a River Reborn

An explorative landscape architecture design focussed on restoring natural river dynamics for the Nile River Basin.

Hilde Huijboom

Msc thesis Landscape Architecture

a River Reborn: a landscape architecture approach for enhancing resilience in the Nile River basin

Keywords

landscape architecture, resilience, Nile River Basin, Nile delta, watershed, design

Author

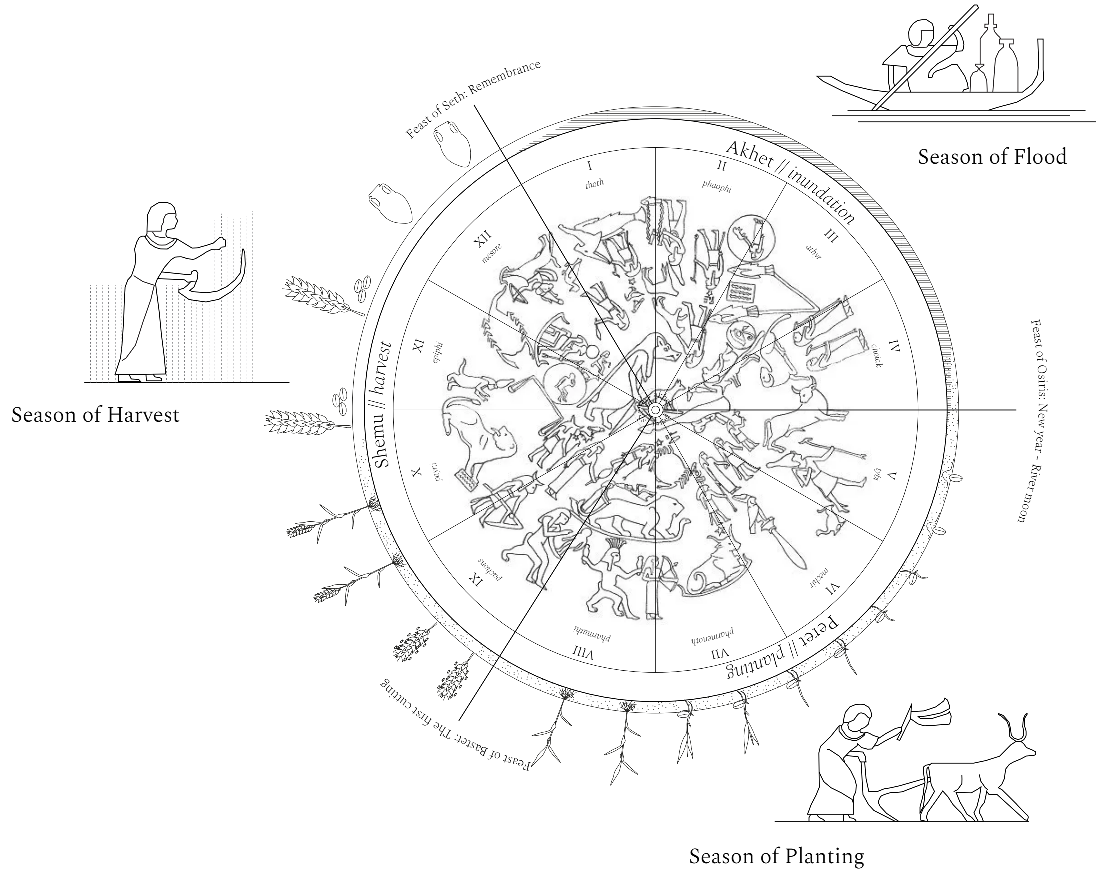
Hilde Huijboom
5485207

Landscape Architecture: Flowscapes

Resilient Coastal Landscapes

1st mentor: prof. dr. Steffen Nijhuis
2nd mentor: dr. Fransje Hooimeijer

Oktober 2023



For thousands of years, ancient Egypt was seen as "a gift of the river Nile". The natural dynamics of the river Nile organized the ancient Egyptian calendar. Dividing the year into three seasons, the season of inundation (Ahket), the season of growth (Peret), and the season of harvest (Shemu) (Abdou, 2022). To me, this represents the way humans have interacted with the processes of nature. It shows knowledge about the river and the balance between humans and nature.

*"As designers, our role is
to create new ground for a
positive engagement
with Nature"*

Julia Watson

Preface

This report is written in the context of the graduation studio Flowscapes, from the masters Landscape Architecture from the Technical University of Delft.

Ever since I first visited Africa, it has fascinated me. The rich heritage, the various landscapes, climates and the diverse cultures intrigue me. Choosing my graduation project, my vacation trip to the Nile in Egypt came to mind. The Nile as a life line through the arid landscape, the large contrast of the fertile line of water and green through the desert land of the Sahara Desert.

