WOVEN WITH WATER

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MLA Dissertation | November 2022

"You must plant the rain before you plant a seed"

WOVEN WITH WATER

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Submitted in partial fulfilment of the Master of Landscape Architecture Degree
120 Credits | MLA Dissertation | November 2020

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ABSTRACT |

The Elephant Marsh is a seasonal wetland that lies on the floodplain of the Lower Shire River in Malawi. This is one of the most productive ecosystems in Malawi that plays an important role in supporting the livelihoods of the local community (Kosamu, 2012) through fisheries, livestock grazing, and agriculture. The Elephant Marsh also plays a significant role in flood storage, attenuation, and purifying sediment-rich water. Furthermore, it is a habitat for over 110 water bird species (Bayliss, 2019).

Unfortunately, upstream development, commercial sugarcane farming, human encroachment, and severe land degradation such as soil erosion, sedimentation, and deforestation within the Shire River Basin have resulted in a decline in remaining natural areas which have led to a decrease in infiltration and water holding capacity in the basin.

This project aims to create a resilient system using fingerponds and rainwater harvesting practices that embrace the process of flooding and precipitation during the wet season by holding water and allowing it to infiltrate into the landscape. Furthermore, the project aims to reconnect the riparian community to a century-old traditional practice of harvesting and weaving reeds and palm leaves into mats and baskets to allow for a deeper relationship to form between the people and place while also creating more opportunities for the community. The term landscape resilience in this project is an aspect of wet theory, which is a way of accommodating flow and other boundary-blurring phenomena of motion, disturbance, and change through fluid occupancies of land and infiltration (Mathur & Da Cunha, 2009). Furthermore, the resilient landscape in this project is also linked to the preservation of traditional knowledge systems that are connected to the landscape to ensure the long-term success of the proposed sustainable practices.

Through research, a site visit, and interviews, the study first uncovers the sense of place and identity of the landscape. Elements of the site are then synthesized through map analysis and visual narratives to understand the different relationships between the social and ecological aspects of the site. Finally, these relationships are then tested in a design intervention that aims to accommodate for uncertainty and forms a more integrated agriculture, aquaculture, and traditional system that retains the functioning of the wetland improves the wetland edge and empowers the community.

CONTENTS |

OBJECTIVES |

RECOGNISE

To understand the **social** and **ecological** systems of the site and their relationships within the wider context of the basin.

RESUSCITATE

To design a landscape that allows for water to slow down, spread and sink into the soil. Also, to accommodate for uncertainty through resilient landscapes.

RESPOND

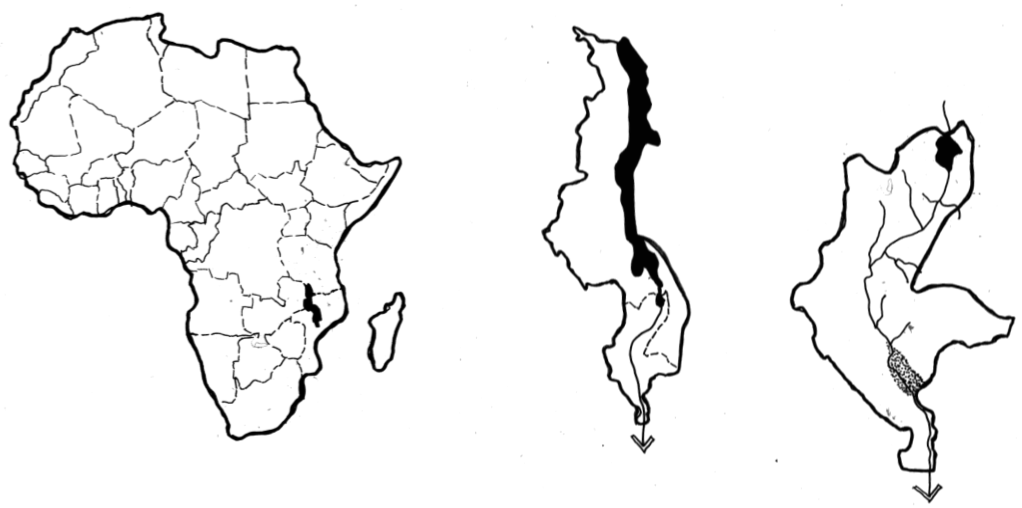
To integrate traditional practice with sustainable ecological systems to form a deeper relationship with people and place.

MALAWI + SHIRE RIVER BASIN

Malawi is a small, landlocked country in southeast Africa. The country has some of the most fertile soils for agricultural use in southern Africa and is also one of the poorest countries in the world (Hughes, Croxton, & Croneborg-Jones, 2019). Therefore, agriculture is the backbone of the Malawian economy (Turpie, Smith, Emerton, & Barnes, 1999). Over 80% of the population depends on farming to survive.

The Shire River is the largest river in Malawi. Much of the water in the Shire River is overflow from lake Malawi (Timberlake, 1997). It also plays an important role in the country's economic, environmental, and social well-being. In Malawi, about 98% of its electricity is generated by hydroelectric power stations along the Shire River (Kaunda & Mtalo, 2013). The Shire River Basin is also a source of water and several commercial irrigation schemes such as sugar plantations that lie along the Lower Shire Valley, providing large-scale employment and export produce (Turpie, 1999).

Unfortunately, the lack of development coordination and water resource management within the Shire River Basin has resulted in the area becoming a hotspot for land degradation and siltation.



(author's own)

Furthermore, the Basin is also vulnerable to the impacts of climate change by experiencing significant weather pattern changes that range from extreme droughts to extreme flooding due to land degradation that has led to a decrease in infiltration and water holding capacity. This has seriously hampered food production and damage to infrastructure and property (Kafatia, 2013).

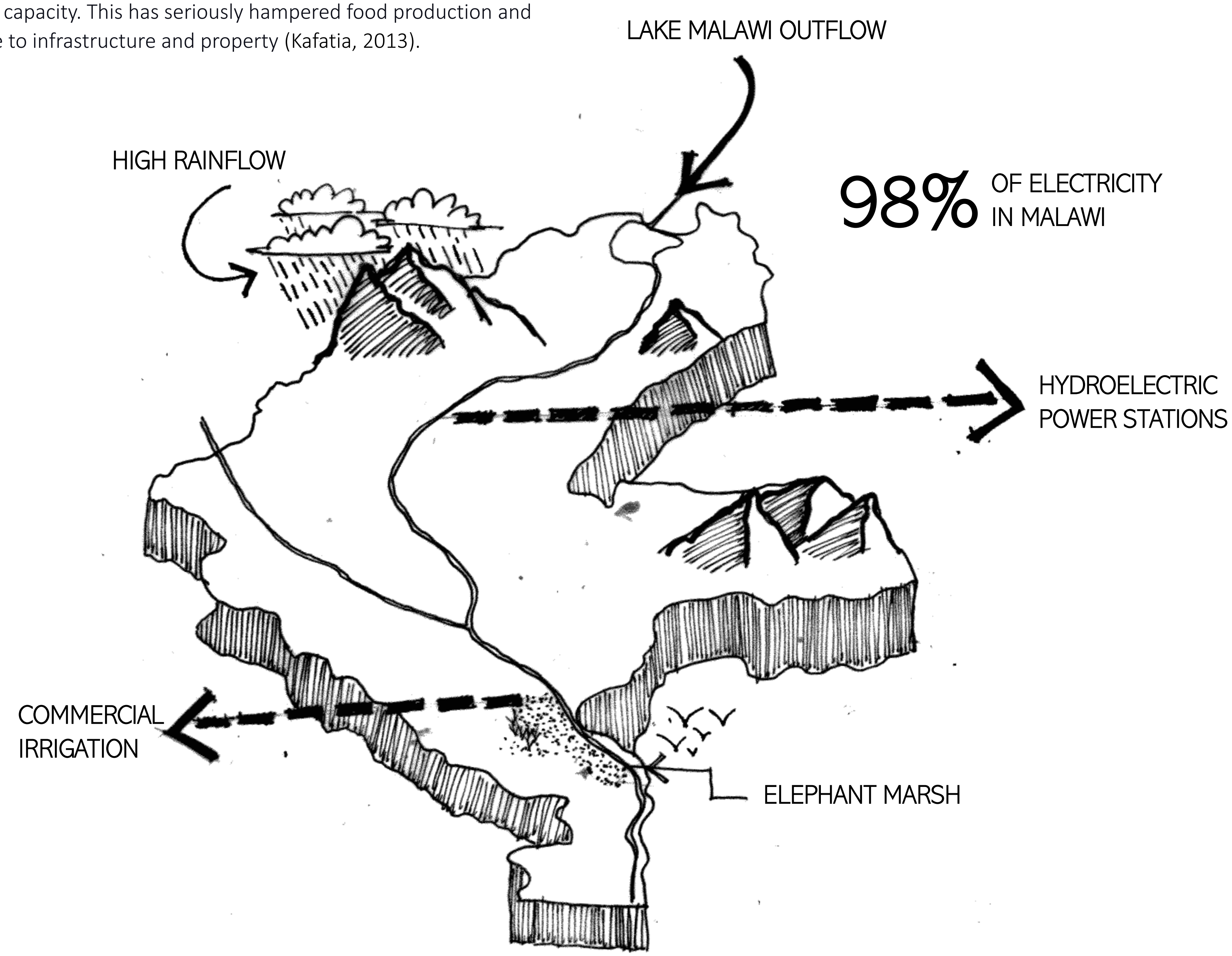


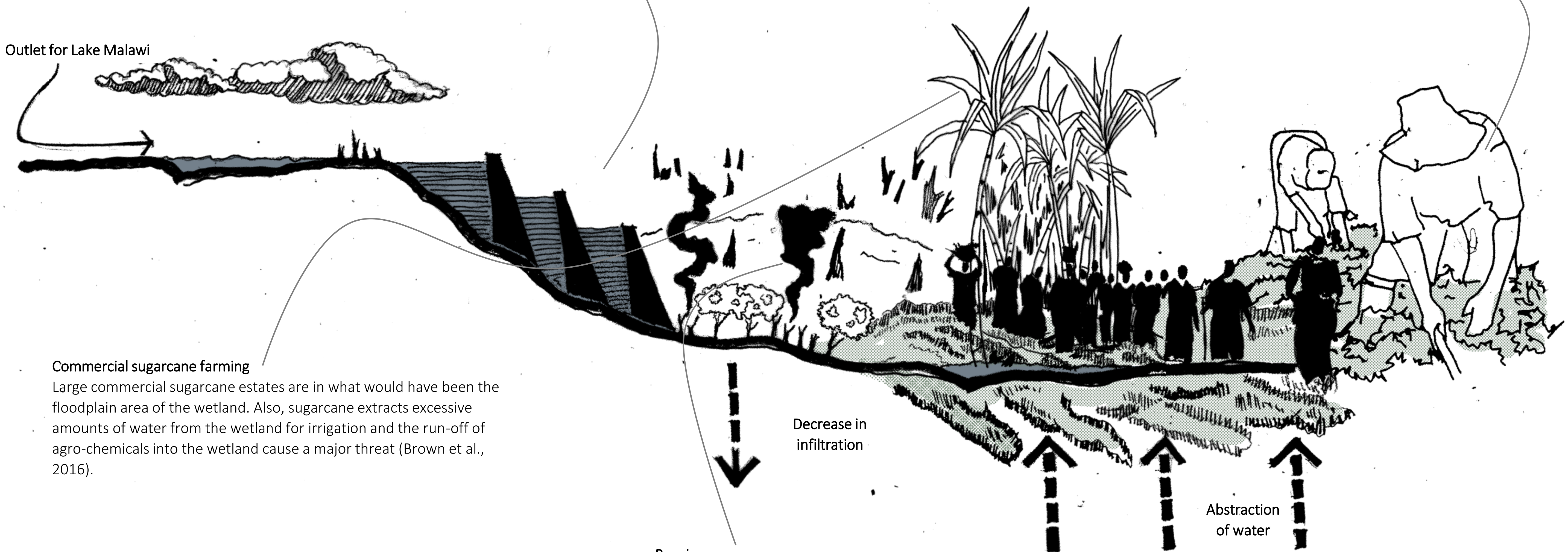
Diagram of Shire River Basin.
(author"s own)

FORCES ALONG THE RIVER SYSTEM

Loss of natural vegetation + reduced filtration
Loss of vegetation is mainly due to land being converted into agriculture. This decrease in natural vegetation has reduced filtration capacity of the catchment area therefore increasing peak river flow and the loss of fertile topsoil. Also, more sediments move down the Shire River Basin and into the Elephant Marsh (Brown et al., 2016).

Upstream development + flow modification
One of the main threats to the Elephant Marsh is the abstraction of water flow due to the development of hydroelectric power station upstream. This reduced water flow impacts the extent of the flooding in the floodplain area of the wetland which affects the biodiversity of the wetland as flow, vegetation, sediment and marsh fauna are interlinked (Brown et al., 2016).

Human encroachment + cultivation
Reduced flow exposes the marshes floodplain edge and therefore enables the encroachment of people along the wetland. This not only increases the extent of cultivation and the harvesting of natural resources but also makes riparian communities more vulnerable to the effects of climate change (Brown et al., 2016).



Commercial sugarcane farming
Large commercial sugarcane estates are in what would have been the floodplain area of the wetland. Also, sugarcane extracts excessive amounts of water from the wetland for irrigation and the run-off of agro-chemicals into the wetland cause a major threat (Brown et al., 2016).

Burning
burning along the marsh happens frequently during the dry season for agriculture purposes. This has caused extensive habitat loss and modification to the landscape. The burning of land for agriculture has also depleted soil nutrients and has caused a breakdown is soil structure that has been partly responsible for saltpans (Mollison, 1988).

Section collage of different forces.
(author’s own)

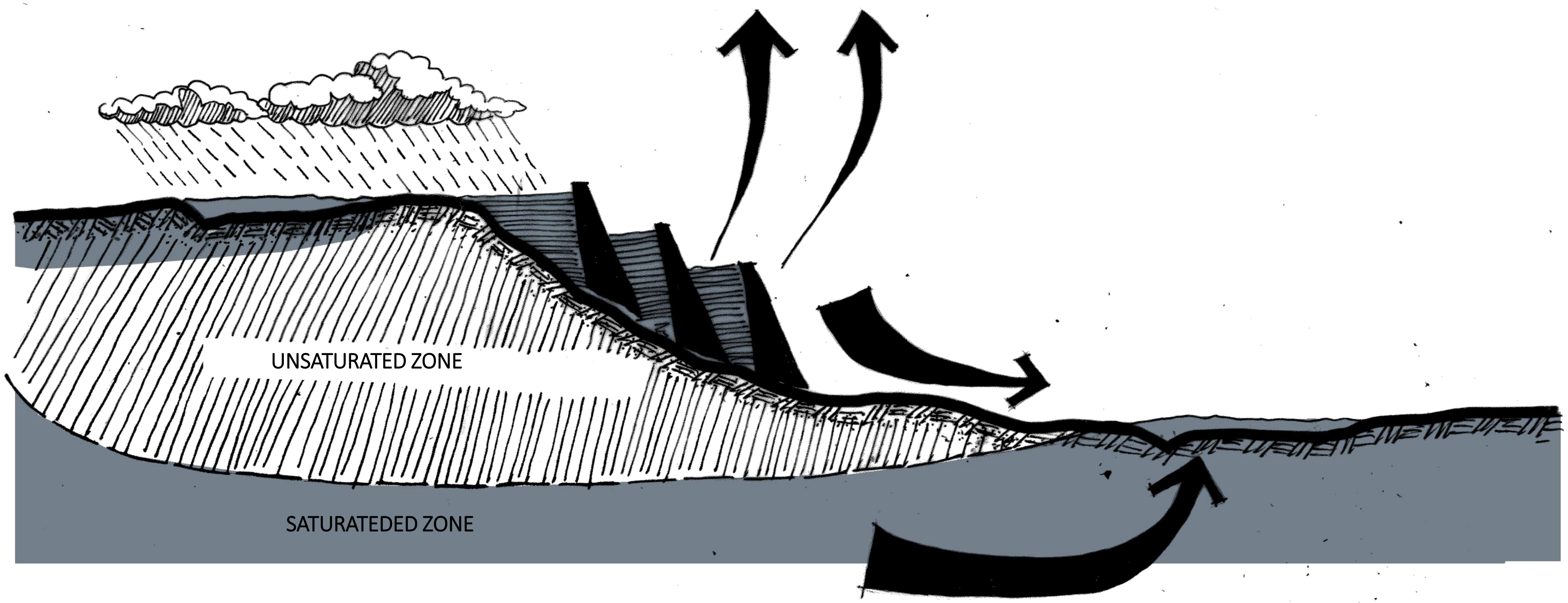
WATER USE IN THE SHIRE RIVER BASIN

Water abstraction

Water in the Shire River Basin is mainly abstracted for irrigation. Abstraction is the process of removing water resources from rivers, lakes, canals or from underground strata. The water abstracted for agricultural purposes comes from two water resources, "blue" water and "green" water (Forsythe & Turpie, 2016).

