a resilient haor

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A research booklet for the Dwelling Graduation Studio: Global Housing 2023/24

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Thank you to my family for supporting me in this long, long process of studying. You didn't always understand what I was doing, but still kept supporting me and showing interest regardless.

I cannot wait to take you all on this next chapter with me.

Contents

Introduction

Framework

The 21st century has witnessed significant global displacement due to various factors, including forced migration caused by war, genocide, and severe climatic and geographic conditions resulting from the climate crisis. Consequently, millions have been forced from their homes, becoming refugees, asylum seekers, and internally displaced persons.

This studio aims to understand the different forms of displacement, the challenges these populations face, and to explore innovative housing design approaches that can mitigate the impacts of large-scale displacement.
The course will analyze the varying living conditions of internally displaced individuals, cross-border asylum seekers, and refugees, questioning whether architecture can aid in the healing process and provide dignity to those in transition.
It will also investigate the transitional state of displacement and its effects on the social-spatial ecology of the case study areas.

The studio will delve into how architecture, particularly housing design, can support a society transitioning to a new ecological paradigm, equipping students with the skills to create meaningful spaces for populations in transition. Students will address the permanent versus temporary aspects of architecture and consider the roles of typology, materials, and technology in creating meaningful spaces for an architecture of transition.

Participants will visit and study transitional dwelling environments in the Delta of Bangladesh, focusing on Sylhet, a rapidly growing secondary region in the northeast of the country. This visit will provide firsthand experience of the living conditions of displaced communities and opportunities to interact with local groups who have also experienced displacement.

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Context

Sylhet is a division in the northeast of Bangladesh, bordered by the Indian states of Meghalaya, Assam, and Tripura to the north, east, and south, respectively. It is also bordered by the Bangladeshi divisions of Chittagong to the southwest and Dhaka and Mymensingh to the west.
The division, with a current population of about 11 million people, is named after its administrative center, the city of Sylhet, which lies on the banks of the Surma River. Sylhet city is home to around 700,000 people, making it the fifth-largest city in Bangladesh.

Dating back to the 14th century, Sylhet is a major commercial and financial hub, hosting several multinational companies and industries, including a significant tea industry.
The city's economy is closely tied to the Bangladeshi diaspora, particularly the British Bangladeshi community, which contributes substantially to the country's annual remittances. These remittances have fueled growth in the real estate and construction sectors.

Like other major Bangladeshi cities such as Dhaka and Chittagong, Sylhet is experiencing a technological, social, cultural, and demographic transition, marked by increasing economic prosperity and widening disparities between the rich and the poor. As of 2021, nearly 27 percent of Sylhet's population lived in slums (Nazem and Sultana, 2021), with 754 slums scattered across the city (Pal and Hussain, 2016). These slums, locally called "colonies," often lack safe and adequate housing, drinking water, and basic services such as toilets, electricity, and health centers. They are frequently located in flood-prone areas.

Outside the city, the larger Sylhet division is a valley formed by the Surma and Kushiara rivers, which are fed by numerous hill streams from the north. The region is known for its natural beauty, tea plantations, and 'haors' (traditional wetlands). However, its location at the basin of Cherrapunji in India, often called the "wettest place on Earth," makes Sylhet vulnerable to monsoon floods. In 2022, record rainfall caused devastating floods, submerging nearly 80 percent of Sylhet, displacing millions, and causing widespread economic losses and damage to croplands.

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Research

Context Analysis: collective knowlege base
Research Plan
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Site Analysis
Design research

Context Analysis

Buddhist & Hinduist Dynasties

The Sylhet region was part of several Buddhist dynasties, like the Kamarupa Kingdom and the Gupta Empire. These dynasties left a mark on the region, with several Buddhist sites and ruins still present today. These ruins showcase the prominence Buddhism once had as the dominant religion in this area during ancient times.[1]

While Buddhism was once the main religion of the region and thus had a significant amount of influence, not much is readily visible from this period. A lot of time has passed since then and in which other religions have taken the main stage.

The Sylhet region came under the influence of multiple Hindu dynasties as well, notably the Pala and Sena dynasties. Hinduism spread its reach and influence during this time, constructing temples and other religious buildings. Today these temples are mainly in ruins, but they still showcase the influence of this period.[2]
Although Islam has taken over as the predominant religion, Hinduism is still the second biggest religion in the region of Sylhet. Some Hindu influences are still very much alive to this day. Such as Hindu festivals, celebrations, art, music, and food. A lot of surnames, even of many Muslims, have Hindu origins. The incorporation of different cultural elements and origins strengthens Sylhet's heritage and showcases a unique religious and cultural mix to this day.[3]

The Hindu dynasties lasted until the Muslim conquest of the region in 1303.

Buddhist & Hinduist Dynasties

During the early 13th century, the Sylhet region was introduced to Islam. Early interaction with Muslim traders and travelers caused a gradual spread of the religion throughout the region. During this period the region was ruled by sultanates like the Delhi Sultanate and the Bengal, until the overtaking by the Mughal Empire in 1538.
The Muslim conquest by the Sultanates has had a long-lasting influence on the region of Sylhet. This conquest was assisted by Shah Jalal, who was a Sufi saint who was one of the most important spreaders of Islam throughout the Sylhet region. As can be seen now, the main religion of the region is still Islam. Some buildings that were constructed during this time still stand today. The Shrine of Hazrat Shah Jalal still attracts many religious visitors to this day. This period marked a significant turning point in the history of Sylhet as the prominent religion shifted from Hindu to Islam.[4]
The region developed into a rich Islamic culture, that laid the foundation for the integration into the Mughal Empire.

The Sylhet region was conquered by the Mughal Empire from 1612 until 1757 when the British East India Company defeated the Mughal Empire at the Battle of Plassey. Only during a brief period during the early 18th century, Sylhet temporarily was under the control of local chieftains and the Manipuri kingdom, before being recovered by the Mughal Empire. Although the Mughal Empire didn't introduce the region to the Islamic religion, it did realize many of the historical monuments and buildings often being mosques, tombs, or palaces. These buildings feature Mughal-style domes, arches, and other decorative elements. The Region's significance began to grow under the Mughal rule as it was chosen as an important outpost in the east.[5] It is also believed that during this time the first region-wide systems of state authority were introduced.[6]

- Freek Van Schaik, Mattia Graaf, Kasper Willemse, Veda Hepark

figure 1: collages from the collective knowledge base: context analysis booklet

1947 Partition

The invasive reforms and improvements under British rule were received by many Indians with skepticism and dissatisfaction.[7] This led to the Sepoy Mutiny (Indian Rebellion) of 1857, which happened in numerous cities in central India but nowhere near the Bengal and Sylhet regions. The uprising was put down violently by the British, though dissatisfaction among Indians continued for the next decades.

In 1947 however, when Britain was suffering from the aftermath of the Second World War and had no longer the resources to control British India, the dissolution of the British Raj after three hundred years eventually occurred.[8]
The increasing polarization of Hindus and Muslims during the previous decades, made it impossible for the two religions to coexist peacefully under one nation. Therefore, the Indian subcontinent was partitioned into two independent states: Hindu-majority India and Muslim-majority Pakistan. During the Partition, millions of Indian Muslims fled to Pakistan and Pakistani Hindus to India, resulting in a mass migration accompanied by massacres and (sexual) violence in the border provinces of Punjab and Bengal.
Bengal was split up by the National Congress into Western Bengal which would join India and East Bengal which became part of Pakistan and was later renamed East Pakistan.[9]

Sylhet's rare situation as a Muslim-majority district in the Hindu-majority province of Assam, raised the question if Sylhet should join East Bengal or remain part of Assam and therefore become a Muslim-minority area in Hindu India.[10]
In a referendum pushed forward by the British Raj, the majority of the Sylhetis voted in favor of joining East Bengal and therefore the new Muslim state of Pakistan.[11] However, to this date, the Sylhet division has the highest Hindu population percentage of all divisions in Bangladesh.

After the Partition in 1947 and the formation of Pakistan, tension started to emerge between East and West Pakistan when the government in West Pakistan ordered Urdu as the sole national language thus suppressing the Bengali-speaking majority of East Pakistan.[12]
Eventually in 1956 both Bengali and Urdu were declared as official languages but new differences developed and tension continued. During the war between India and Pakistan in 1965, East Pakistanis were left feeling unprotected by the West Pakistani-dominant army from a potential Indian invasion.
Following this, Sheikh Mujibur Rahman, leader of the Awami League, demanded more defense, political, and economic East Pakistan in the Six Point movement. This significantly increased the call for independence among the Bengali population.

- Freek Van Schaik, Mattia Graaf, Kasper Willemse, Veda Hepark

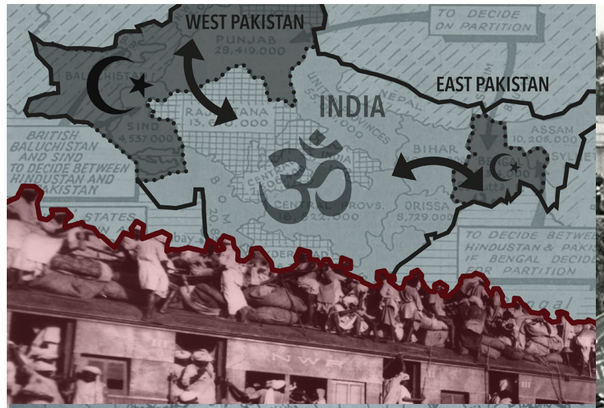


Figure 2: collages from the collective knowledge base

Fig. x: Rally in Trafalgar Square 1971

Population and density

Bangladesh is known for its high population density, making it one of the most densely populated countries globally. With approximately 1,329 people per km2,3 its population density is significantly higher compared to many countries, including the Netherlands, which has around 522 people per km2 which is 2,5 times less dense than Bangladesh.3 The Sylhet division, with a population desity of 873 people per km2, is notable for its relatively lower population density compared to the national average.4 Within the Sylhet division, the highest density is found in the Sylhet district where Sylhet city is found. The highest density is found in the Dhaka district which has a major influence on the average population density in Bangladesh.

2. Worldometer, Bangladesh Population, (2023)
3. Worldometer, The Netherlands Population, (2023)
4. Bangladesh Bureau of Statistics, Population and Housing Census 2022: Preliminary Report (2022), 12.

A notable demographic feature of Bangladesh is its beneficial age pyramid. The population is predominantly young, with a substantial part under the age of 30.5 This youthful demographic structure means there isn't a significant aging population, unlike many Western countries. Youthfulness is often seen as a positive aspect, having a lot of young people entering the working age is like having an opportunity for economic growth.7 It means there are many people who can work and contribute to the economy, which can make things better.

However a youthful population in Bangladesh also faces potential challenges. The pressure on resources, such as healthcare, education and employment opportunities can be overwhelming.8 Making sure everyone gets a good education can be challenging in a county with such a high young population. Moreover, despite the potential for economic growth, ensuring meaningful employment opportunities for the youth can be difficult. High youth unemployment rates can lead to social unrest and create a threat to the overall stability.

5. PopulationPyramid.net, Population Pyramids of the World from 1950 to 2100, (2022).
6. Ibid.
7. Voxco, PopulationPyramid.net, Population Pyramid: Decoding Age and Gender Dynamics, (2022).
8. Ibid.

The Sylhet Division constitutes 5.39% of the national household rate, whereas the Dhaka Division holds the majority at 28.35%, with an average household size of 4.03 individuals in the year 2011. Despite the demographic increases in population density and households, there has been a consistent decline in household size between 2001 and 2011. This trend suggests that housing conditions may be deteriorating, as individuals find themselves living in smaller living spaces. This situation appears to be a consequence of the lack of alternative housing solutions to accommodate the 2.5% increase in households across the country.18

18. Bangladeh Bureau of Statisitcs, Ministry Of Planning, Population & Housing Census 2022 Preliminary Report, August 2022, 45

- Marion Achach, Ecelia Kastelein, Nynke Keulen, Sue Vern Lai

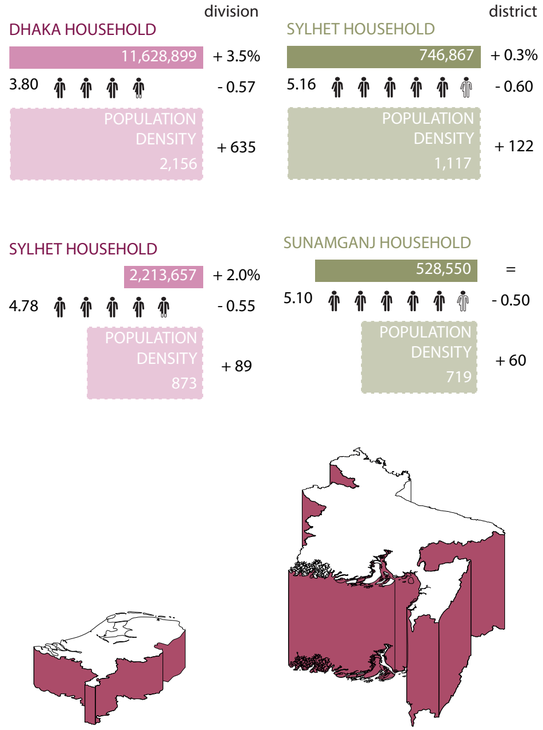


figure 3: Population density of The Netherlands (left) and Bangladesh (right), 2023

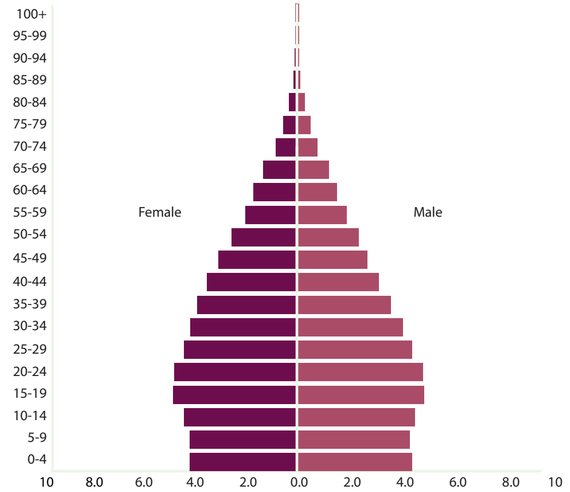


figure 4: Population Density per District and Sylhet Divisions, 2022

Income

In 2022, the average income per household in Bangladesh stood at 32,422 Bangladeshi Taka (BDT) per month, equivalent to approximately 277.92 euros. This figure represents the total income earned by a typical household in the country.[13]

On a per capita basis, the average income in Bangladesh for 2022 was 7,614 BDT per month, which is approximately 65.27 euros. This per capita income signifies the average income earned by each individual in the country.

It is worth noting that income levels in urban areas of Bangladesh tend to be higher than in rural areas.

In the figure below, the income inequality can be seen. The term «HIES» stands for Household Income and Expenditure Survey. It is a measure used to assess the income and spending patterns of households in a given region or country. In the context of HIES, a value of 0 typically signifies a low income or poverty, while a value of 1 indicates a high income or affluence.

In Bangladesh, a HIES value of 0.499 in 2022 suggests that the average household income in the country is closer to the lower end of the income spectrum. This means that a significant portion of the population may be experiencing lower income levels or living in economically challenging conditions.

Migration

Internal migration in Bangladesh predominantly occurs in districts like Dhaka, Gazipur, and Narayanganj, which attract over 20% of migrants.[14] This migration primarily involves people moving from rural areas to urban centers in search of better livelihood opportunities while escaping vulnerabilities in their places of origin and adopting adaptive strategies in their new destinations.[15] Over the last decade, there has been a shift in migration patterns in Sylhet District, with populations from neighboring districts relocating to the division's administrative capital or the southern areas of the region.

The reasons for migration affect men and women differently. For men, the main pull factors are typically economic opportunities, while women and girls are disproportionately driven to migrate for marriage. On the other hand, push factors, such as natural disasters and family issues, play a significant role in internal migration. Notably, Sylhet Division stands out with the highest rate of internal migration driven by economic prospects, establishing it as a regional economic hub.[16]

- Marion Achach, Ecelia Kastelein, Nynke Keulen, Sue Vern Lai

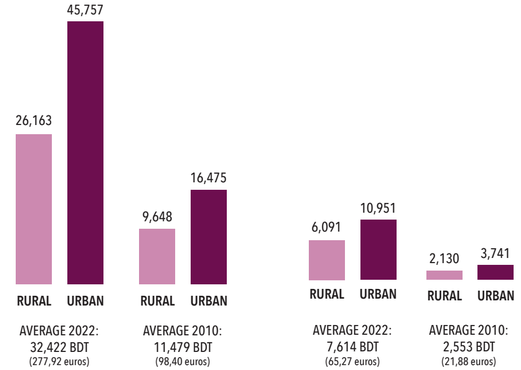


Figure 5 : Income per household in Bangladesh, 2023

Figure 6: Income per capita in Bangladesh, 2023

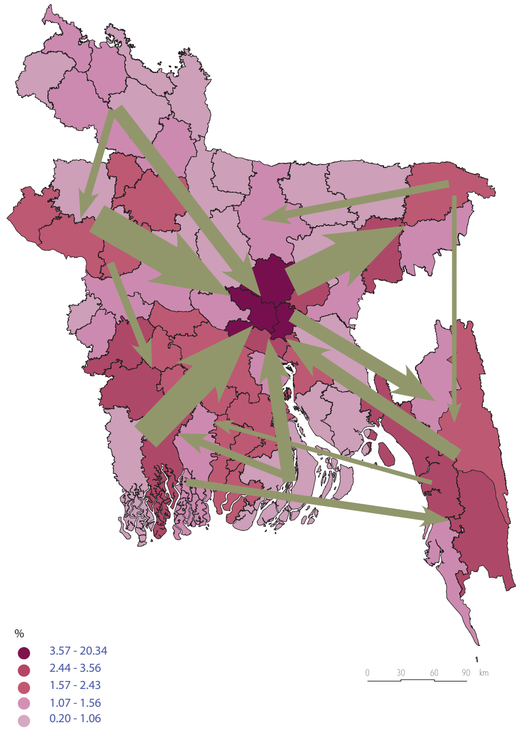
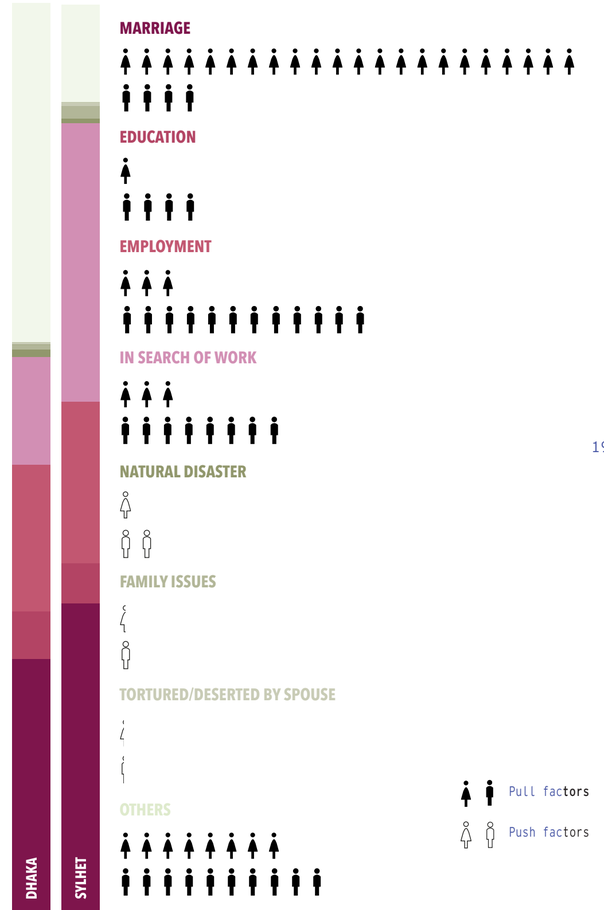


figure 7: Distribution of Internal Migration Less than 5 years by District and Inter-divisional migration flow, 2011.



Bangladesh is situated within the South Asian region, encompassing a geographical expanse that also includes Sri Lanka, India, Afghanistan, Pakistan, Bhutan, Nepal, Iran, and the Maldives.

Bangladesh is a land area of roughly 145,000 km2, serving as the homeland for an estimated population of around 140 million individuals.[17] The nation finds itself geographically surrounded by India. In the southeast, the border is delineated by Myanmar, while to the south, Bangladesh's coastal boundary extends along the Bay of Bengal.[18]
When Bangladesh gained its independence in 1971, the country initially consisted of four administrative divisions: Chittagong, Dhaka, Khulna, and Rajshahi. Over time some divisions were split, culminating in the current eight-division administrative structure.[19]

Each division is designated after its principal city, which serves as the administrative capital for its respective jurisdiction. Furthermore, every division is further subdivided into districts, which, in turn, are partitioned into Upazilas (this is similar to a province or a municipality).[20]

Dhaka Division: Encompassing the nation's capital and largest city, Dhaka19, this division spans an area of 20,509 km2 and houses a population of approximately 45.6 million Bangladeshis.[21]

Sylhet Division: Distinguished by its robust economy, replete with tea plantations and citrus orchards, the Sylhet Division has a substantial portion of its people working abroad, notably in the United Kingdom. It encompasses an area of 12,635 km2 and is inhabited by a population of approximately 11.4 million.[22]

- Christelle Rarivo, Ginger Hanssens, Kim Schoenmakers, Lisa Wellink

figure 8: Map showing Asia, South Asia and Bangladesh

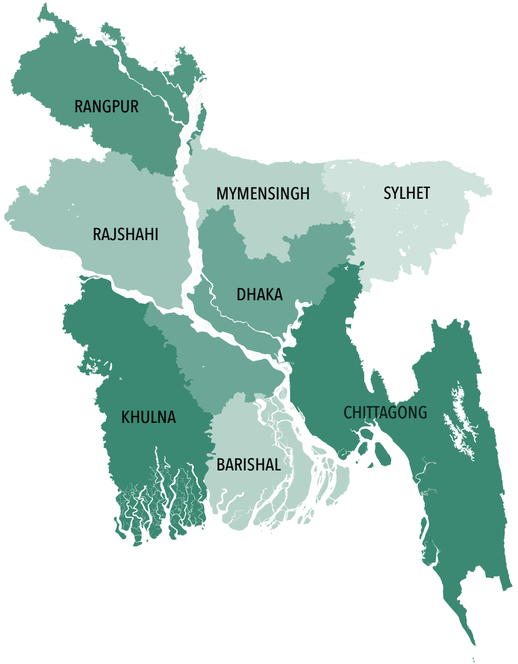


figure 9: Bangladesh divisions

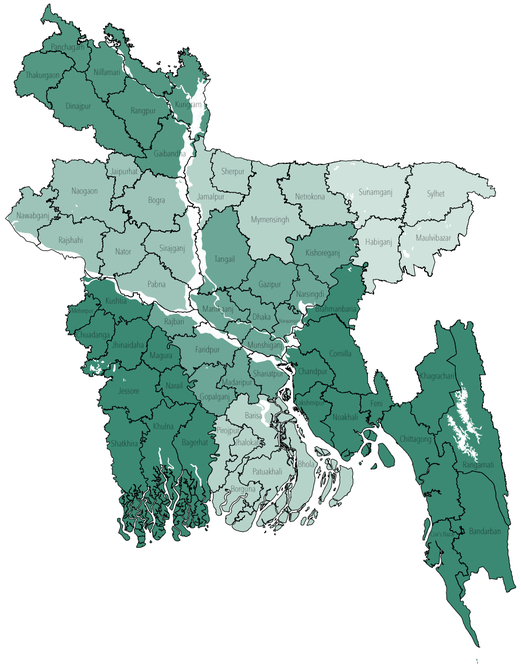


figure 10: Bangladesh districts

Bangladesh is renowned for its predominantly flat and low-lying topography. Nevertheless, approximately 21% of its land area comprises hilly terrain, primarily located in the southeastern and northeastern regions of the country, where elevations can reach as high as 1,000 meters above sea level.[23]
However, the majority of Bangladesh's elevations remain below the 10-meter mark above sea level, with this flat topography gradually diminishing in height as one moves towards the coastal southern regions.[24]

The Sylhet division has a hilly topography with varying altitudes ranging from 30 to 240 meters. The region is bordered by hillocks, except on the western plain boundary. The center consists of low-laying flood plains, also known as haors.[25]

70% of the country's land is used for agriculture. This consists of 3 types of rice cultivation; Aus, Boro, and Aman paddies. Other agriculture consists of year-round crops, tea gardens, and Mixed agriculture. 59% of Bangladesh's land is arable, which means used for temporary crops. Only 6,5% of the land is used for permanent crops.[26] The country also has some fallow land, which is a technique of not sowing the arable land during one or more growing seasons.[27] 4,6% of Bangladesh is covered by pasture land, which is land used for grazing livestock.[28]

The remaining land consists of 11% forest and woods. 18% consists of swamps, marshes, and mountains.[29]

The land use is determined by its physiography, climate, and land type related to flooding.[30] The depth of flooding is key in the determination of land use, this determines which crops can be cultivated.

- Christelle Rarivo, Ginger Hanssens, Kim Schoenmakers, Lisa Wellink

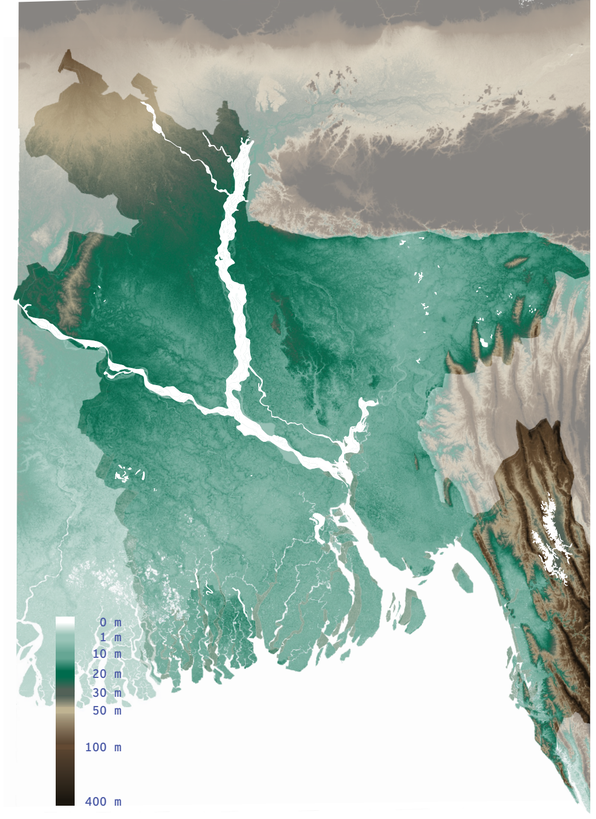


figure 11: Elevation map Bangladesh

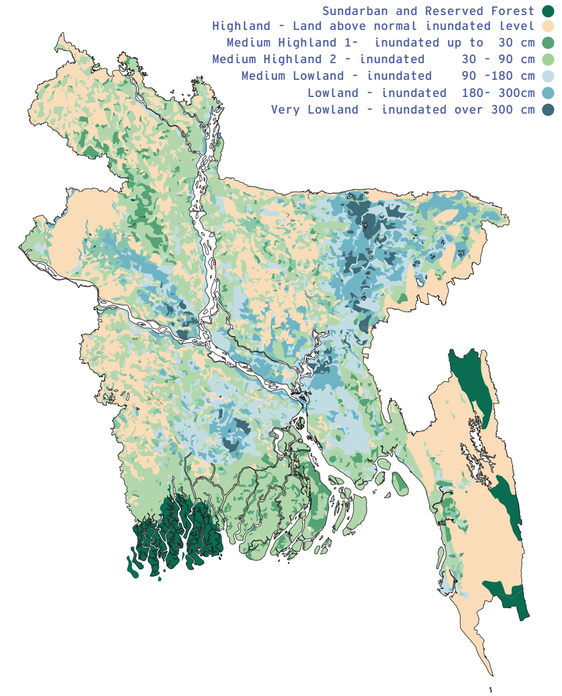


figure 12: Land types Bangladesh

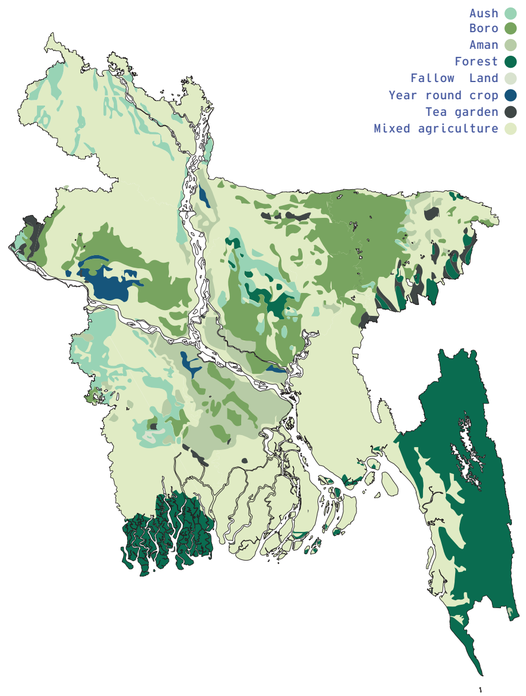


Figure 13: Land use Bangladesh

Bangladesh experiences a diverse range of seasons, with a transition occurring approximately every two months.[31] These seasonal changes are categorized according to the prevailing weather conditions in specific regions, leading to Bangladesh being referred to as 'The land of Six Seasons'; summer, rainy season, autumn, late autumn, winter, and spring.[32] Summer is the first season in Bangladesh, as April is the first month of the new year according to the Bengali Calendar.[33]

From a climatic perspective, Bangladesh can be identified as having four well-defined seasons; a dry winter season spanning from December to February, a warm pre-monsoon summer season occurring from February to June, a wet monsoon season extending from June to October, and a post-monsoon autumn season that continues from October to December.[34] Over 71% of the yearly rainfall occurs in the monsoon period.

