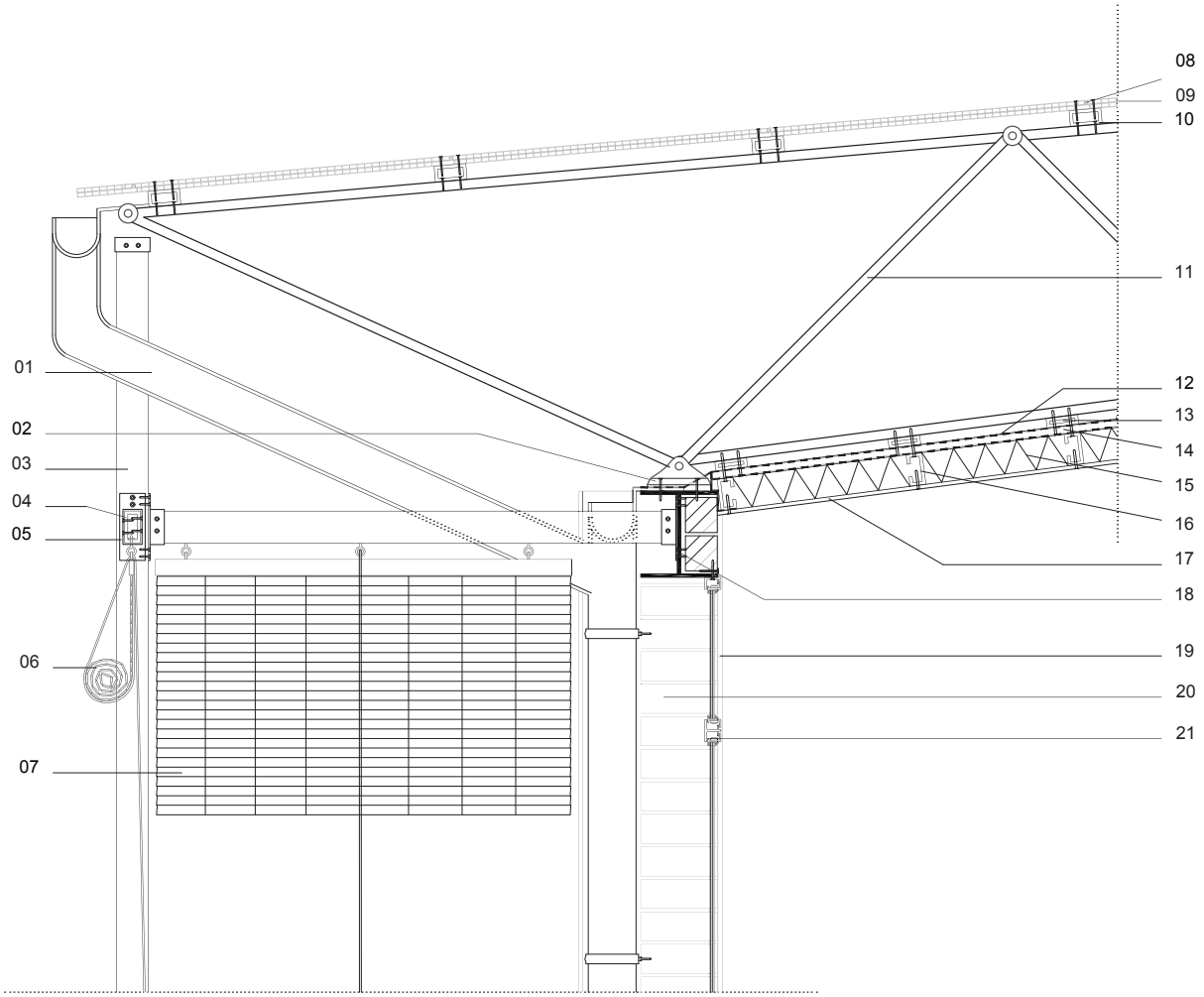

30 mm transparant polycarbonate roof (8,5% slope)
50 mm x 10 mm hollow steel purlin
sloping flat steel truss - Warren configuration
150 mm diameter steel rain gutter
30 mm x 10 mm hollow steel purlin
19 mm OSB board
100 mm rigid foam insulatin EPS
12 mm gypsum plate
800 mm
1050 mm
2800 mm
170 mm
concrete slab C15
50 mm steel deck
200 mm steel beam
bamboo-wood rolling sun shading
bamboo-wood rolling sun shading
170 mm
2800 mm
12 mm gypsum board
200 mm x 100 mm recycled plastic brick - UniBrick, Rushabh Chheda -
270 mm steel beam
450 mm steel girder
steel reinforcement haunch web - moment resisting frame
170 mm
3550 mm
15 mm neat cement finish
50 mm wood fibre insulation board
100 mm earth for insulation
50 mm steel deck
100 mm x 50 mm hollow steel profile
100 mm x 50 mm hollow steel profile
bamboo-wood rolling sun shading
170 mm
wooden structure mezzanine
3550 mm
mild steel window frame
450 mm steel column
compressed stabilized earth block
200 mm Sylhet Sand
300 mm cruched hardcore
permeable paving
swale
300 mm cruched hardcore
earth
600 mm
700 mm reinforced concrete C15
10 mm concrete C15
200 mm cruched aggregates
700 mm
6330 mm
6330 mm
6750 mm
AA' SECTION



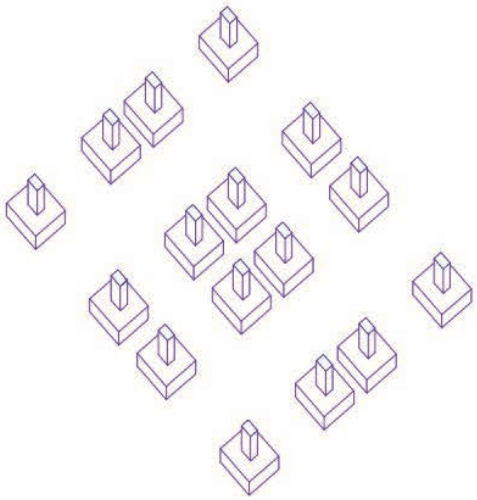
01_ 450 mm steel column
02_ 40 mm air
03_ compressed stabilized earth block
04_ stiffener plates - hight 150 mm
05_ steel column baseplate
06_ high strength concrete grouting
07_ 200 mm Sylhet Sand
08_ 300 mm cruched hardcore
09_ 300 mm cruched hardcore
10_ 700 mm reinforced concrete C15
11_ beam's top main reinforcement bars
12_ 10 mm concrete C15
13_ 200 mm cruched aggregates
14_ 15 mm neat cement finish
15_ 50 mm wood fibre insulation board
16_ 200 mm floor slab
17_ beam's top main reinforcement bars
18_ anchor bolts placed inside beam's stirrups
19_ beam's side torsional reinforcement bars
20_ earth
21_ footing bottom reinforcement mesh
22_ water insulation membrane



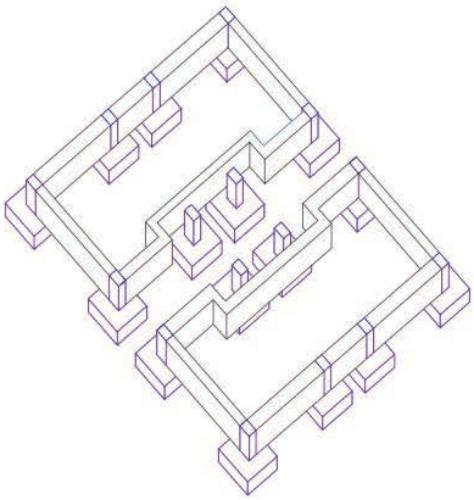
01_ garde corps mesh wire rope
02_ concrete slab C15
03_ 50 mm steel deck
04_ 100 mm x 50 mm hollow steel profile
05_ 200 mm steel beam
06_ 450 mm steel column
07_ bamboo-wood rolling sun shading
08_ bamboo-wood rolling sun shading
09_ compressed stabilized earth block
10_ mild steel window frame
11_ compressed stabilized earth block
12_ 40 mm air
13_ 15 mm neat cement finish
14_ 50 mm wood fibre insulation board
15_ 100 mm earth for insulation
16_ separation layer
17_ 50 mm steel deck
18_ 270 mm steel beam
19_ 450 mm steel girder
20_ steel reinforcement haunch web - moment resisting frame