Green water

This is the water transpired by plants that comes from rainwater stored in soil. This is normally regulated by rainfall, vegetation cover, soil organic matter and biological communities that exist in the soil. Green water is used in plant processes at is returned into the atmosphere through plant evapotranspiration (Forsythe, 2016).



Blue water

includes water on the surface such as lake and groundwater reservoirs, this type of water is reliant in rainfall and upstream run-off and is more of the physical properties of the catchment. Blue water is returned to the atmosphere through evaporation or becomes part of the green water cycle through irrigation and the uptake from crops and plants.

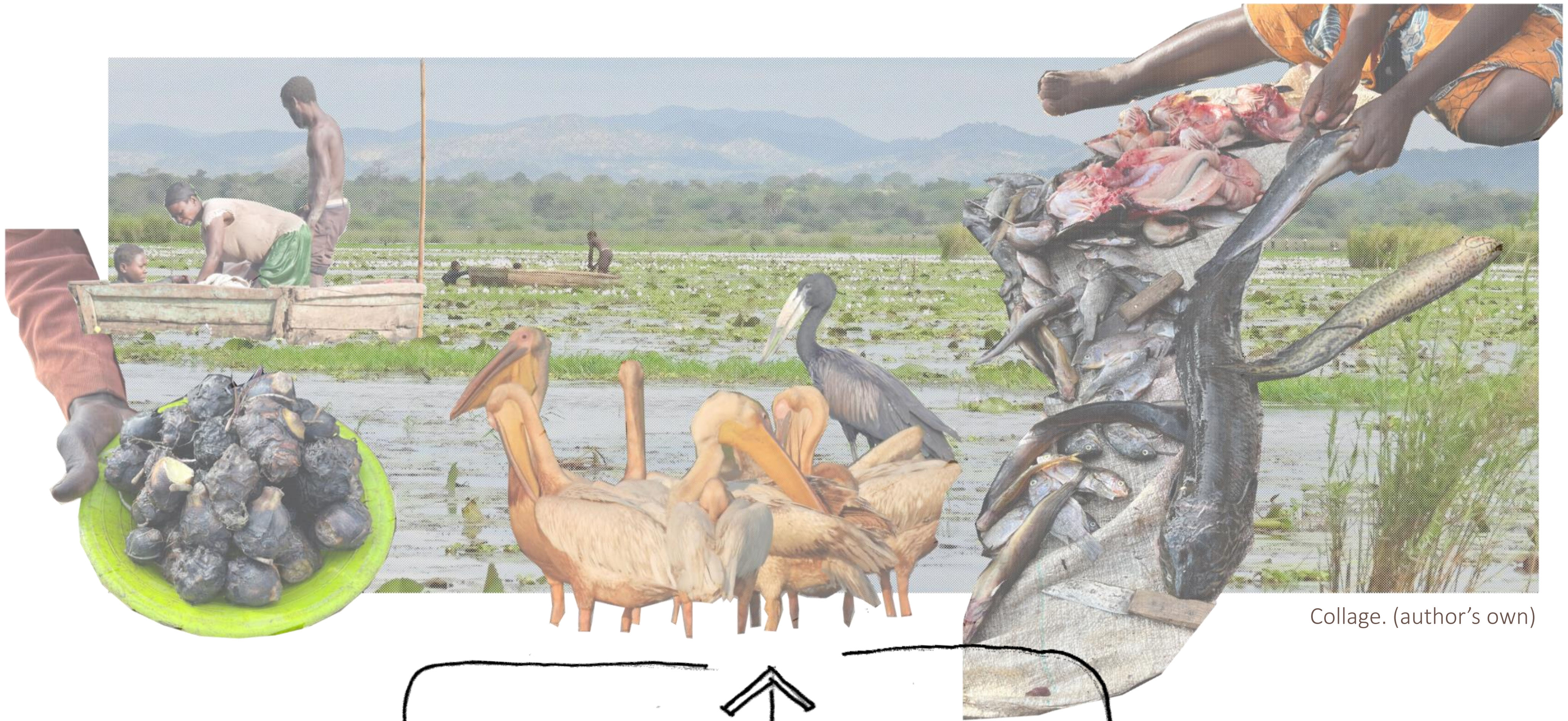
Majority of the water that is used for irrigation along the Shire River falls under the blue water cycle and since the catchment is already heavily degraded, there is little water infiltration that occurs within the few naturally vegetated areas. Therefore, decreasing the rate if ground water recharge and the conversion of blue water into green water through plant uptake. The trade-off is that the health of the wetland and other ecosystems being compromised and at risk.

Water use section.
(author's own)

THE ELEPHANT MARSH

The **Elephant Marsh** is a seasonal wetland that is located at the southern end of the lower shire valley and is part of the floodplain of the Shire River. This is one of the most productive ecosystems in Malawi which contributes to thousands of households in the area (Timberlake, 1997).

The name Elephant Marsh was given by David Livingstone, an early missionary explorer in Malawi, who reportedly met 800 elephants in the wetland (Hughes, 1992). The Elephant Marsh is important because it provides regulating services in the form of flood attenuation, sediment retention, water quality improvement, critical habitat for wildlife populations, and carbon sequestration (Forsythe & Turpie, 2016). The marsh also plays an important role in supporting the livelihoods of the local community. Households in the area use the marsh for agriculture, fishing, and collecting wild foods and raw materials for home consumption or sale. These coping strategies for the poorer household can be very important, particularly in times of drought and poor harvests. Many floodplain and upland households have agricultural plots out on the marshes, and some household members tend to them on a semi-permanent basis, spending several days a week residing in temporary structures (Turpie, 1999).



Collage. (author's own)

THE ELEPHANT MARSH.

REGULATING SERVICES

- Flood attenuation
- Water quality amelioration
- Sediment retention
- Carbon sequestration
- Critical habitat for wildlife population

ECOSYSTEM SERVICES

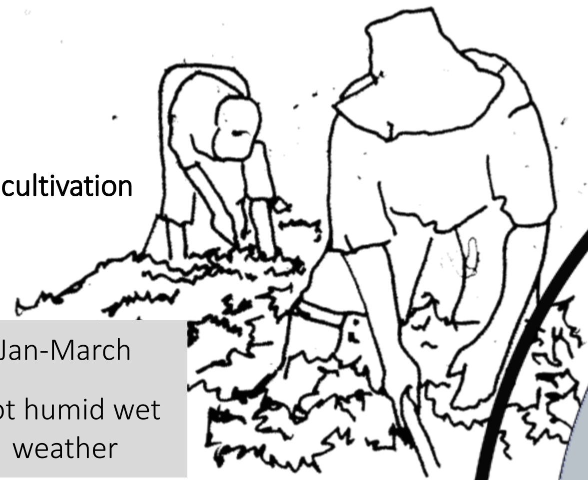
- Fisheries
- Wild plants
- Agriculture (Dry season farming)
- Water provision

FORCES ALONG THE MARSH

Drawings and diagram showing the correlation between seasons, water levels and human activities along the elephant marsh. (author's own)

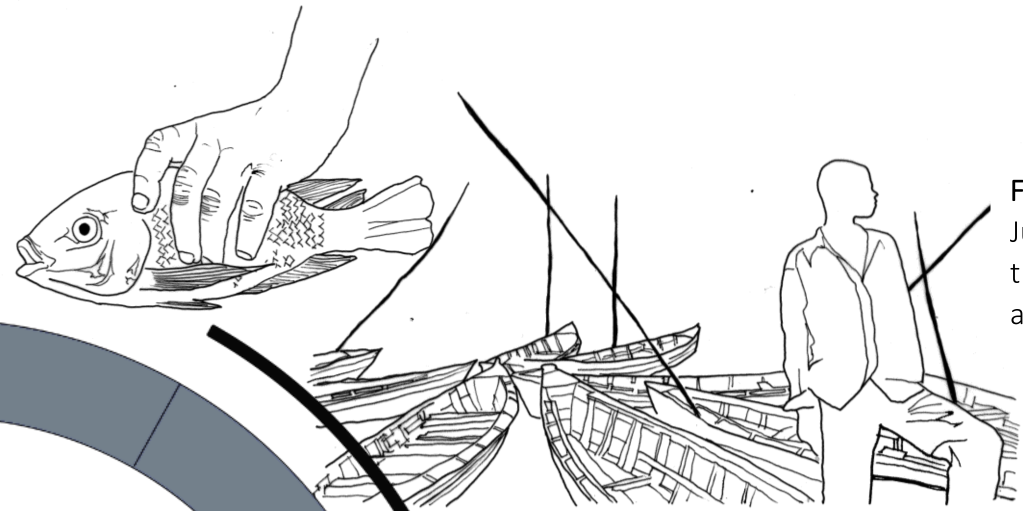
Cultivation is one of the main human pressures on the marsh and this is determined by its accessibility which is determined by the degree of wetness and extent of the flooding within the marsh. There's more access to the marsh in dry season compared to the wet season. Additionally, access is also determined by surrounding human population (Forsythe & Turpie, 2016).

Upland cultivation



Jan-March

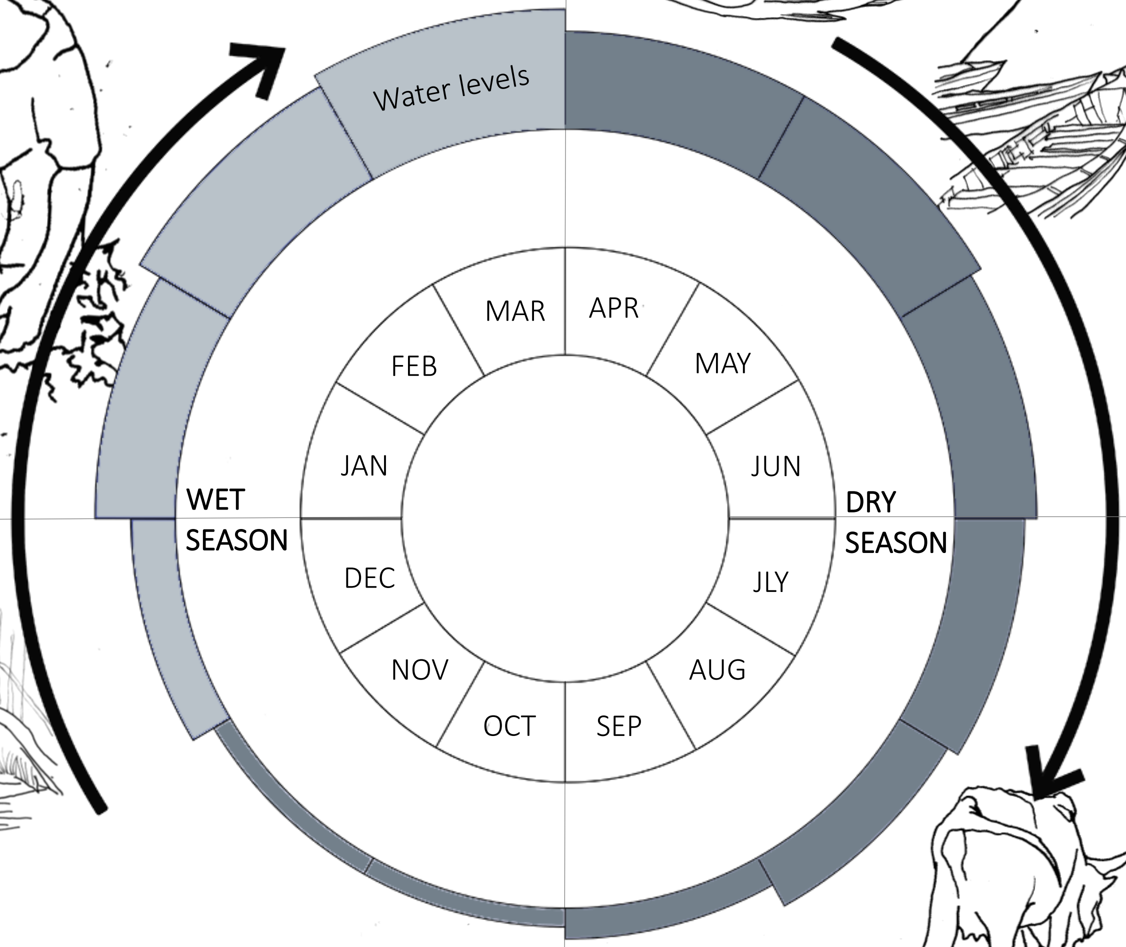
Hot humid wet weather



Fishing mostly occurs between April and July when flood waters are receding and the fish become easier to catch (Kosamu et al., 2012).

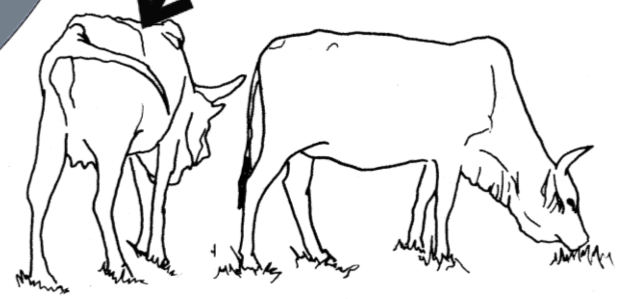
April- June

Humid cool weather



Recession agriculture is complemented by fishing, the main crops grown include rice, maize, sorghum, millet, beans, cassava, and sweet potatoes which are sold at the local market.

Migratory birds



The best **grazing period** in the wetland is during the dry season. Much of the grazing occurs on crop residues but natural floodplain grasses are also grazed (Forsythe, 2016).

The **dry season** is a difficult time when grazing land is limited, agriculture has dried out and there is minimal protein supply.

Harvesting of the **wild staple foods**, such as water-lily bulbs, known locally as nyika, happens mainly at the end of the dry season and in years of bad agricultural harvests.

Oct-Dec

Hot windy wet weather

Most of the **harvesting of grass** species happens throughout the dry season from June to September (Turpie et al, 1999)

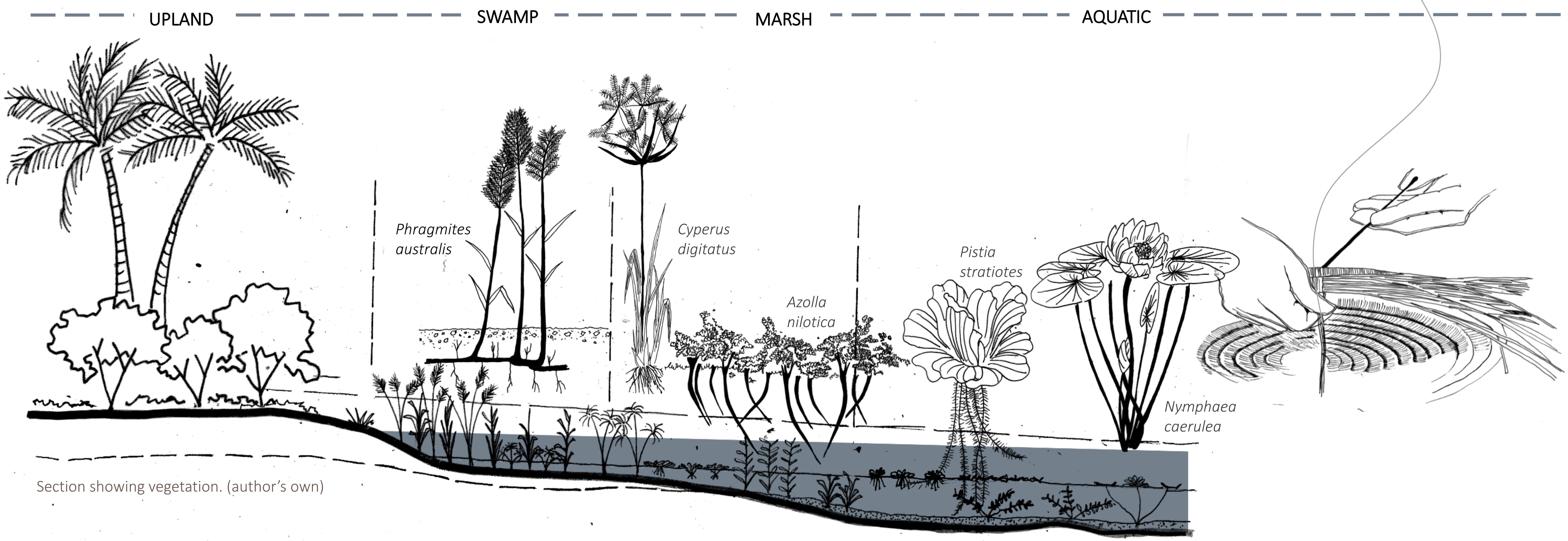
July-Sept

Hot dry weather

VEGETATION ALONG THE MARSH

Four vegetation zones exist within the Elephant Marsh. These include the aquatic zone, the marsh, the swamp and the grassland and woodland zone (Howard-Williams & Lenton, 1975).