Bangladesh's climate seasons exhibit regional variations. The coastal southeast, including Chittagong and the area north to Comilla, experiences relatively stable temperatures and heavy rainfall, exceeding 2500 mm annually, with notable dewfall in winter. The northeastern part, where Sylhet is located, is marked by high humidity, heavy rainfall, and a cloudy, cool winter.
In the northern region, there are extremes, with a very wet rainy season (around 3000 mm per year) and a relatively dry summer, along with temperature fluctuations between 10 degrees and 30 degrees throughout the year. Moving to the western region, lower rainfall and fewer extremes are observed compared to the north. The western part of the country is the driest of all regions of Bangladesh.[35]

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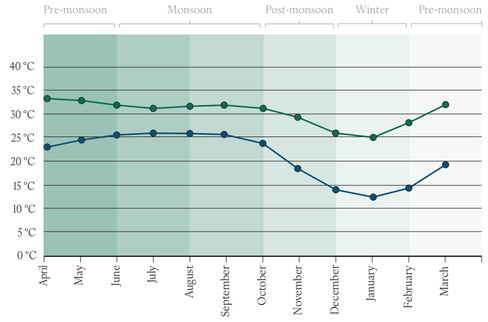

figure x: Minimum and maximum monthly temperature

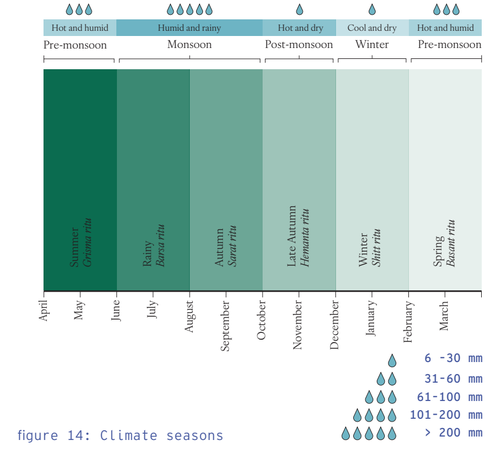

figure 14: Climate seasons

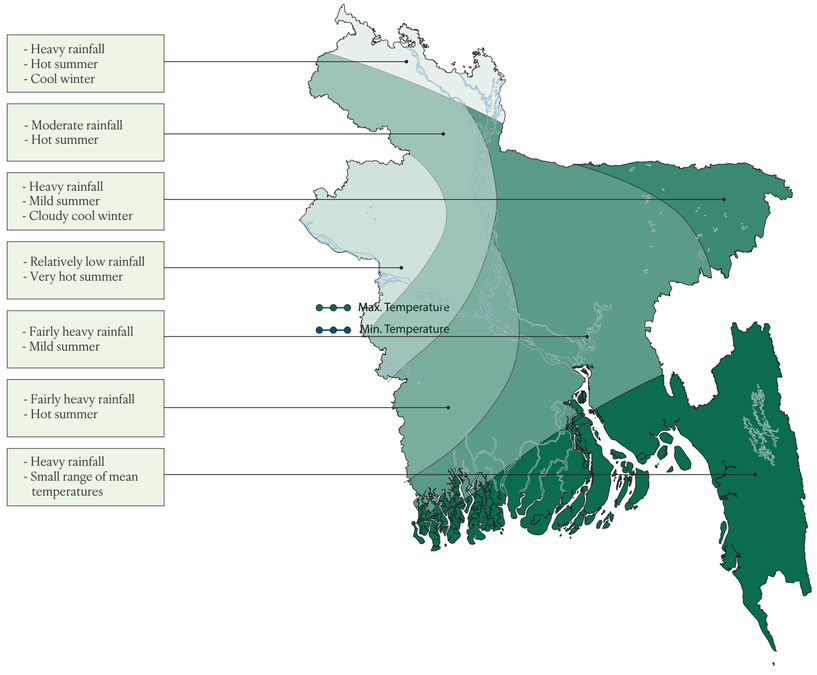

figure 15: climatic zones

Climate change is up there with one of the biggest global issues we are dealing with today. Bangladesh produces only 0.56% of the global emissions and yet is one of the most vulnerable countries in terms of climate change effects due to the geographical conditions and location.
By 2050, millions of people will have lost their homes due to rising sea levels and floods.[36] Many people who are affected will migrate to higher ground or often to the bigger cities like Dhaka and Chittagong. The problem with this is that these cities are not equipped to handle such mass migration. They are also not immune to the changing climate and face a lot of floods as well due to heavy rainfall and sinking ground levels.[37]
On the flip side of too much water, they are also dealing with droughts in other parts of the country which will affect water resources.[38]

Much of Bangladesh is situated in the Ganges-Brahmaputra-Meghna river delta, which is vast low-lying land. When heavy rains occur upstream or in the catchment areas of these rivers, the water flows downstream into the delta, causing rivers to overflow their banks.
The low-lying land provides little natural protection against river flooding, making the region highly susceptible to inundation during monsoon seasons.[39] The flat and low-lying terrain can also impede the natural drainage of floodwaters. In many areas, the land's lack of elevation makes it difficult for floodwaters to recede quickly, leading to prolonged inundation.[40]

- Christelle Rarivo, Ginger Hanssens, Kim Schoenmakers, Lisa Wellink

figure 16: Residents sought higher ground on a flooded street in the Sylhet region.

Since Bangladesh's independence in 1971 there have been over 78 extreme floods which resulted in at least 42 thousand deaths and billions of dollars in economic damages.[41]

It is important to consider the factors that cause floods in Bangladesh. The most obvious one is the low topography. Bangladesh's generally low-lying terrain, combined with one of the largest Delta's in the world, plays a significant role in flood occurrences. Then throughout the entire country, but more so in the Sylhet division, they're dealing with heavy rainfall, this can lead to increased water flow into Bangladeshi rivers.[42]

Since the Himalayan mountains aren't far north from Bangladesh, the melting snow and glacial movements contribute to rising river levels.
Less obvious factors include river siltation, erosion and landslides which can change the flow of the river. This together with tides and wind patterns can slow down river outflow, and when water cannot go anywhere it will cause floods.
Then we as humans are ofcourse also a factor since our interventions can make flooding worse.
An example is the construction of dams and embankments, if not done right they can lead to a faster water flow and make the situation only worse in other places.

Something that might be unexpected is that deforestation can also worsen floods since the roots of trees works as structural integrity for land, if this is removed it can cause erosion and siltation which reduces the rivers water capacity and causes overflowing.
Then lastly, on a larger scale, earthquakes can alter river flow patterns and morphology, resulting in issues mentioned previously.[43]

In figure X is shown which types of floods occur in which months and most of the floods do happen during monsoon season but deviate to pre- and post-monsoon season.[44]

One thing that is very important to mention is that floods are not always bad. Mild flooding is necessary for healthy crops, not only does it fertalise the land, it also prevents farmers from needing to install artificial irrigation which can be quite expensive.[45] However, the frequency and intensity of the current floods are not beneficial to the agriculture anymore, they destroy the land and impact the livelihoods of millions of people.[46]

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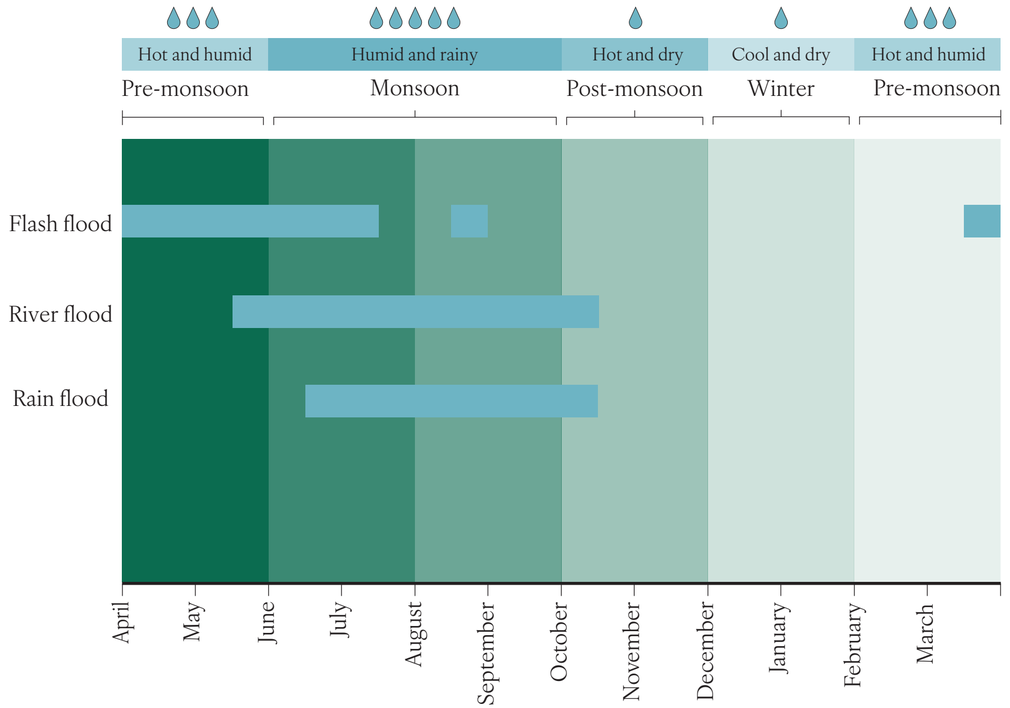


figure 17: seasons diagram rainfall and floods

The flood risk map shows the dangerous areas based on assessment of land that has been flooded over the years, specifically using data from the monsoon season of 2017 to 2020, and adds factors such as elevation, population density and distance from the river to predict how impactful a flood would be and how dangerous the area is if a flood were to occur.[47]

Since the areas around the river are prone to flood this is an extremely high risk area, as is the very low lying land in the Sylhet division. Depending on the type of land (fig. 8), water depth during flooding can range from 90 cm to more than 3 meters deep.[48]

The map also shows which areas are most susceptible to river and monsoon rain floods, these areas are the lowest lying land in Bangladesh as seen in figure 7 and thus the water gravitationally ends up there. Then there are the flash floods, these are floods that occur fast but also recede faster than monsoon floods. And last but not least the tidal surge flood area which is located in the south of the country where the Bay of Bengal is situated.[49]

Bangladesh's vulnerability to floods is exacerbated by its dependence on the monsoon seasons which are likely to change and shift. Climate change is also expected to increase the frequency and severity of flooding, posing significant challenges to the country's socio-economic development and infrastructure.[50]

On average around 25% of Bangladesh's land gets flooded each year and with extreme floods like the flash flood of 2022 this percentage goes up to 60%. This can increase even more in the next decades due to climate change.[51]

The Sylhet Division, and specifically the Sunamganj district are heavily affected by monsoon and flash floods as previously deducted by the flood risk map. The floods of 2022 in Sylhet started around May and continued throughout the monsoon season with the worst happening in June.[52] The Sylhet rivers Surma and Kushiara overflowed 11cm and 17 cm respectively above danger levels,[53] which is generally measured as higher than annual flood levels.[54]

These 2022 flash floods were partially caused by the heavy rainfall in Cherrapunji, India at that time. These floods caused millions of people to lose their homes and belongings and thousands of hectares of agricultural land was affected.[55]

- Christelle Rarivo, Ginger Hanssens, Kim Schoenmakers, Lisa Wellink

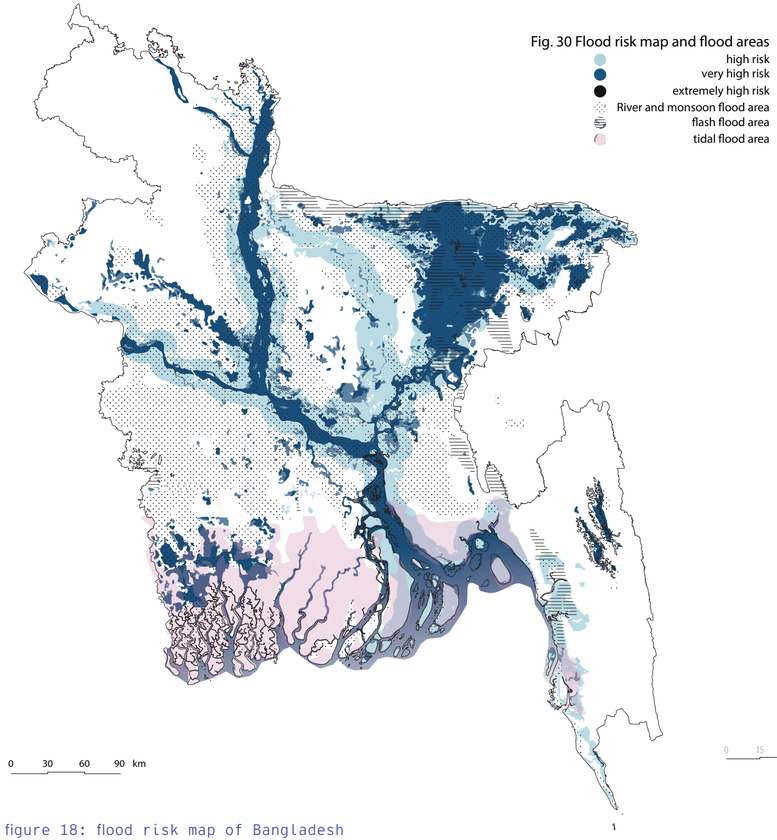
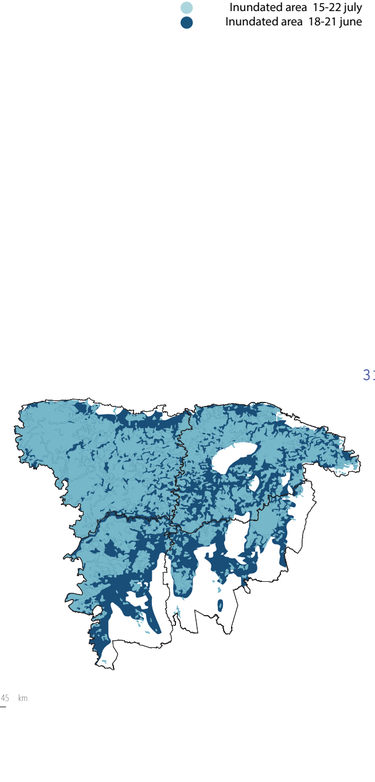


figure 18: flood risk map of Bangladesh



Due to climate change the sea level will rise and globally this will increase the risk of flooding. Bangladesh has the second highest percentage of population with a high risk of exposure to flooding. The highest is The Netherlands.[56]

There are a lot of factors that affect the prediction of sea level rise. If any were to change this has impact on the outcomes. The ice caps might melt quicker, global emmissions might rise or, hopefully, drop. But the predictions that this map is based on is what will happen if things do not change.[57] The sea level predictions differ a lot based on circumstance but since this map is based on worst case scenario where global emmissions do not drop, the sea level is predicted to rise 1m by 2100 or more if the ice caps were to melt quicker.[58]

The map in figure 36 shows the land that will be under the new tide level in 2030, 2050 and 2100.This does not take into consideration the existing embankments and the futher implementation of flood management.

This map does not show what the country will look like after the annual flooding, since these are just the sea level predictions. However, it is easy to imagine from the previous flood risk map how the majority of the country will be under water when a flood or tidal surge were to occur in these future scenarios.[59]

- Christelle Rarivo, Ginger Hanssens, Kim Schoenmakers, Lisa Wellink

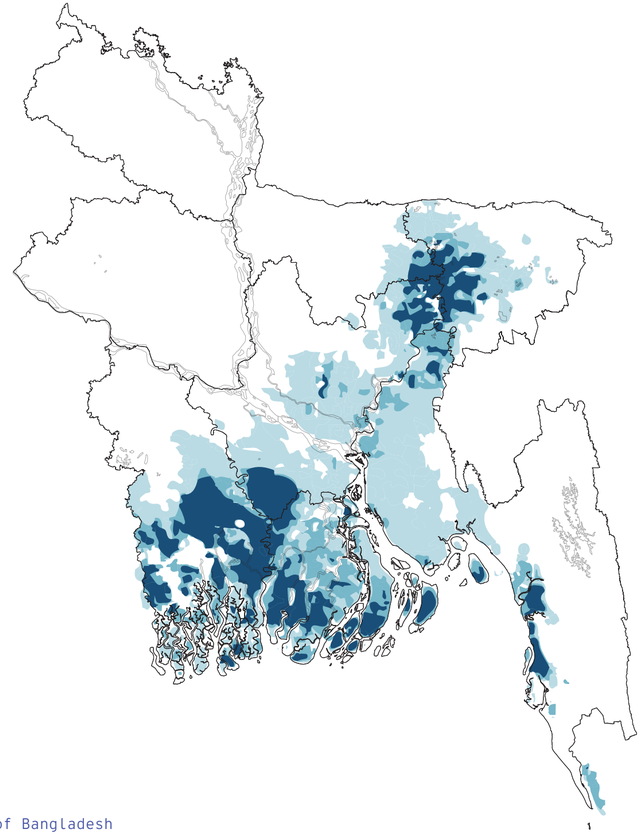


figure 19: sea level rise map of Bangladesh

Research Plan

Bangladesh is undergoing rapid urbanisation. This accelerated urban growth has led to a significant upsurge in waste generation, especially in major cities such as Dhaka.
Consequently, the quality of life, the environment, and people's health are negatively impacted.[60] The growing amount of waste is currently calculated at 16 thousand tonnes of waste produced every day in the urban regions.[61] However, more than half of this amount is organic waste.[62] Due to the fact that Bangladesh is an agricultural economy, this organic waste is often composted in order to be used as fertiliser.[63] This means that the bigger issue for waste in the country is caused by the plastics that cannot decompose. These plastics pollute the streets, soil and block drainage systems, which further worsens the flooding issues Bangladesh faces.[64]

Every year around the monsoon season Bangladesh faces massive floods across the country. These floods are caused by heavy rainfall and made worse by lack of drainage.[65] The area most affected is the Sylhet Division because of the low lying land, including the haors, also known as the wetlands.

The existing waste management infrastructure in urban areas like Dhaka is typically organised at the municipal level, with a significant reliance on volunteer efforts or community-driven initiatives. Various waste collection methods are employed, including community-based collection, which involves volunteers from the local community conducting door-to-door waste collection services, usually funded by the households. The collected waste is subsequently transported to a transfer station, before its final disposal in landfills.[66]

In addition to this, there exists a sector of informal waste collectors who gather waste from the streets, with a primary emphasis on recyclable materials such as plastics, paper, and glass, which hold economic value. These informal collectors receive compensation from private sectors involved in the recycling of these materials.[67]

While Sylhet City only has around 700.000 inhabitants, not nearly as many as Dhaka with 10 million, it still has similar waste collection systems and waste management issues. Around 26% of Sylhet's household waste is deposited in public spaces and drains.[68]
One very unmistakable sight in Sylhet and other areas is the waste accumulation around rivers and other bodies of water. The Surma river is not immune to this, and its pollution causes several problems for people living near the river, ranging from odour nuisances[69] to skin and health conditions.[70]

The Surma River sustains the livelihoods of millions residing along its banks and serves as a vital resource for activities such as fishing and bathing. Since the water quality of the river is negatively impacted by multiple factors including waste disposal, these practices are not safe for people to continue.[71]

Seeing as the Tanguar Haor sits in the floodplain of the Surma river[72] and, the river is polluted with waste and plastic from cities and villages along the riverbanks, the trash that is discarded into the Surma can eventually end up in the Tanguar Haor and pollute the water and soil.

The Tanguar Haor is a wetland located in the Sunamganj district, west of Sylhet, and is very low lying land. Due to the low lying nature of the haor it is inundated for around 7 to 8 months a year.[73] It is highly affected by rainfall and floods since it lies at the foot of the Meghalaya mountains. When heavy rains occur upstream or in the catchment areas of these rivers, the water flows downstream into the delta, causing rivers to overflow their banks.[74]
The land's lack of elevation makes it difficult for floodwaters to recede quickly, leading to prolonged inundation.

During the visit to Tanguar Haor for the fieldwork, it became apparent that the extent of waste pollution in this ecosystem does not come close to that at the urban scale. Nonetheless, the absence of large scale waste pollution in this specific ecosystem does not negate the existence of environmental concerns. This became evident after our lunch break on the boat tour where employees burned the styrofoam plates and cups that were used. Tourism is one of the major factors of plastic pollution in the Tanguar Haor, since it is such a popular destination, especially during the monsoon season while the haor is under water.[75]

In urban environments, a recurring challenge associated with waste management, stems from an absence of accountability.[76] The lack of a communal sense of responsibility among individuals residing in non-cohesive communities contributes to the accumulation of waste in public spaces. Contrarily, in Tanguar Haor, the settlements are configured in a manner that fosters a communal atmosphere, instilling a sense of accountability among its inhabitants.

This is seen in the reduced presence of litter in public areas, as the linear streets function akin to courtyards or front yards for residents.
Notwithstanding this arrangement, waste is still generated, with disposal methods including burning and burial. Yet there are also instances of repurposing, such as the utilisation of rice and cement bags in the construction of embankments and certain walls or fences.

One of the biggest plastic pollutants, both in urban and rural areas, are the single use small plastic packaging used for 'mini-packs', these are often chips or nuts sold in small quantities.[77]
During the wet season the land is flooded and the people living in the haors are guarded off from the villages and cities in the surrounding area, since hiring a boat is often too expensive. Because there is no food import during this period, including these mini-packs, this also means there is less plastic waste.[78]

Due to the annual flooding of the haors the houses are greatly impacted by water damage, especially from flash floods.[79] Most houses in the region are built on plinths made of mud that gets washed away by the floods and therefore needs to be reapplied each year after the monsoon season. Currently, many houses in the haor settlements are made from corrugated metal sheets, since this is one of the most affordable materials available. This metal, unfortunately, is not fully resistant against water damage either, as it is prone to rust and thus deteriorates over time.[80]

While observing the way the people in the haors live and taking the Khudi Bari as a case study it becomes clear that a ground connection is very important to them. Due to the fact that all social activities happen on the ground floor in the streets and the courtyards[81] the people rarely use the elevated floor of the Kudi Bari and prefer to close off the ground floor with these corrugated metal sheets used for the walls. So simply raising the houses from the ground to avoid flood damage seems to not work well with the needs of the residents.

To create the best living situation for the people in the haor it is essential to understand the way people currently live with the seasonal changes of the monsoon floods and create a solution for the problems they face.
For this reason, we must pose the question: how to design a dwelling that is both flood resilient and accomodates the needs of residents?

According to Fahim Bhai there currently is not enough space for waste separation in households since there is already a lack of space which is maximised to the current needs. The lack of priority of waste management that already starts within the home, creates a big issue within the whole waste management system.[82] This brings forward one of the architectural design challenges that should be faced working on the topic of waste management: how to maximise space and still make room for a proper waste sorting station?

Since there is already an existing communal infrastructure based on teamwork and sharing of resources,[83] regulating a communal waste management system seems to be more viable than in an urban setting, where these communal practices are less common.

So another topic that needs to be adressed is: how to create space within the settlement to teach awareness of the larger issue and health complications that arise from polluting the ground, river and the air?

Although there are initiatives to create a better waste management system, for example by Fahim Bhai, founder of GarbageMan Ltd, these organisations are still a long way from being able to manage the waste of 170 million people living around the country.
Granted, the best solution for waste management is to reduce the use of materials like plastic. However, this takes time and needs governmental initiative, so in the meantime reusing and recycling this waste seems like the best way forward.
How can waste become part of a circular system?

The overarching research question that will eventually lead to a Design Hypothesis will be:

How can sustainable and durable housing be built for the people of the Tanguar Haor that can withstand annual flooding, create a solution for the water pollution and subsequently address the needs of the residents?

figure 20: title

The Khudi Bari is a very smart and affordable design by MTA for flood and earthquake prone areas. Because of the demountability it makes it possible for the residents to pack up their house and move somewhere else, whether permanent or temporarily.
Creating it out of bamboo and CGI makes it affordable. CGI being one of the most affordable and available materials while bamboo is a lot more sustainable. They also use steel joints, which are a little more expensive but last very long and are reusable which makes it a valid investment for the family.
The design makes it possible to join multiple base units and create a larger space.

Something that becomes clear when you visit the Khudi Bari's in the Haor area is that most people have closed off the ground floor to occupy the space. Either to make the most of the building's footprint or because the people in the Haor really value a ground floor connection because most of the daily activities take place on the ground floor and outdoors. Making the space on the first floor mostly for storage and sleeping at night.

figure 21: photo of the project c MTA

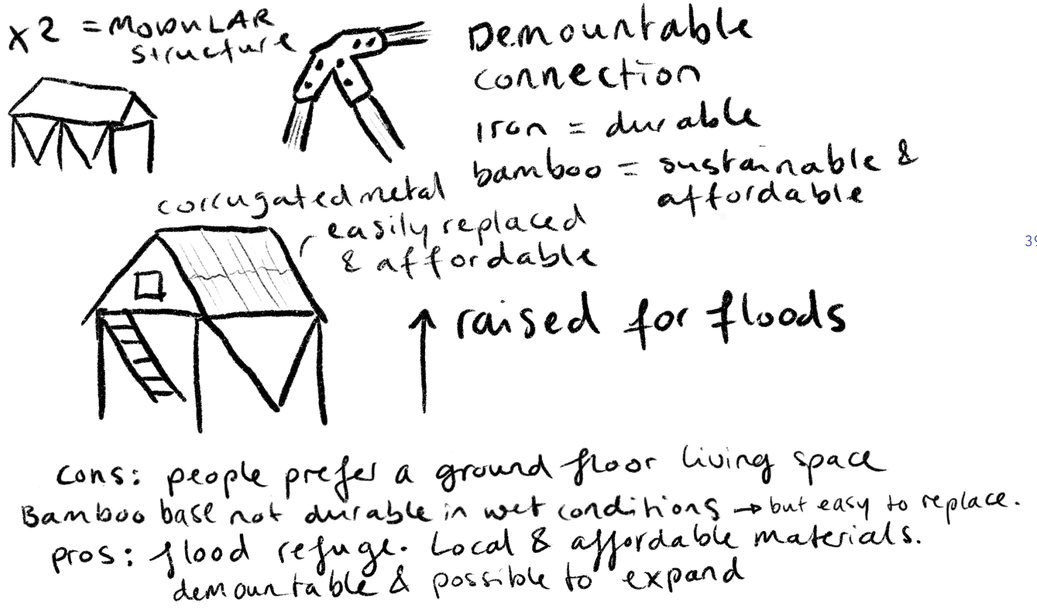


figure 22: analysis sketches and findings

The Kirinda project in Sri Lanka by Shigeru Ban is located in an area that was hit by a tsunami. The houses are made from local materials and uses local workforce to reduce cost and involve the residents.

The location is not a very densely populated area which makes it possible to design quite spacious area's like the hall and the court which function as a buffer between the bedrooms and the public space.

This court also functions as a kind of living space and works well with the local climate since it has a roof but is open on all sides to let through air.

A downside to the project is that there isn't much in terms of an urban design, making the houses quite scattered throughout the area. Not having an urban design makes the outside space not much of a public and social space and creates rather empty zones.

figure 23: photo of the court c ArchDaily

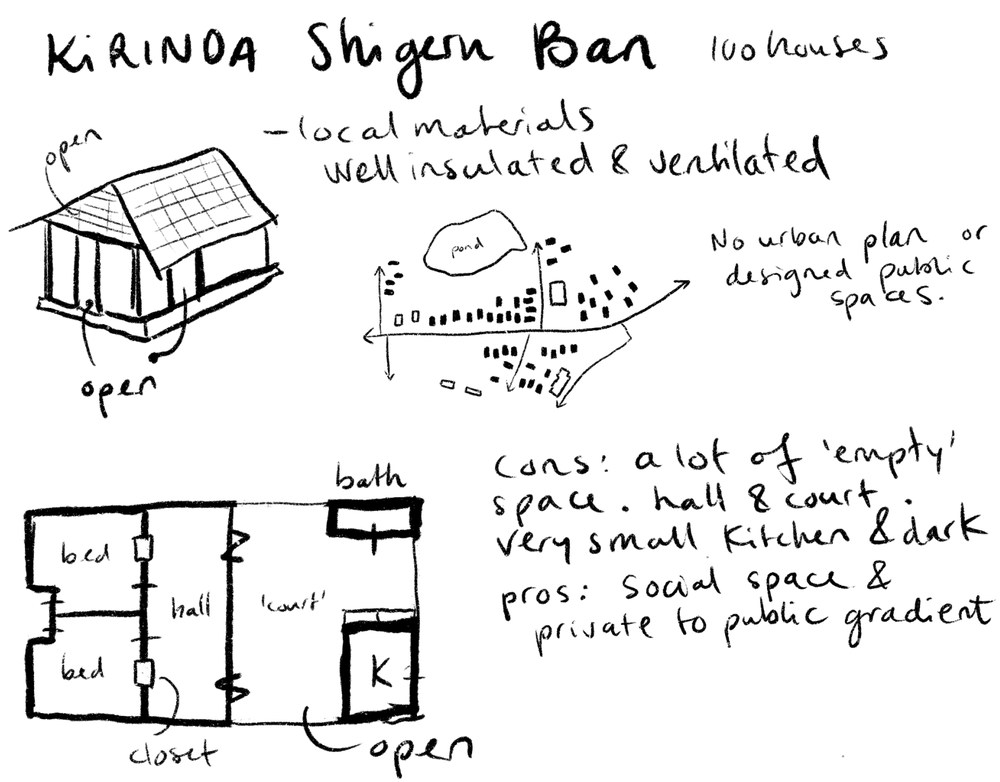


figure 24: analysis sketches and findings

Territory to inhabitant by Rozana Montiel is quite an interesting design. At first glance it doesn't look much like a house and more like a public pavillion or sanitary facility because of it's open appearance.

However the two closed 'boxes' are the bedroom and bathroom with a kitchen and staircase inbetween. The staircase leading to an open rooftop area which is still covered to provide shade and some form of privacy.

The design also offers quite a large terrace in relation to the private space. In a climate like this it might be a smart design move to make the living area and kitchen in a more open and public space, it creates a nice buffer zone.