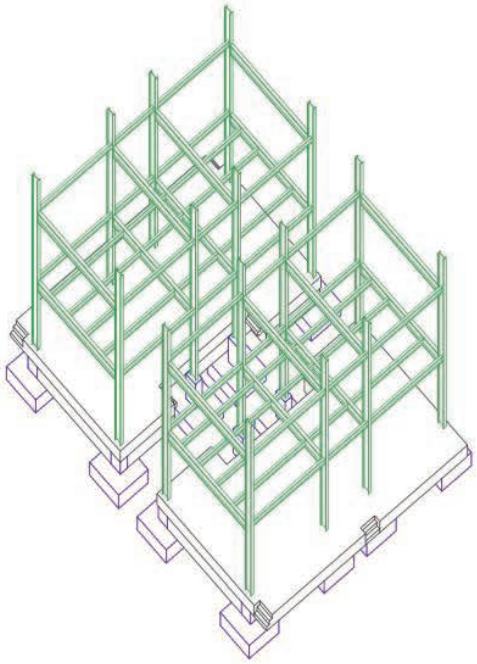
01_ 150 mm diameter steel rain gutter
02_ steel base plate footage
03_ 100 mm x 50 mm hollow steel profile
04_ 100 mm x 50 mm hollow steel profile
05_ mild steel clog
06_ bamboo-wood rolling sun shading
07_ bamboo-wood rolling sun shading
08_ interlocking of polycarbonate plates (clip)
09_ 30 mm transparant polycarbonate roof (8,5% slope)
10_ 50 mm x 10 mm hollow steel purlin
11_ sloping flat steel truss - Warren configuration - node connection
12_ waterproofing membrane
13_ 30 mm x 10 mm hollow steel purlin
14_ 19 mm OSB board
15_ 100 mm wood fibre insulation board
16_ 100 mm steel purlin
17_ 12 mm gypsum board
18_ 270 mm steel beam
19_ 450 mm steel column
20_ compressed stabilized earth block
21_ mild steel window frame