Usually poorer and middle income household harvest reeds, papyrus and palm leaves to make mats, hats, baskets and other products for household use and to sell at the local market when the opportunity arises. Most of the harvesting of grass species happens throughout the dry season (June- September) when people need cash for food (Forsythe & Turpie, 2016).



Section showing vegetation. (author's own)

Grassland and woodland: This is the dry land vegetation, the miombo woodland covers most of the untransformed areas (Brown et al., 2016). The area is also dominated by grasses such as Hermarthria altissima, Setaria phragmitoides and Vetiveria nigratans. Furthermore, there are clumps of palms (Hyphaene ventricosa) in places that are protected from grazing (Kafatia, 2013).

Swamp Vegetation (Littoral Zone) : The main swamp plants are *Typha domingensis*, *Phragmites australis* and papyrus among others.

Marsh Vegetation: This is the vegetation where the water depth is between 0.2 – 1m. The main species is *Cyperus digitatus*, *Echinochloa haploclada*, *Leersia hexandra*, *Vossia cuspidata* (hippo grass), the floating stemmed *Ipomoea aquatica* and *Ludwigia stolonifera.*

Aquatic Zone: Main floating species include the fern (*Azolla nilotica*, Salvinia hastata), the "Shire cabbage" (*Pistia stratiotes*) and the duckweed (*Spirodela polyrhiza*). The rooted plants include waterweed (*Ceratophyllum demersum*), water lily (*Nymphaea caerulea*), and water chestnut (*Trapa natans*).

SITE PLAN

There are **several irrigation schemes** that occur along the Elephant marsh that cultivate sugar, but the mains ones are Nchalo Illovo Sugar Estate and Kaombe Agricane Estate (Forsythe, 2016).

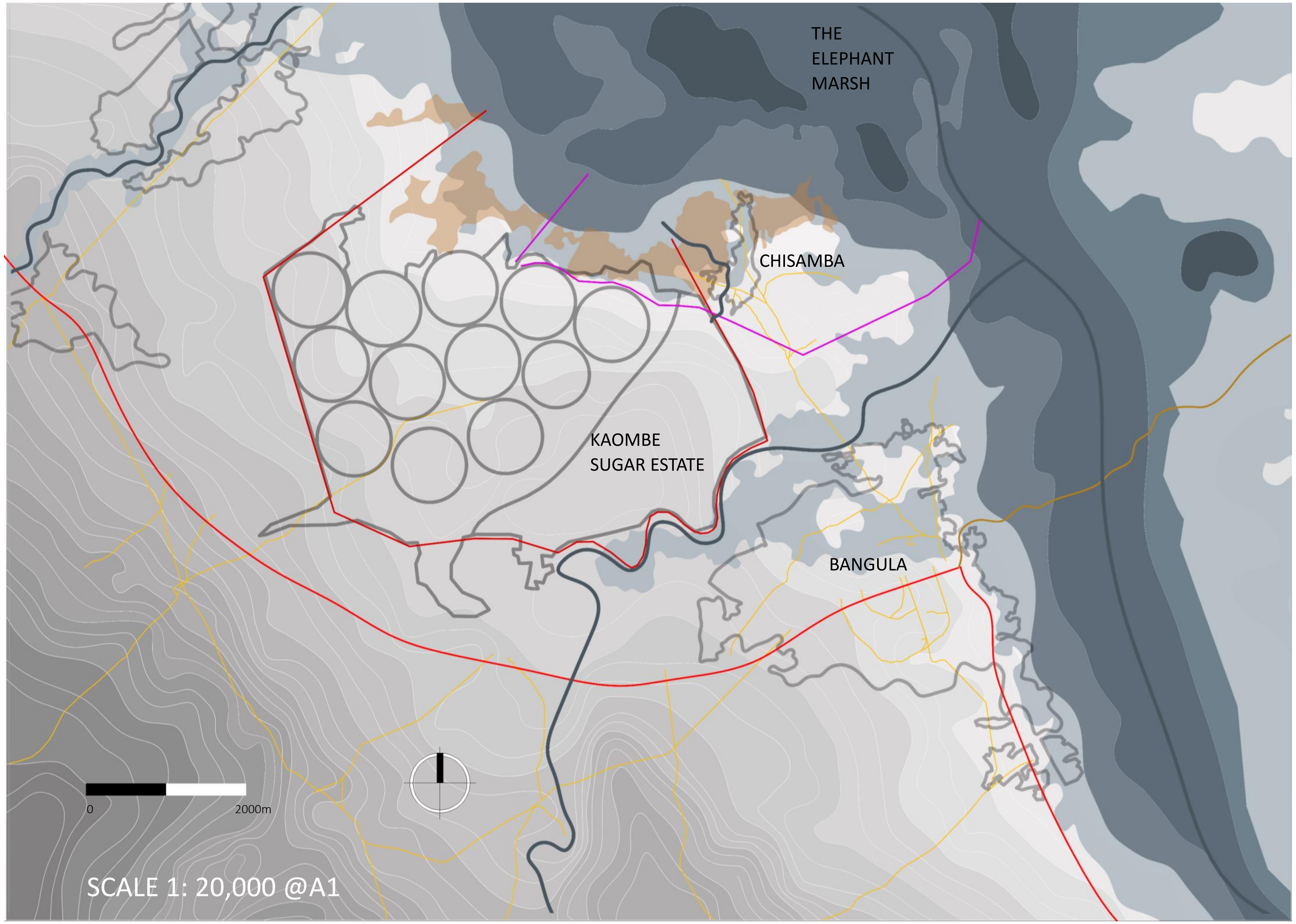
Sugar production along the Elephant Marsh has had a negative impact on the environment leading to drier conditions of the floodplain margin. The type of negative impacts include:

Water pollution

Fertilization of sugarcane crops is a major source of metal and nutrients that pollute wetlands and water sources (Nakiyemba Were, Isabirye, Mathijs, Deckers, & Poesen, 2010). This run-off of agro-chemicals such as pesticides and fertilizers into the wetland has raised the possibility of contamination and eutrophication within the Shire river (MARSH, 2016). Furthermore, Groundwaters can also be affected through leaching of nutrients from fertilizers applied to the crops (Cheesman, 2004).

Excessive water consumption

Sugarcane cultivation mostly relies on irrigation in many areas. It has been estimated that a cane crop of 100 t/ ha would be expected to consume in total approximately 7.5 Ml/ha water. This can lead to the depletion of groundwater resources. Furthermore, this excessive rate of water consumption can increase the salinization and pH of the soil (Cheesman, 2004).

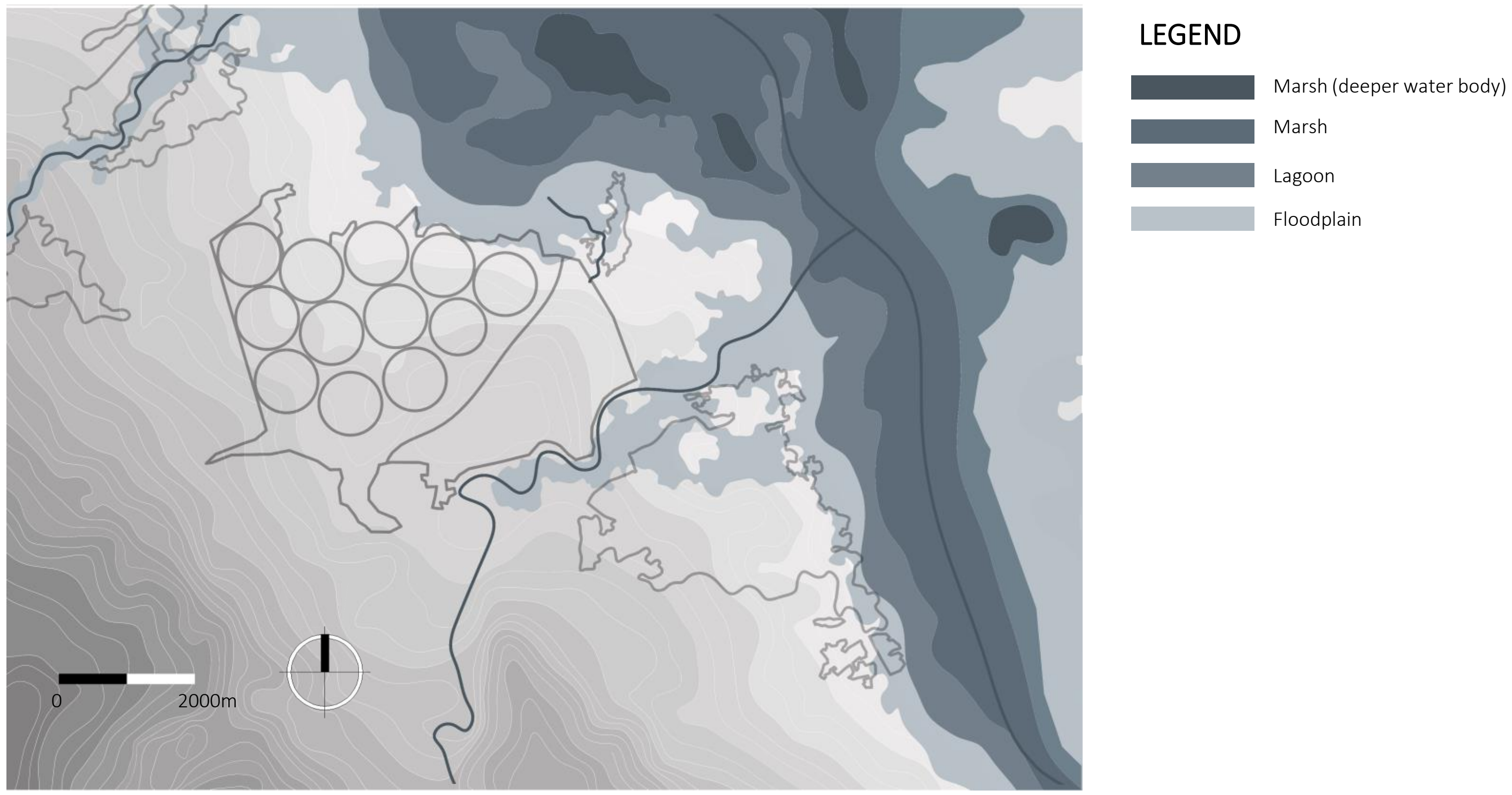


LEGEND

- Marsh (deeper water body)
- Marsh
- Lagoon
- Floodplain
- Mud pan with saline soil
- River
- Settlement
- Canal
- Fence
- M1 main road
- Secondary road
- Tertiary paths

Source: Google Earth, 2020; Mwale, 2015; Atkins, 2012.

SITE PLAN ANALYSIS



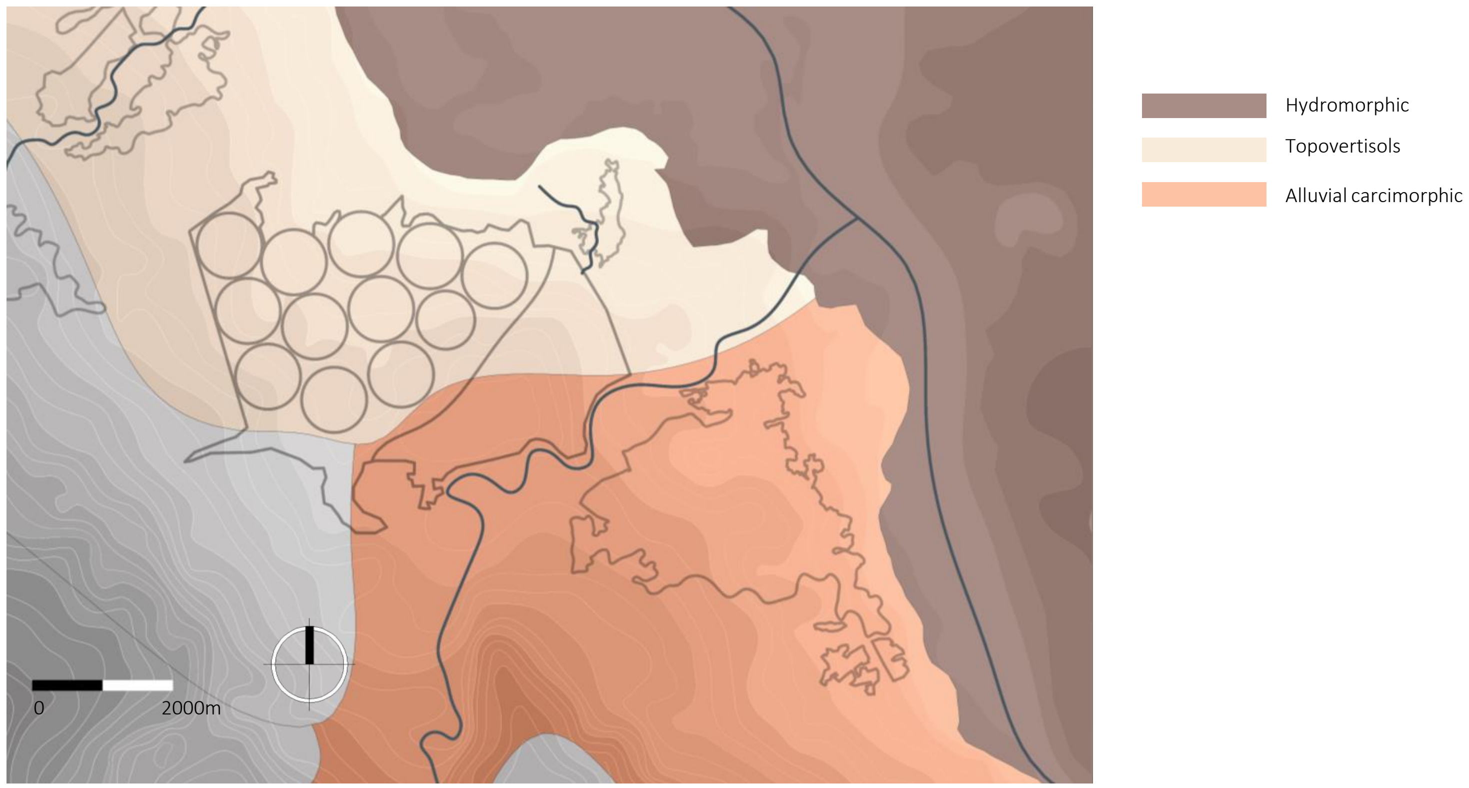
Source: (Atkins, 2012; Mwale, 2015)

Hydrology

The Shire River passes through the Elephant Marsh and branches out into smaller ephemeral rivers such as Thangadzi River and Kandaladala River.

Groundwater from shallow alluvial aquifer is the main water supply source for the rural population along the Elephant Marsh (Kafatia, 2013) (C. Banda et al., 2020). Rural communities receive this water through hand-pumped boreholes which in some cases contain high saline (C. Banda et al., 2020).

Flooding in the Shire River occurs almost every year at different scales. The highest occurrence of flooding happens in the low-lying areas of the Shire River Basin, and this is often due to sediment deposition in river channels and floodplains coming from the degraded catchment area (Kafatia, 2013).



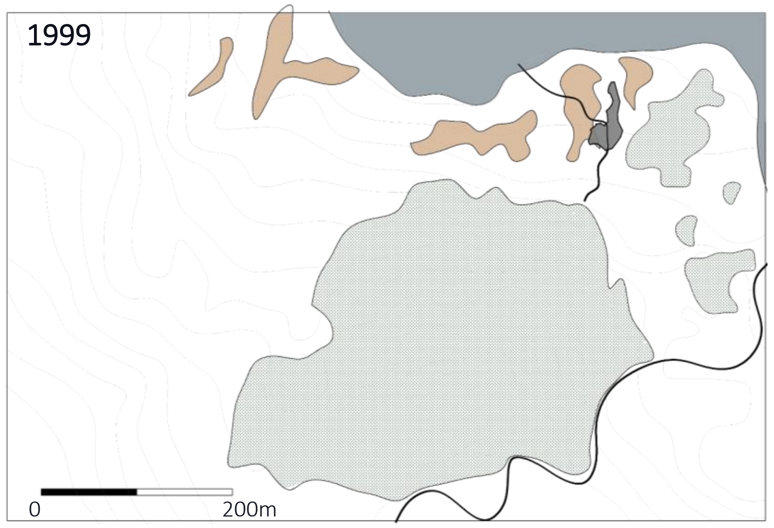
Source: (Mwale, 2015)

Soil

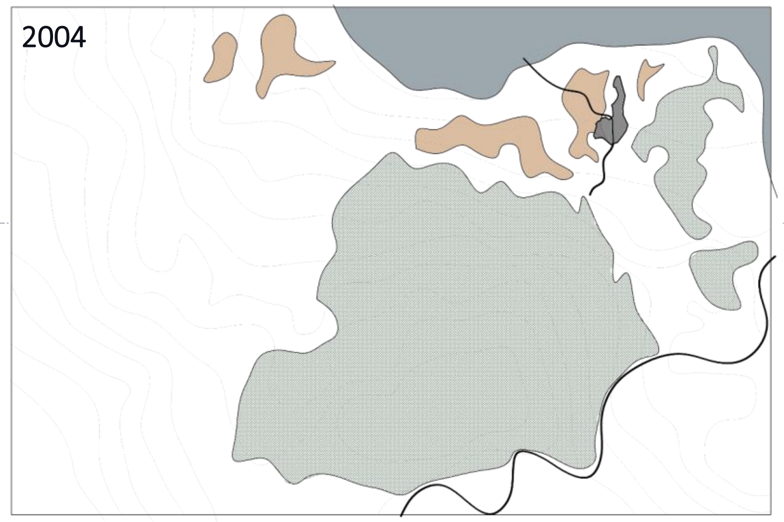
There are three major type of soils that make up the wetland and its edge. These soils include hydromorphic soils, topovertisols, and alluvial carcimorphic soils.

