



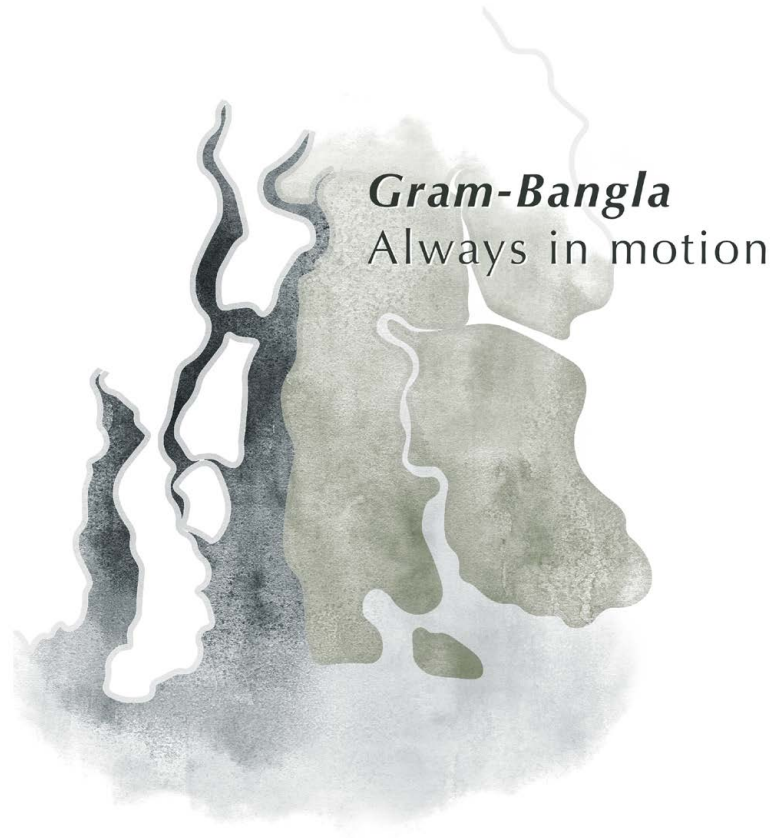
Gram-Bangla, Always in motion

A case of Sundarban Biosphere Reserve, India

ADELINE CONSTANCE
AGRAWAL ISHITA LALITKUMAR
Professor: Fabiano Lemes de Oliveira



POLITECNICO
MILANO 1863



Gram-Bangla
Always in motion

ABSTRACT

Italian

Il cambiamento climatico è una delle sfide più urgenti a livello globale e i Paesi vulnerabili come l'India sono particolarmente esposti alle sue conseguenze. La Sundarbans, la più grande foresta di mangrovie del mondo, è una di queste regioni che si trova ad affrontare gravi sfide legate al clima. Le Sundarbans si trovano nel delta dei fiumi Gange, Brahmaputra e Meghna e sono condivise da India e Bangladesh. L'area ospita circa 4 milioni di persone ed è considerata uno degli ecosistemi più fragili a livello globale. Le caratteristiche paesaggistiche dell'area portano a una costante evoluzione e a una perpetua trasformazione dei suoi costituenti.

Le Sundarbans devono affrontare una moltitudine di sfide poste dal cambiamento climatico, come l'intensificazione dei cicloni e l'aumento del livello del mare, che portano a un'enorme perdita di biodiversità e habitat. Gli effetti cumulativi di queste sfide hanno portato a una scarsa gestione delle risorse nelle aree rurali, con conseguente migrazione di massa e scarso sostentamento delle comunità. La regione è un esempio di come le aree vulnerabili siano più soggette alle conseguenze del cambiamento climatico e di come affrontarle sia fondamentale per costruire la resilienza in questi luoghi.

Le soluzioni basate sulla natura (NBS) sono emerse come un approccio promettente per mitigare gli impatti dei cambiamenti climatici. Si tratta di un insieme di pratiche che utilizzano i sistemi naturali per affrontare le sfide ambientali, sociali ed economiche. Misure paesaggistiche innovative possono promuovere una migliore gestione delle risorse nel contesto rurale delle Sundarbans.

I paesaggi umanitari sono misure paesaggistiche dinamiche e flessibili che rispondono alle esigenze delle comunità vulnerabili, anche in uno scenario post-catastrofe. Inoltre, i metodi indigeni di gestione delle risorse hanno il potenziale per fornire preziose indicazioni sulle pratiche di uso sostenibile del territorio nelle Sundarbans. In conclusione, i principi di progettazione adattativa e resiliente sono fondamentali per sviluppare paesaggi in grado di resistere agli impatti dei cambiamenti climatici in futuro.

ABSTRACT

English

Climate change is one of the most pressing global challenges, with vulnerable countries such as India being particularly susceptible to its consequences. The Sundarbans, the world's largest mangrove forest, is one such region facing severe climate-related challenges. The Sundarbans is situated in the delta of the Ganges, Brahmaputra, and Meghna rivers and is shared between India and Bangladesh. The area is home to approximately 4 million people and is considered one of the most fragile ecosystems globally. The landscape characteristics of the area lead to a constant evolution and perpetual transformation of its constituents.

The Sundarbans faces a multitude of challenges posed by climate change such as the intensification of cyclones and escalating sea levels, leading to a huge loss of biodiversity and habitat. The cumulative effects of these challenges have led to low resource management in rural areas, resulting in mass migration and poor community livelihood. The region is an example of how vulnerable areas are more prone to the consequences of climate change, and how addressing these is critical for building resilience in such places.

Nature-Based Solutions (NBS) have emerged as a promising approach to mitigating the impacts of climate change. These are a set of practices that make use of natural systems to address environmental, social and economic challenges. Innovative landscape measures can promote better resource management in the rural context of Sundarbans.

Humanitarian landscapes are dynamic and flexible landscape measures that are responsive to the needs of vulnerable communities, even in a post disaster scenario. Moreover, indigenous methods of resource management have the potential to provide valuable insights into sustainable land-use practices in the Sundarbans. In conclusion, adaptive and resilient design principles are critical for developing landscapes that are capable of withstanding climate change impacts in future.

ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to Professor Fabiano Lemes de Oliveira for his invaluable support and guidance throughout our academic journey. His encouragement, feedback, and assistance were instrumental in the completion of this thesis. We would also like to acknowledge the contributions of our friends and family, whose unwavering support and love sustained us throughout this challenging process.

THESIS STATEMENT

“Mitigating the coastal impact and adapting to sea level rise by implementing innovative rural Nature Based Solutions and providing refuge for a balanced human-nature coexistence”

1. What are the nature based tools which can be used to mitigate climate impact in vulnerable areas?
2. Can the introduction of landscape and environmental measures build a resilient ecosystem for the sundarbans?
3. What are Humanitarian landscapes? Can they be a solution to striking a balance between human and nature in the Sundarbans Biosphere reserve?
4. How can water become an asset rather than a threat to the Sundarbans population?
5. How can humans coexist with the cyclones and rising salinity levels in the Sundarbans?

KEY WORDS:

Mitigation, adaptation, resilience, mangroves, coastal impact, Nature-Based Solutions, rural landscape, humanitarian landscape, climate action, cyclone prone area, indigenous practices

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A Catalogue of Rural Nature-Based Solutions



INDIA'S CULTURAL HERITAGE

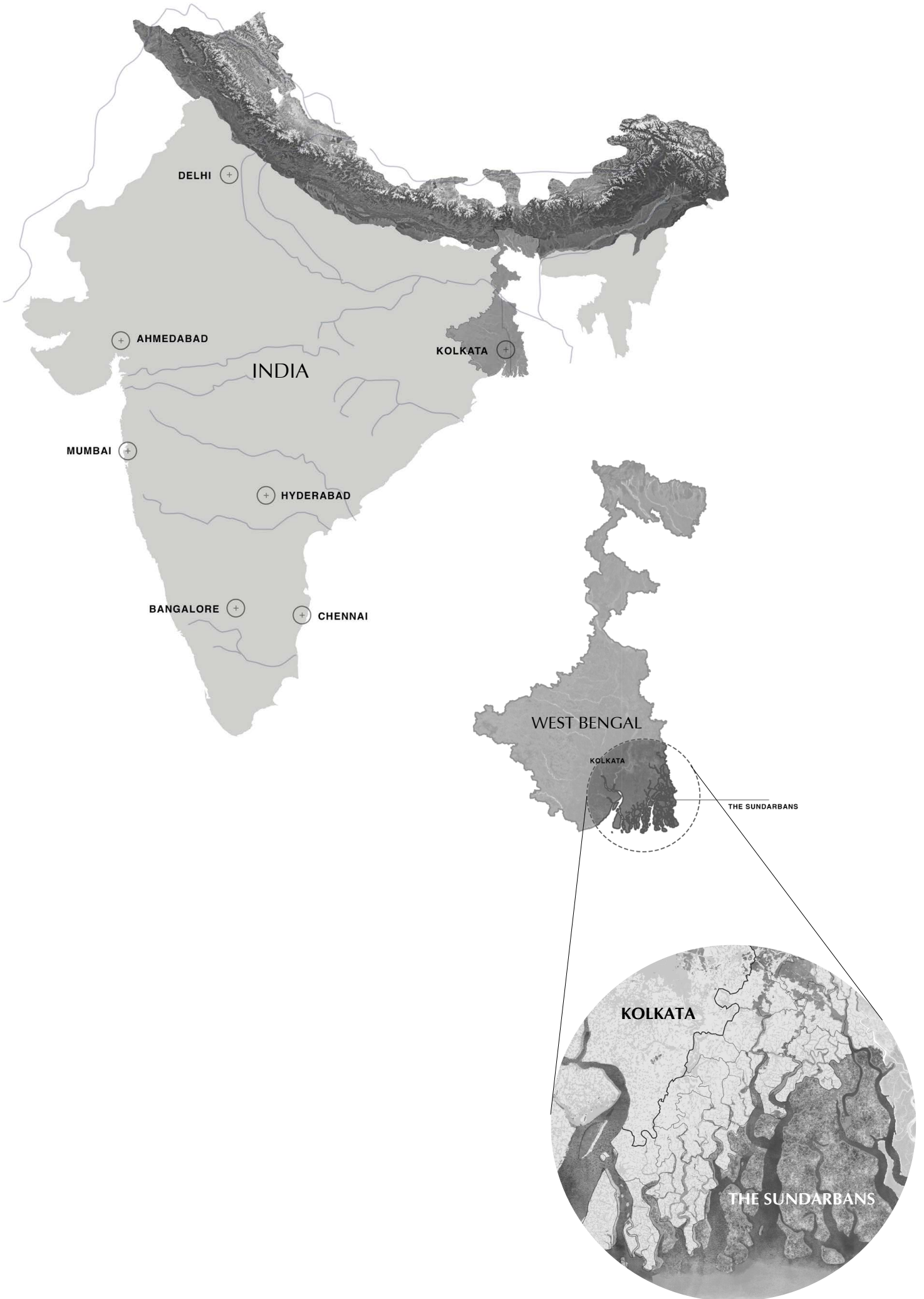


INTRODUCTION

India is a country located in South Asia, with a population of approximately 1.366 billion people as of 2021 (World Bank). The majority of India's population lives in rural areas, with around 65% of the population residing in rural communities (World Bank). Agriculture is a major sector of the Indian economy, employing around 60% of the population and contributing to about 16% of India's GDP (National Portal of India). However, India is facing significant challenges related to climate change, including more frequent and severe extreme weather events, sea level rise, and changes in rainfall patterns (World Bank). As a result, India is highly vulnerable to the impacts of climate change.

West Bengal is a state located in the eastern region of India, bordering Bangladesh to the east. Its capital and largest city is Kolkata, which is a major cultural, commercial, and educational hub of the region. **Kolkata** has a rich history and was once the capital of British India. West Bengal is also home to diverse landscapes, including the Himalayas in the north and the Sundarbans mangrove forest in the south.

The Sundarbans forest, located in the southern part of West Bengal, is the **world's largest mangrove forest ecosystem**, covering an area of approximately 10,000 km (World Wildlife Fund, n.d.). The Sundarbans is home to a diverse range of flora and fauna, including the Bengal tiger, saltwater crocodile, and several species of birds and reptiles (World Wildlife Fund, n.d.). The Sundarbans is also a **UNESCO World Heritage Site and a Ramsar Wetland of International Importance** (UNESCO, n.d.; Ramsar Convention, n.d.).



DEMOGRAPHICAL DATA

Factors shaping West Bengal

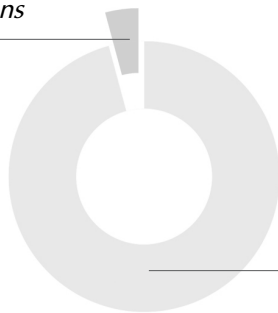


West Bengal is the fourth most populous state in India with a population of around 103 million, and a population growth rate of approximately 9.13% between 2011 and 2021. However, around 19.98% of the population lives below the poverty line, and approximately 15 million people, or 15% of the total population, are vulnerable to cyclones.

The state has also seen significant urbanization, with the urban population representing around 36.4% of the total population. This urbanization is supported by a diverse industrial base, with major industries including jute, tea, textiles, chemicals, and engineering.

Approximately 4.5 million people live in the Sundarbans Biosphere Reserve, highlighting the importance of balancing economic development with environmental protection in West Bengal.

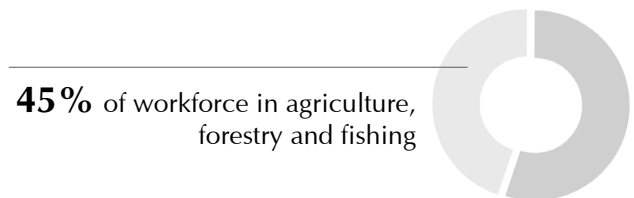
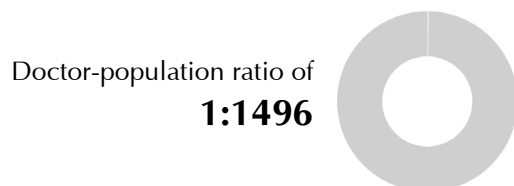
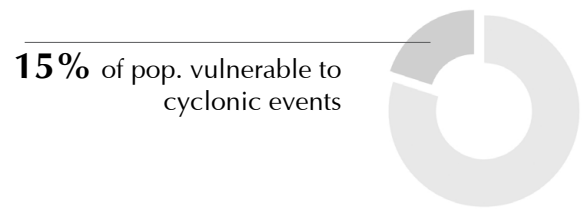
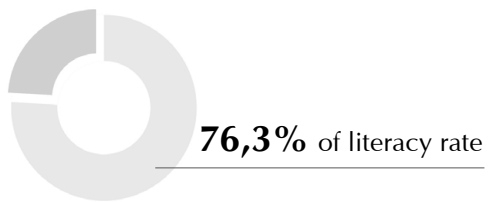
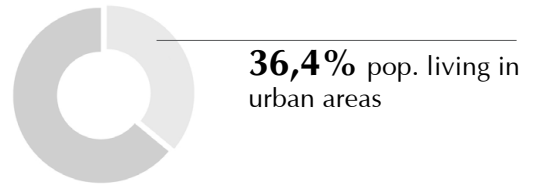
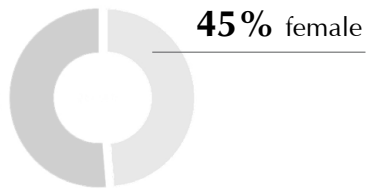
4,5million
The Sundarbans



98,5million
West Bengal

9% pop. growth
2011 - 2021





GLOBAL SCALE ANALYSIS





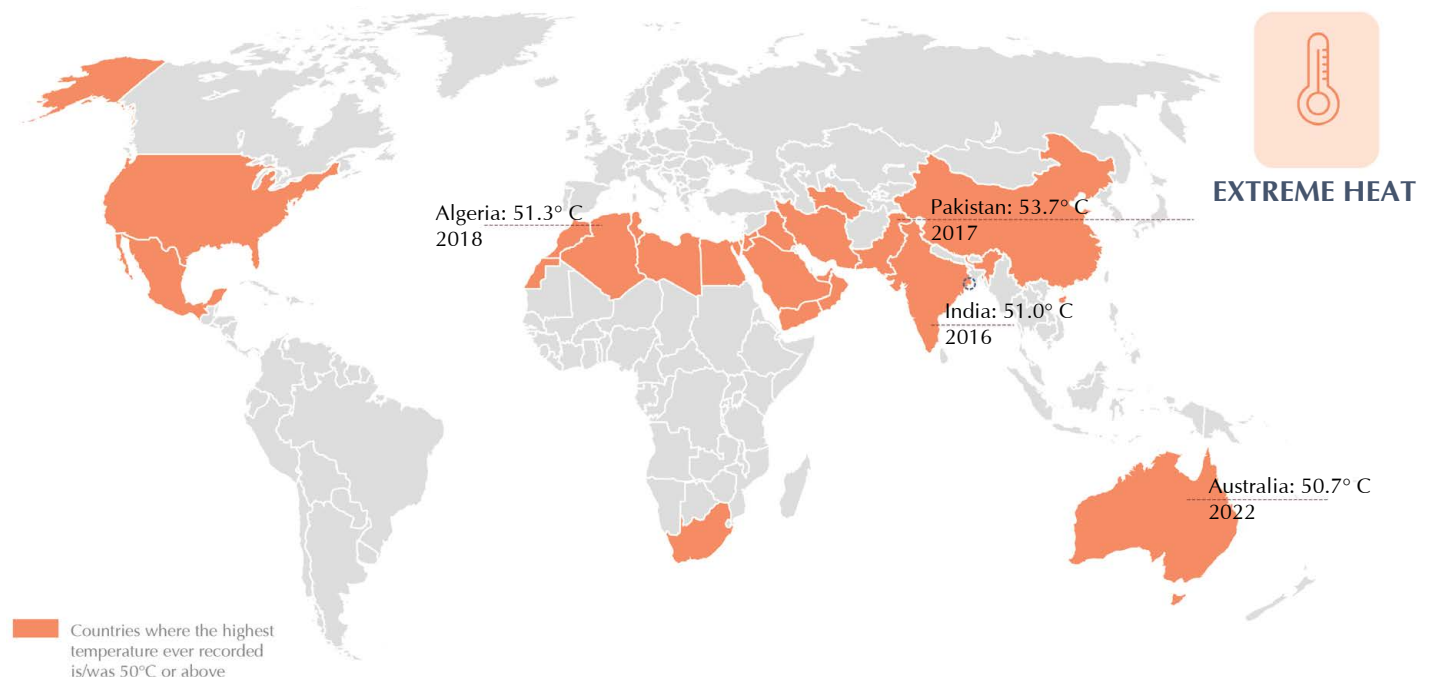
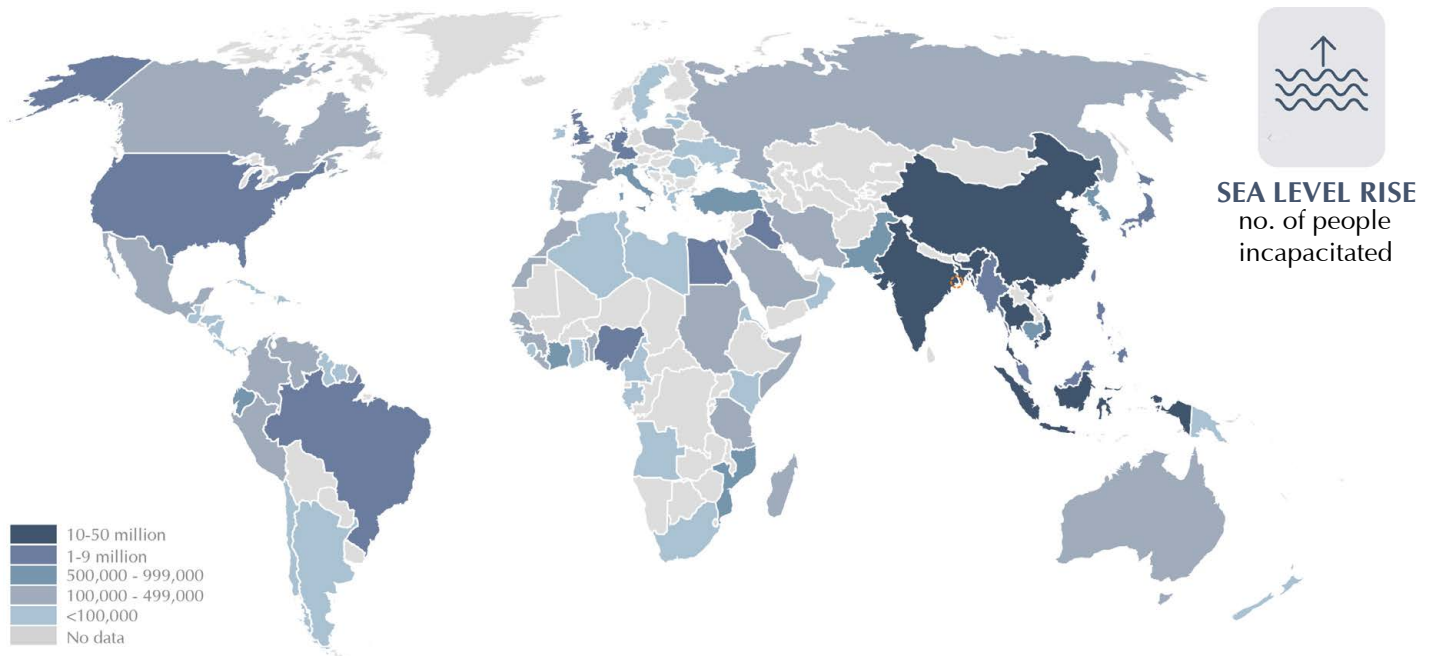
CLIMATE MAPPING

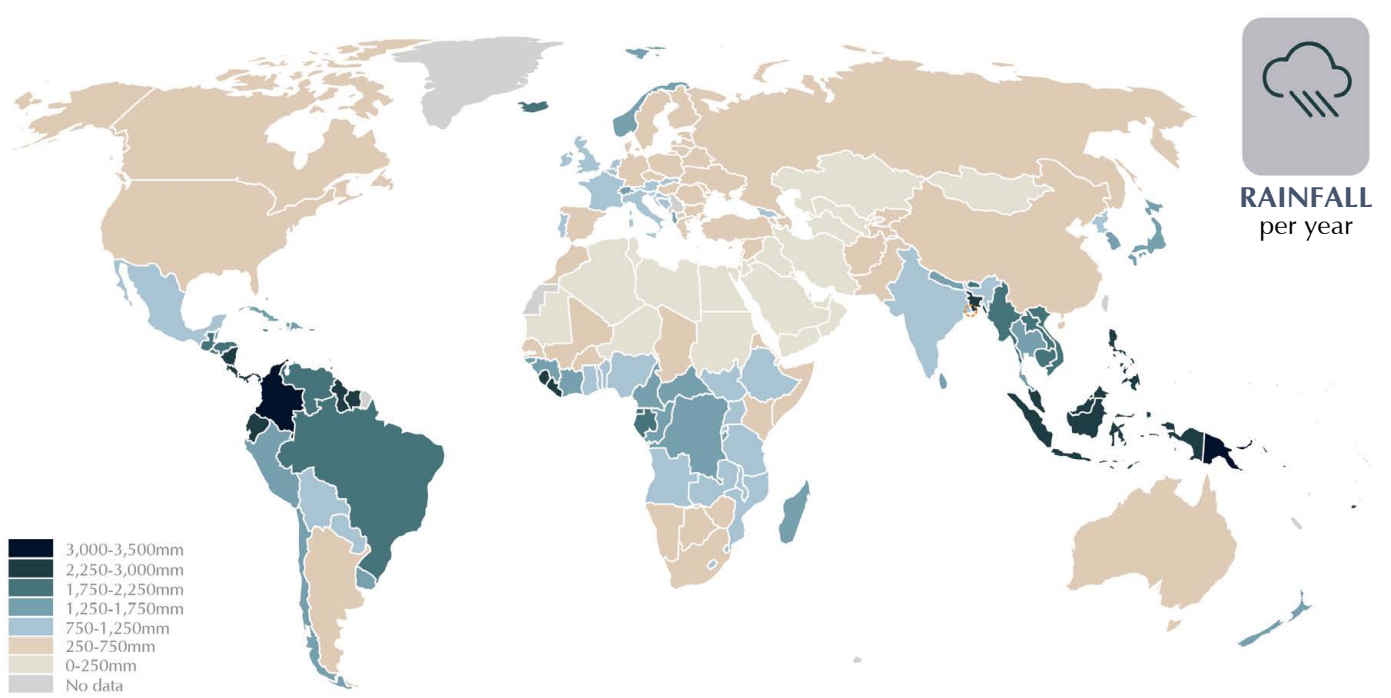
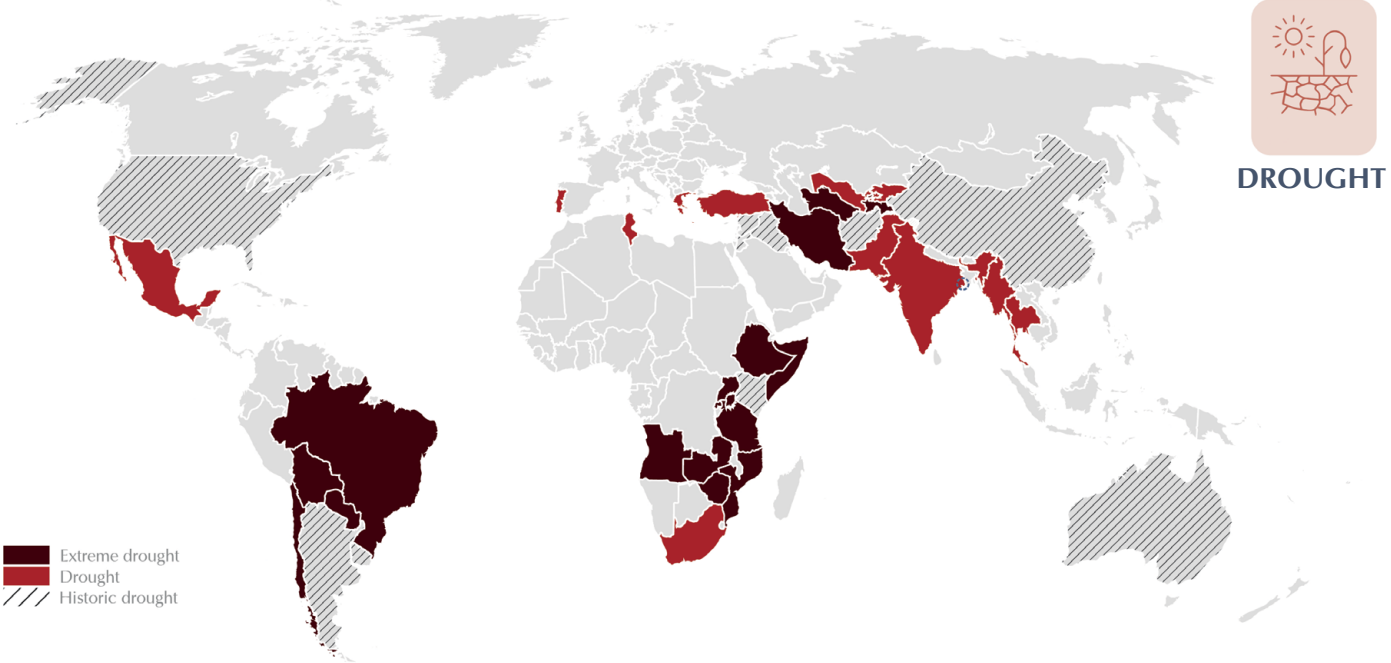
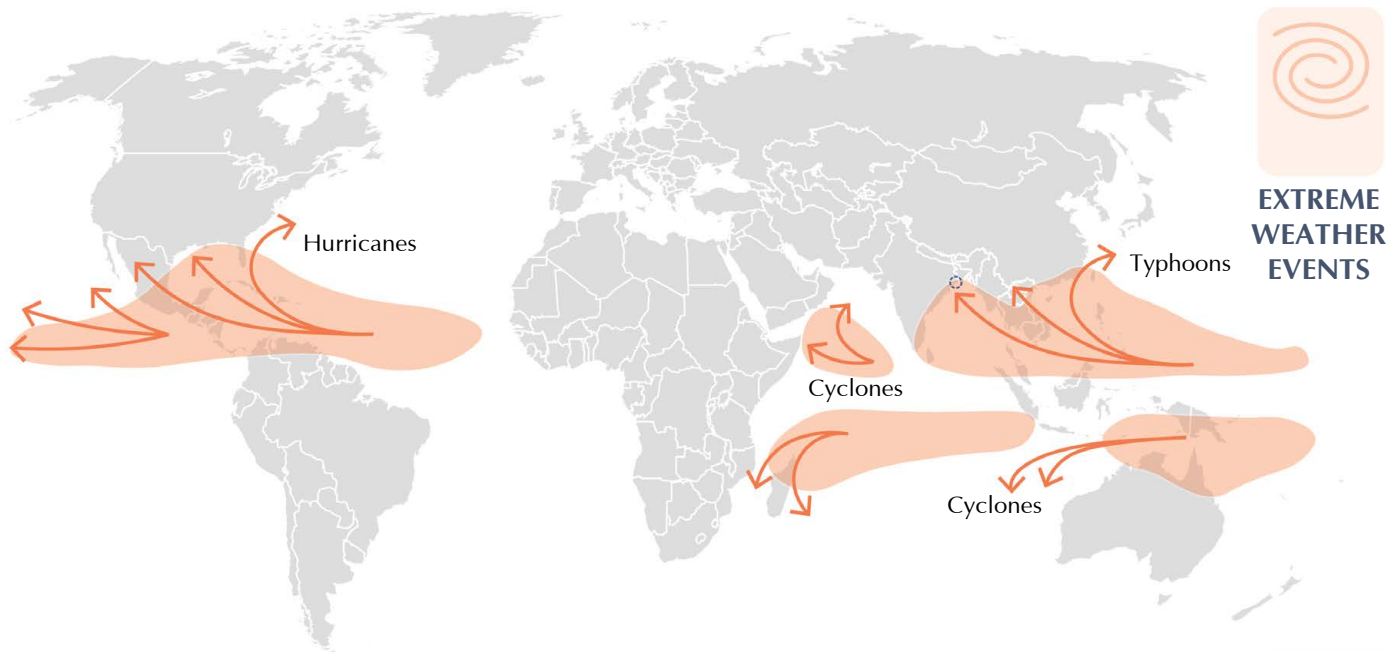
Challenges of the World

Since the onset of the Industrial Revolution, human activities such as burning of fossil fuels, deforestation, and agriculture have led to a significant increase in greenhouse gas concentrations in the atmosphere (IPCC, 2014). The concentration of carbon dioxide in the atmosphere has increased by 47% since pre-industrial times (NASA, 2022), and has led to climate change, which poses direct consequences to our planet's balance and ecosystems.

The most pressing threats posed by climate change are sea level rise and extreme weather events, such as heatwaves, droughts, cyclones, and heavy rainfall. Sea levels have already risen by 21-24 cm since 1880 and are projected to rise by another 30-120 cm by 2100 (IPCC, 2019). Extreme weather events are becoming increasingly common and intense, leading to significant damage to infrastructure, property, and human life (IPCC, 2014).

Certain countries are more vulnerable to the impacts of climate change than others, with developing nations being particularly at risk due to their weaker economies, limited resources, and geographical location (UNFCCC, 2018). India is the second-most populous country in the world, with a population of around 1.4 billion (UN, 2022). The state of West Bengal, which is home to the Sundarbans forest and the city of Kolkata, has a population of 91 million (Knoema, 2021). This region is particularly vulnerable to climate change impacts such as sea level rise, salinity intrusion, and flooding and more (UNDP, 2020).





Mangroves represents
14,8 million ha

Mangroves forests are present in
113 countries
out of 223

'MANGROVES AS A SOLU



'Globally, the area of mangroves decreased by

1,04million ha

between 1990 and 2020'

More than

60 species

of mangrove trees in the World

TION TO CLIMATE CRISIS'



The Sundarbans



The distribution of Mangroves around the World

Source: Global Forest Resources Assessment (FRA), 2020; World Wild life

“Mangroves cover only 0.1% of the Earth, yet they could literally ‘save the world’.”



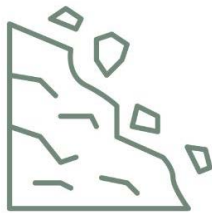
1. Climate Regulation

Mangroves can store up to 10 times more carbon per hectare than a conventional land forest in their leaves, roots, wood and sediments they are holding. In addition, they stabilize the temperature.



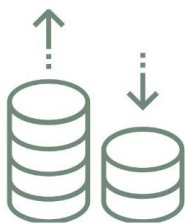
2. Biodiversity and Habitat

They may occupy only a fraction of the earth's surface (just 0.1%) but mangroves are home to nearly 60 unique species. There are 40 species of birds, 10 species of reptiles, six species of mammals, and one species of amphibians found only in this ecosystem.



3. Erosion

The roots of the mangrove prevent from soil erosion, reduce the impacts of cyclones and stabilize the coast



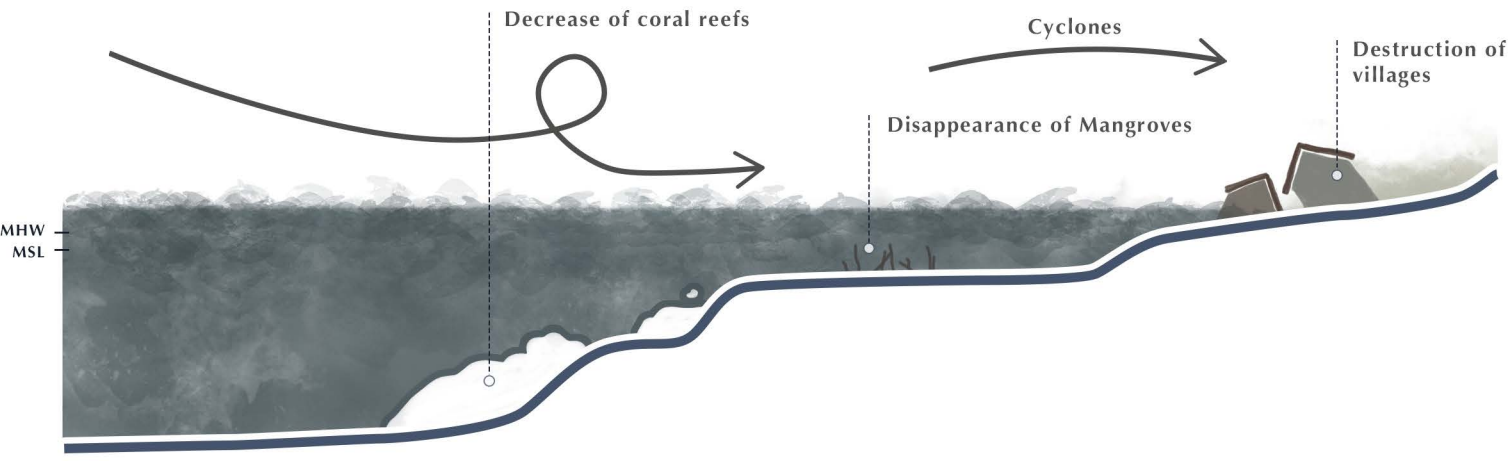
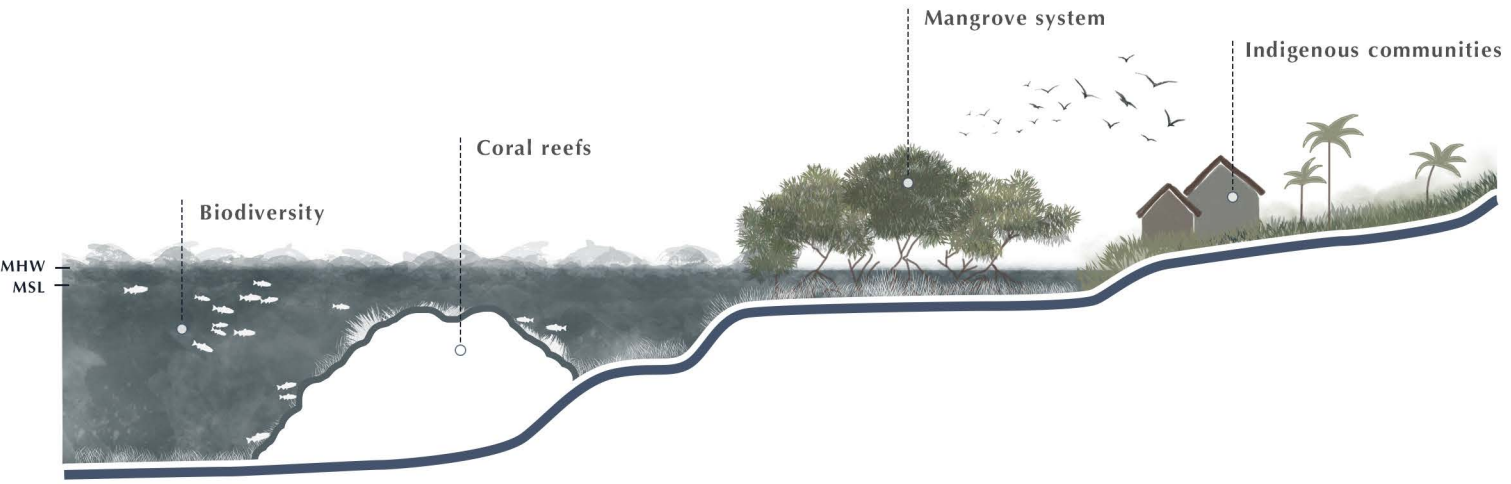
4. Resource and Economy

They are an essential source of income for local populations. From small-scale fishing to sustainable logging, mangroves are an integral part of the way of life of local people.



5. Air and water quality

The roots of the mangrove stabilize the coast. The impressive network of submerged roots acts as a filter for sediment, helping to clean up the waterways.



How does the Anthropocene impact biodiversity in these ecosystems ?
 Since 2000, more than 35% of these ecosystems have disappeared on a global scale.
 This reduction is a direct consequence from pollution, acidification of the ocean, sea level rise, deforestation oil spills, etc.



TERRITORIAL ANALYSIS

+ HIMALAYA

+ HOOGHLY RIVER

+ KOLKATA





SUNDARBANS

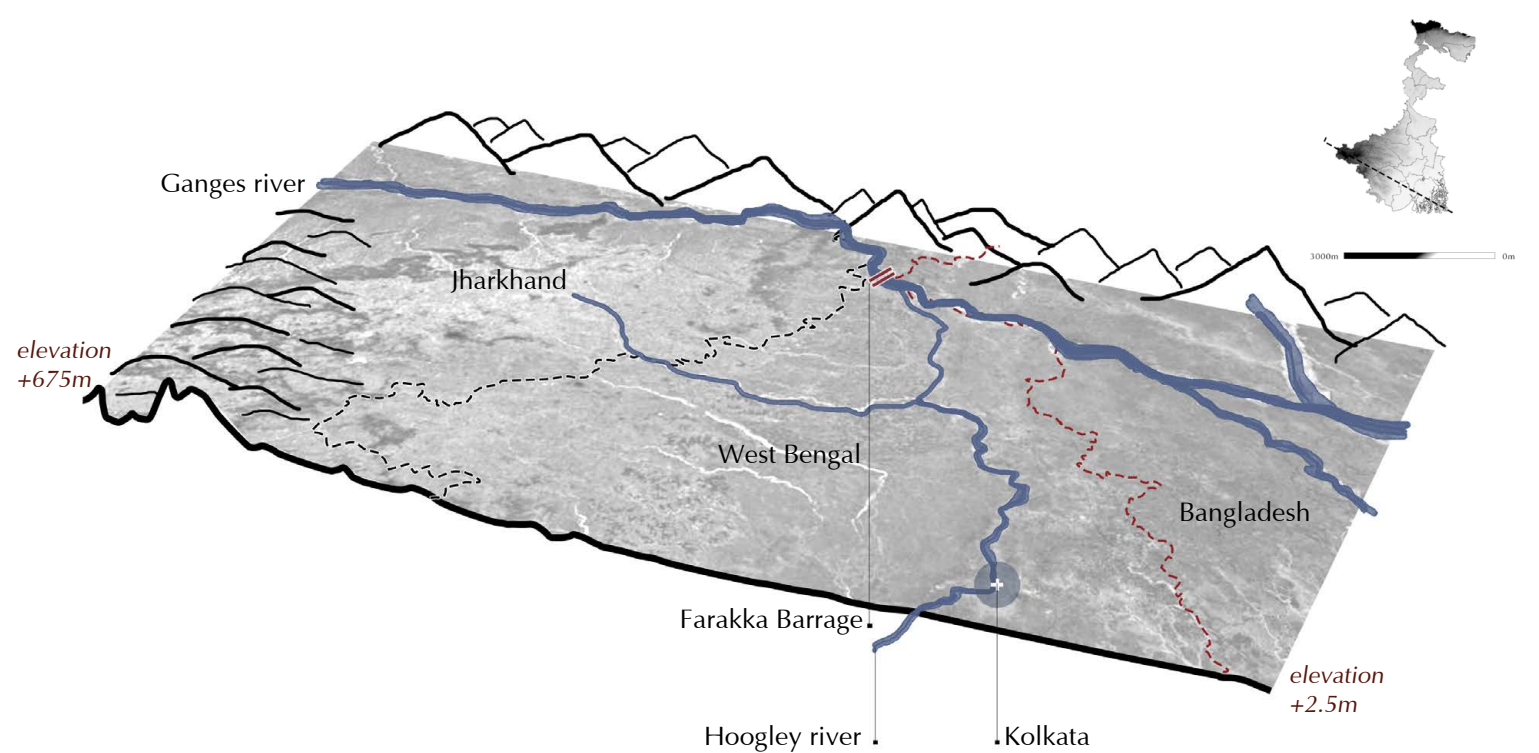
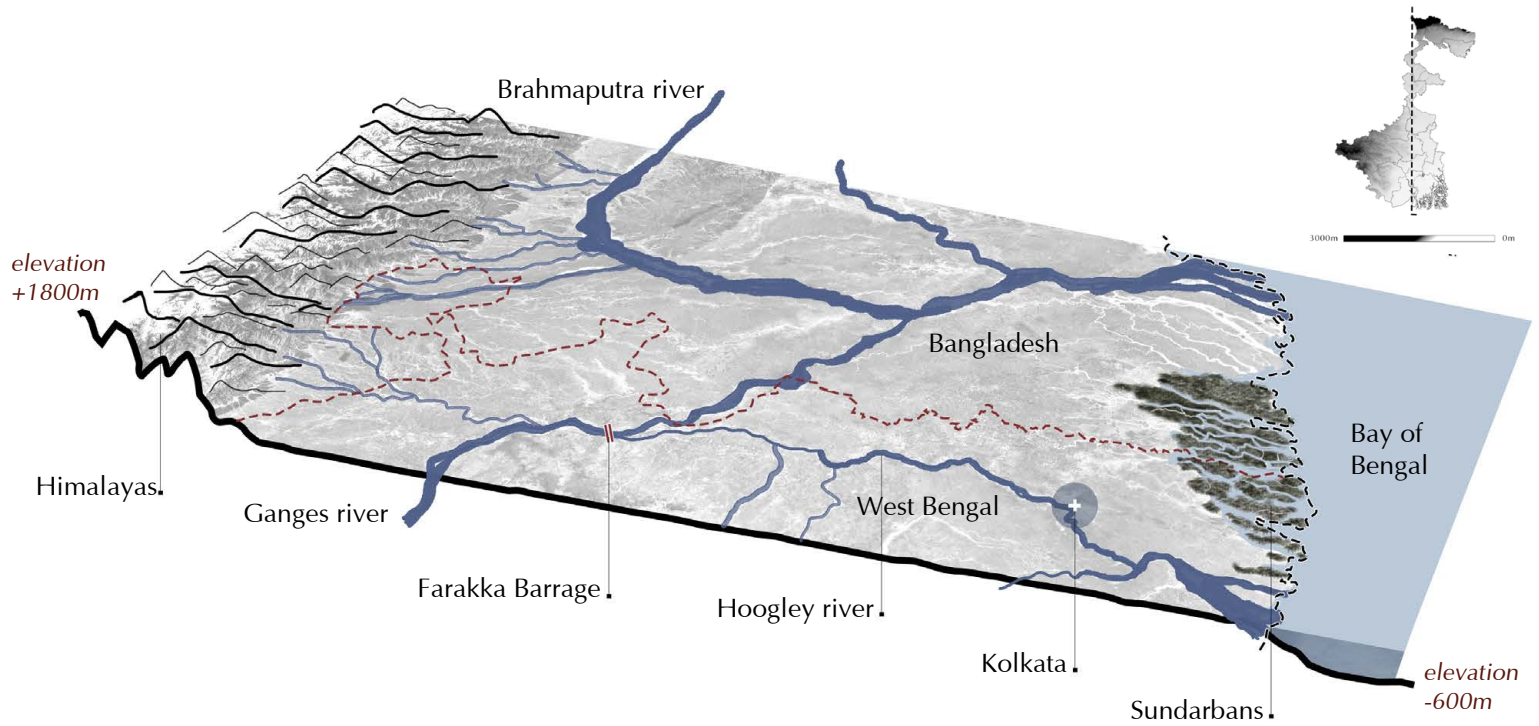
BLUE INFRASTRUCTURE

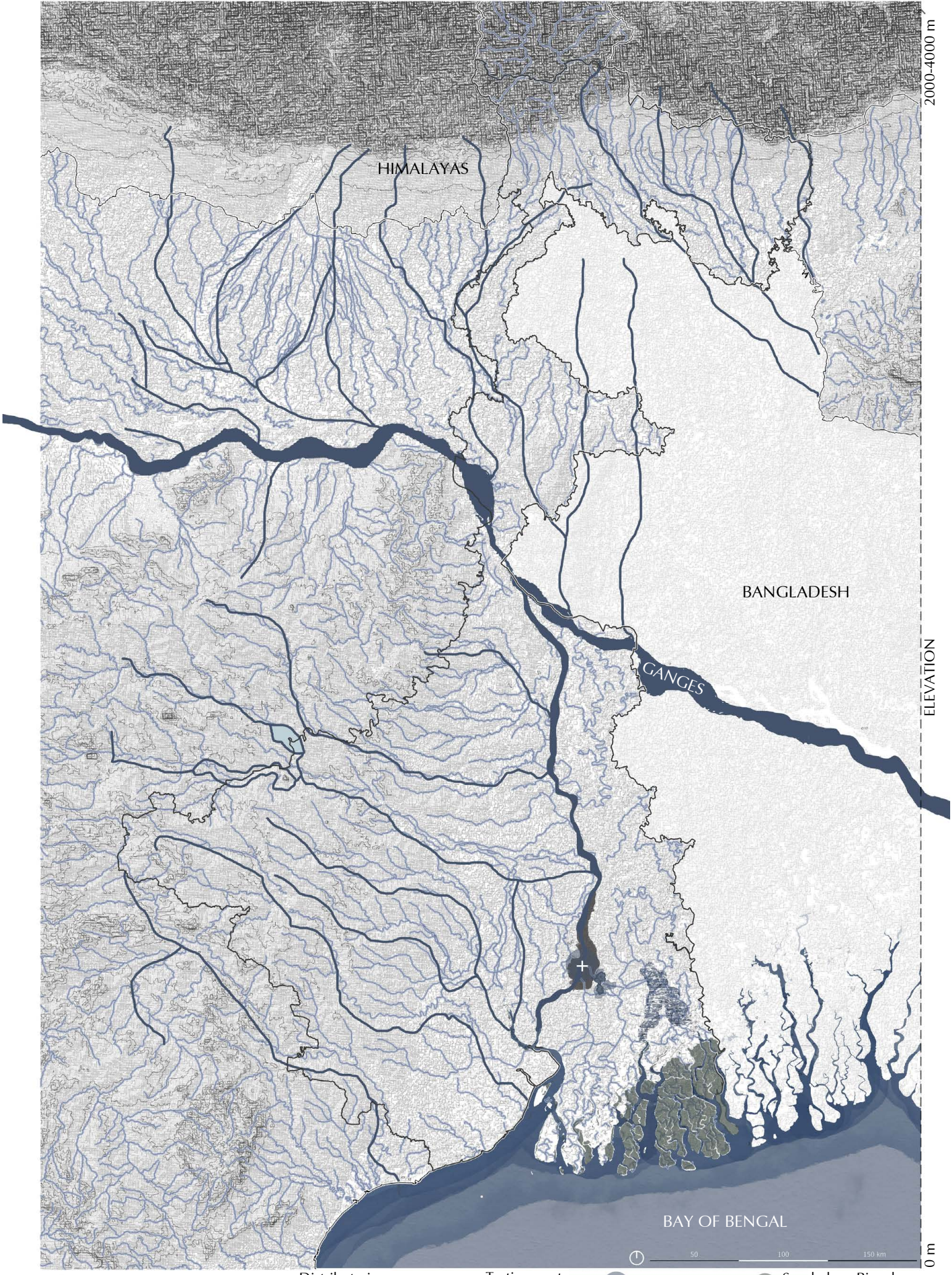
Water Systems

West Bengal is composed of numerous different water systems. Primarily the River Ganges with its tributaries and distributaries.