Replicating a similar approach in a high dense area however might not work in terms of privacy and use of the space.

figure 25: photo of the project c ArchDaily

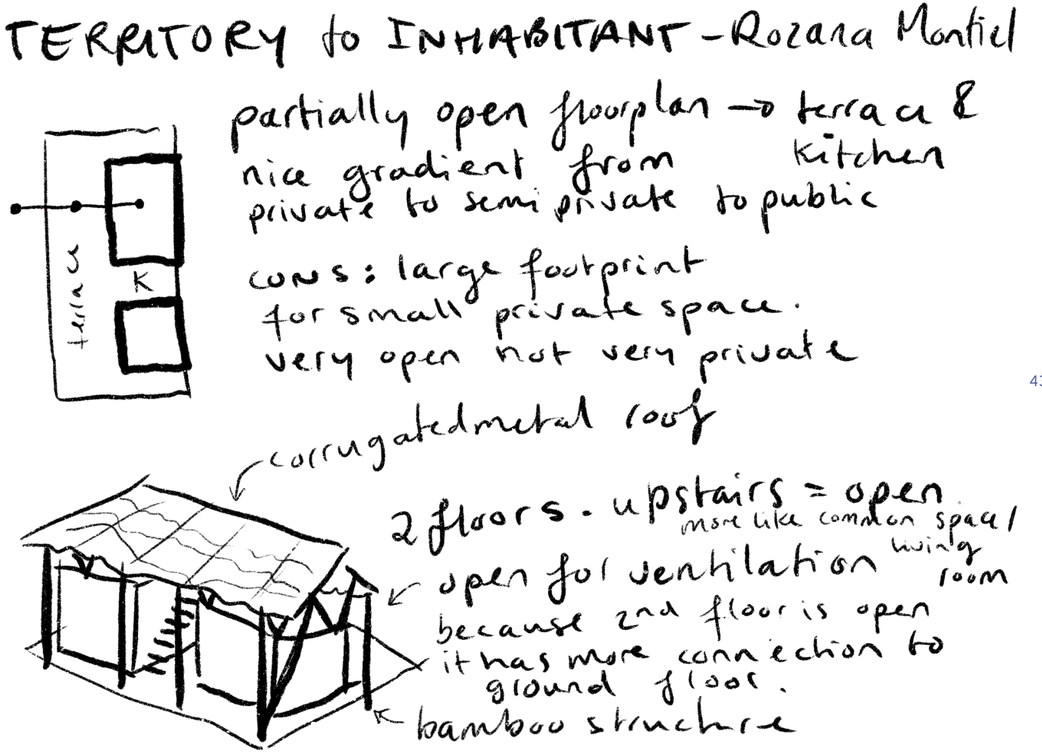


figure 26: analysis sketches and findings

"In warm climates space itself is the primary resource" - Charles Correa[84]

Correa talks about the hierarchy of spaces that make up a living space and environment. He mentions four different spaces in this hierarchy that can be interpreted as public, semi-public, semi-private and private spaces.[85] Public being the main square in a village or city, semi-public a communal courtyard, semi-private a veranda or garden, and private is the living quarters itself.

One very important aspect to these hierarchal spaces is that there is no one formula how much square meters you need for one or the other but it is essential that there is a right balance. A small house might be accompanied by a larger garden for example.[86]

What is nice about this project is that each plot is similar in size but there are different housing types ranging from small to larger houses. Each dwelling having their own plot makes it easy for them to change and expand their house over time. This incrementality creates a possibility for different income groups and family sizes to move in and grow.

figure 27: photo of the housing project c ArchDaily

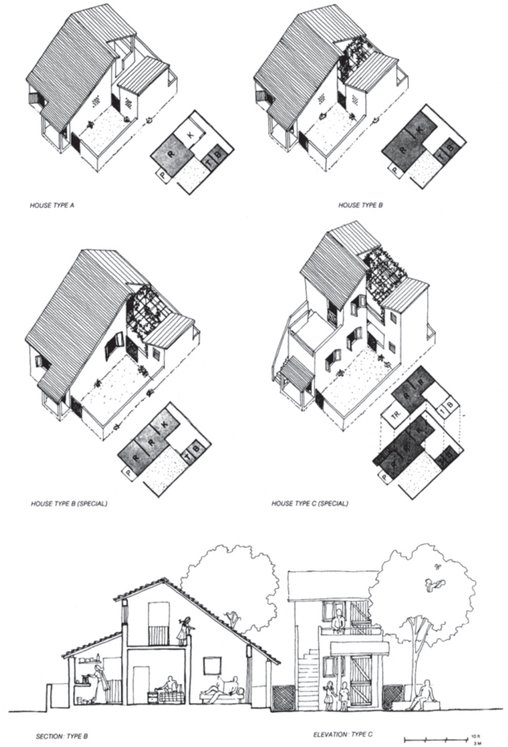
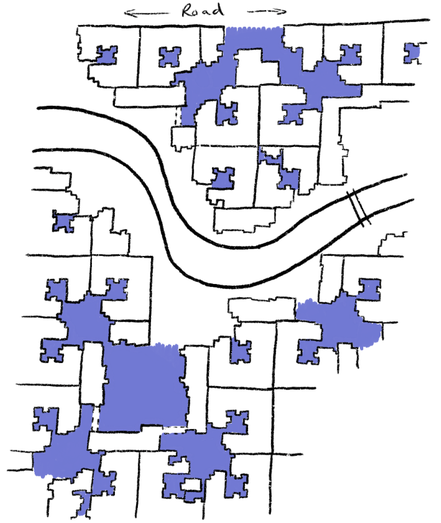


figure 28: diagram of the housing project c ArchDaily



+ low rise high density
+ different type of open spaces
+ courtyard clusters
+ different housing types in 1 cluster
- courtyard is the only acces point

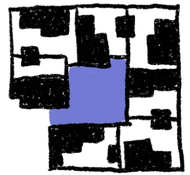


figure 29: analysis sketches and findings

The Meti school by Anna Heringer is a very nice example of building with earth and bamboo. This case study was mostly a material and climatic one.
Finding out how to connect bamboo together to form a solid main structure and figure out a way to connect the bamboo to a plinth without using cement or steel connections.
In this case they form the earth around the bamboo to create a stiff beam structure. They have the bamboo structure on the outside of the facade which is an interesting design choice. With the large overhanging roof the bamboo structure is protected from the rain and lasts longer.

Creating a thick earth wall creates thermal mass and cools down the building on the ground floor.
The upper structure is quite light and it has fabric as a second ceiling that acts as a barrier to capture the heat radiated from the CGI roof.

figure 30: title

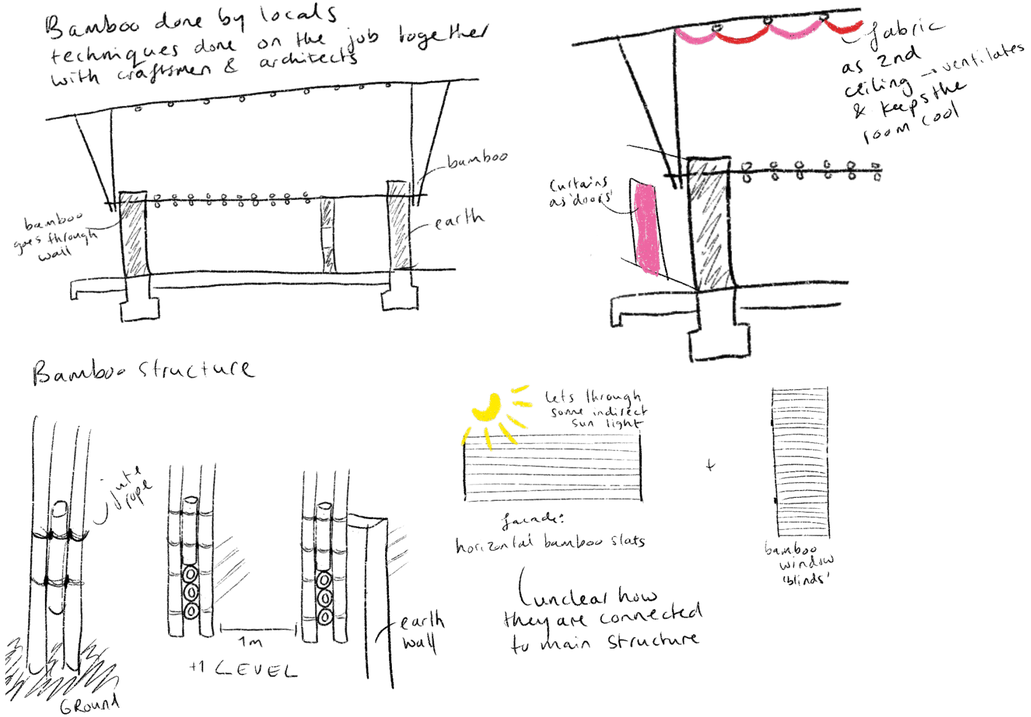


figure 31: analysis sketches and findings

4,000 euro spent for
Two houses (ground floor), a toilet, kitchen, wash area with tubewell, cow shade, storage, and a courtyard.
1288sq ft, 119.7 sq. mtrs

2000 euro per house

which is 33 euro's per square meter including the facilities mentioned above
The houses are only 14m2
The total built area is only about half of the 119m2 plot
So then it would be 66 euro's per built m2

A very rough calculation for the entire Haor 3 it would be 33x11329 = 375.000 euro's for the whole Masterplan.
A more accurate calculation will be made when the Masterplan is final.

MARINA

An earth brick, bamboo house would be around 1500-2000 taka per sq ft according to marina's look at Christelle's design.

With the global rule of thumb of a house being 5 times the yearly income this comes down to 1965-2535 euro's maximum for a house

Calculated this would be 136-181 euro's per m2
for my small house of 25m2 this would be 3400-4525 euro's
for my larger house of 47m2 this would be 6392-8507 euro's

figure 32: facade of the Bangla Bari house

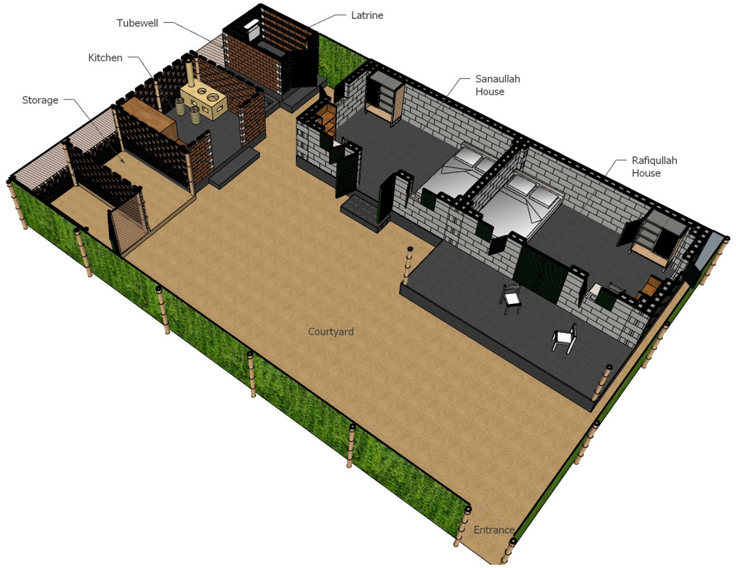


figure 33: 3D plan of the Bangla Bari house

Tanguar Haor

Spanning 9,727 hectares in the Sunamganj district, the Tanguar Haor sustains over 60,000 residents across 88 villages and houses various plant and animal species.

Most residents of the Haor region rely heavily on agriculture for their livelihoods. While the monsoon rains are generally beneficial to Haor farmers, excessively heavy rainfall can be detrimental.

Due to the large family sizes common in Haor communities, agriculture alone often fails to provide sufficient economic security. These families need greater access to non-agricultural income opportunities, such as tourism, handicrafts, agro-based farming, and transportation.

The size of these families also poses a significant barrier to children's education. Many families prefer their children to become skilled farmers at a young age rather than attending school, as farming provides a quicker—albeit smaller—economic return. For many impoverished families, immediate survival takes precedence over long-term planning.

Transportation issues further hinder school attendance. During the rainy season, hand-paddled boats are the only means of transportation and are prone to capsizing in the floodwaters, making parents reluctant to risk their children's safety for education.

Despite these challenges, all Haor villages have access to electricity, which has improved living conditions. Electricity supports agricultural innovation, enhances communication, and boosts education and business opportunities.[87]

Unfortunately, the ecosystem of the haor faces threats from plastic pollution, overfishing, deforestation, soil erosion, and unregulated extraction of natural resources.

Pollution from engine oil used by numerous recreational boats, including unregulated overnight houseboats, along with leaked sewage and discarded plastic waste, is contaminating the haor's water.
Although the recent rise in tourism at Tanguar Haor presents economic opportunities for the local population, it endangers the ecosystem due to insufficient regulation.
Villagers report that pollution from recreational boats, overnight houseboats, leaked sewage, and discarded plastic waste continues to affect the water quality.

At busy docks like Tekerghat, it was observed that boat operators were dumping plastic waste directly into the wetland without any oversight.
Some boat owners acknowledged that certain vessels lack proper sewage disposal systems, and that some boats often use disposable plastic utensils. This has also been witnessed during the field trip.

During high tide, plastic waste flood adjacent agricultural lands. This debris accumulates on the banks as the water recedes, impacting cultivation.[88]

figure 34: photo haor, by author

More than half of the population of the Tanguar Haor uses a hanging latrine which often means people directly defecate in the river, or they use a toilet on stilts which hangs above the water, either way the human waste ends up in the water because of the lack of sewage. In some cases people have a small toilet outhouse called a 'pit-latrine' however during floods the toilet cannot be used and the excrement also washes away with the water making the water pollution worse.

Three quarters of the people drink from shallow tube wells and almost twenty percent drink the water directly from the river. Because the human waste is also secreted in the river, polluting the surface water, drinking this water leads to disease like diarhoea, fevers, colds and in some cases even cholera.[89]

figure 35: photo of woman washing, by author

figure 36: photo of hanging latrines[90]

The average household size is around 6 people, but there are smaller families and even families with up to 12 people.

Most households earn their money from farming or fishing. The income in Tahirpur is below 5.000 taka per month, which is very low and classifying them in the category 'poor' in terms of livelyhood status.

There are not very many people older than 60, which could relate back to the pollution and health issues the people in the Haor face.

Table 7. Classification of household expenditure (IUCN et al., 2008).

Head of expenditure	Percent of household	Annual expenditure (BDT)	Percent of total income
Clothing	99.1	4641	10
Education	50.9	6931	15
Health	96.0	7080	15
Lighting	5.6	6279	13
Fuel	85.0	2933	6
Transportation	85.0	6058	13
Recreation	20.6	3278	7
Total	100	37,201	80

figure 37: Household expenditure[92]

				Tahirpur		Jamalganj	
Subcomponents	**Unit**	**Maximum**	**Minimum**	**AV**	**SV**	**AV**	**SV**
Ratio of uneducated to educated people	Ratio	5	0	1.106	0.221	1.083	0.217
Percentage of female headed households	%	100	0	12.500	0.125	5.000	0.050
Percentage of female educated persons	%	100	0	25.000	0.250	25.250	0.253
Percentage of households where head of the households completed primary school	%	100	0	52.500	0.525	35.000	0.350
Ratio of independent members to dependent members	Ratio	5	0	0.507	0.101	0.550	0.110
Percentage of households with family members working in different communities	%	100	0	40.000	0.400	25.000	0.250
Average number of earning members		4	1	1.375	0.125	1.500	0.167
Average agricultural livelihood diversity index		1	0.2	0.265	0.081	0.281	0.101
Percentage of households of which income per month is below 5,000 or $60	%	100	0	15.000	0.150	2.500	0.025
Percentage of households whose secondary occupation is fishing	%	100	0	87.500	0.875	92.500	0.925
Percentage of households do not receive any warning about flood before it occurred	%	100	0	5.000	0.050	2.500	0.025
Average number of livestock they own		57	0	2.200	0.039	4.875	0.086
Average item of livestock they own		3	0	0.975	0.325	0.925	0.308
Percentage of households dependent solely on agricultural land for food	%	100	0	82.500	0.825	80.000	0.800

figure 38: Statistics Tahirpur including income[91]

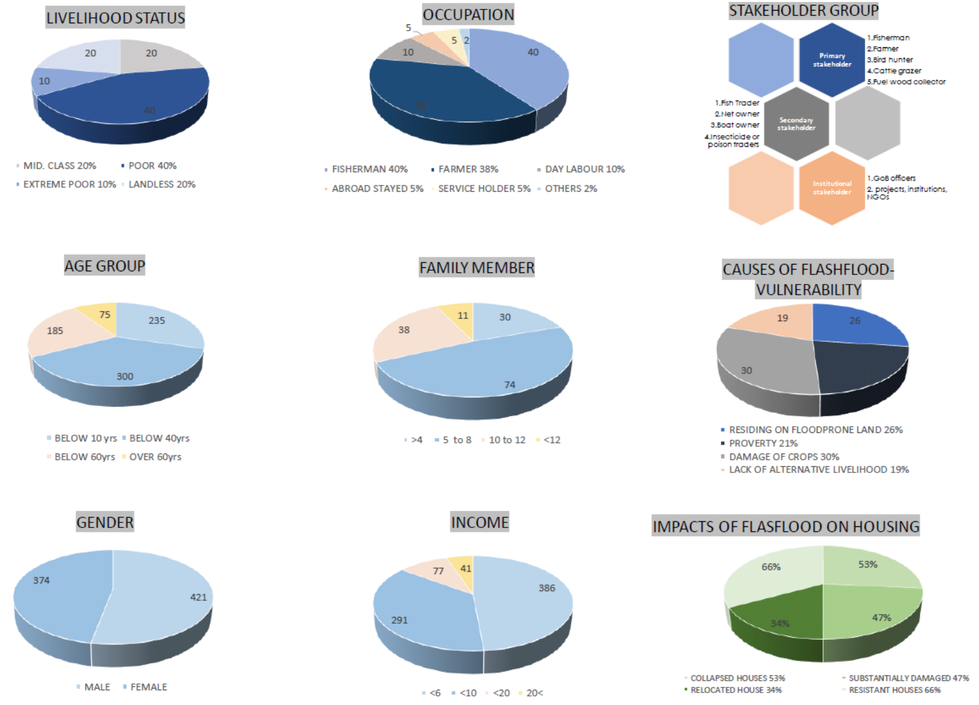


figure 39: social infrastructure Haor c Afsary Toma

people of the haor, photo´s by Nynke Keulen

figure 40: a collage of the existing settlement, by Author

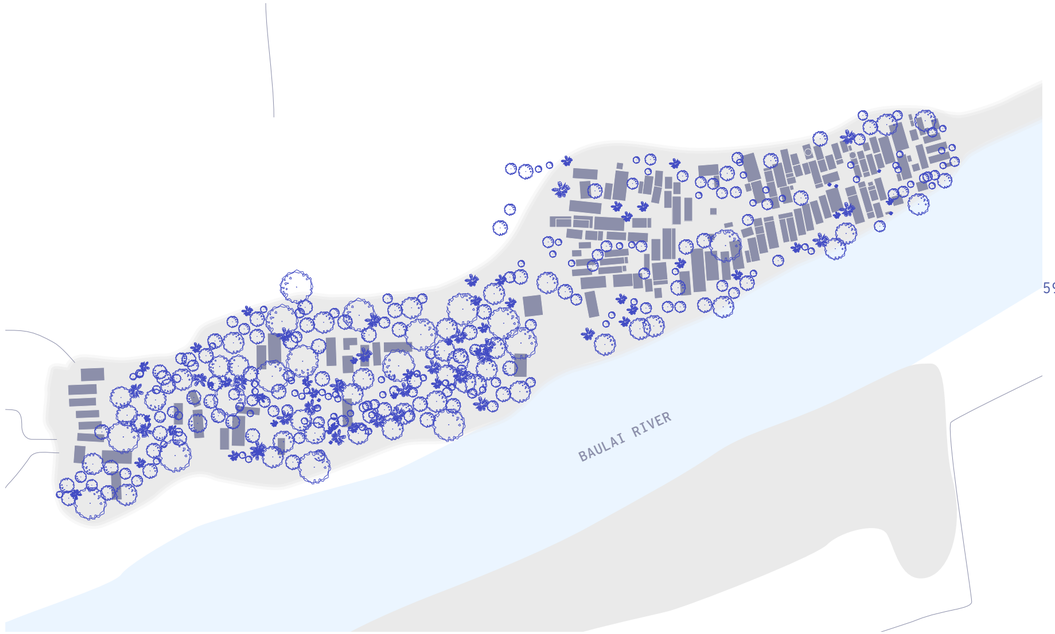


figure 41: a plan of the existing settlement, site 3 on the right side

The site analysis consisted of mapping site 3 by looking at google maps, to see where all the existing houses were and going through video footage from the field trip to see if the data matched.

After the mapping was done I counted the houses which ended up being around 100. Knowing that the average household size is around 5-6 people I could deduce that this settlement has around 500-600 people living in it.

With a rough landmass of 1.13 ha the density comes down to:
GSI: 0,37
FSI: 0,37

GSI and FSI being the same because all of the houses only have one floor except 1, the Khudi Bari.

figure 42: photo of a family, by Nynke Keulen

figure 43: existing site

When the location of all the houses were mapped, I went in to map all the trees through google earth.
Then I went back into the video from the field trip to decide the quality of housing and which houses could be preserved. Unfortunately most of the houses were in the same state as seen on this page: rusted CGI sheets.
The houses I decided to keep were the houses made from brick and plaster, and the Khudi Bari.
The buildings that were included in this were the Mosque and also the school.

Another aspect that should be kept is the main pathway which is made of concrete.

figure 44: photo of the main street on site 3 © Author

figure 45: existing site documentation, in red the buildings that should be preserved

The settlement has a lot of weaknesses, which makes sense because of the annual flooding and also the socio economic standing of most of the Haor's residents.

In terms of flood damage the embankment and the plinth and foundation of the houses are the most affected.
The embankment edge condition bearing the brunt of the flooding impact.
The foundation of the houses being made of mud makes it very easy for the floodwater to wash away the edges, this means that the foundation needs to be reapplied with mud after each monsoon season.
Then the entire house is made up of Corrugated Galvanised Iron, which will rust when it is exposed to water for a prolonged amount of time, this is seen in the plinth of most houses.

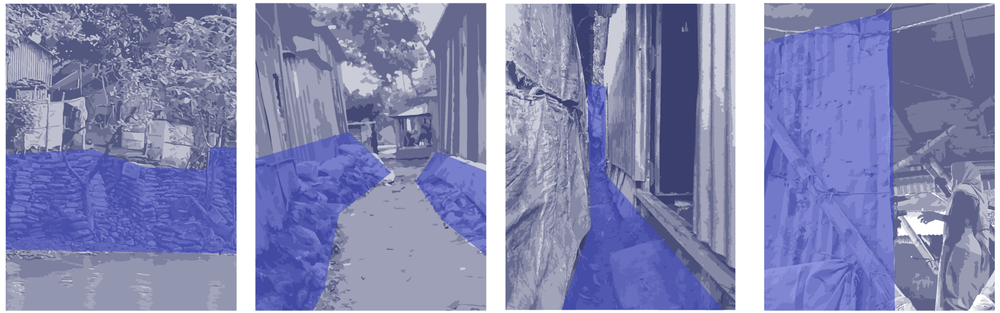
Because of the socio economic conditions the CGI sheets are also the cheapest available or even reused, which makes them even more vulnerable to the climatic conditions.

Then in terms of the urban environment of the settlement, the main pathway is quite small, so it is only accessible for pedestrians, but the narrow alleys that connect the houses to the main circulation route is so tight it's hard for an adult to fit through without walking sideways.

Since a lot of the activities and living happen outdoors these narrow alleys definitely don't add to the living conditions of the residents.

As mentioned before, pollution is also a factor in the Haor, plastic waste not only being washed ashore, but also discarded in these narrow alleys.

figure 46: trash at site 3



fragile embankment | damaged plinth | narrow alleys | damaged materials

figure 47: weaknesses settlement

plastic waste tourists

plastic waste being burned

plastic waste scattered through the site

deteriorated materials

Aside from the weaknesses the current settlement also has strengths. The main strenght is definitely the open spaces, the courtyards scattered throughout the settlement, and also the main circulation route that goes from one end of the settlement to the other.

There are a few brick and plaster houses scattered throughout the settlement which are more sturdy and flood resistand aside from offering a better living condition.

There is a mosque and a school, and a few shops where the residents can buy snacks.

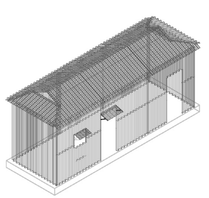
figure 48: photo of main street and shop

figure 49: strengths settlement

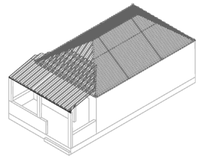
Since all of the houses are built by the residents themselves, it is quite hard to determine a standard typology of houses.
From several sources it does seem that most houses are narrow and long, the spaces being divided by thin walls, often without doors. And most of the rooms will have a bed to maximise the amount of people that can live in one house.
The kitchen will either be in the front or back of the house, generally consisting of a small storage area and a Chula, which is a clay fire stove.

All possible area's where one can hang objects or clothing are used.

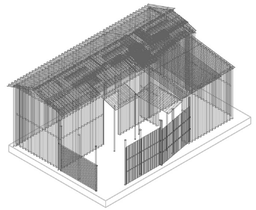
figure 50: photo of a living space, by Nynke Keulen



CGI house



stone house with veranda



CGI house - extended

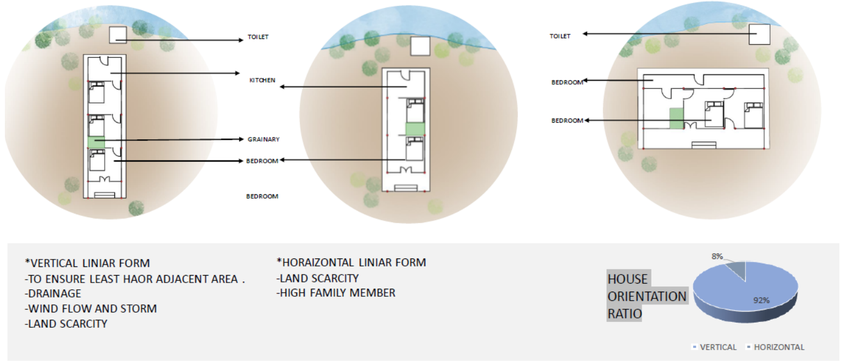


figure 51: existing house typologies c Afsary Toma

The haor is a wetland which means that for over half the year the land is under water. Which would make one think that there is no problem with clean water, whether for drinking or other uses. However clean drinking water is a big issue, especially in dry season.[93]
Even in the wet season, however, clean water is not widely available. Most people use the water from the Haor for all of their daily needs, which sometimes includes drinking. As you can imagine this often leads to disease. [94]

A solution of the past were ponds within the community to store water, however these ponds were not looked after and soon dissappeared from the landscape.
Another source of clean water are deep tube wells which are widely used throughout bangladesh, the Tanguar Haor, however, has around ten percent less access to these tube wells.[95]

Tubewells that are widely used around Bangladesh are shallow tube-wells, however they are unsafe for drinking because about a fourth of these shallow tube wells are contaminated with arsenic, the levels exceeding the national standard.
Arsenic in water poses a significant public health hazard due to its inorganic form, which is more toxic than the organically bound arsenic found in most foods. High concentrations of arsenic in groundwater are a global issue, with Bangladesh being one of the most affected countries.

Chronic exposure to arsenic commonly leads to symptoms such as melanosis, keratosis, gangrene, peripheral vascular disorders, skin cancer, and various internal cancers.[96]
The safest water sources for drinking water when looking at arsenic contamination and disease are rainwater, followed by a deep tubewell.[97]

figure 52: people bathing in the haor river, c Nynke Keulen

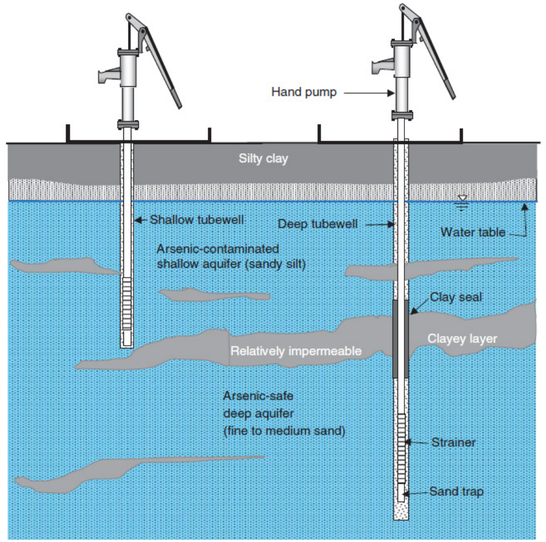


Figure 3 Manually operated deep and shallow tubewells in Bangladesh.

figure 53: shallow well pump versus deep well pump

Dry toilets or composting toilets employ a biological method to decompose waste into nutrient-rich compost, which can be used as plant fertilizer.

Benefits of Using a Dry Toilet:
Environmentally Friendly: These toilets conserve water as they do not require flushing. They also generate less wastewater, alleviating the pressure on wastewater treatment systems. Cost-Effective: In regions where water is scarce, dry toilets are often more economical than traditional flush toilets. Compact: Their smaller size compared to flush toilets makes dry toilets suitable for limited spaces. Easy to Maintain: Generally low-maintenance, dry toilets do not need chemicals or electricity to operate.

How Composting Toilets Work:
Composting toilets convert waste into compost through a biological process. This begins with a layer of carbon-rich material, such as sawdust or wood chips, placed at the bottom of the toilet. As waste is added, it mixes with this material, promoting the activity of microorganisms that break down the waste. The resulting compost can then be used to enrich soil for plants.[98]

There are also several possibilities for a floating toilet. This would be great in area's where it floods regularly. Mohammad Talut thought of one design for the haor's in Bangladesh.

The idea is that nyone can construct it using three to five empty fuel barrels, a plastic sanitary pan, bamboo, rope, and some polythene sheets or cloth for shade.

To create the toilets, three barrels are aligned horizontally. Two barrels serve as the platform or floor, while the middle one functions as the waste reservoir, modified to fit a gooseneck plastic pan.

In the dry season, the latrine sits on the ground, but during the monsoon, it floats. The gooseneck plastic cover ensures that waste remains contained within the barrel. A 200-liter barrel can hold up to 160 liters of waste before it needs to be emptied into a reservoir, which can then be used to produce fertilizer. According to Talut's estimates, a three-member family can use this latrine for up to a month before it requires emptying. Due to the durable nature of the materials, such a latrine can last for four to five years.

The total cost of this floating latrine is approximately BDT 3,000 (around USD 40), significantly cheaper than conventional toilets, which are ten times more expensive. Talut got the idea when he noticed a large number of empty barrels at the administration headquarters.[99]

The downside and reason this latrine design has not been implemented in my masterplan, is that it needs significantly more space than was available on Site 3 if I were to give every household their own toilet. And it would still be an outhouse. Having a toilet on the second floor where it is safe from the floods all year round and also easily accessible seemed to be a better option.

Using the dry toilet it wouldn't need sewage or running water, and the compost can be used as fertiliser for their gardens.

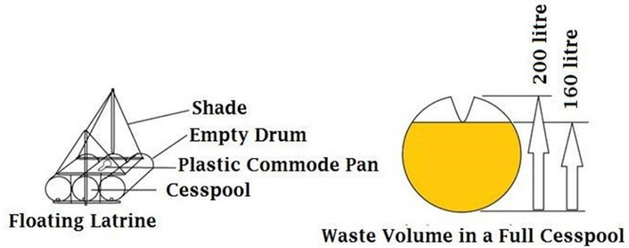


figure 54: Mohammad Talut's floating toilet design.

figure 55: example of a dry toilet

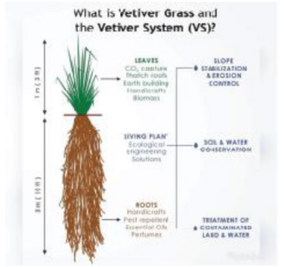
The embankment mostly needs strengthening of top soil which gets washed away by the river and floods.
To strengthen the top soil a combination of things can be used. Trees which take root in the embankment and strengthen the soil.