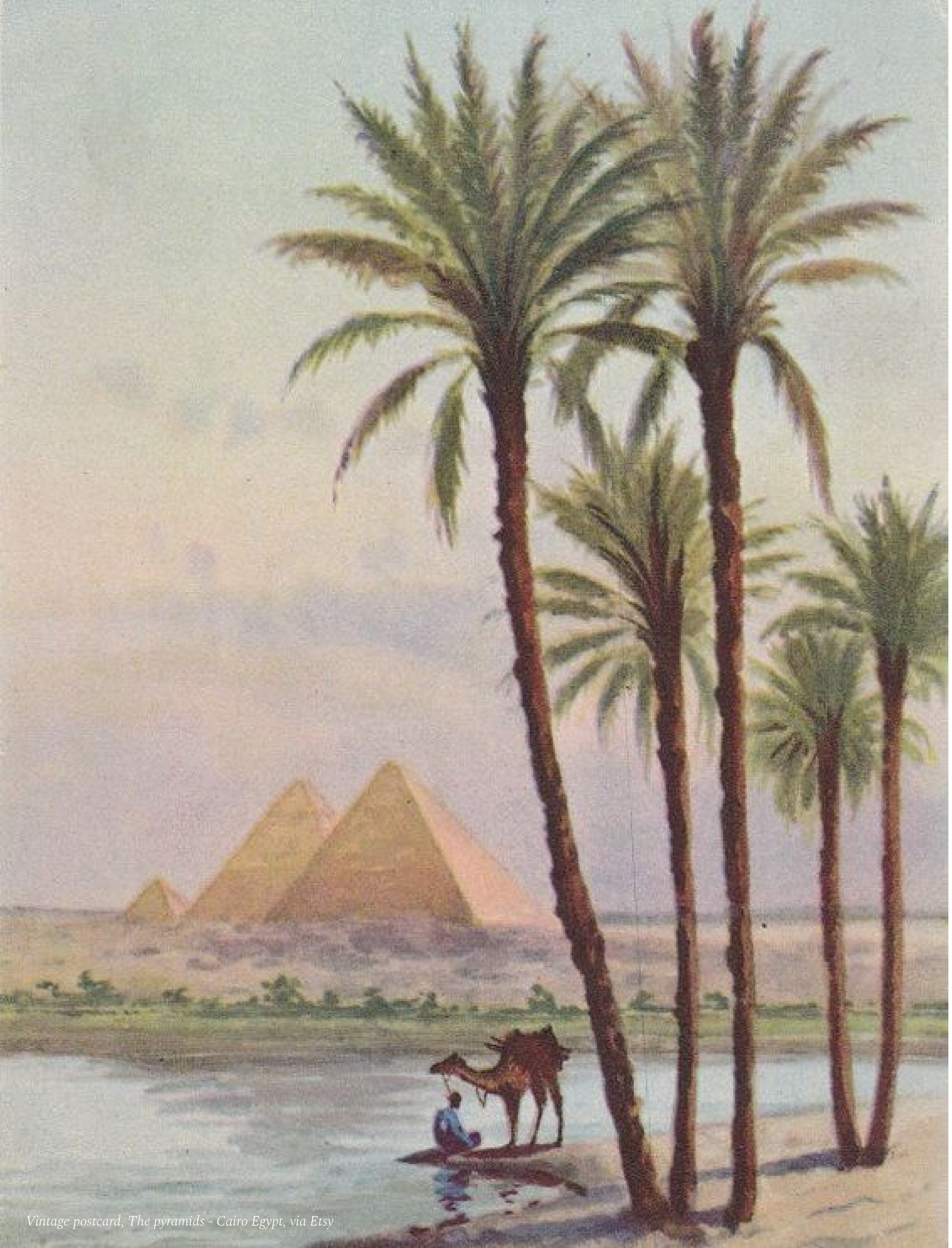
Acknowledgements

Firsly, I would like to thank my mentors Steffen Nijhuis and Fransje Hooimeijer. They have been guiding me throughout this project with great care, support and encouragement.

Thanks to my fellow students from the Landscape Architecture master for making this graduation process fun, for supporting each other, for inspiring me in my project and all the motivating words during our multiple coffee breaks.

I would like to thank my friends and family for being a huge emotional support to me throughout this process.

Contents



Vintage postcard, The pyramids - Cairo Egypt, via Etsy

1 *Introduction*

1.1 Location

Source: edited by presentor, data derived from Lehner, B., Grill G. (2013) HydroSheds

The Nile River Basin

The Nile River Basin is the catchment area of the Nile River. It covers almost 10% of Africa. The Nile is the longest river in the world, known as the "father" of African rivers. The river empties in the Mediterranean Sea after rising south of the equator and flowing into northern Africa. The River is formed by three main streams, the Blue Nile, The Atbara which originates in the Ethiopian highlands, and the White Nile, which headstreams flows into lake Victoria and Albert. The basin includes parts of Tanzania, Burundi, Rwanda, the Democratic Republic of the Congo, Kenya, Uganda, South Sudan, Ethiopia, Sudan and Egypt (Hopwood, et.al. , 2023).

Africa

Africa is the second-largest continent in the world, home to numerous natural wonders and diverse cultures. The Atlantic Ocean borders the continent on the west, the Medierranean Sea on the north, the Red Sea and the Indian Ocean on the east, and the waters of the Atlantic and Indian seas on the south. The climate of Africa is influenced by its location, topography and ocean currents. The Equator divides the continent roughly evenly in half, the majority of Africa is located in the tropical area, which includes high temperatures and high humidity levels. The northern and southern regions of the continent experience arid and semi-arid climates, with low rainfall and high temperatures (WorldAtlas, n.d.).

The Nile has played a significant role in shaping the history and development of the continent. The fertile banks of the Nile have provided the conditions for ancient civilizations to emmerge, such as Egypt and Nubia (History, n.d.).

Eleven counties of the Nile

The Nile flows through eleven countries, namely Burundi, Rwanda, Tanzania, Uganda, Kenya, the Democratic Republic of Congo, South Sudan, Sudan, Ethiopia, Eritrea, and Egypt (World Bank, 2018). Each of these countries has its own unique cultural and historical significance. The presence of the Nile has shaped diverse socio-economic and political dynamics in these countries (Tvedt, 2010).