The unique feature of geography of the state from north to south (northern part being Himalayan Range, central being the Gangetic plains and the extreme south being Bay of Bengal covered by the Blue forests of Sundarbans) and west to east defines the flows of these systems. The complexity of these blue systems increases in the southern end with the presence of Hoogly (freshwater river), wetlands/Aquaculture, the Sundarbans (mangroves), estuaries and Bay of Bengal.

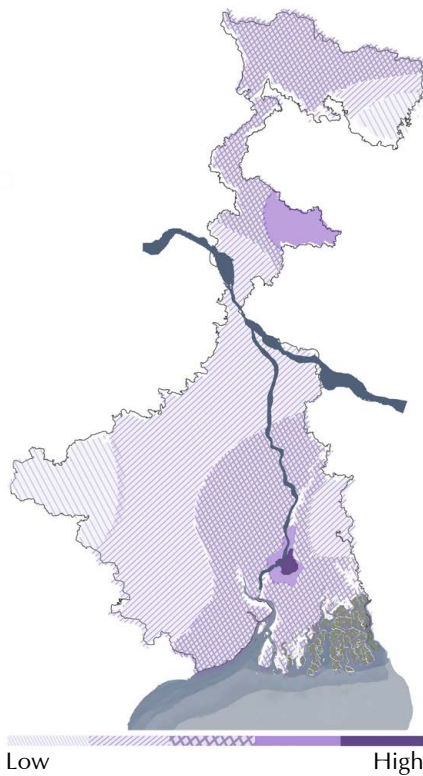
Territorial Analysis



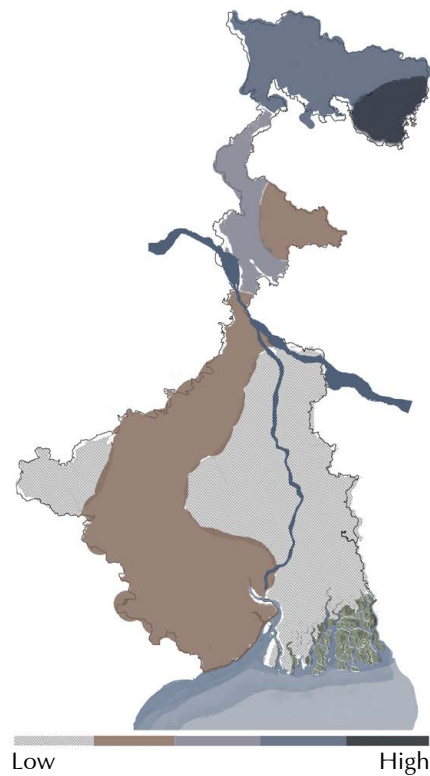


WATER RESOURCES AND RISK ASSESSMENT MAP

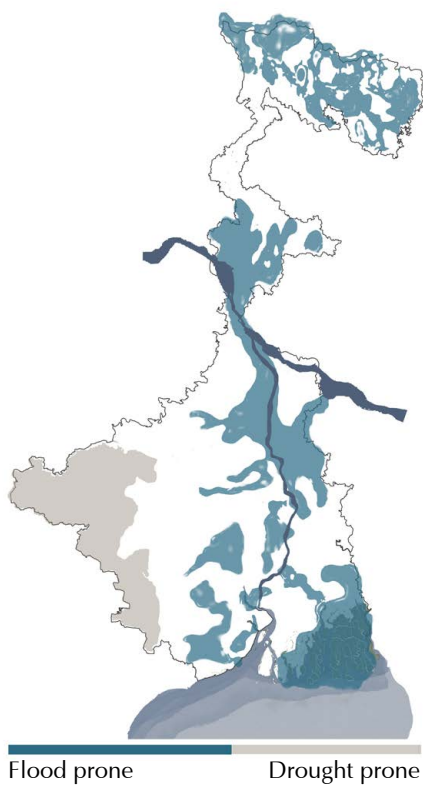
Analysis



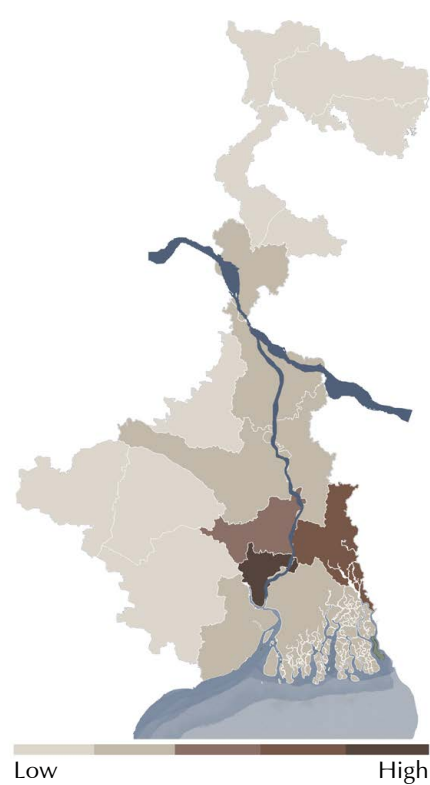
WATER DEMAND is very high in Kolkata due to high concentration of population and intensive farming in the southeast part of the state.



WATER AVAILABILITY map indicates that most water-stressed regions are the ones owing to moisture scarcity in the west and great demand of water in the southeast.



FLOOD PRONE ZONES are low-lying areas which get flooded due to topography and remain waterlogged for long periods due to lack of proper drainage.





POPULATION PRESSURE is the highest in Kolkata and the south eastern part of the state, decreasing towards the Sundarbans.

This stretch faces issues of **high water demand, low portable water** availability and is a **flood prone zone** moving from high population density end (Kolkata) to lower population density (Sundarbans), making it an important focus area to be resolved.


The **intersection between two water systems** is a critical point, being the area of high population density, flood prone and high water demand. The **presence of freshwater systems** reduces the stress on water availability to some extent.

The transition zone is an area of **high water demand, low fresh water availability, and is a flood prone area** (mainly due to cyclones). This is an area with **low population** in the state giving it a different character.

 Water availability- Highly stressed

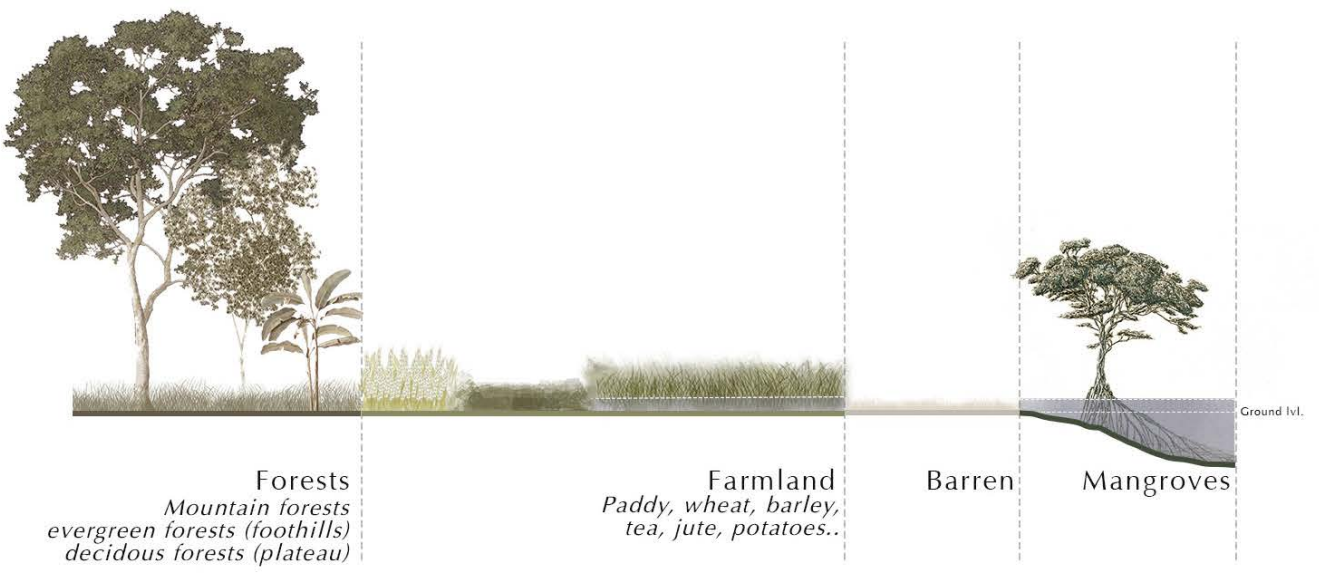
 Flood prone area

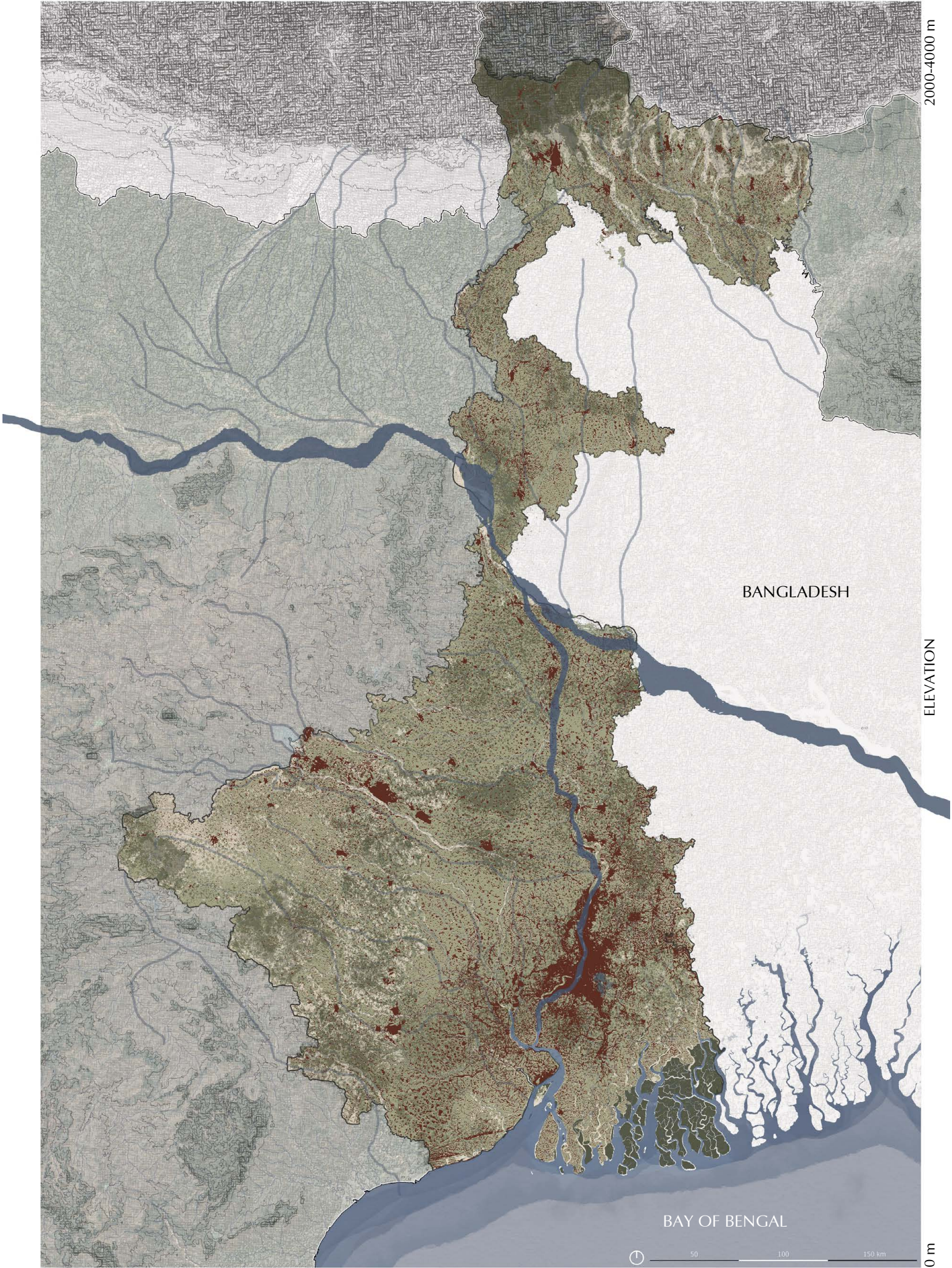
 Water demand

 Population pressure

GREEN INFRASTRUCTURE

West Bengal is composed of various different vegetation, varying topography being one of the biggest reasons, along with different rainfall patterns and temperatures. The state demonstrates Mountain Temperate, Mixed Evergreen Forest, Deciduous Forest, varying varieties of crop cultivation and Mangroves.





2000-4000 m

ELEVATION

BANGLADESH

BAY OF BENGAL



0 m

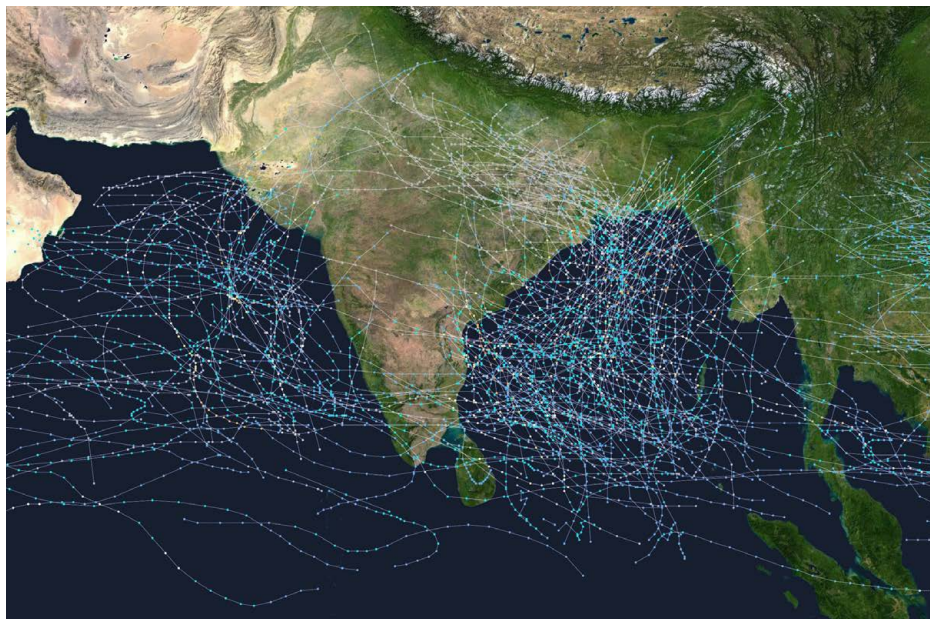
- Mangroves
- Forest
- Farmland
- Fallow/Bare
- Kolkata





SUNDARBANS, 'The Cyclone Capital of India'

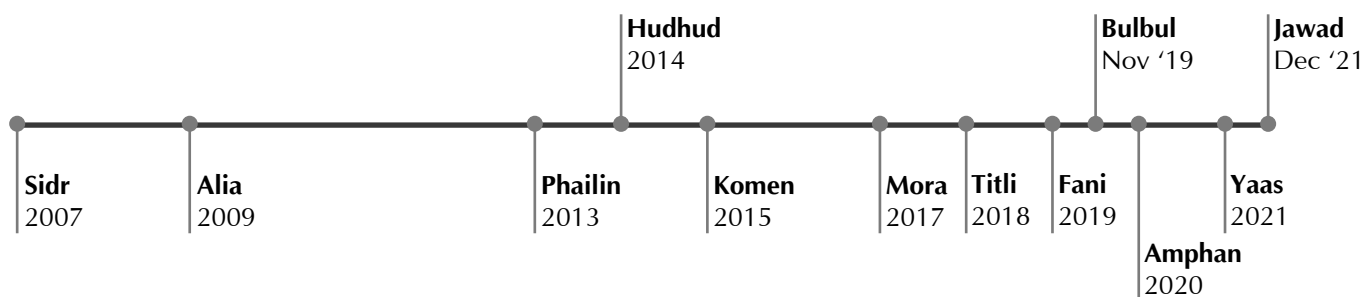
The Bay of Bengal is the most vulnerable area in terms of increasing severe cyclonic storms over the years. The South 24 Paraganas district within the Sundarbans, is one of the most affected, with the return period of cyclonic storms as 1.67 years on a scale of 1.5 to 60 years, according to the India Meteorological Department (IMD). For severe storms, the return period was 2.61 years. Shorter return periods indicate more frequent cyclones.



Cumulative track map of all North Indian Ocean cyclones from 1970 to 2005

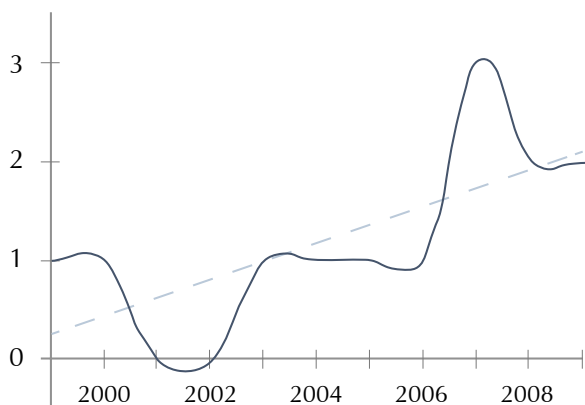
Source: Wikipedia

Increasing Timelines of the cyclones hitting Sundarbans



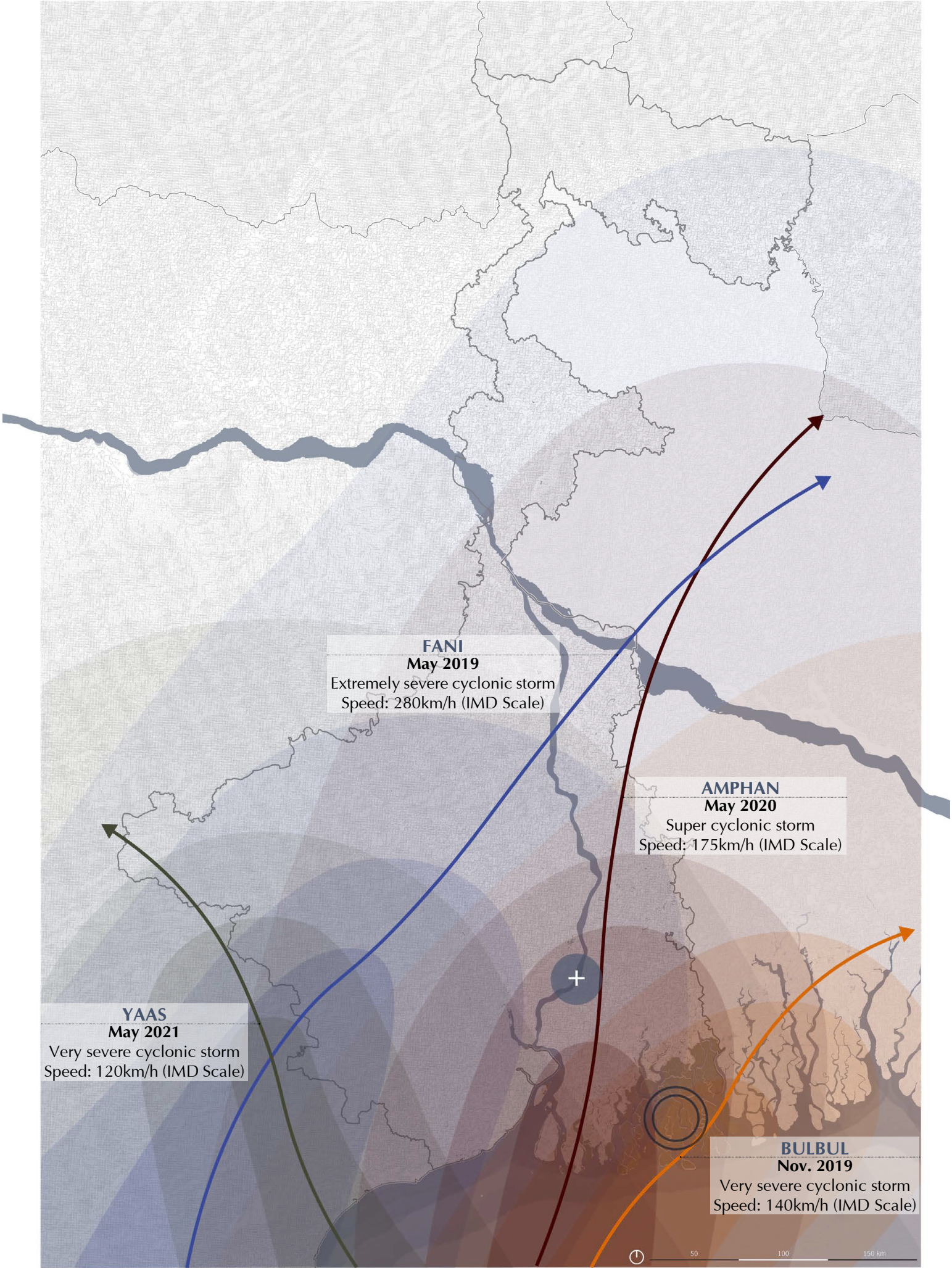
Source: ndtv.com/swasthIndia

Frequency of severe Cyclonic storm over the Northern Bay of Bengal



Source: Sundarbans Future Imperfect, Climate Adaptation Report - WWF

As seen from the graph, the trends of severe cyclones over the Bay of Bengal increased by 26% over the years. From 1999-2005, there were number of depressions, but only three developed into cyclonic storms. However, in the next four years, there were seven such cyclonic storms formed in this area.



+ Kolkata

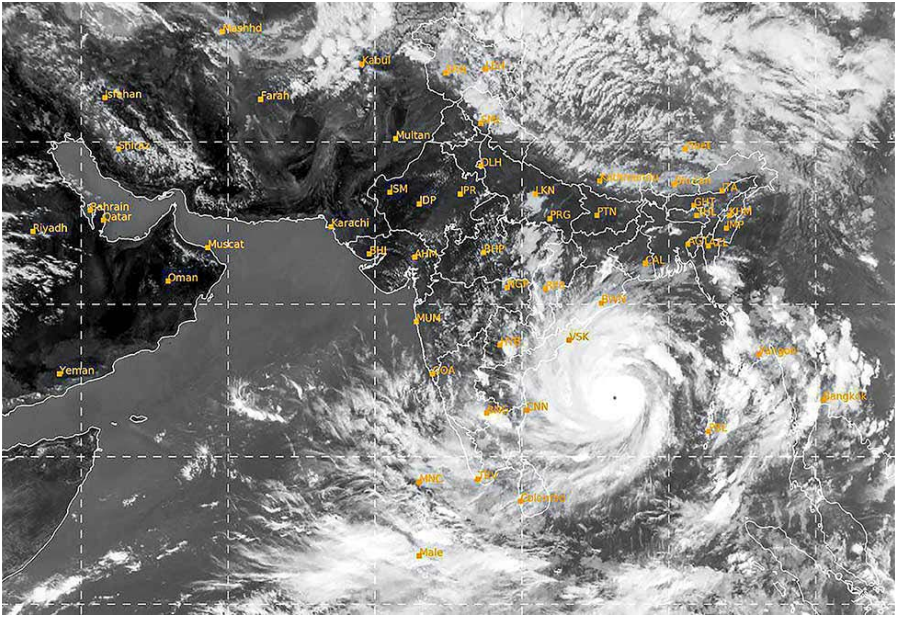
⊙ Sundarbans

IMPACT of the Cyclones

A case of Amphan

Amphan was the first super cyclone to be formed in the Bay of Bengal after 21 years, since 1999. It caused a huge destruction in the Lower Deltaic West Bengal, including the Sundarbans and the Community development blocks.

After forming a depression in the Bay of Bengal and with increasing wind speeds, Amphan hit the coast of Sundarban on 20th May, 2020 with an average speed of 185km/h. Around 158,000 ha of mangroves were severely damaged in the region, projecting a destruction of 28% in Sundarbans. Fortunately, the landfall of the cyclone happened during a low tide time, hence saving the area from an even bigger disaster.



Source: India Meteorological Department, Pune

'Water water everywhere, not a drop to drink'



Source: Ismail Ferdous/Alexia Foundation

Loss/Severe damage to rural housing, causing the loss of shelter for most of the village population



Intrusion of Saltwater in Agricultural fields, destroying the yield of crops and making the land unusable for coming 2/3 years

Damage to Infrastructure, with the flooding of several public and private buildings, including the cyclone shelters



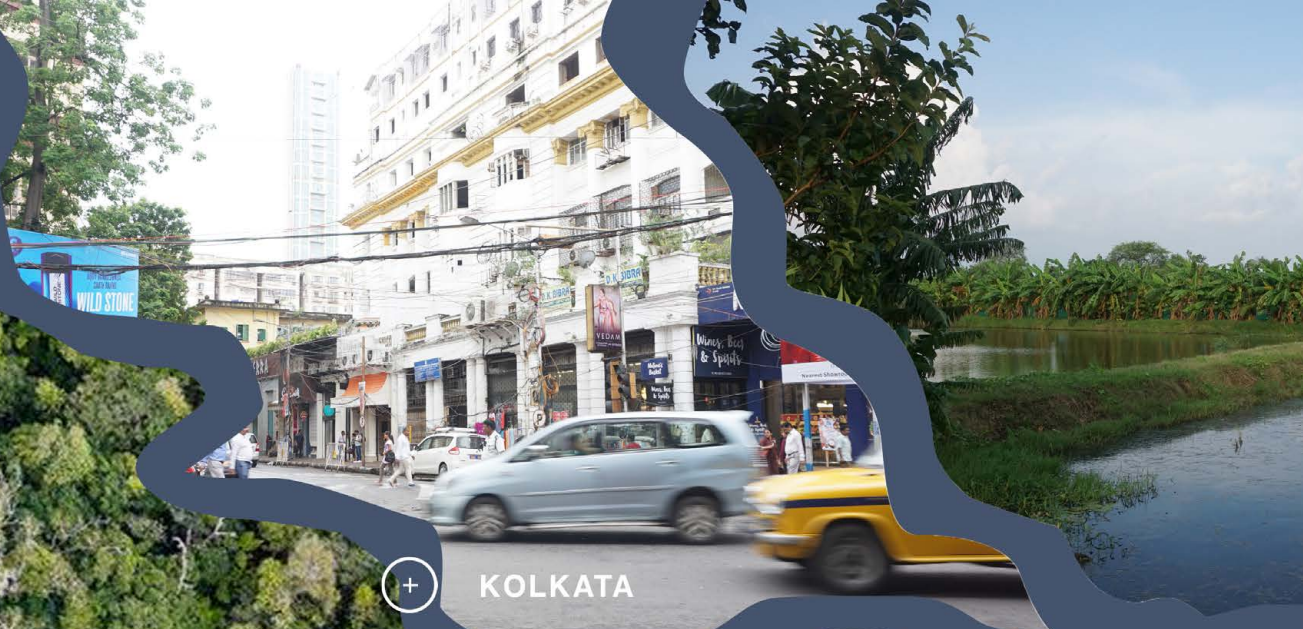
Loss of livelihood, owing to the loss of their vegetable gardens, fishing ponds and source of freshwater



Breach of embankments, leading the saltwater to intrude inside the villages, destroying the fields, ponds and houses



Depletion of Aquaculture and livestock, causing loss of daily food and means of income



KOLKATA



SUNDARBANS



REGIONAL ANALYSIS

PUKUR



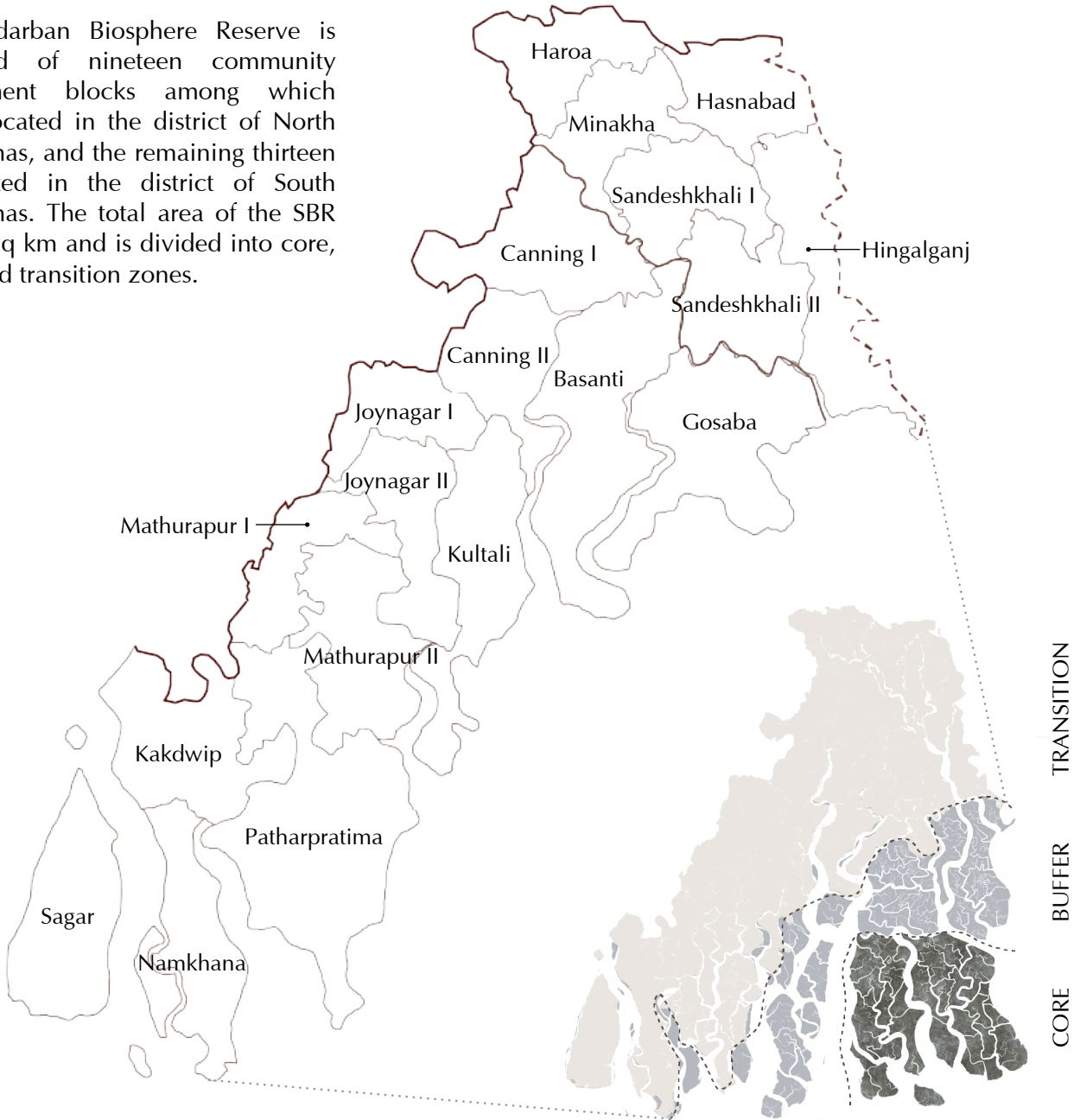
AQUACULTURE



SUNDARBANS BIOSPHERE RESERVE

Zone Distribution

The Sundarban Biosphere Reserve is comprised of nineteen community development blocks among which six are located in the district of North 24-Parganas, and the remaining thirteen are located in the district of South 24-Parganas. The total area of the SBR is 9,630 sq km and is divided into core, buffer, and transition zones.



TRANSITION



Community development blocks

Mono-cropped agriculture

BUFFER



Honey collection

Fishing

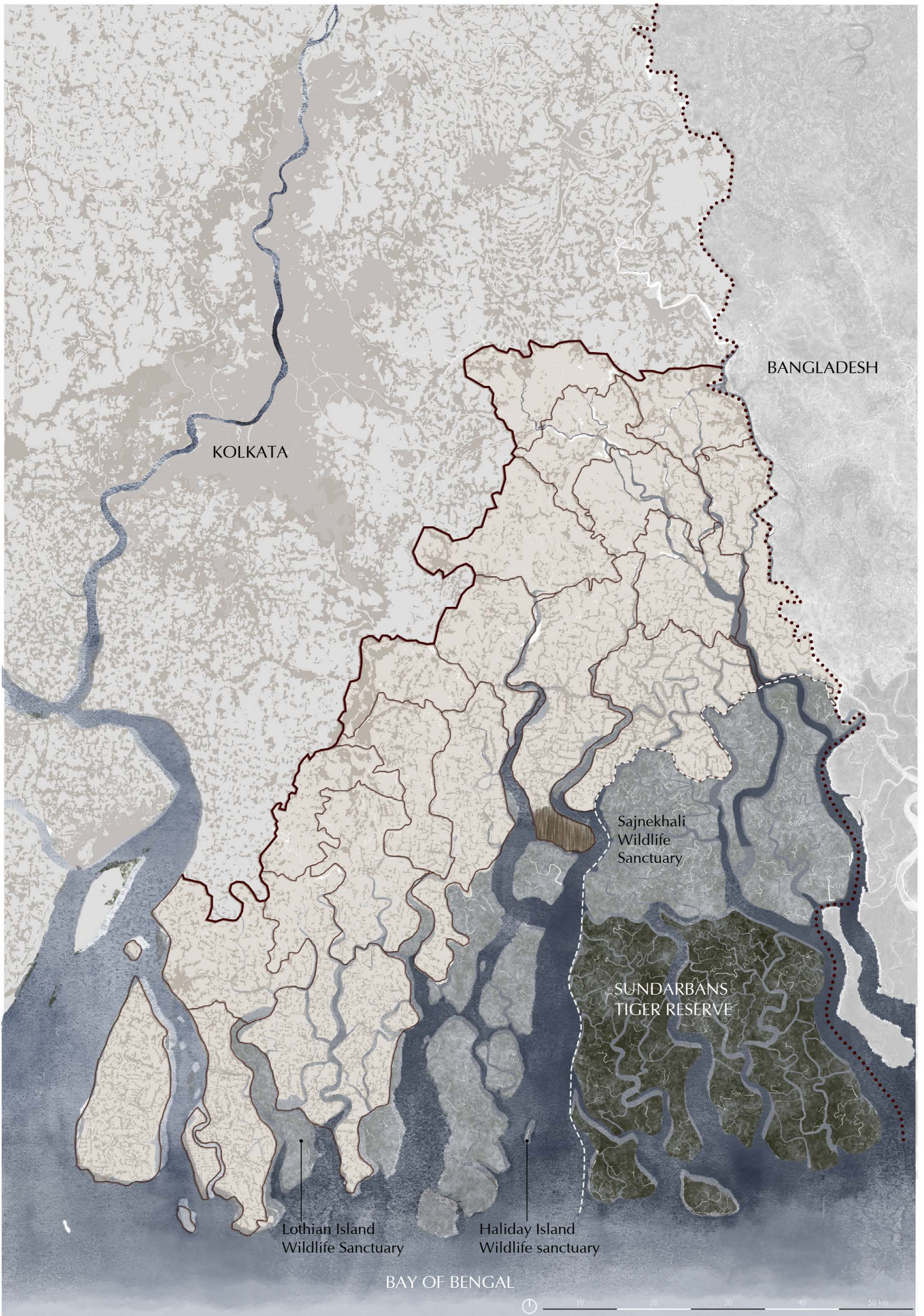
Tourist services

CORE



Preservation of flora and fauna

Research



- Core Area
- Buffer Area
- Transition Area
- Stable Area
- Inhabited but under Notified Forest Area

LANDSCAPE SYSTEMS

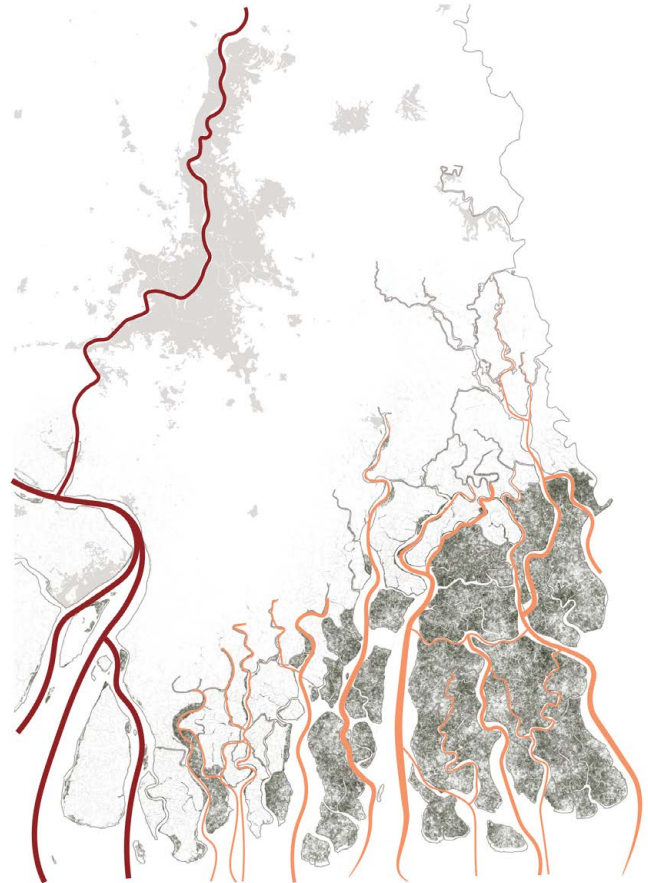
Blue Forests

SALINITY STUDY

There are two existing water systems in the Landscape:

The freshwater river Hooghly which originates from the Himalayas and go into the Bay of Bengal. It is the tributary of the holy Ganges and passes through Kolkata.

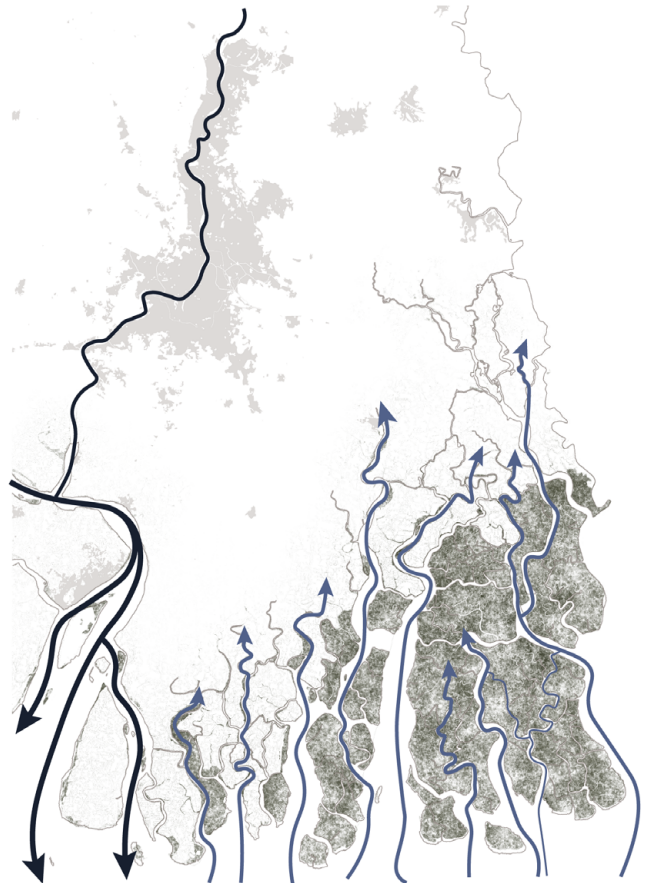
The other system is saltwater estuaries which are a part of the sea and the landscape of Sundarbans. They reach from the sea towards the mainland, forming the islands on the way.