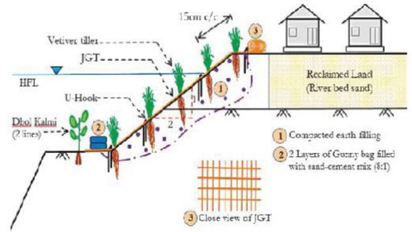
Vetiver, which also has very long and strong roots which will protect the top soil. And a surface of geo jute can be used to keep everything in place while the vetiver settles and grows, this jute naturally deteriorates over time.[100]
Vetiver doesn't just strengthen soil but it also serves to deter pests and weeds and can be used for animal feed.[101]

Another plant that can be used to cut the waves hitting the embankment is Ipomoea aquatica or otherwise known as Water Morning Glory. Not only would it protect the embankment, the plant also has water purifying qualities[102] which would in turn make the water safer for use and create a healthier ecosystem.

figure 56: water morning glory Tanguar Haor c Author

Vetiver grass has been selected for its inherent special attributes and easy availability throughout the country
It will survive complete submergence in water for up to 3 months.





Bamboo crib

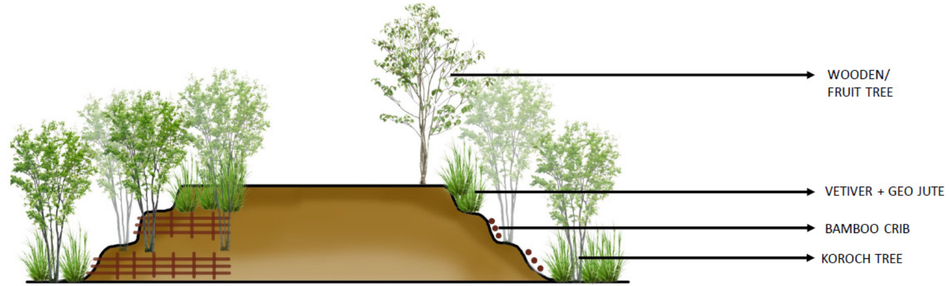


figure 57: site protection strategy c Afsary Toma

To determine which materials should be used in the final design I first researched which materials were most common and available in Bangladesh.
These materials are: CGI, brick, concrete, bamboo, mud and wood.
After determining these I created a material matrix, on one side the different uses within the building: foundation, plinth, wall, structure and roof.
and on the other side the deciding factors: durability, affordability, maintenance, skillset needed, reusability or recyclability, the environmental impact in terms of CO2 and water resistance.

Seeing as a lot of these factors either overlap or are dependent on each other the final result depends on my own criteria as well.
For example durability and affordability go hand in hand, brick might be more expensive and is bad for the environment but it lasts very long, so it is an investment. On the other hand, bamboo is very affordable but has a significantly shorter lifespan, but that is alright because the environmental impact is below zero (meaning it actually absorbs CO2) and grows so quick it is easy to replace when necessary.

To make all these factors a little easier to grasp I've condensed all the factors into: durability, affordability, environmental impact and water resistance.

The main outcome for the building elements are: brick foundation and plinth, brick and bamboo main structure, bamboo walls and CGI roof.

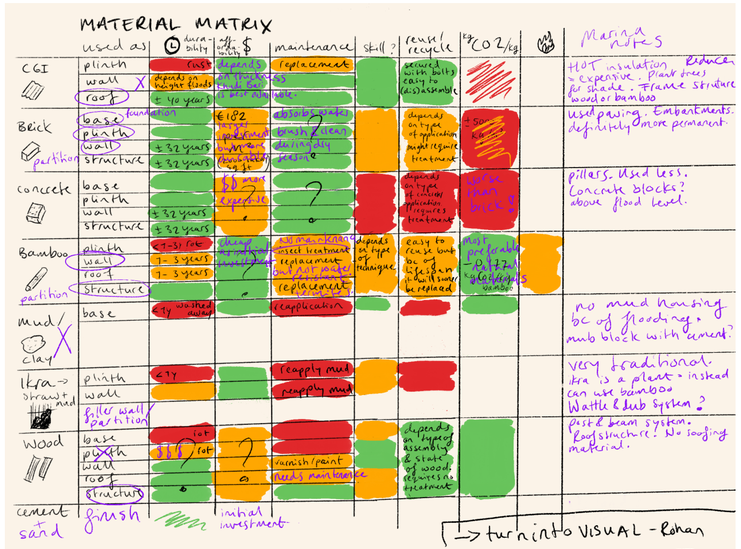


figure 58: material matrix research

figure 59: material matrix conclusion

Bamboo is a locally available and readily used building material. It is a very strong material with similar strength as metal.

It is a very sustainable building material because it is a natural product and it does not take long to grow, it even has a lower than zero

It does need to be treated against insects and the durability of the material in water is not long even when treated.
So this material will be used as replaceable facade panels and structure that is protected from the rain, to make the lifespan longer. The lifespan of bamboo is around 1 to 3 years, depending on the conditions.

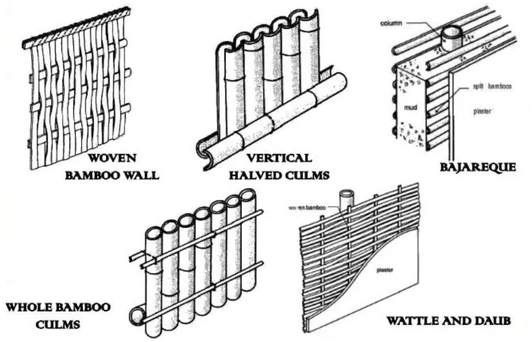


figure 60: bamboo joining technique: Mortise and tenon[104]

figure 61: bamboo joining technique: lashing[103]

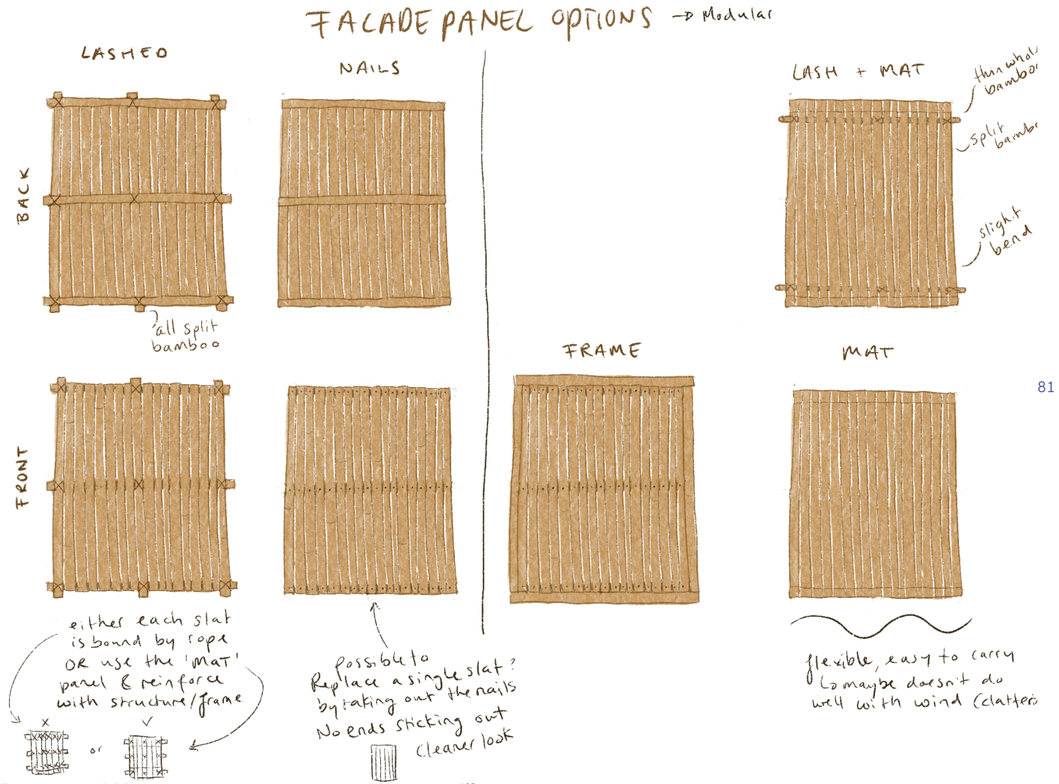


figure 62: different bamboo wall construction types[105]

Bamboo Structure + reused wood

Bamboo is both grown locally as bought at a nearby market in Badaghat

The wood will be reused from the houses that are taken down

Bamboo + Hay facade panels

Bamboo is both grown locally as bought at a nearby market in Badaghat

The rice hay is already dried locally after harvest

Bamboo Lifecycle
The bamboo from the old settlement will be reused for the facade panels, since the facade panels have the shortest lifespan. When these deteriorate they will be used as fibre for the compostable toilets.
This compost will be used as fertiliser in people's private gardens but also for the new bamboo to grow. It could even be used or sold to farmers or other people outside of the settlement and create income generation.
This new bamboo will then be used if a new structure is needed or parts need to be replaced. The old bamboo that isn't viable as a structural element anymore can then be reused for the facade panels, and so the circle begins again.

rice hay

bamboo facade

wood structure

bamboo structure

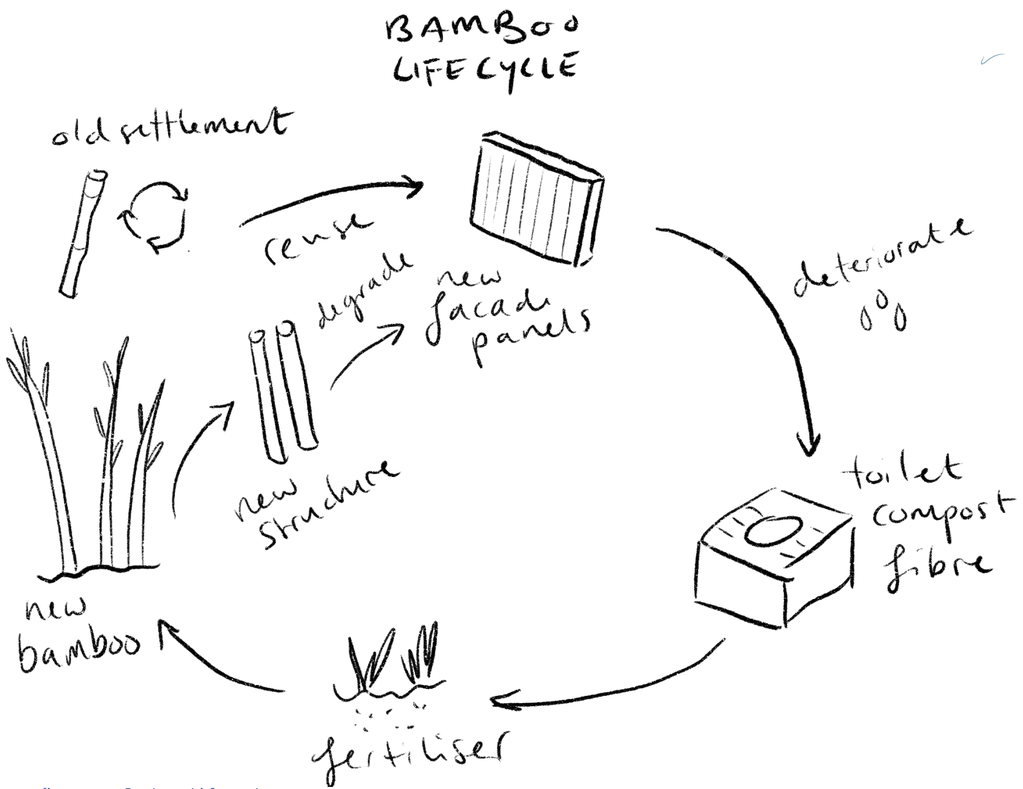
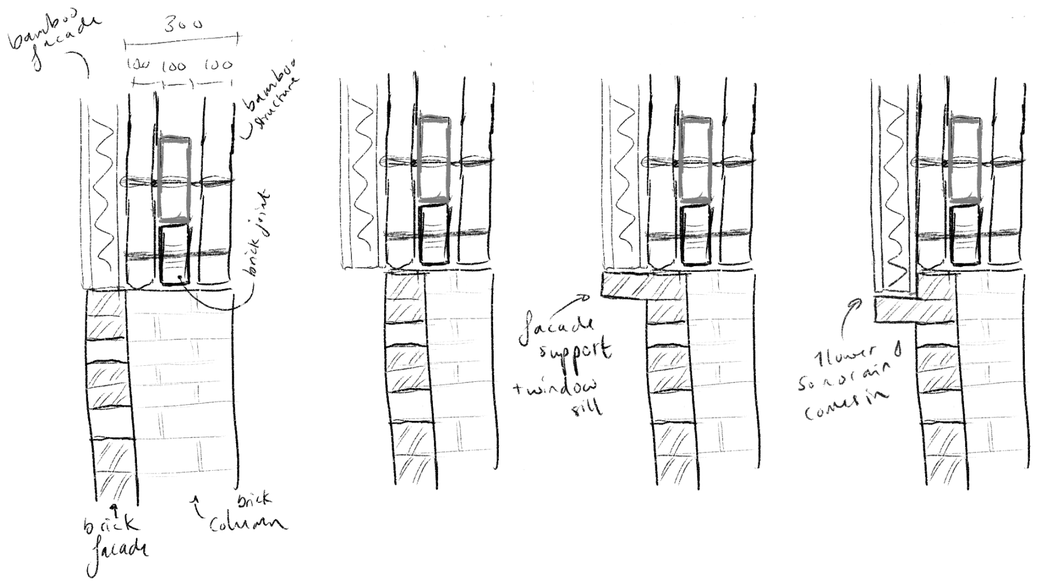


figure x: Bamboo lifecycle

The choice to use brick is because it is a large industry in Bangladesh so it is locally available. Plus as concluded from the material matrix, brick was the best option for a plinth that is often flooded.

Fired brick is ofcourse not great for the environment, which is why the use of brick is limited to only the foundation and plinth. To reduce the use of brick even more I've implemented a column structure and the walls of the plinth are only decorative not structural, which means they can be one singular row instead of the standard of two brick rows.
Then the foundation is only brick casting (with the columns also extending to the foundation) and filled with earth.

figure 63: workers at a brick kiln c Aljazeera



too wide
takes away space
in floorplan

figure 64: sketches of brick columns

Earth brick or sundried brick was discussed as an option as well however the water resistant properties were not as well known as the standard fired brick. Options to make the earth brick water resistant included cow dung, or other options were to mix the earth brick with a small amount of cement. However these options were not tested in similar conditions of the Haor where the houses can be under water for up to 2 weeks at a time.

figure 65: brick jali inspiration

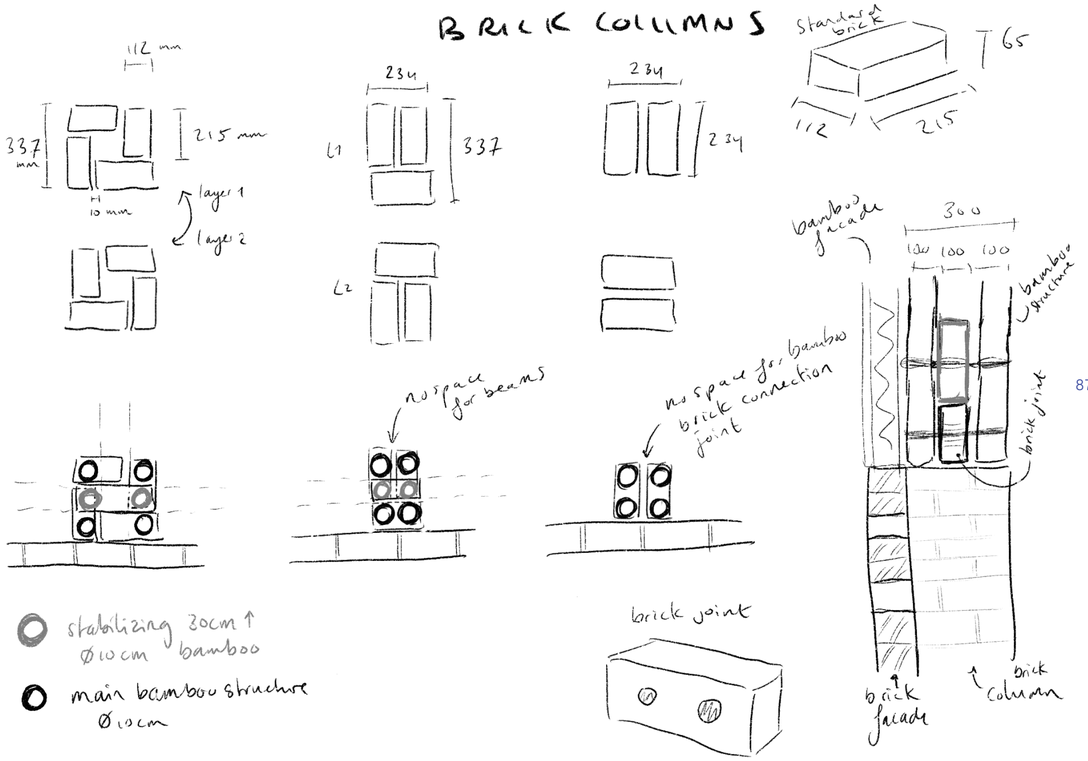


figure 66: sketches of brick columns

The cost of a house quite difficult to determine. In the 'case study' chapter I've analysed a home that uses similar materials which is also located in Bangladesh. This house comes down to around $2000. However I wanted to go into a little more detail how much my design would cost taking into account the materials, since some of them are reused like the roof.
Finding costs of materials is quite difficult but I have used the graduation project of the Harvard University '$2000 home: Cocreating in the Bengal Delta' to determine the cost per square metre.

This estimate was still in the earlier stages of the project so the cost might be slightly different for the end result. The most important part was that the final cost was below the global rule of thumb of the cost of housing. This is 5 times the annual pay of the homeowner.

The maximum pay in Tahirpur is $60 a month which adds up to $720 a year. With the rule of thumb this means a house can cost a maximum of $3600, which is already on the higher side if you compare it to the Khudi Bari by MTA which only costs $400.

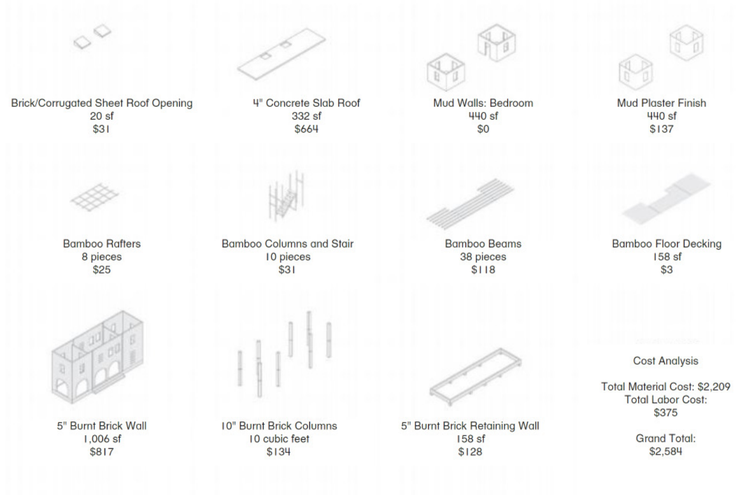


figure 67: material costs, from $2000 dollar home[106]

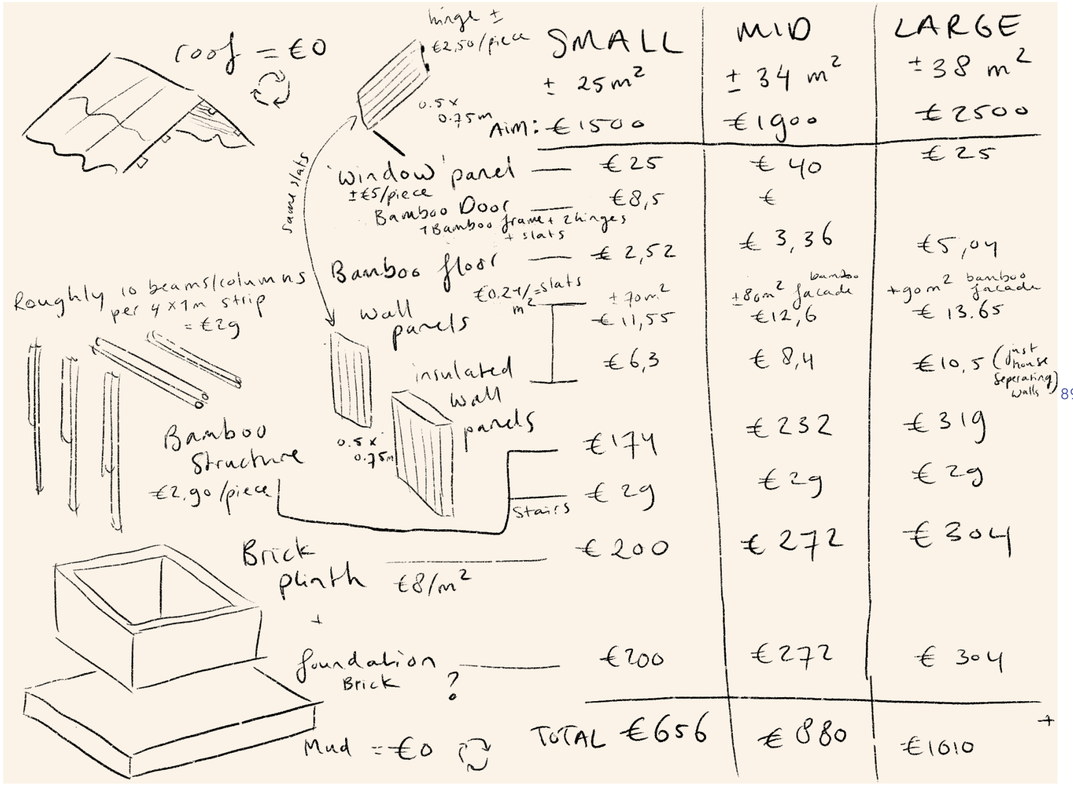


figure 68: cost of materials

The initial idea was to recycle plastic waste into building materials. However since the plastic waste in the Haor is significantly lower than that in the cities this wasn't really possible without importing plastic waste from the cities.
Furthermore the BT tutor reminded me to look at the R-strategies. Recycling is lower on the 'ladder' than reusing, since it takes more energy to recycle a product.

This lead me to re-think how waste can play a role in the design. Since I am building on an existing site, the previous building materials would go to waste. So to minimise the waste I've decided to re-use as much as possible from the old settlement.

The majority of the material consists of CGI sheets, of which a lot are rusted, but some are definitely still viable to use as roofing.
To attach the CGI to the bamboo main structure I'm reusing the wood, since drilling into bamboo lessens the structural integrity.

The bamboo in the current settlement will be reused as facade panels, cow sheds and fencing.

Rice and cement bags will be used as door panels, in a bamboo frame.

The plastic waste that is present will be upcycled into objects like bags which in turn can be sold to provide income generation.

There are some concrete columns, but not enough to be used in the housing design. So these will be used to create semi permanent market stalls. on the square.

Then since the toilet is compostable any and all bio-based materials, like bamboo and food scraps can be used to make fertiliser, which in turn can be used in the gardens, or to grow more bamboo.

To minimise the waste, most trees will be kept. The design is therefore mostly designed around the trees. The trees that will have to be taken down will then be reused in the design.

The existing waste management infrastructure in urban areas like Dhaka is typically organised at the municipal level, with a significant reliance on volunteer efforts or community-driven initiatives. Various waste collection methods are employed, including community-based collection, which involves volunteers from the local community conducting door-to-door waste collection services, usually funded by the households. The collected waste is subsequently transported to a transfer station, before its final disposal in landfills.

In addition to this, there exists a sector of informal waste collectors who gather waste from the streets, with a primary emphasis on recyclable materials such as plastics, paper, and glass, which hold economic value. These informal collectors receive compensation from private sectors involved in the recycling of these materials.[107]

Water pollution is a significant threat to the health of the Tanguar Haor ecosystem. The use of agrochemicals, particularly in rice fields, negatively impacts aquatic life. Additionally, human waste is a major pollutant due to the scarcity of sanitary latrines, and solid household waste is frequently disposed of directly into the haor. With a local population of approximately 60,000, this pollution degrades water quality, contributes to eutrophication, and raises coliform bacteria levels.[108]

figure 69: upcycling projects

figure 70: waste sorting

CURRENT CONTEXT OF POST-CONSUMER PLASTIC WASTE

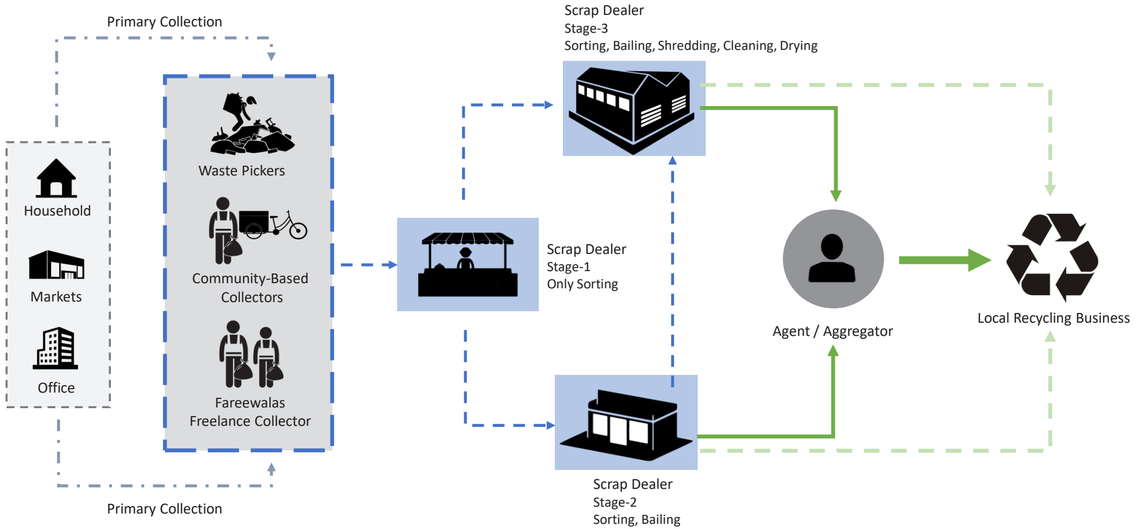
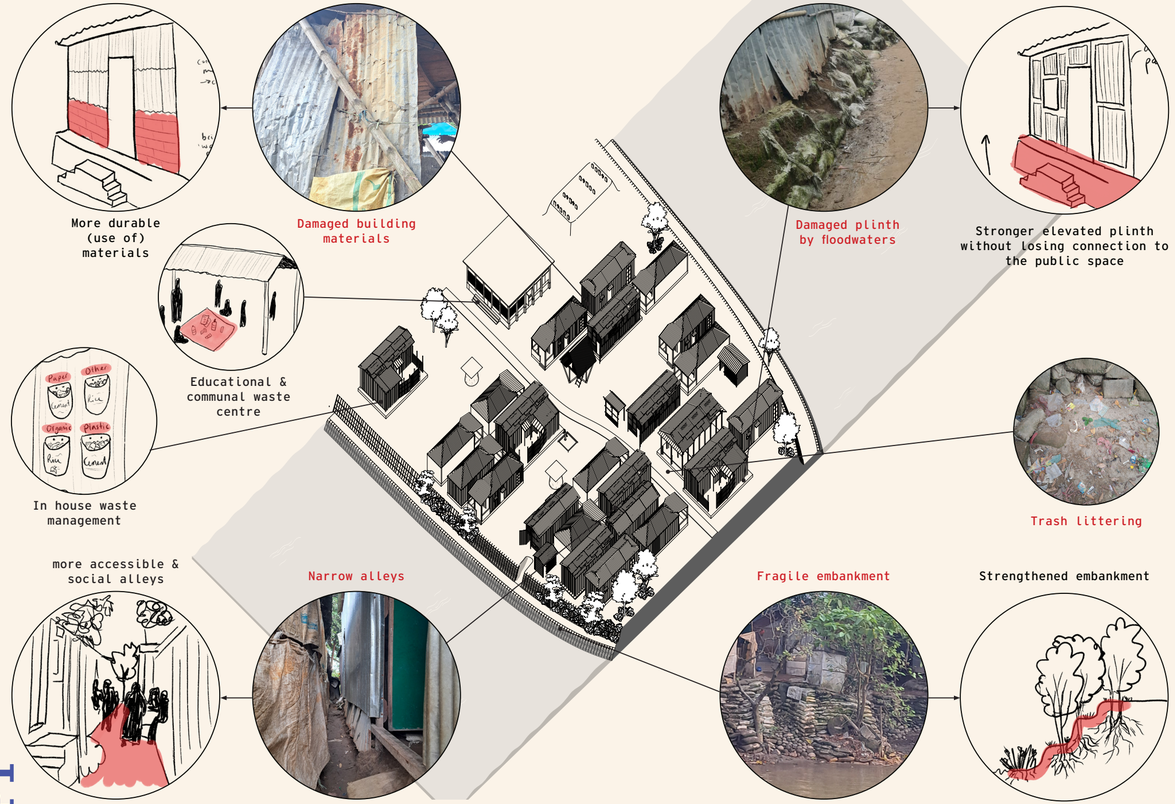


figure 71: the current plastic waste system in the city, by GarbageMan

Design Process

P1
P2
P3



Waste not

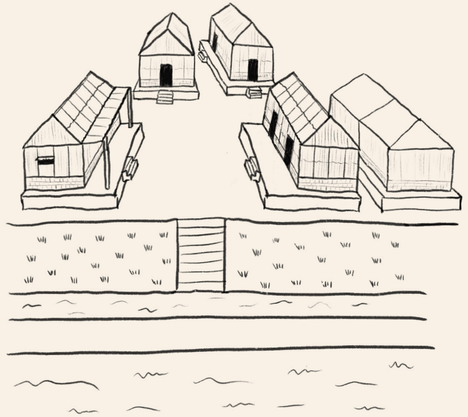
Ginger Hanssens | 4438337

How can sustainable housing be built for the people of the Tanguar Haor that can withstand annual flooding and subsequently create a solution for the waste pollution?

To find a solution for the current issues it is important to look at the existing structure of the haor and the ways people live within the settlement. A very important aspect is the connection to the public space. A lot of the living and activities happen outside rather than inside, and when it is inside it is on the ground floor. So the connection between the houses and the streets and courtyards need to stay in place. Another important aspect is the low income of most of the families, they upgrade their houses step by step, once it is economically viable for them. Then the use and connection to the water is a big part of their daily lives, used for washing, cleaning and drinking, so this connection needs to stay but the different uses may need different sources.