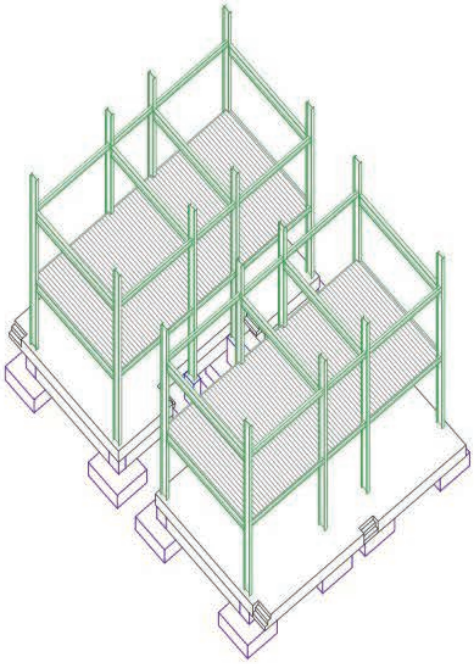
foundation steel columns



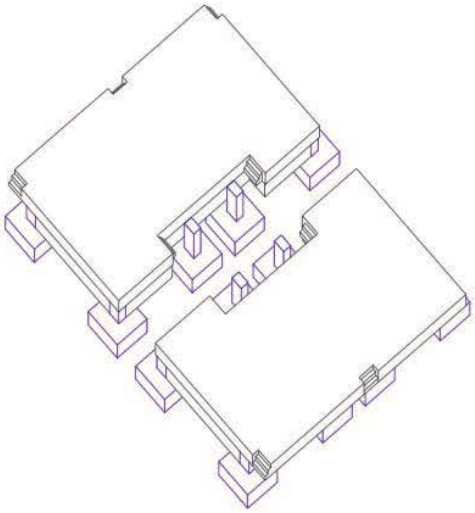
foundation non-bearing walls



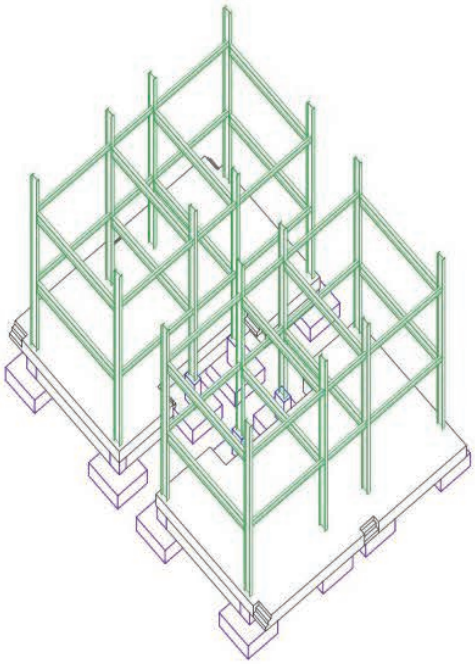
floor steel structure



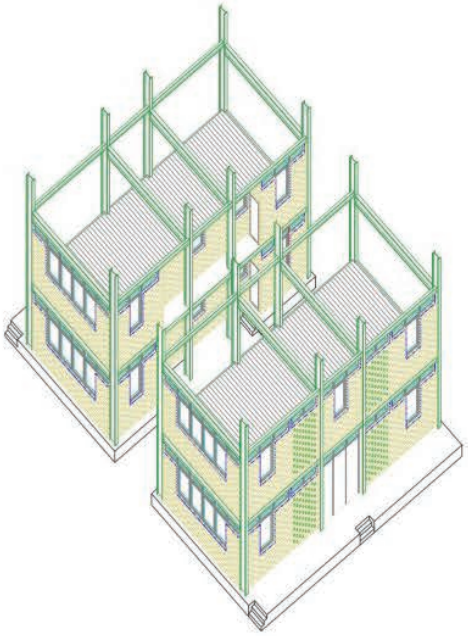
metal deck flooring



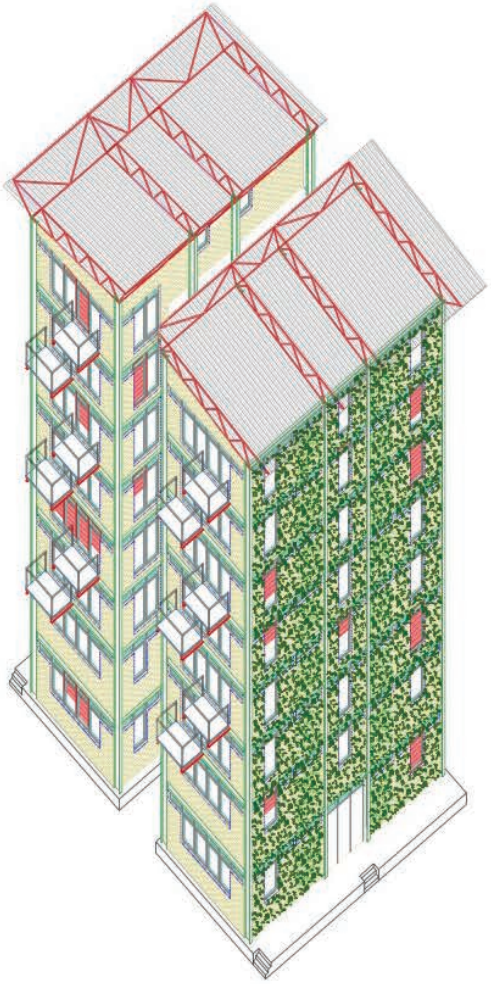
concrete slab



primary steel structure



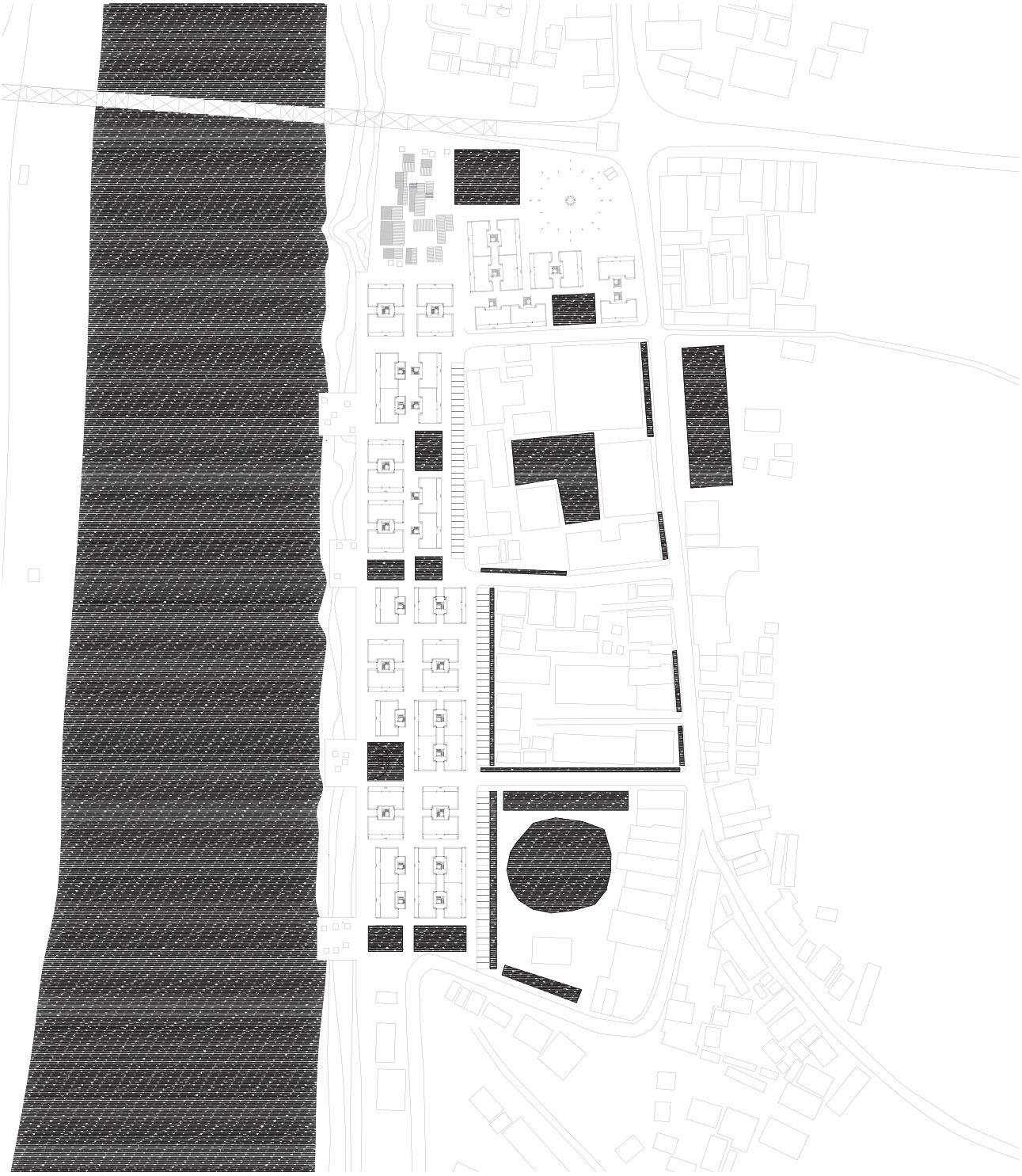
exterior and interior walls



steel truss and polycarbonate roof

Urban scale

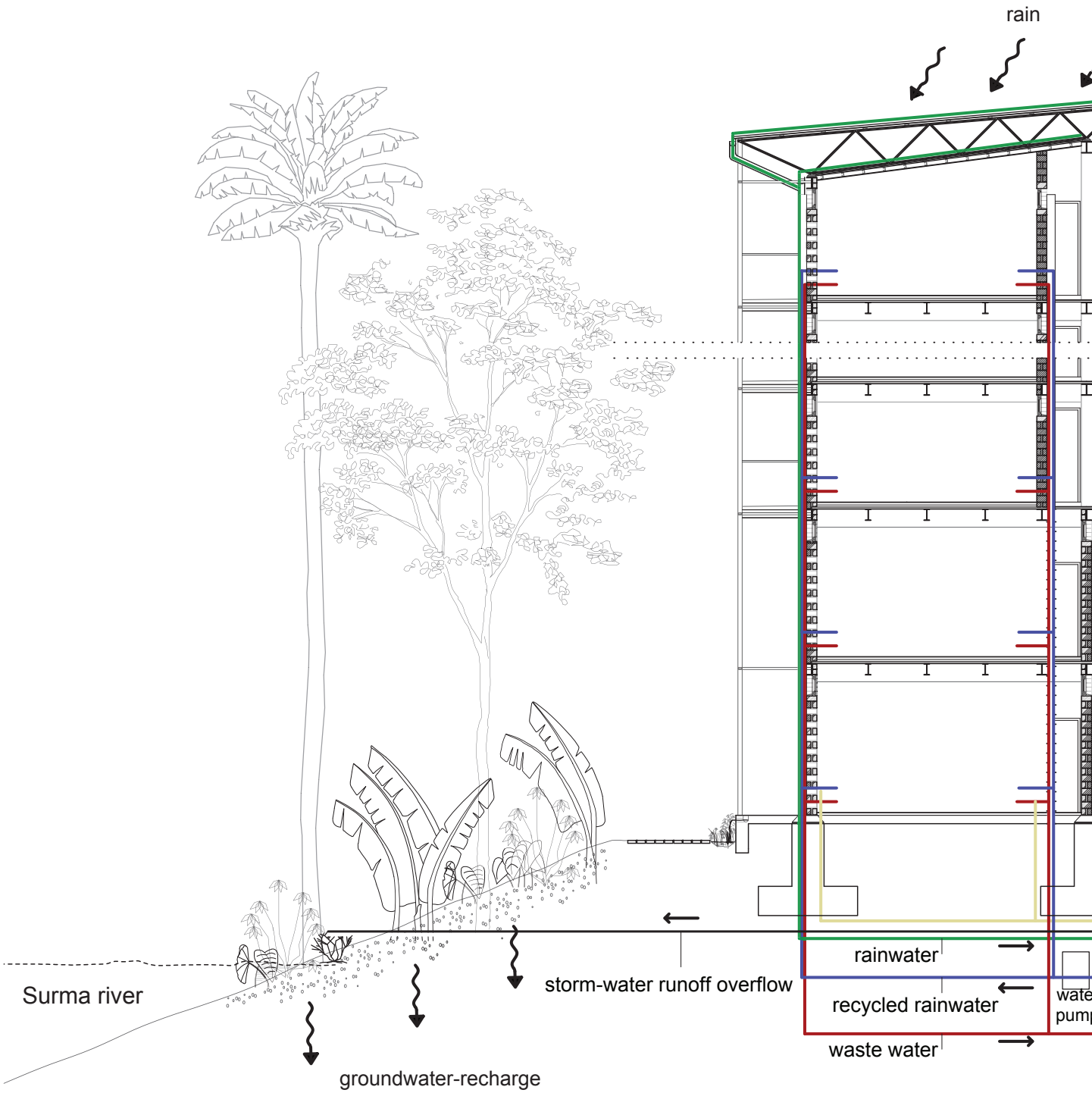
The strategy involves implementing various small and medium-scale water collector spaces (represented by black hatches) between Sylhet City (on the right) and the project location. These collectors are designed to manage and mitigate the impact of heavy rainfall. By capturing and storing rainwater, these spaces help prevent the area from flooding as water runs towards the river.