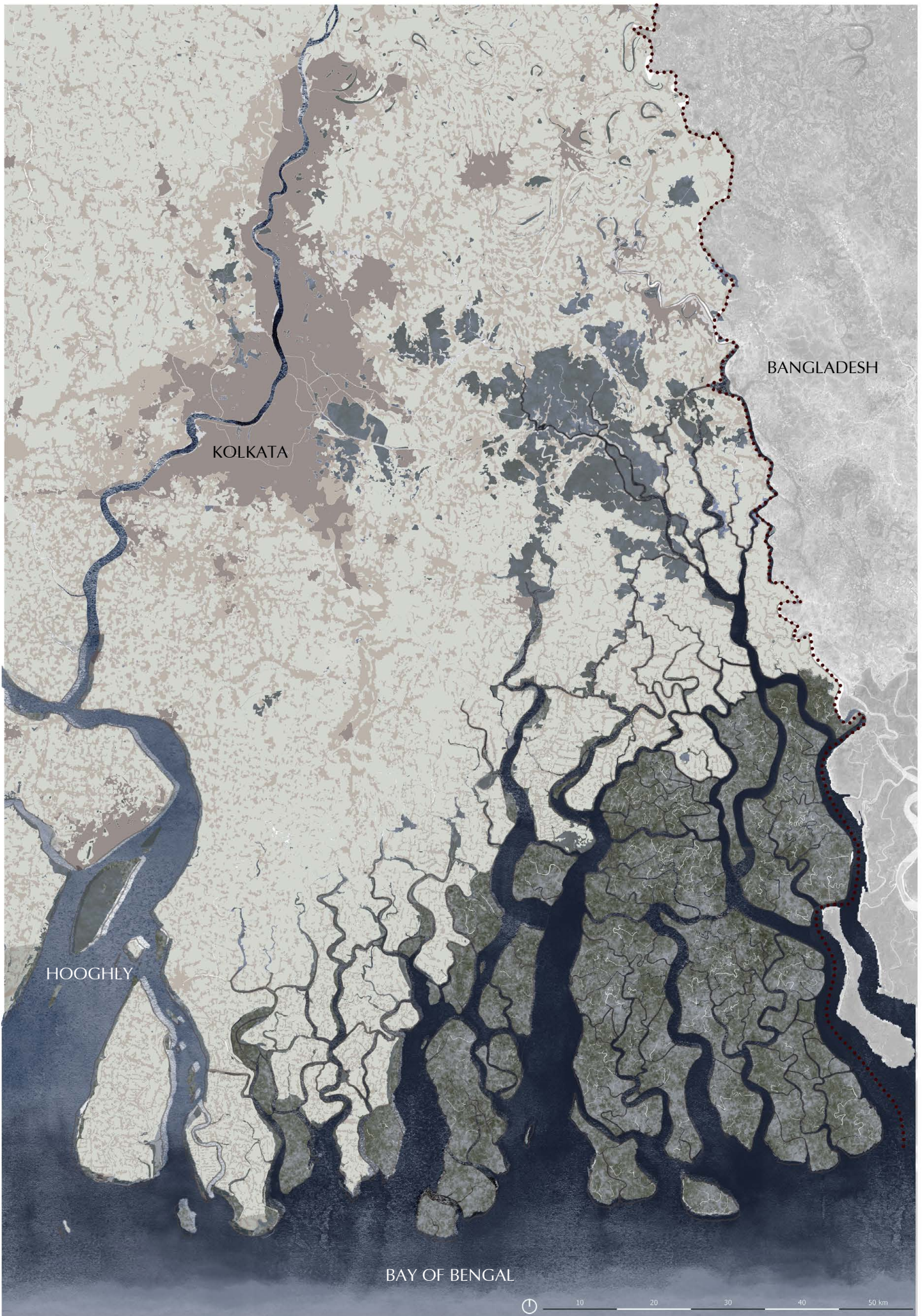


● Freshwater river ● Saltwater river

DIRECTION OF FLOW

The map shows the natural flow of water, which forms a complex system in the landscape. It has a typical character unique to the Sundarbans, with the river Hooghly flowing from the north towards the Bay of Bengal while the estuaries from the Ocean towards the mainland.





- Freshwater river
- Estuaries (Saltwater)
- Mangrove system
- Salt marshes/Aquaculture
- Agricultural land



East Kolkata Wetlands



River Hoogley



Fishing at Wetlands



A fishing hut at East Kolkata Wetlands



Daily catch of Fishes



Woman catching Prawn larvae in the rivers



Fishing boat in Sundarbans



Fishing activities



Tiger prawn Aquaculture



The Sundarbans

TRANSPORT SYSTEMS

KOLKATA

CANNING

GADKHALI

GOSABA

PAKHIRALAY

The collage features several key elements:

- Kolkata:** Includes an airplane icon, a taxi icon, a photo of a busy street with yellow taxis, and a photo of a taxi's interior.
- Canning:** Features a train icon, a photo of a train on tracks, and a satellite map with a highlighted area.
- Gadkhali:** Shows a rickshaw icon, a photo of a rickshaw, and a photo of a person in a rickshaw.
- Gosaba:** Includes a boat icon, a photo of a boat on a river, and a photo of a boat's deck.
- Pakhiralay:** Shows a motorcycle icon, a photo of a person on a motorcycle, and a photo of a street scene.

 A winding path connects these locations, and a large grey abstract shape is present in the lower right quadrant. The background is a grid of dashed lines.



KOLKATA

BANGLADESH

BAY OF BENGAL



⚓ Railway

— Primary roads

— Secondary connections

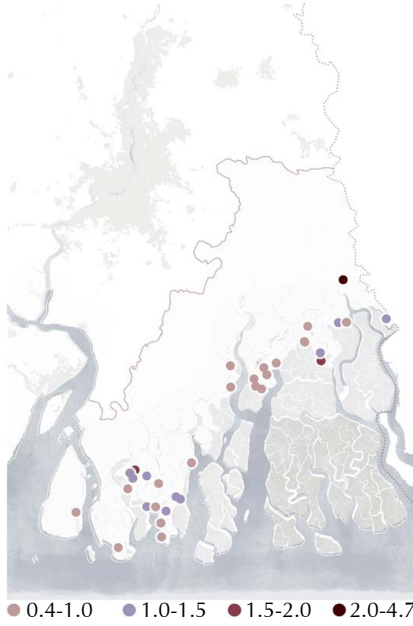
SALINITY STUDY

Rivers and Groundwater systems

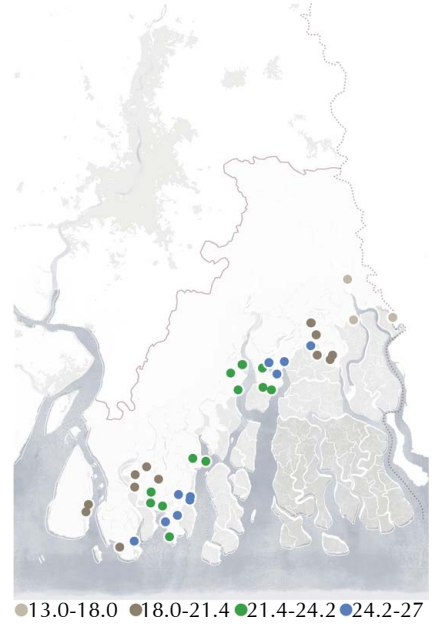
The salinity in the Indian sundarbans has been increasing in the estuaries, tube well water in the villages (transition zone) as well as in the lower part of River Hoogly.

Fresh water salinity measures 0.5 ppt or less. And from the maps it can be seen that a lot of freshwater sources are already above this range.

Water salinity of Tubewell Water 2019



Water salinity of River Water 2019



IMPACTS

The salinity comparisons of 2012 and 2050 maps, shows the progressive increase in the salinity with the rise in the sea level. The increase can be seen northwards and eastwards prominently.

The most prominent impacts of this rise in salinity will be -



Drinking water shortage

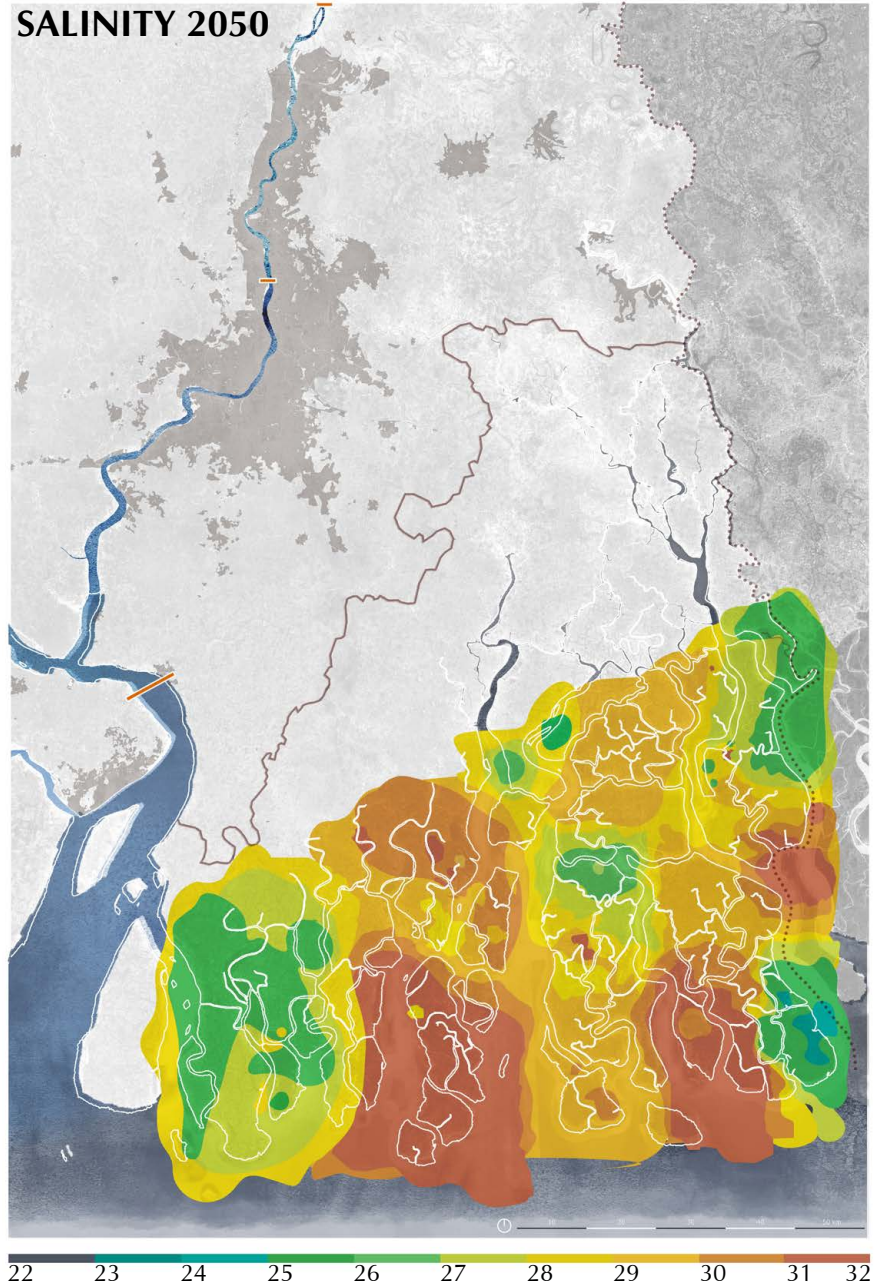


Water scarcity for irrigation during dry season

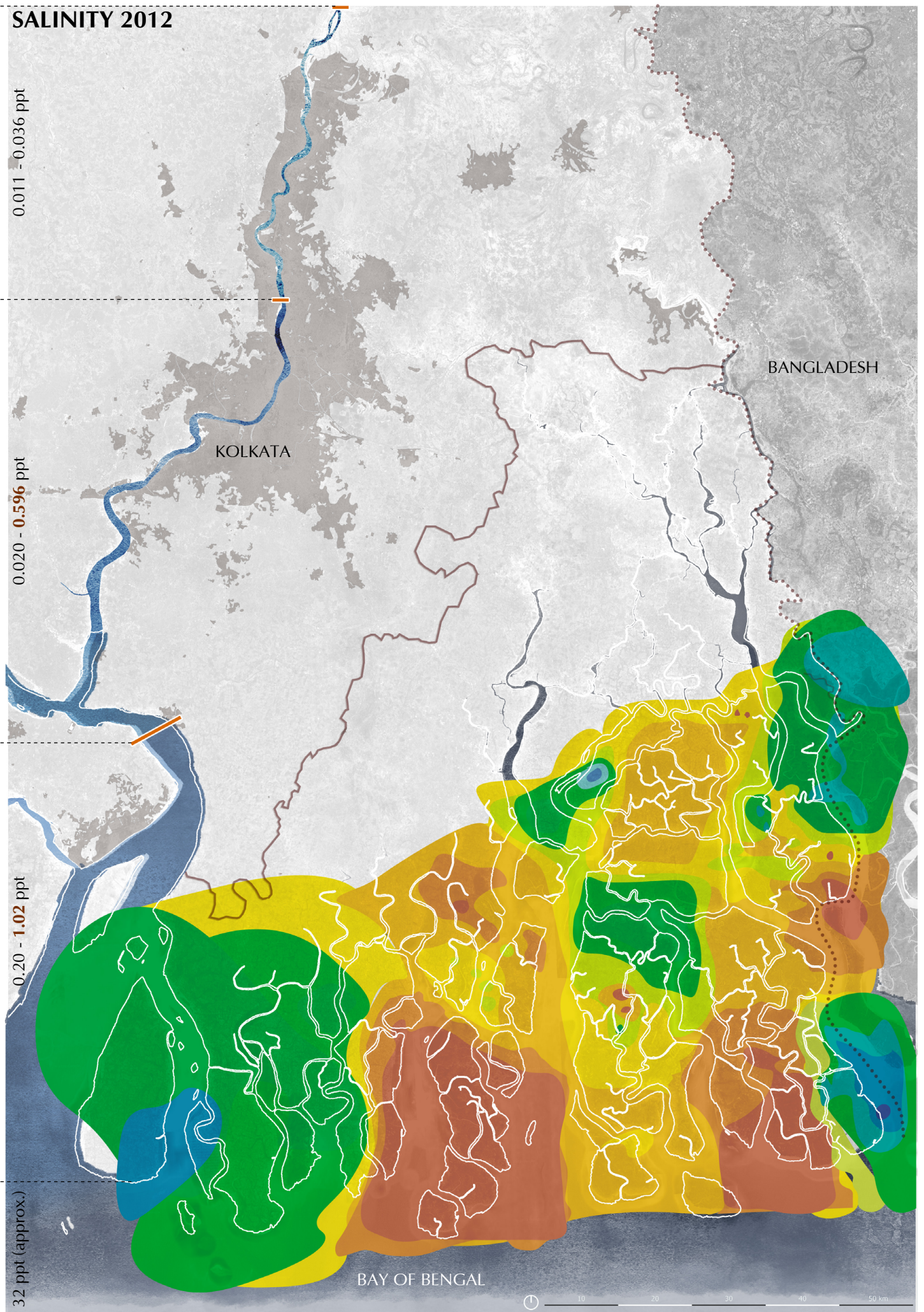


Changes in mangrove species composition especially in Sundarbans core forest area

SALINITY 2050



SALINITY 2012



CONCLUSION MAP

Synthesis of all systems

After analyzing the Sundarbans biosphere reserve and its relation to the city of Kolkata, several conclusions were formed. The region is predominantly rural and characterized by extensive agricultural activity, along with a high density of urbanization in the metropolitan city of Kolkata, leading to a high demand for water in the region. Moreover, there is a presence of large saline systems, one of them being a wastewater aquaculture system on the East of the city.

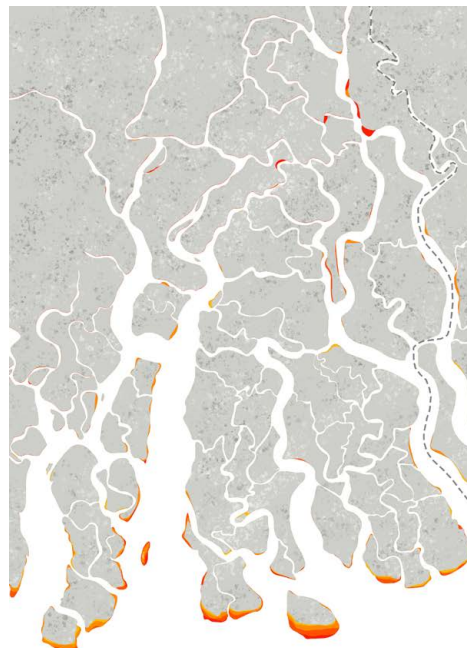
The region has an increased impact of Climate change and its consequences, major ones being rising salinity and the cyclones. The aftermath of these creates erosion, loss of biodiversity, livelihood, resources, habitats, and more. The uncertain future of the Sundarbans and its surrounding calls for significant actions to be taken to preserve and protect the unique ecological and cultural heritage of the region. It is only through collaborative efforts and a concerted focus on conservation and sustainability that the Sundarbans can be safeguarded for future generations.

THE DYNAMIC LANDSCAPE

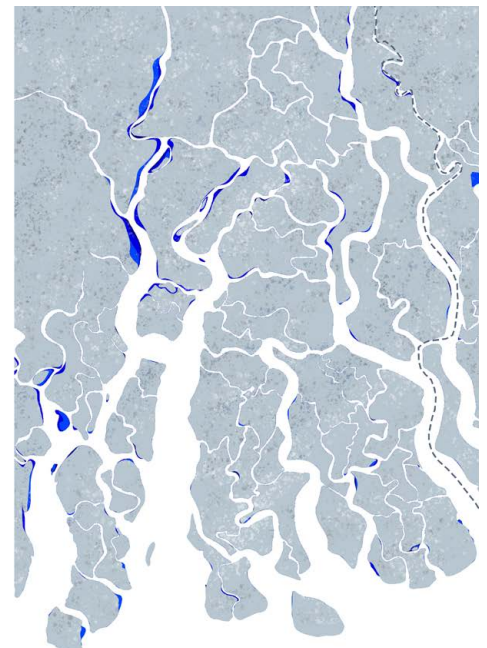
Evolving mangrove system



Erosion in the Sundarbans

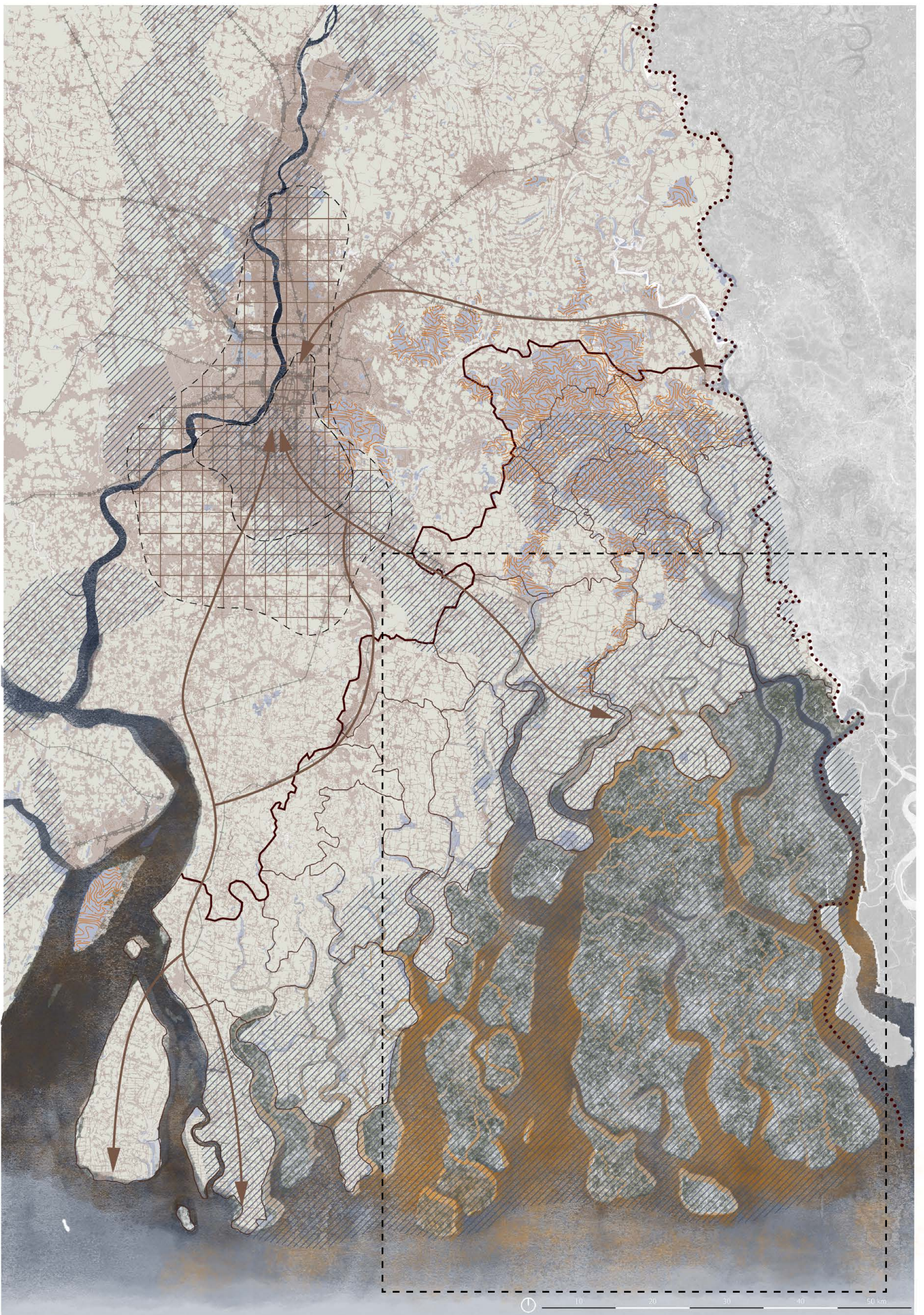


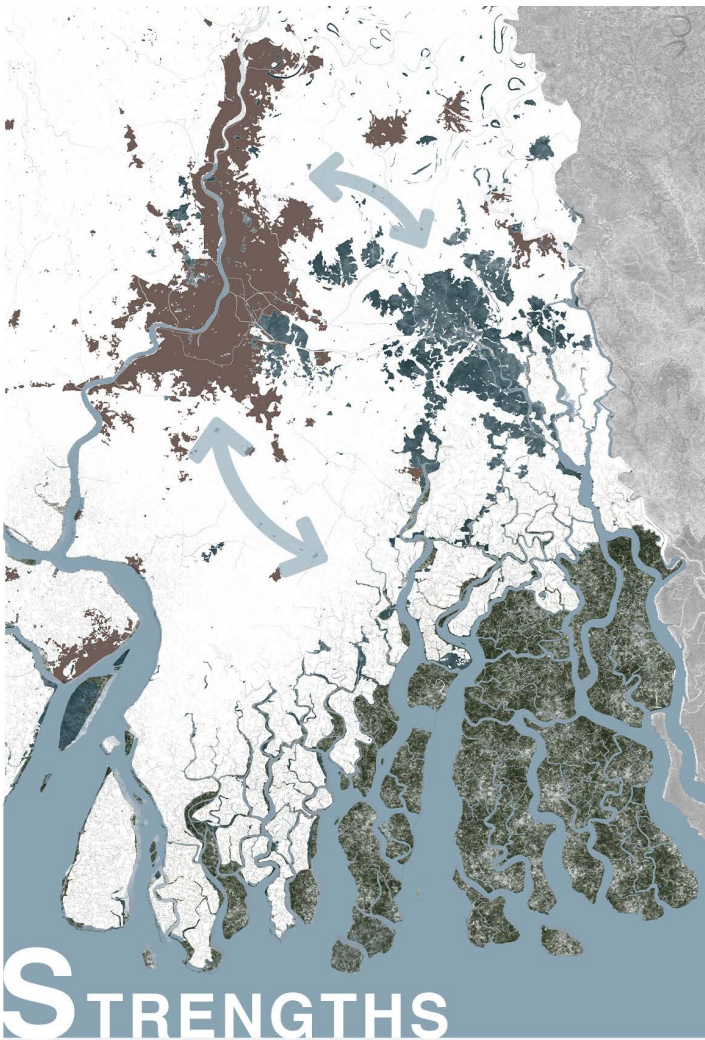
Sedimentation in the Sundarbans



The Sundarbans is a highly dynamic and is constantly reshaped by the movement of water and sediment. Anthropogenic activities, such as deforestation, aquaculture, and infrastructure construction, have caused significant loss of mangrove species in the Sundarbans forest, raising concerns about its ecological and economic impacts. Climate change-induced sea-level rise and increased storm surges have further exacerbated the loss of mangrove species due to inundation and erosion. However, afforestation efforts, such as planting and regeneration of mangrove species in degraded areas, have been successful in some regions, leading to an increase in the overall mangrove cover in the Sundarbans.

Sundarbans faces erosion due to a reduction in sediment load from upstream dams, resulting in increased salinity in the mangrove forest. This has ecological and socio-economic consequences, including loss of habitat, reduction in mangrove cover, and negative impacts on marine species and local communities. Sedimentation can have a positive impact by contributing to mangrove growth, but it also requires careful management.





STRENGTHS



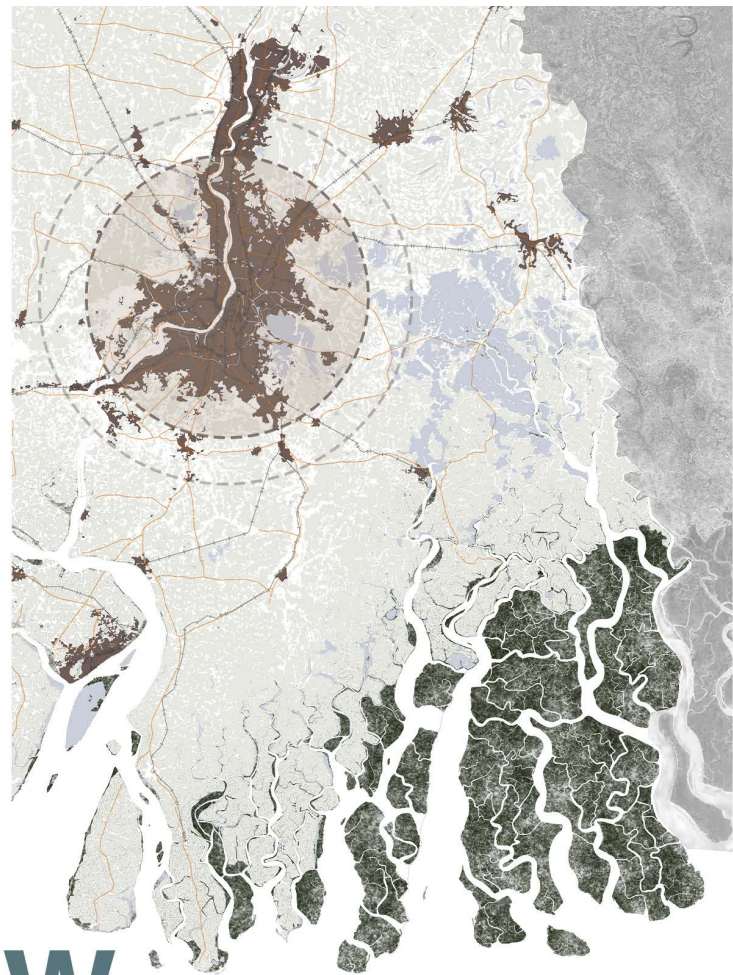
CARBON SINK
WETLANDS
PROXIMITY TO
WATER



RURAL CHARACTER
INDIGENOUS PRACTICES
MANGROVES



CIRCULAR ECONOMY
BIODIVERSITY AND
HABITAT
PROXIMITY TO
KOLKATA



WEAKNESSES



SCARCITY OF FRESHWATER
SYSTEM
LOW PROTECTION OF
EMBANKMENTS

POOOR DISASTER RISK
MANAGEMENT

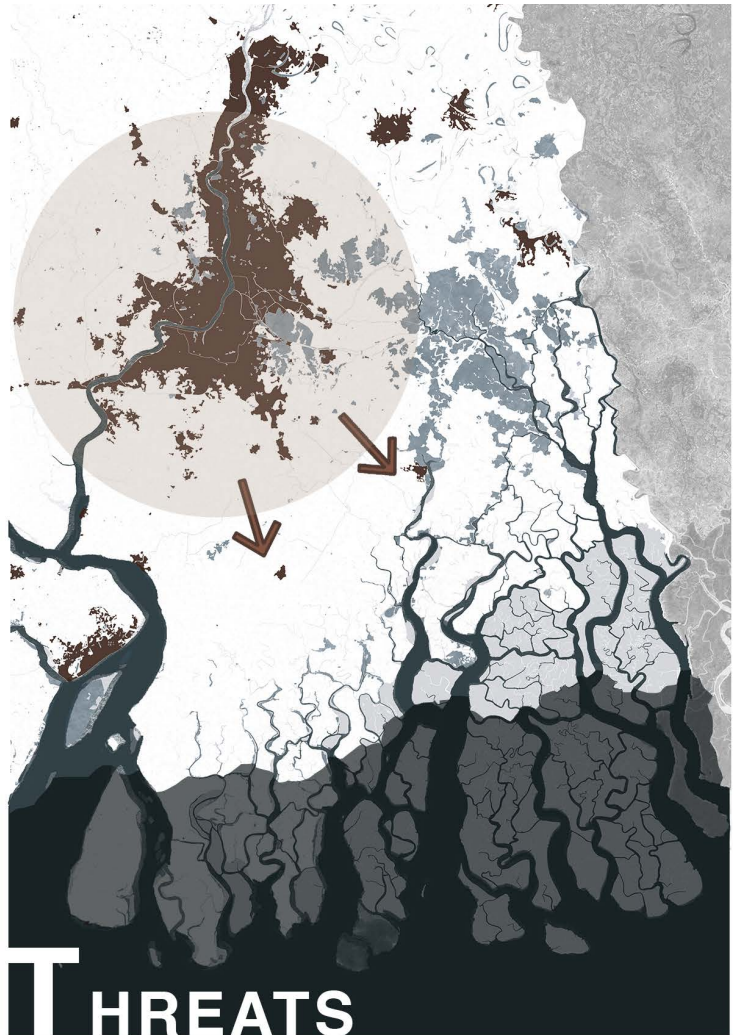


LOSS OF BIODIVERSITY
LOSS OF AGRICULTURAL LAND

LOW AWARENESS AND
WILLINGNESS OF PEOPLE



INDIVIDUALIST
CHARACTER
LOW COMMUNITY ENGAGEMENT
LOW CONNECTIVITY WITH
KOLKATA



IMPROVE HUMAN/NATURE RELATIONS

CO-HABITATION OF HUMAN-NATURE SYSTEMS

REDESIGN SPACES DUE TO LOW DENSITY POPULATION

RESTORATION OF COASTLINE

STRENGTH THE RELATIONS WITH KOLKATA

IMPROVE COMMUNITY WELL-BEING, ECONOMY AND EDUCATION

ENHANCE THE CULTURAL PRATICES

SEA LEVEL RISE
CYCLONES

FLOODING EVENTS

INCREASE OF SALINITY
HIGH TEMPERATURE

IMpACT OF THE
URbAN CITY

CLIMATE MIGRATION

PROJECTED DEVASTATION, 2100

By the year 2100, the region from Kolkata to the Sundarbans forest in eastern India is likely to face significant impacts from climate change. One major challenge will be the rise in sea level, which could result in the loss of land, displacement of populations, and increased salinity in freshwater sources.

The city of Kolkata, which is located on the eastern bank of the Hooghly River, is expected to experience a sea level rise of up to 1.5 meters by 2100, which would result in the flooding of low-lying areas and displacement of over 1.5 million people (Maiti et al., 2018). In addition, the rapid growth of Kolkata's population, which is expected to reach over 20 million by 2100 (United Nations, 2022), will exacerbate the city's vulnerability to climate change impacts.

The Sundarbans forest, which is home to numerous species and provides livelihoods for thousands of people, is also at risk. It is estimated that the Sundarbans could lose up to 96% of its forest cover by 2100 due to sea level rise, leading to the displacement of over 6 million people (Dasgupta et al., 2015). The increased salinity in freshwater sources due to rising sea levels could also have significant impacts on the livelihoods of local communities, who rely on fishing and agriculture.

The impacts of climate change are likely to exacerbate existing challenges, such as poverty and lack of access to basic services. In addition, the migration of villages from the low-lying areas to higher ground could result in conflicts over resources and increased pressure on land and water resources (Rakshit et al., 2020).

To address these challenges, it is crucial to implement measures to mitigate the effects of climate change and build resilience in the region. Urgent action is needed to address these challenges and build resilience in the region for the future.

2100



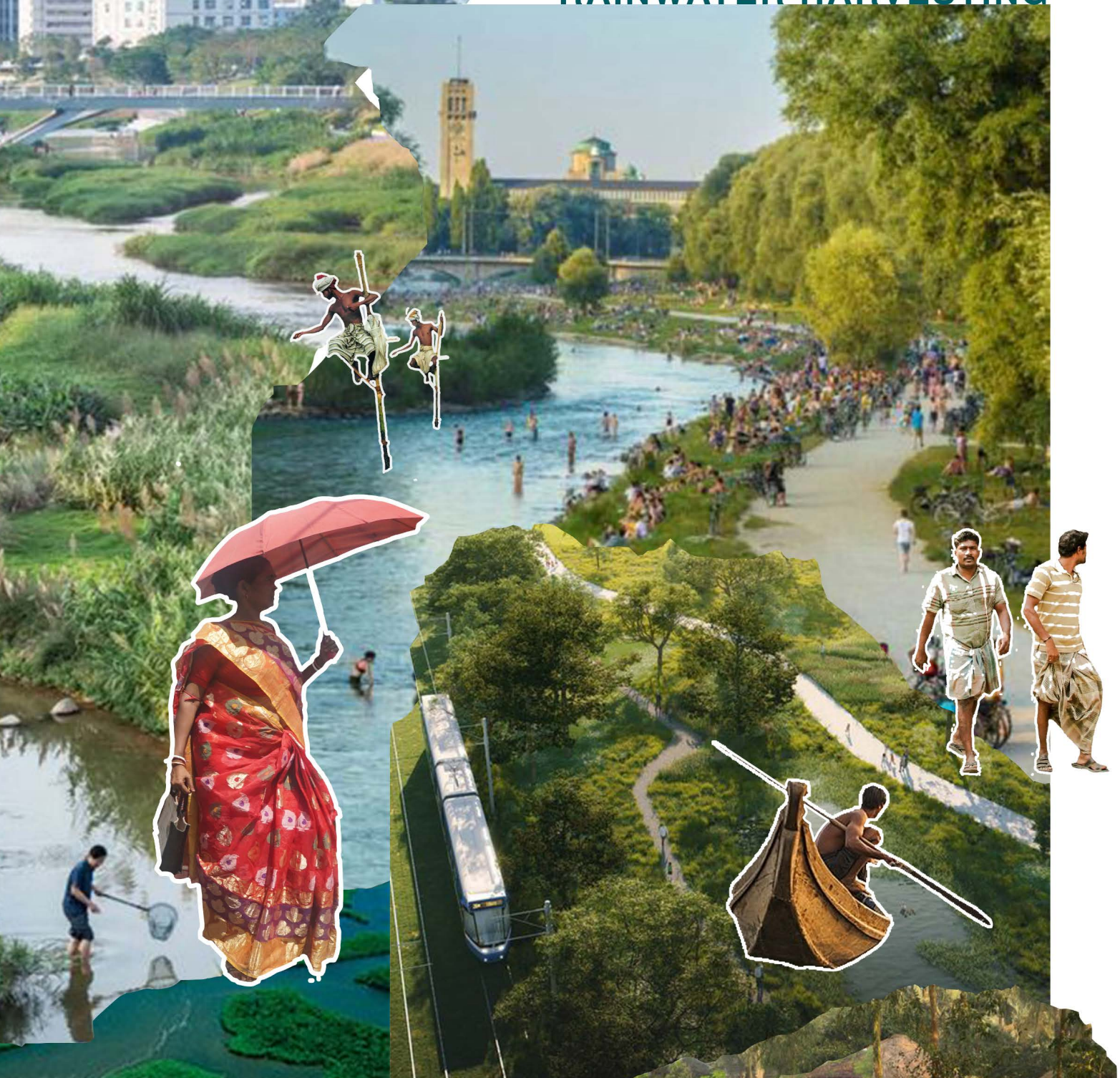
GREEN STREETS



RURAL ECOSYSTEMS
MANGROVE EXPERIENCE

TH

RAINWATER HARVESTING



GREEN TRANSPORTS GROVE AQUACULTURE



THE UTOPIAN VISION OF THE SUNDARBANS OF TOMORROW

REGIONAL STRATEGY

After conducting a comprehensive analysis of the complex system of Sundarbans, including the current and projected consequences of climate change on it, a set of proposals and strategies has been developed. These proposals have been designed with consideration for both the natural ecosystem of the Sundarbans and the cultural heritage of its 4.5 million population. The two proposed strategies comprise a strong and resilient green framework, consisting of a series of proposals. The backbone of this framework is formed by mangroves and their

associated ecosystems, along with the complex water system, aimed at creating a space for biodiversity and people to coexist harmoniously.

Nature-based solutions have been the foundational principle and guiding thought for the entire design strategy, at all scales and have been considered in relation to all the systems. The final strategy is a combination of green and blue systems, while also taking into account the transport and biodiversity connections throughout the entire region.



*Directly connected to
and Affected by*

DESIGN OBJECTIVES

FOCUS THEMES

Connect



Living environment

Adapt



Water

Restore



Flora & Fauna

Manage



Soil & Built

Create



Mobility

Protect



Materials

POLICIES AND STRATEGIES

Laws, Policies and Suggestions are provided at the strategic level, before moving forward with the Master Plan

These are marked with the following:

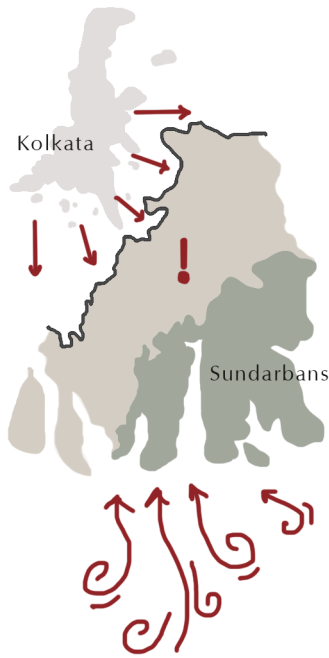
M: Must - A law

S: Should - A policy

C: Could - A suggestion



CONCEPTUAL DIAGRAMS



WHY ?

The transition zone needs **urgent attention** being extremely vulnerable to Climate Change impacts especially due to the **cyclones**. The area also acts as a buffer to the reserved forest from the expansion of Kolkata. Hence it is divided into 3 zones as per the **level of emergency** to act.



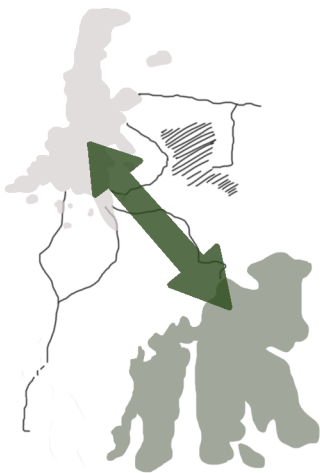
ZONES

The Sundarban Biosphere Reserve to be divided into three longitudinal zones according to a radius to the coast as well as urgent need for **restoration**. [M]

The zones will be divided as Z1: Urgent Restoration required; Z2: Management of existing resources; Z3: Creation of Strategic plans to improve future situations. [M]

All the coastal edges have to be protected with a Mangrove layer in Z1 and Z2. [M]

Proposal of cyclone shelters, health and education facilities in every 2/4km radius. [M]



WHY ?

The existing transport connections can be potential **ecological corridors** also connecting existing blue and green to form a continuous system, **bringing in more green to the city**.



GREEN CORRIDORS

Transversal wedges are created in the regional scale according to different characters and need for solutions. [M]

Rainwater harvesting as a solution to collect stormwater to be used in dry season and emergencies. [M]

Green wedges are proposed along to bring the green into the city of Kolkata and making a stronger ecological connect with the forest. [S]



WHY ?

The accessibility of Sundarbans from Kolkata is currently very limited. Hence, **existing connection is improved** and **more connections are introduced** to enhance the accessibility.



TRANSPORT CONNECTIONS

Proposal of better transport connections from Kolkata to the Sundarban Biosphere Reserve. [M]

Increase of tourist activities in cohesion with the locals to generate more income and resources for the people. [S]

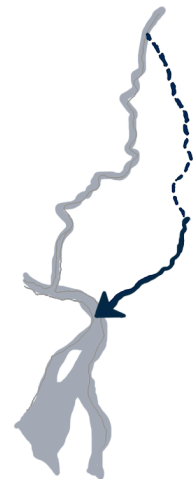
Improvement of soft mobility along with primary transport options in the villages. [S]

A system of Pukurs on village scale for better water management, along with the setup of a communal pukur to create a community belongingness to their land and water. [M]



WHY ?

The availability of fresh water in the S-E part of Kolkata is low. The area is also prone to flooding during monsoon. Hence a new creek is proposed from the northern part of Hooghly and the southern part of the creek which is already existing is reimagined. The creek will help manage the flooding issues along with improving the freshwater availability. The creek also connects the fragmented blue and green infrastructure improving the biodiversity in the area.



NEW CREEK

A new water system is proposed to bring more freshwater from Hooghly to the agriculture fields and villages. [S]

A nature-based phytofiltration system to be setup along the Hooghly river to make the water cleaner for the use in Kolkata and surrounding villages. [M]

Proposal of making the aquaculture practices more sustainable with the inclusion of Mangrove plantation with the same. [S]

New freshwater reservoirs are proposed in the territory, fed by the Hooghly and rain. [M]

FOUNDATION OF THE STRATEGY



ZONE 1: RESTORE

This zone is in **urgent need of immediate actions** due to its proximity to the coast and high vulnerability to erosion, sea level rise and more. Extreme measures have been proposed in order to save the Sundarbans and the community in this zone, which are imagined as *'must-have'* laws.

ZONE 2: MANAGE

The proposed policies in this zone prioritize the **enhancement of current systems**, with the objective of **improved resource management**. The goal is to make it more sustainable and adaptive to the climate conditions of today, thinking of the future scenario.

ZONE 3: CREATE

As this zone is not currently situated in the forefront of the emergency situation, several recommendations have been put forward to **boost its resilience** against future climate-related challenges.

	ZONE 1 (Z1)	ZONE 2 (Z2)	ZONE 3 (Z3)
WEDGE 1 (W1)	Z1W1 Pilgrimage and Mangrove restoration	Z2W1 Ecotourism	Z3W1 Regulation of clean freshwater system
WEDGE 2 (W2)	Z1W2 Management of freshwater systems,coastal protection, conservation of indigenous practices	Z2W2 Enhancing the existing water system	Z3W2 Sustainable agriculture practices
WEDGE 3 (W3)	Z1W3 Ecotourism, Mangrove and biodiversity restoration	Z2W3 Improving connection between Kolkata and Sundarbans	Z3W3 Introduction of freshwater systems in relation with the city
WEDGE 4 (W4)	Z1W4 Mangrove aquaculture, biodiversity restoration and coastal protection	Z2W4 Management of existing wastewater aquaculture	Z3W4 Management of existing wastewater aquaculture

Following the allocation of zones and wedges in the region, some intersections were formed, each possessing a distinct character as seen from the table. The area of the intersection between Zone and Wedge was designed with specific goals that cater to the unique landscape and cultural conditions, which were previously analyzed.

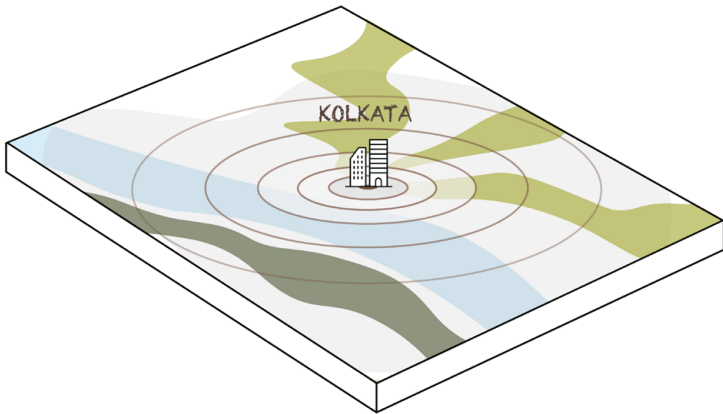
These proposed goals were developed while taking into account the local practices, cultural heritage, and available resources of the area and its inhabitants.

STRATEGY 1 'NATURAL ELEMENTS AS A SANCTUARY TO LIFE'



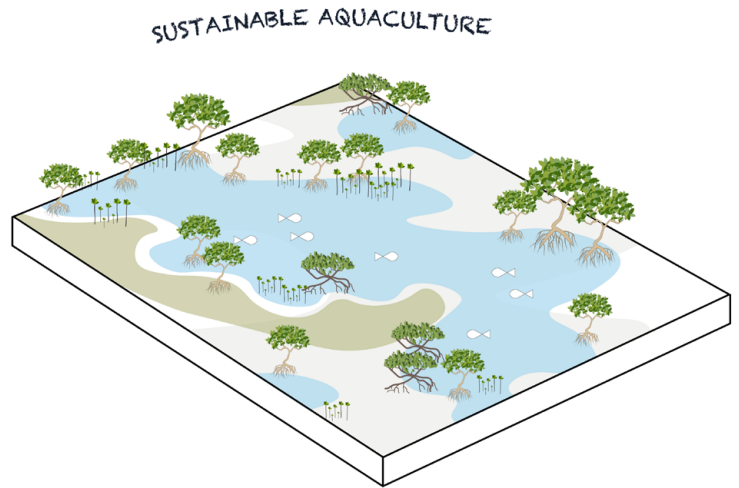
Green Arteries

Green corridors are linear open spaces that connect urban and natural areas, providing a range of benefits such as improving biodiversity, providing recreational opportunities, creating habitat and enhancing air quality.



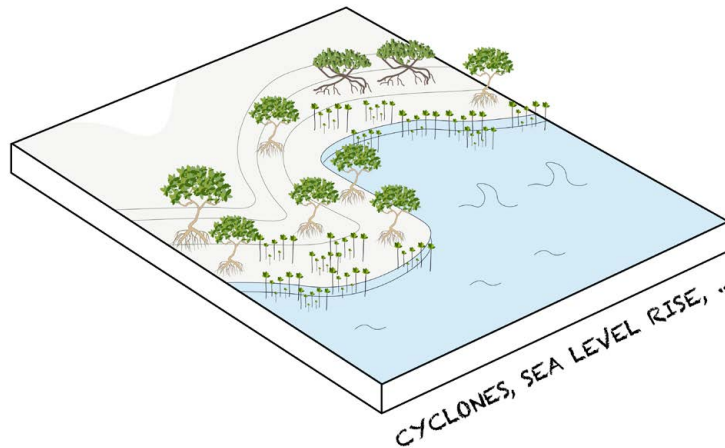
Associated Mangrove Aquaculture

Associated mangrove aquaculture is a sustainable approach that involves the integration of mangrove forests and aquaculture ponds. This approach not only improves the yield but also protects the coastal ecosystem and increases the livelihood opportunities for local communities.