River course

The Nile River flows from south to north, where it empties in the Mediterranean Sea. The Nile is formed by three main tributaries, The White Nile, fed by numerous streams and lakes from the Lake Plateau of East Africa, the Atbara river and the Blue Nile, both originating from the Ethiopian highlands.

White Nile

The White Nile originates in Lake Victoria, located in Tanzania, Uganda and Kenya. The river then flows northwards through Uganda and into the Sudd, a vast swamp in South Sudan. From there the White Nile flows northwards to Khartoum in Sudan, where it joins with the Blue Nile, forming the main Nile River. The White Nile is around 3.700 kilometers long and its watershed covers an area of around 1.1 million square kilometers (Hopwood, et.al. , 2023). The name White Nile comes from the colour of the water, created by the clay sediment that the water carries.

Blue Nile

The Blue Nile, also known as Al-Nil Al-Azraq in Arabic, and Aby in Amharic. The Blue Nile originates in Ethiopia at Lake Tana, at a height of 1800 meters above sea level. It is approximately 1.450 km long and travels from Ethopia through multiple rapids and drops into a gorge, a deep canyon, to Sudan where it meets the White Nile at Khartoum (Hopwood, et.al. , 2023). The Blue Nile floods cut off a substantial quantity of fertile soil from the Ethiopian Highlands during the summer monsoon season. It carries it downstream as silt, turning the water a dark brown or nearly black color. The Blue Nile is the largest tributary to the Nile and accounts for more than 85% of the Nile's streamflow, despite being shorter than the White Nile (Moustafa et.al., 2012). The River is a valuable resource for Egypt and Sudan. 59% of the water that enters Egypt originated from the Ethiopian highlands. In Sudan, the river is a valuable resource, where the Sennar and Roseires dams produce 80% of the nation's hydropower-generated electricity. Additionally, the Gezira Scheme is irrigated by these dams, which is used to produce high-quality cotton, wheat and animal feed crop production.

Atbara River

The Atbara River, alsno known as the Red Nile and / or the Black Nile rises in Ethiopia. It flows for about 805 km to the Nile in Sudan, joining it in Atbarah. The Atbarah River is a seasonal river, most of the year, it is a little stream. In the monsoon season the Atbarah rises 5 meters above its normal waterlevel. The Atbara River is the last tributary of the Nile before it reaches the Mediterranean Sea (Hopwood, et.al. , 2023).

Image by wirestock on Freepik

Gift of the Nile

The River Nile has been a lifeline for northeastern Africa for thousands of years, supporting the growth of civilization, agriculture, and trade. The history of the Nile can be traced back to ancient times. The fertile banks of the Nile has supported the civilization of the ancient Egyptians. Since Egypt received almost no rain, the ancient Egyptians worshiped the river and considered the water from the Nile as the source of life. The Greek historian Herodotus has written, "Egypt is the gift of the Nile". The ancient Egyptians developed ways to make perfect use of the gift of water, a complex system of irrigation to irrigate their fields to produce large amounts of crops to support the growing population. The Nile also played a crucial role in trading routes in the region, goods were transported to the Mediterranean Sea and then traded throughout the ancient world (Tvedt, 2022). During these ancient times, the relationship between people and the Nile was symbiotic. A harmonious balance between men and nature. In the 19th century, Europeans came to explore the Nile River. The Nile became political, and Europeans sought power to control the river's waters and the land surrounding the river. Nowadays, the Nile still plays a vital role in civilization in northeast Africa. Water is a vital resource for agriculture, industry and domestic use. However, the Nile is facing multiple threats, including pollution, climate change and overuse (Tvedt, T., Oestigaard, T., 2015).

“Misinterpretation of the present is the inevitable consequence of a lack of knowledge about the past”