The design hypothesis that is proposed then also takes these factors into account by creating a demonstrative settlement structure which can be applied through phases to the rest of the settlement.
This prototype settlement will showcase different ways to upgrade the current housing. It will be flexible by having one size plot which can accommodate different household sizes or even multiple houses on one plot. This gives the chance for the houses to change according to the needs of the changing household. The houses will be modular and easy to build for the residents themselves.

In terms of waste management this will be done on two scales, both within the household and on a communal scale. The focus will lie on educating the people on different strategies to reuse or recycle certain waste materials and thus keeping the soil, water and air clean.



BottomUP Phasing

4. Modular wall & roof panels

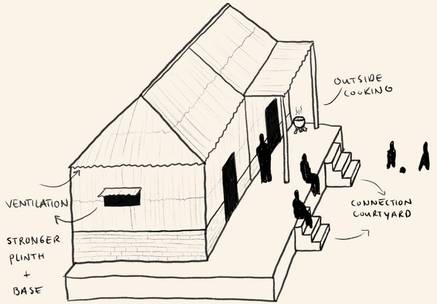
3. Stronger plinth material

2. Stronger base/plot

1. Strengthened embankment

- Clean water

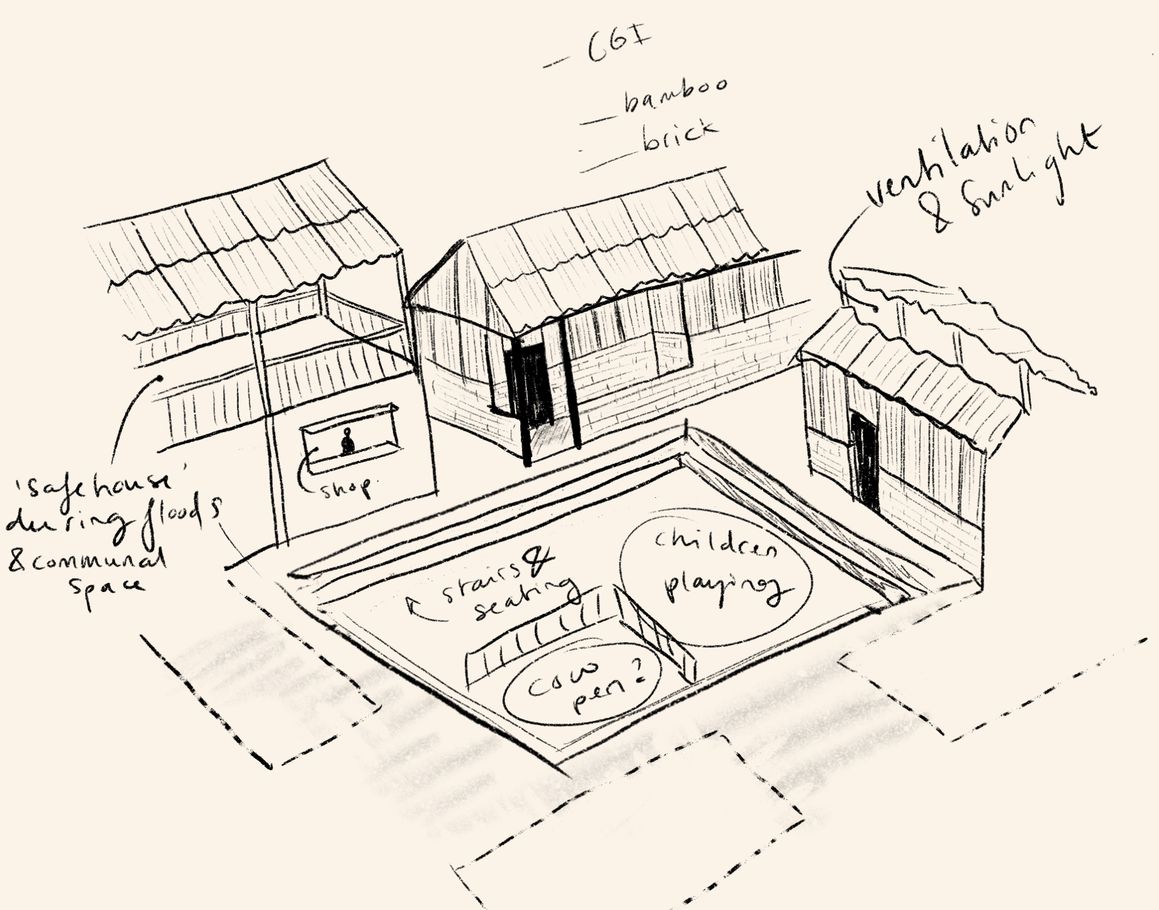
- Second embankment



Prototype

Possible variables within the plot to accomodate changing households


public
semi private
semi public
clean water pond
filtered &or rain water

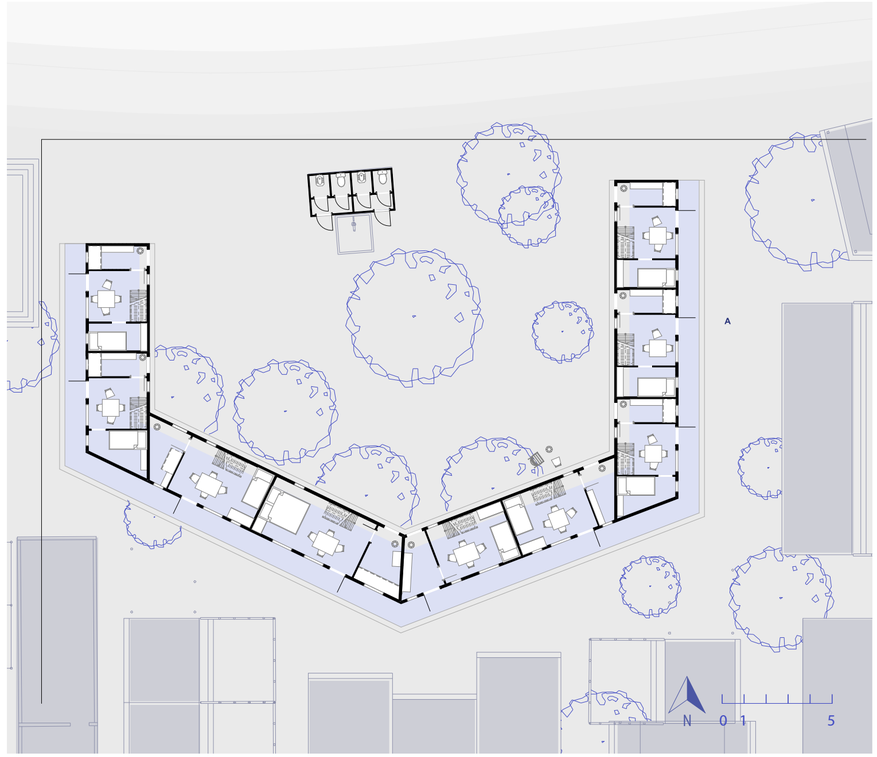

- CGI
- bamboo
- brick
ventilation & sunlight
'safehouse' during floods & communal space
shop
stairs & seating
children playing
cow pen?

U-Courtyard:
56 houses | 336+ people

Solo's
Garden: 47 houses | 141+ people
single veranda: 29 houses | 203+ people
double veranda: 17 houses | 85+ people

Existing:
Stone: 5 houses | 30+ people
Khudi Bari:
3 houses | 6+ people

total
157 houses
801+ people

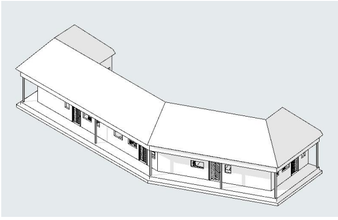


Clustering
Type U-Courtyard

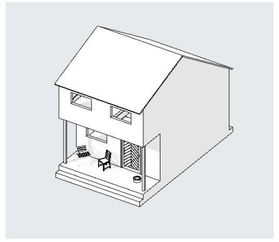
Types: straight + diagonal

straight:
3 houses | 12+ people
diagonal:
6 houses | 24-36+ people

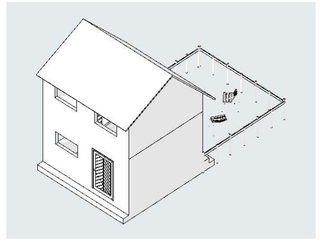
total in masterplan
8 clusters varying in size
6-9 households per cluster
56 houses | 336+ people



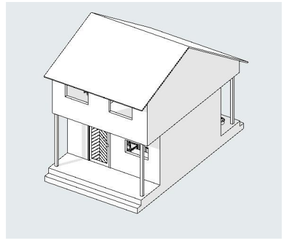
section north to south 1:400



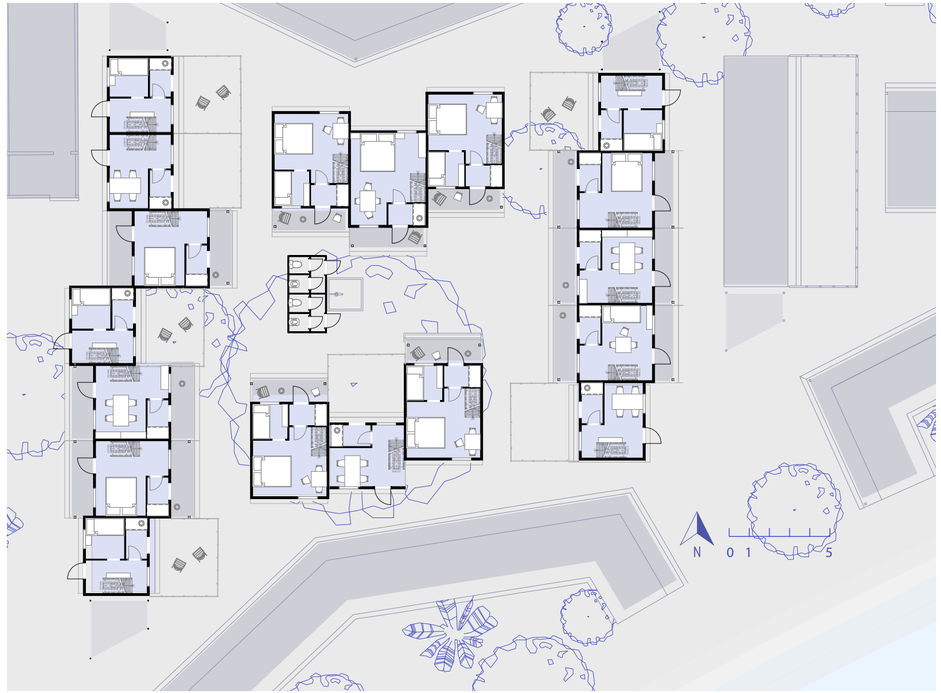
single veranda



garden



double veranda



Clustering Courtyard

Types:
garden + single veranda + double veranda

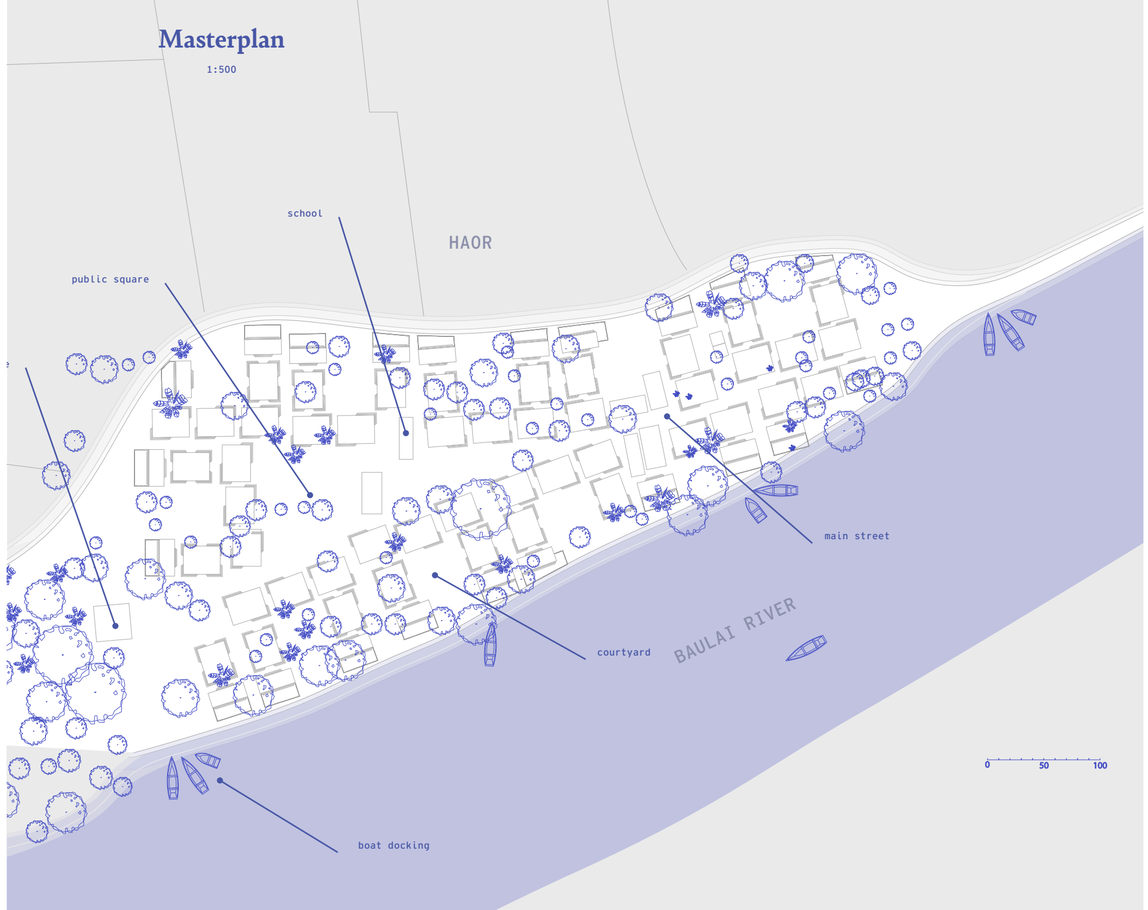
garden:
7 houses | 21+ people
single veranda:
5 houses | 35+ people
double veranda:
6 houses | 30+ people

total
18 houses | 86+ people

subtitle

Masterplan

1:500



Cluster

1:100

section 1:400

Veranda

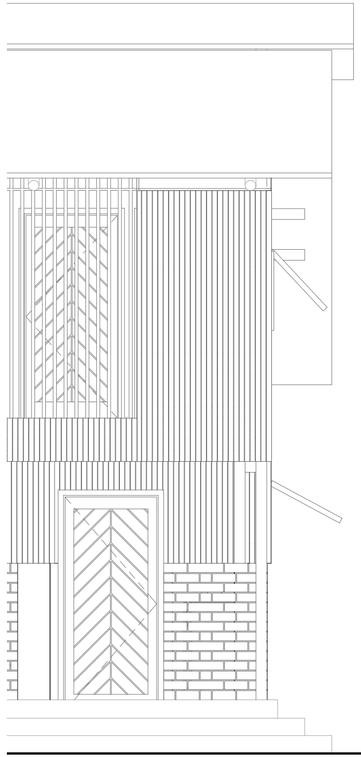
Shop

Courtyard

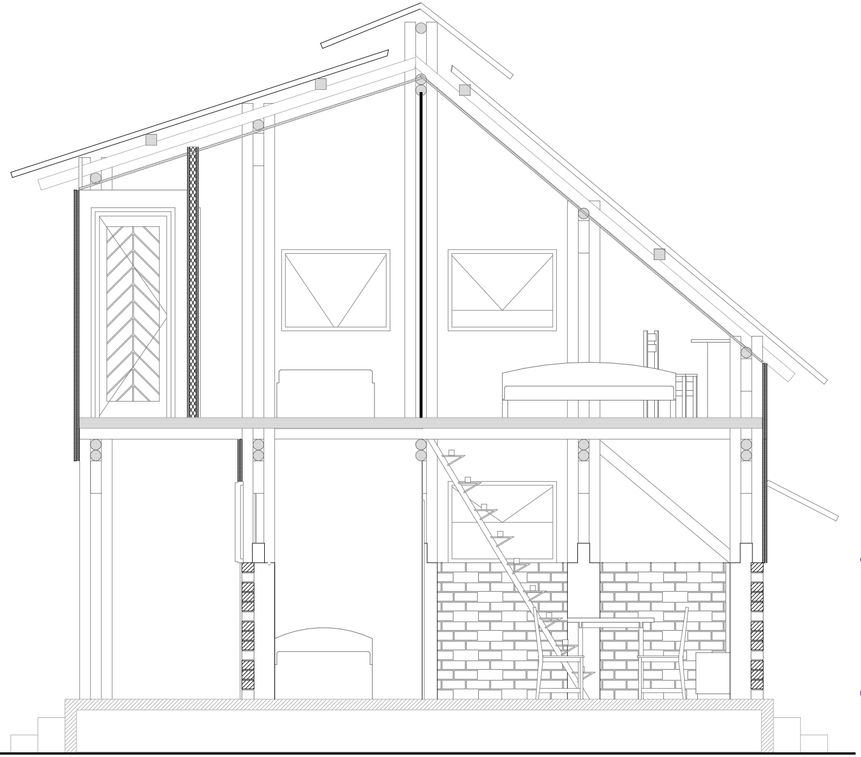
1:200

0 1 5

Facade



Section



facade and building section 1:40

1:20

Designing is an ever changing process. Creating draft designs, getting feedback, changing the design, getting new information, changing the design, and so on.
In the sketches there is a very simplified diagrams of certain design decisions specifically focused on the cluster design. How does one create a courtyard cluster? What is the space used for, when is it too small and when is it too big. How do the houses form the courtyard. Should the houses be seperate or together. How do you create flexibility within the cluster to build around the existing trees and change with the embankment?

These were some of the design topics that decided the final cluster.

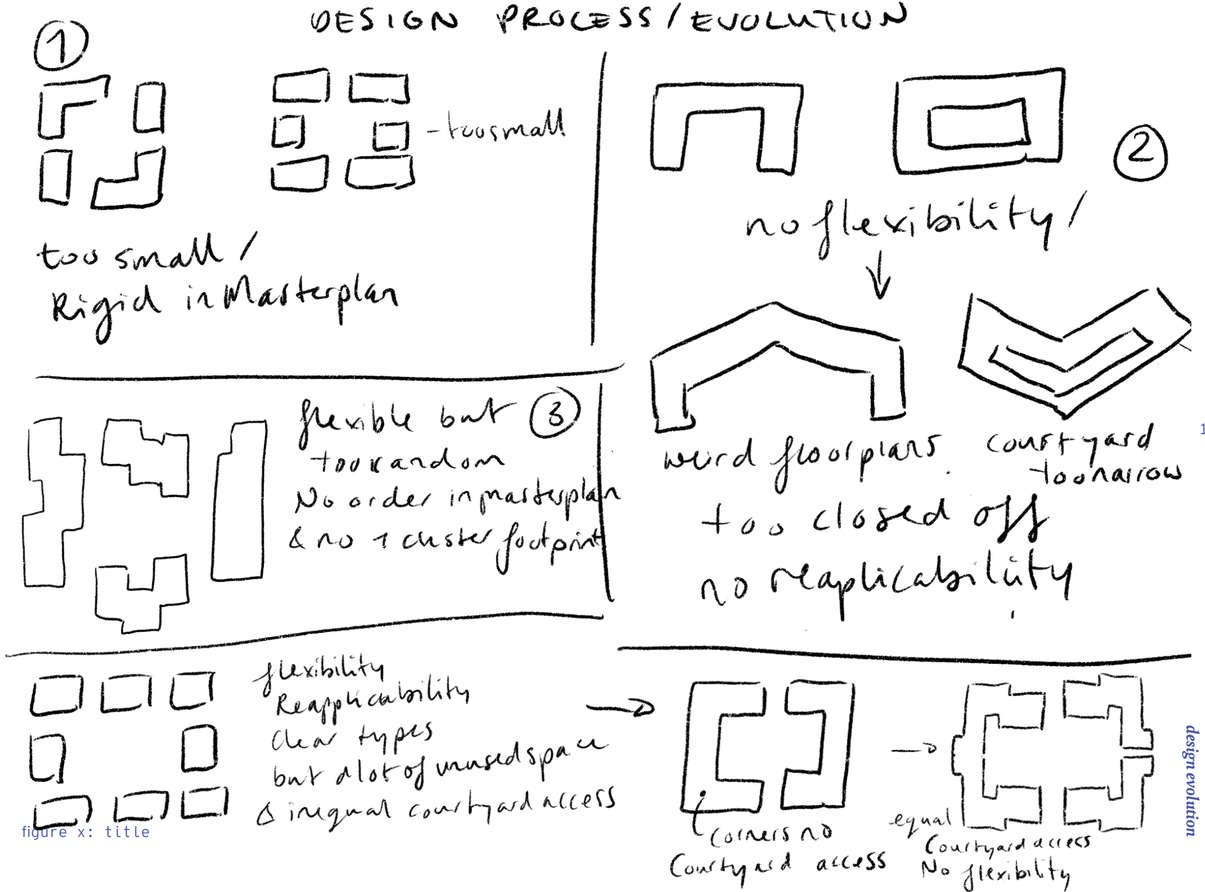


figure x: title

Design

Design Approach

No Waste

re circular nomy

re-use and keep

better material use

Flood Resilience

strengthen embankment

stronger foundation
and plinth

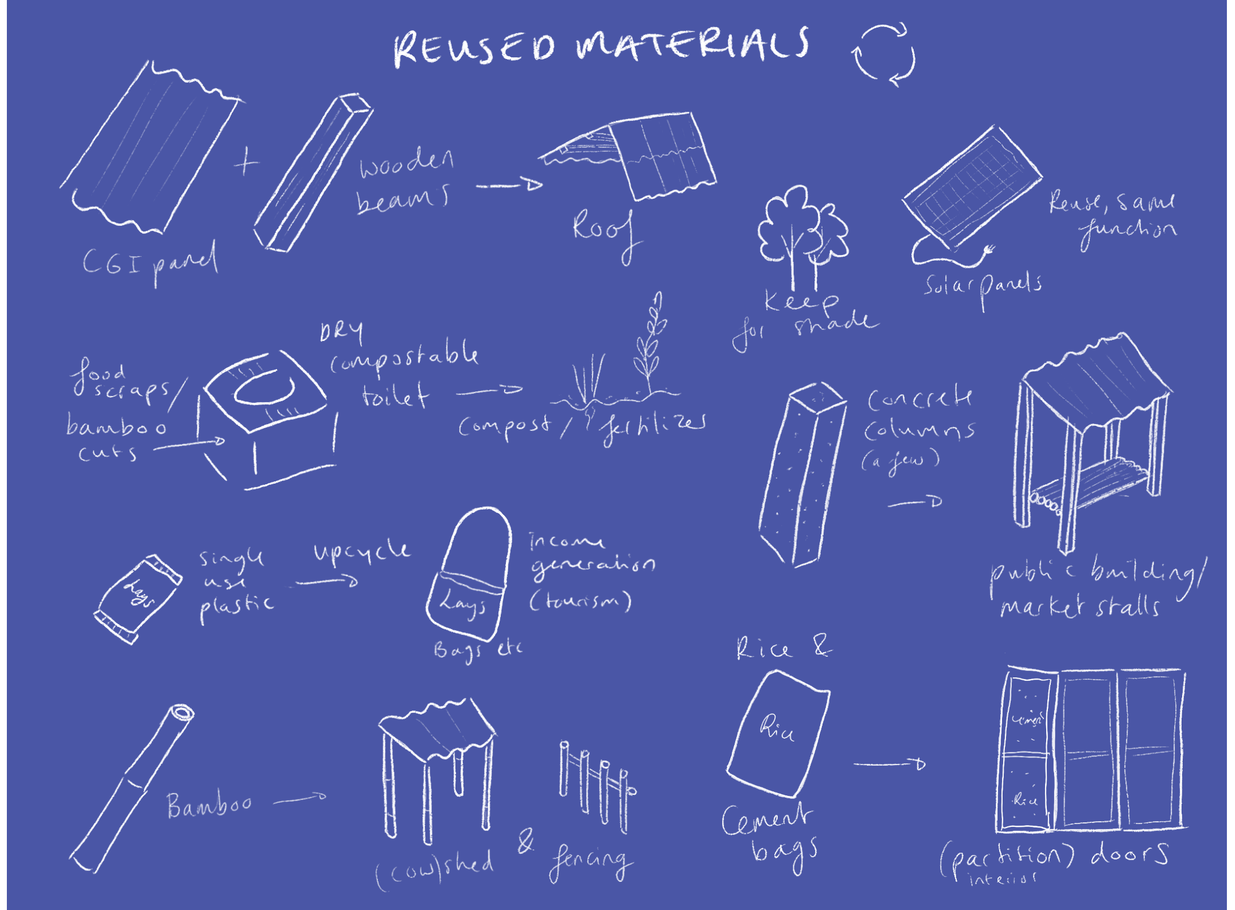
elevate house

Sanitation

clean drinking water

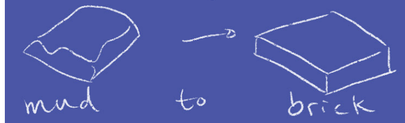
safe bathing water

toilet solution

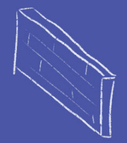


FLOOD RESILIENCE

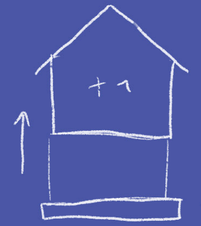
stronger foundation



A more durable plinth



Strengthen embankment against soil erosion



add story for flood refuge & raised foundation

bamboo structure raised above flood levels

openings in brick wall for flood water to recede + lessen impact on wall.

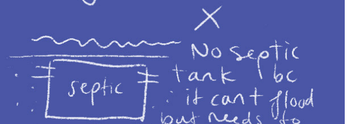
SANITATION

No defecation in the river

toilet above floodlevel

toilet accessible but seperate from living space

Compostable toilet bc of no sewage



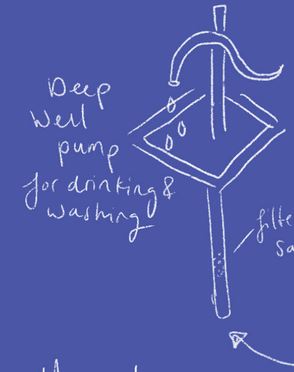
No septic tank bc it can't flood but needs to be underground

makes river safer to bathe

however a bathroom space will be provided

gutter system to alleviate heavy rainfall that might cause mild flood

small pond for 'rainwater 'storage' to clean clothes etc & for cooling environment / air



Deep Well pump for drinking & washing

filters for safe water

Rainwater absorption by soil to keep groundwater level up

"Living in an Asian City involves much more than the use of a small room. Such a cell is only one element in a whole system of spaces people need in order to live. This system ins generally hierarchical consisting of four major elements: space needed by the family for exclusively private use such as cooking and sleeping; areas of intimate contact i.e. the front doorstep where children play, you meet your neighbour, etc.; neighbourhood places e.g. the city water tap where you become part of your community; and finally, the principal urban area e.g. the maidan (open space) used by the whole city." - Charles Correa[109]

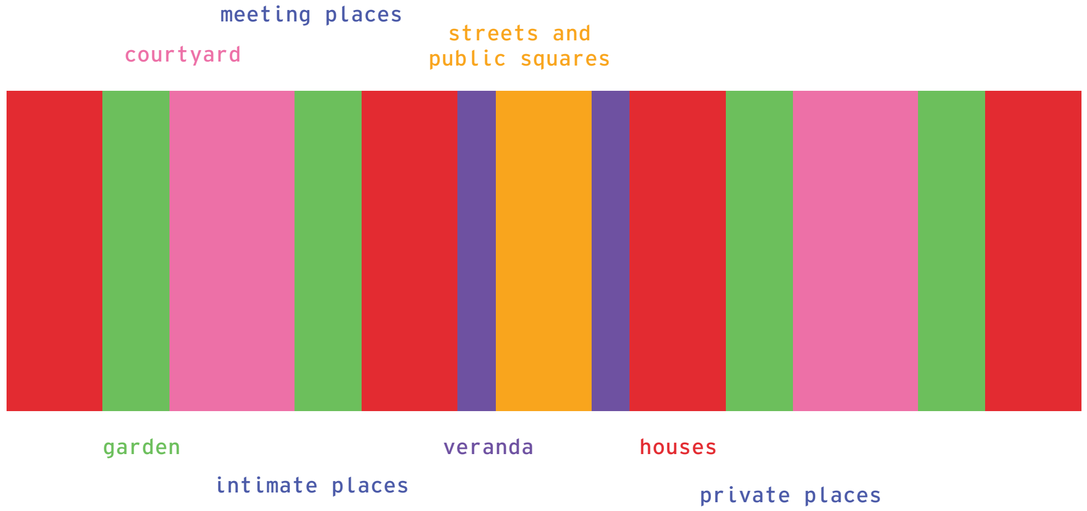
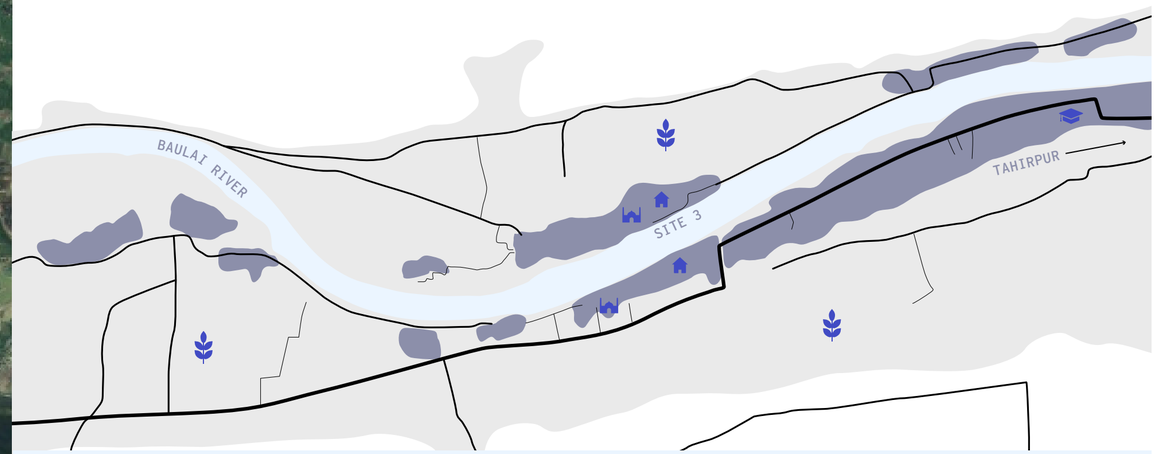
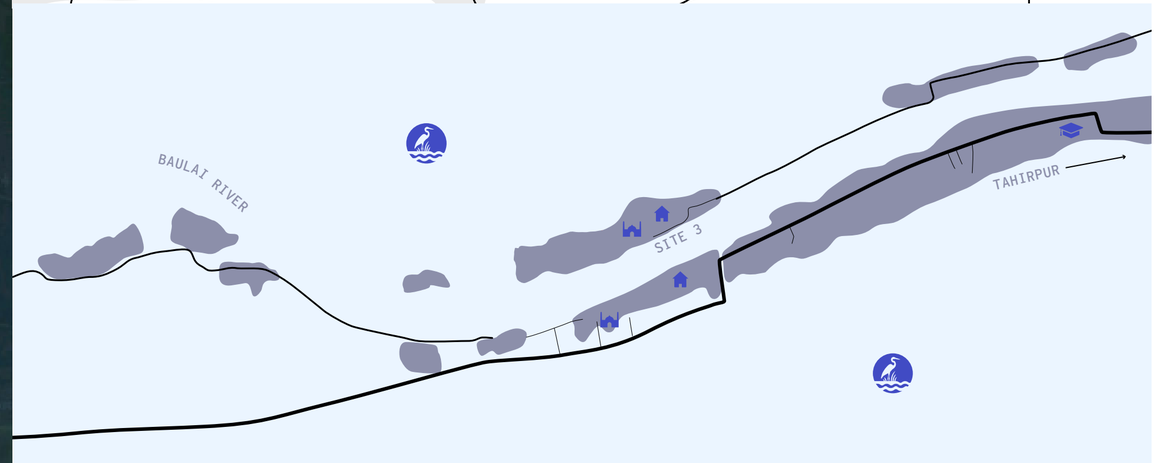