Coastal protection

Mangroves as a coastal protection measure involve the use of mangrove forests to protect coastlines from erosion, storm surges, and other coastal hazards.

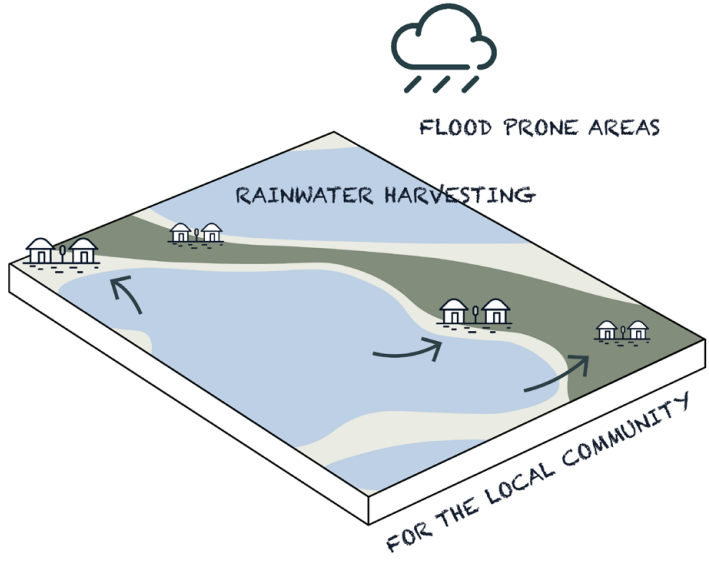




STRATEGY 2 'WATER UPSIDE DOWN'

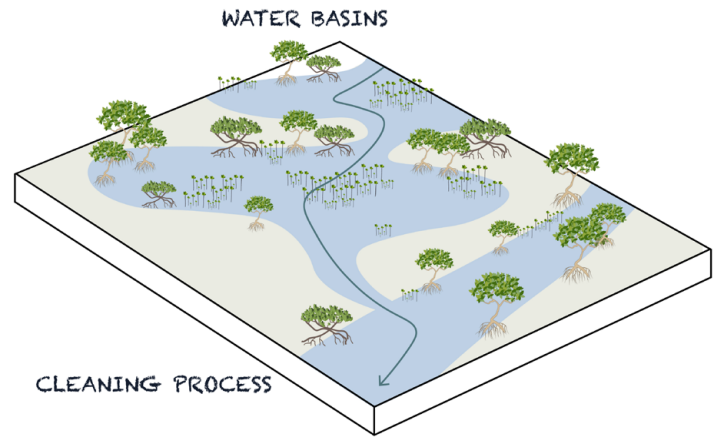
Local water management

Local water management refers to the management of water resources within a specific area, such as a neighborhood or community. It involves using various techniques to capture, store, and treat rainwater and other forms of precipitation, as well as managing wastewater and stormwater. The goal is to promote sustainable water use.



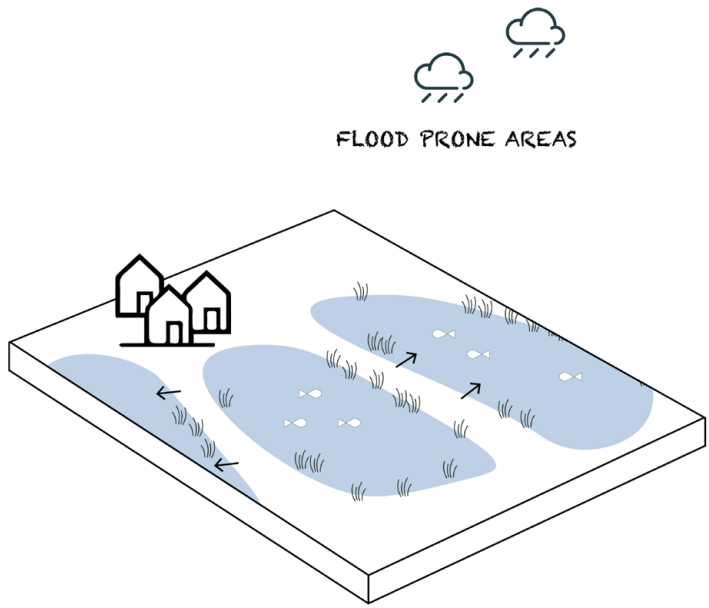
Phytofiltration

Phytofiltration is a natural water filtration technique that uses plants to remove pollutants from water. The process involves planting specific types of vegetation in and around bodies of water, such as wetlands or ponds. The plants absorb contaminants from the water through their roots, while bacteria in the soil break down the pollutants.



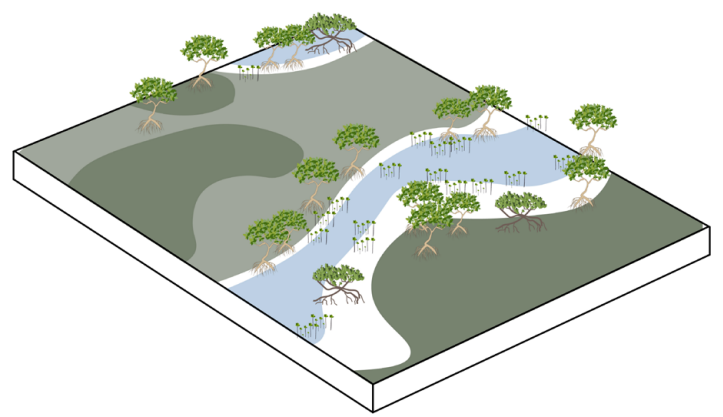
Pukurs

Pukurs are traditional earthen reservoirs found in the Bengal region of South Asia. They are used to collect and store rainwater for agricultural irrigation and household use. Pukurs are often part of a larger system of water management that includes canals etc.



Blue corridors

Blue corridors are ecological networks that link aquatic habitats, such as rivers, lakes, and wetlands, with surrounding terrestrial ecosystems. The goal of blue corridors is to protect and enhance biodiversity by providing habitats for a wide range of species, as well as opportunities for migration and dispersal. Blue corridors can also provide other benefits, such as flood control and water purification.

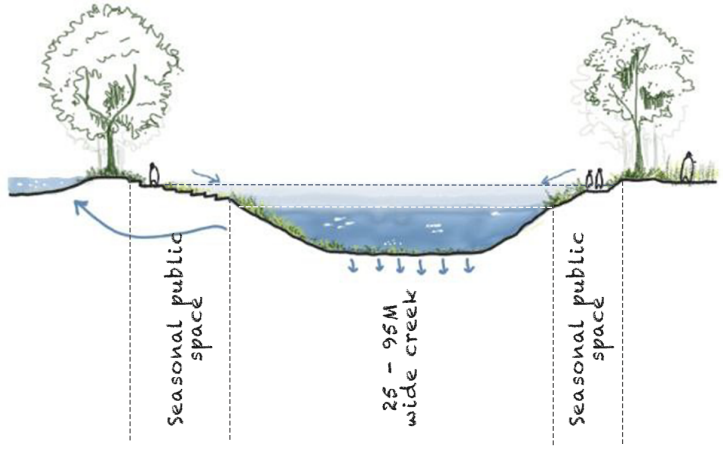




PROPOSED STRATEGY

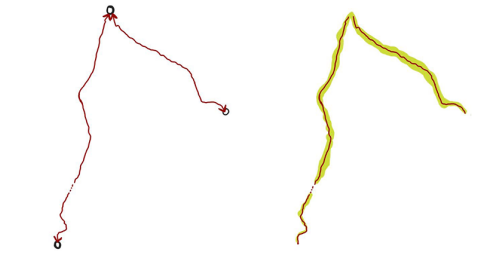
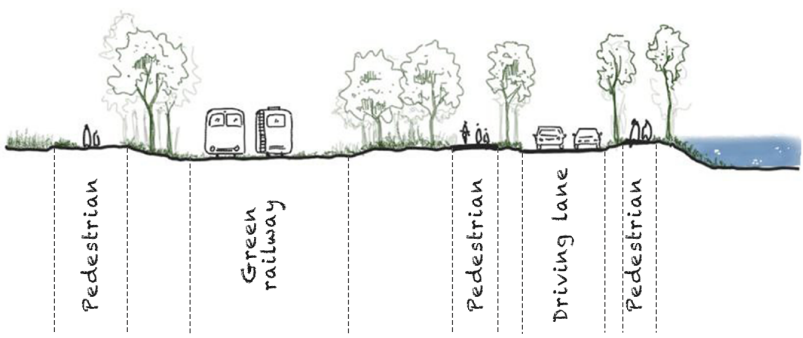
Green and blue systems

1.



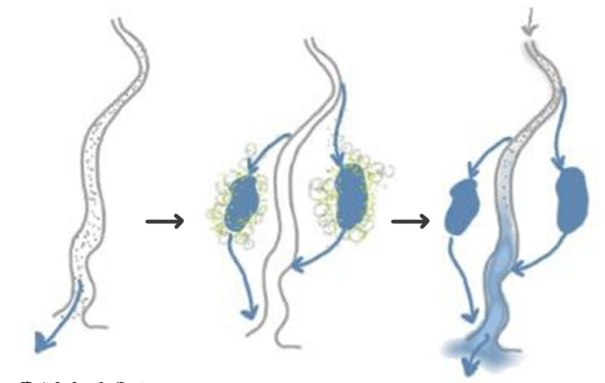
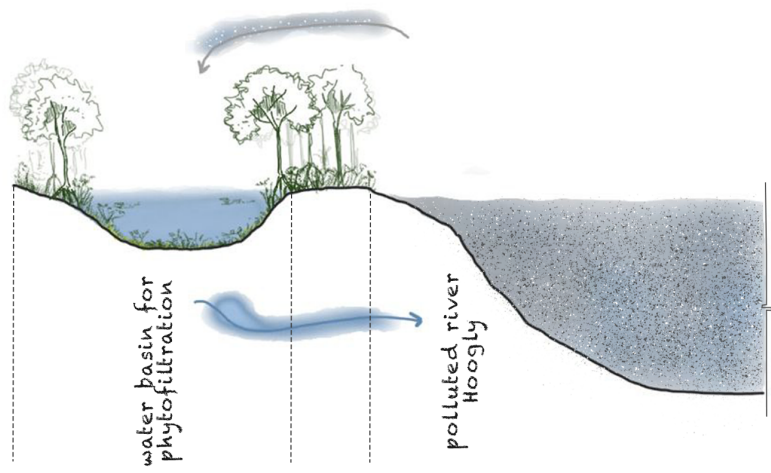
ECOLOGICAL CORRIDOR FRESHWATER SYSTEM SPONGE

2.

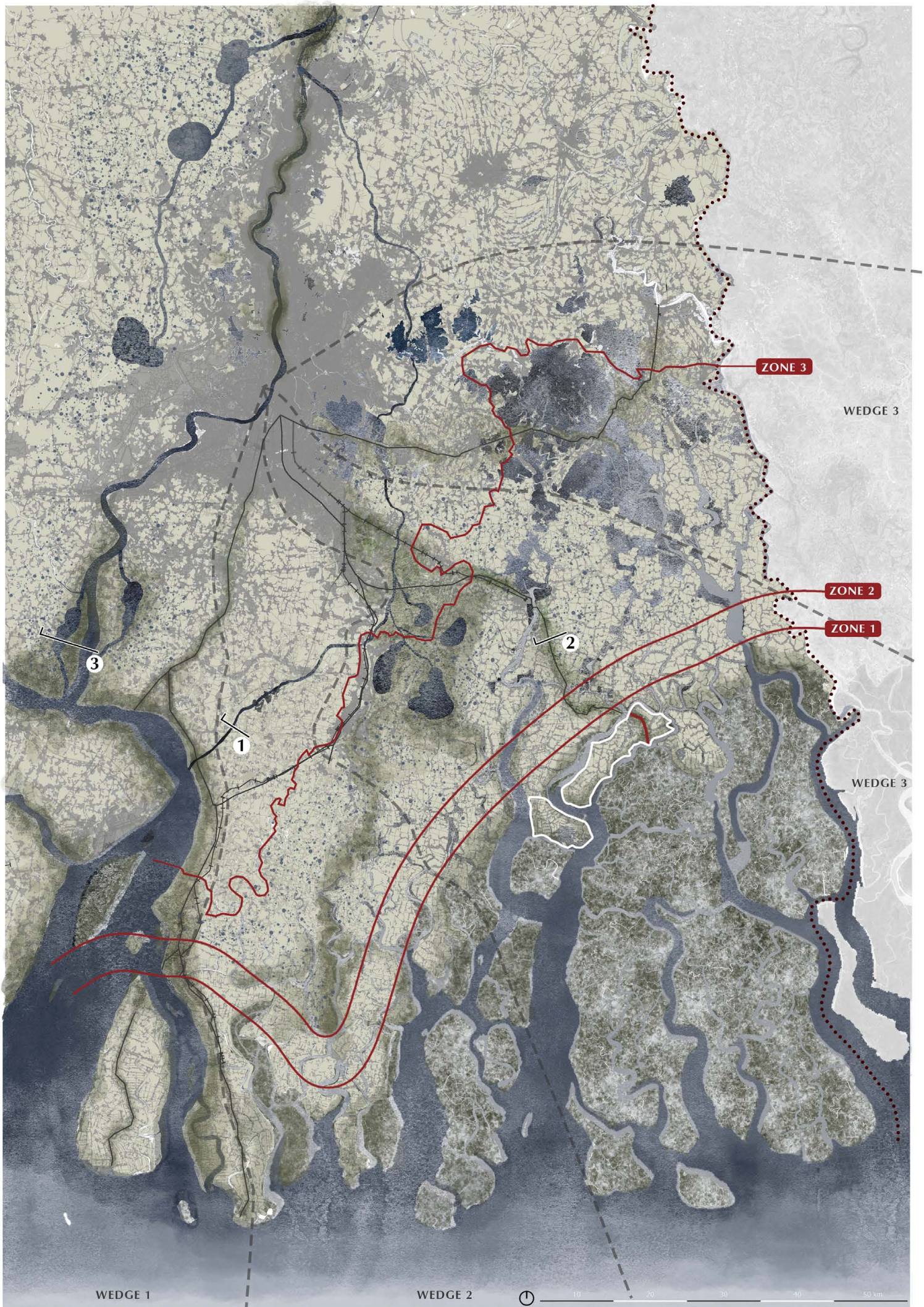


IMPROVED CONNECTIVITY GREEN CORRIDORS

3.



POLLUTED RIVER HOOGHLY ADDITION OF BASINS PHYTO-FILTRATION





BAY OF BENGAL

RURAL ANALYSIS



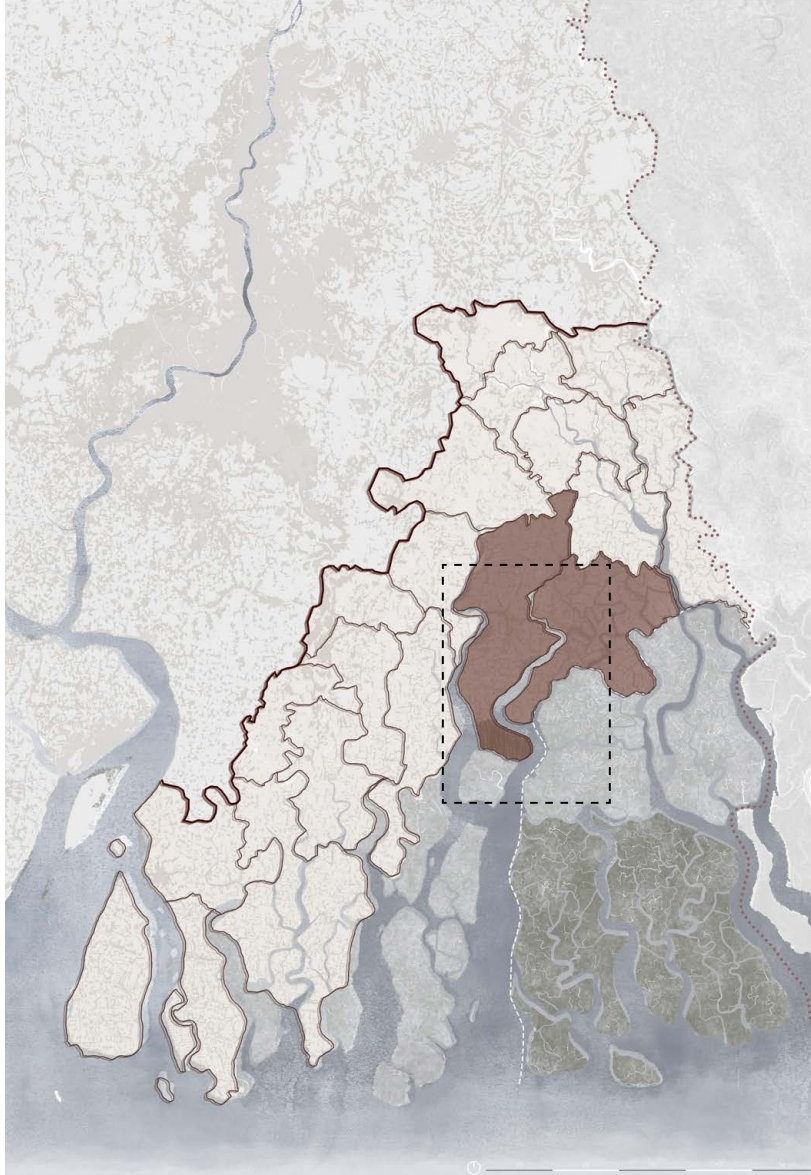
+ THATCH ROOF

+ AQUACULTURE

+ GOSABA

GRAM-BANGLA

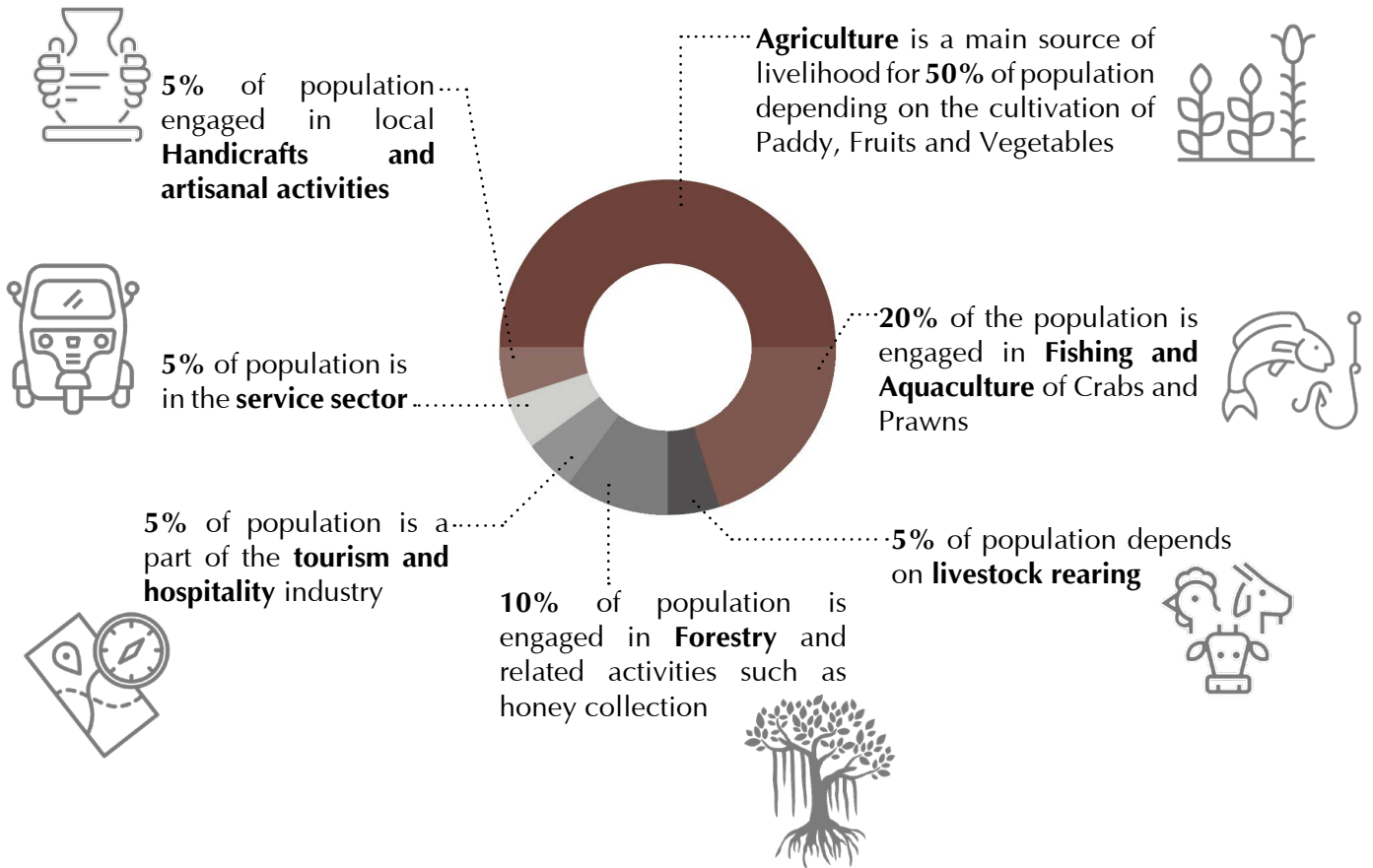
THE SUNDARBANS DELTA



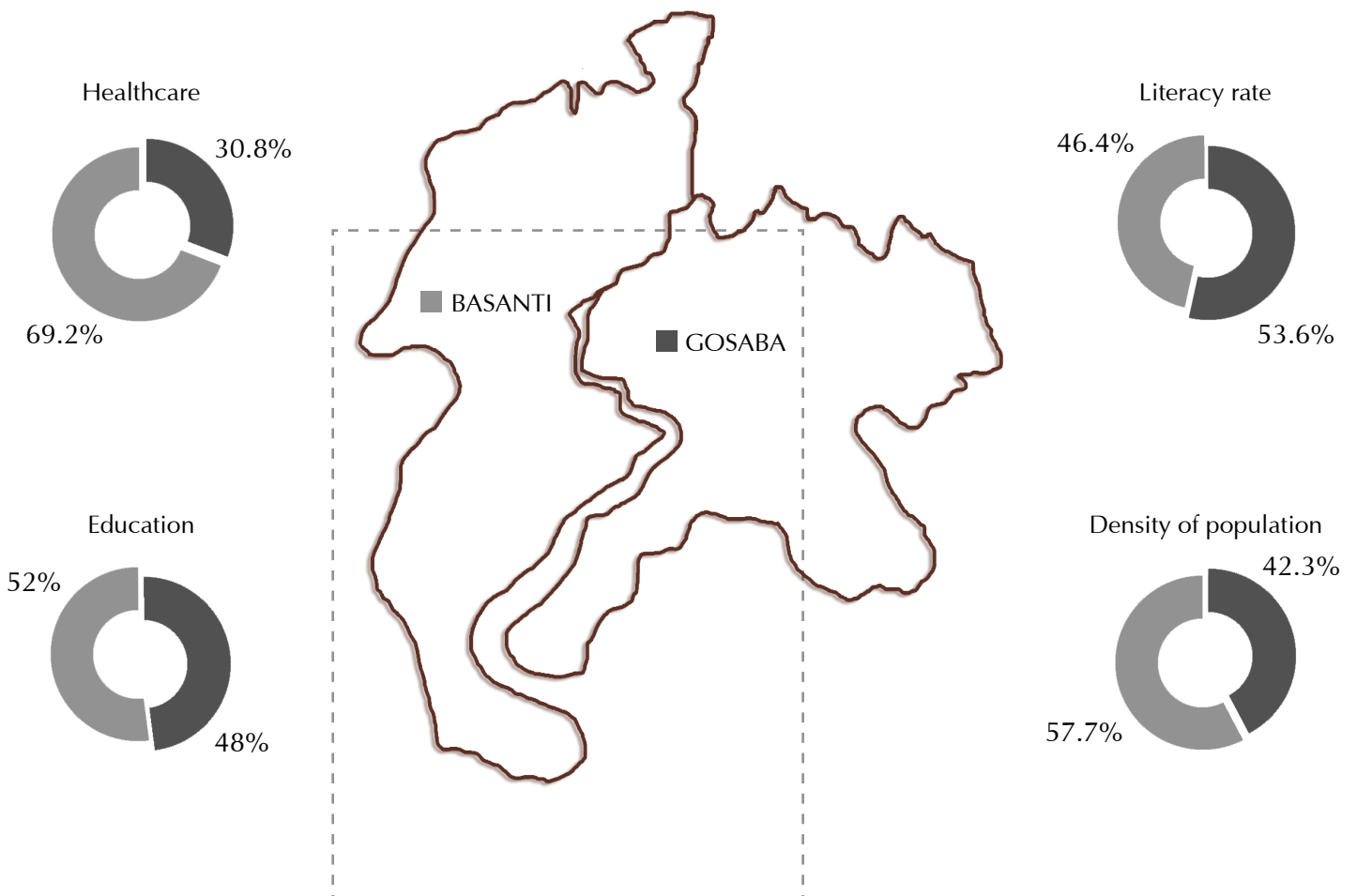
The blocks of Sundarbans are predominantly rural areas with a rich and unique cultural heritage. An analysis of the rural aspect reveals communities that are deeply connected to the natural environment, with livelihoods that are dependent on agriculture, fishing, and forest resources.

The native people of the Sundarbans have a long history of living in harmony with the Sundarbans ecosystem, which is home to a diverse range of flora and fauna. The area is particularly renowned for the Royal Bengal Tiger. Fishing is one of the essential source of livelihood for the local population, with fishermen using traditional methods such as fishing nets and traps. Agriculture is another important occupation, with paddy cultivation being the primary crop grown in the region. The people also engage in honey collection from the beehives that are found in the mangrove forests, which are home to a variety of honeybee species.

Primary occupation in the villages

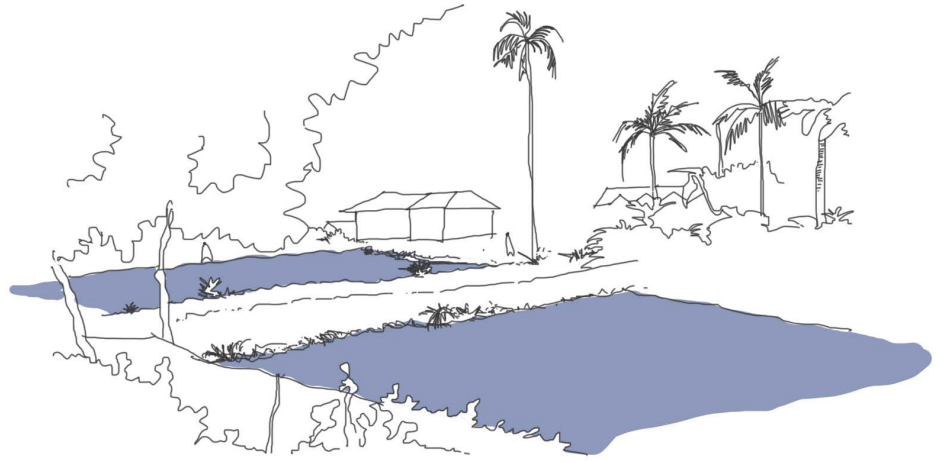


Comparison of Block data

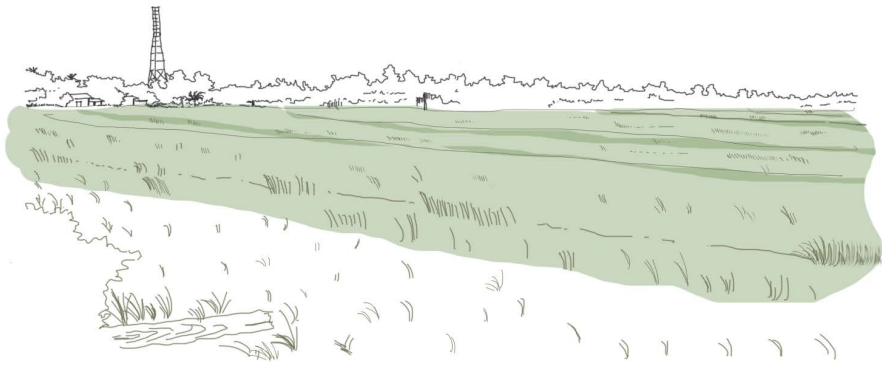


NATURAL LANDSCAPE ELEMENTS

Pukurs are traditional man-made ponds or reservoirs commonly found in rural areas West Bengal. They are used for irrigation, fish farming, and as a source of water for household and agricultural purposes. They also play an important role in the conservation of biodiversity and are often used as community gathering places for social events.



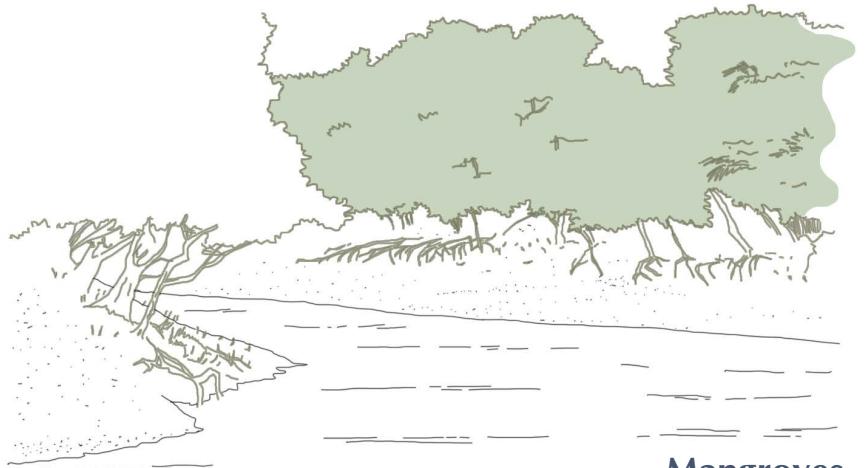
Pukurs



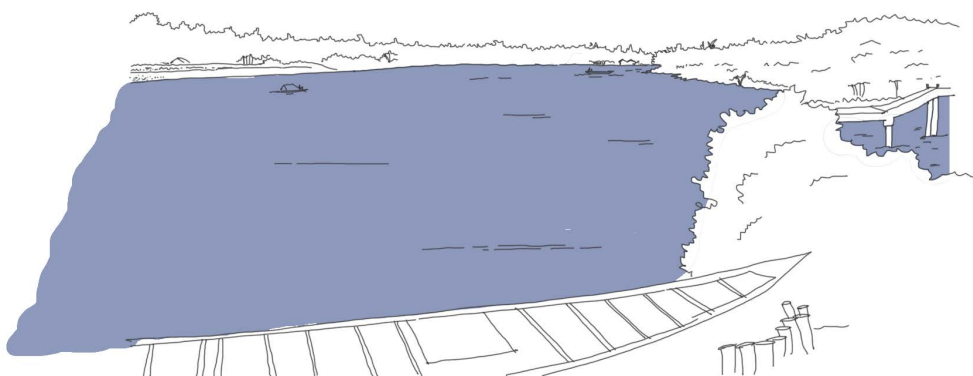
Agriculture

The villages rely on agriculture as their main source of income. The fertile soil and favorable climate of the region make it ideal for cultivation. However, the farmers face challenges such as natural calamities, lack of modern equipment, and market access.

Sundarbans are known for its rich Mangrove forests, which play a crucial role in protecting the region from natural disasters like cyclones and tidal waves, as well as supporting the local biodiversity. However, these forests are under threat from deforestation, climate change, and human activity.



Mangroves




Estuaries

Sundarbans delta region and is home to several estuaries that serve as a crucial habitat for a variety of aquatic species and provide livelihood opportunities. However, pollution and climate change pose a threat, highlighting the need for conservation efforts.



 Mangrove Forest

 Agriculture land with Pukur systems

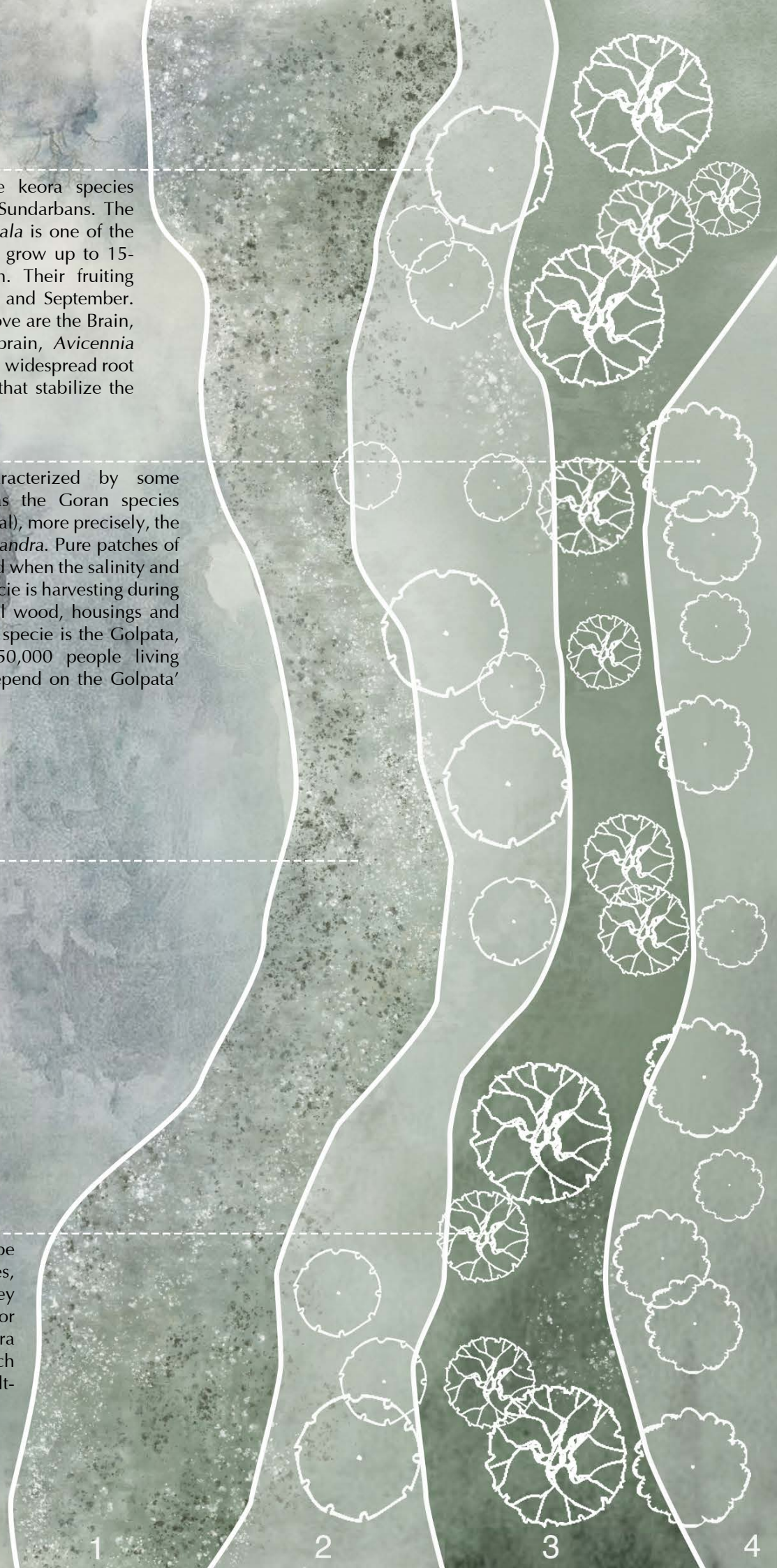
 Estuaries and canals

Above the grassland, the keora species represents 3164ha of the Sundarbans. The tok keora, *Sonneratia apetala* is one of the most dominant one. They grow up to 15-20m in and are evergreen. Their fruiting season is between August and September. An other dominant mangrove are the Brain, more precisely the kalo brain, *Avicennia alba*. They are defined by a widespread root system (pneumatophores) that stabilize the sediments of the coastline.

The highlands are characterized by some dominant species such as the Goran species (representing 9097ha in total), more precisely, the Jhamti Goran, *Ceriops decandra*. Pure patches of this mangrove can be found when the salinity and elevation are high. The specie is harvesting during November to April for fuel wood, housings and more. An other significant specie is the Golpata, *Nypa fruticans*. 'About 50,000 people living around the Sundarbans depend on the Golpata' (Faizuddin et al. 2000a).

Grassland

Below the highland can be found the tora mangroves, *Aegialitis rotundifolia*. They are defined as small trees or shrubs of 2/3m tall. The Tora specie is halophytic, which means that they are salt-tolerant.



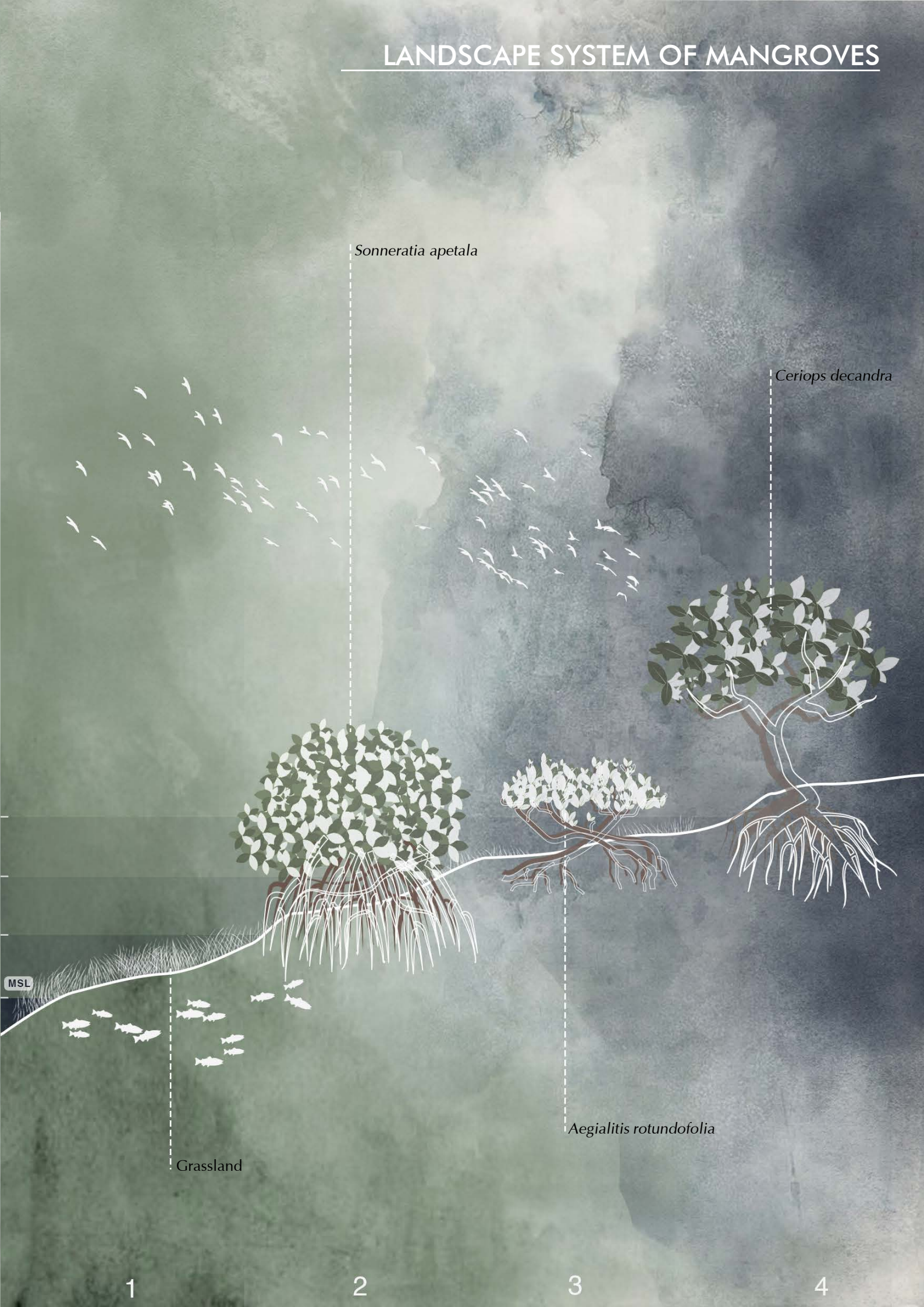
1

2

3

4

LANDSCAPE SYSTEM OF MANGROVES



Sonneratia apetala

Ceriops decandra

MSL

Grassland

Aegialitis rotundifolia

1

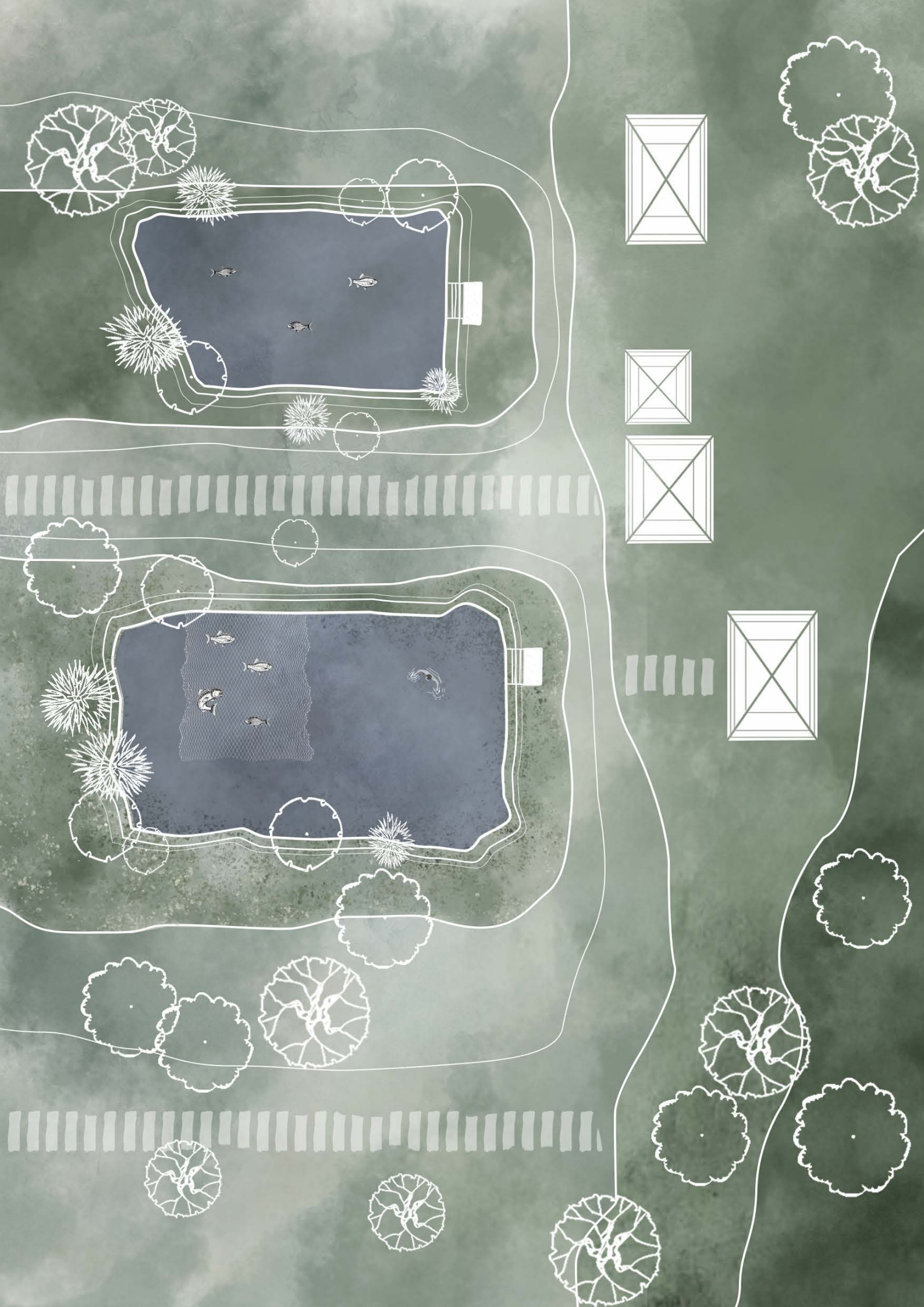
2

3

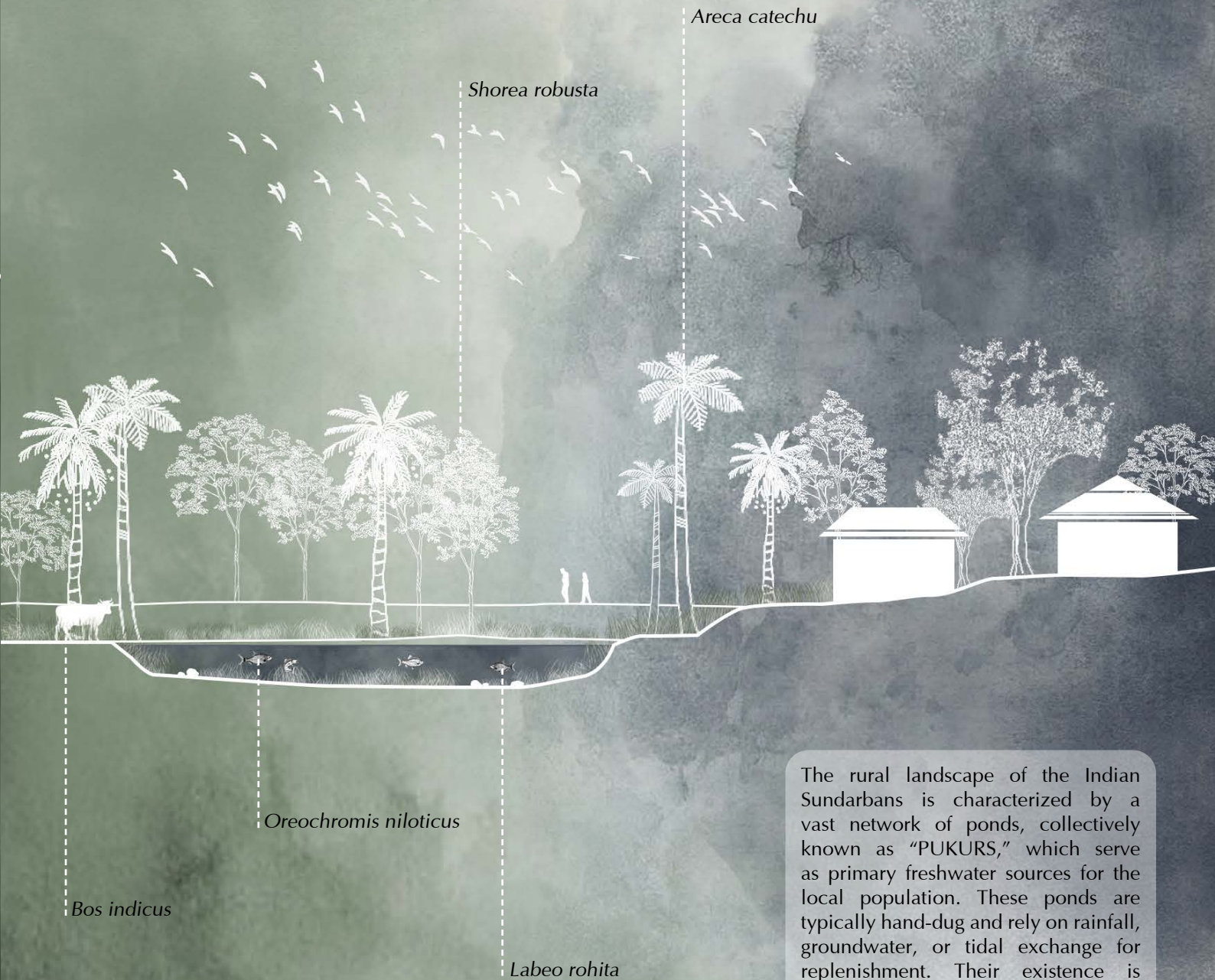
4







LANDSCAPE SYSTEM OF PUKURS



Areca catechu

Shorea robusta

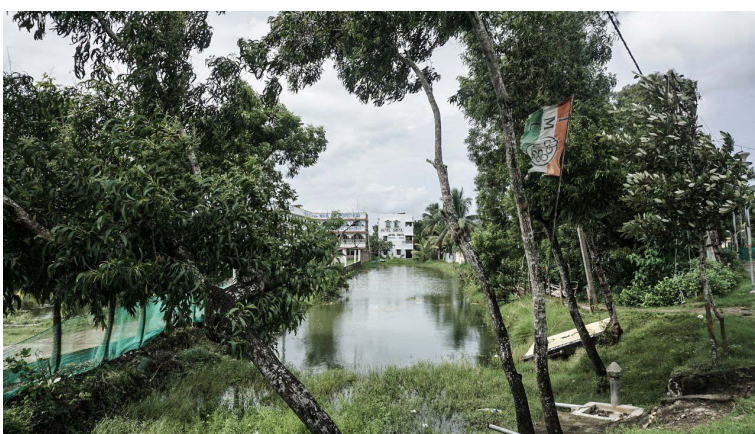
Oreochromis niloticus

Bos indicus

Labeo rohita

The rural landscape of the Indian Sundarbans is characterized by a vast network of ponds, collectively known as "PUKURS," which serve as primary freshwater sources for the local population. These ponds are typically hand-dug and rely on rainfall, groundwater, or tidal exchange for replenishment. Their existence is critical for enabling human habitation in this region of the Sundarbans. While historically used for domestic purposes, the proliferation of aquaculture in the wake of the blue revolution has prompted an increase in the number of these ponds. The economic benefits of aquaculture have made it a popular activity among villagers, further driving the expansion of these ponds.