Terje Tvedt

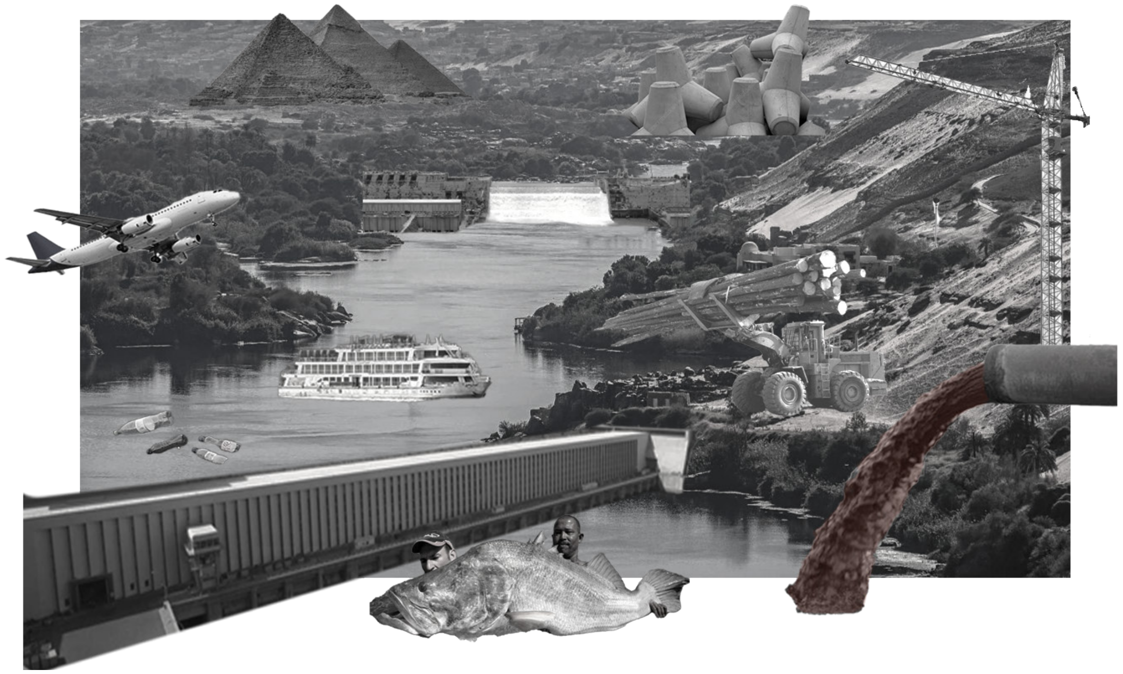
Symbiotic landscape

During ancient times, the relationship between humans and the Nile can be described as symbiotic. There was a codependence between humans and nature. The Nile River would flood annually, leaving a rich natural silt deposit, creating fertile ground along the banks of the river, and creating conditions to grow food and build civilizations.

Controlling landscape

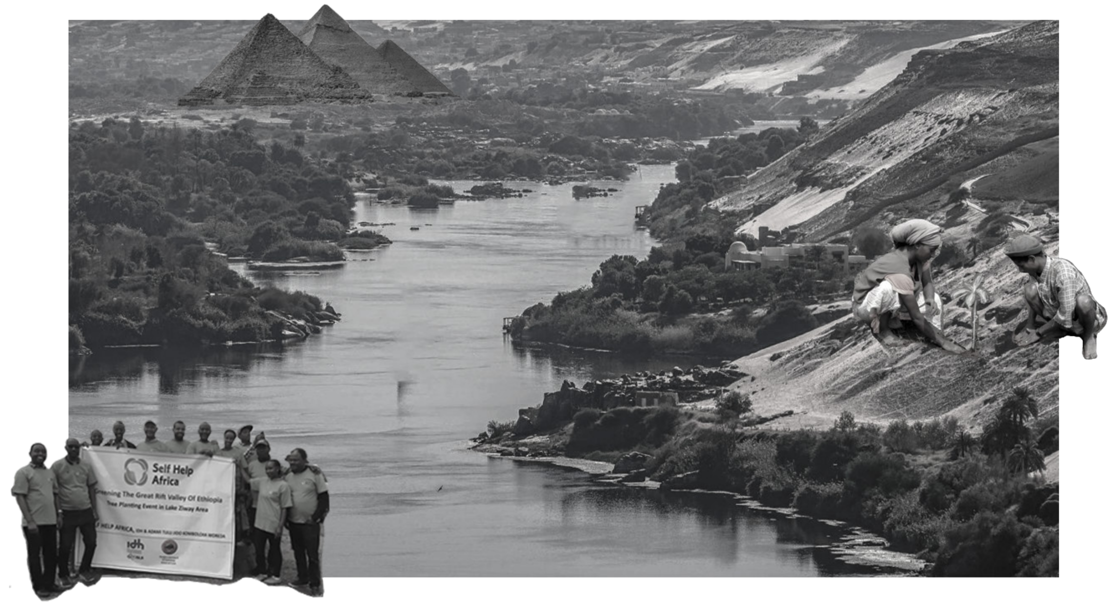
Extensive infrastructural works are arising in order to provide for the agricultural sector. Agricultural land is expended and canals are excavated. Dams are built to control the seasonal floods, changing from seasonal to perennial agriculture. The rhythm of the Nile changes and the dam influences the ecosystem of the river and surrounding landscape on all levels. Power battles are being fought to claim authority.