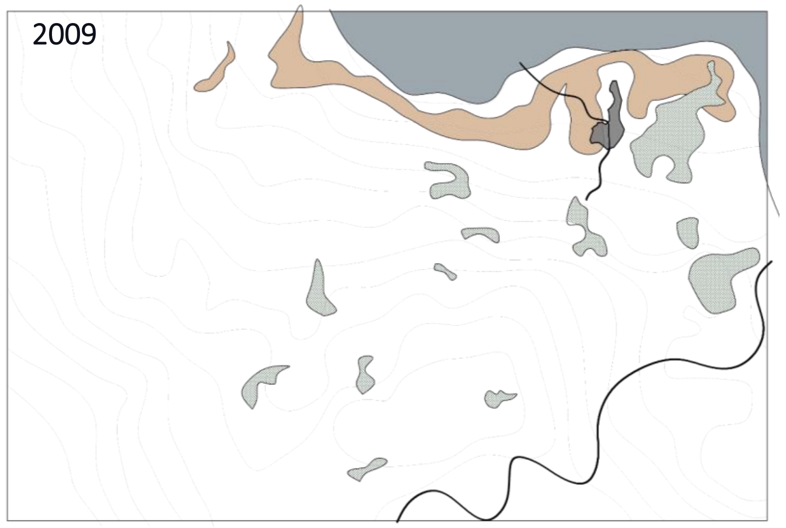
Hydromorphic soils form the majority of wetland and are characterized by poorly drained heavy soils which become water logging during the wet season. The topovertisols soils that exist at the top edge of the wetland are fertile soils which are also difficult to farm and extremely prone to erosion. Alluvial carcimorphic soils, which form the bottom half of the wetland edge consist of mopanosols, these are dark grey sandy clay soils with low permeability, this alluvial soil is also rich in nutrients for agriculture production (Kafatia, 2013).

THE HISTORY OF THE SUGAR ESTATE

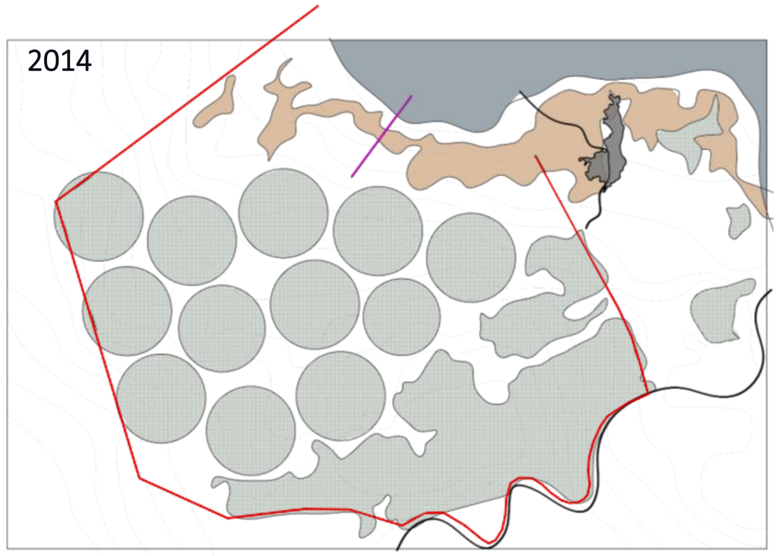


Increase in **human population** and **poverty** in the area has resulted in the clearing of natural vegetation for cultivation and settlement.





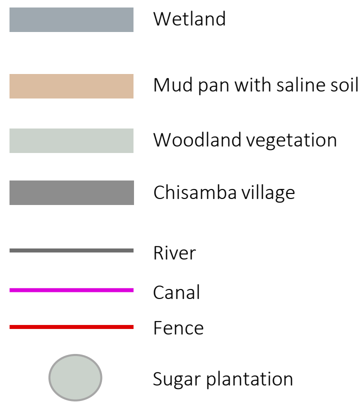
Kaombe Argicane Estate is a small privately owned sugar estate that was established in 2009. The conversion of customary land into private land for estate development has decreased land size holding for low-income communities in the area, especially for women (Kafatia, 2013).



The estate also contains an approximately 800 ha nature reserve, the Thangadzi River Conservancy. Furthermore, the estate also employs between 73 and 250 staff depending on the season and supports surrounding villages with a collective population over 8,000 people (Studd, 2019).

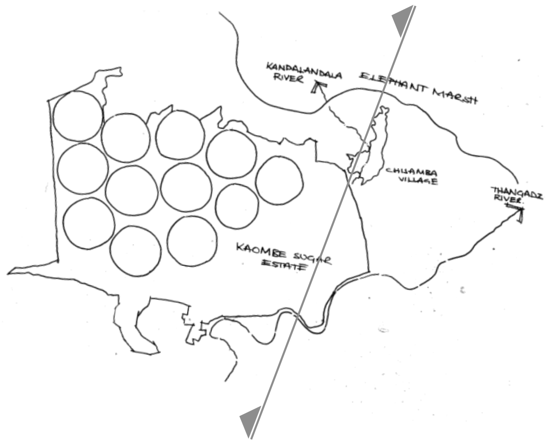
The site initially **abstracted water** directly from the Elephant Marsh, however issues of sedimentation and salinity prompted the site to build a canal to abstract water directly from the Shire River. Run off from the site is channelled into the Elephant Marsh (Studd, 2019).

LEGEND



Diagrams (author's own)
Source: (Google Earth, 2020)

SECTION THROUGH THE SITE



Collage (author's own)

Collapsed soil profile

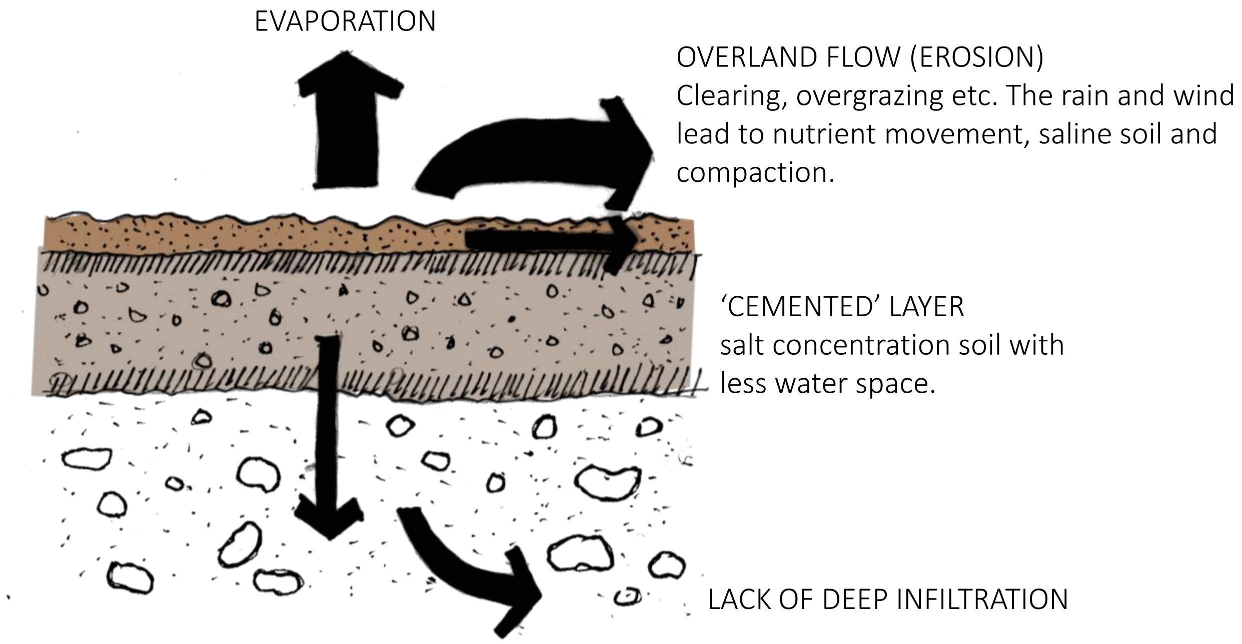
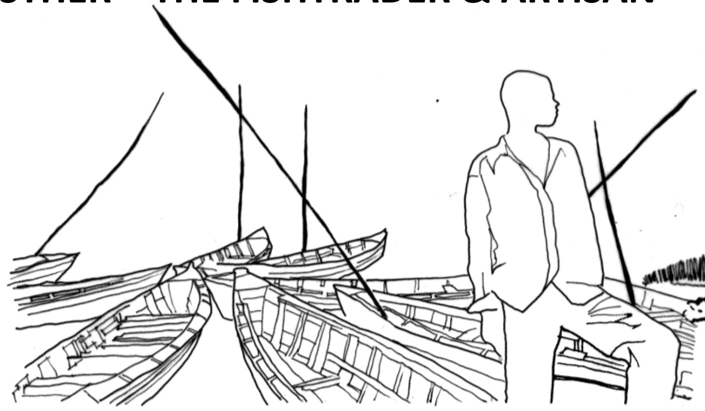


Diagram showing soil collapse and a cemented hardpan, sealing off the subsoil and making it impossible for vegetation to grow. A long rehabilitation process would have to take place for vegetation growth. (Mollison, 1988)

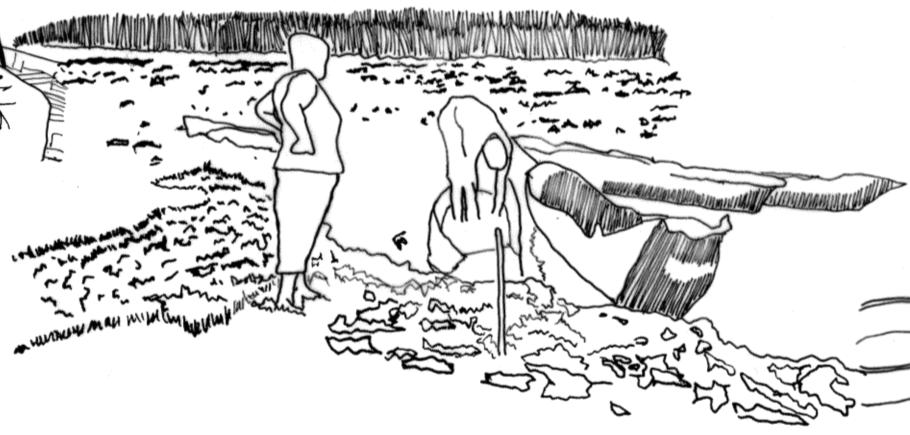
Challenges

- **Excessive water abstraction** and burning of land for agriculture has led to soil erosion, soil salination and lack of infiltration, therefore restricting plant growth.
- **Low-income communities** along the Elephant marsh are further **marginalized** because of privately owed sugar estates that extract water from the landscape causing more pressure on the wetland in providing its natural resources for the community's livelihood.

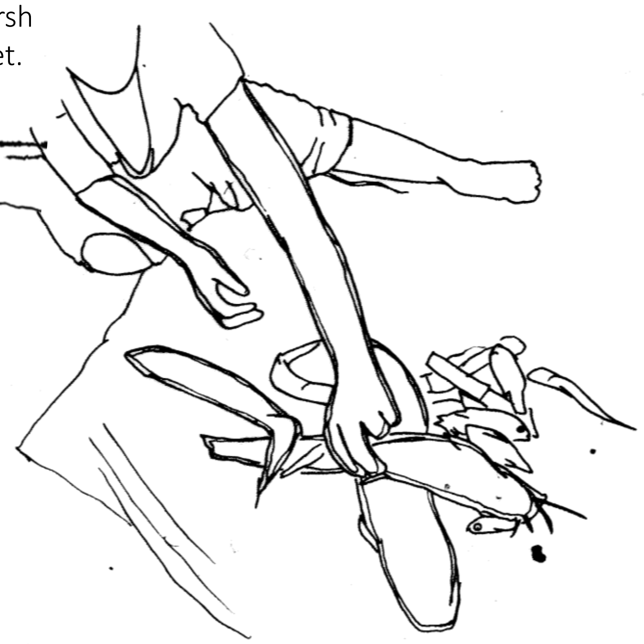
ESTHER – THE FISHTRADER & ARTISAN



Esther, who is both a fish trader and an artisan, normally buys a 5-liter basin of fish from a fisherman at the edge of the elephant marsh in the early dry season. Normally the fish are small.



Esther sits and lays out the fish to sell at the edge of the marsh which is also a local market.

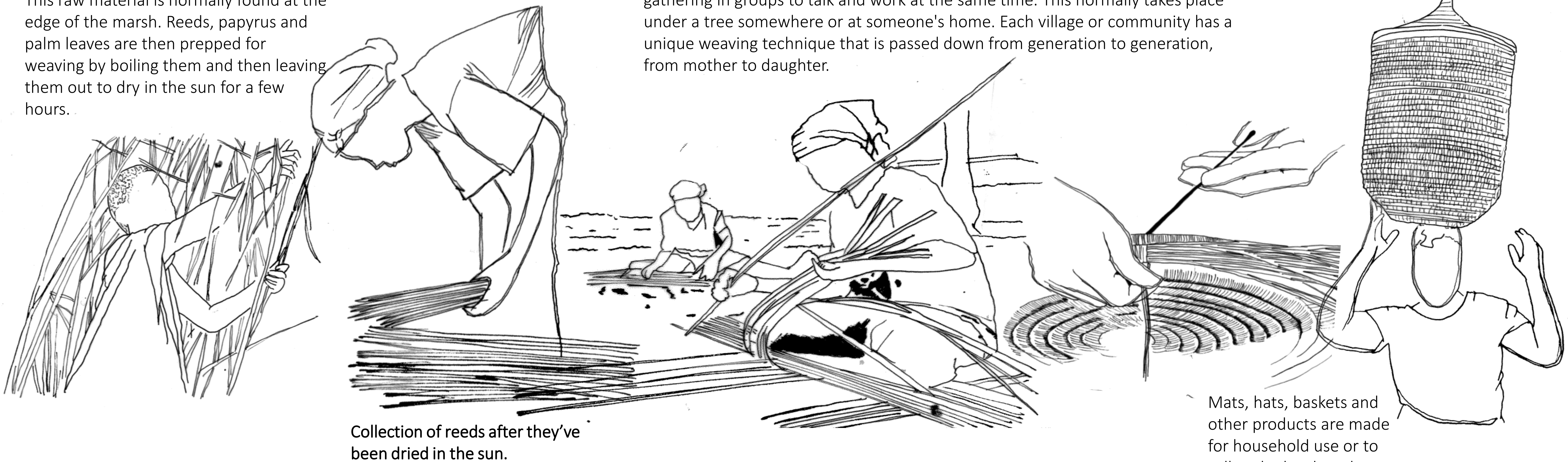


During the first half of the dry season, the fisherman goes out into the wetland at night to catch fish so that he can sell his catch to the fish traders in the morning.

During the second half of the dry season, when there is low water levels, she harvests reeds and palm leaves from the edge of the marsh.

This raw material is normally found at the edge of the marsh. Reeds, papyrus and palm leaves are then prepped for weaving by boiling them and then leaving them out to dry in the sun for a few hours.

The weaving process is a mobile and often social event that involves women gathering in groups to talk and work at the same time. This normally takes place under a tree somewhere or at someone's home. Each village or community has a unique weaving technique that is passed down from generation to generation, from mother to daughter.



Collection of reeds after they've been dried in the sun.

Mats, hats, baskets and other products are made for household use or to sell at the local market.

Drawings (author's own)

METHODOLOGY

This design methodology will involve **cyclical refinement** of the project objectives. This is a shift from a methodology that is linear and technical to one that allows for understanding to be gained in one place that can feed back to other processes and allow for adjustments. Furthermore, this design methodology will help build resilience in the landscape proposal by allowing the process to be open to uncertainty and adaptation with each cycle bringing me one step closer to a more integrated and flexible solution.