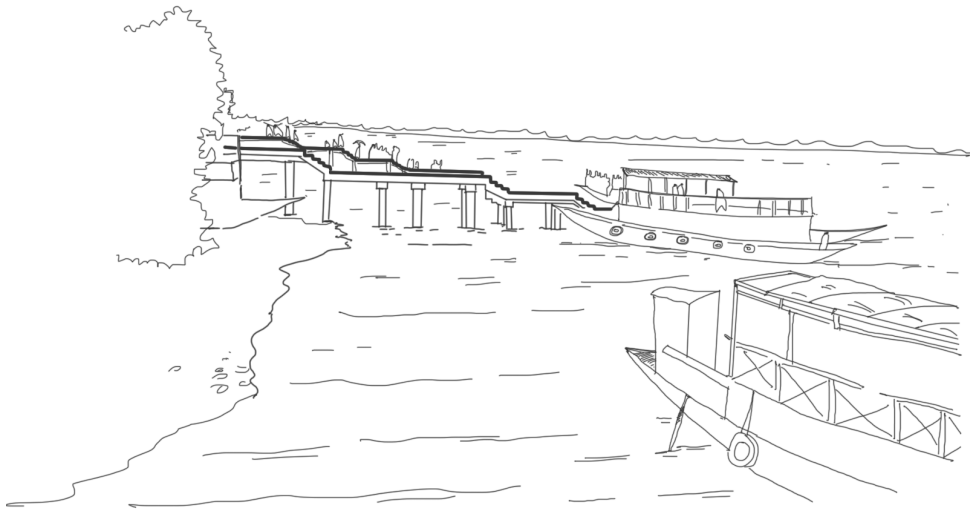


ACTIVE ELEMENTS

There is a strong presence of local markets which cater to the commercial needs of the village. They are typically small in size and have a community-based structure, where local farmers and artisans can sell their products directly to consumers.



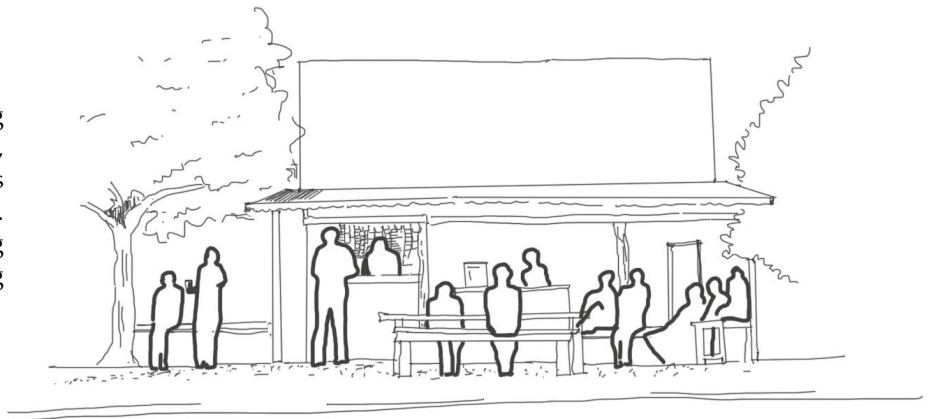
Markets



Piers serve as critical communal spaces that facilitate a range of social and economic activities. They serve as critical transportation links and gathering places for activities such as fishing and trade.

Piers

Social spots serve as important meeting places where people gather to socialize, exchange news, and discuss various topics ranging from politics to sports. They play a crucial role in fostering a sense of community and belonging among villagers.

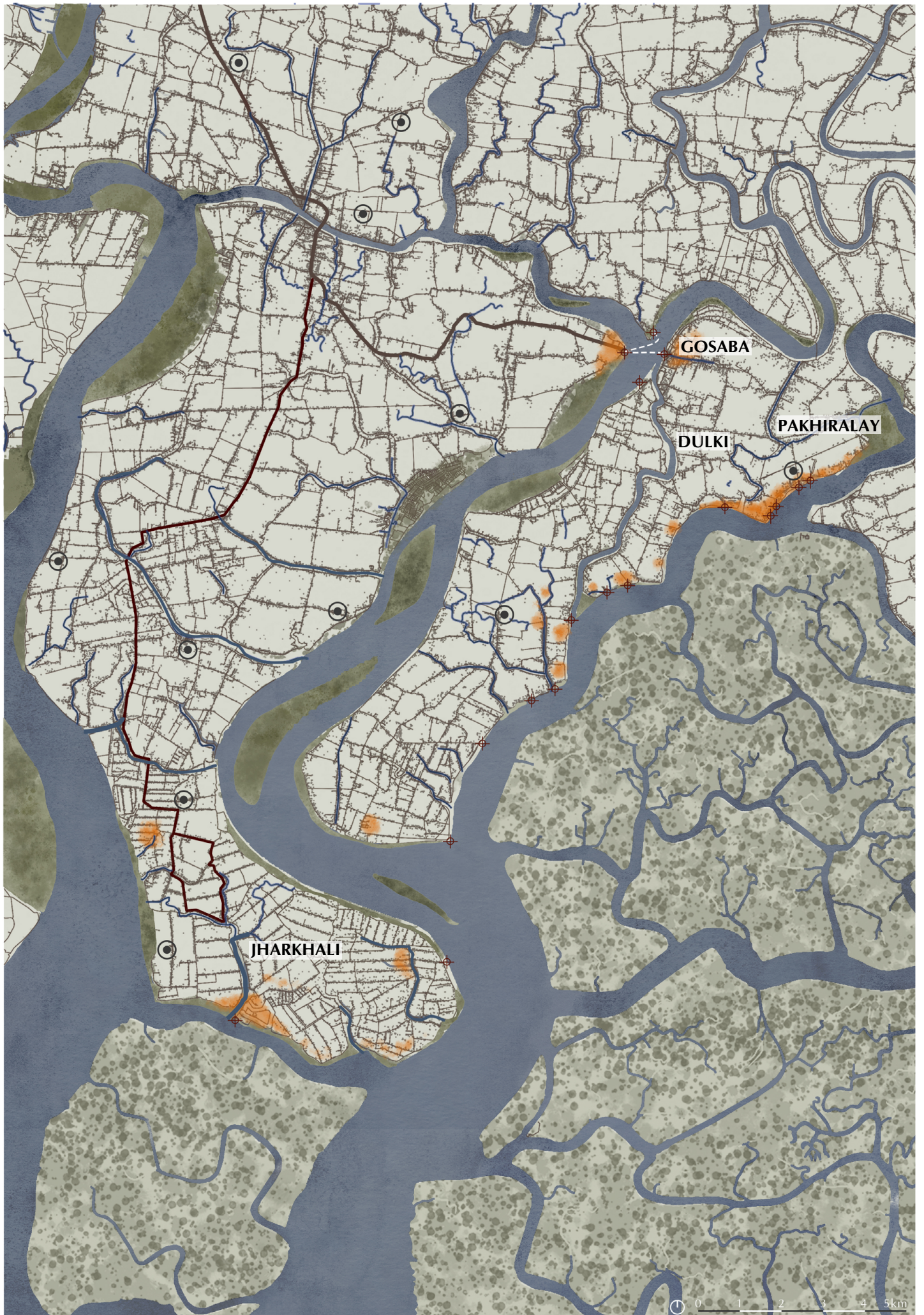


Social spots



The presence of Sundarbans make Gosaba a tourist destination. Visitors can find various accommodations, restaurants, and shops selling souvenirs and local handicrafts.

Tourist areas



— Highway

— Primary road

● Active centers

⊕ Piers/Ferry points

⊙ Cyclone Shelters



1-2m deep pukurs



3m wide rural street



commercial street



excess water

freshwater reservoir

commercial node of the village



pukur 1-2m deep





20-100mm paddy ponding

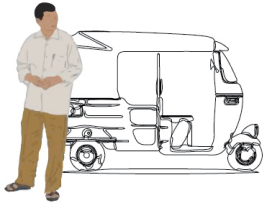






SITE SURVEYS

LOCALS/RESIDENTS



VIRPAN / 32yrs / M

Village : Sonarkhali
Education : 7th class (from Basanti village)
Occupation : Auto driver

Virpan drives auto around villages in gosaba. None of the family members work in agriculture, but they have a **pond with fishes** to eat (for family use). He thinks **lack of education and political issues** are a problem in the village, along with poor availability of drinking water.

"My wife has to walk 1.5 kms for filling drinking water"

Issue to be solved : increase in job opportunities in the village.

Additional thought : There is a reduction in cattle rearing after the floods.



SHARMILA / 29yrs / F

Village : Gosaba, Pakhiraley
Education : 8th class
Occupation : Housewife , Home stay
(Owned by husband) , goat rearing

Sharmila is a home maker who's husband runs a resort and also works as a farmer in their own farm. They grow paddy which sometimes has a surplus to be sold in the market along with some seasonal vegetables. As per Sharmila drinking water , **lack of education facilities and poor medical facilities** are a problem in the village.

"I have 1 pond that i use for daily activities like washing dishes, clothes, fishing, showering etc. I clean the pond with potassium once in a while as it gets dirty especially in summer."

Issue to be solved : Education facilities



MINAL / 35yrs / M

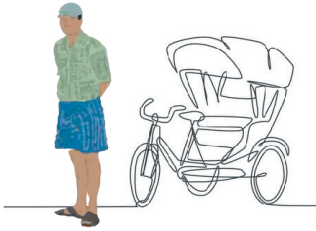
Village : Gosaba, Pakhiraley
Education : High school + Graduation (from Kolkata)
Occupation : Tourist Guide (Sundarbans)

Minal works as a tour guide for day trips to Sajnakhali forest. He has a farm adjacent to his house, with goats, cows and also chickens.

"We are pretty self sufficient, we grow our own food, build our own house, have a pond for daily water needs. We only go to market for clothes and medicines."

Issue to be solved : Mangroves needs to be planted in villages, not in the forest area.

Additional thought : Freshwater is a big issue in villages in Sundarbans. There are no plants to convert saline water to freshwater.



PRITISH / 32yrs / M

Village : Jharkhali
Education : B. Sc Geology
Occupation : Toto-driver , farmer

Pritish is from Bangladesh and is a Hindu migrant who came to India due to Hindu / Muslim tensions in his country. He has 2 acres of agriculture land, next to his house, along with 4 ponds with freshwater fishes and 20 goats. The drinking water in his Villages is good with a govt. Tube well located 5 mins from the house.

"The closest school is 5kms, and its very far for children to walk that distance. I also think the village needs a govt. School"

Issue to be solved : Embankments needs to be made and improved

Additional thought : Jharkhali in total has good quality of groundwater fit for drinking.



DIPAK / 33yrs / M

Village : Gosaba
Education : High school (Gosaba) + Graduation (Canning)
Occupation : Home stay Manager

Dipak owns a few home stays in Pakhiraley. He lives and works there. According to him drinking water is a big issue in the village.

"The support provided by government to us is very poor. NGO's are the ones that actually help during floods."

Issue to be solved : Salinity issue in drinking water and the issue of skin diseases due to poor quality of water.

Additional thought : Because of cyclones and salinity levels, a lot of agricultural practices have stopped.



KALPANA / 29yrs / F

Village : Gosaba
Education : High school (10th class)
Occupation : Tea stall + tourist boat

Kalpana has a small house with the front part being used as a tea stall.

"Drinking water is a big issue in Gosaba. The supply of water from government pipelines is Irregular"

Issue to be solved : Issue of drinking water and medical facilities

SURVEY CONCLUSIONS

■ Yes ■ No

Traveling to work to nearby villages ?



Apart from Toto and auto drivers who have to travel to adjacent villages, people Don't need to travel for work.

Do you or any of your family members work in agriculture?



Most of the people own farms, with family members and additional people Working in there.

Location of the farm adjacent to the house



The farm is always located adjacent to the house with small freshwater ponds to cater the high water need to the crops (mainly paddy)

Do you have a pond ?



Everyone has a freshwater pond to meet the household water needs apart from drinking water (bore well or govt. tub wells)

Do you practice fishing or aquaculture?



Since everyone has a pond, fishes are farmed mostly by each household for self consumption. Additionally with people owning multiple ponds practice aquaculture.



Have you seen a rise in salinity levels in the village? Which areas are more affected?

The salinity is due to flooding caused by cyclones as the rivers surrounding the villages are all salt water rivers.

Not only the coastal areas, but much inland areas are also affected during cyclones.

Have you noticed changing patterns in the agriculture or settlements here in the past 5/10 years?

Due to increase in the no. of cyclones in past years and increased flooding, more land is becoming unfit for agriculture and there has been an increase in aquaculture. Another change has been increase in home stays and tourist infrastructure (Especially in Gosaba) due to Nature based tourism.



Do you practice other occupations during flood/monsoon season, how do you support yourselves in these times?

Most of the villagers rely on support from the government and NGO'S for basic necessities and move to Flood rescue centers.

In the last years, there is also migration to other cities for work (mainly as laborers).

Reasons for flooding in Sunderbans

As per the locals in the villages, the reason for flooding are the cyclones that lead to intrusion of salty water in the villages and causes destruction.

There is never flooding due to rainfall. Instead, rainfall is actually the source of freshwater for the villages, which is very essential.







RURAL STRATEGY

During a thorough analysis, including a site visit, it was discovered that there is a significant disconnection between different villages and block areas. Upon conducting site surveys and pictorial analysis, it was concluded that there is a lack of accessibility to resources and basic necessities. The destruction of mangroves and loss of biodiversity in these areas has resulted in severe impacts during cyclones, as well as a scarcity of clean drinking water. Furthermore, increasing salinity has made it more challenging for people to rely on agriculture, which has traditionally been a primary source of income and livelihood for the villagers. To address these issues,

a comprehensive strategy has been proposed for this rural landscape. The plan involves creating a system of 2/4km zones with necessary life essentials and a spine connecting these zones throughout the islands. The objectives for 2 and 4km concept varies according to the needs of the local people and the level of emergency required in each. This strategy is proposed as a module that can be implemented in all the blocks of zone 1 and could be extended to zone 2 (as per regional strategy). Implementing this system can bring about significant change in the resource access for the people of Sundarbans, positively impacting the entire region.



WHY ?

Loss of mangroves and biodiversity

Mangroves have been highly impacted due to erosion and construction along the edges, leaving them more exposed to cyclone impact and reducing biodiversity. These belts along the edges should be restored urgently.

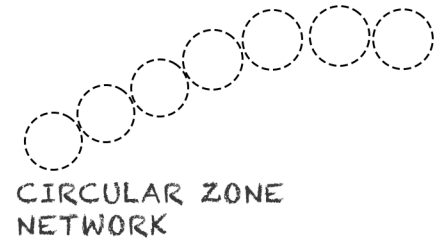
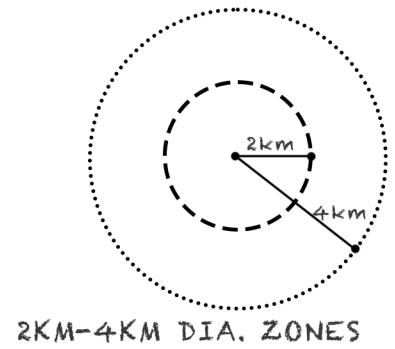




WHY ?

Lack of accessibility to resources

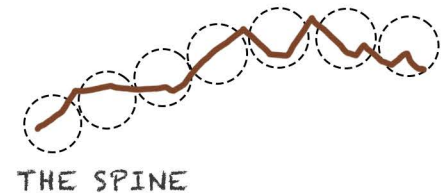
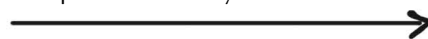
A majority of the facilities on the island are distributed unevenly, with some located at considerable distances. The zone system allows to distribute and ensure that the resources are accessible to all with a 2km and 4km radius system.



WHY ?

Lack of transport connectivity

The islands are not connected to each other because there is a lack of transportation options and no defined link between the different areas. As a solution, a spine is proposed to unite the various zones and provide better transport connectivity.



THE STRATEGICAL VISION

Collage inspired by the *'Instant Emergency Shelter'*



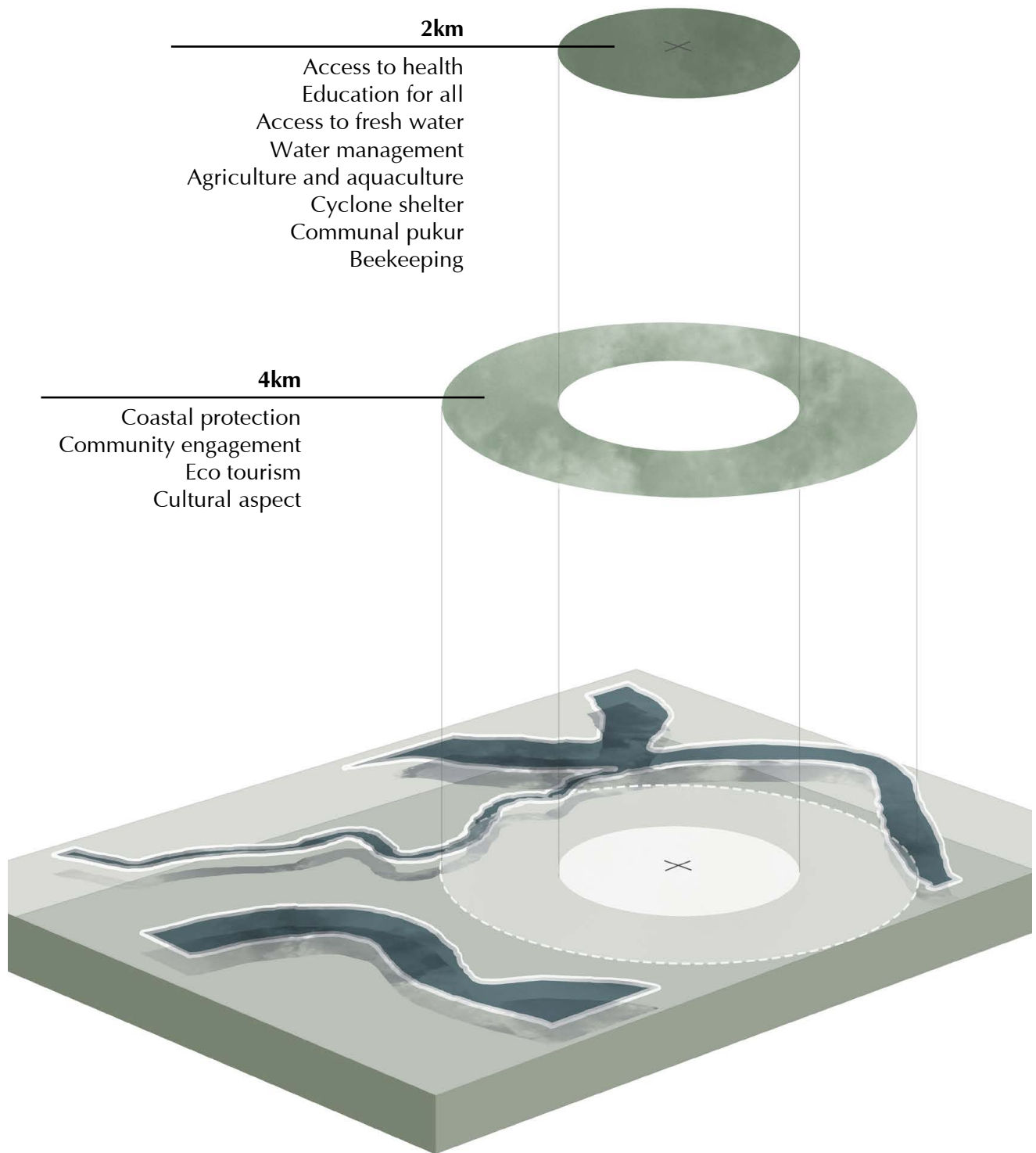


— Existing primary connections
 — Proposed primary connections
 - - - Zone line
● Proposed Activity centers
 Proposed Radial zones
○ Existing cyclone shelters
● Proposed cyclone shelters

Gram-Bangla, Always in Motion

STRATEGY DETAILS





VILLAGE BLOCK VISION

Gosaba village

The rural strategy entails selecting a village block of a 2km radius for an in-depth analysis and design. This design solution will be replicable across 2km blocks in the region. This approach aims to gain a better understanding of the cultural heritage of the communities and propose design solutions that can have a significant impact on a larger scale.

To propose a design solution, the landscape of the village of Gosaba and the challenges faced by the communities were analyzed closely. The design solution aims to serve as an empowerment center and refuge in times of need. Factors like the impact of cyclones, the need

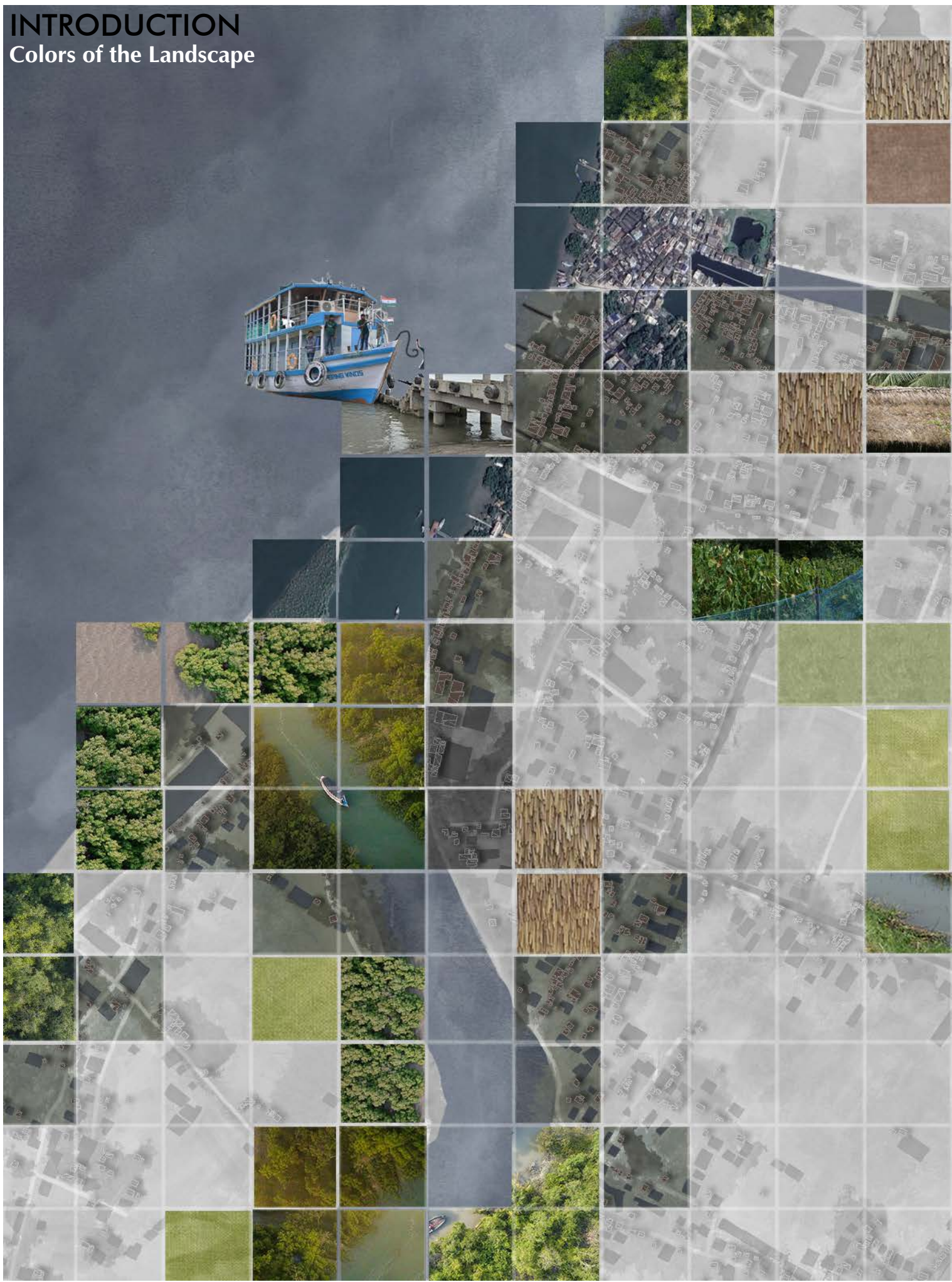
for community spaces and other fundamental needs were considered. A comprehensive solution was found by merging landscape and architecture, which aims to seamlessly blend with the existing landscape while still standing out and making a positive impact on the community. The primary goal is to develop a sustainable and meaningful solution that serves both form and function.

A framework of nature-based solutions was considered as a system for the whole project. This approach provides the necessary ecological balance for the community-based humanitarian project.

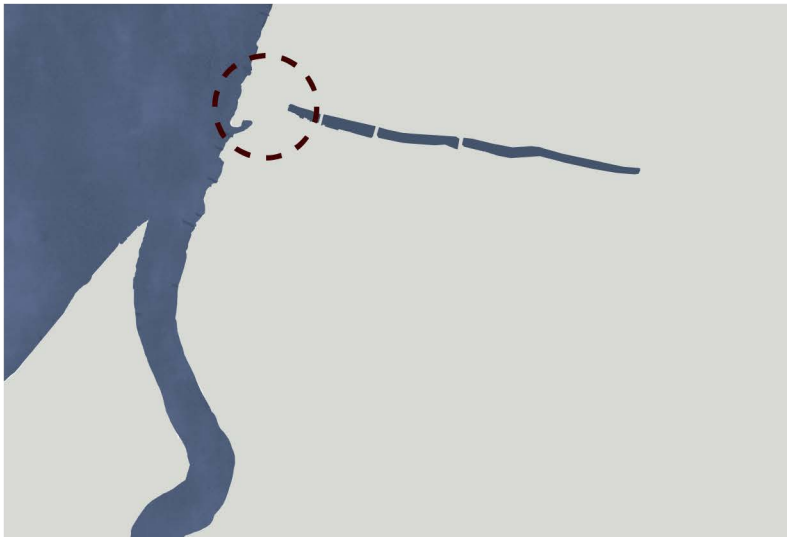


INTRODUCTION

Colors of the Landscape



ANALYSIS



Estuaries

The water canal is disconnected to a greater water system, leading to sewage and sanitation problems for the village.



Green system

Green connections are interrupted, including the mangrove systems along the coastline.



Pukurs

Pukurs are small and separated in common areas, with a possibility to be used for irrigation and communal purpose.



Roads

All the transport connections are tertiary and disconnected. There is a need of primary connection through the village.



Built

The density of built fabric is irregular, with a big cluster of buildings in the active areas and sparse in others.



Piers


Several piers on the coast facilitate easier transport access for resources and pause point for tourists.

FOCUS AREA

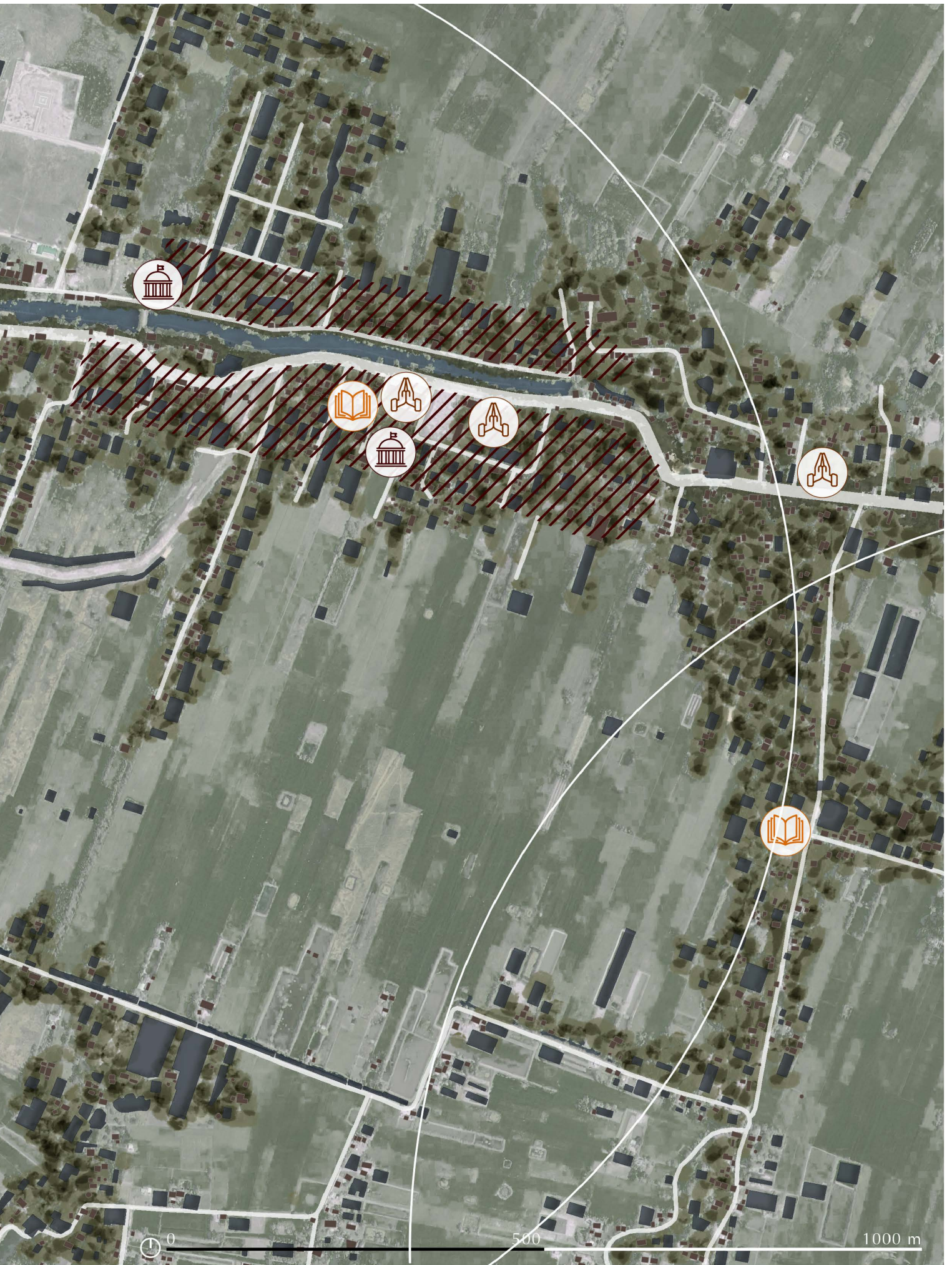
Analysis of the active zones



 Active/Commercial center

 Tourist centric areas

 Government i



Institutions



Religious buildings



Schools

CHALLENGES MAP

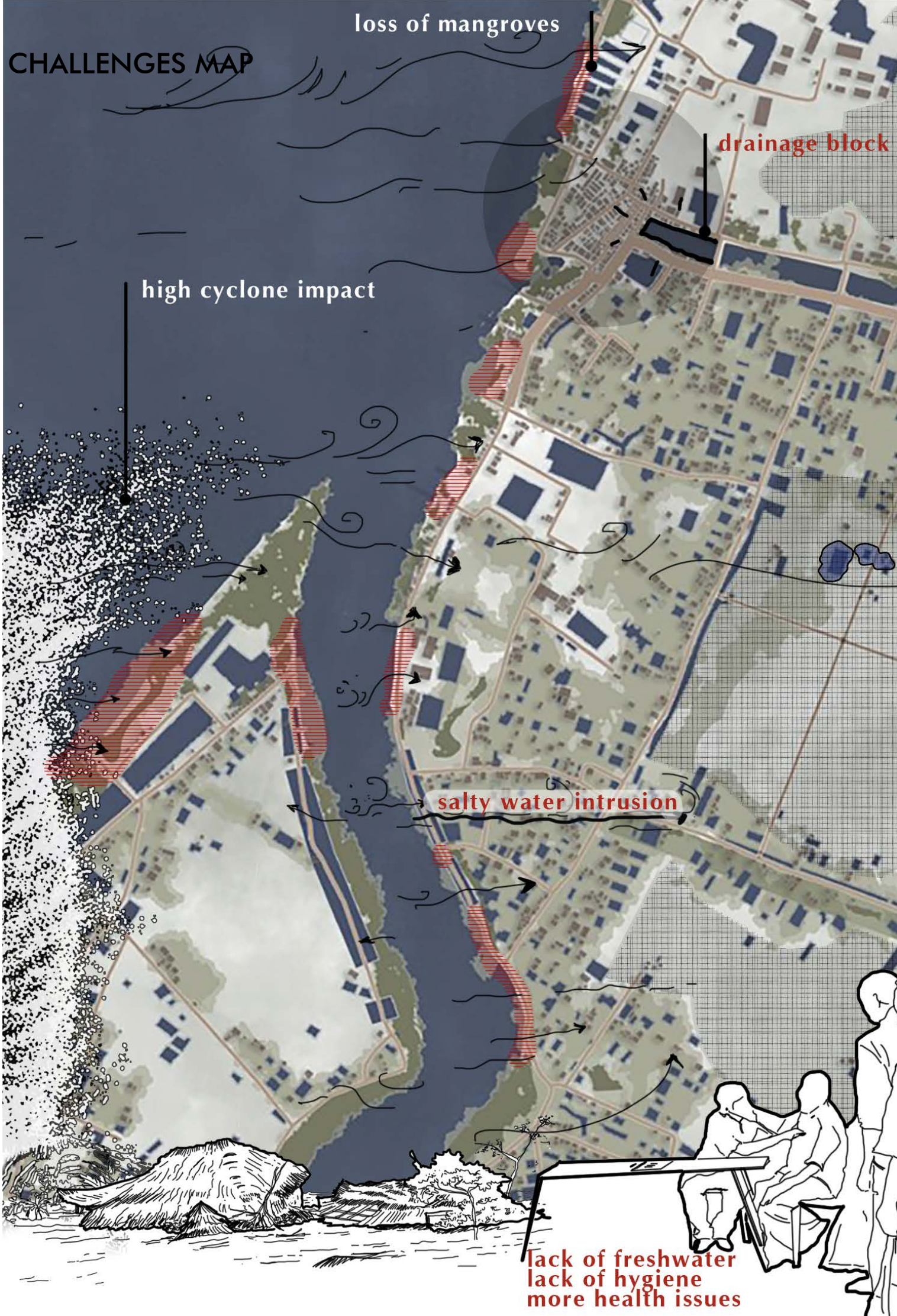
loss of mangroves

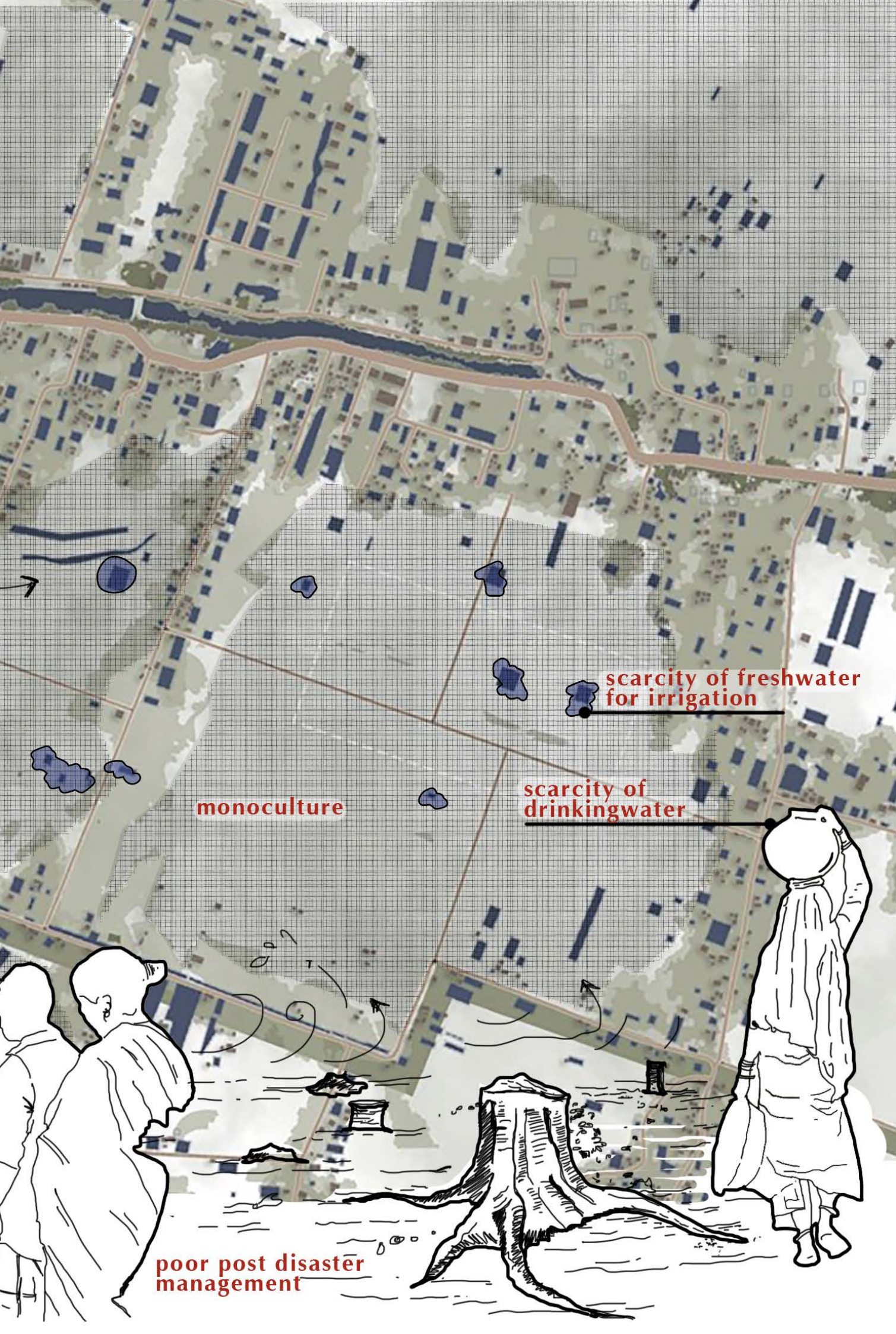
drainage block

high cyclone impact

salty water intrusion

lack of freshwater
lack of hygiene
more health issues





scarcity of freshwater for irrigation

monoculture

scarcity of drinking water

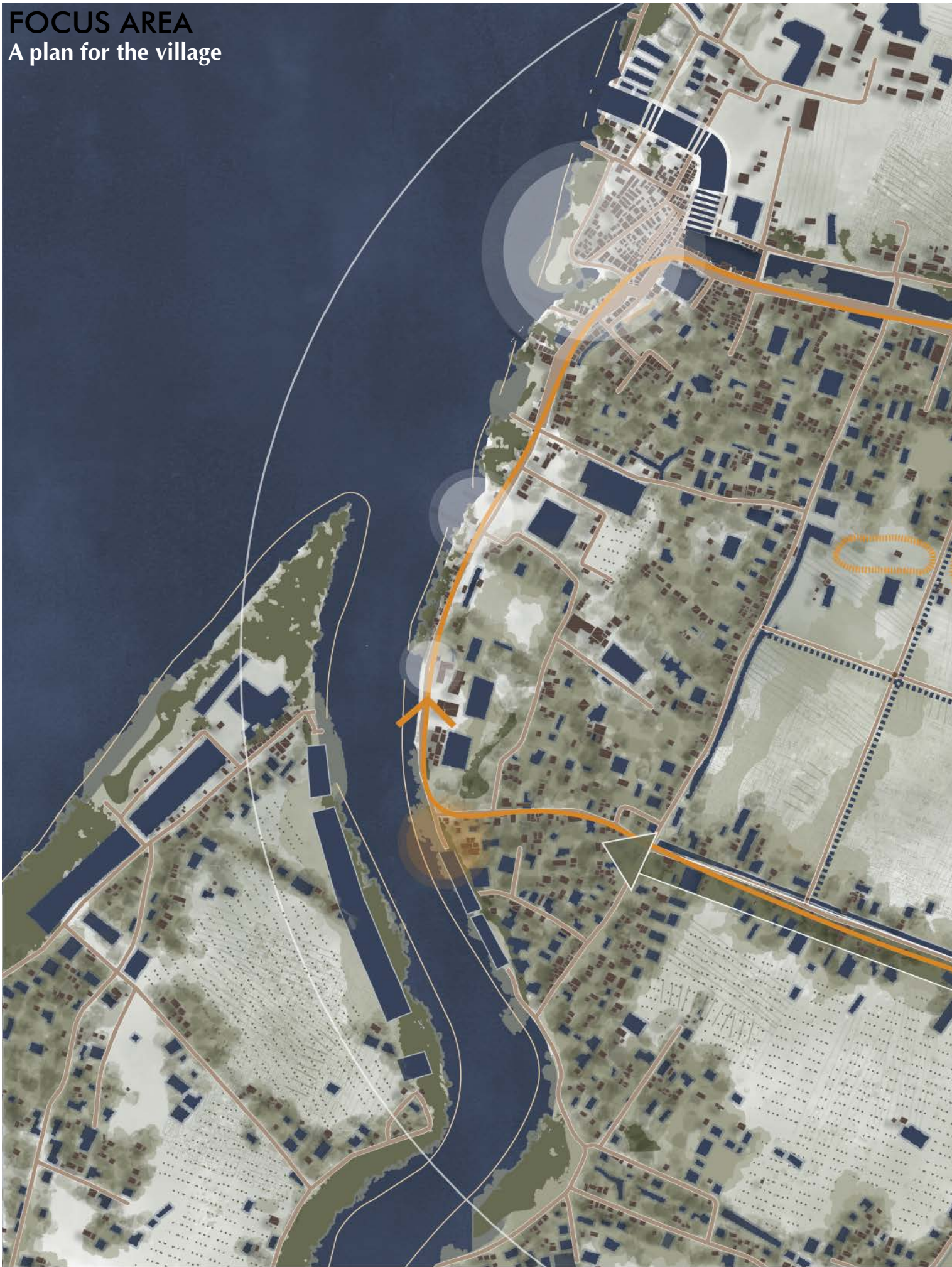
poor post disaster management





FOCUS AREA

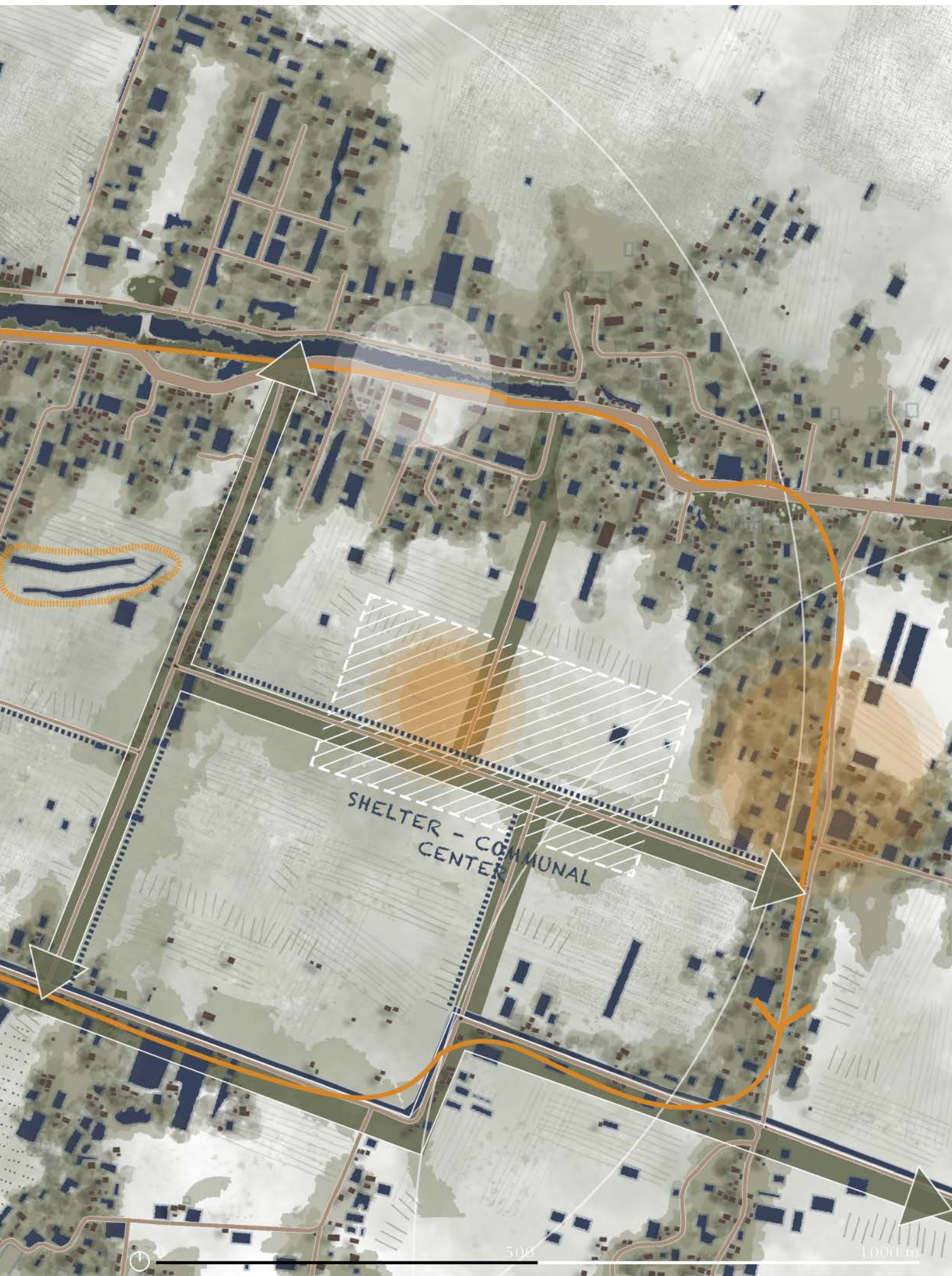
A plan for the village



○ Existing Active centers

● Proposed Active centers

— Rural loop



Wetlands



Green corridors



Rural street

STRATEGY



Estuaries

A new connection of the canal to estuary to facilitate the movement of water and proper drainage.