Commodifying landscape

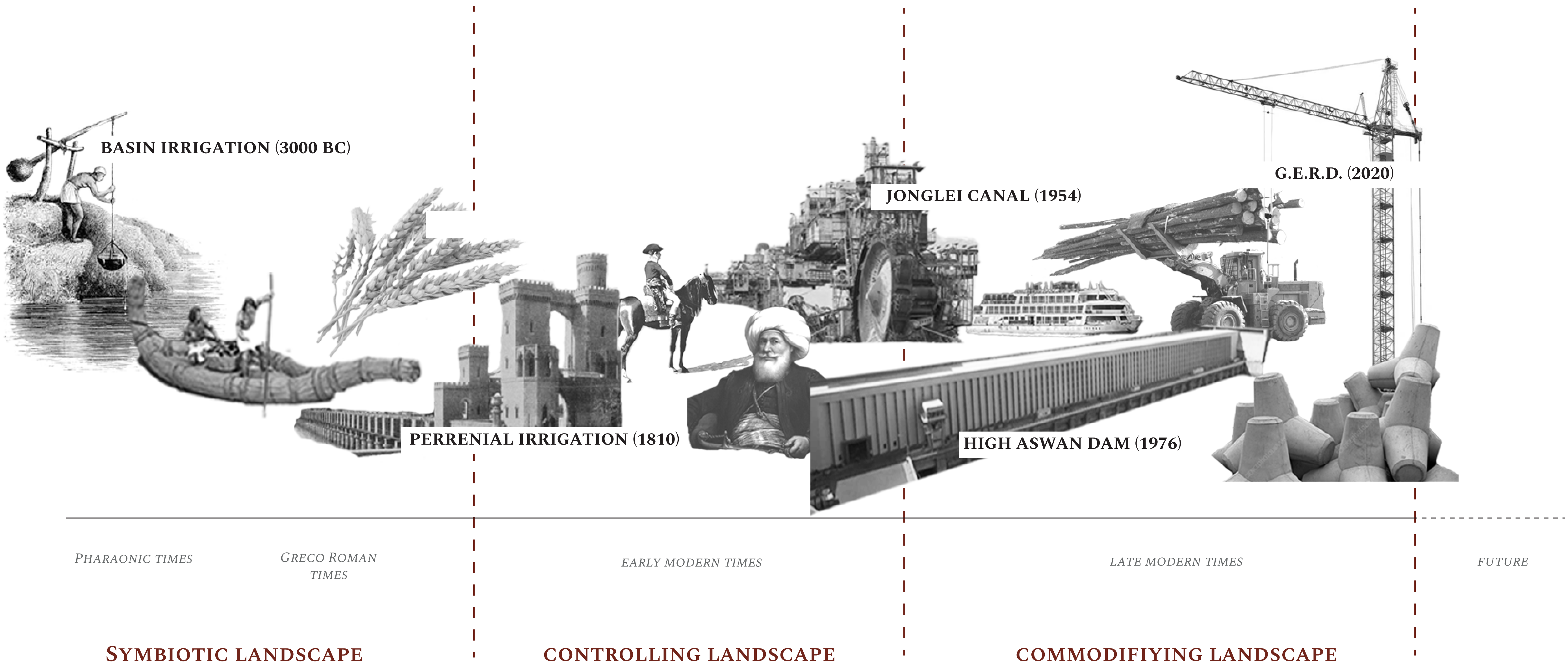


A steady increase in population and tourism has led the landscape to become more and more utilized. At a rapid pace, new developments and large constructions and projects are arising. The focus has shifted towards economic-based policies to provide for the demands of the population. Desert land reclamation is happening, the first desert cities are arising, creating livable land in unlivable natural conditions.

Adaptive landscape



Today, the Nile basin is facing an unprecedented array of challenges. These challenges are a reflection of the broader global challenges, stemming from climate change and unsustainable practices done by humans. In the years prior, the shifts in landscaping practices have been defined by technology, economy, and industrialization (Redeker, 2020). To face today's challenges, a more holistic approach is needed. A landscape-based shift of landscaping practices along the Nile can serve as a powerful example of an approach to our global challenges.


BASIN IRRIGATION (3000 BC)
PERRENIAL IRRIGATION (1810)
JONGLEI CANAL (1954)
HIGH ASWAN DAM (1976)
G.E.R.D. (2020)
PHARAONIC TIMES
GRECO ROMAN TIMES
EARLY MODERN TIMES
LATE MODERN TIMES
FUTURE
SYMBIOTIC LANDSCAPE
CONTROLLING LANDSCAPE
COMMODIFIYING LANDSCAPE

1.3 Problem statement

An uncertain future for many

The Nile is the home to millions of people, it flows through 11 countries in North-, East-Africa. The countries are heavily dependent on the water of the Nile as the main source of their livelihood.

For five thousand years, nature has dominated the river's constitution and functions, but from the mid-nineteenth century to today, different countries and regimes have increasingly influenced the Nile river system (Tvedt, 2021). Ambitious water management of big irrigation projects and the building of large dams has resulted in an imbalance in the relationship between the river, delta, sea, and people. The landscape of the Nile River Basin has changed from dynamic and natural, to a highly controlled and obstructed river.

Before the Nile was completely tamed in Egypt, the river had resisted erosion and subsidence in the delta from the sea for thousands of years. It carried nearly 200 million tonnes of soil and sediment annually. Sea currents and waves always tend to erode the coastline, before, the Nile water filled with sediment battled this coastal erosion. The Aswan Dam changed that natural battle between silt and sea overnight (Tvedt, 2021).

Upstream, countries are growing rapidly. The demand for food and space has resulted in deforestation around the sources of the Nile. As a consequence, deforestation has led the soil to erode. Dams are obstructing the flow of eroded soil and have been building up in the lakes. These places have become more prone to flooding.

A big part of the current landscape of the Nile River Basin consists of hard structures. The coast is currently defended by concrete, irrigation canals are hard concrete channels without vegetation and the large dams are massive structures obscuring the natural water flow. The landscape can currently be described as, non-resilient. It is a sturdy landscape, unable to move with change over time. Current measures are fixed and unable to move with future uncertainty.

The Nile River Basin has shifted from a nature-dominated river landscape into a human-dominated river landscape. The people living in the Nile River Basin may become victims of this disbalance. A transboundary strategy is needed in order to restore the balance of relationships. A landscape-based regional design approach is needed to employ a landscape approach in which social and ecological processes are the basis for spatial design exploration and solutions throughout the scales.

1.4 Research objective + questions

Research objective

This research explores the potentials of landscape-based design to bring back natural river processes to increase resilience of the Nile River Basin. Therefore the following research objective is formulated:

To explore a landscape architectural design approach and identify design principles that focus on restoring natural river dynamics in the Nile River Basin, while enhancing the ecological, socio-economic value, hydrological functioning and overall resilience of the basin.

The goal of this research is to conduct research through design. The research adopts a transboundary approach, disregarding political boundaries.

Research questions

In order to answer the main research objective, three sub-questions have been formulated. First, a basic understanding of the Nile River Basin landscape is needed. Secondly, an overview of possible (design) principles is conducted. After that, the principles are translated into a site-specific design.

Understanding | Q1

The first research question aims to result in a complete analysis of the Nile River Basin.

How to understand the current Nile River basin from a landscape perspective and what challenges and potentials belong to the current natural and cultural condition of the river and basin?