1. RECOGNISE

I began by understanding the social and ecological systems of the site through online publications about the Shire River Basin and the Elephant Marsh, as well as looking at case studies about African wetlands.

A site visit and 2 interviews with one community member and one sugar estate member were conducted to connect with the realities of the site in terms of the materiality and socio-economic dynamics of Chisamba village. Overall the assessment of the landscape grounded my understanding of the sense of place and identity of the landscape inhabitants.

2. RESPOND

To identify various opportunities within the landscape, I began with conceptual model-making to understand the process of infiltration and how that could be applied to my site.

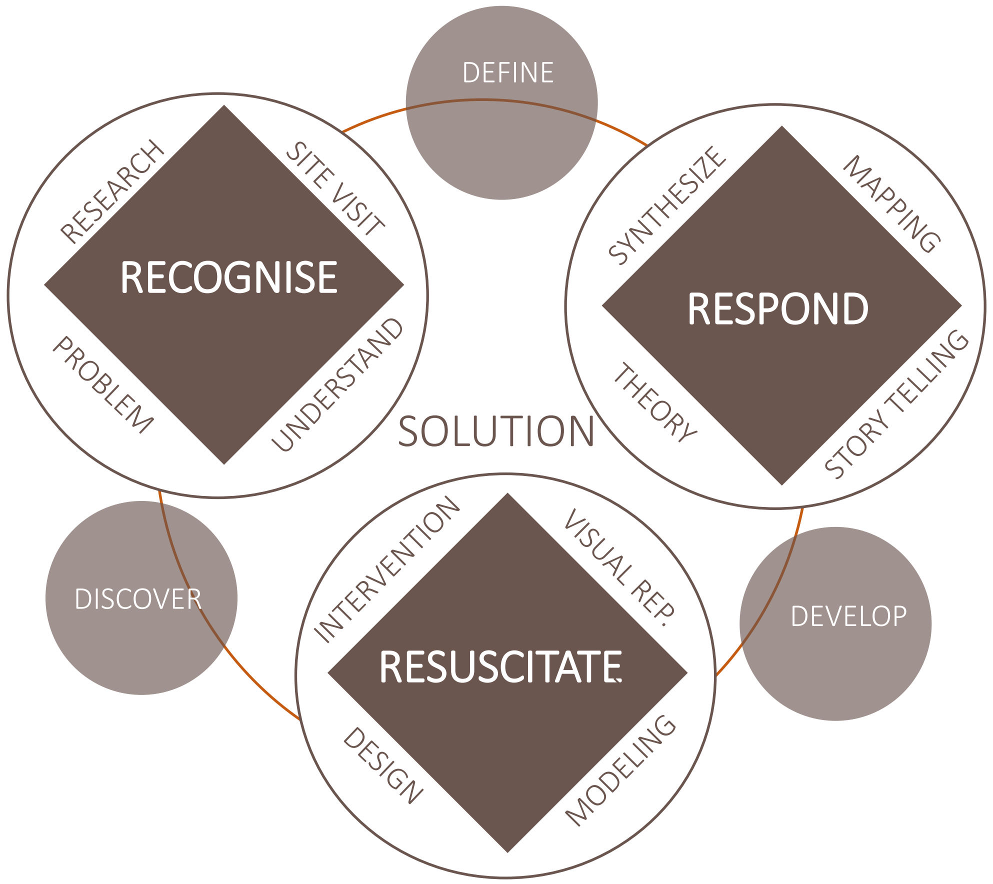
I engaged with the site's conditions over time to understand the links between the hydrological systems relation to urbanization and how that has impacted the soil and vegetation of the site.

Storytelling using an active participant within the site revealed the type of spaces and interventions that could be used in this project.

3. RESUSCITATE

Modeling experiments of the flooding and precipitation process on the edge of the wetland will enable me to have a better understanding of the current movement of water on the site and how that can be changed to allow for more infiltration into the soil as well as how the community can collaborate with the flooding process through an integrated aquaculture and agriculture practice that is more sustainable.

Furthermore, incorporate the practice of weaving into my design proposal as a construction material and providing spaces where the harvesting of these plants can take place easily and more sustainably.



LITERATURE REVIEW 1

SOAK: Mumbai in an estuary
-Mathur & Da Cunha

Visual representation: The nature of Ian McHarg is present beyond the literal layering of maps. Mathur and da Cunha strive to bring the section back into the mapping process instead of working in plan view. The reason for this is because plan view often shows the land as superior and sees the water as an outsider.

Having maps represented in section shifts these boundaries of the land and water and replaces them with the horizon by showing the land and sea as equals that show depth. There is also an emphasis to distinguish between different conditions no matter how diffused the edge. Plan view is a good perspective to see problems, but it is also difficult to take in a holistic overview. Section view allows for the viewer to experience a place at ground level (Mathur & Da Cunha, 2009).

The interesting thing about SOAK is that the interventions do not work towards an end scenario but instead are viewed as seeds that have the potential to unfold and extend possibilities in more than one way. They chose to suspend the idea of a final product that is "phased" in time, and instead focus on where and how a design initiative begins and on how it might evolve and extend in time. SOAK shows how flooding issues cannot to solved by flood-control measures but rather by making a place that is absorbent and resilient (Mathur & Da Cunha, 2009).

This is an important consideration for my own approach for this project. The process of understanding the site through plan view and sections can lead to incremental solutions.

'accommodate uncertainty through resilience, not overcome it with prediction.' – (Mathur & Da Cunha, 2009).

Fingerponds: seasonal integrated aquaculture in east African freshwater wetlands: exploring their potential for wise use strategies

A Fingerponds system is an integrated aquaculture and agriculture system that retains the functioning of wetlands. The Fingerponds system is a concept that combines the socio-economic (livelihoods, costs, benefits) with the biophysical aspects of the site (water, fish, soil, inputs) (Kipkemboi, 2006).

The advantage of this system is that it supports the continuation of fish growth and supply of fish in the dry season whilst the raised beds provide crops. It also retains the functioning of wetlands by not affecting their hydrology nor impeding natural flooding regimes (Denny, 2006). Furthermore, it provides more options for produce and creates a link between various components of the farming system.

The water in the pond can be used to irrigate the gardens, while the sludge from the bottom of the pond is removed during the dry season and is used as a fertilizer that's spread over the raised beds. The surplus vegetables from the adjacent gardens can be removed and used as food for fish or composted and applied as green manure (Kipkemboi, 2006).

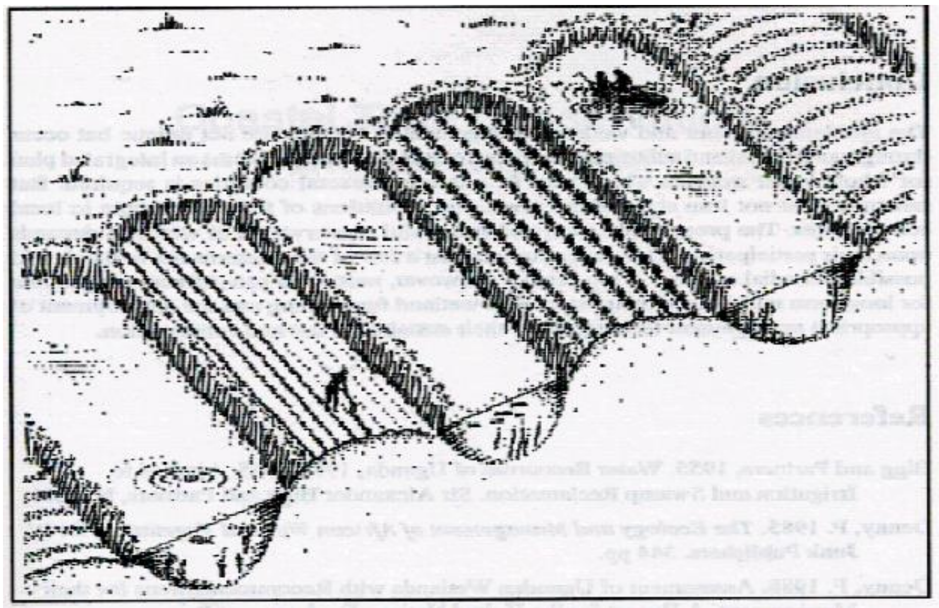


Image shows how fingerponds and raised beds are positioned and fenced with reeds (Denny, 2006).

Furthermore, the water levels of this system are un-regulated and rely on natural flooding of the wetland during the rainy season. This can also be a challenge in sites where seasonal flooding can be unreliable, meaning that the control of this system is limited. Sites can also remain flooded for longer than expected or may dry up soon than expected. Another challenge is the size of the fish being caught in the ponds which the community has complained to be too small.

Conclusions:

- the choice of site is very important. The condition of the site is what determines the level of success for Fingerponds such as rainfall, reliable seasonal flooding, land, and soil suitability.
- This system, whether successful or not, provides a feedback loop which is a process whereby the outputs of a system are circled back and used as inputs.
- Through the design, we can learn more about the interrelations and entities of the system.

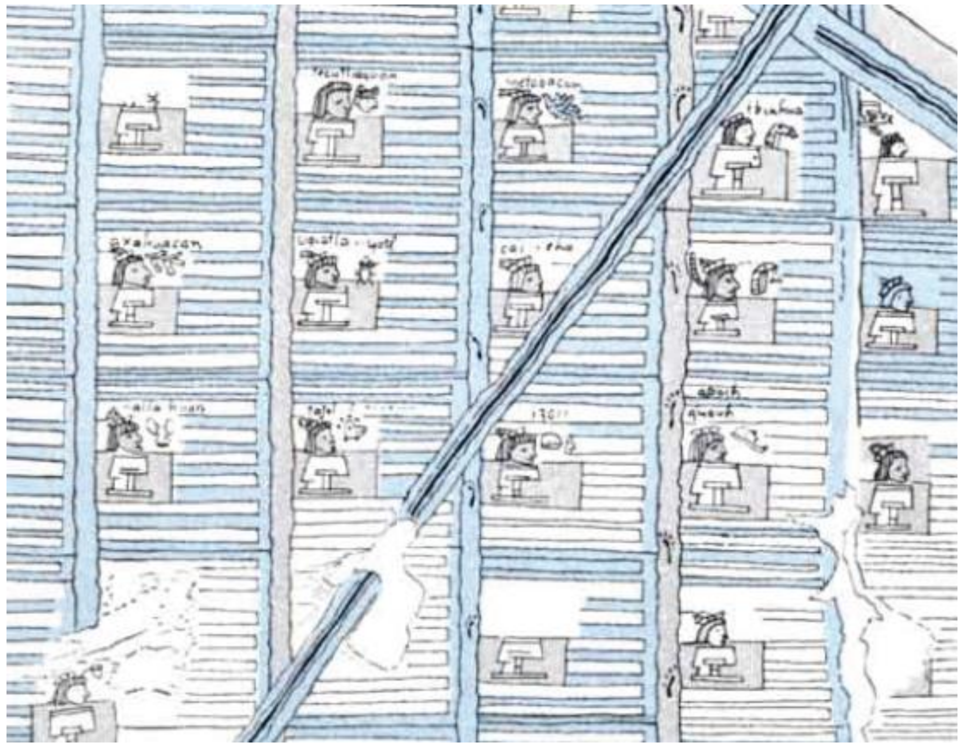
'the living landscape is dynamic in its processes and is always evolving.' – (Murphy, 2011).

LITERATURE REVIEW 3

The chinampas of Mexico

This is an ancient agricultural system that was created by the Aztecs in Mexico. This system provided the Aztecs with land and a surplus of food. Chinampas, which are also known as 'floating gardens', are islands that are covered by the lake in a maze of canals and raised gardens.

Chinampas are constructed by creating a boundary of willow stakes that are anchored to the bottom of the lake. Reeds are then woven into the framework of the stakes to create a container. This container is filled with different layers of organic material such as aquatic plants, lake mud, organic sediments, and the like. Over time, the organic material becomes a body of fertile soil that can then be used to grow agriculture (Coe, 1964).



This is a ancient Aztec map showing how the system looks in plan view (Coe, 1964).

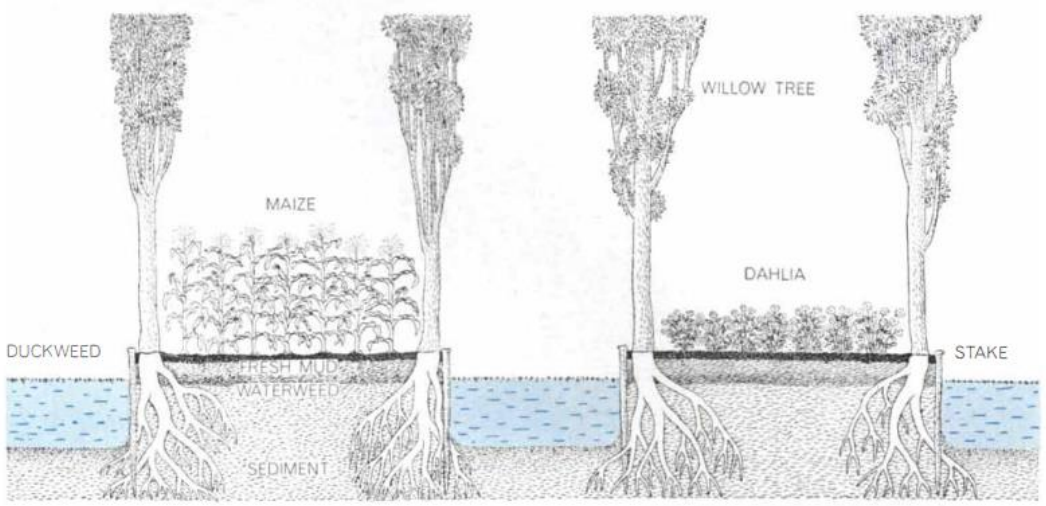


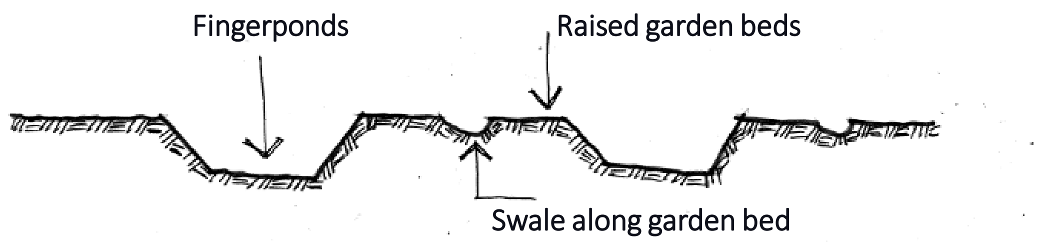
Image shows a cross section of the chinampas and canals. The different layers of organic matter is what makes the soil fertile and the stakes and willow trees are what secure the structure. (Coe, 1964)

Conclusions:

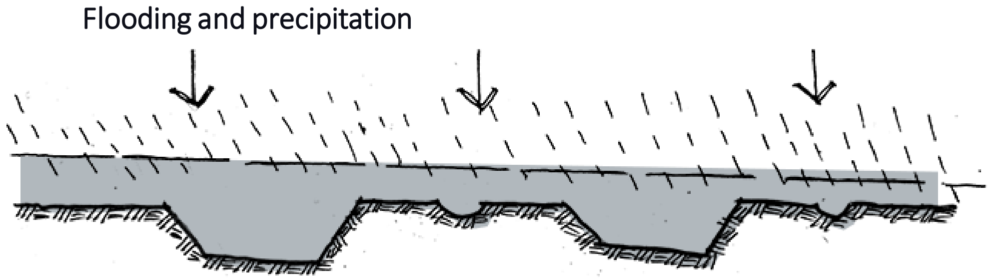
- A similar approach can be applied to the regular flooding system that occurs along the elephant marsh so that the soil and agriculture in the area is thriving and preserved
- Traditional practice of weaving can be applied to the construction of the raised garden beds so that the community is tied to the process.

HOW FINGERPONDS WORK

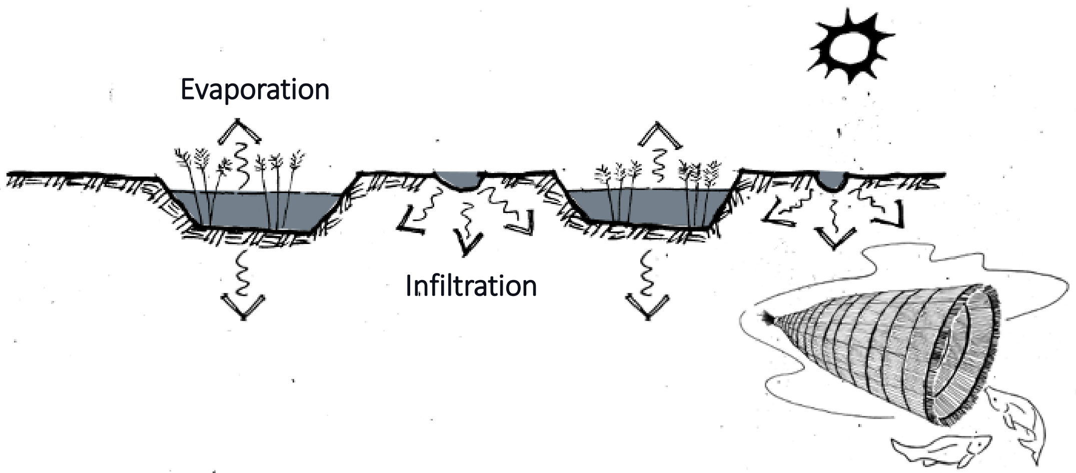
During the **dry season**, earthen ponds known as fingerponds are dug at the edge of the wetland with raised beds for cultivation.