Green system

New green connections and stronger mangrove belts are proposed to have a more comprehensive green-blue system.



Pukurs

Pukurs to be used in communal way, as excess water retention and canals to irrigate agricultural fields.



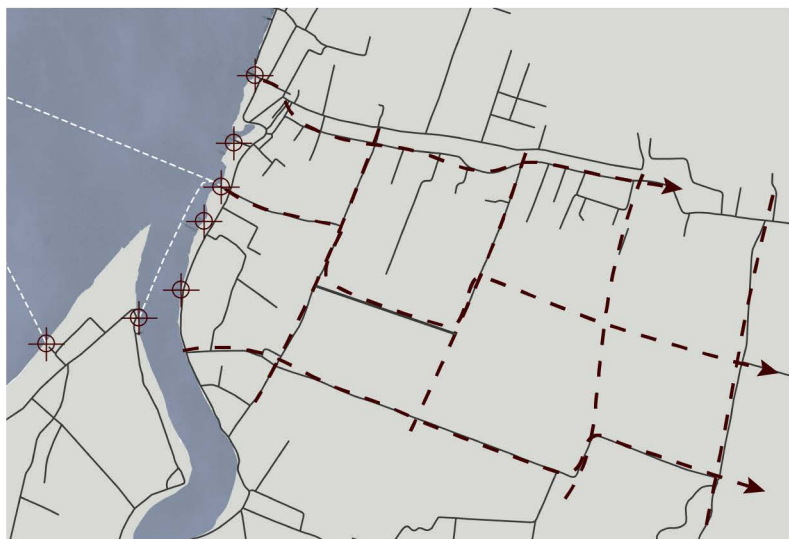
Loop

Rural green streets are proposed along with a loop to make the experience of the rural fabric more profound.



Built

New built areas are proposed in the fabric so as to balance the concentration of activity and make way for biodiversity as well.



Structure

Piers and the roads are connected in a way to create a coherent structure in the rural fabric.

RURAL LOOP

Experience of the landscape

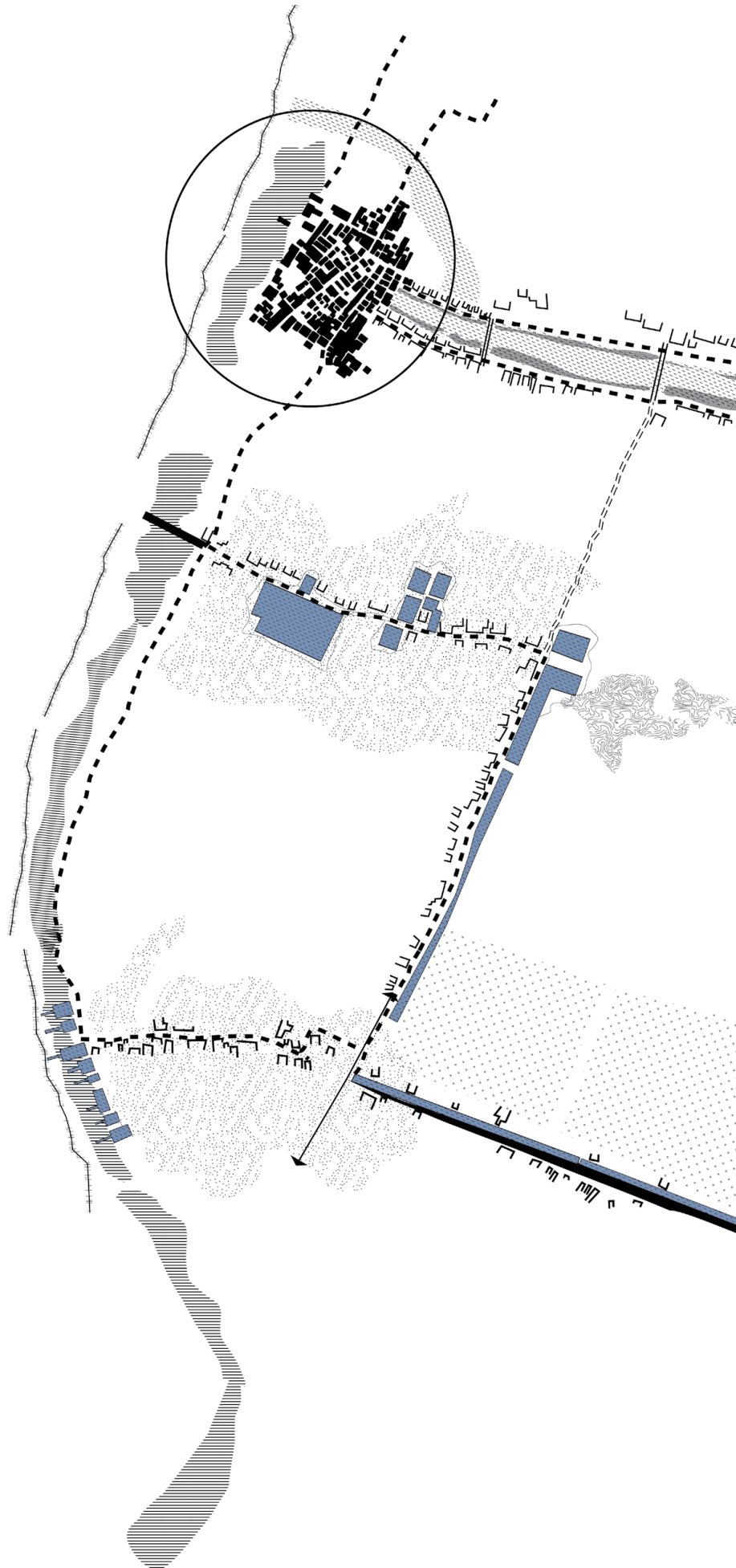


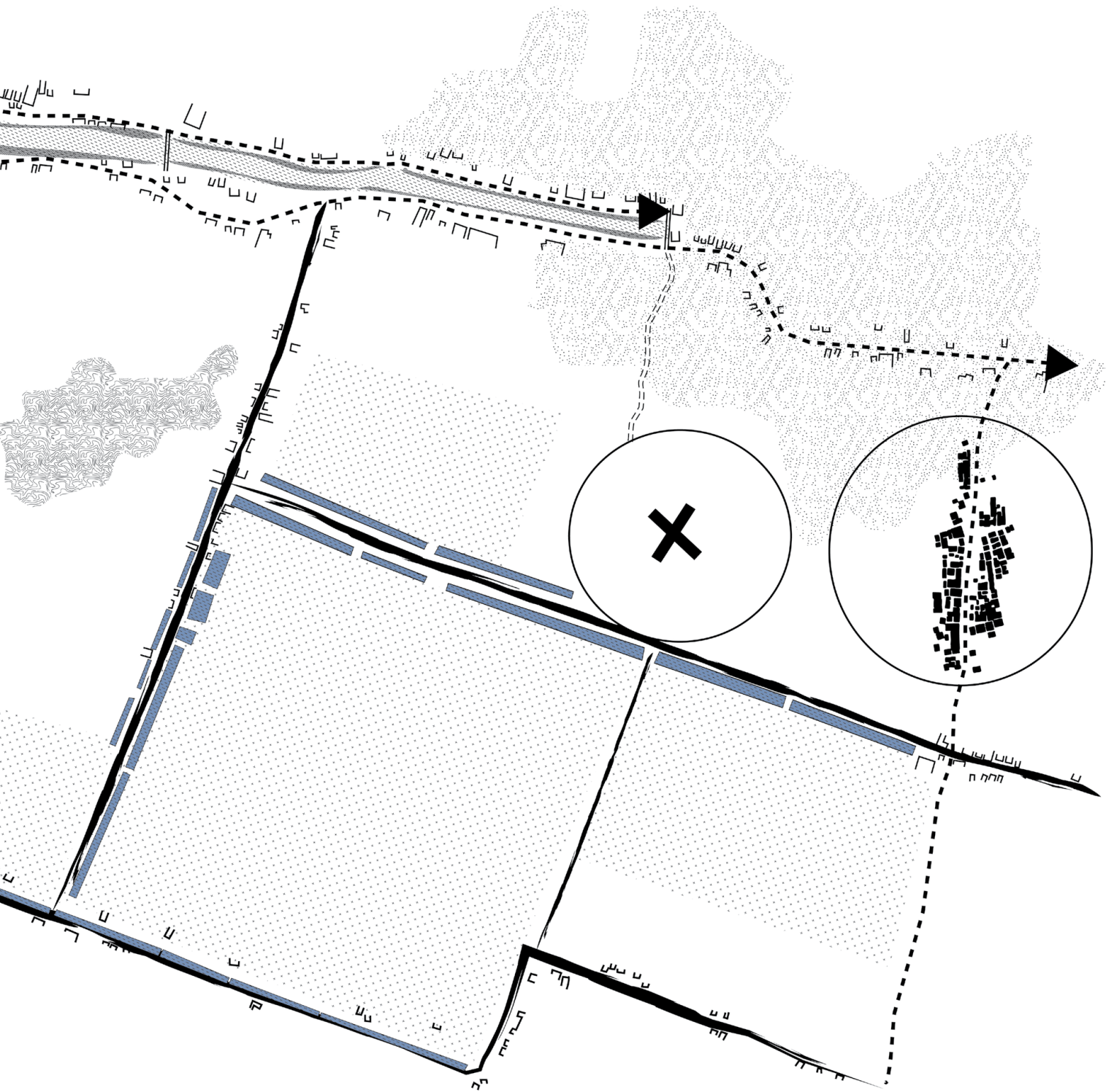


STRUCTURE MAP

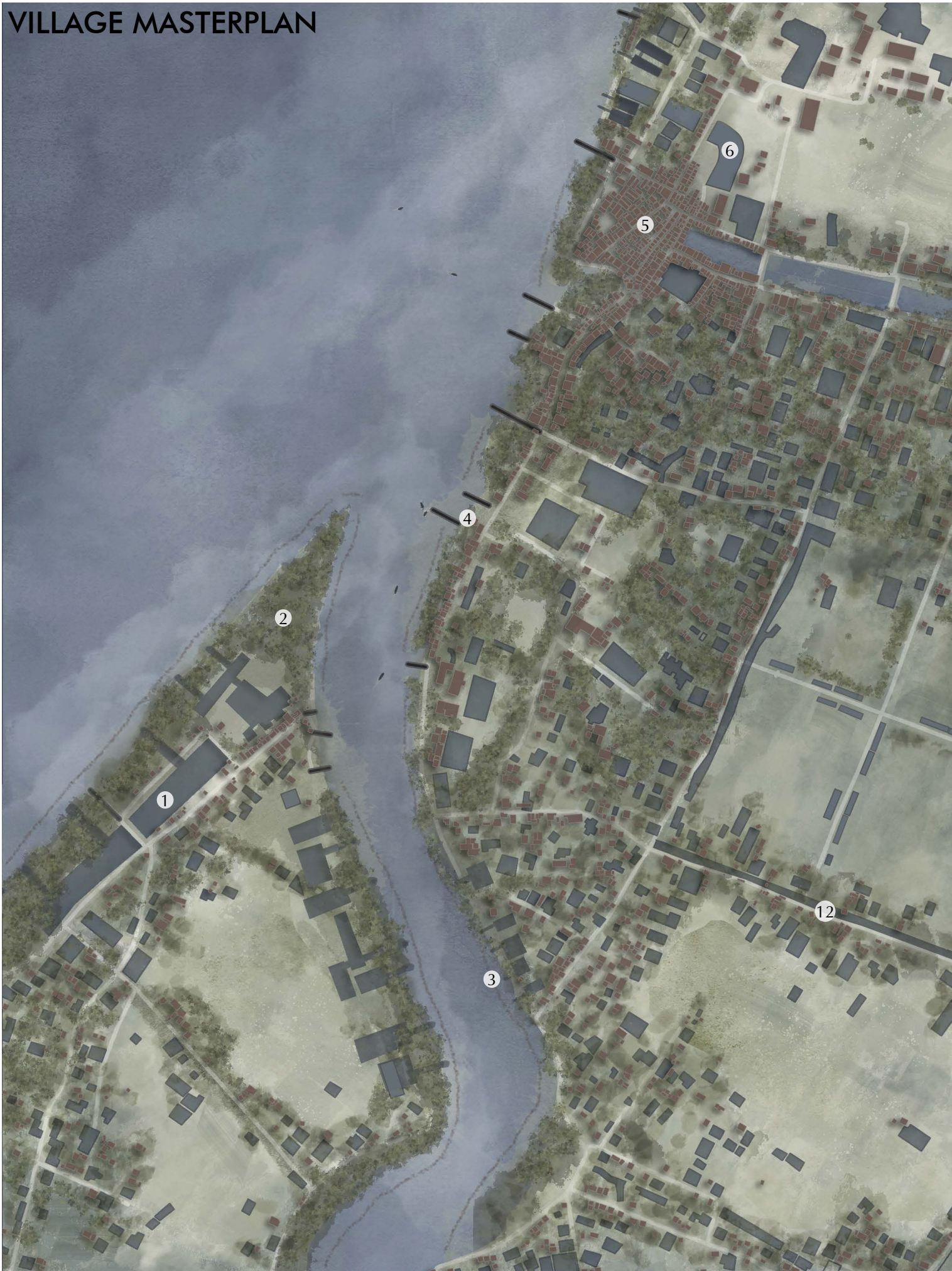
The structure map provides a comprehensive overview of how the masterplan is composed, with an overall grid-like structure. Three to five dominant axes intersect each other to form the structure, with each axis primarily following the existing road network or accessible pathways. However, each axis is defined by various elements, such as the middle horizontal axis that starts from the village's entry point, extends through the rural setting and inland wetlands, and ends at the rural street leading to the cyclone shelter. The reading of each axis varies, depending on the existing situation.

These axes function as a system of blue and green infrastructures, connecting different landscape elements to create a more resilient landscape system. They serve as "connecting corridors," allowing for the smooth flow of movement and resources while enhancing the natural environment.





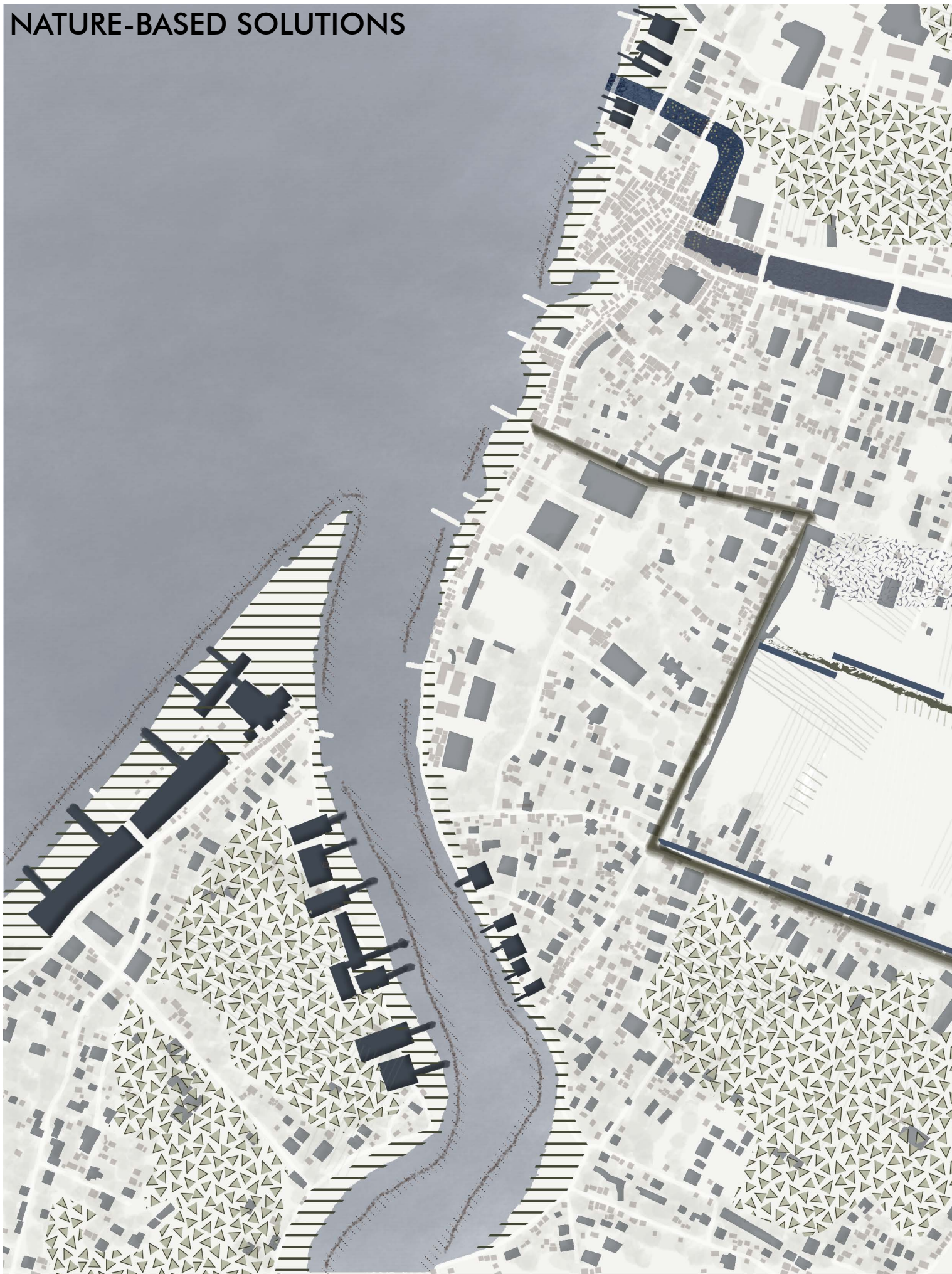
VILLAGE MASTERPLAN





- 1. Associated Mangrove Aquaculture
- 2. Mangrove as coastal shield
- 3. Sustainable dams
- 4. Piers
- 5. Active center
- 6. New outlet canal
- 7. Inland wetlands
- 8. Common Service Center
- 9. Communal center/shelter
- 10. New active center
- 11. Communal pukurs
- 12. Irrigation pukurs

NATURE-BASED SOLUTIONS



≡ Mangroves

⚡ Salt tolerant Agriculture

■ Associated Mangrove Aquaculture

⚡ Inland Wetlands



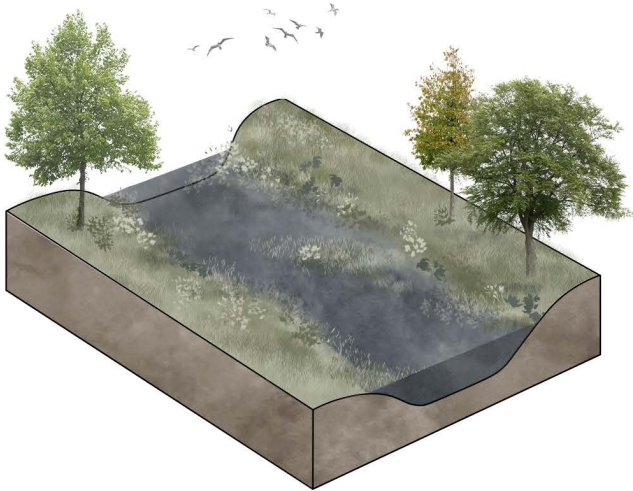
Canal extension with Phytofiltration

Sustainable Dams

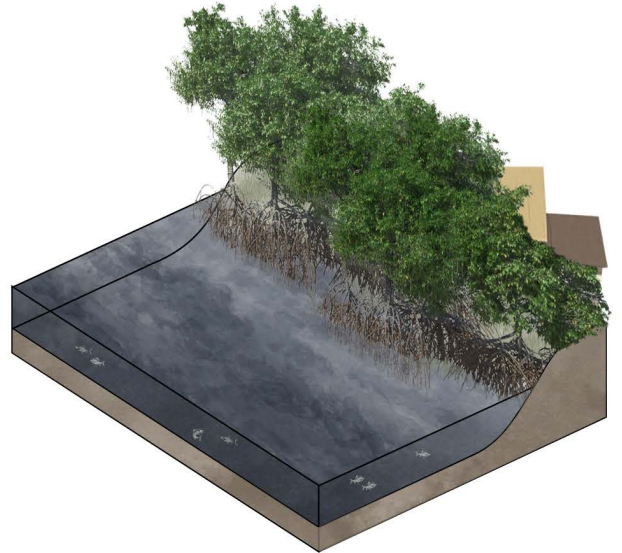
Rural Streets

New proposals

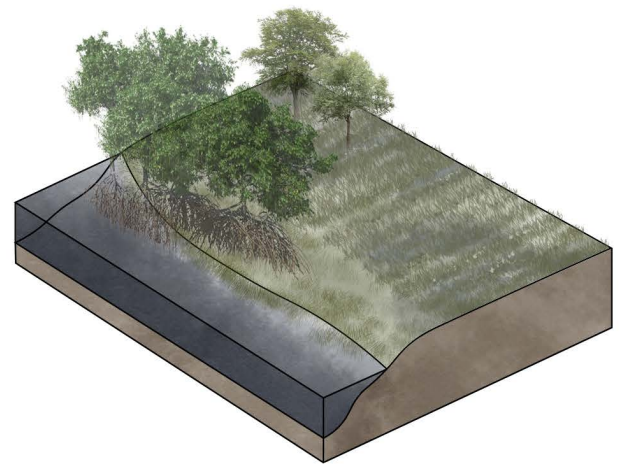
Phytofiltration



Mangroves



Communal pukur

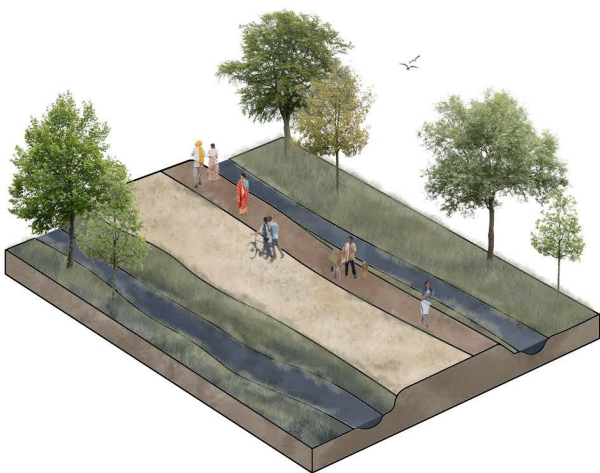
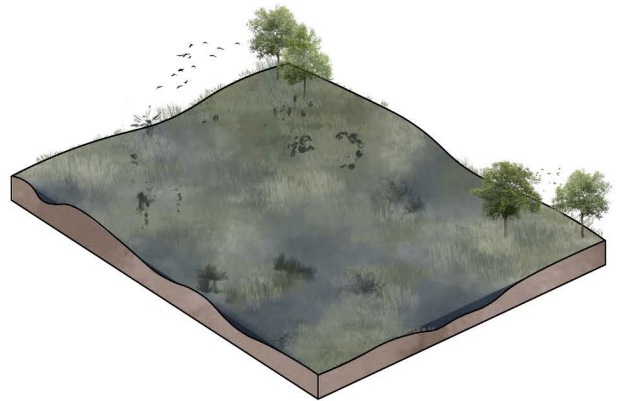


Salt tolerant

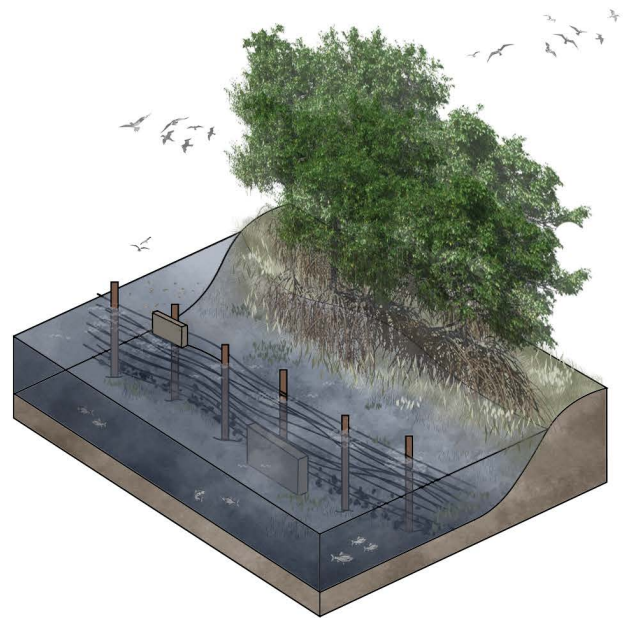
Associated Mangrove Aquaculture



Wetlands



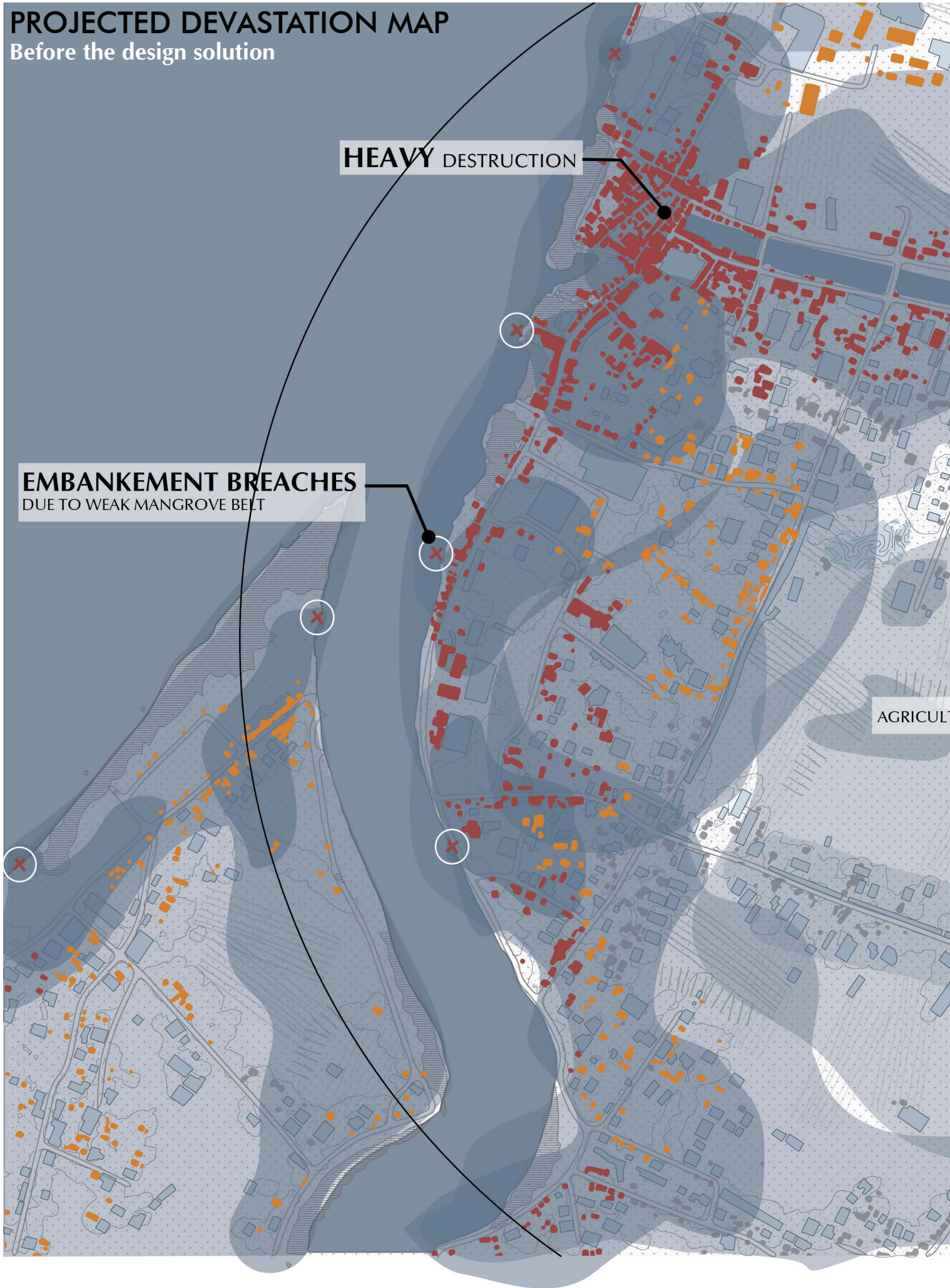
Rural Street



Sustainable Dams

PROJECTED DEVASTATION MAP

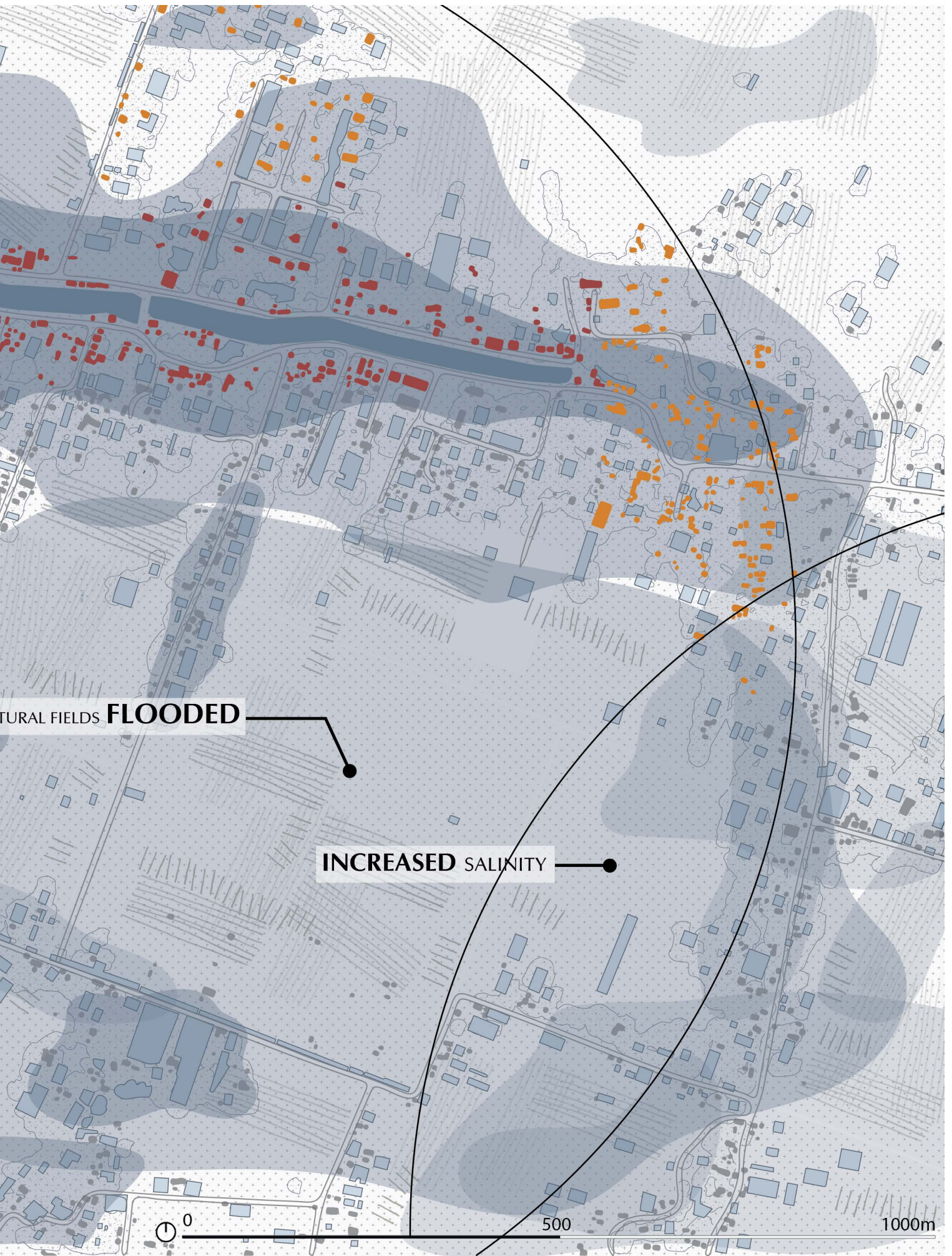
Before the design solution



HEAVY DESTRUCTION

EMBANKMENT BREACHES
DUE TO WEAK MANGROVE BELT

AGRICULTURE



FLOODED AGRICULTURAL FIELDS

INCREASED SALINITY



Built destruction High → Low





PROJECTED DEVASTATION MAP

After the design solution

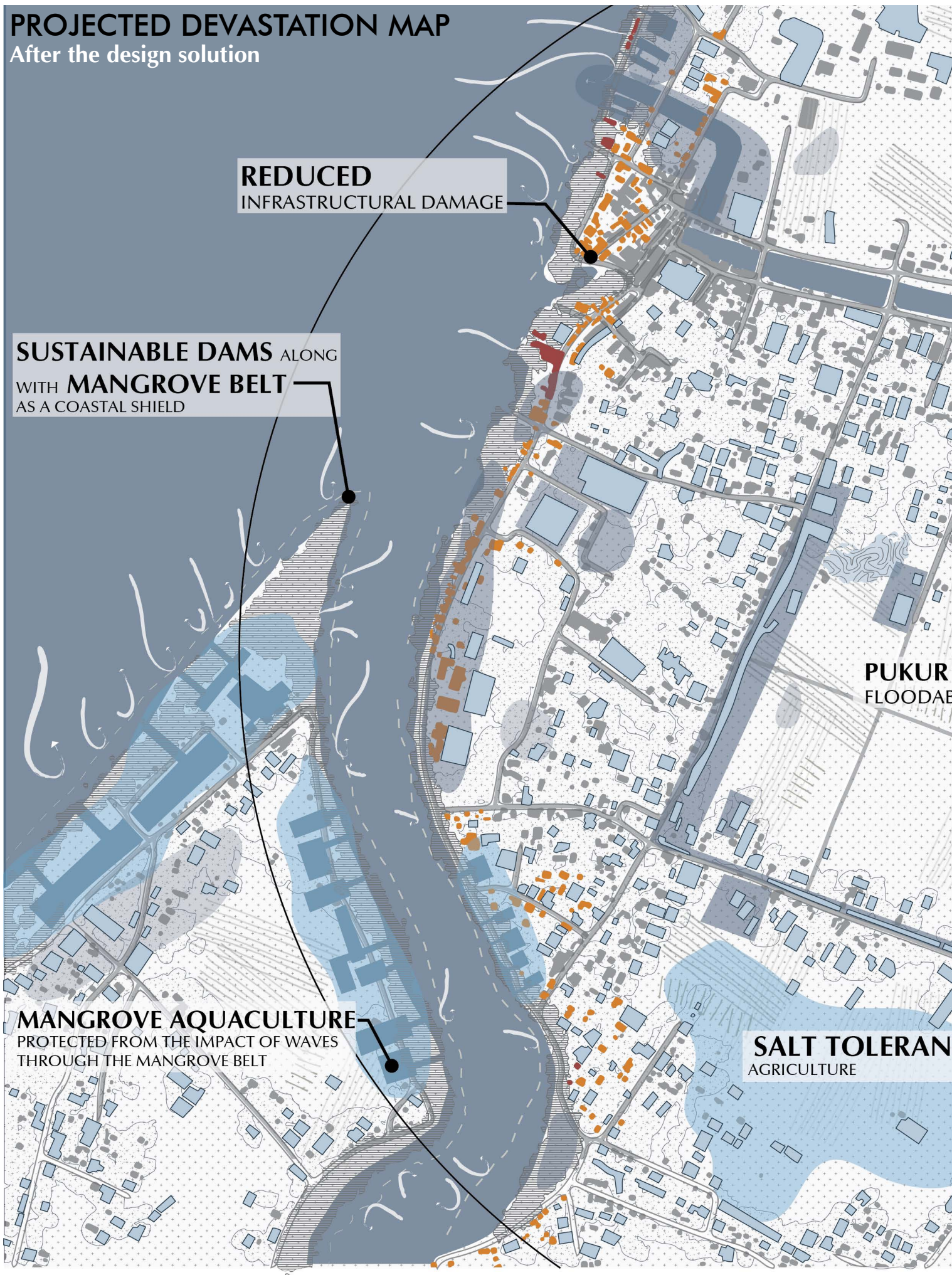
REDUCED
INFRASTRUCTURAL DAMAGE

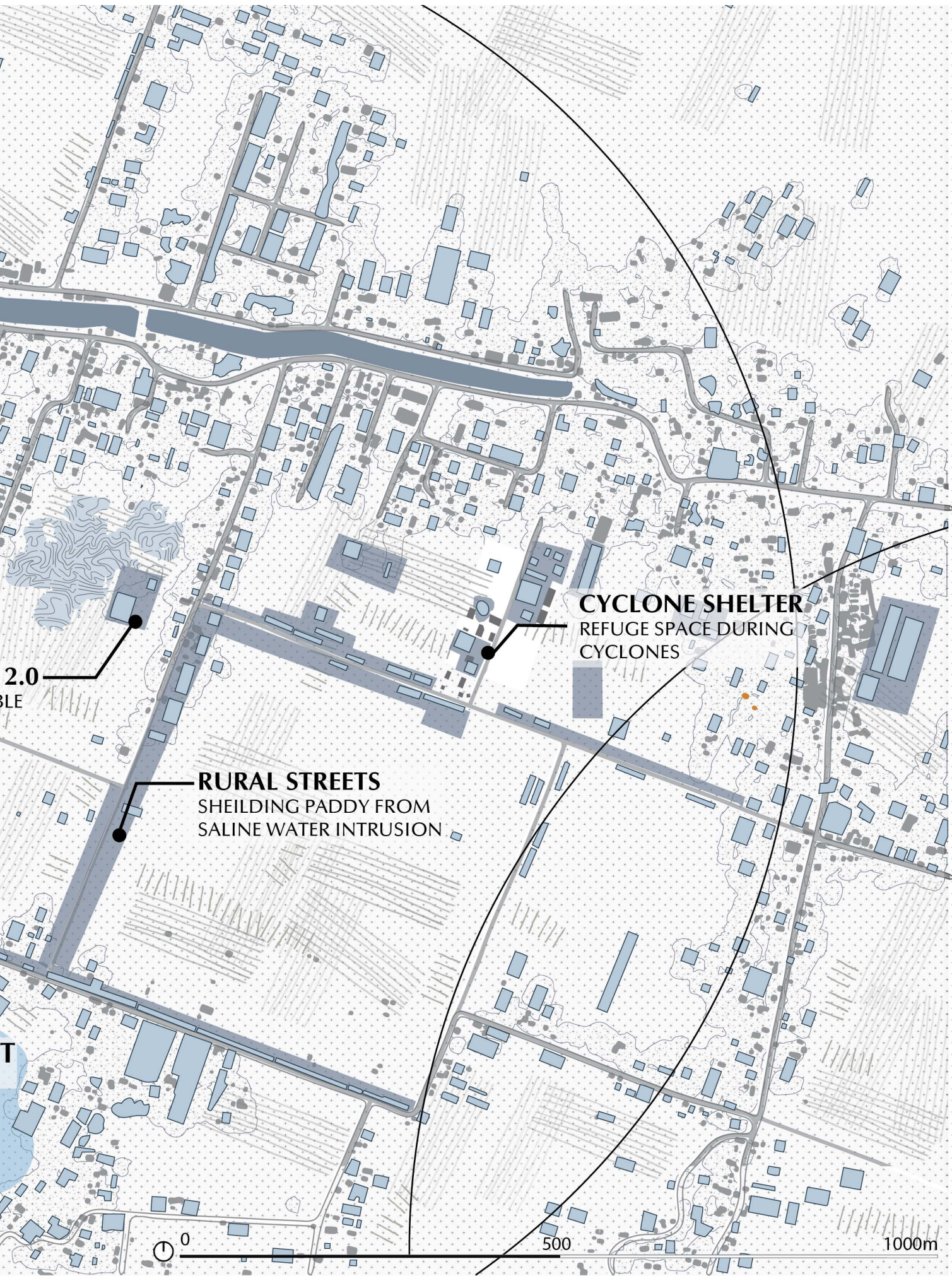
SUSTAINABLE DAMS ALONG
WITH **MANGROVE BELT**
AS A COASTAL SHIELD

MANGROVE AQUACULTURE
PROTECTED FROM THE IMPACT OF WAVES
THROUGH THE MANGROVE BELT

SALT TOLERANT
AGRICULTURE

PUKUR
FLOODAE





CYCLONE SHELTER
REFUGE SPACE DURING
CYCLONES

RURAL STREETS
SHEILDING PADDY FROM
SALINE WATER INTRUSION

2.0
BLE

Built destruction High → Low

REFUGE AND EMPOWERMENT CENTER

The rural strategy proposes a comprehensive system of interconnected solutions, while the design of the refuge and empowerment center takes this approach to a more detailed level. This center is strategically located within the context and offers easy access, providing shelter for hundreds of people in case of a disaster, as well as serving as a communal refuge. It brings people together for various activities, learning opportunities, and education, empowering them with new skills and knowledge. The center acts as a catalyst to enhance skills, provide job opportunities, and meet fundamental needs of life, as outlined in the 2/4km rural

strategy. It serves as a focal point for the village and 2km zone, becoming a component of the larger 2km systems proposed in villages throughout the Sundarbans. The center provides refuge for humans, animals, and biodiversity, and is designed to adapt to the present scenario while being mindful of an uncertain future. The design is based on the existing topography, land, and buildings, while still maintaining a contemporary feel in the rural environment. The design solution reimagines and enhances the system of pukurs seen in the villages, along with other nature-based solutions.