Solutions | Q2

The goal of the second research question is to conduct an overview of possible solutions and principles to ennhance resilience in the Nile River basin.

What specific landscape architecture strategies and (design)principles, aligned with the watershed approach and focused on the natural river system and processes, can be employed to enhance overall resilience in the Nile River Basin?

Design | Q3

The third research question focuses on the implementation of the results from research question 2.

How can landscape architecture design be implemented on a local scale on three locations; upstream, midstream and downstream of the River Nile, evaluating the interconnection and influence of the designs based on their place within the river system?

Methodology

A variety of methods will be used to answer the research questions and subquestions. Spatial analysis techniques such as mapping, GIS data collection and satellite image analysis. Rigorous literature review, study of insightful exemplar projects and research-by-design approaches.

Research structure

A literature review will be carried out to guide and structure the research. The existing literature informs and guides my research. The theoretical framework is based on the literature review, it helps to set the context for the research. The methods and methodologies used in previous studies inform possible research methods for this research. In short, the theory helps to build a solid foundation for the research by providing guidelines for a structured design project.

RQ1 // understanding

The first research question is to gain an understanding of the Nile River Basin and the river system in general. A literature review will be carried out to answer this question. In addition, the Nile River Basin will be mapped to gain a full understanding of the different components in the landscape of the basin. GIS data will be used to map the area. Where data is not available, extensive analysis of satellite imagery from Google Earth and photographic data will be used to provide a complete overview.

RQ2 // solutions

The second research question aims to provide an overview of possible strategies and (design) principles to work towards a resilient Nile River Basin. The literature review plays an important role in answering this research question. In addition, case studies will be analysed.

RQ3 // design

The third research question focuses on the implementation of the results of research questions 1 and 2 in a situated design. Three design sites will be selected based on the theoretical framework previously established. The three sites are first analysed in more detail using mapping techniques, satellite image analysis and literature review. In addition, local problems and potentials will be explored through a literature review and the study of case studies. Once a complete overview of the local context has been established, it is time to implement the landscape architectural design. This is done through research by design. This approach combines creative design thinking and research. It helps to understand the existing situation while actively creating and testing new concepts and designs.

Expected outcomes

RQ1 // understanding

The expected outcomes of research question 1 are an in-depth exploration and review of textual and graphic materials relating to the river system in general and to the Nile River and its basin. It aims to facilitate an understanding of the hydrological, natural, ecological and historical condition of the river and basin.

RQ2 // solutions

The second research question aims to provide an overview of potential strategies and principles for increasing the resilience of the Nile Basin. The review will include an analysis of examples, theories, historical reviews and philosophical perspectives. By drawing on historical practices, the lessons of the past can contribute to the success of the present and future. The findings are summarised in strategies with associated design principles.