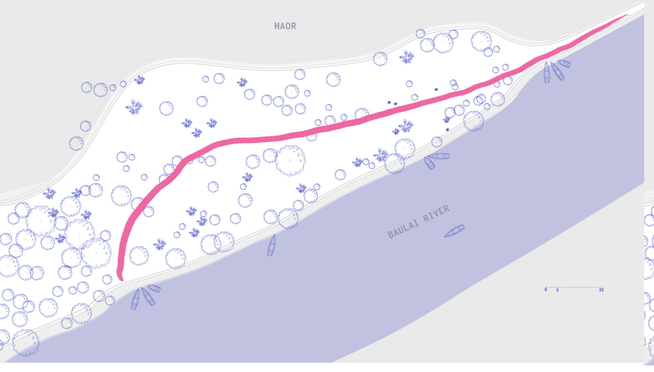
diagram hierarchy of spaces

Urban Strategy

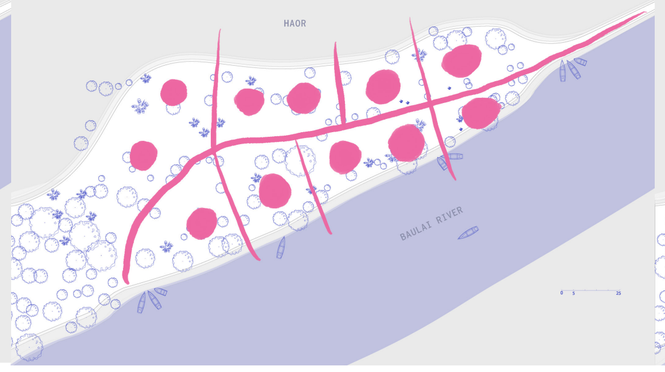




Tahirpur existing situation - dry season, wet season 1:5000



main circulation



circulation and
courtyards

building mass
around courtyard

room for water
and air

masterplan 1:1000

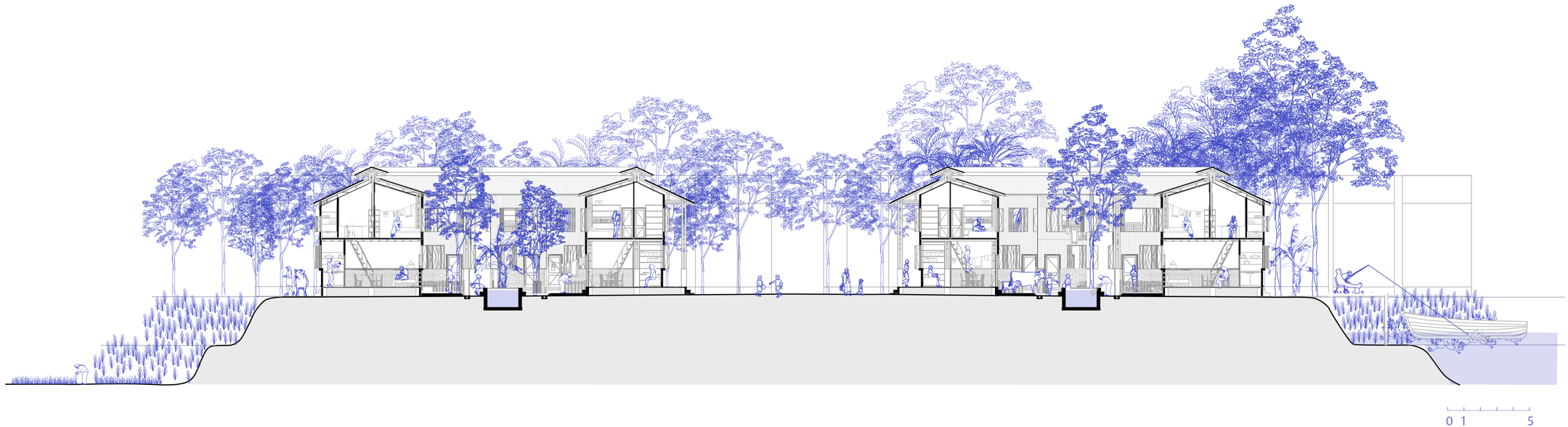
In the whole plan the strengths of the current settlement were used to determine the new masterplan. These are the main circulation route, the trees and the courtyards. Together with the orientation of the openings in the courtyard, to let the water through.

This resulted in a long main road that leads to the public square which will be used for multiple things like a market, but also daily activities like drying hay and cow dung. The school borders the public square so it would also function as a play area for the children.

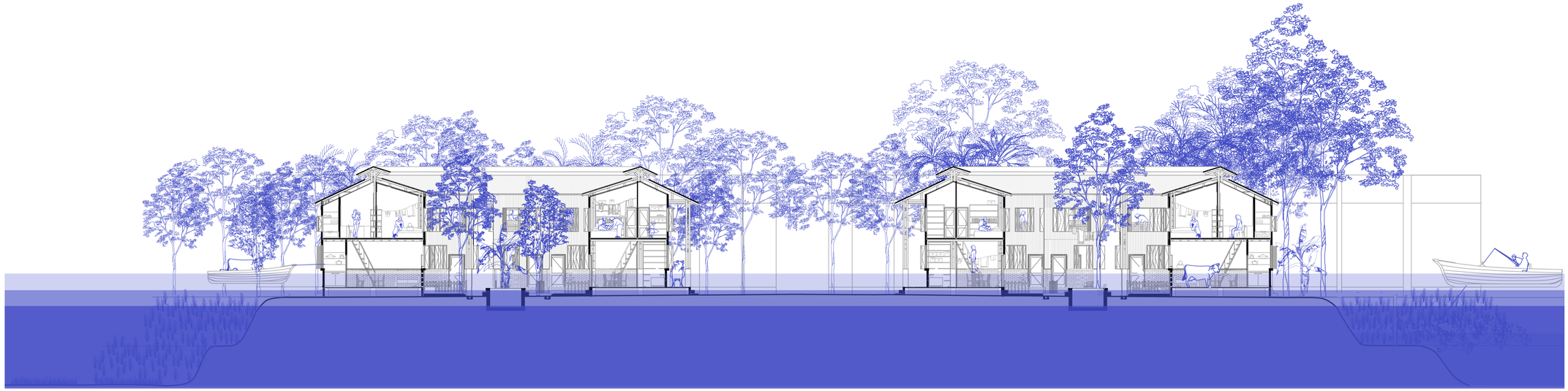
Throughout the masterplan there are multiple amenities including shops, a pharmacy and doctor, an upcycling shop where plastic waste is used to make products to sell to tourists and inhabitants.

The road on the riverside will only be available during dry season, and the main purpose is to let emergency services in. During the wet season all the roads in the vicinity are under water so to get to the settlement you would need a boat.

Section North to South - dry season 1:200



Section North to South - wet season 1:200

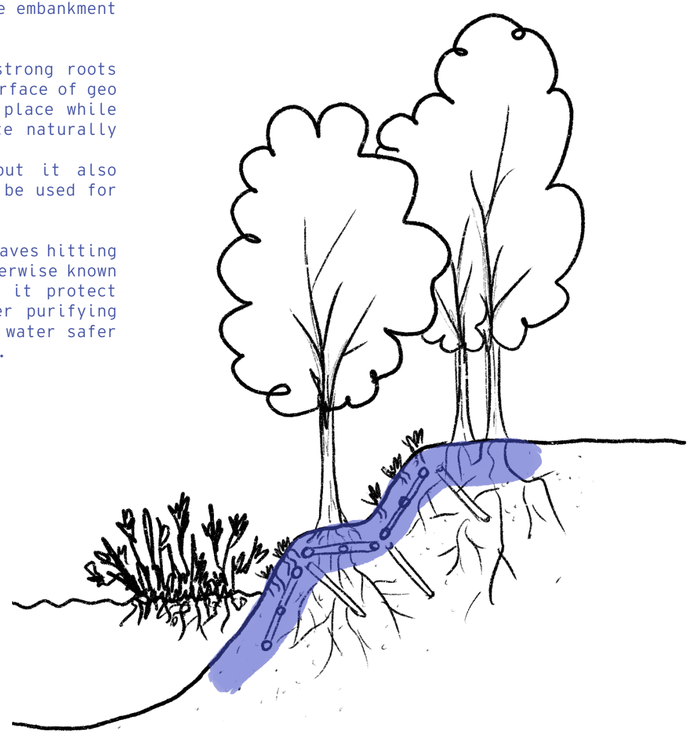


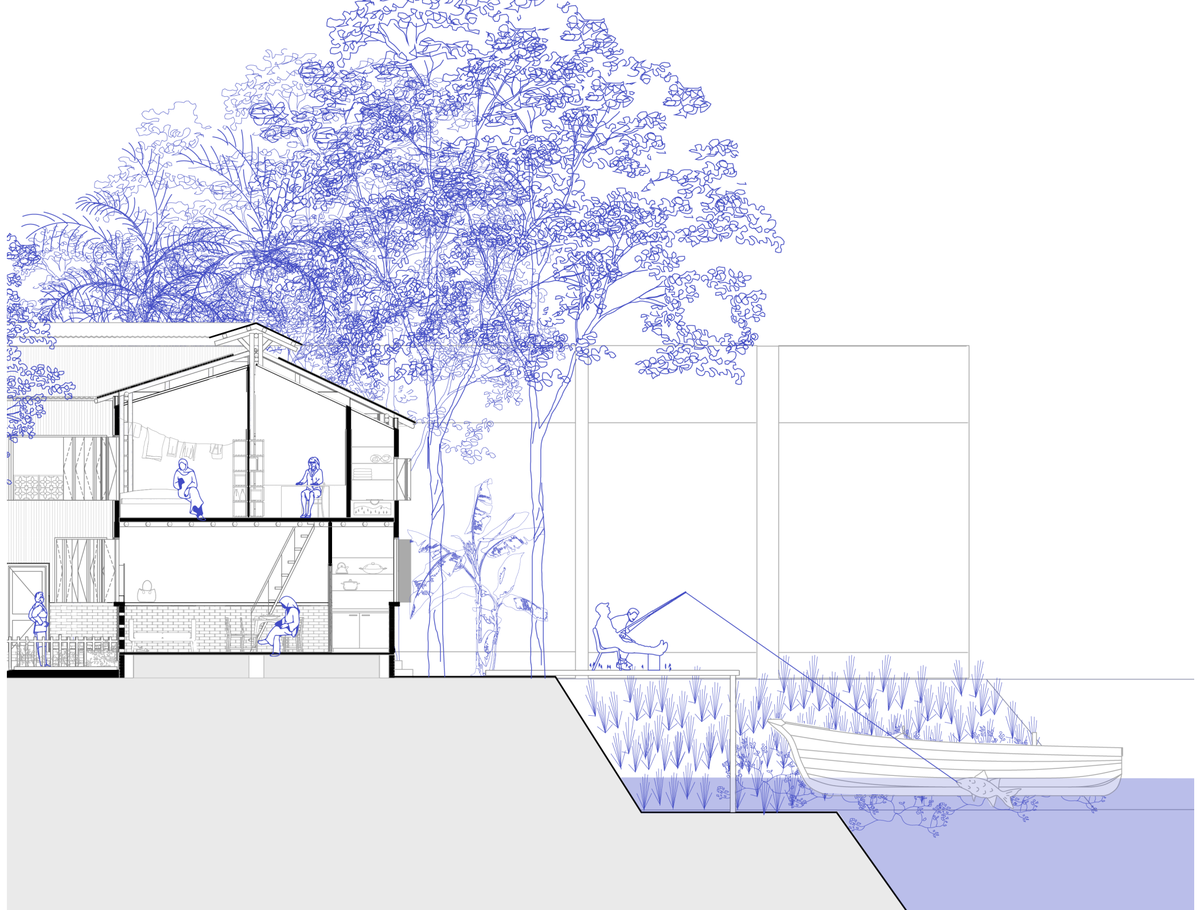
0 1 5

The embankment mostly needs strengthening of top soil which gets washed away by the river and floods.
To strengthen the top soil a combination of things can be used. Trees which take root in the embankment and strengthen the soil.

Vetiver, which also has very long and strong roots which will protect the top soil. And a surface of geo jute can be used to keep everything in place while the vetiver settles and grows, this jute naturally deteriorates over time.[110]
Vetiver doesn't just strengthen soil but it also serves to deter pests and weeds and can be used for animal feed.[111]

Another plant that can be used to cut the waves hitting the embankment is Ipomoea aquatica or otherwise known as Water Morning Glory. Not only would it protect the embankment, the plant also has water purifying qualities[112] which would in turn make the water safer for use and create a healthier ecosystem.





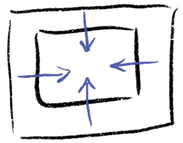
Cluster Strategy

The Courtyard

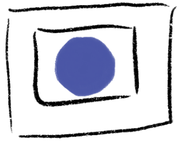
The courtyard forms the centre of a cluster.
It forms a semi public space that is shared with all the residents, it provides a social space, but also hosts a pond and clean drinking water through a deepwell pump. The pond is useful to cool down the courtyard but is also essential for daily chores like washing clothes and dishes.
Around the pond each dwelling has their own garden that can be used for just socialising or to tend a foodgarden, keep lifestock and other things that are part of their daily lives.

Each cluster has four units that form the courtyard. The unit varies from 4-5 dwellings in each unit, because of the column structure it is easy to adjust the unit to the space of the embankment. Every dwelling has a ground floor and first floor. This to keep the connection to the ground floor but also provide a safe zone in times of flooding.

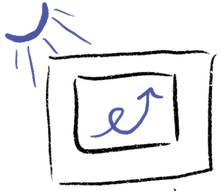
why a courtyard typology?



create community

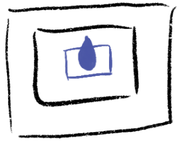


more room for daily activities

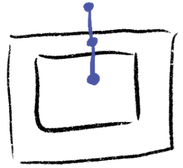


climatic comfort

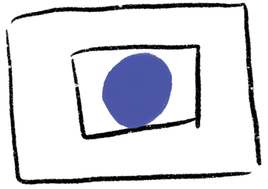
building around the trees



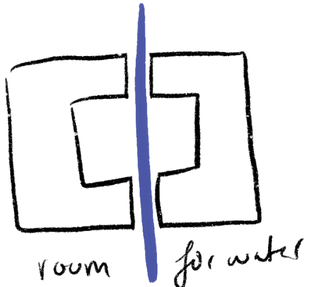
space for clean water



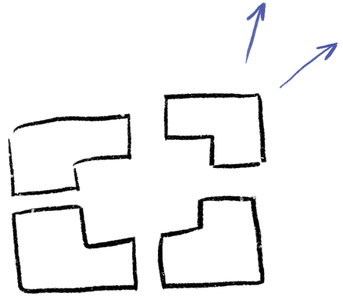
Create a hierarchy of spaces



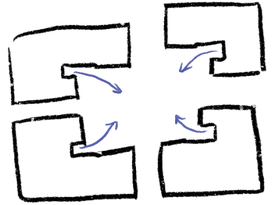
base form



room for water & connection harbour + river

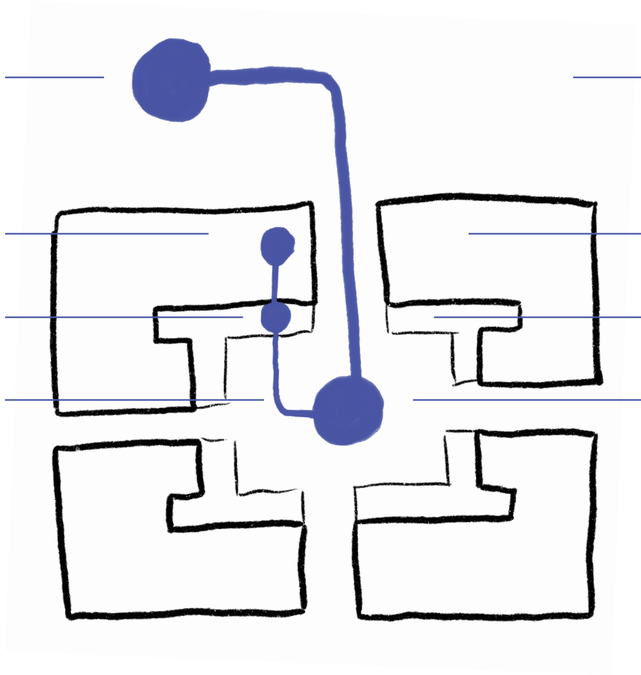


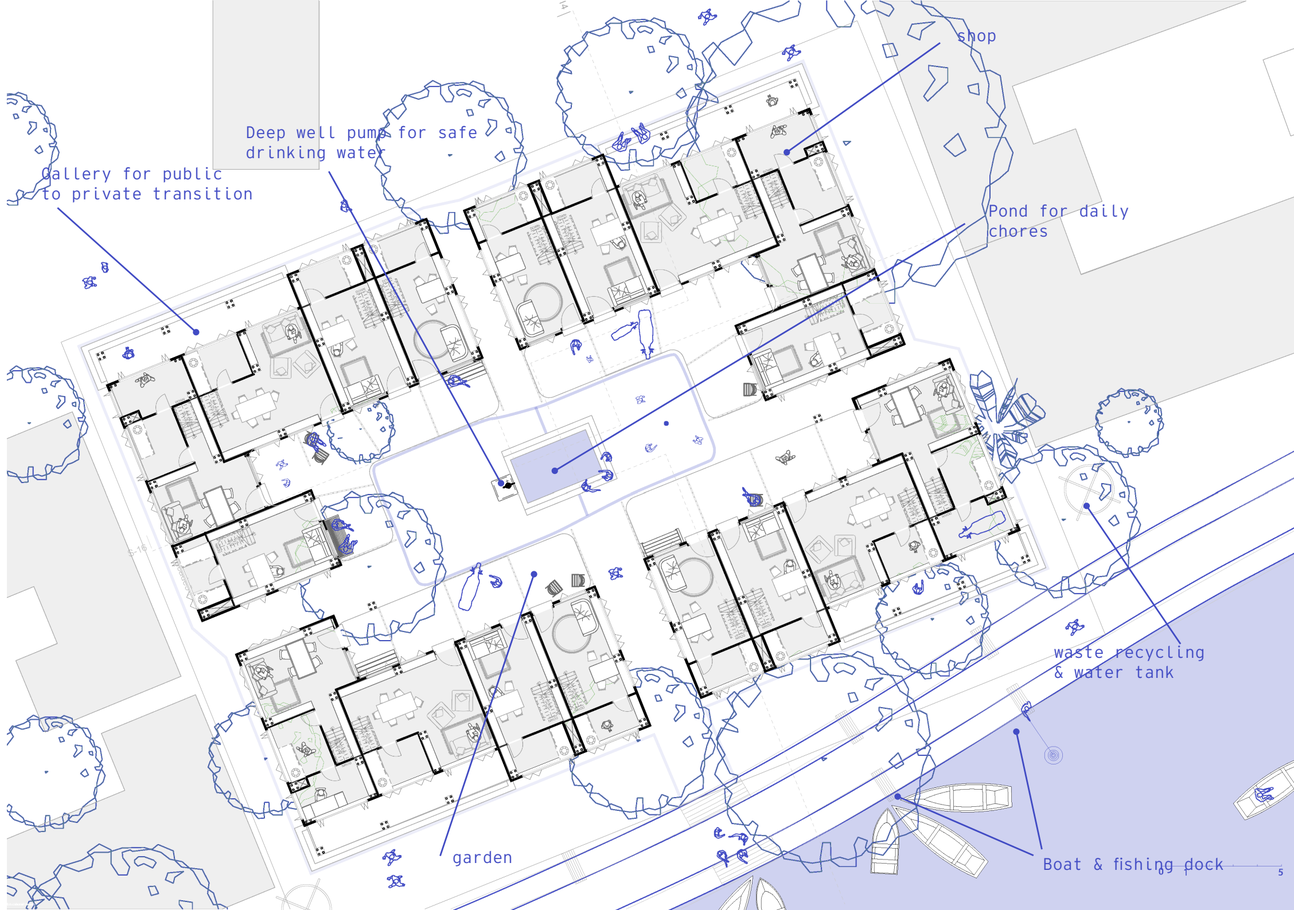
flexibility in masterplan for trees + landscape



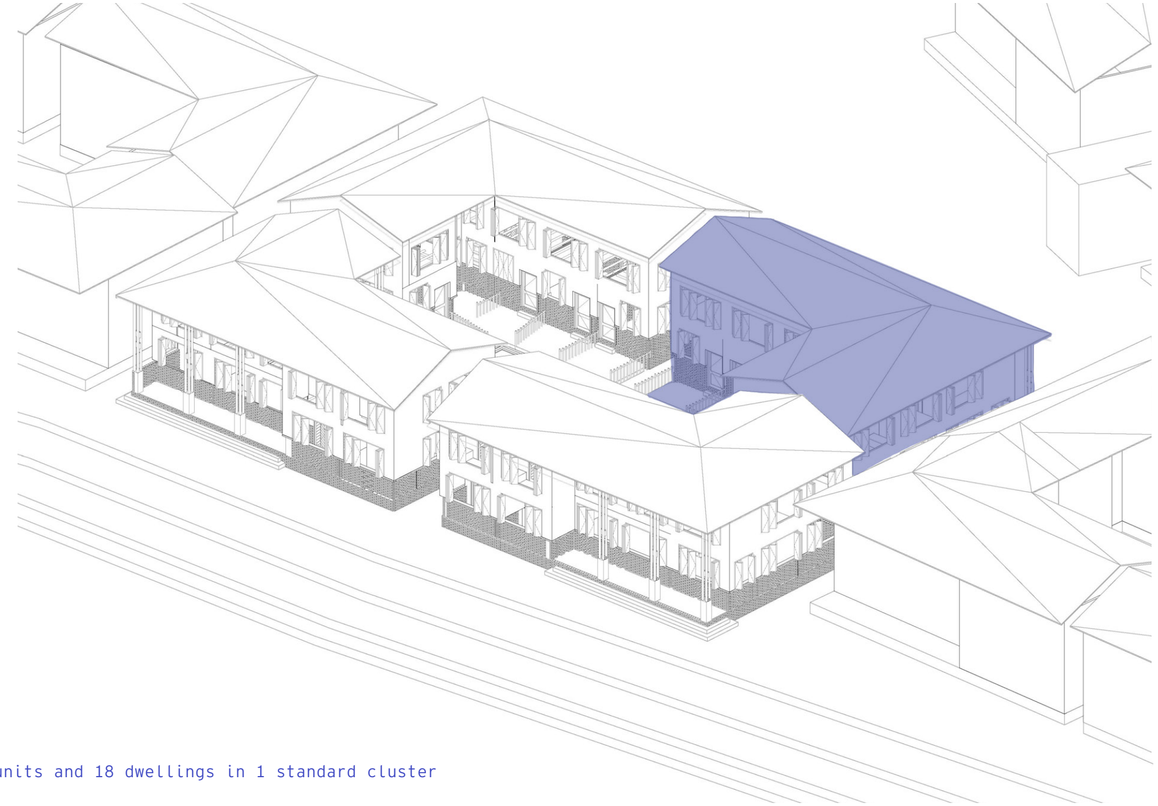
corner access to courtyard

hierarchy of spaces courtyard

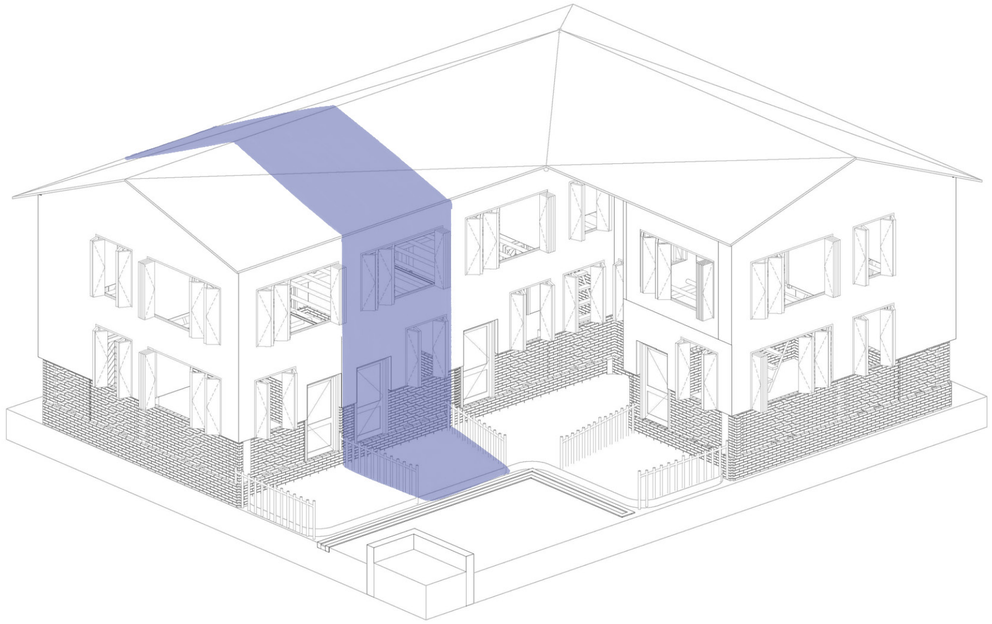




cluster - 1 unit highlighted



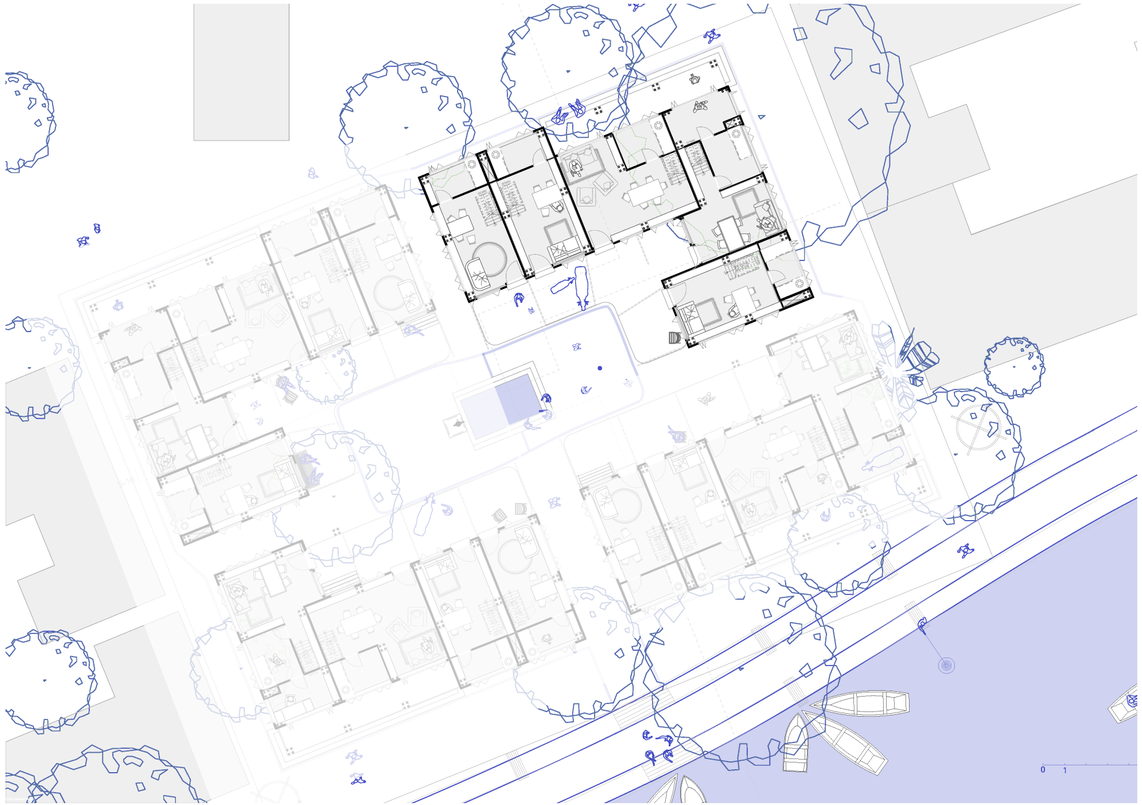
4 units and 18 dwellings in 1 standard cluster