THE SITE

Location of the Communal Shelter



Active centers

Tourism buildings/area

Main roads/loop

1 Ma



1 Mangrove as coastal shield

2 Water bodies

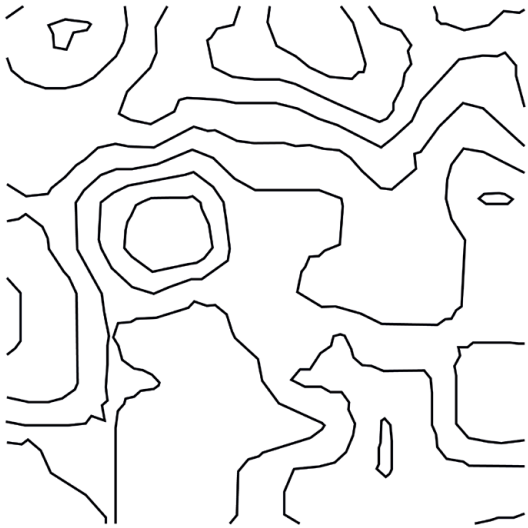
3 Rural street

4 Retention ponds

CONCEPTUAL FRAMEWORK FOR DESIGN

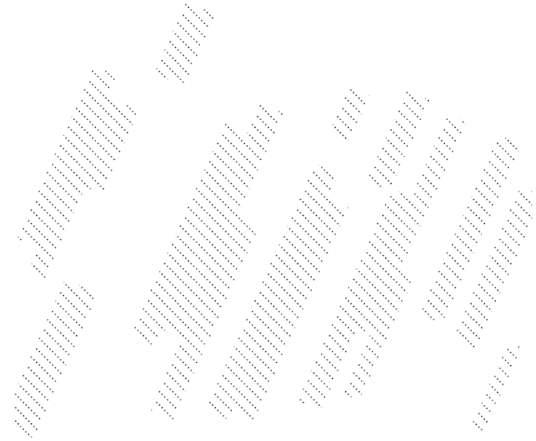
The first inspirations of the design emerged from the existing landscape, topography and cultural practices of the locals. With agriculture being one of the main source of livelihood, the land has been shaped throughout the decades and offers a unique grid structure to the site. The plinth was conceived with the aim of fitting in this singular and rustic landscape. Buildings have been added to this plinth with the similar

goal of following existing landscape elements, such as the pukurs. Pukurs are common water features in the local villages which have a unique and individual character. Some of these pukurs have been reimagined with more communal functions. In this strategy, they are part of a larger water system and offer direct solutions to the Climate Change impacts such as flooding events.



Existing contours

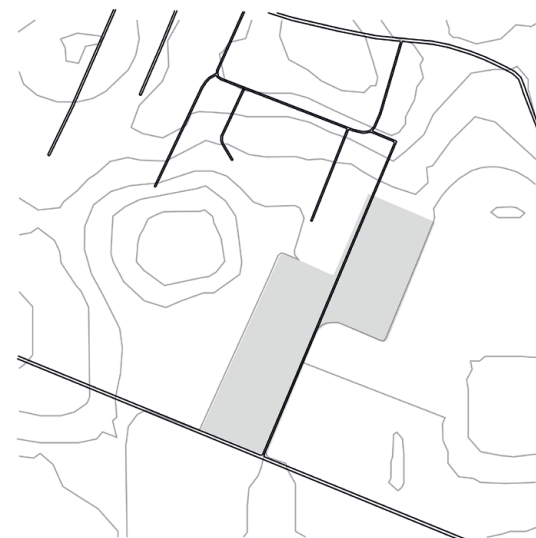
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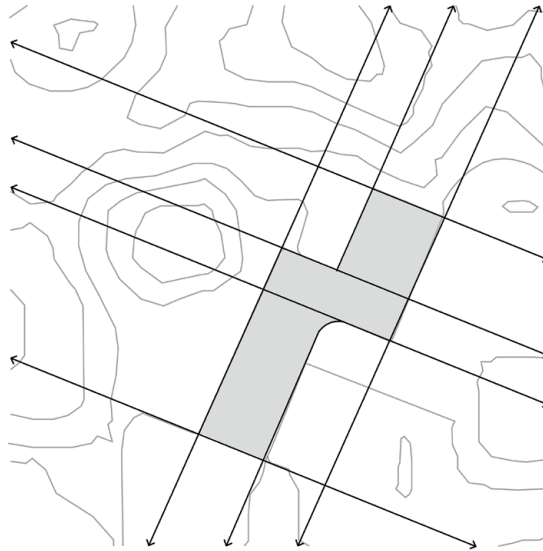
Existing landscape structure



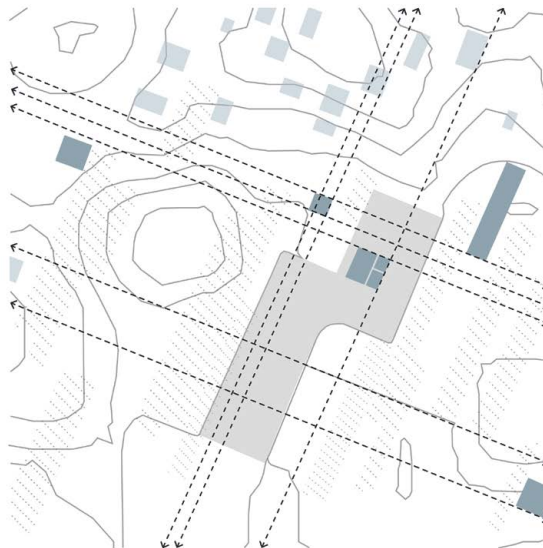
Merging the existing contours with the landscape



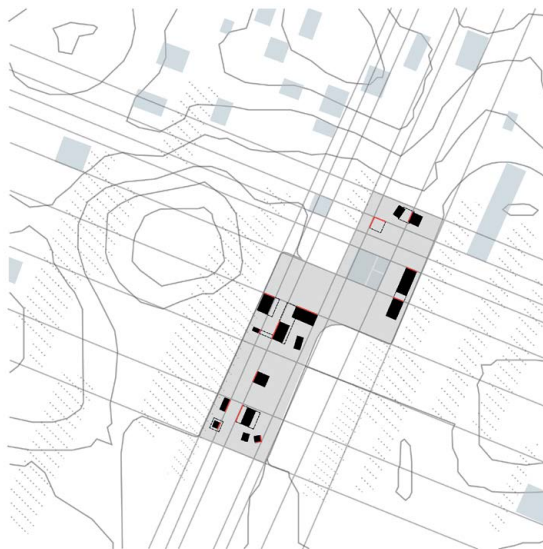
Adapting the design to the new landscape and topography



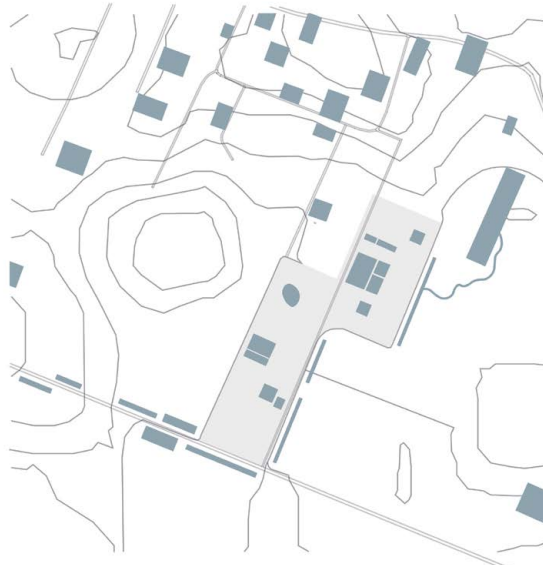
Creating a grid system according to lines of the plinth



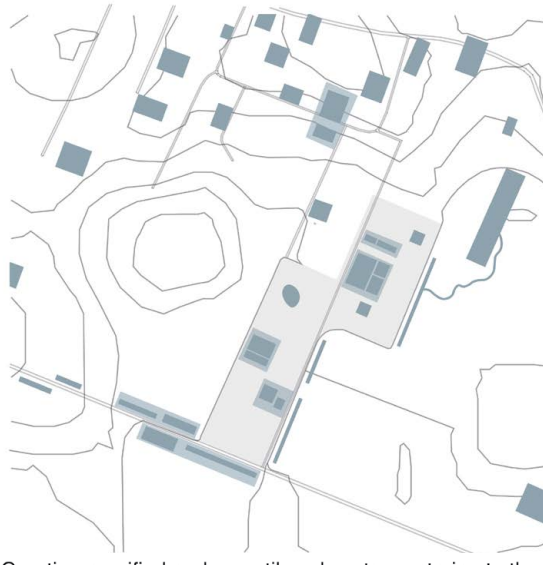
Creating a grid system according to lines of the existing pukurs and agricultural fields



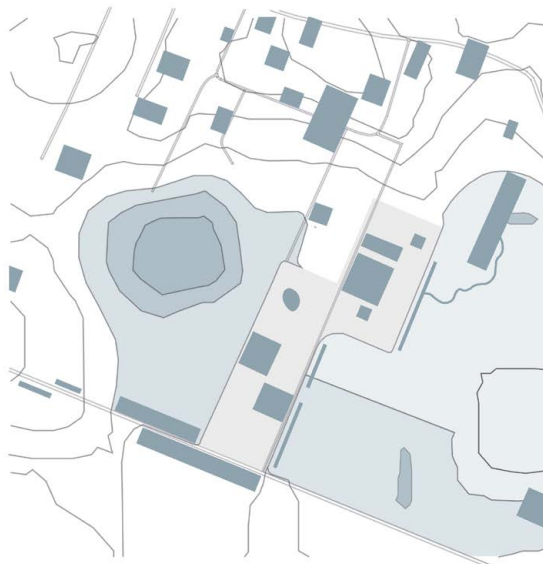
Placing the building according to the merged grid lines



Existing pukur system, individualistic and fragmented, considered as the base framework of a larger hierarchical structure



Creating a unified and versatile subsystem catering to the community which is dependant on the rainfall conditions



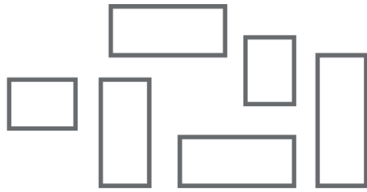
Creating a hierarchy of nested water systems with the largest being a retention basins, interconnected and interdependant on the subsystems

CYCLONE RESISTANT DESIGN

Information referred from: *Cyclone Resistant Building Architecture* (Ankush Agarwal, 2007)

■ Low cyclone resistance

■ High cyclone resistance



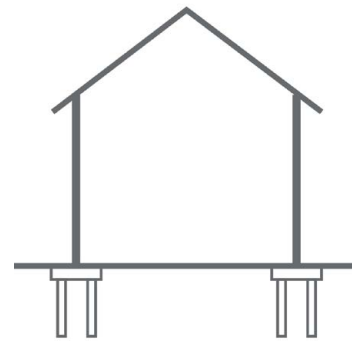
PLANNING

Effective planning in cyclone-prone areas should avoid row planning that creates wind tunnels and instead adopt a dynamic approach to ensure community safety.

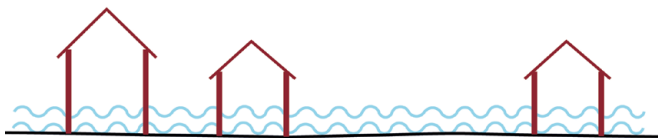
« Simple, compact, symmetrical shapes are best »

FOUNDATION

Pile foundation
appropriate for alluvial soil

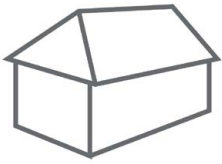


« The square plan is better than the rectangle since it allows high winds to go around them. The rectangle is better than the L-shaped plan. »

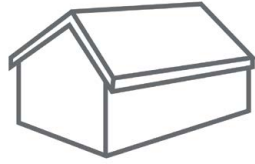


PLINTH

Natural plinth
recommand for flood prone areas



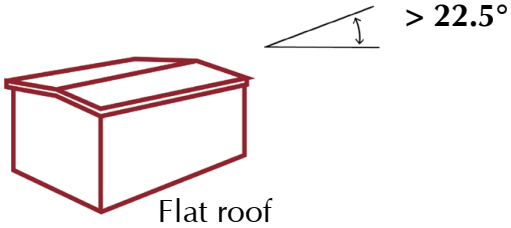
Hip roof



Gable roof

ROOF

It is recommended to have a minimum angle of 22.5° to make it more resilient to strong winds.



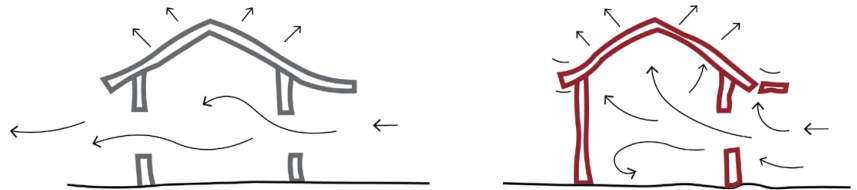
Flat roof

Flat roof
Unsuitable for cyclone prone areas

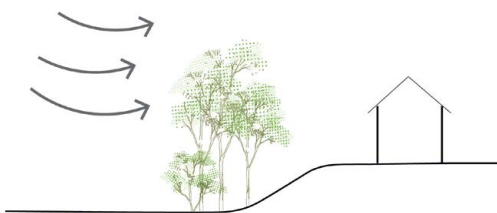
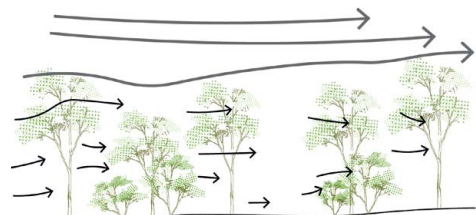
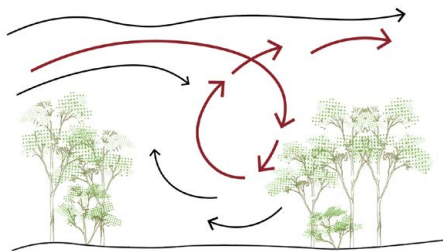
«If longer shapes are used, they must be designed to withstand the forces of the wind.»

OPENINGS

Cross-ventilation
as a must for enclosed structures



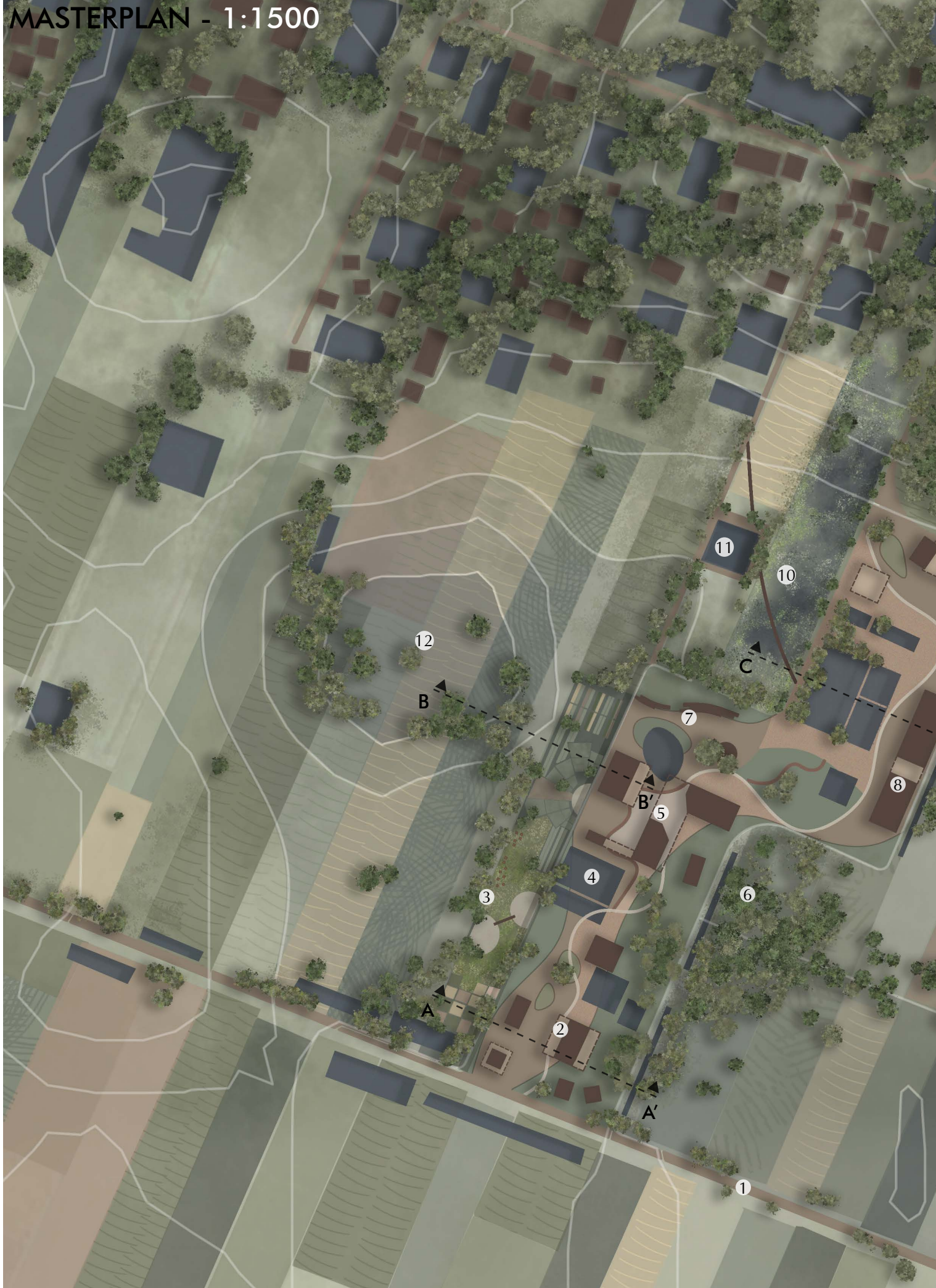
«If overhangs or canopies are desired, they should be braced by ties held to the main structures»

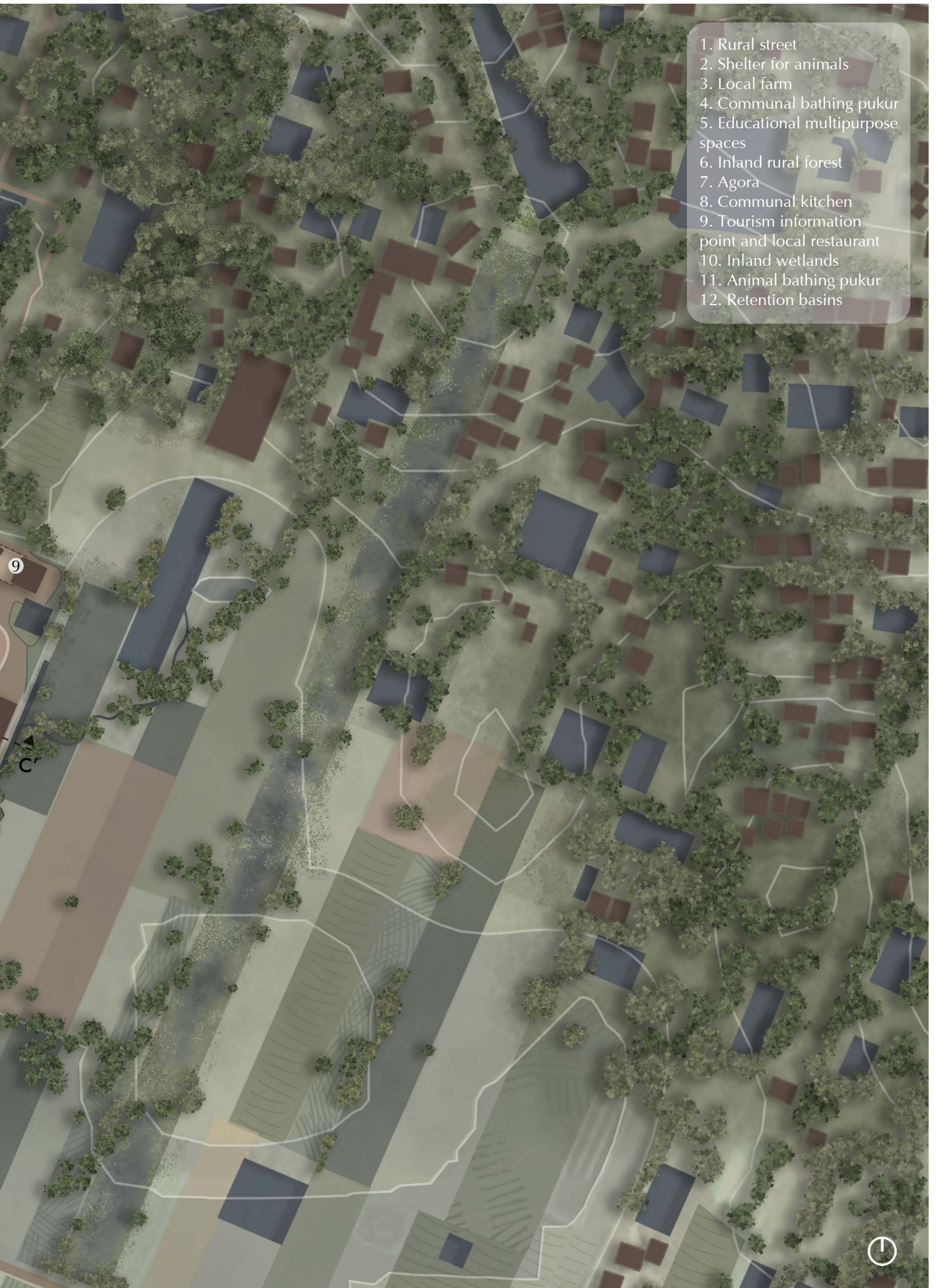


VEGETATION

Vegetation can act as a windbreaker in cyclone prone areas to minimize the impact of strong winds

MASTERPLAN - 1:1500





- 1. Rural street
- 2. Shelter for animals
- 3. Local farm
- 4. Communal bathing pukur
- 5. Educational multipurpose spaces
- 6. Inland rural forest
- 7. Agora
- 8. Communal kitchen
- 9. Tourism information point and local restaurant
- 10. Inland wetlands
- 11. Animal bathing pukur
- 12. Retention basins

Functional Space Diagrams

The site comprises of multiple systems that have been developed together as a cohesive design. The objective is to establish a connection between outdoor public spaces and the surrounding buildings, considering the local traditions and indigenous practices, while also promoting a sense of community and safety. Each aspect of the design has been meticulously planned with the use of local materials, and can serve the community for various purposes such as education, recreation, and economic development.

This pukur is a part of the public space which aims to gather people, has a communal and **recreational purpose**

These pukurs are designed to serve as **communal bathing** spaces for locals, and are often used as a social activity, either as part of a cultural or religious ceremony

The primary function of this pukur is to serve as a **bathing space for animals**, particularly large ones such as cows

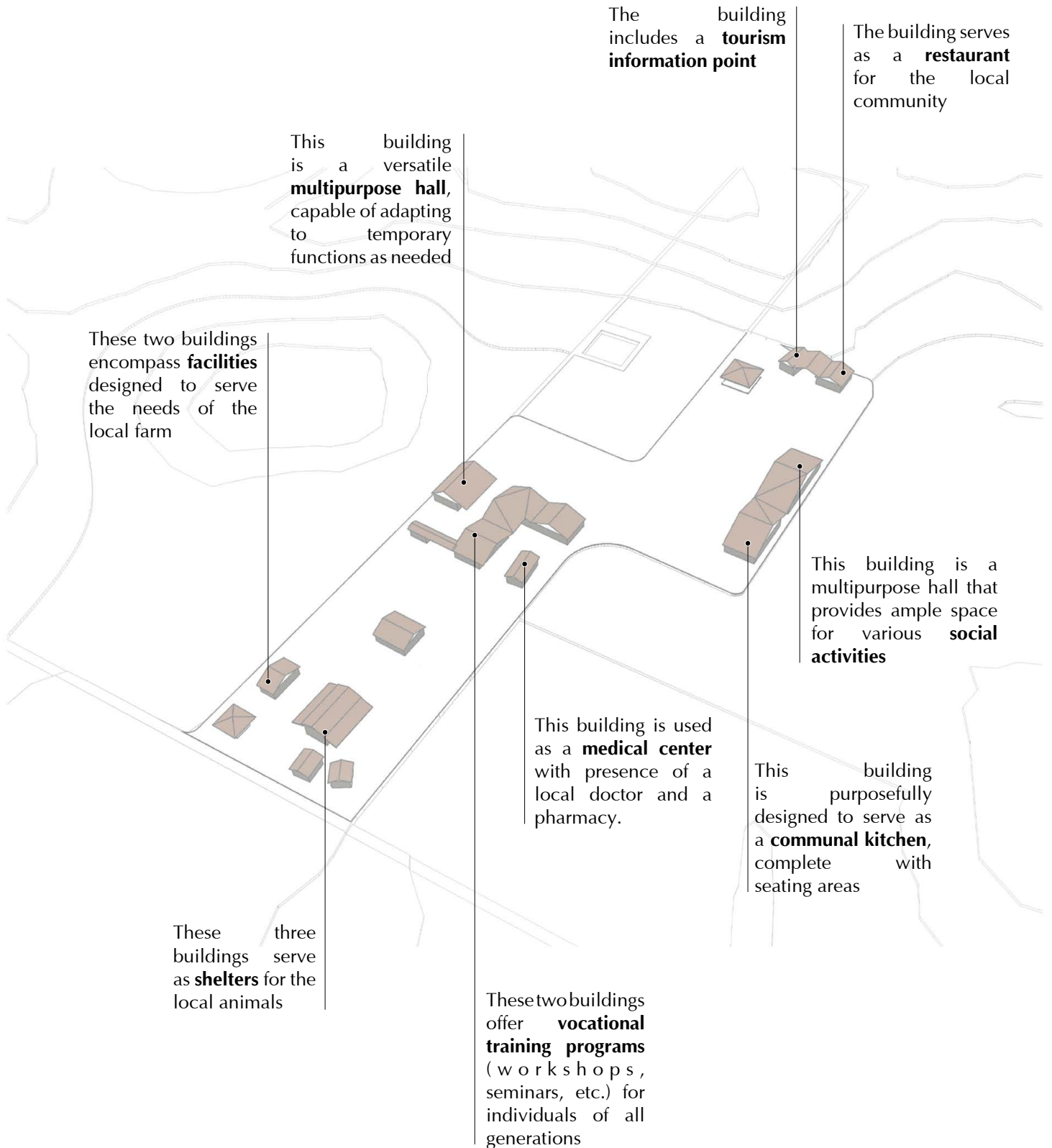
This pukur collaborates with the nearby restaurant for various **daily uses**

The two pukurs function together as a cohesive system, serving both as a source of **fishing** and as vital reservoirs of **drinking water** for the local animals.

This pre-existing pukur has been partitioned into three distinct sections. While two sections are utilized as part of a **water purification system** for drinkable water, the third section is designated for **cleaning dishes** and is equipped with live fish to assist in the cleaning process



Water



Galvanized sheets



CSEB blocks



Bamboo



Sal wood

The aim of this public space, commonly referred to as an 'agora', is to bring people together as a community. It serves as the central hub of the community and features a communal pukur for recreational use and seating areas for relaxation

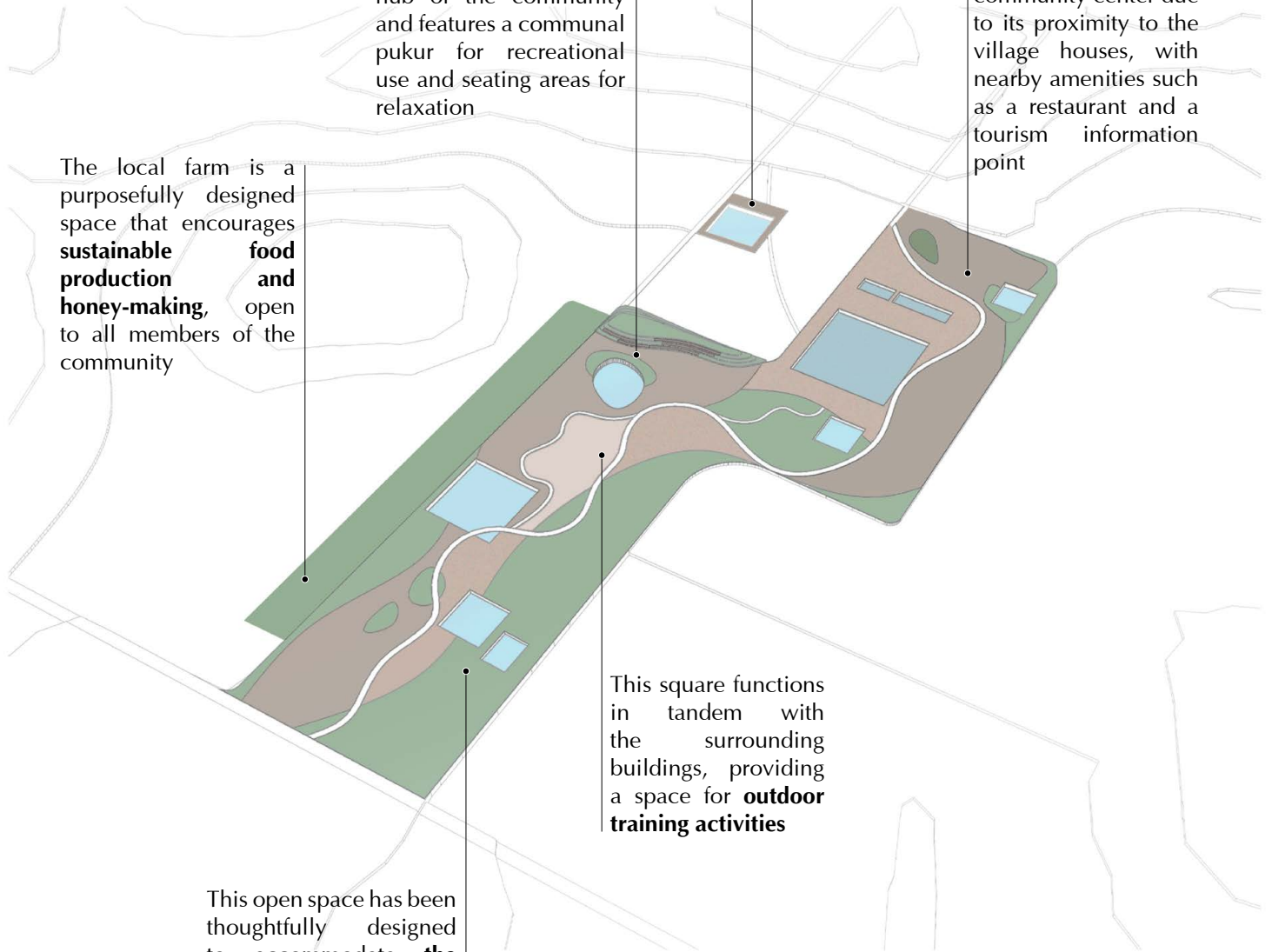
This space has been purposefully created to cater to the **needs of the local animals**

This space serves as **the entrance** to the community center due to its proximity to the village houses, with nearby amenities such as a restaurant and a tourism information point

The local farm is a purposefully designed space that encourages **sustainable food production and honey-making**, open to all members of the community

This square functions in tandem with the surrounding buildings, providing a space for **outdoor training activities**

This open space has been thoughtfully designed to accommodate **the needs of local animals**, recognizing their importance as significant members of the community's ecosystem



Permeable bricks



Natural stones



Decomposed Granite



Gravel

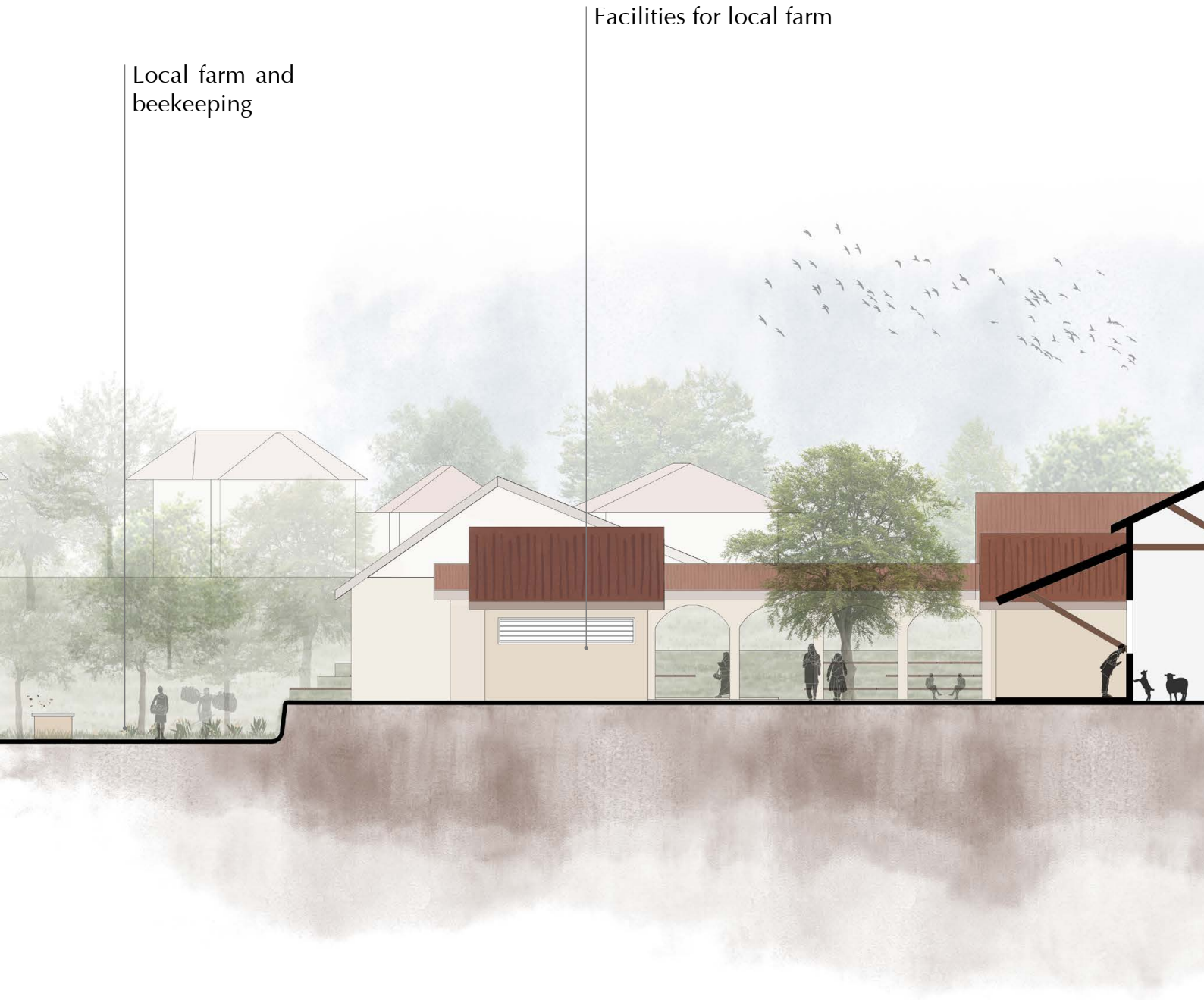




Section AA'

Local farm and
beekeeping

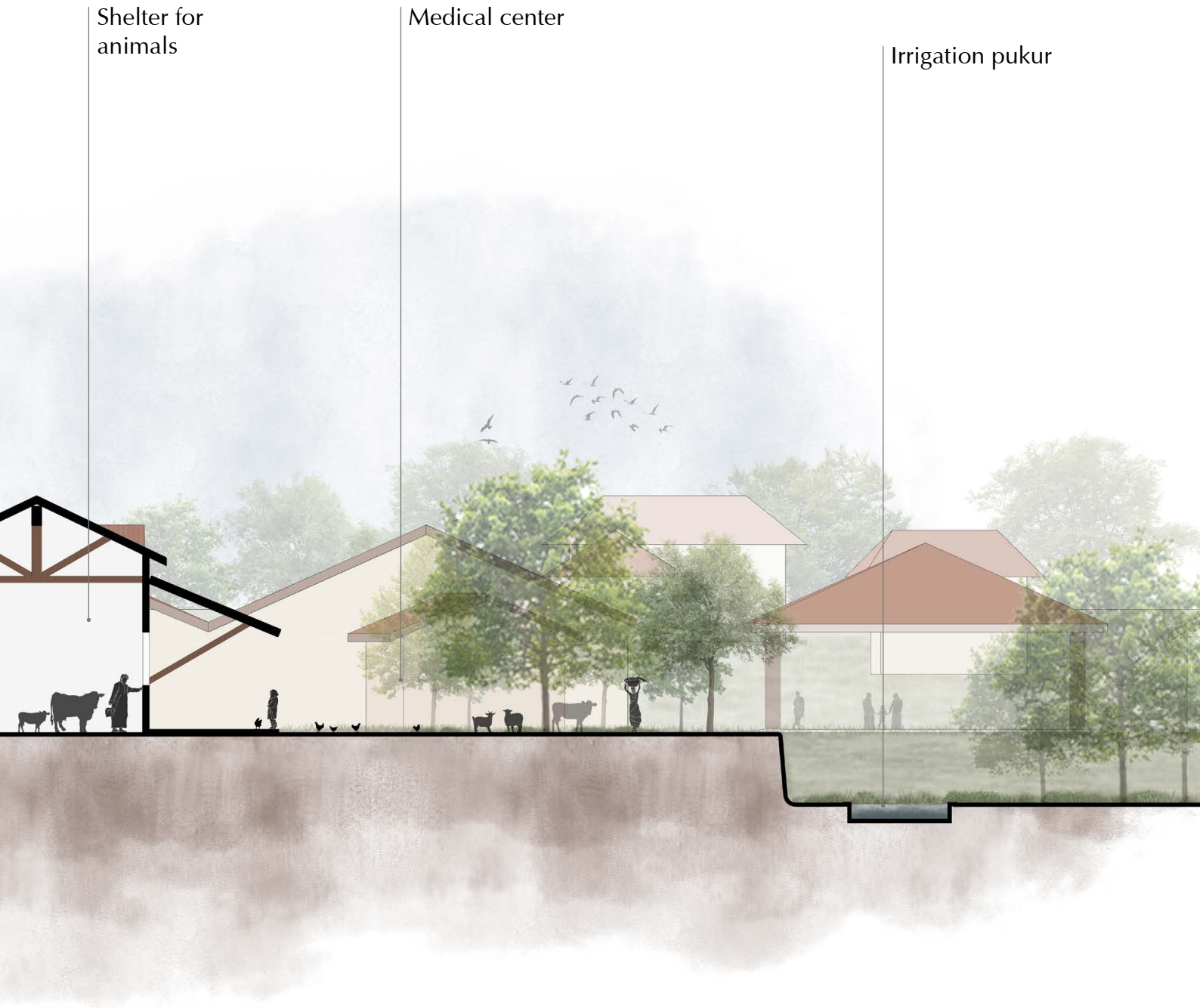
Facilities for local farm



Shelter for animals

Medical center

Irrigation pukur



Section BB'

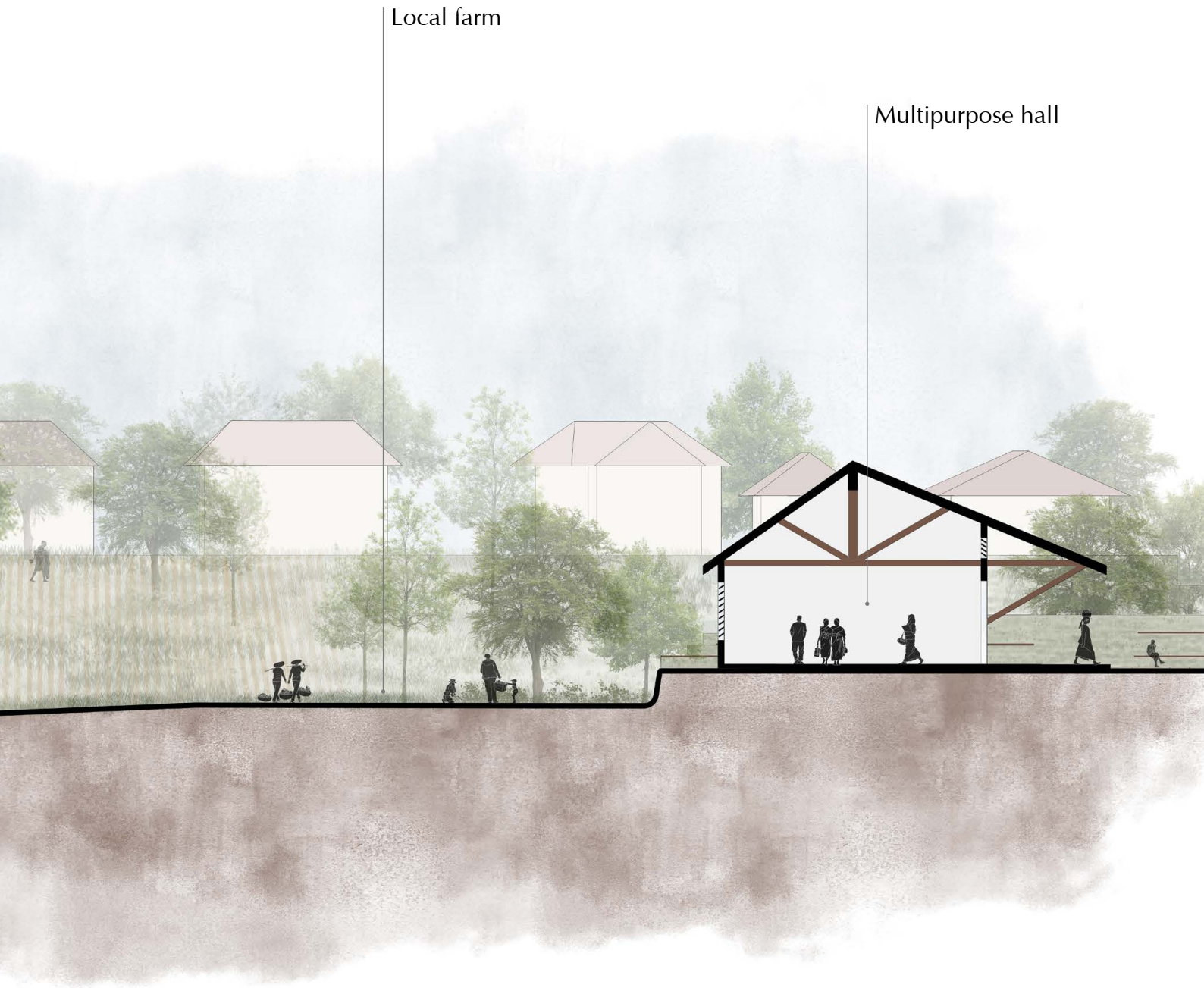
Agricultural fields

Retention basin



Local farm

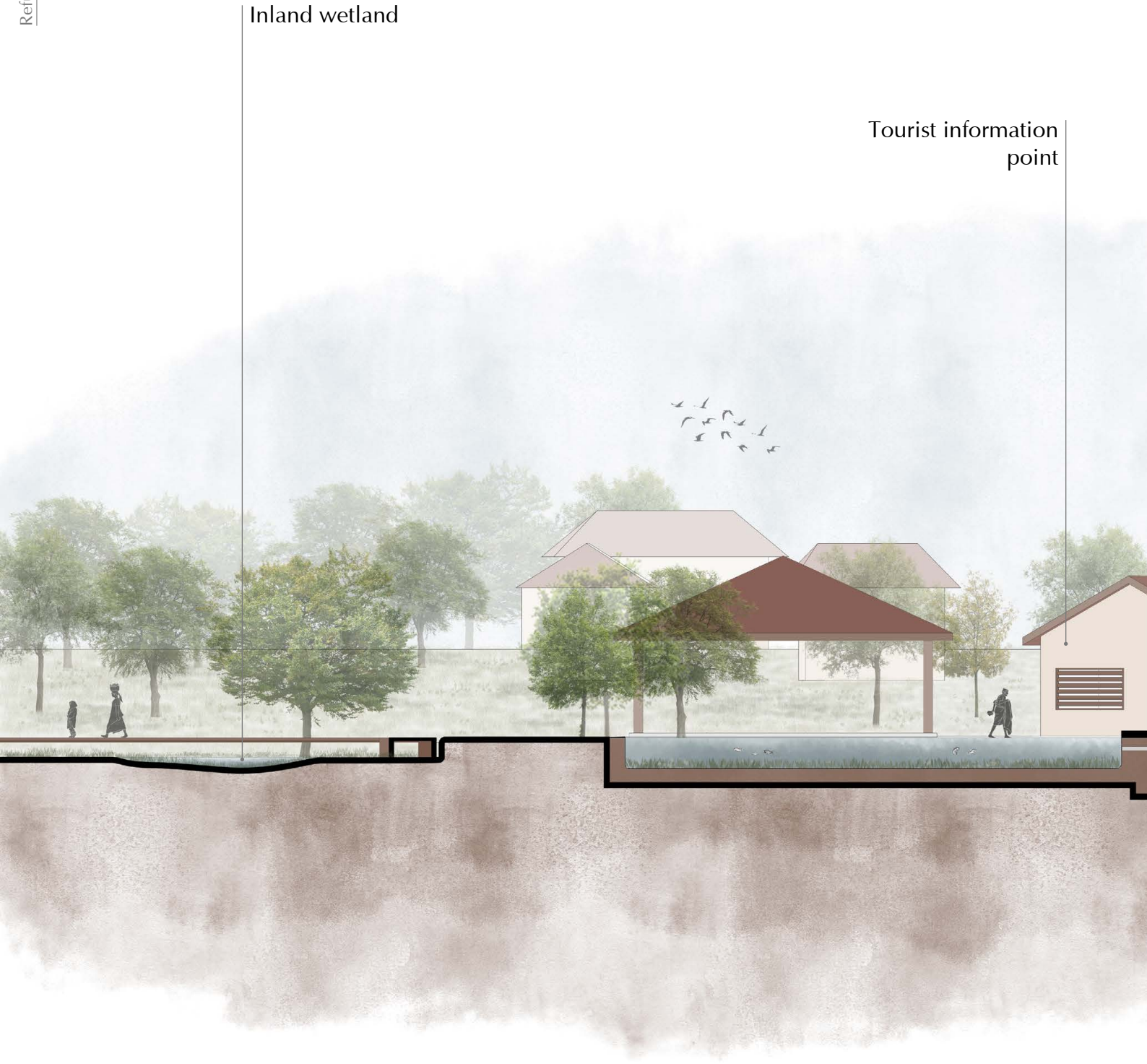
Multipurpose hall



Section CC'