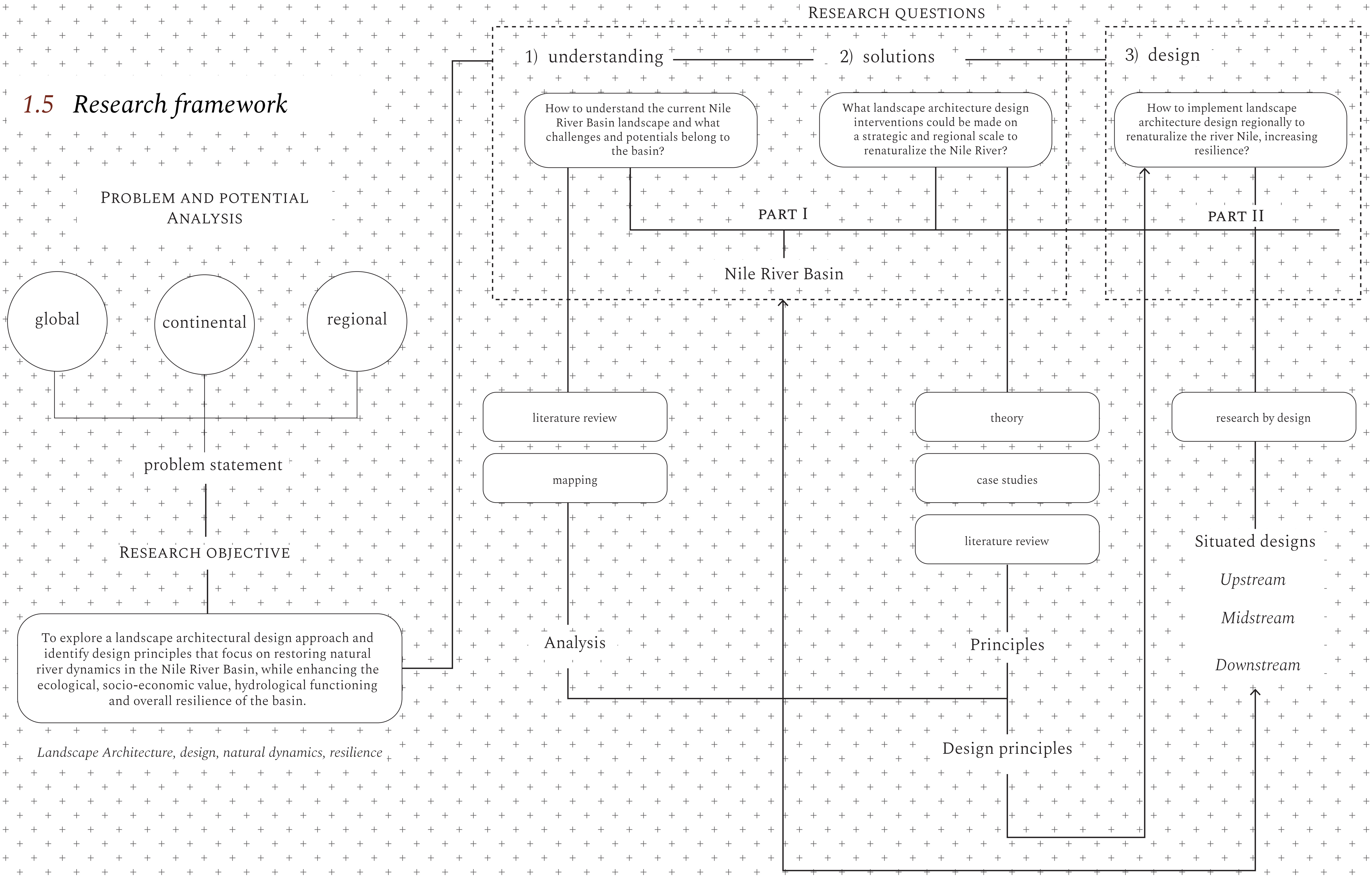
RQ3 // design

Research leads to the practical application of results from previous research questions. This part of the research will produce three situated landscape architecture designs, each strategically located along the Nile River system, encompassing the upstream, midstream and downstream regions. The designs will be based on the principles derived in research question 2.

The designs will be explained textually and graphically. Each site will include a detailed site-specific analysis of the context, local problems and potentials. The designs will be explained graphically in multi-scale plans, sections and visualisations.

By implementing these landscape architectural designs at various scales along the Nile River system, the research aims to illustrate the practical feasibility of the strategy and principles outlined above. The designs will serve as examples of how to increase resilience for their specific location and for the Nile River Basin as a whole.

1.5 Research framework



1.6 *Relevance*

Social relevance

In my graduation project, I want to design based on the natural system. The Nile flows through 11 counties and is highly conflict-sensitive. With my graduation project, I want to show that there should be a transboundary approach with the landscape as the basis. Besides that, millions of people are dependent on the water and land of the Nile. My graduation project includes the importance of the relationship between the land and water of the Nile to the people that are depending on it. Currently, many of the inhabitants are facing challenges. With my graduation project, I want to show that there is hope for a better future where the landscape is resilient to current and future challenges. In my work, I am learning from the past, including the site-specific cultural past.

Professional relevance

My graduation work relates to the professional framework of landscape architecture because it uses a landscape-first approach in order to make conscious design choices. It shows how landscape and landscape processes can form the basis of solutions. I believe that my work can contribute to the professional field of Landscape Architecture by showing an approach on how to deal with these types of challenges.

Scientific relevance

In terms of the scientific framework, I believe that my graduation work can contribute to the knowledge about the Nile River Basin. Even though a lot of research has been done about the Nile, I can add a landscape architecture approach to this. Using the knowledge there is about the Nile in order to design this landscape.

1.7 *Reading guide*

Research methodology

First of, this research will be introced by a theoretical framework, explaining the main theories that guide the research. After this, the research approach is explained. The river system is used as a way to structure the research. The theoretical framework and the research approach together form the research methodology.

Part I // The Nile River Basin

The results of the research are divided into two parts. The first part is focused on the Nile River Basin. It mainly seeks the answers to research question 1, which is about the understanding of the Nile River landscape, and to research question 2, which is mainly about conducting an overview of strategies and design principles to work towards a resilient Nile River Basin.

Both of these chapters are connecting to the large scale of the whole basin.

Part II // up-mid-down

The second part of the results is showing the explorative site specific designs. There are three designs, correlating to the river system, upstream, midstream and downstream of the river Nile. For all designs a small complementary analysis is done, explaining local challenges the site is facing and for each location a site specific overview of potentials and principles are conducted. Then the site specific local designs are explained through text and graphic material.

Conclusion and discussion

At the end, the results are concluded by answering the research questions and the main research objective. This is followed by a discussion. Ending this report is the reflection, where the project, the process and the results are reflected on.

At the very end, the reader can find the bibliography and a glossary.

Painting: "Bathing in the river" Adam Styka (1890-1959)

2 *Research methodology*

2.1 Theoretical framework

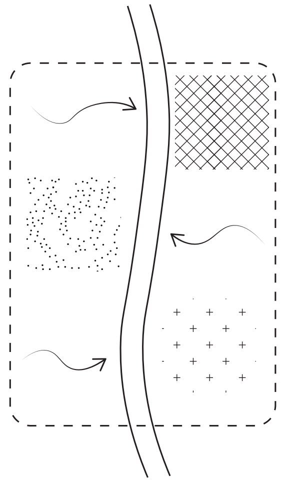
Three main theories are followed to conduct this research. The watershed approach, resilience theory and the landscape based approach help to structure the research and understand the structure and relationship within the Nile River Basin.

Watershed approach

The watershed approach is a systematic approach. It is based on the concept of a watershed, which refers to the area of land that drains water into a common outlet, such as a river, lake, or ocean. The watershed includes all land, vegetation and waterbodies and is identified based on boundaries, typically defined by topography or landforms that direct the flow of water.