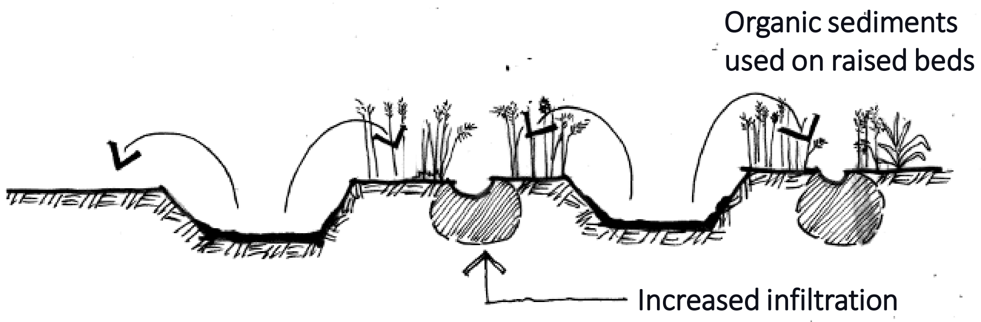
During the **wet season,** flooding and precipitation fill up the fingerponds with water.



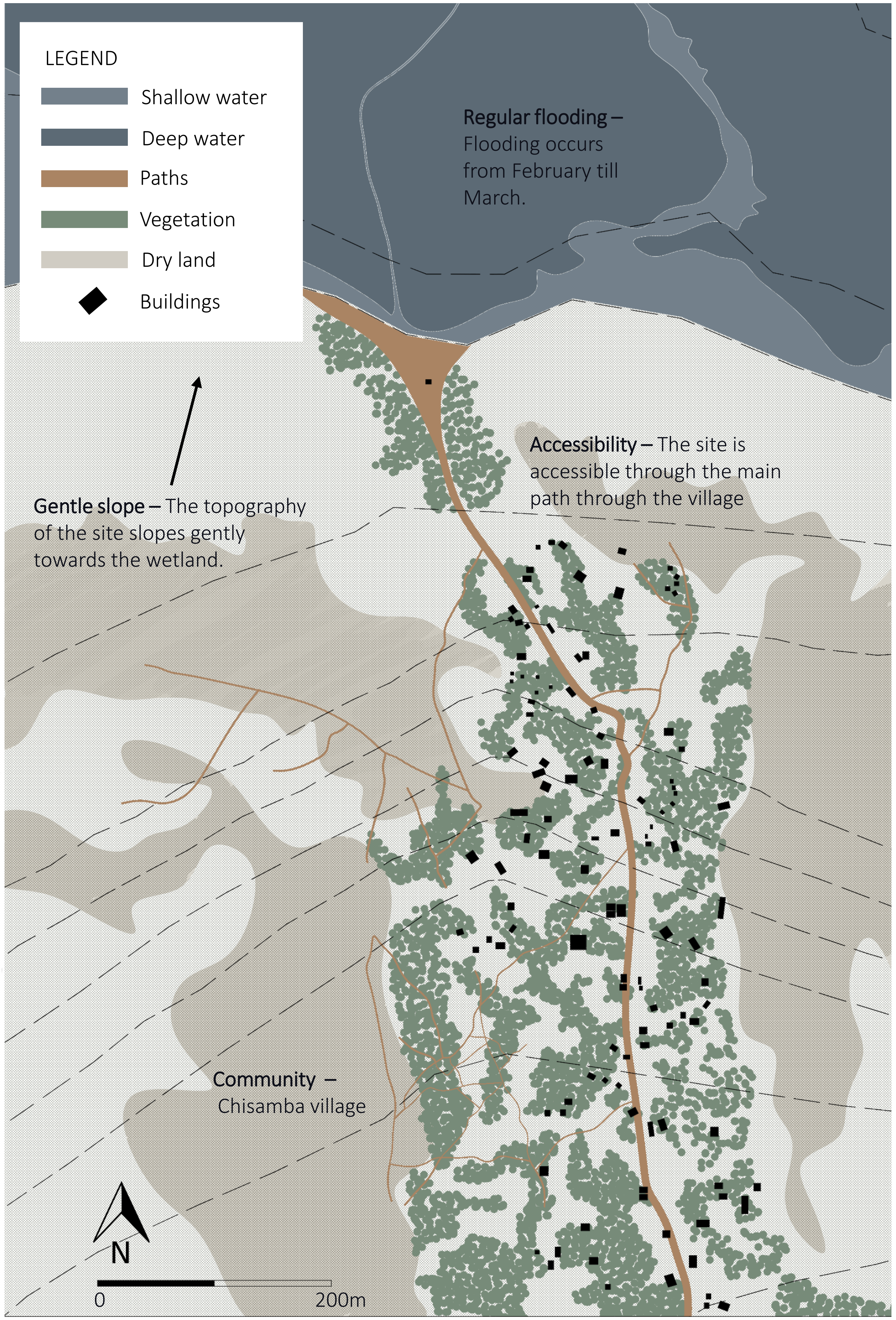
As the flooding **water recedes**, fish and water are trapped in the fingerponds. Infiltration and evaporation take place. All fish need to be harvested when water levels reach 0.5m in depth.



Fingerponds dry out during the late dry season through evaporation and infiltration. **Organic matter** from the pond system can be used on the raised bed as fertilizer for crops.



SITE CRITERIA



SCALE 1: 2000 @A1

MODEL MAKING 1

Model 1: Understanding the process of infiltration through model making.

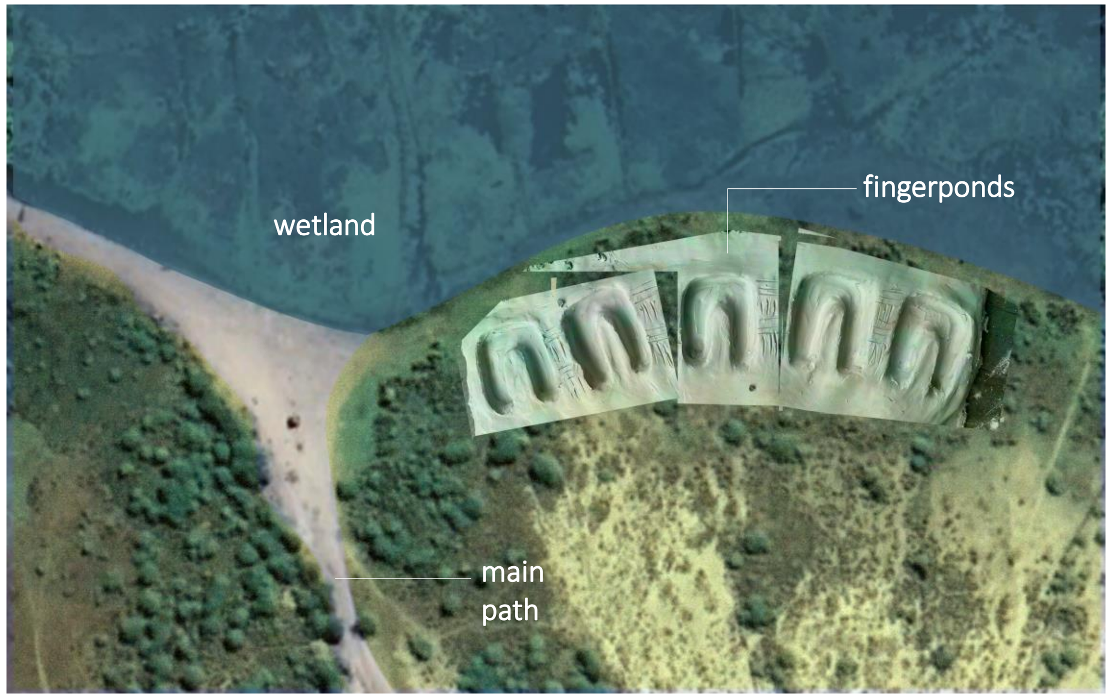
(author's own)

Model 1:

Exploring the process of infiltration through a model. For this model, I used newspapers, glue, and string as my building materials. The purpose of this exercise was to conceptualize the process of infiltration, which is defined as how water enters a space gradually.

The model has no base to highlight how increased infiltration has an impact on every side of the model and how this process can be used to create new dimensions along the landscape, both on the surface and underground. Furthermore, the idea is to create multiple spaces that allow for water to move with ease.

MODEL MAKING 2



Model 2: Clay model of fingerponds along edge of wetland.

(author's own)

Model 2:

I used clay modeling as a way of integrating the shape of the fingerponds into the existing landscape. The fingerponds are made to follow the curve of the wetland edge and to be close to the main path through Chisamba village.

The shape of the fingerponds was designed in a u-shape so that the island provides a hub to monitor the activities around the fingerponds, such as fish harvesting and agriculture. Furthermore, the side of the fingerpond facing the wetland would not be accessible to humans, therefore protecting the integrity of the wetland edge.

Model 3:

Since the construction of the fingerponds would be slow. The design also looked at methods to decrease the rate of erosion along the edge of the pond as the flood cycle comes and goes. Model 3 shows how the edge of the pond would be constructed. A terraced edge is used to reduce the rate of evaporation so that each time the water drops below a new terrace, the surface area is reduced.

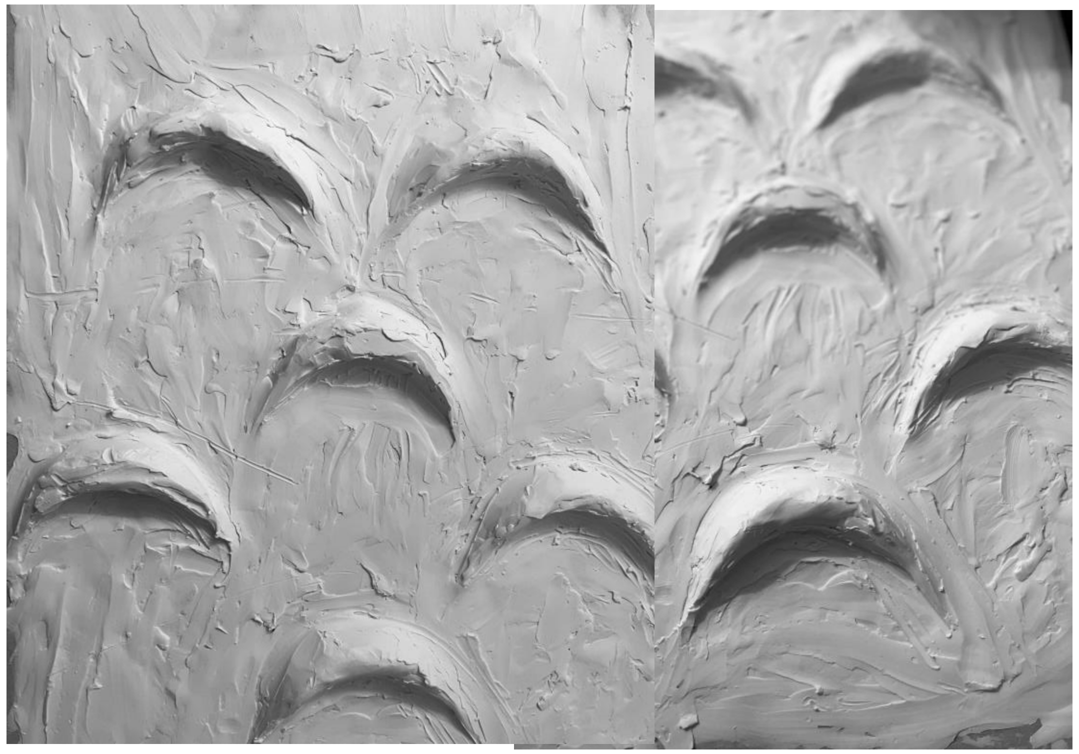
Furthermore, a biodegradable geotextile would be used to prevent erosion and stabilize the soil along the edge so that aquatic vegetation can eventually grow around the fingerponds with time.

Model 4:

This model explored the idea of using earthworks such as semi-circular bunds to hold rainwater around dry barren soil.

Model 3: Clay model of fingerponds edge with terraced steps.

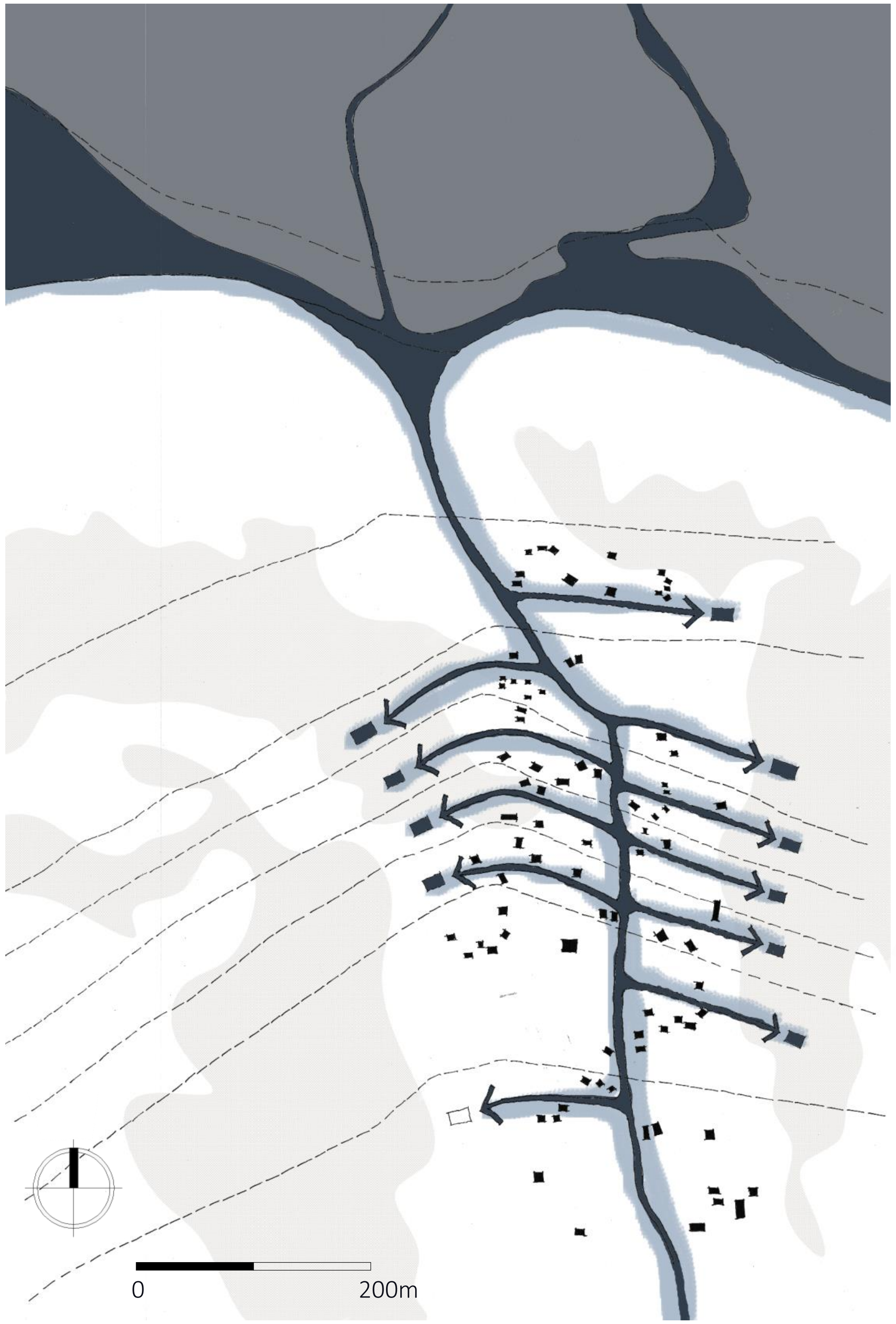
(author's own)



Model 4: Clay model of semi-circular bunds.

(author's own)

FRAMEWORK 1 – WHERE DO WE BEGIN?



SCALE 1: 2000 @A1

Map showing water moving down the main path through Chisamba village and being diverted into the village using swales into infiltration pits.