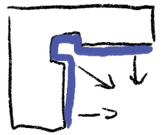
4-5 dwellings in 1 unit

unit- 1 dwelling highlighted

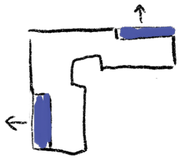
Elevation 1:100



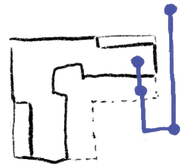
What do I want ?
from unit type



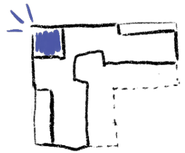
equal
courtyard
access



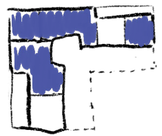
softer
transition
street side



hierarchy
of spaces

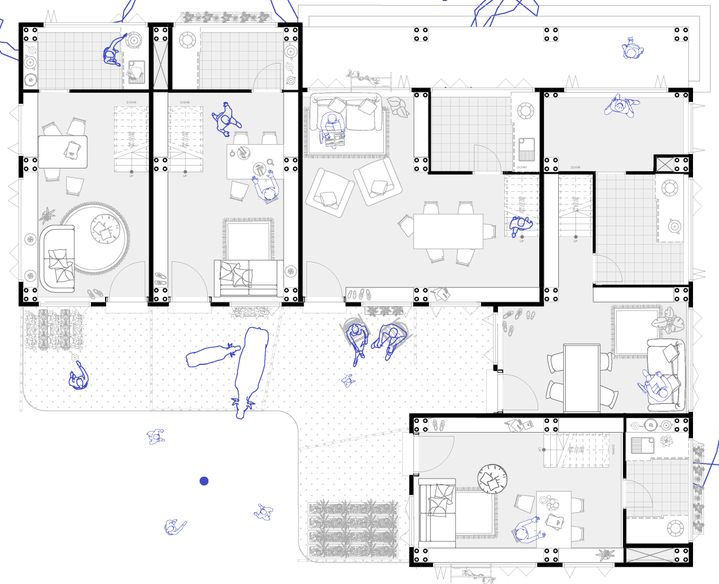


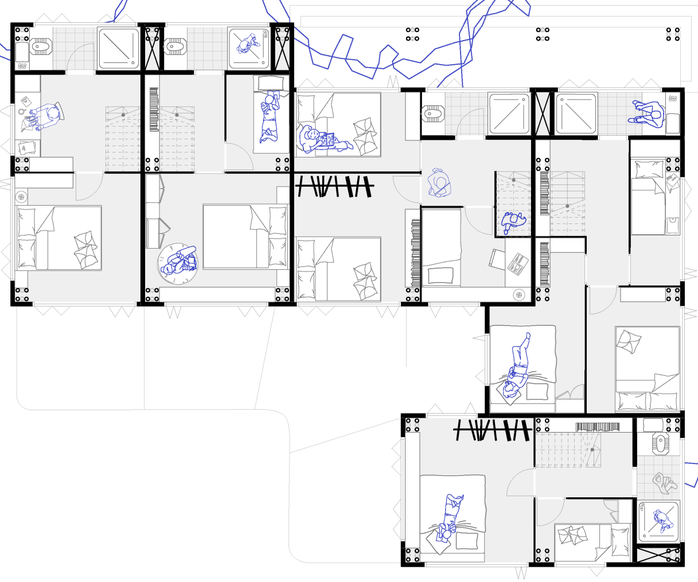
Corner shop
on street side



different size
houses for
varying households

Floorplan unit - ground floor 1:100

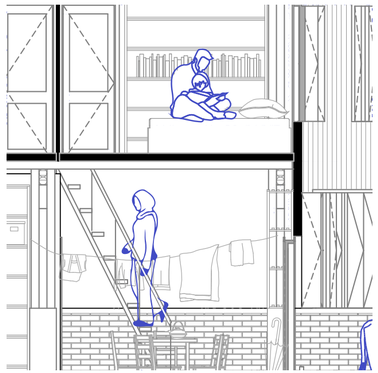




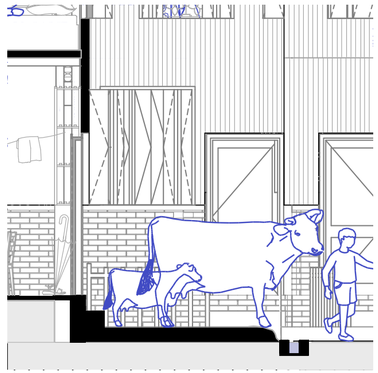
Floorplan unit - first floor 1:100

Section cluster 1:100

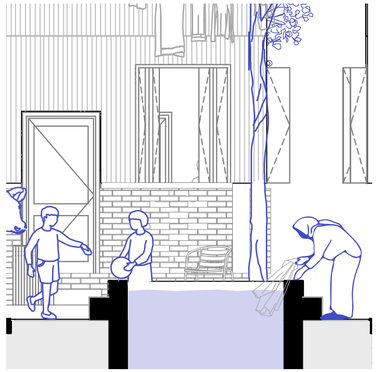
gallery/veranda
& shop



living space
& bedroom

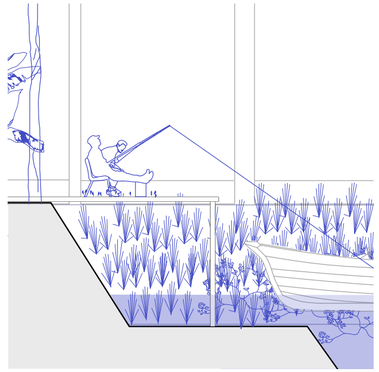


garden & cattle



pond for daily
chores

living space
& kitchen



boat docking &
fishing jetty

There are three dwelling types, one is a small dwelling for the nuclear family, one is mid sized for an extended family and the larger one is the shophouse. Each dwelling has two floors, the ground floor with living space and kitchen, and an upper floor with bedrooms and bathroom.
Each dwelling has large openable bifold window shutters to help with ventilation, but also keep out the sun when necessary.

The dwellings have a column structure that doesn't just function as the main structure but also serves a home function. Shelving is placed between the colums giving more storage space and the bamboo columns also give the possibility to hang laundry and other necessities in between.

Floorplans - Nuclear Family 1:100

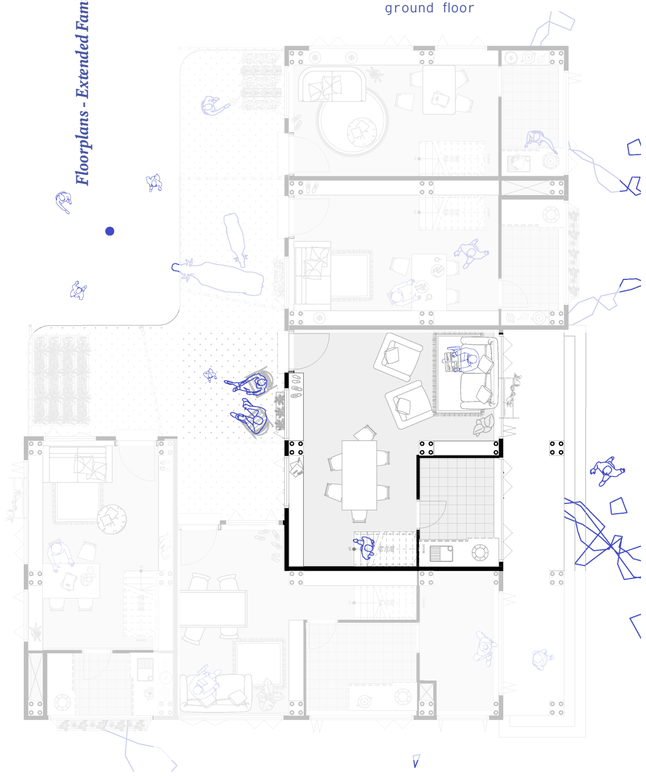
ground floor

first floor

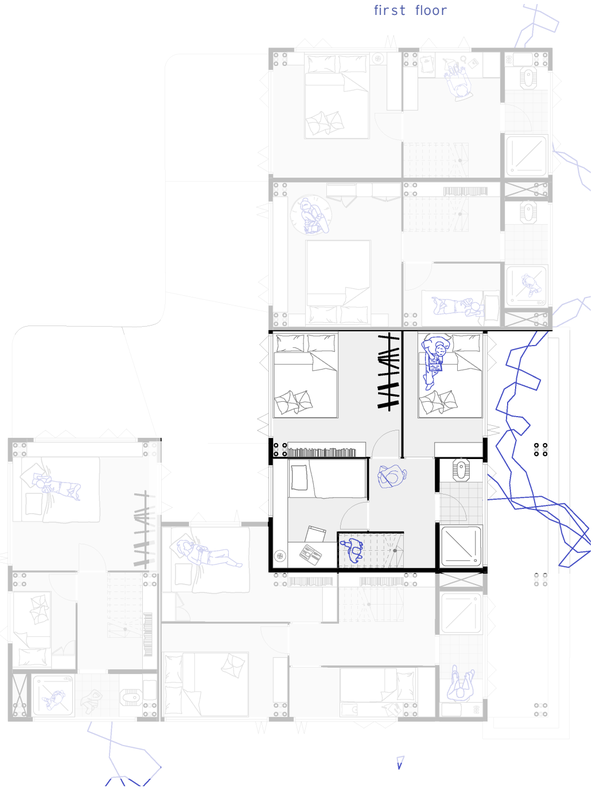
36-42m2
2-3+ people

Floorplans - Extended Family 1:100

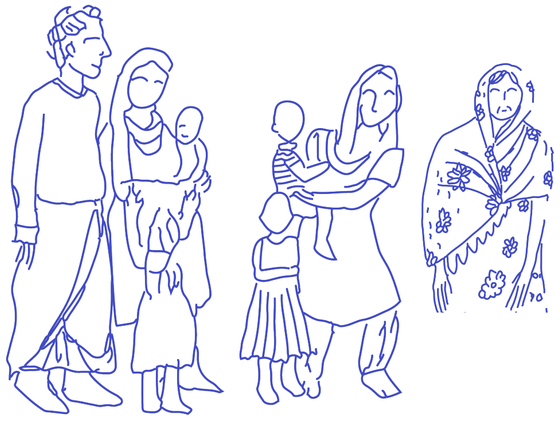
ground floor



first floor

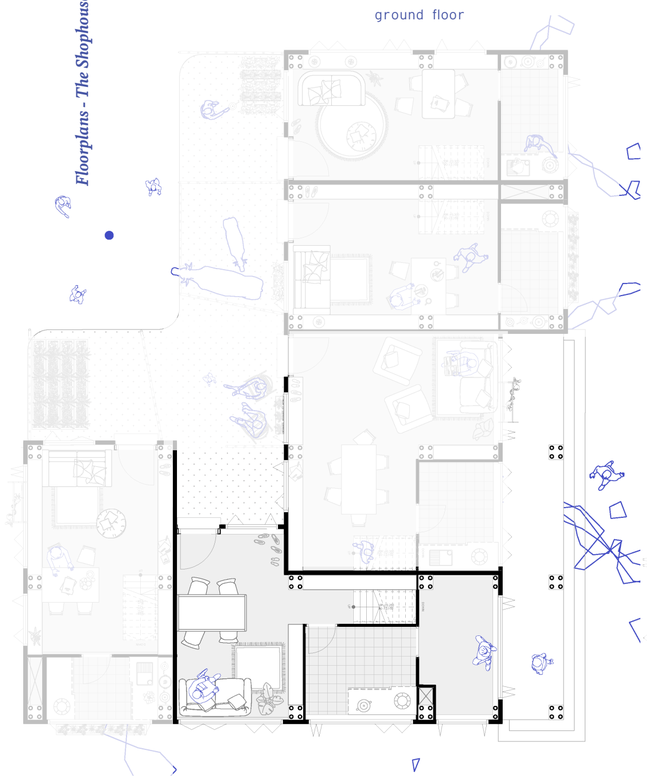


52m2
5+ people

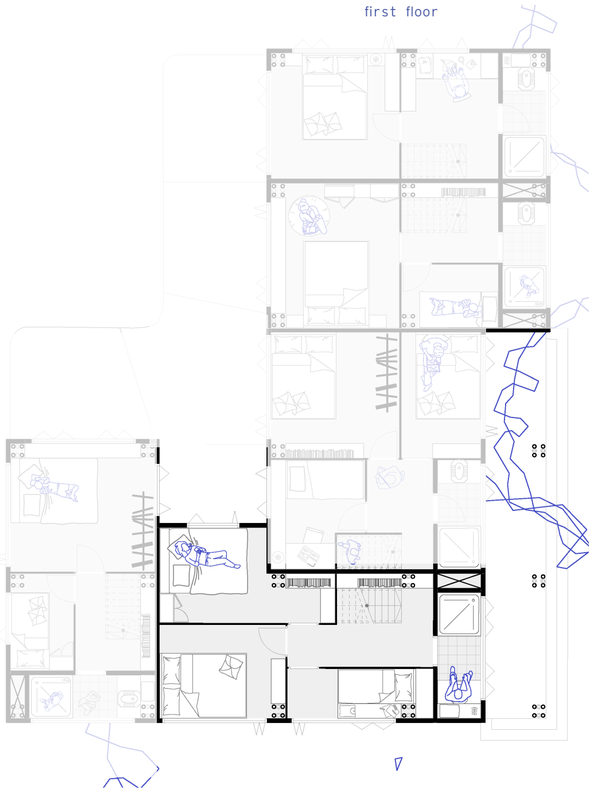


Floorplans - The Shophouse 1:100

ground floor



first floor



54m2
5+ people

Managerial strategy

The masterplan consists of courtyard clusters which are made up of 2-4 units depending on how much space there is on the embankment. Each unit consists of three different dwelling types totalling 4-5 dwellings in each unit.
Since the dwellings share a wall it means that the families in each unit are sharing the cost and building labour of their houses. This financing can happen with a small term loan.

An outside benefactor will finance part of the project to make it cheaper for the residents and there will be a bamboo expert to teach the residents how to build so there won't be any extra labour costs since they will have the knowledge to build themselves.

The prefabricated bamboo facade panels are perfect work for the women of the Haor, and the heavy labour of the brick laying and bamboo construction can fall upon the men.

Maintenance of the public space and their own homes will fall upon the people themselves. Since it's a relatively small village the communal effort probably won't need an overseer.

In the community centre there will be workshops to teach people how to upcycle and recycle materials. Both single use materials like plastics but also construction waste like unused bamboo scraps.

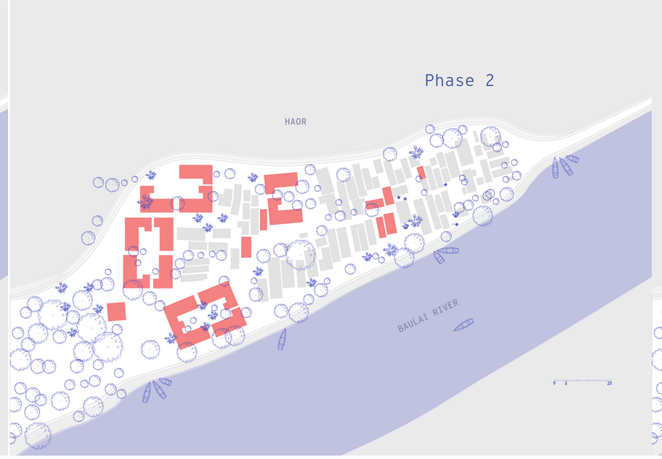
Hopefully the masterplan will be realised fully but in case funding is cut off before it's finished the project will be designed in such a way that the spatial quality will stay intact throughout each phase since the masterplan is realised cluster by cluster.

In phase one clusters will be built on open unbuilt land so as to not evict anyone and to act as either temporary housing until the next phase is finished or permanent rehousing.

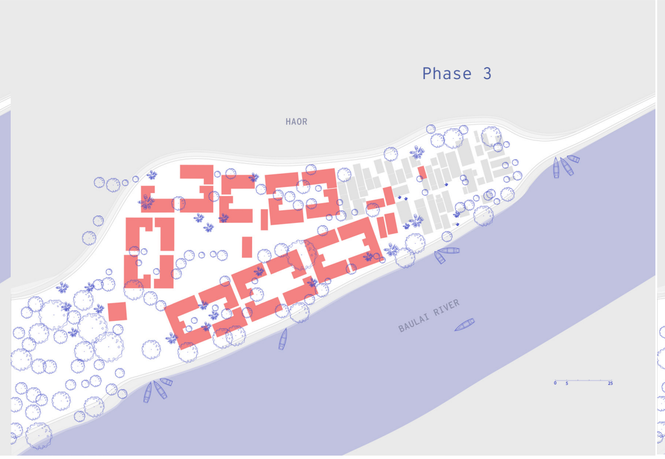
The income varies between 3875 - 5000 taka a month for the people in the Tahirpur and Tanguar Haor area Which is 33-42 euro's a month and 393-507 euro's yearly