Inland wetland

Tourist information point



Pukur for drinking water

Multifunctional event space

Local restaurant

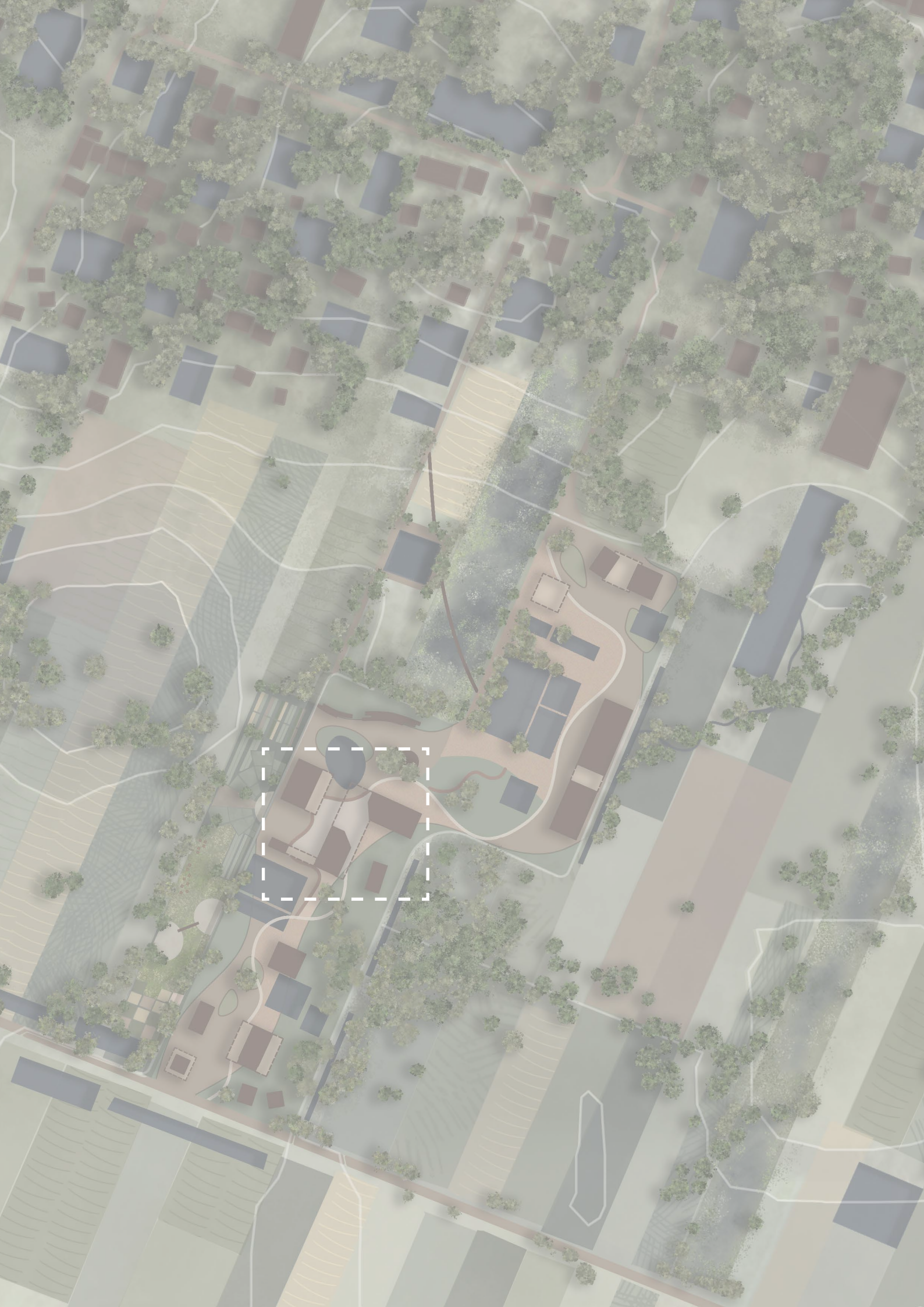
Irrigation pukur



ZOOM PLAN

The central area of the design, known as the “zoom,” integrates public spaces and multifunctional buildings. Its purpose is to provide a communal gathering space for local residents of all ages, offering educational training and various activities. The design incorporates blue and green systems, including recreational ponds, canals for stormwater collection, and a local

farm nearby. All materials used in the buildings and landscape are locally sourced, and can be constructed using indigenous practices by the community. The design aims to convey a rural atmosphere while remaining innovative. It is also designed to withstand cyclones and adverse weather conditions, while maintaining an aesthetic appeal.

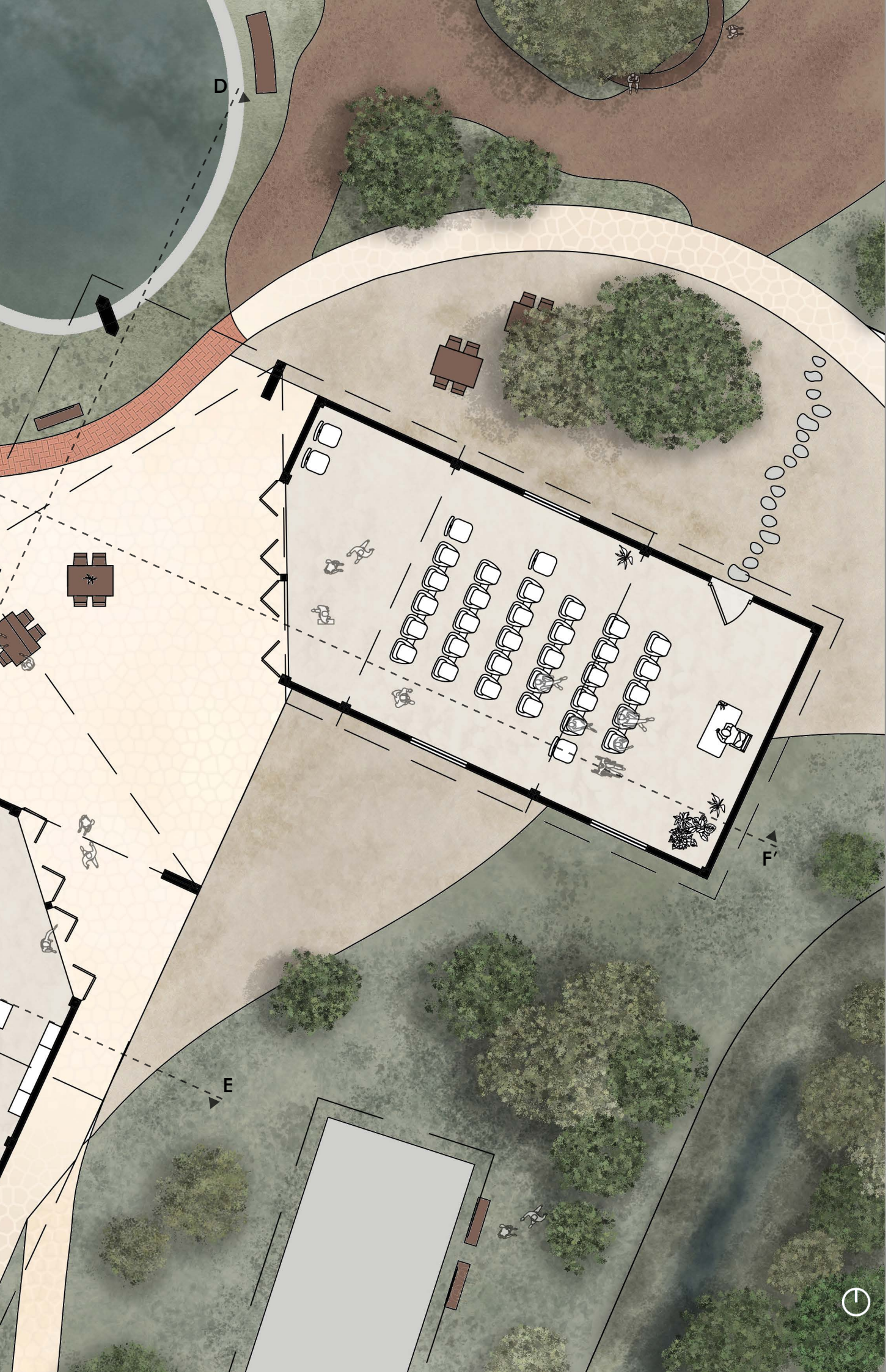




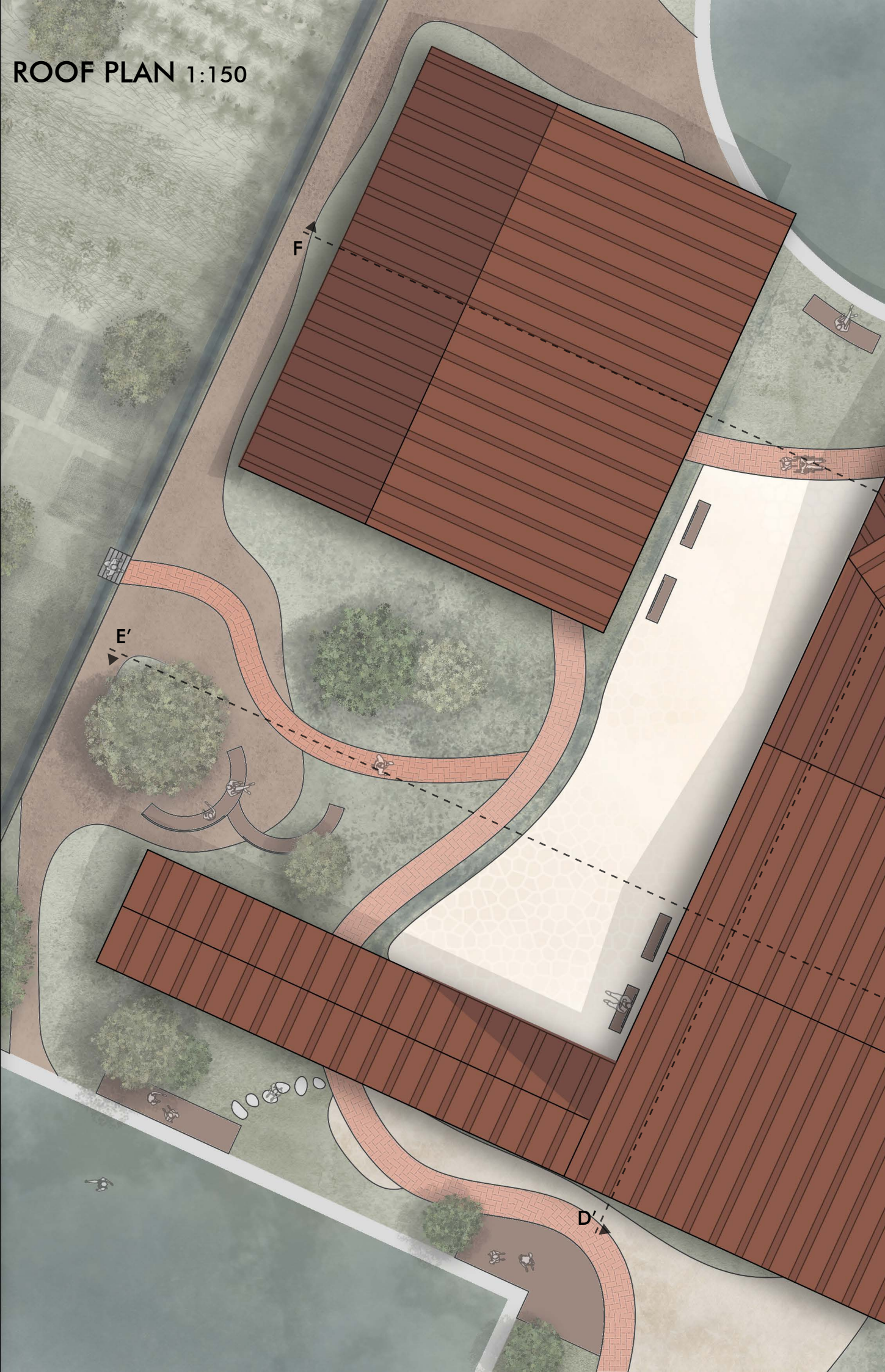


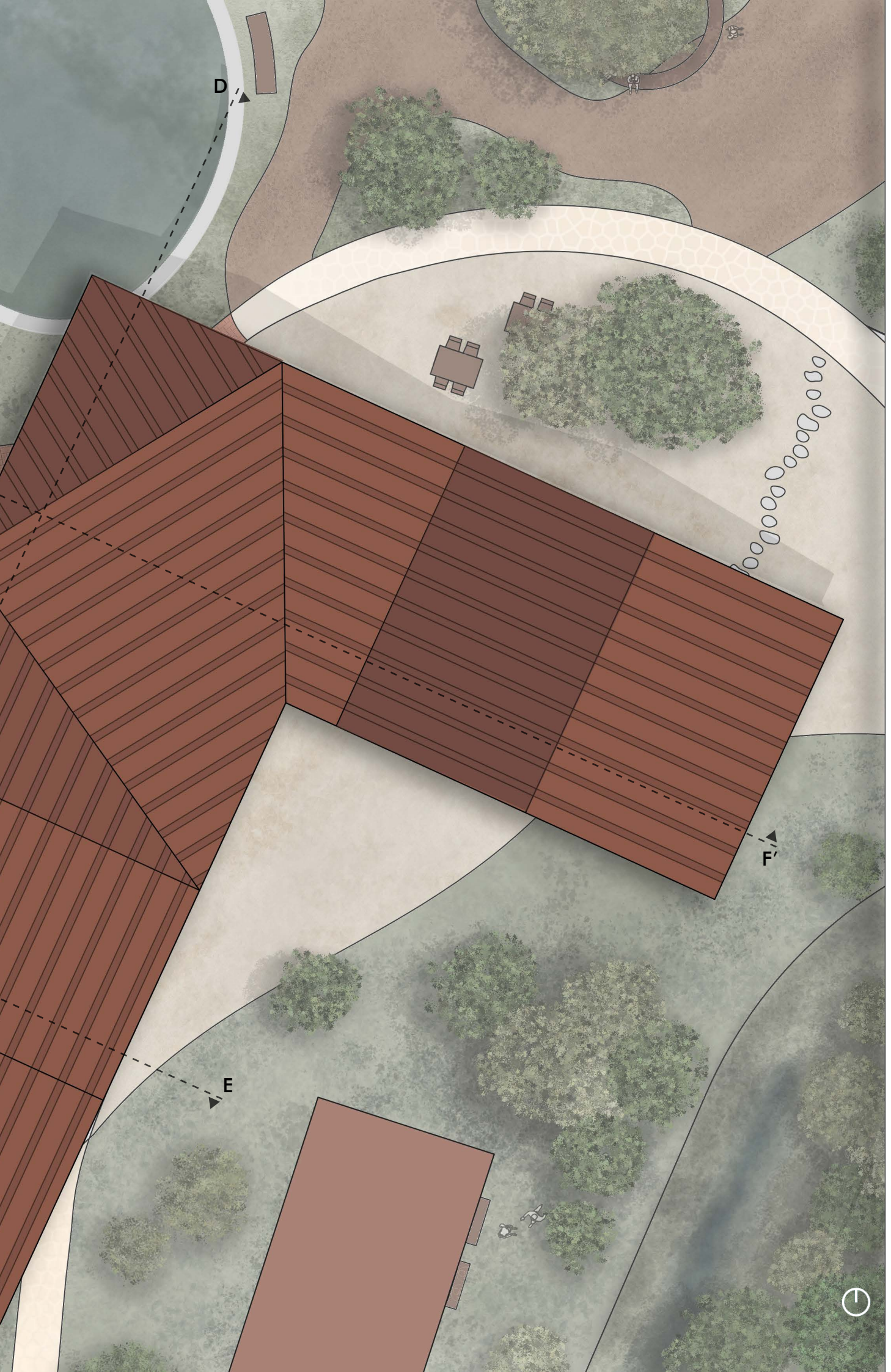
ZOOM MASTERPLAN 1:150





ROOF PLAN 1:150

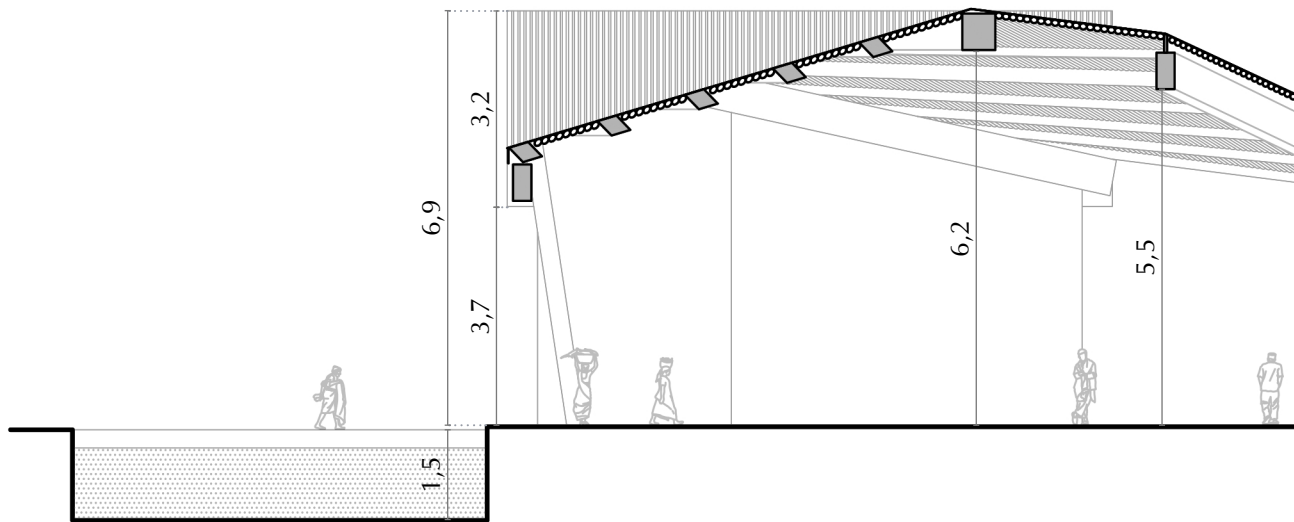








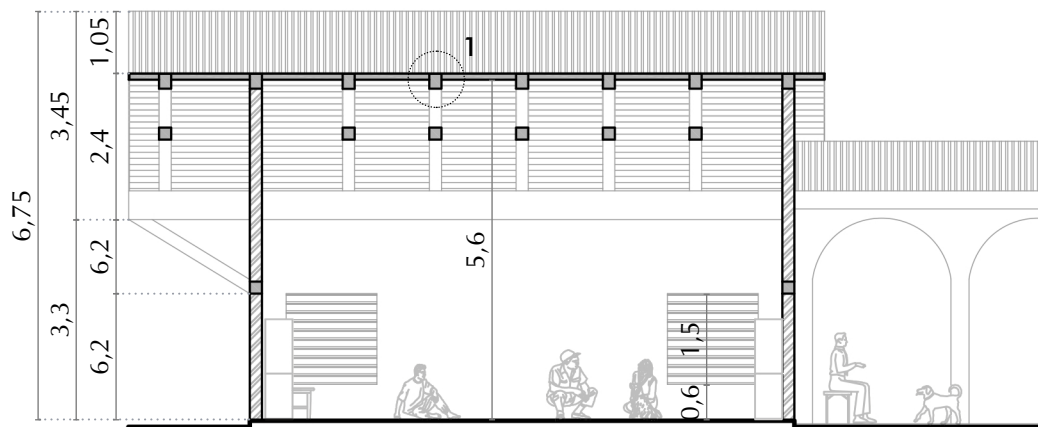
Section DD' 1:125
All dimensions are in m



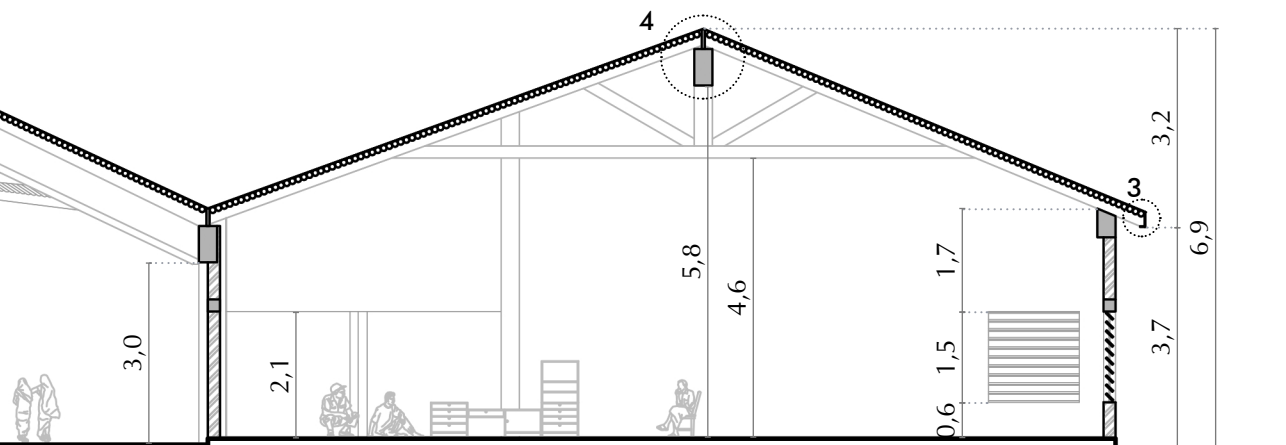
Recreational pukur
 It is a part of the blue system of the public space, inclusive of water cleaning species and fishes

Semi-open public space/Outdoor training
 The space acts as an activity generator in the Agora of the empowerment center, giving people a chance to learn

Section EE' 1:125
All dimensions are in m



Vocational training - Workshops
 The building acts as a space to enable the vocational training amongst the community, to enhance their skills

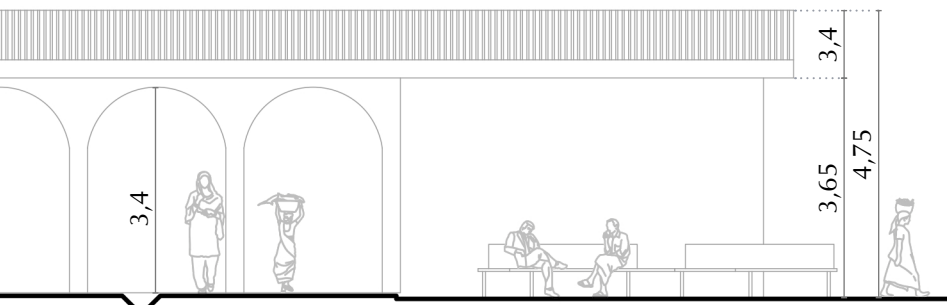
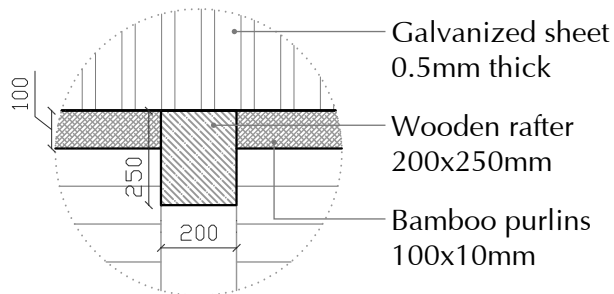


Vocational training - Workshops

The building acts as a space to enable the vocational training amongst the community, to enhance their skills

Section detail 1 1:20

All dimensions are in mm

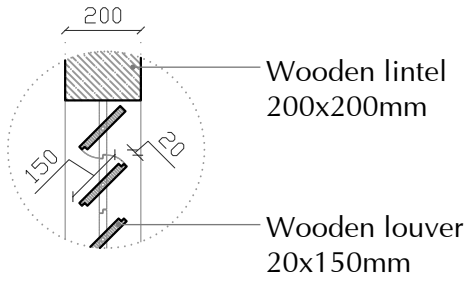


Courtyard/Pathway

Storage

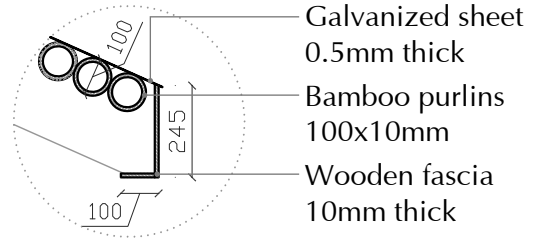
Section detail 2 1:20

All dimensions are in mm



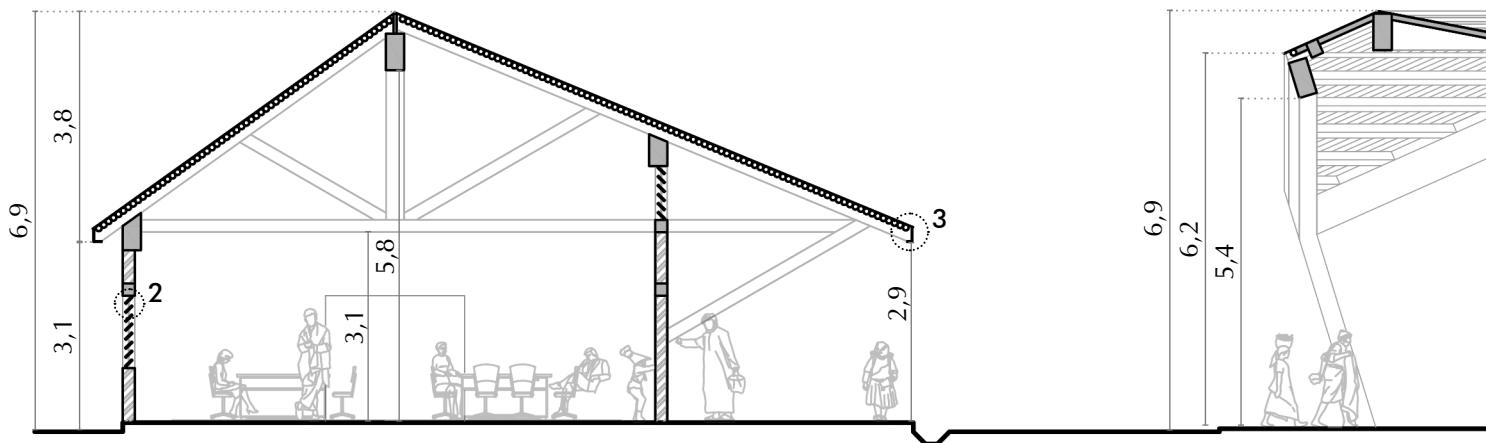
Section detail 3 1:20

All dimensions are in mm



Section FF' 1:125

All dimensions are in m

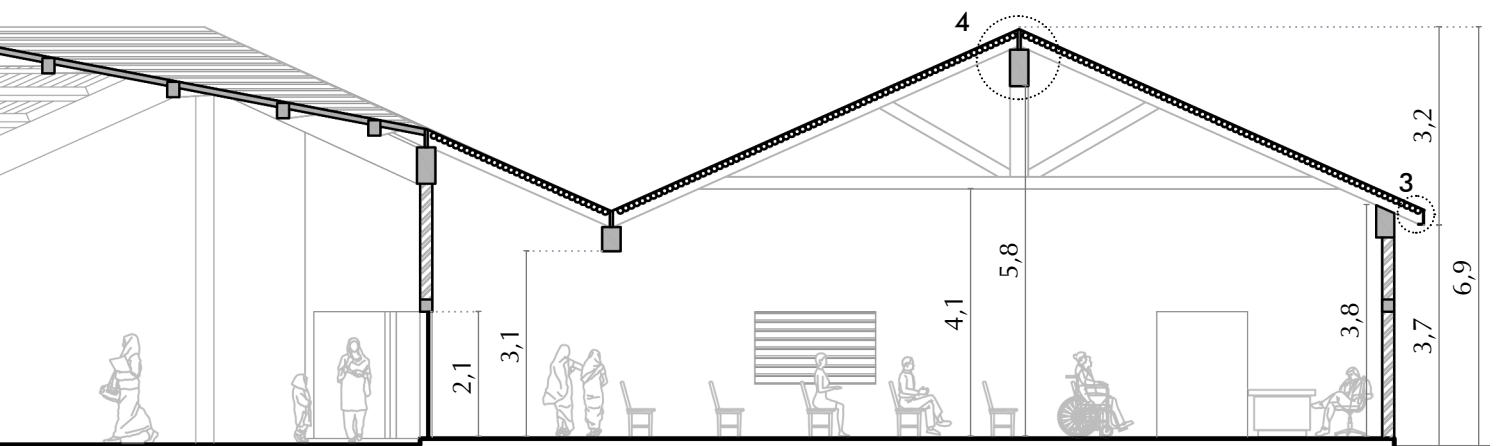
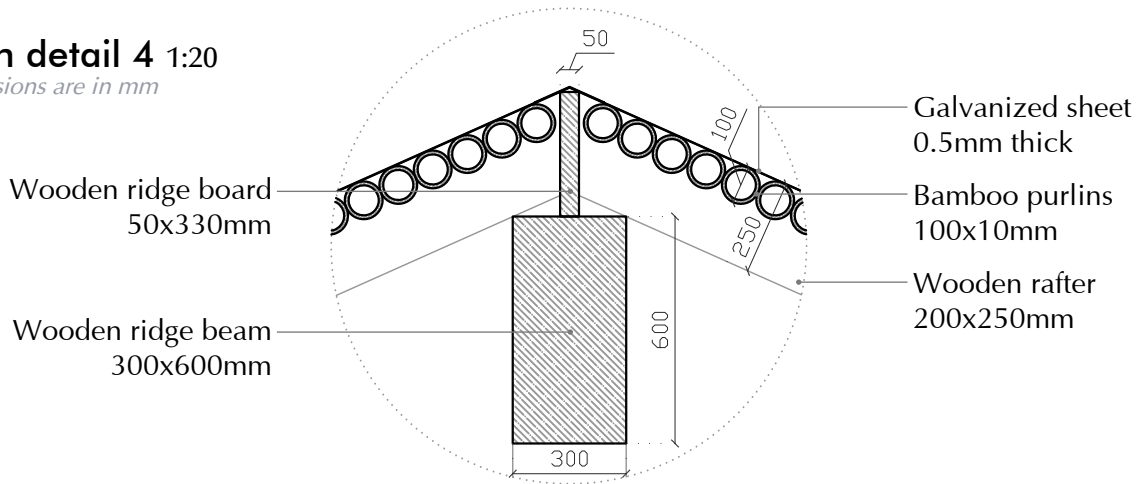


Multipurpose hall

Semi-open public space
The space acts as a public square, the Agora of the center, giving people a place to meet and interact.

Section detail 4 1:20

All dimensions are in mm



Public space/Outdoor training
 as an activity generator in
 the empowerment center,
 people a chance to learn

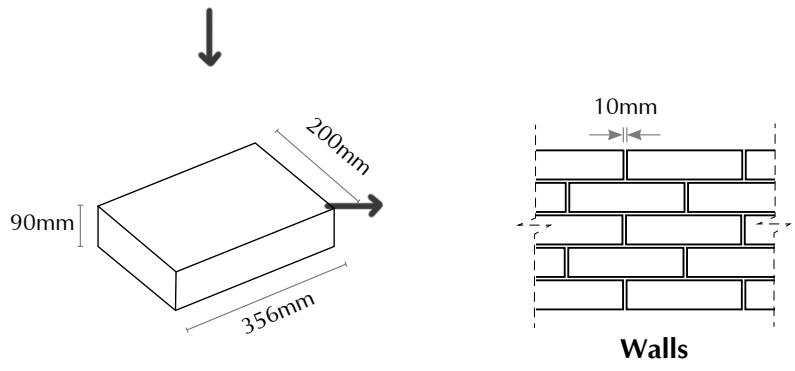
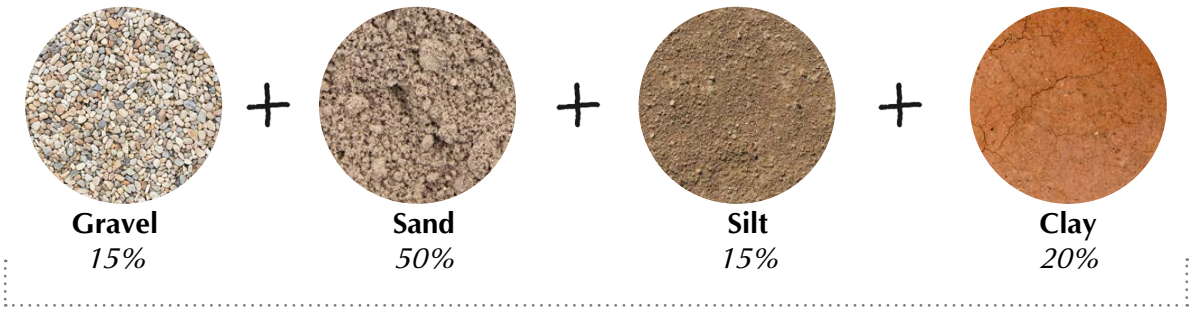
Vocational training - Seminars/classes
 The building acts as a space to enable the
 vocational training amongst the community, to
 enhance their skills





MATERIAL DETAILS

CSEB blocks



Wooden structure

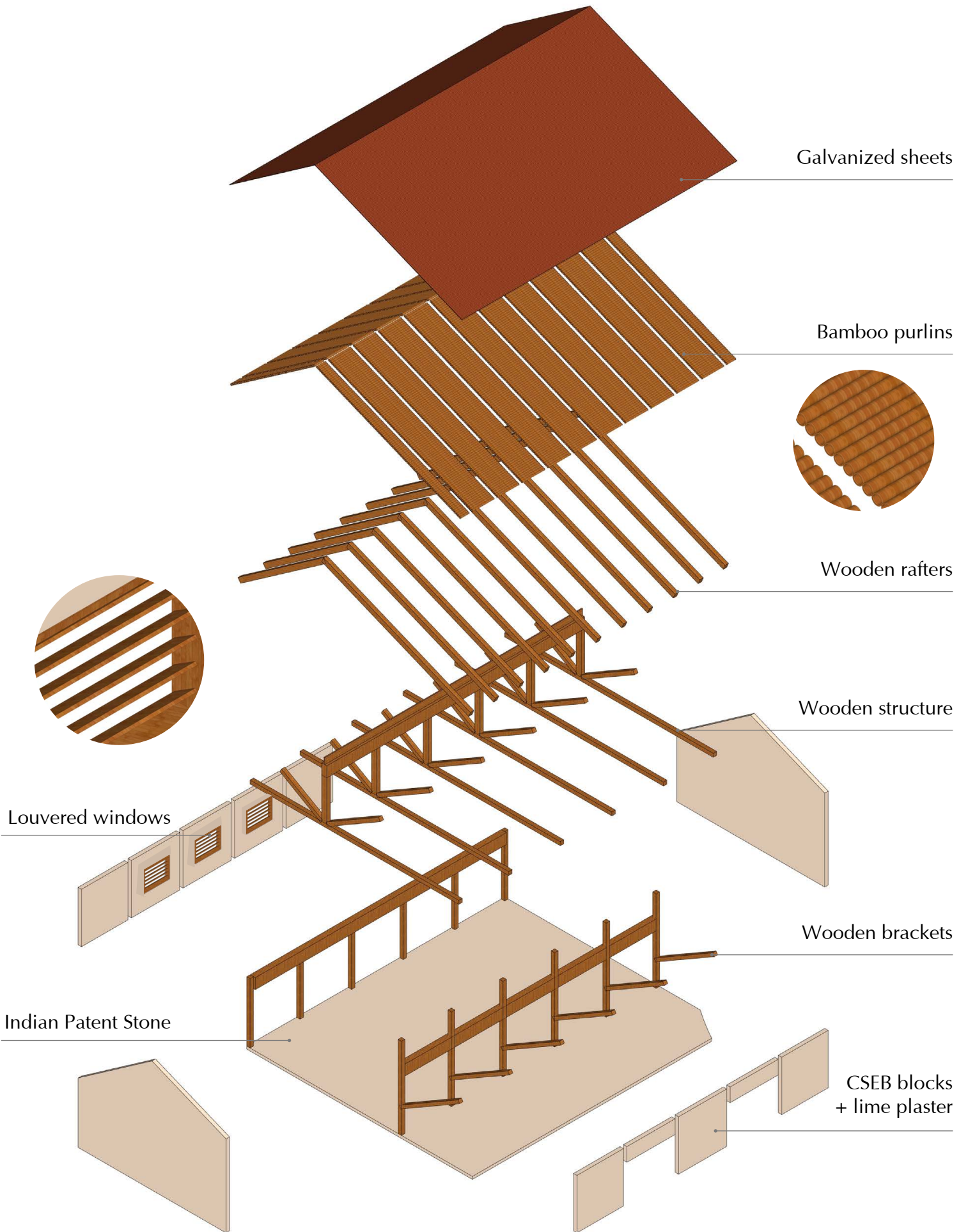


Bamboo roof structure



IPS - Indian Patent Stone flooring



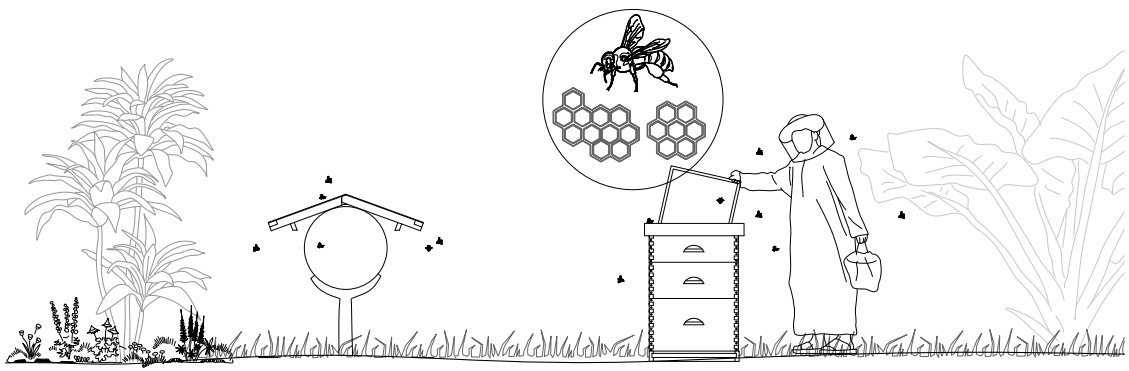




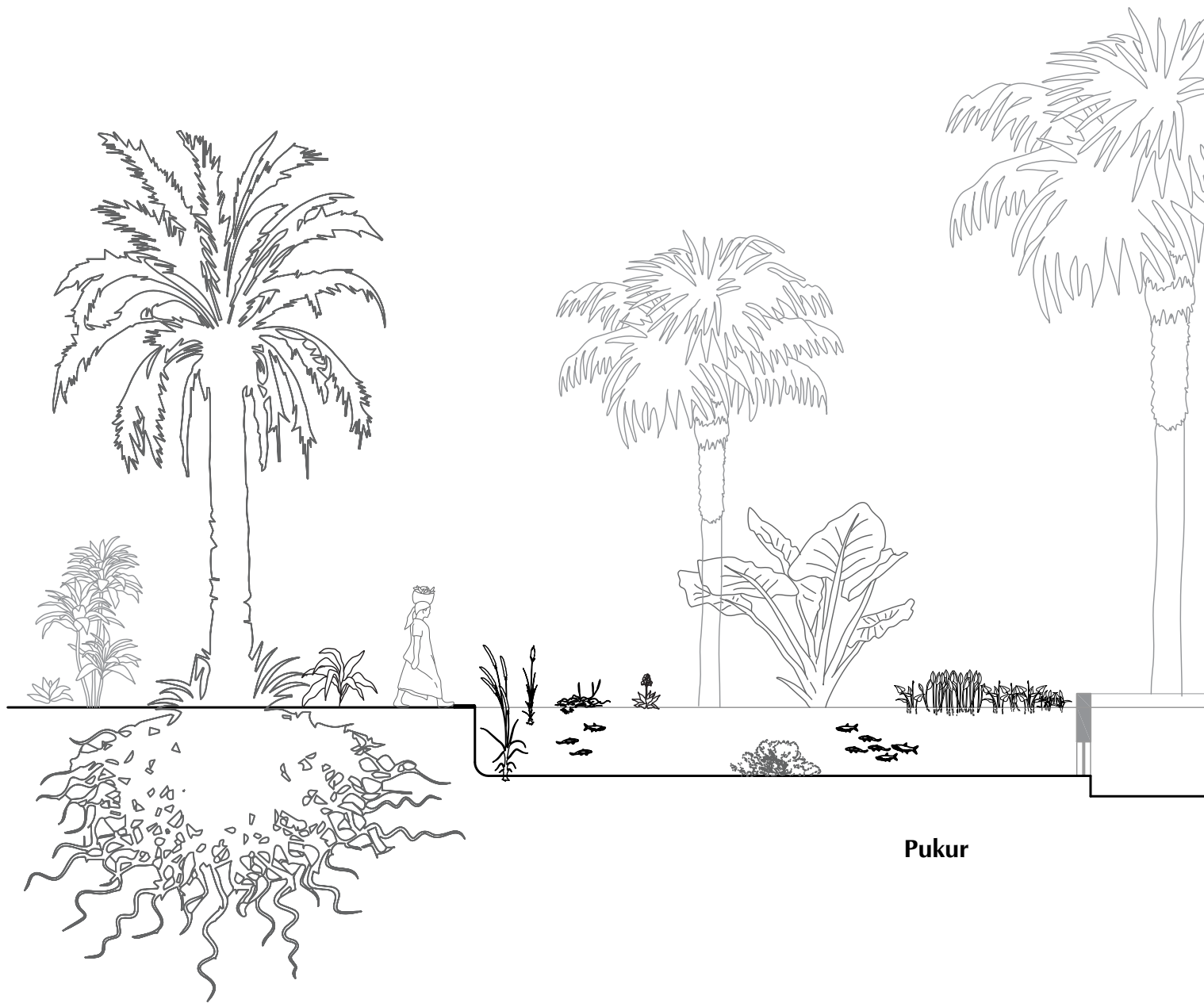


NATURE-BASED SOLUTIONS

Section details



Beekeeping



Pukur



Local farm



Rural street





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