(author's own)

Swales and infiltration pits

Taking advantage of the spinal pedestrian path and how water moves through the compressed soil down to the wetland. Swales will be used along households to divert rainwater through household gardens and into infiltration pits located in the drier areas of the site

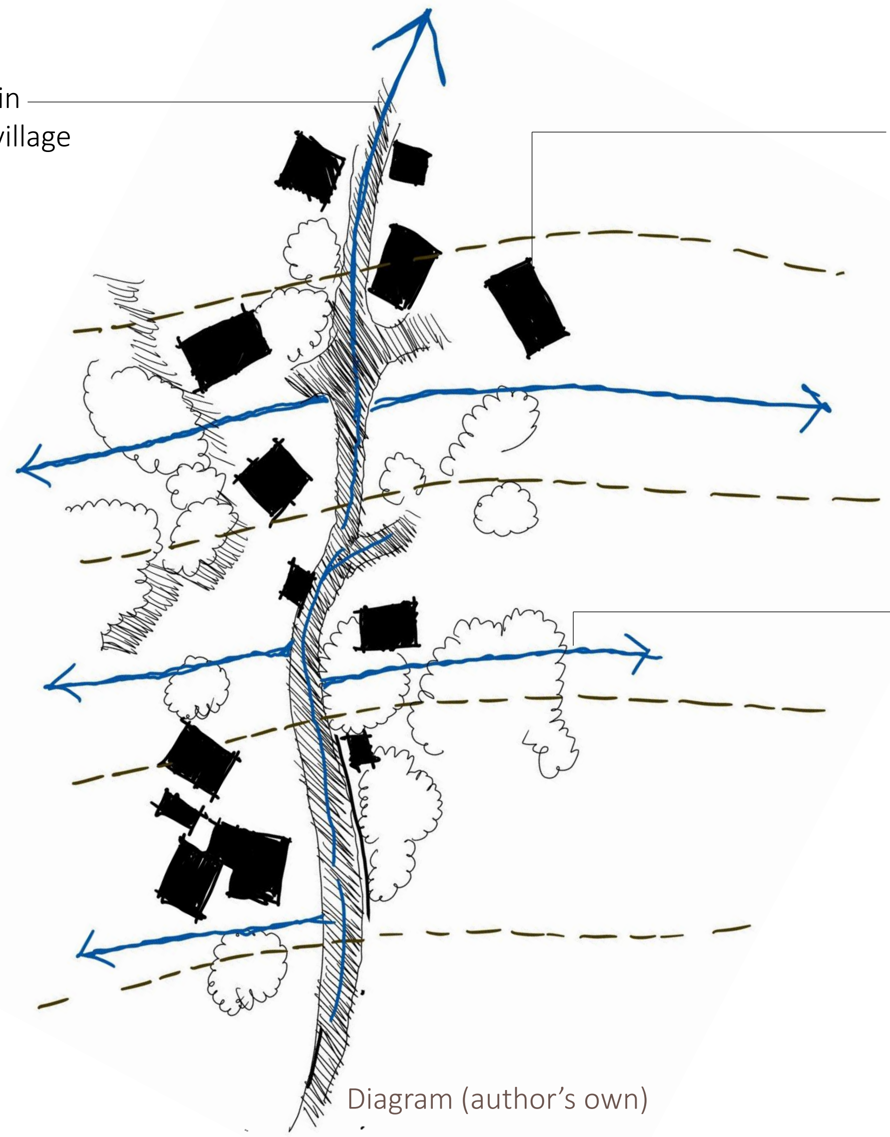
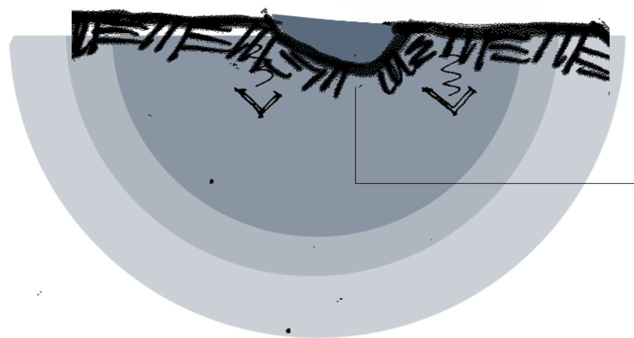


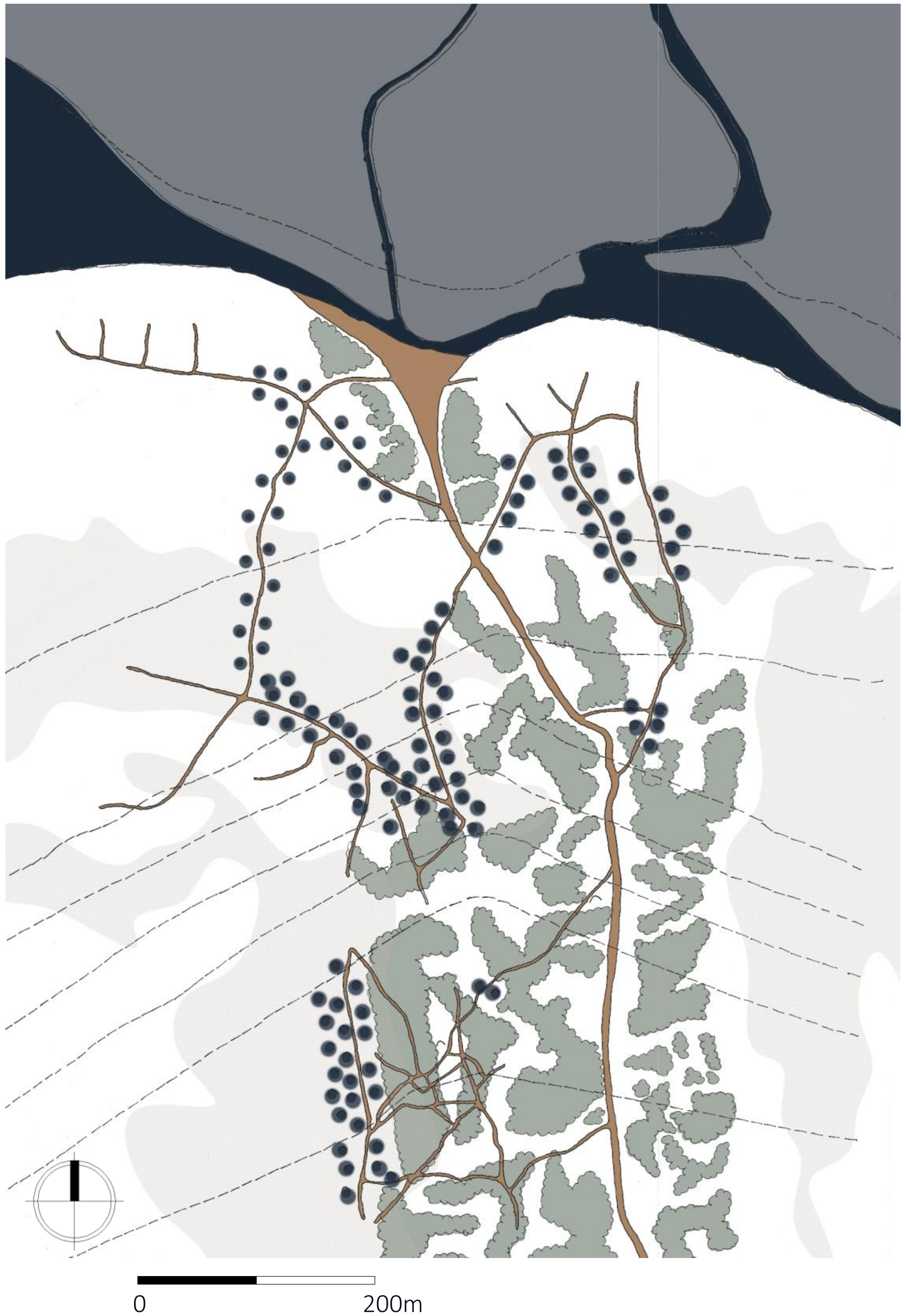
Diagram (author's own)



Cross-section of a swale holding and infiltrating water.

(author's own)

THE FRAMEWORK 2



SCALE 1: 2000 @A1

Map showing where the semi-circular bunds would be located along paths heading towards the fingerponds, and perpendicular to site contours.

(author's own)

Micro-catchment areas using semi-circular bunds

These are small earth bunds that are placed perpendicular to contours. Runoff is collected with the bunds and water infiltrates into the soil. Micro-catchments are mainly used for growing trees or bushes. These bunds can rehabilitate the soil and therefore benefit biodiversity and people (Adimassu, Mekonnen, Yirga, & Kessler, 2014).

These bunds will be placed along the tertiary paths leading to the fingerponds and wetland edge. The trees planted along the paths will mainly produce fruits and resources (palm trees). The trees will also provide shade as community members walk toward the edge of the wetland.

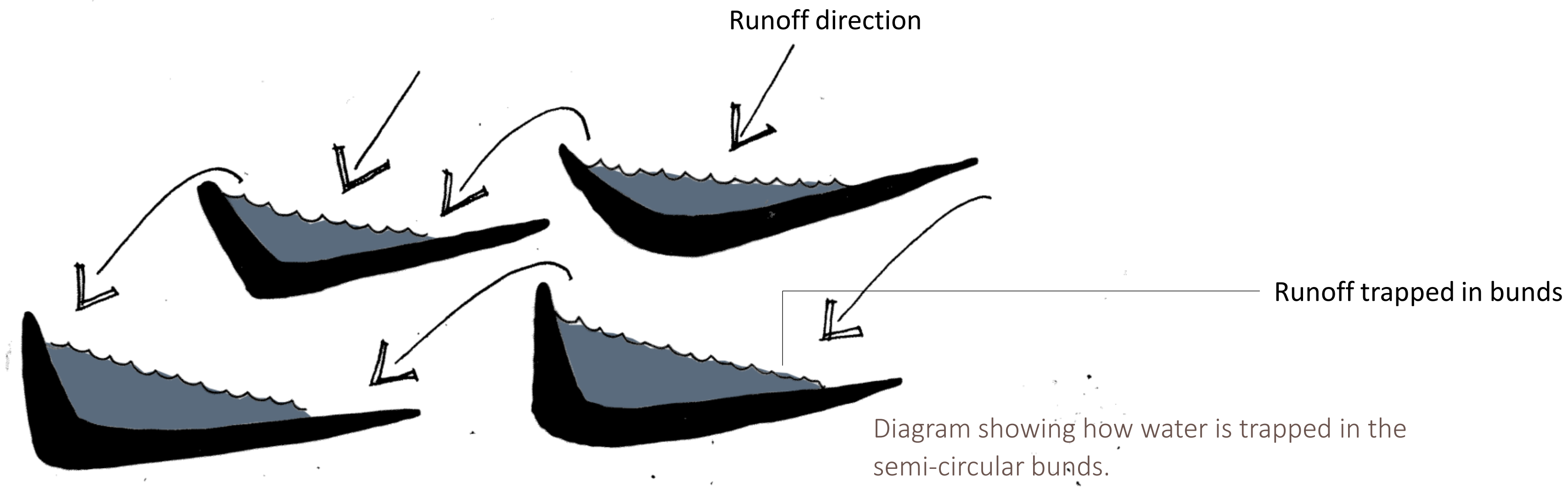


Diagram showing how water is trapped in the semi-circular bunds.

(author's own)

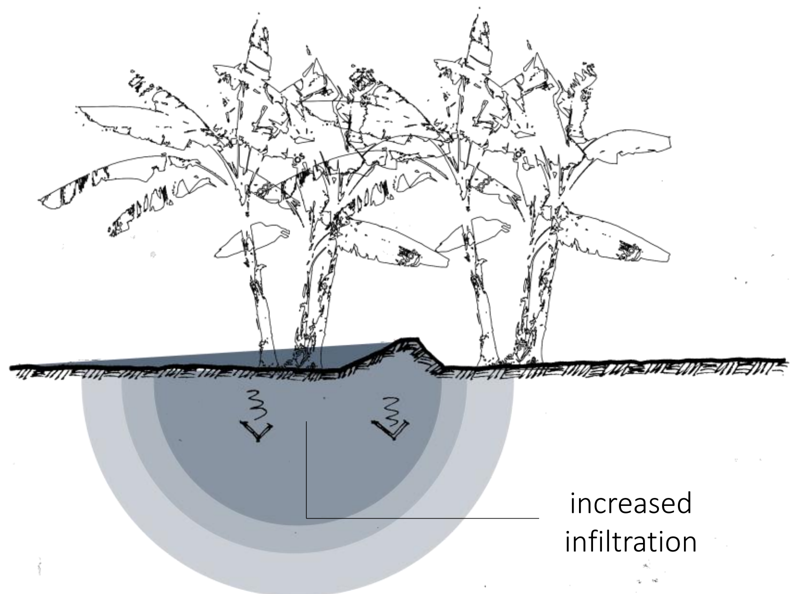


Image showing cross-section of semi-circular bunds and increase of infiltration around bund.

(author's own)

THE FRAMEWORK 3

SCALE 1: 2000 @A1

Map showing where fingerponds would be located near the edge of the wetland where regular flooding occurs.

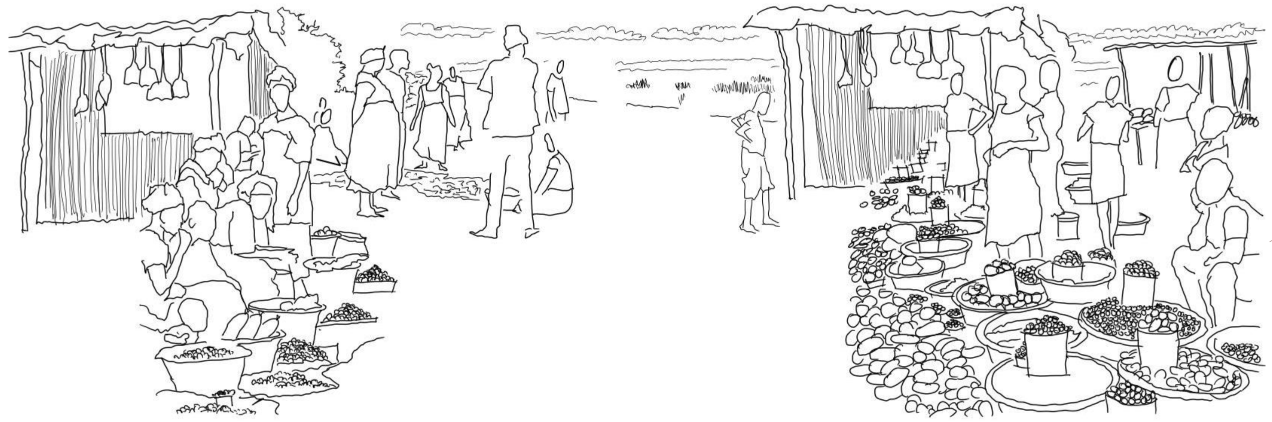
(author's own)

Fingerponds and raised garden beds

- **Improve the edge of the wetland** by creating earthworks that hold water and let it infiltrate into the ground as recharge. This can also enable trees and other vegetation to grow along the edge and further increasing water infiltration due to the roots.
- **Water harvesting and diversifying food production and natural resources** for local communities along the wetland, especially during the dry season using fingerponds which is an integrated fish and crop production system that uses water from annual floods and rainfall.
- Reviving **indigenous weaving practices** through the construction of the raised garden beds that would be woven to create a container for the beds. The maintenance of the raised beds after each flooding cycle will be part of the process in preserving this century-old traditional practice weaving reeds

Drawing showing how local market would thrive along the edge of the wetland because of diversified food production.