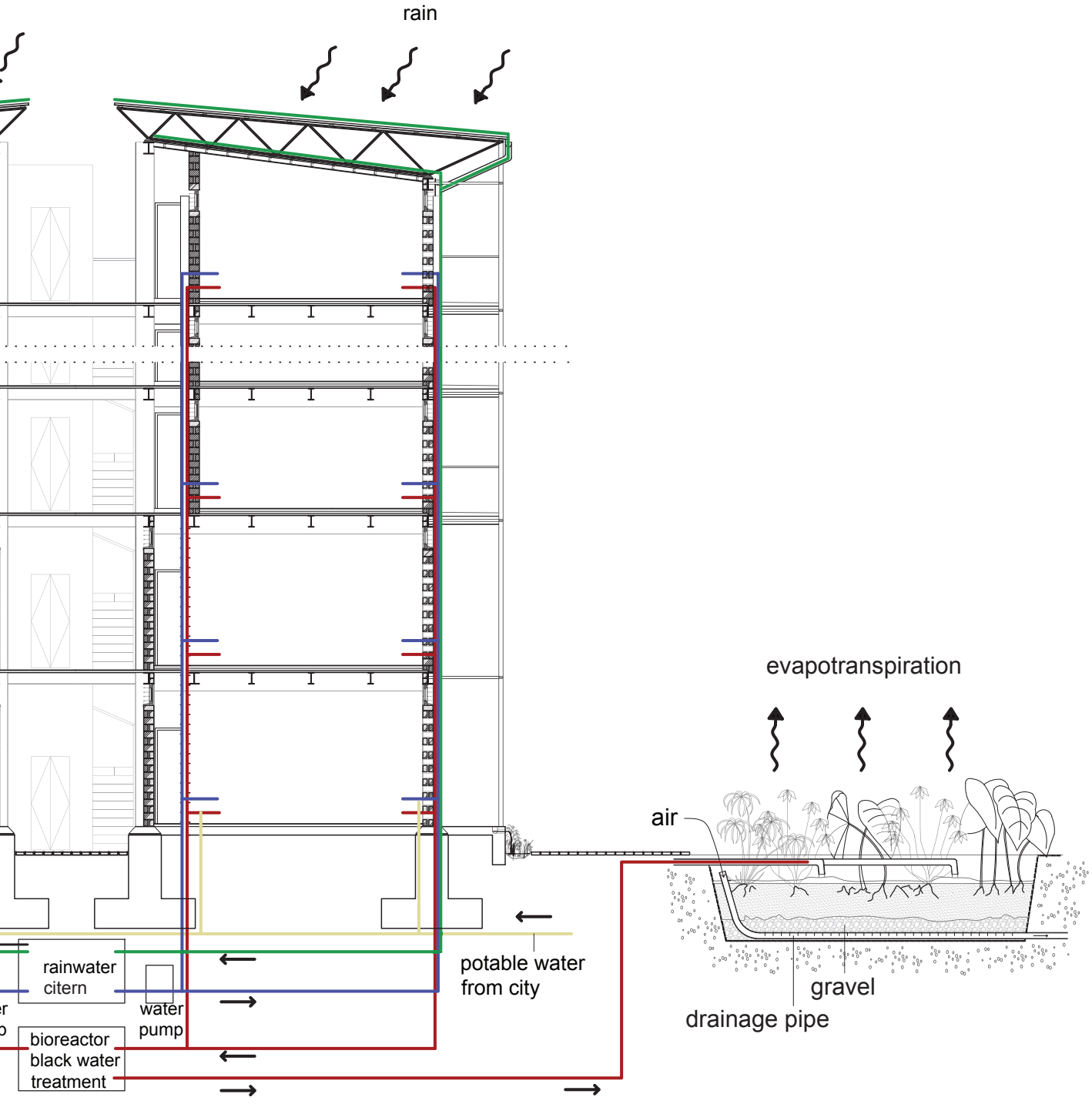


Urban scale

The water-collecting spaces include green public areas designed between the clusters, such as rain gardens and sports fields. Additionally, parking spots with permeable paving, swales next to pavements and in front of the parking areas, as well as ponds and porous flooring, all contribute to efficient rainwater management. These features collectively help to capture, store, and infiltrate rainwater.

Building scale



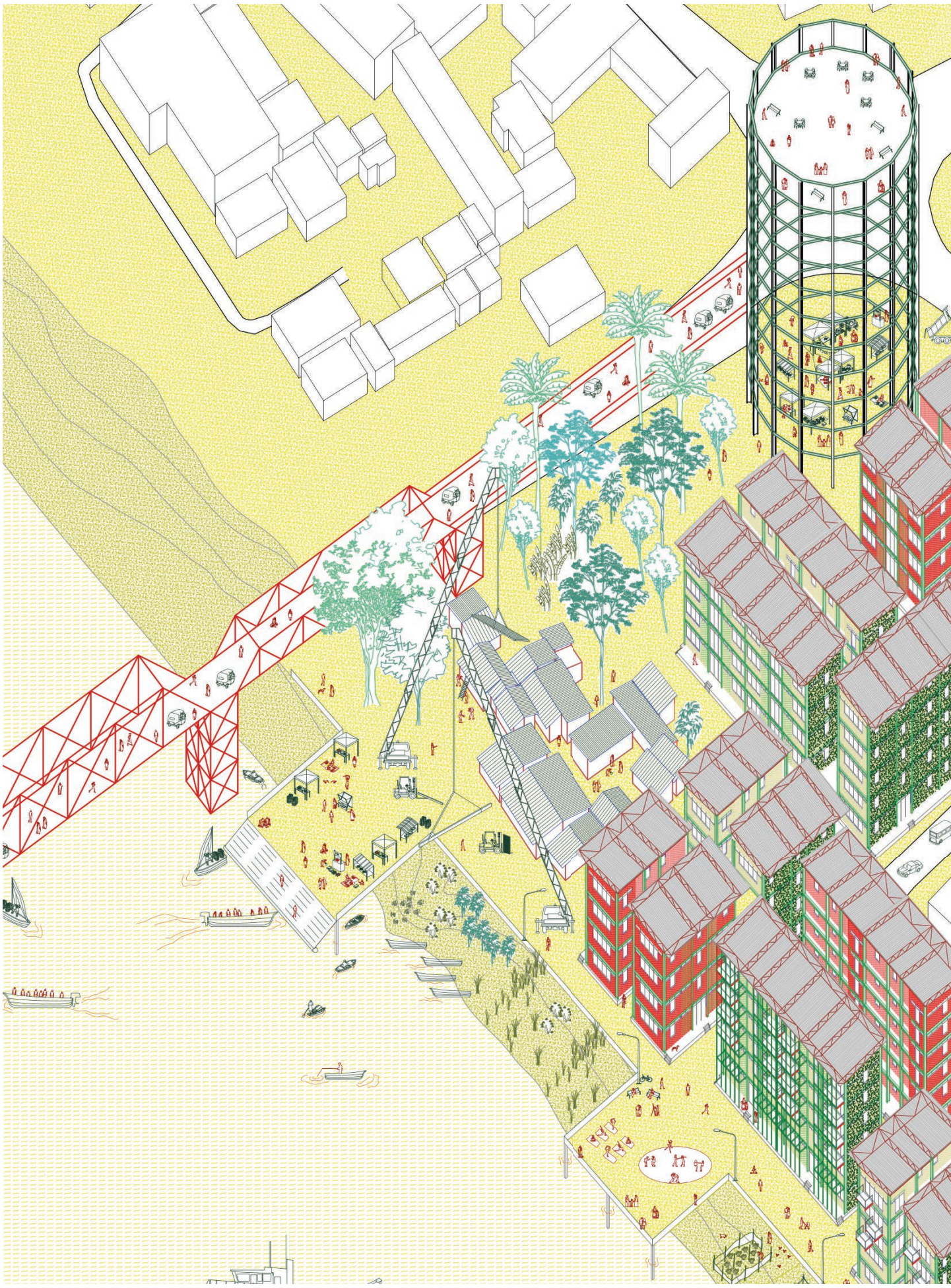

rain
evapotranspiration
air
rainwater
citern
water
pump
bioreactor
black water
treatment
potable water
from city
gravel
drainage pipe