phasing

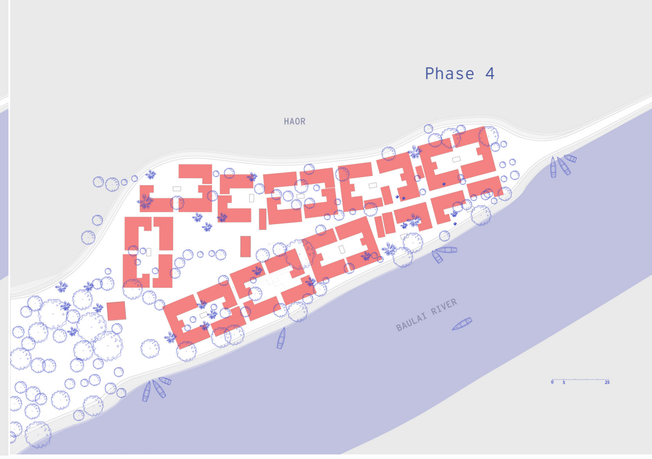
Phase 1



Phase 2

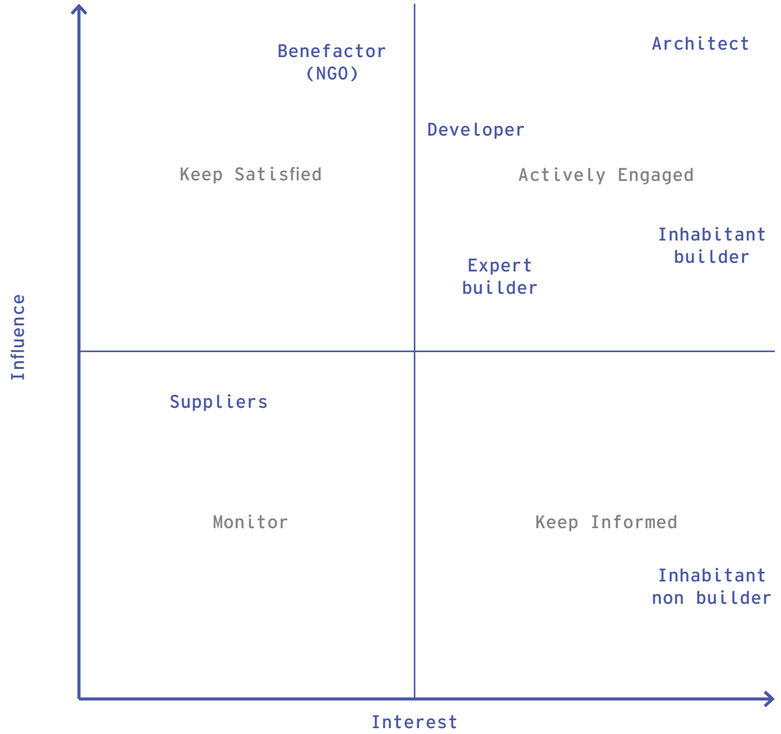


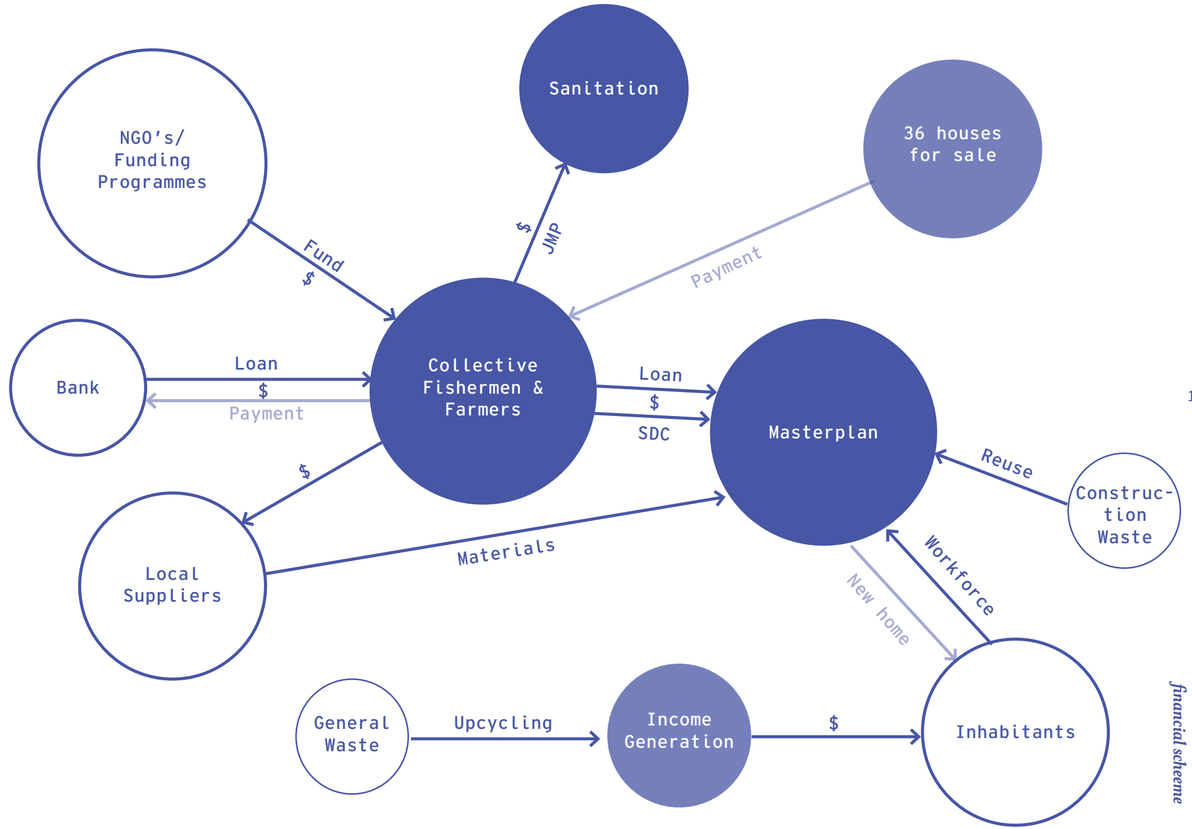
Phase 3



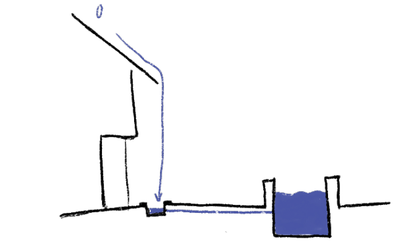
Phase 4

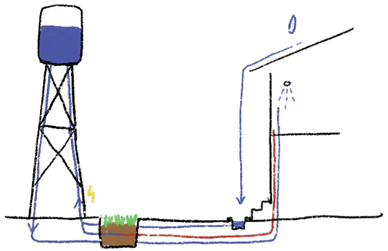
stakeholder analysis



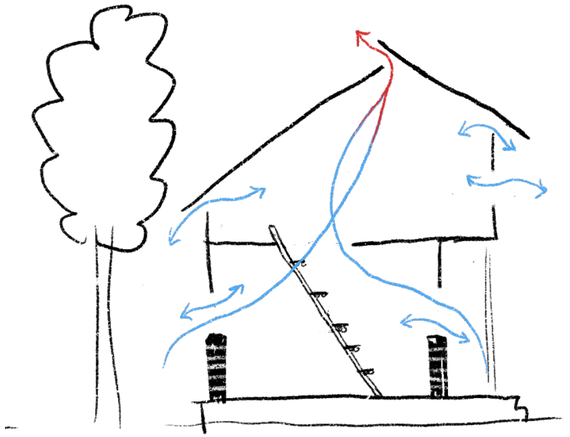


financial scheeme

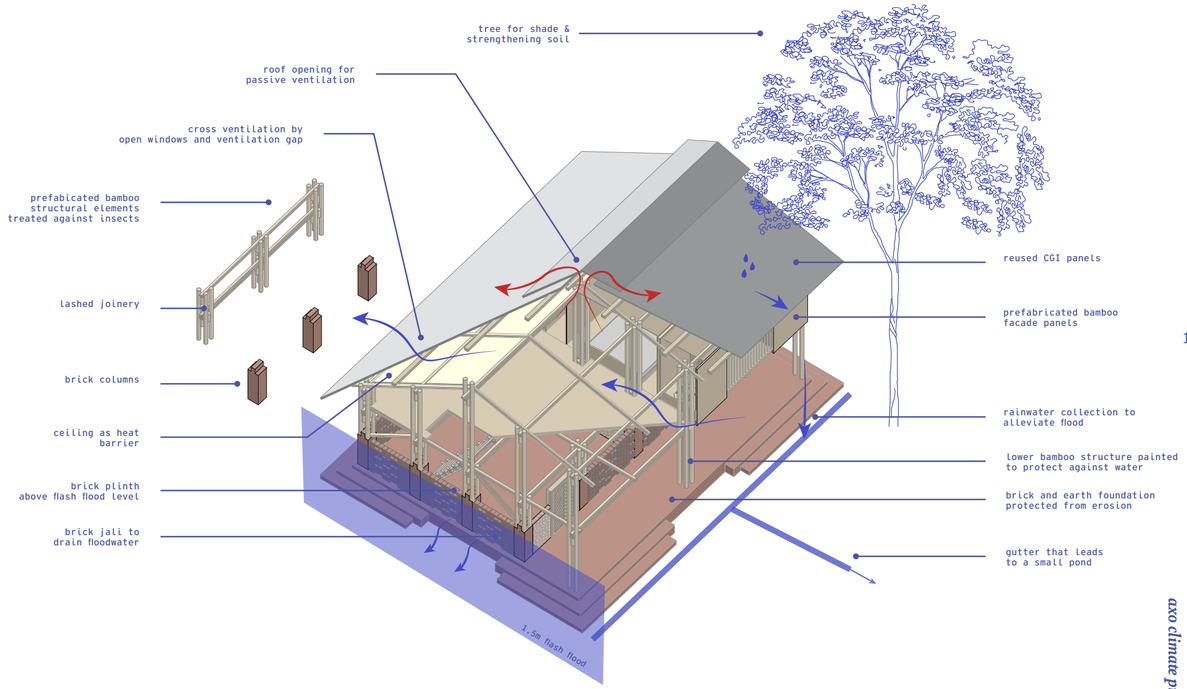


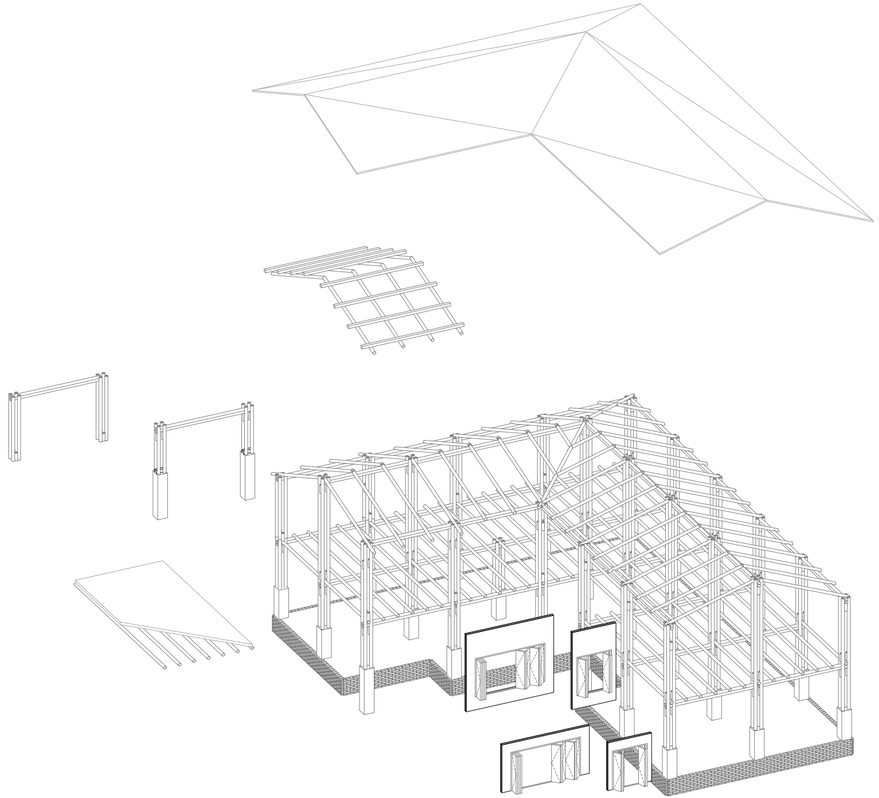


water system

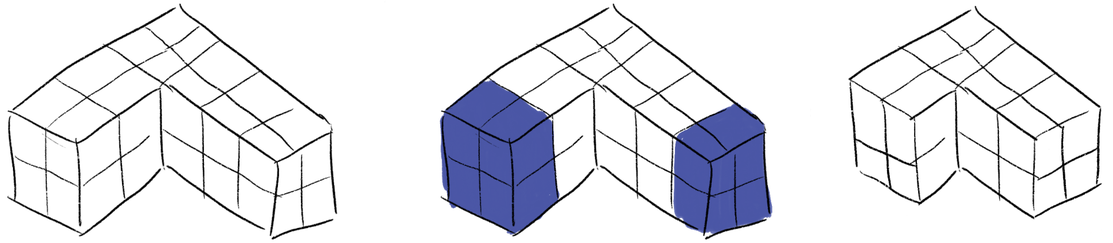


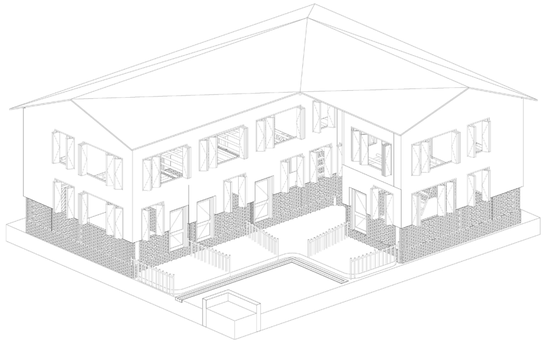
cross ventilation and thermal pull

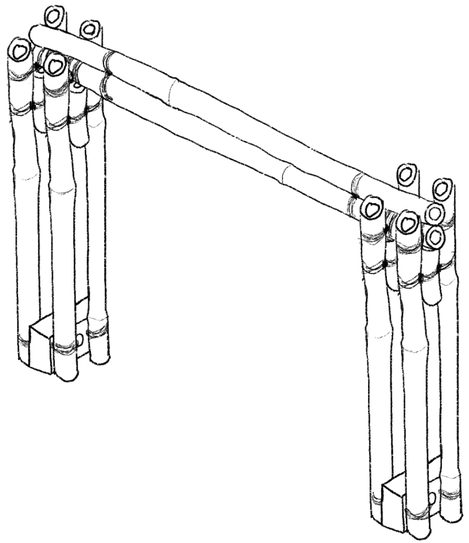




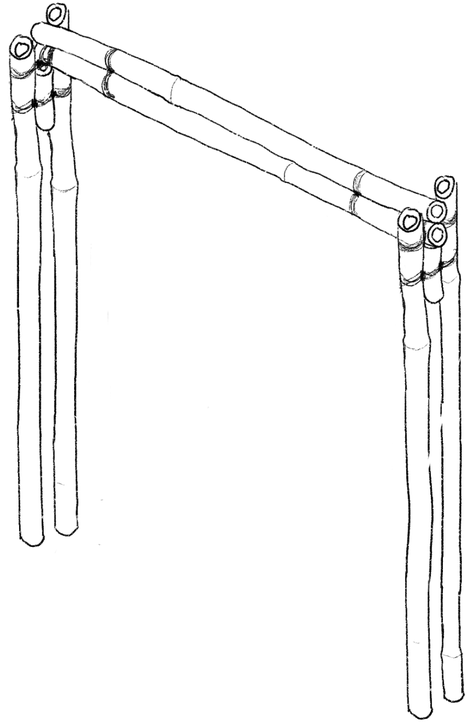
add or subtract



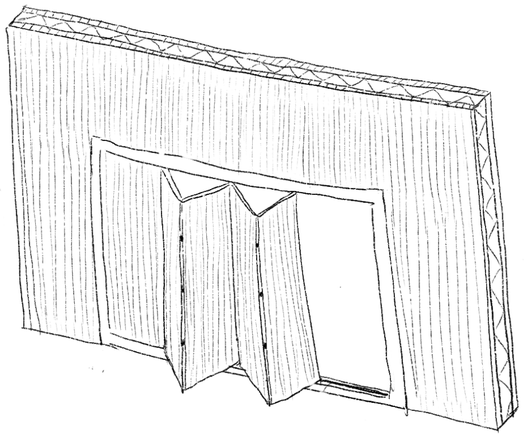




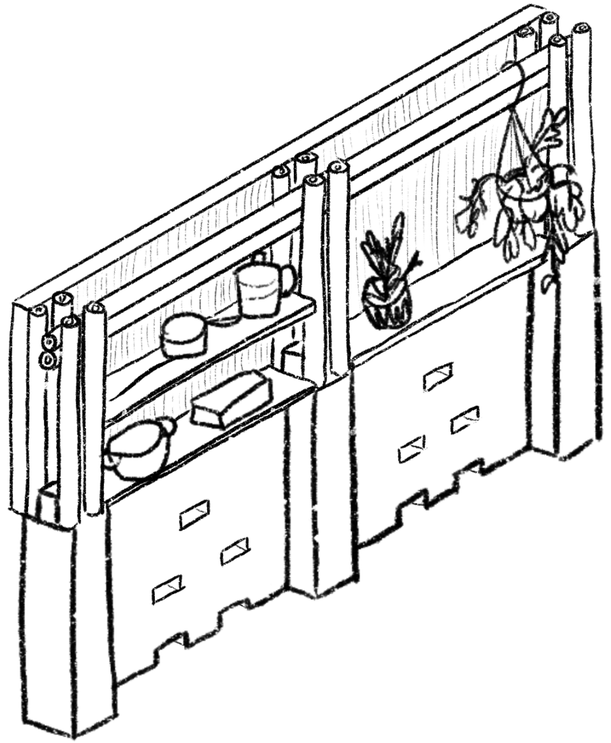
ground floor bamboo structure



first floor bamboo structure

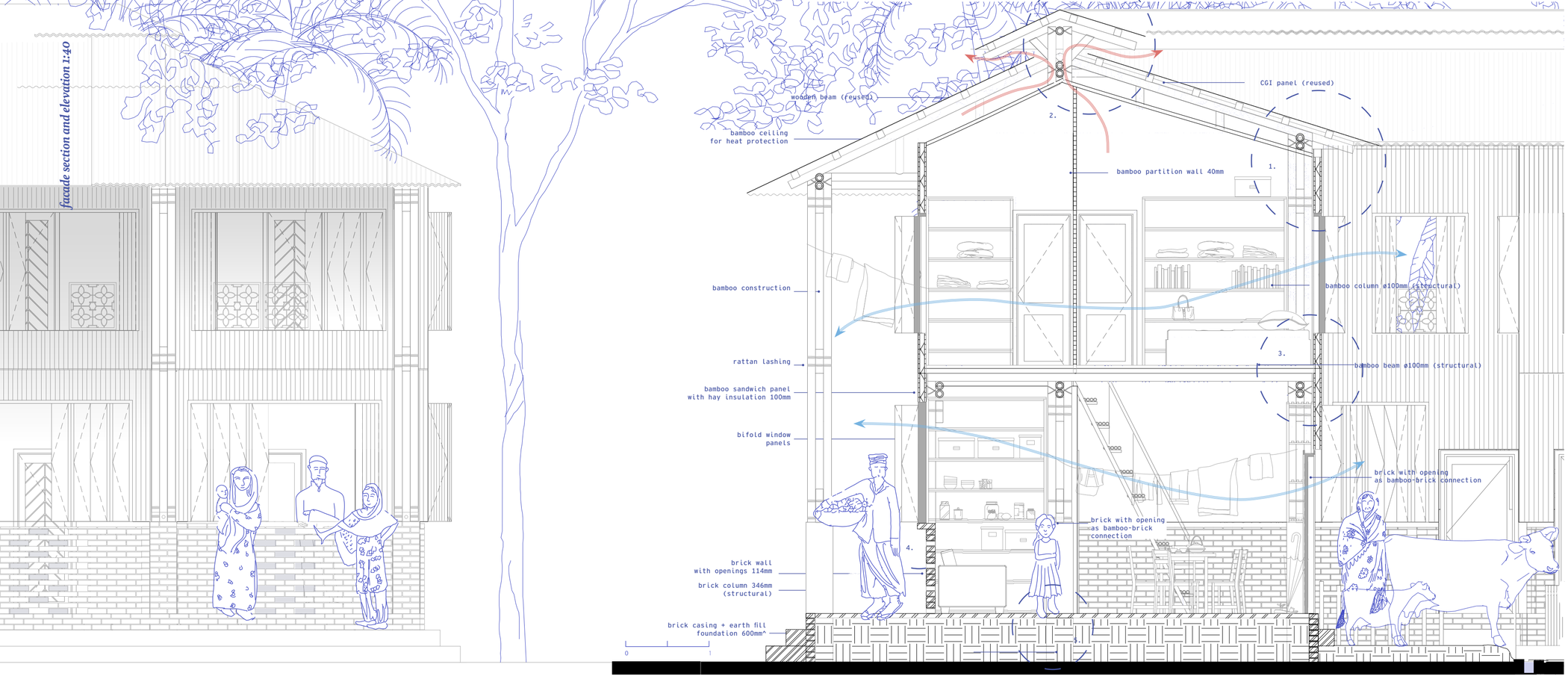


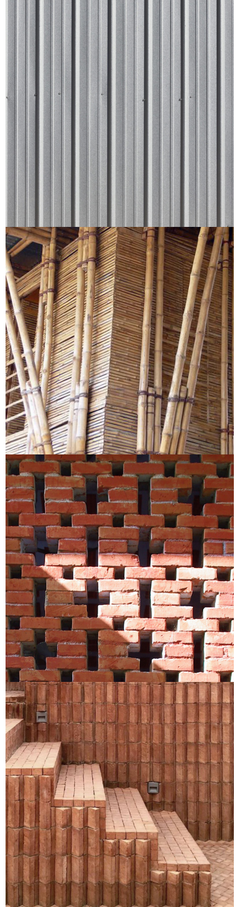
prefab bamboo facade panel with hay insulation
and bifold window

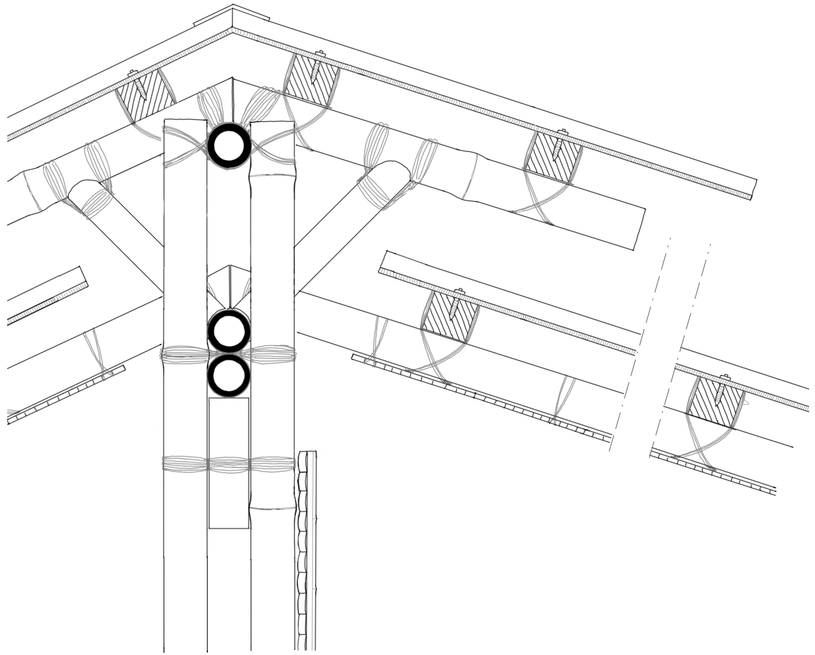


wall from the inside, with shelving units

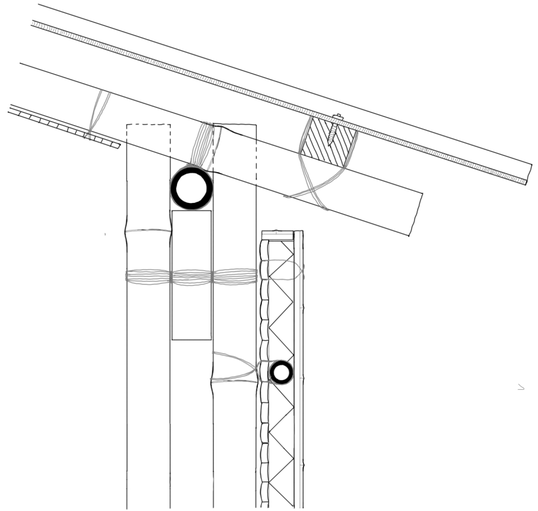
facade section and elevation 1:40







2. roof nook

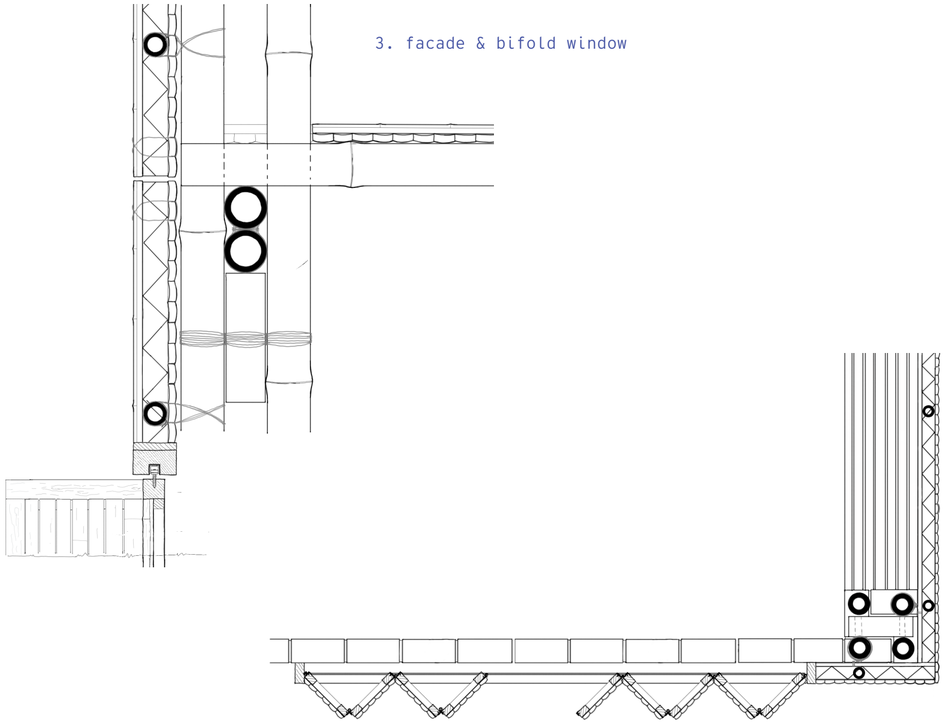


1. roof edge

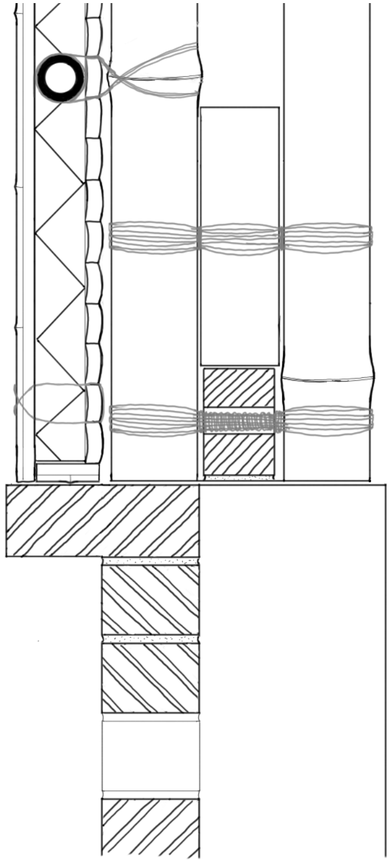
roof detail 1:10

facade detail 1:10

3. facade & bifold window



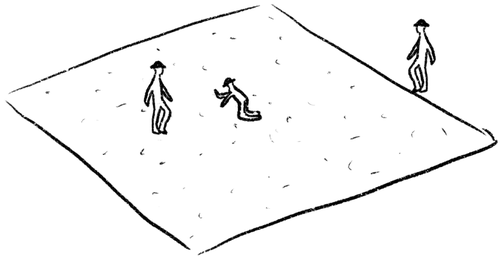
horizontal 1:20
facade & bifold window



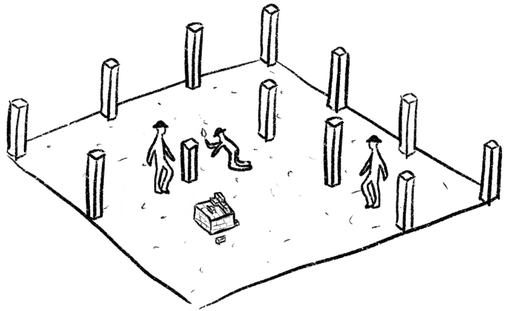
4. plinth

plinth detail 1:5

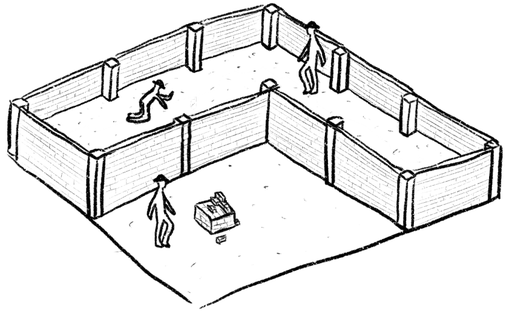
Preparing the site



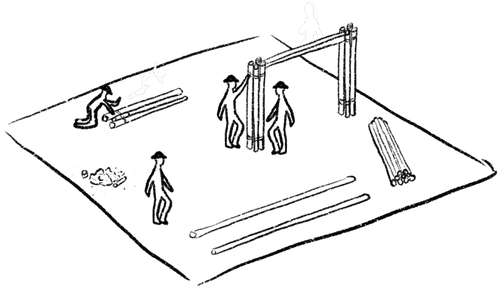
building the foundation



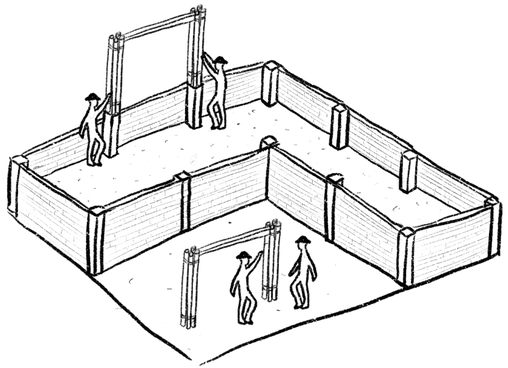
building the plinth



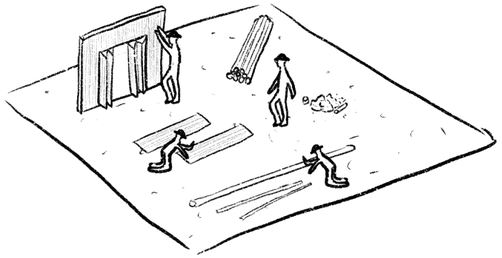
prefabricating the structural elements

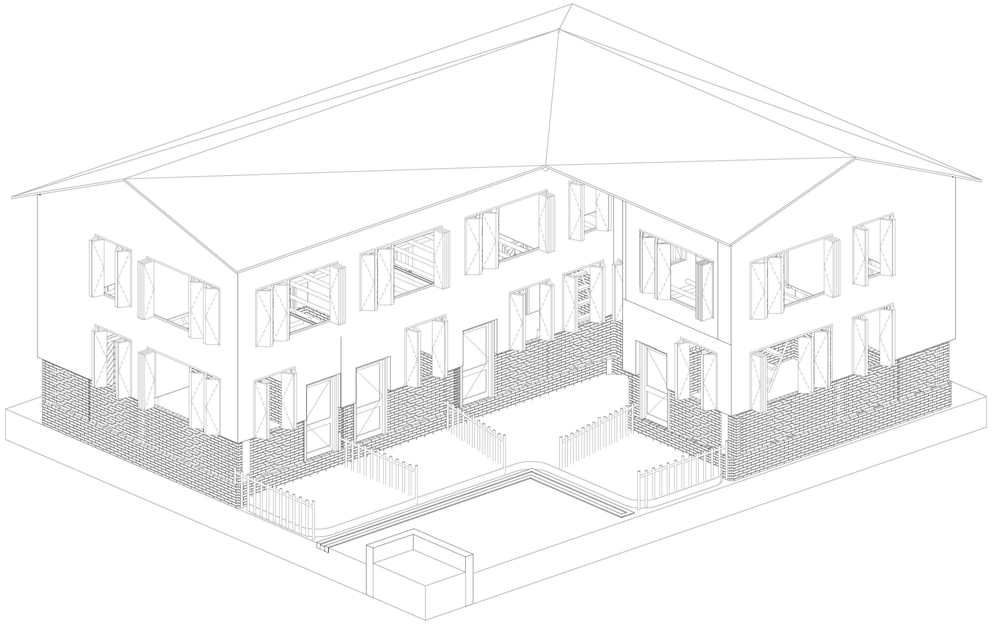


assembling the structural elements



prefabricating the facade panels





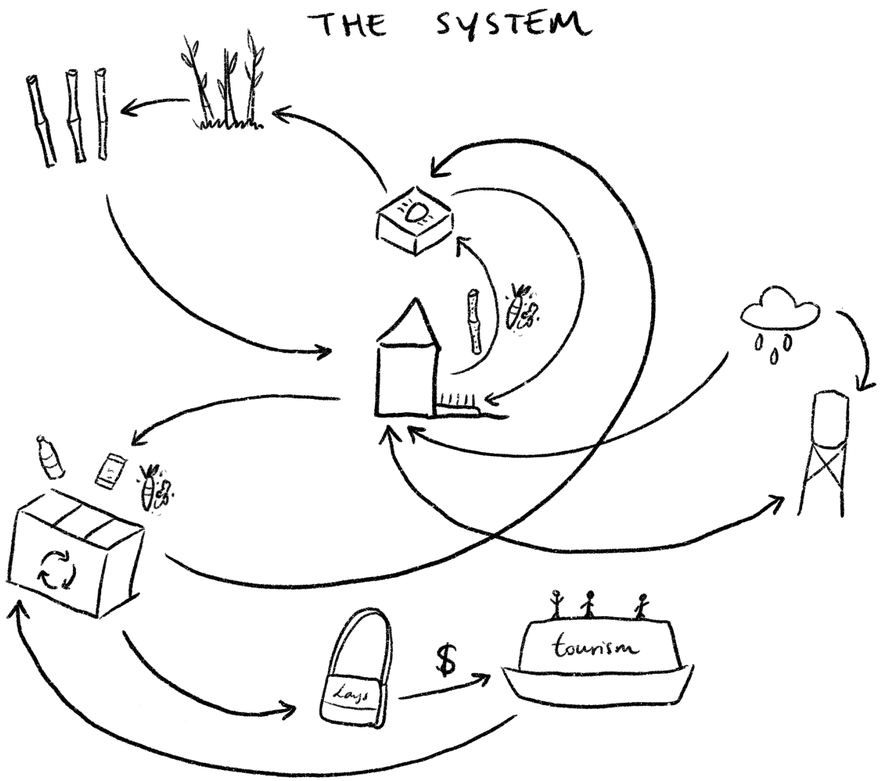
The final circular system within the entire project is difficult to synthesise in one drawing. This diagram shows the simplified version of the circularity in terms of materials, water, and waste, both plastic and natural waste.

The bamboo scraps are used as fibre for the compost toilets which creates fertiliser for plants to grow including new bamboo. When the bamboo lifecycle ends within a few years this new bamboo can be used to upgrade the houses again.

Both the natural and plastic waste from both homes and tourists can be sorted at the waste station each cluster has. The natural waste ends up composting again and the plastic waste is upcycled into products which can then be sold again to the tourists. Creating a mutually beneficial system of a less than ideal material, until plastic waste is taken care of on a governmental level.

The water of the river is already significantly cleaner because the human excrement now does not end up in the river and all of the waste products are sorted at the waste station.

The rain water is stored both in a pond and in a water tower, which gets used by the residents. The showerwater from the homes get filtered and reused again, creating a circular water system.



Reflection

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

My design topic is focused on circularity, waste reduction and flood management. It aligns with the Global Housing studio's aim to understand the various forms of displacement, and to mitigate the consequences of massive displacement, in part due to climate change. Another studio goal is to understand the social aspects, like the challenges faced by these populations, and explore new housing design approaches for an architecture of transition. In line with the studio description, this graduation project will investigate the transitional state and its consequences to the social-spatial ecology of the Tanguar Haor.
Aside from the Architecture master track, the project also touches on topics that fall in line with the master tracks within the master programme: Building Technology, Landscape, Urbanism and Management. The approach for the building technological aspects is having an integrated design, such as circularity, water management and waste reduction. Global Housing is also one of few Architecture studios that focus on a managerial aspect to see whether a project is feasible, which is especially important with regards to this housing project specifically for low-income families.

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

At the start of the graduation project, my focus for our Environment and Territory research group was on climate change and the problems that come with it, such as natural disasters and flooding, which is an important issue in Sylhet and the Haors.
While visiting Sylhet, something that stood out was the scale of waste pollution on the streets and the riverbanks. This led me to do more research into this waste management issue and I found that not only does the waste that pollutes the river and the gutters affect the water quality, it also exacerbates the flooding issues, as the water has nowhere to go.
For this reason, a design idea was based on the usage of this waste as a building material.
A problem I later faced was that waste pollution plays a significantly smaller role in my preferred design location, the Haors, because of the unique ecosystem. So the decisions I faced were: do I bring more waste into the Haors from the city in the form of building materials made from plastic? Do I change my design location to fit the specific topic of recycling plastic waste into building materials? Or do I rethink the way waste, or the lack of waste, can be brought into the design and research?
In hindsight, I was so, set on the idea of using solid/plastic waste as a building material that it influenced and delayed research into other possibilities. After consulting with my tutors, I looked into the idea of circularity and reusing, instead of recycling. This opened up the possibility to re-use materials that would normally turn into building waste, thus reducing waste by maximizing the material's potential for certain uses. This is especially important in a flood-prone area.
At the current stage of this project, plastic waste remains relevant in the form of a small waste management system that is more of a social aspect of the project than part of the actual building design.

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

As mentioned in my research plan, the fieldwork was definitely an essential research method. Something I noticed after we returned to the Netherlands, is how little information we really gathered during our short visit in the Haors. I really wished we had more time to walk around, talk to people and be able to sit, draw and assess. Because the daytrip to the Haors was so rushed, I did most of the Haor fieldwork research after the fieldtrip based on the video's and photo's I took, trying to piece everything together.

Thankfully there were more research articles and documents about the Tanguar Haor than previously expected, so this definitely filled some of the gaps in my field work. Unfortunately the Tanguar Haor is very large, so it's possible that this information isn't entirely specific to my design location.
Afsary Toma from Marina Tabassum's office has been a significant help during research for any and all questions regarding the specific site, since she did her own thesis about the Haors and lived there for a few months.

Something that I have found lacking in my own research and design approach, is the use of case studies. I have definitely looked at case studies, but I wish I dug deeper into specific case studies, as well as the architects' intention behind design decisions and their philosophies. Aside from the Khudi Bari by MTA, it was also quite difficult to find case studies that are located in a similar ecosystem as the Haors.
Another criticism on my own approach, is that I've found it quite difficult to simultaneously do research and work on my design. During my research I barely worked on my design and while working on my design, I barely managed research, unless it was for very specific issues I faced. Because there are so many aspects to the graduation project, it is very easy for me to only focus on one or the other.

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

My project focuses on circularity and reusing as many building materials from the old settlement as I can. Since construction is such a large polluter globally, I think this project really adds societal value in that regard. Especially if you look at how so many buildings are taken down to make room for something new, instead of being renovated. If the building is really not up to standards anymore, looking into how to reuse or even recycle the building waste into the new project could really lessen the impact on the environment.
Another aspect that many of us will be facing in our projects, are floods due to climate change. In this project, specifically in the Haors, I focus on living with the water, instead of trying to keep the water out. To learn to live with nature instead of fighting against it, is, in my opinion, a very important angle to take into account.

In terms of ethical aspects, it has been quite difficult to decide what a 'better' way of living is for people of a culture that is entirely different from my own. For example, who am I to decide that bathing in a bathroom is better than bathing in a river? Of course my literature research concludes that the river is polluted, which is a strong argument for this design decision, but it still feels unethical to tell someone how they should live. We come into their home and decide that their current way of living in what we call 'shacks' isn't good enough and so we build them a new and better home according to our standards.

As architects we, of course, do have more than mere opinions supporting our claim of what makes a better home, but who says the inhabitants of the region agree? In a real-life situation we would be in actual contact with the residents to make sure that our decisions affect them positively. This personal and on-site contact for the duration of the project is something that has unfortunately not been possible. Hence, our decisions are mainly based on our short fieldtrip, research and our own knowledge, which is hopefully enough to ensure fitting solutions to the assessed problems.

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

One of the important parts of my design is to keep most of the trees in the current settlement, since they strengthen the embankment and create much needed shade. From the start of this project, I wanted to create something replicable but flexible in the larger scale of the masterplan. Flexibility in the masterplan was not just necessary to be able to build around the trees, but also to accommodate the organic landscape of the embankment. The current design is made up of an L-shaped unit with 5 dwellings that can be arranged into courtyards, either closed courtyards, or U-shaped open courtyards, based on what the landscape allows. Generally the L-shape can be transferred as is, but if the context demands it, it is also easy to take away or add dwellings to the standard unit, as the designed structure and shape allow for it.
This flexibility makes it easy to recontextualise the design in other wetland communities, and possibly even in an urban environment.
6. How did the unique design location of the Haors influence and challenge your project?
The first important aspect of the Haors is how the site changes each season. During the dry season, the farmlands are used, but during the wet season their occupation changes and the accessibility of the settlement is limited to water transport. During flash floods, even the embankment isn't high enough to protect the people living in the region. However, adding height to the embankment will create a divide between the settlement and the farmlands during dry season. So, then, how do you design a house that is flood resilient? Creating a house on poles seems to be the most logical solution, although social activities for the inhabitants all happen in the courtyards and the streets, creating a strong need for there to also be a ground floor connection.

7. What is your role as an architect in the larger political framework of displacement and climate change?

As architects I think we can sometimes get lost in the artistic aspects of the profession and forget that almost everything in this world is political or is influenced by political choices. You can see that with the nitrogen laws in the Netherlands that put a hold on a lot of ongoing projects, but it's also as simple as zoning laws.
Since housing is such an integral part of everyone's lives, no matter which societal group they're part of, architects have quite the impact on peoples lives, and we might not always be aware of it. This is especially true for me, because almost all projects that I have worked on during my studies were never going to be built, so there is this disconnect between the design and the real world, and how it might have affected people down the line. I think the Global Housing Studio especially challenges me to think about how housing can change over time with people's own influence.

I have always found it fascinating on how to balance intention and reality. How to put forward your idea of how something must be, but at the same time be able to let it go and think about how people will actually use or interpret your design.
There are multiple projects where the intention of the architect was a lot different than how it came to be used and perceived by the residents. A good example of this is The Robin Hood Gardens. This project shows what I mentioned before, who are we to decide, or know, what a good design is for people in a different culture or societal group.

I mention all of this because to mitigate displacement and 'fight' climate change we must understand where we have influence and when this influence stops and we must realise the reality of the situation.
As the consequences of climate change are becoming more real each year I think we as architects have a duty to do our part. Construction is one of the most polluting industries in the world, so we must make environmentally conscious choices where we can but we also must build with the predictions of coming decades in our minds.

Conclusion

At this point in the project I have very much focused on finding balance between realistically building for flooding that might get worse with time, and yet also keeping in mind the way people prefer to live.
Moving forward I want to make it explicit and clear to an outsiders perspective, how my design decisions really address the issues and how my design answers my research question. I also want to create hypothetical future scenarios. How people will change my design and how climate change will affect it in the future.
Something I have learned during this process is that I can be quite stubborn at my own detriment. At certain points in the project I knew something was wrong or missing, but I continued because of a lack of time and I thought it would all come together eventually. Unfortunately, in some cases it did come back as a problem and I would have to change it. This is also definitely a part of architecture, the process of redefining and rethinking certain design decisions. In other cases I genuinely was stuck with the issue and could not figure out a solution and had to wait for a tutoring session to discuss and get a different perspective. Something I can take away from this is to learn to step back and look at the whole picture to find a solution on my own, or possibly to discuss it with a fellow student to get an outsiders perspective. This way I would not have to wait for tutoring, which was only once a week, and be more productive with the time I have.

Endnotes

Endnotes

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