(author's own)



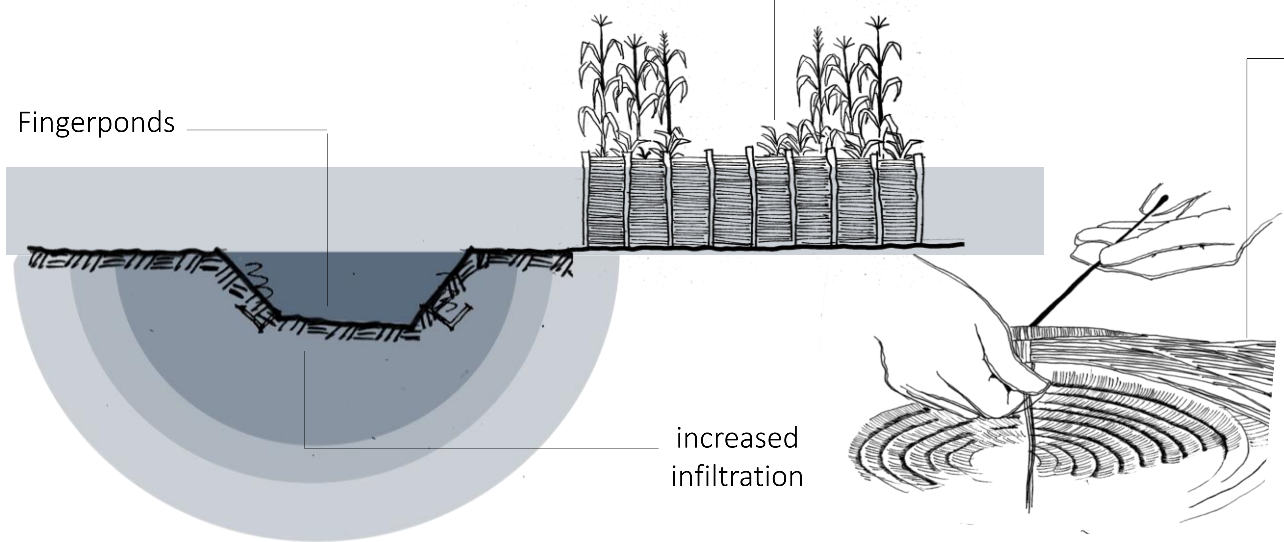
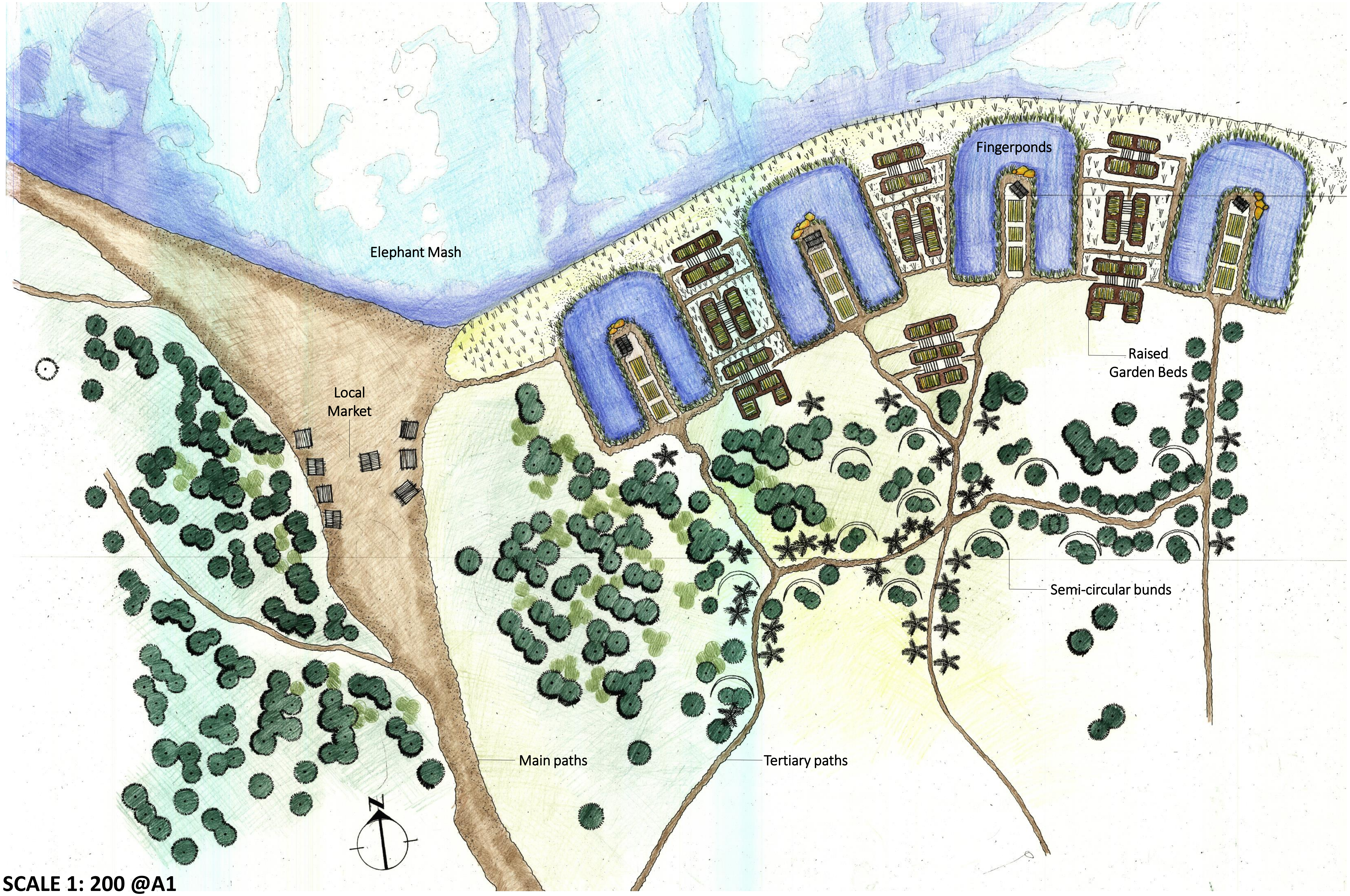


Diagram (author's own)

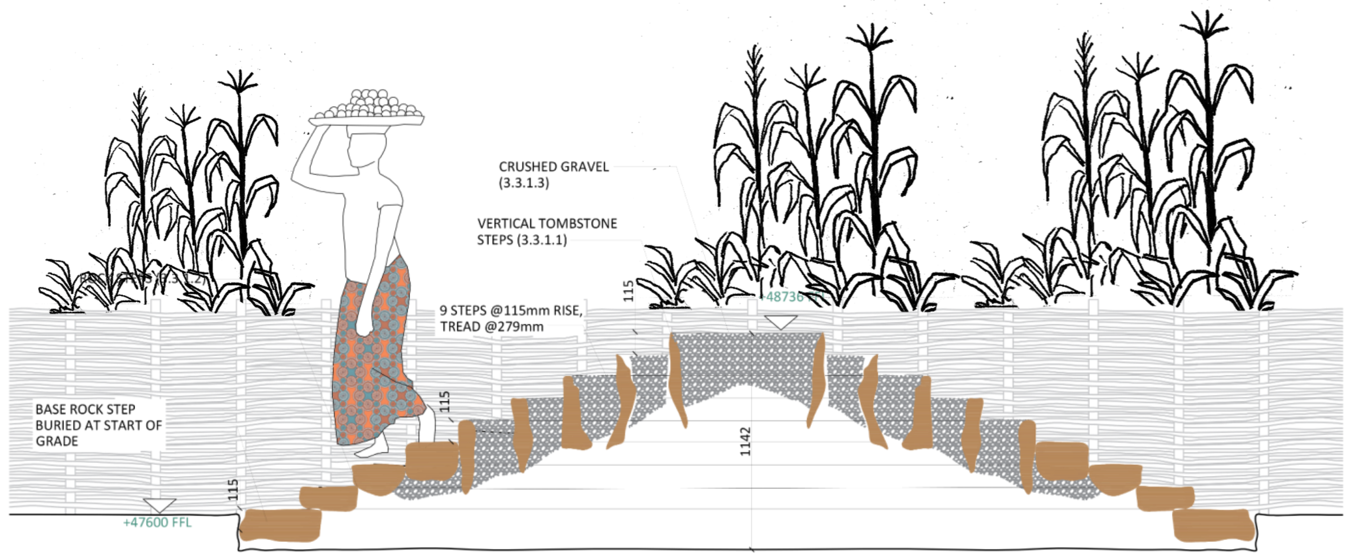
THE DESIGN PROPOSAL



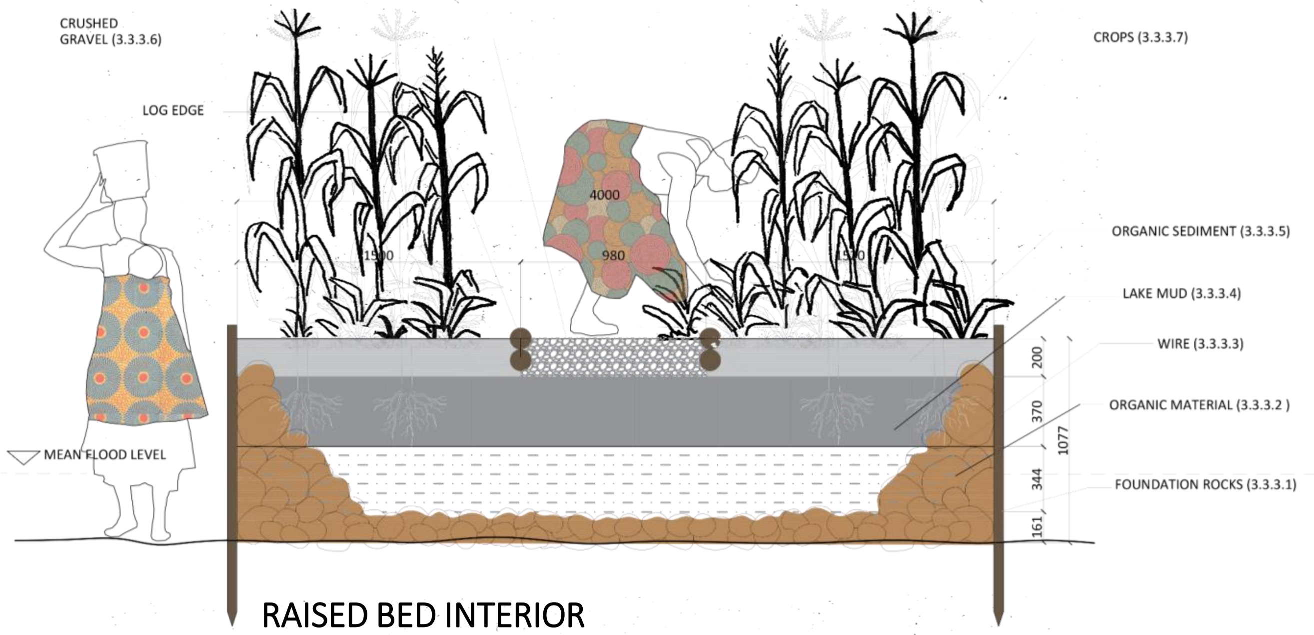
SCALE 1: 200 @A1

0 25 50m

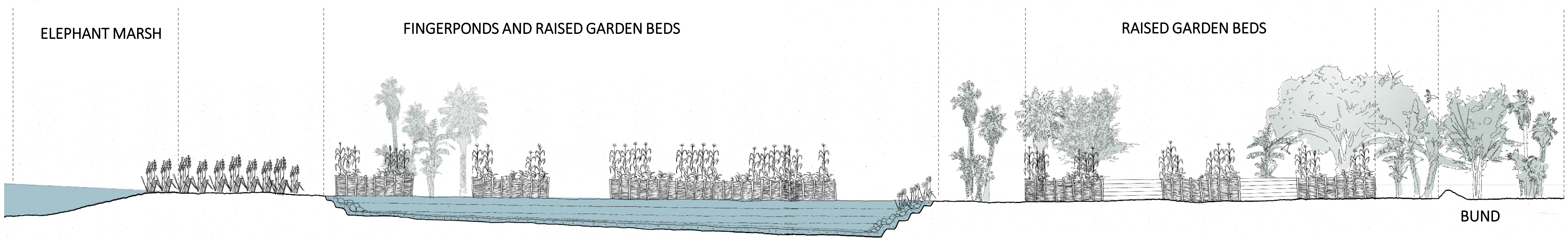
SECTION & DETAIL



RAISED BED STEPS
SCALE 1:20

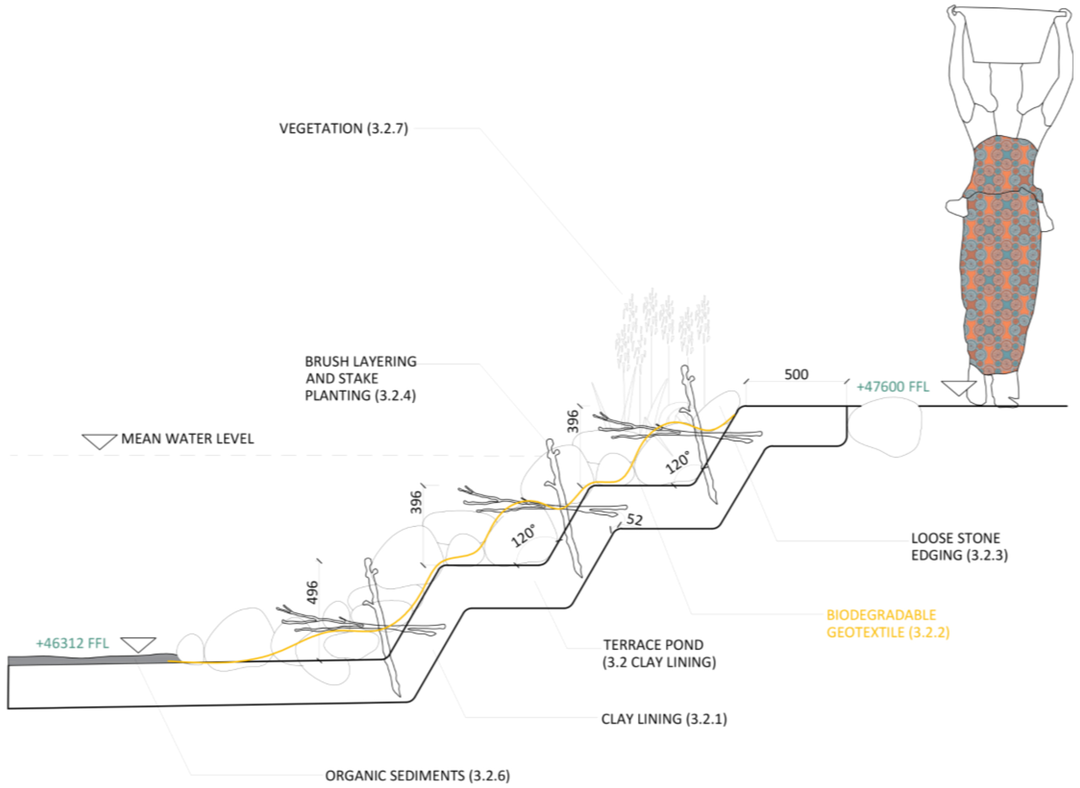


RAISED BED INTERIOR
SCALE 1:20

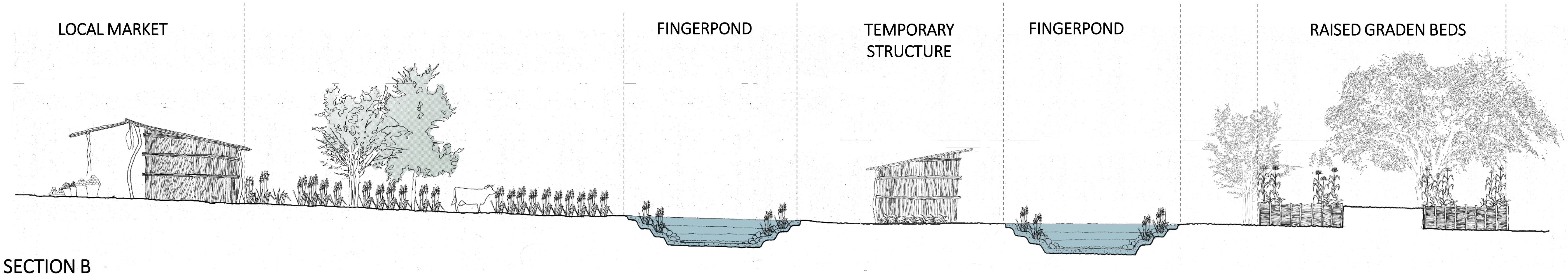


SECTION A
SCALE 1:50

SECTION & DETAIL



FINGERPOND EDGE DETAIL
SCALE 1:20



SECTION B
SCALE 1:50

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ETHICS APPLICATION FORM

Please Note:
Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form **before** collecting or analysing data. The objective of submitting this application *prior* to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the **EBE Ethics in Research Handbook** (available from the UCT EBE, Research Ethics website) prior to completing this application form: http://www.ebe.uct.ac.za/ebe/research/ethics1

APPLICANT'S DETAILS		
Name of principal researcher, student or external applicant		Nicola Chidyaonga
Department		Architecture and Planning
Preferred email address of applicant		chdnic005@myuct.ac.za
If Student	Your Degree: e.g., MSc, PhD, etc.	Master of Landscape Architecture
	Credit Value of Research: e.g., 60/120/180/360 etc.	120 credits
	Name of Supervisor (if supervised):	Clinton Hindes
If this is a researchcontract, indicate the source of funding/sponsorship		-
Project Title		Overflow: An approach to wetland restoration and community development in the lower shire valley of Malawi

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

APPLICATION BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	Nicola Chidyaonga		17/05/2022
SUPPORTED BY	Full name	Signature	Date
Supervisor (where applicable)	Clinton Hindes		23 05 22

APPROVED BY	Full name	Signature	Date
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section 1; and for all Undergraduate research (Including Honours).			
Chair: Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the questions in Section 1.	Prof. H. von Blottnitz		5 July 2022