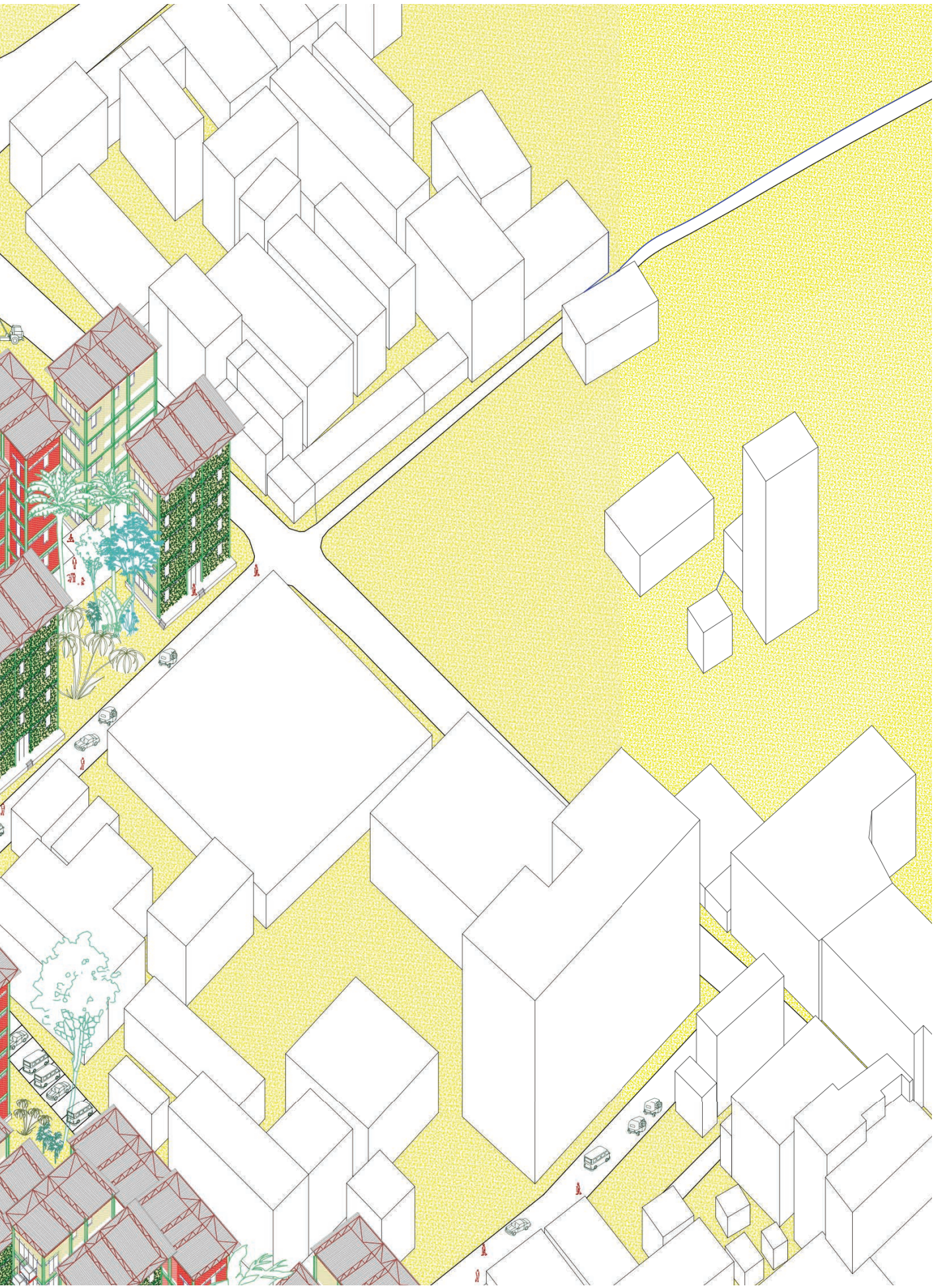
Axonometric view

Preliminary design

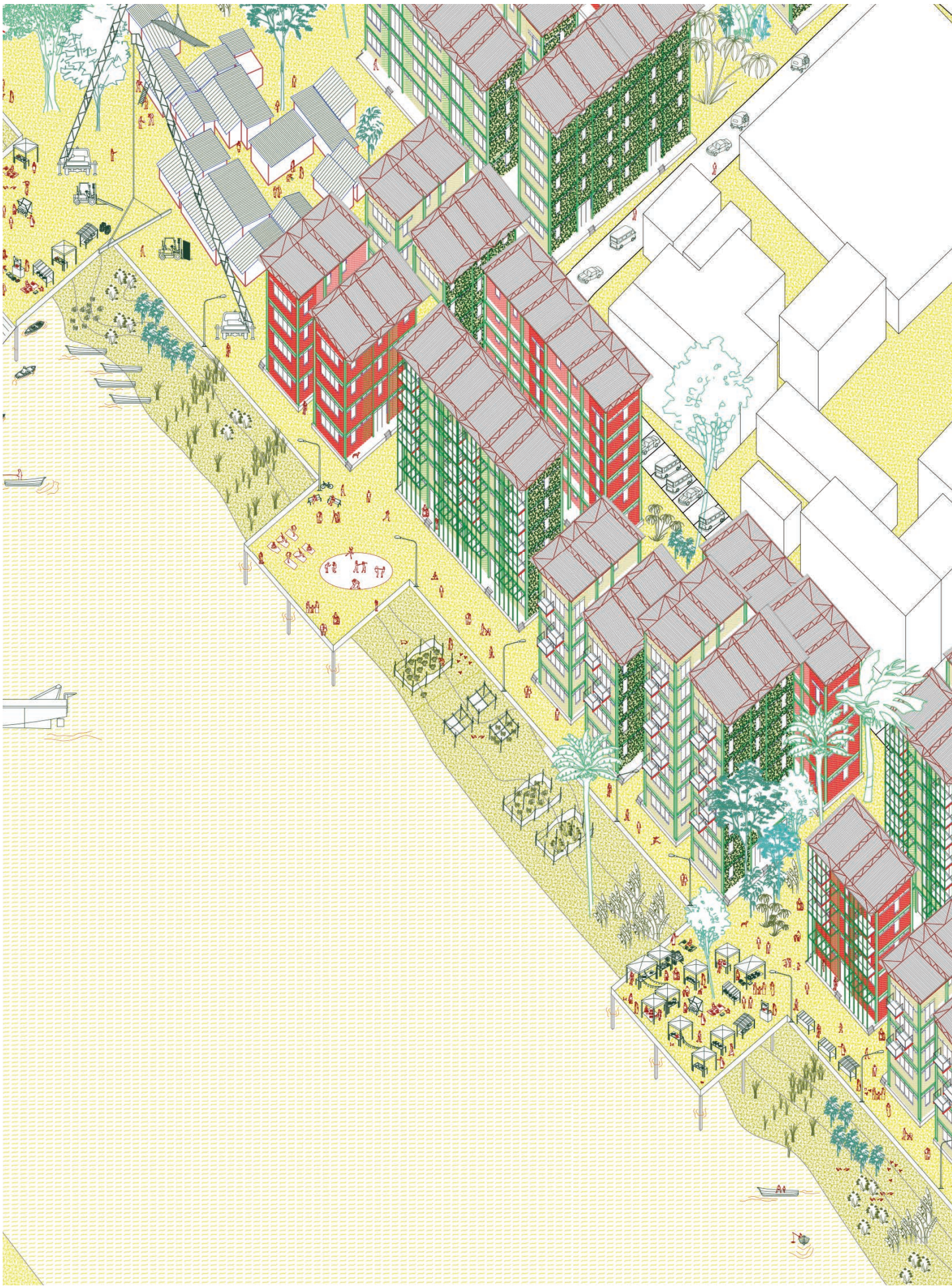
Final design

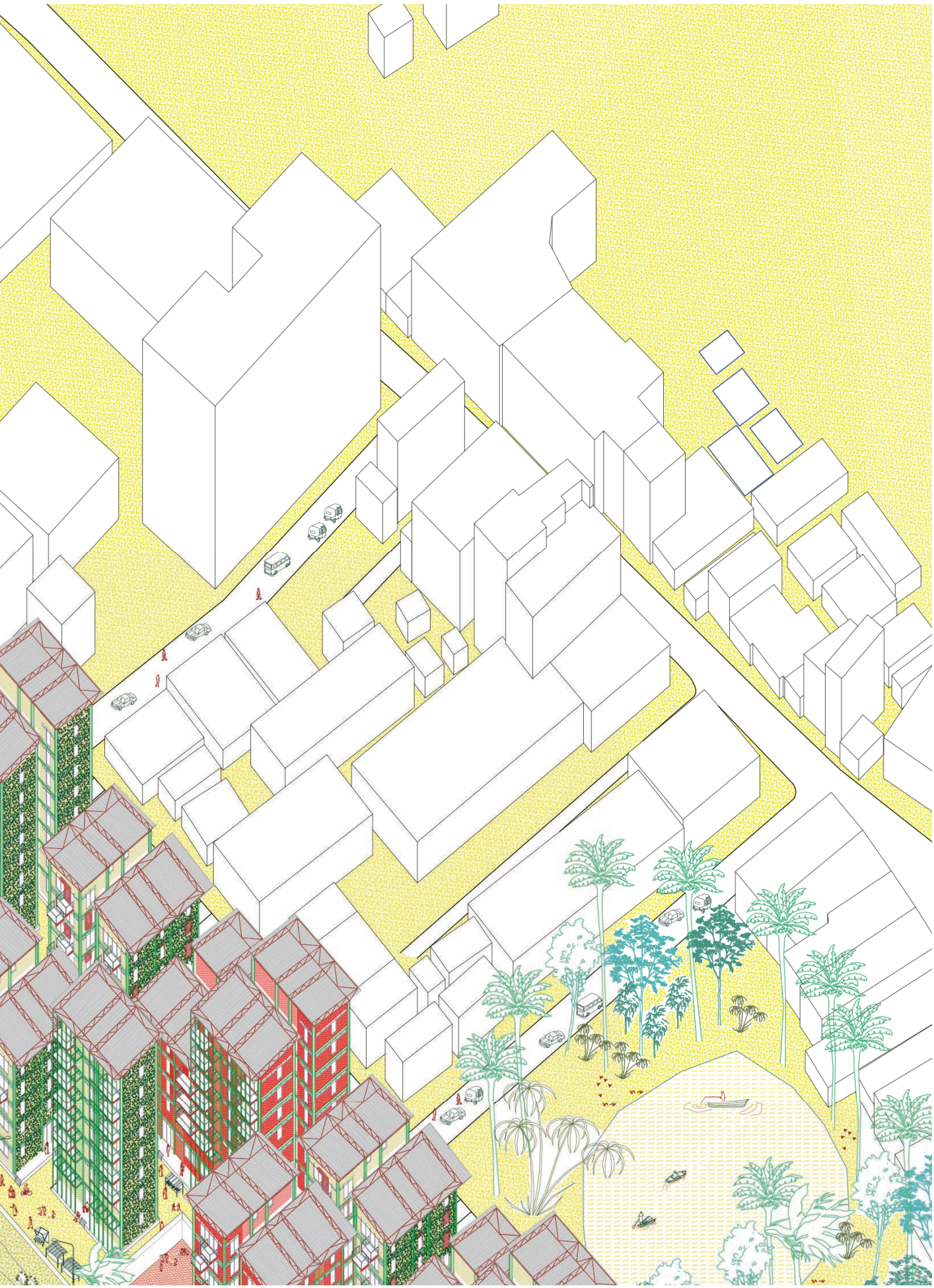
Axonometric view





Axonometric view





Axonometric view

1. What is the relation between your graduation project topic, your master track (A, U, BT, LA, MBE), and your master programme (MSc AUBS)?

The studio's focus on housing as a global phenomenon and the urgency of providing adequate housing, improve living conditions and promote social equity in rapidly growing developing countries, which serves as a foundation for the project's exploration of comprehensive urban redevelopment. The main design objective, focused on revitalizing the riverbank and adjoining slum in Sylhet, uses housing redevelopment as a catalyst. The project aims to foster a resilient and sustainable waterfront, directly addressing the pressing challenges of housing shortage, low-income housing, and solid waste management in the context of Bangladesh's urban development. The project further explores the intersections between community and waste, and architecture and waste, emphasizing the need for sustainable design interventions and the role of architecture in shaping socio-spatial relationships to raise awareness and promote responsibility for durable waste management.

2. How did your research influence your design/recommendations and how did the design/recommendations influence your research?

Initially, the research influenced design. Research on the local community's living conditions informed the design of spaces that cater to their specific needs and activities, creating an environment that aligns with the current residents requirements. Research on the current methods of solid waste treatment led to the design of an adequate space dedicated to waste segregation and recycling for further use.

At this stage, design made the link between housing and solid waste. The design influenced research by exploring how recycled and salvaged building components from waste could be integrated into housing. Making use of recycled materials reduces construction costs, decreases open-field waste dumping, and provides income generation opportunities. In line with the suggested paradigm shift from a linear to circular built environment, the project investigates ways to support recovery and reuse in the local context of Bangladesh.

Because of its unique potential for reuse, steel is chosen as the main material for the project's structural components. Integrating locally produced as well as repurposed steel beams from decommissioned buildings in the region for the new housing redevelopment results in a shortened supply chain. Additionally, these beams may again be recovered for reuse in future projects after their possible end of service life in this project. This method shows how research and design may be successfully integrated to produce sustainable construction practices.

3. How do you assess the value of your way of working (your approach, your used methods, used methodology)?

The planned methodology proved relevant, and I conducted my research and design according to the planned methods of fieldwork, mapping, literature review, and comparative case study analysis. The literature review involved some iterative processes. For instance, I initially considered and then discarded the idea of using waste as building materials, focusing instead on waste segregation. However, I later revisited the potential use of waste in the design to make it an integral part of the housing project. This led to an in-depth investigation of circular economy.

Case studies were essential in understanding how theoretical concepts from the literature are implemented in real projects. They allowed me to incorporate elements from various case studies, each time focusing on a specific aspect, such as building components, structure, or recycling facilities, to inform particular parts of my project.

4. How do you assess the academic and societal value, scope and implication of your graduation project, including ethical aspects?

The project addresses two pressing issues:

the housing shortage in metropolitan regions due to significant rural-to-urban migration and the escalating concerns about solid waste, a major environmental problem in developing countries such as Bangladesh. It contributes to the discourse on sustainable urban development in regions facing these challenges by proposing comprehensive strategies for waste segregation and circular design strategies, offering insights into how theoretical frameworks may be applied in practice.

The project promotes positive behavioral changes in waste management and aligns with ongoing discussions on circularity and sustainable resource management. It introduces a preliminary concept for a small-scale solid waste management strategy and offers a way to provide affordable housing for a mixed-income community by using waste materials in the construction and involving the residents in the waste collection and recycling process. This way, the project adds value both to the academic discourse as well as society, proposing considerable social and environmental contributions.

5. How do you assess the value of the transferability of your project results?

The transferability of the project fundamentally lies in its design elements, as well as its managerial strategy. The project addresses waste management particularly along significantly affected riverbanks, where local authorities struggle to manage daily waste production due to rapid population growth and ineffective waste treatment systems. Simultaneously, the project addresses an increasing housing shortage in Bangladesh amid growing numbers of informal settlements and slums. Divided into two phases, the project focuses on creating a waste-treatment facility transforming solid waste into building materials first, supporting phase two, the development and delivery of a housing project, by providing it with these components. Although highly interlinked, phase one could also be separated and support the construction of any other architectural project.

The transferability of the project regarding its design elements is diverse, however a few elements should be mentioned. The clustering results in a delicate relationship of private, semi-private, and public spaces, providing a sensitive solution for residents of different income groups in a highly dense neighborhood. Additionally, the widely available steel material has a unique potential for reusability, which supports the integration of circularity aspects, making it flexible and useful in a variety of scenarios.

6. How do you reflect on the ethical considerations of designing for vulnerable communities in the “Global South”?

Designing for vulnerable communities in the so-called “Global South” and proposing a solution that aims at improving a local situation from the position of privilege is certainly an ambivalent stance to take.

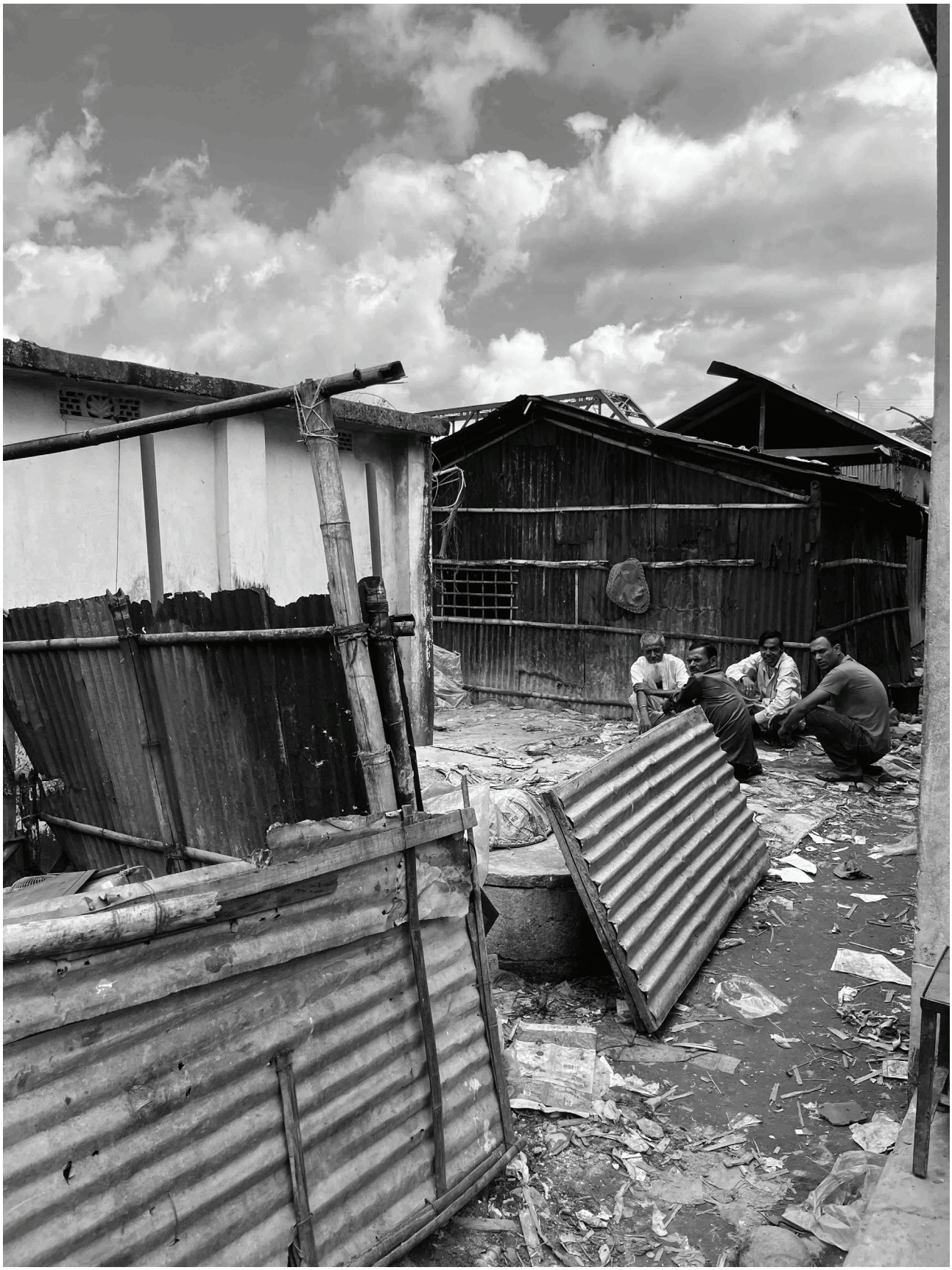
The United Nations, led by the most powerful countries of the so-called “developed economies” or “Global North”, lead the charge against global warming, adopting themes such as sustainability and circularity and deploying development programs, while been responsible for the underlying mechanisms in the first place. Sadly, it is the already struggling “Global South” that is the most vulnerable to the effects of climate change. Communities in Bangladesh are among the first victims of rising sea levels and increasingly extreme weather events due to several factors. These include its unique geographic location and flat deltaic topography, extreme climate variability (Monsoon), its high population density and poverty rate, and the dependency of the majority of the population on crop agriculture, highly influenced by climate variability and change itself, all of which is compounded by a catastrophic waste generation in the rapidly urbanizing country.

Bangladesh and other nations like it are unable to meet the objectives set by the “Global North” as they are often preoccupied with their basic survival needs. Simultaneously, the “Global North” offers aid to the “Global South”, imposing Western solutions on vulnerable local communities, a behavior sometimes referred to as “neo-colonialism” because of its underlying arrogance and ignorance towards local contexts. This might also extend to the proposition of solutions for waste management as well as the implementation of circular strategies in the built environment.

This becomes obvious when reflecting on the question of circularity. While “the West” is paranoidly working on how to overcome the current take-make-waste paradigm and implement circular strategies, communities in slums, have forever acted “circular” in the sense that material reuse is a common practice.

An example for this is the reuse of CI-sheets, slums in Bangladesh are almost only built from salvaged materials. However, being worried about survival, material reuse is not adopted as a systemic approach but rather out of necessity. Moreover, adopting European principles of how circular principles and sustainability should be executed, be it the recycling of solid waste for secondary building materials or the reuse of salvaged components such as steel beams, might emphasize and support local efforts.

Accordingly, this project aims at respecting the local community and context by promoting active community participation in the creation of building secondary materials for their new homes, fostering a sense of ownership and pride. At the same time, this approach encourages a shift in the perception and awareness of the omnipresent waste, demonstrating the benefits and aesthetic possibilities of recycled materials as well as persuading municipalities such as Sylhet City that they can turn solid waste into useful resources. As a result, residents themselves will demonstrate that living in an apartment constructed partly from repurposed materials doesn’t need to be a drawback, instead that it may be just as elegant as one constructed from new materials.



Muslim settlement, slum, Keane Bridge, Sylhet, E.V.

BIBLIOGRAPHY

Ahmed, M. F., & Islam, M. S. (2014). Urbanization and Environmental Problem: An Empirical Study In Sylhet City,Bangladesh. Research on Humanities and Social Sciences, 4(3), 161– 172. https://www.iiste.org/Journals/index.php/RHSS/artic le/download/11167/11468

Ahsan H., Hasnat A., Rapid urbanisation and growing demand for affordable housing in Bangladesh – policy insights. (25 January 2023). https://policyinsightsonline.com/2023/01/rapid- urbanisation-and-growing-demand-for-affordable- housing-in-bangladesh/

Alam R, Chowdhury MAI, GMJ, Karanjit B and Shrestha LR. 2006. Solid waste 4.11 management in Kathmandu, the capital city of Nepal. Journal of Solid Waste Technological Management. 32: 2p.

Ara, S., Khan, R., & Uddin, M. S. (2021). URBANIZATION CHALLENGE: SOLID WASTE MANAGEMENT IN SYLHET CITY, BANGLADESH. International Journal of Engineering Applied Sciences and Technology, 5(10), SSN No. 2455- 2143.

Bangladesh | History, Capital, Map, Flag, Population, & Facts.". Encyclopedia Britannica. September 19, 2023.

Bangladesh Geography, Maps, Climate, Environment and Terrain from Bangladesh." n.d. Country Reports. https://www.countryreports.org/ country/Bangladesh/ geography.htm.

Behr, D. M., Chen, L., Goel, A., Haider, K. T., Singh, S., Zaman, A., & International Finance Corporation. (2021). Introducing the Adequate Housing Index (AHI): A New Approach to Estimate the Adequate Housing Deficit within and across Emerging Economies. In Policy Research Working Paper. https://documents1.worldbank.org/curated/en/370141635794493951/pdf/Introducing-the-Adequate-Housing-Index-AHI-A-New-Approach-to-Estimate-the-Adequate-Housing-Deficit-within-and-across-Emerging-Economies.pdf

Britannica, The «Sylhet». Encyclopedia Britannica, 7 Oct. 2023, https://www.britannica.com/place/Sylhet. Accessed 10 October 2023.

Caldeira, T. P. (2017). Peripheral urbanization: Autoconstruction, transversal logics, and politics in cities of the global south. Environment and Planning D: So org/10.1177/0263775816658479

Collective. (2023-2024). Architecture of Transition. MSc 3/4 Graduation Studio Global Housing : Architecture of transition in the Bangladesh Delta.

Community-based waste management systems for low- income areas. (n.d.). Climate & Clean Air Coalition. https://www.ccacoalition.org/projects/community-based-waste-management-systems-low-income-areas

Connett P., (2007). Zero Waste: a key move towards a sustainable society. New York. USA.

Correa, C. (1985). The New Landscape. Strand Books.

Correa, C. (2000). Housing and Urbanisation. Thames & Hudson.

Delve. Ho, L., & Limpaecher, A.(2022c, March 17). What is Phenomenological Research Design? Essential Guide to Coding Qualitative Data. https://delvetool.com/blog/phenomenology

Durand-Lasserve A., Clerc V. Regularization and integration of irregular settlements: lessons from experience. UNDP, UN-Habitat, World Bank, Urban Management Program (UMP), Working Paper n°6, 113p., 1996, Urban Management and Land. halshs-01186713

Ferdous Hoque S., Dr. (2017, February 16). Life on the banks of a polluted river | REACH: Improving water security for the poor. REACH: Improving Water Security for the Poor. https://reachwater.uk/life-on-the-banks-of- a-polluted-river/ Oxford University

Flooding affects millions in Sylhet", The Business Standard, May 20, 2022, https://www.tbsnews.net/bangladesh/flooding-affects-millions- sylhet-423510.

Giusti L., «A review of waste management practices and their impact on human health,» Waste management , vol. 29, no. 8, pp. 2227-2239, 2009.

Haque, A. K. E., Mukhopadhyay, P., Nepal, M., & Shammin, R. (2022). Climate change and community resilience. https://doi.org/10.1007/978-981-16-0680-9

Hossain, M. S., Shehab, M. M., Islam, M. R., Shah, M. E., & Pal, S. (2018). Review on solid waste management process and environmental impact due to solid waste in Sylhet City Corporation, Bangladesh. International Journal of Environment and Waste Management, 22(1/2/3/4), 296. https://doi.org/10.1504/ijewm.2018.094117

info@theworldofinfo. com. n.d. “BANGLADESH Geo ciety and Space, 35(1), 3- 20. https://doi.Geography and Landscape - The World of Info.”

Islam MA and Hossain MS, Islam MT and Iqbal SA. 2017. Municipal solid waste management in Sylhet city, Bangladesh. Proceedings of the Waste Safe 2017, 5th International Conference on Solid Waste Management in South Asian Countries, Khulna, Bangladesh.

Islam, M., Parvez, A., Dr. Abul Hossain, Bethan Cobley, Javed Hussen, & Bread for the World (BftW), Germany. (2013b). Dalit initiatives in Bangladesh (By Nagorik Uddyog & Bangladesh Dalit and Excluded Rights Movement; First Edition). https://idsn.org/wp-content/uploads/2015/01/Dalit-Initiatives-in-Bangladesg.pdf

Jha, K. (2023, December 20). What are CSEB bricks? What are its advantages and disadvantages? Housing News. https://housing.com/news/cseb-bricks-advantages-and-disadvantages/

Khatun, Mossammat Ayesha, Bazlur Rashid, and Hans Olav Hygen. “Climate of Bangladesh.” Norwegian Meteorological Institute, May 31, 2016.

Knippers, J. (2008). New Building Products from Waste Materials in India. DETAIL.

Letsch, Lucia, Shouro Dasgupta and Elizabeth JZ Robinson, “Tackling flooding in Bangladesh in a changing climate ” Grantham Research Institute on Climate Change and the Environment, August 23, 2023, https://www.lse. ac.uk/granthaminstitute/wp-content/uploads/2023/08/Tackling-flooding- in-Bangladesh-in-a-changing-climate.pdf.

Lipi, A. I., & Hasan, N. (2021). URBANIZATION IN BANGLADESH: EMERGING CHALLENGES AND THE WAY FORWARD. Bangladesh Journal of Multidisciplinary Scientific Research, 3(1), 33– 44. https://ResearchGate. https://www.researchga te.net/publication/344404070_CHALLENGES_OF_SOLID_WASTE_MANAGEMENT_IN_SYLHET_CITY_CORPORATION

Medina M. 2005. Serving the unserved: informal refuse collection in Mexico. Waste Management and Research. 23: 390-397.

Mehedi Ahmed Ansary, and M. R. Arefin. “Assessment of Predominant Frequencies in Dhaka City, Bangladesh Using Ambient Vibration.” Asian Journal of Civil Engineering 21 (1): 91–104. 2019.

Mills, R. (2023, March 1). Holbein Gardens: Delivering a low-carbon structure with reclaimed steel - The Institution of Structural Engineers. https://www.istructe.org/journal/volumes/volume-101-(2023)/issue-3/holbein-gardens-low-carbon-reclaimed-steel/

MoEF. 2010. National 3 R strategy for waste management. Ministry of Environment and Forests, Government of the People’s Republic of Bangladesh.

Mukhim P., The many sides to Sweepers’ Lane in Shillong. (11 December 2021.). Civil Society Magazine. https://www.civilsocietyonline.com/governanc e/many-sides-to-sweepers-lane/

Murata, F., Terao, T., Hayashi, T. et al. Relationship between atmospheric conditions at Dhaka, Bangladesh, and rainfall at Cherrapunjee, India. Nat Hazards 44, 399–410 (2008). https://doi.org/10.1007/s11069-007-9125-2

Nazneen, S. (2019). Negotiating gender equity in the Global South: The Politics of Domestic Violence Policy. https://library.oapen.org/handle/20.500.12657/25894

Noor Aziah, A., MD Mizanur, R., & Nurul Hamiruddin, S. (2013). Methodologies in Architectural Research. International Islamic University Malaysia, ISBN: 978-3142-24–8.

Pervin, I. A., Rahman, S. M., Nepal, M., Haque, A., Karim, H., & Dhakal, G. (2019). Adapting to urban flooding: a case of two cities in South Asia. Water Policy, 22(S1), 162– 188. https://doi.org/10.2166/

doi.org/10.46281/bjmsr.v3i1.1112

Mamun, M. R. A., Lovely, S. J., & Akther, S. (2018). CHALLENGES OF SOLID WASTE MANAGEMENT IN SYLHET CITY CORPORATION. ResearchGate. https://www.researchga te.net/publication/344404070_CHALLENGES_OF_SOLID_WASTE_MANAGEMENT_IN_SYLHET_CITY_CORPORATION

Mamun, M. R. A., Lovely, S. J., & Akther, S. (2018b). CHALLENGES OF SOLID WASTE MANAGEMENT IN SYLHET CITY CORPORATION. wp.2019.174

Rahman, A., Yousuf, A., Sakib, N., & Ahmed, M. (2011). Solid waste management of Sylhet city in terms of energy. ResearchGate. https://www.researchgate.net/publ ication/303370064_Solid_waste_management_of_Sylhet _city_in_terms_of_energy

Rahman, M., Ishaque, F., Hossain, Md. A., Mahdy, I. H., & Roy, P. P. (2021). Impact of industrialization and urbanization on water quality of Surma River of Sylhet City. Desalination and Water Treatment. https://doi.org/10.5004/dwt.2021.27661

Rao, V. (2006). Slum as theory: the South/Asian city and globalization. International Journal of Urban and Regional Research, 30(1), 225–232. https://doi.org/10.1111/j.1468-2427.2006.00658.x

Salvia, G., Zimmermann, N., Willan, C., Hale, J. R., Gitau, H., Muindi, K., Gichana, E., & Davies, M. (2021). The wicked problem of waste management: An attention- based analysis of stakeholder behaviours. Journal of Cleaner Production, 326, 129200. https://doi.org/10.1016/j.jclepro.2021.129200

SD Action. (2022, June 17). Flood situation in Sylhet, Bangladesh.. Surma River overflows!!!! 17.06.2022, 2:00pm [Video]. YouTube. https://www.youtube.com/watch?v=6knVm5oaScY

Shahid, Shamsuddin. “Recent Trends in the Climate of Bangladesh.” Climate Research 42, no. 3 (July 20, 2010): 185–93. https://doi.org/10.3354/cr00889.

Uddin, M. J., & Jeong, Y. (2021). Urban river pollution in Bangladesh during last 40 years: potential public health and ecological risk, present policy, and future prospects toward smart water management. Heliyon, 7(2), e06107. https://doi.org/10.1016/j.heliyon.2021.e06107

UN-Habitat. (2018). SDG Indicator 11.1.1 Training Module: Adequate Housing and Slum Upgrading [Training module]. In Monitoring and Reporting the SDGs. United Nations Human Settlement Programme (UN-Habitat). https://unhabitat.org/sites/default/files/2020/06/indicator_11.1.1_training_module_adequate_housing_and_slum_upgrading.pdf

UNICEF. (2021). Challenges, Opportunities and Strategic Pathways Forward. Waste Management in Informal Settlements.

UN Women, Dalit rights activists break new grounds in South Asia. (2018, August 3). Asia- Pacific. https://asiapacific.unwomen.org/en/news-and- events/stories/2018/08/dalit-rights-activists-break-new- grounds

Voukkali, I., Papamichael, I., Loizia, P. et al. Urbanization and solid waste production: prospects and challenges. Environ Sci Pollut Res (2023). https://doi.org/10.1007/s11356-023-27670-2

Voumik, L. C., Mimi, M. B., & Raihan, A. (2023). Nexus between urbanization, industrialization, natural resources rent, and anthropogenic carbon emissions in South Asia: CS-ARDL approach. Anthropocene Science, 2(1), 48– 61. https://doi.org/10.1007/s44177-023-00047-3