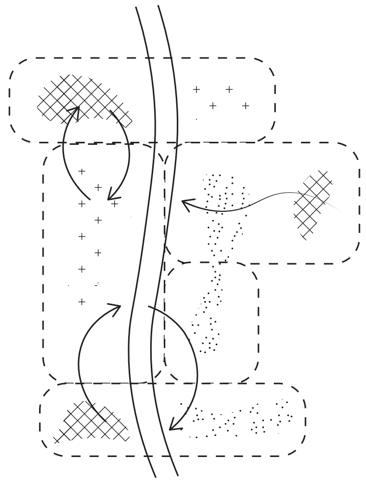
The watershed approach recognizes the interconnection and influence within a specific watershed, meaning that action taken at one scale or place within the watershed has consequences on another scale or place within the watershed and vice versa (Hooimeijer, F.L., et. al., 2021).

The watershed approach recognizes that land use practices, for example, agriculture, forestry, urbanization and industry have effect on the water quality, quantity and the overall health of the ecosystem. The watershed approach aims to improve sustainable management and protection of the watershed and the related ecosystems by taking into account the connections between land and water systems, including stakeholders, and using adaptive management practices. Collaboration between all stakeholders involved is desirable for effective watershed management.



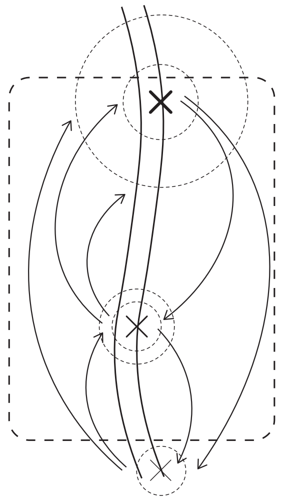
1) the watershed

the watershed includes all land, vegetation and waterbodies.



2) interconnected systems

various components within a watershed are interconnected and influence eachoter, e.g. water, groundwater, soil, vegetation, wildlife, human activity.



3) changes in watershed effect

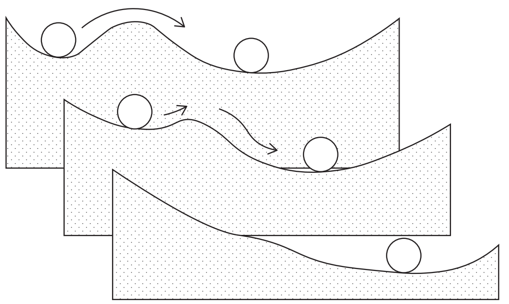
changes in one part of the watershed can have effect on other components.

Resilience theory

The resilience theory forms a strategy that emphasizes the necessity of maintaining options, viewing events from a regional rather than local perspective, and emphasizing heterogeneity. The resilience theory is based on the attitude of assuming future occurrences are unexpected. In 1973, C.S. Holling defined ecological resilience as the amount of disturbance that an ecosysstem could withstand without changing the stable states.

Working with a resilience framework accommodates the ability to design systems that can absorb and accommodate future changes in whatever form they may take, rather than the ability to predict the future precisely. This would mean that instead of assuming you have enough information, you would have to acknowledge the ignorance (Holling, 1973).

In relation to landscape architecture, the resilience theory emphasizes the importance of creating conditions that can withstand and respond to change, while also providing a range of benefits to humans and the environment. The resilience theory views the landscape as a dynamic and complex system with adaptive capacities. The role of the landscape architect is to understand and work with natural processes to develop designs that promote resilience.



Resilience and adaptive capacity

The ball represents the system, the arrow represents the disturbances. The valleys represent the domains. Based on Gunderson, L. H., (2000).

Landscape based urbanism

The landscape-based approach refers to the methodology that emphasizes that the landscape is a complex system of natural and human-made elements that shape the built environment. The landscape-based approach uses the landscape as the basic condition, including physical features, ecosystems, cultural artifacts, and social structures, to guide and shape changes in a particular region or place. The analysis of the specific context of a landscape is an important aspect of the approach, revealing the characters and dynamics of the landscape and how it influences the current state. Mapping and drawing are usefull ways to communicate and represent visual thinking. The landscape-based approach includes a holistic perspective, considering the landscape as a whole, integrating all dimensions and the interconnectedness and interdependence of the different components within a landscape (Nijhuis, S. 2019).

Main take-away

The watershed approach, resilience theory and landscape-based urbanism are all valuable theories and approaches to help structure the research and design work.

The watershed approach helps to understand natural systems, emphasising the interconnectedness within watersheds. The watershed approach also helps to structure the research by recognising that the three design sites are based on their placement within the river system and how they are connected to each other.

Resilience theory teaches how to create systems and designs that can adapt and recover from disturbance. It expresses the method of creating conditions rather than designing a fixed landscape.

Integration of landscape-based urbanism promotes the integration of natural systems and green spaces into urban environments. Designing a multi-functional landscape that involves long-term planning and vision.

Integrating these approaches into research and design leads to design that is not only aesthetically pleasing but also sustainable, resilient and responsive.

2.2 Research approach

River system

To structure this research, the river system and natural processes are used as a method. No river on earth is the same, each river is unique and is shaped by its site-specific topography, climates, and geology. Regardless, there are a couple of general principles of a river system that apply to most rivers in the world. First of all, water flows from high to low. Generally speaking, the river system can be divided into upstream, midstream, and downstream. Based on this, the three design locations are chosen.

Upstream

The upstream section of a river system refers to the part of the river that is closer to its source, where the river originates. Upstream areas are typically found at higher elevations, often in mountainous regions. In the upstream area, the gradient is usually steep, causing the water to flow with great force. This can result in rapids and waterfalls. Since the water is flowing with rapid force, there is usually less sediment in the upstream section. The channel of the course is mostly narrow since the river has not had the time to widen its path (Prominski, et. al., 2012).

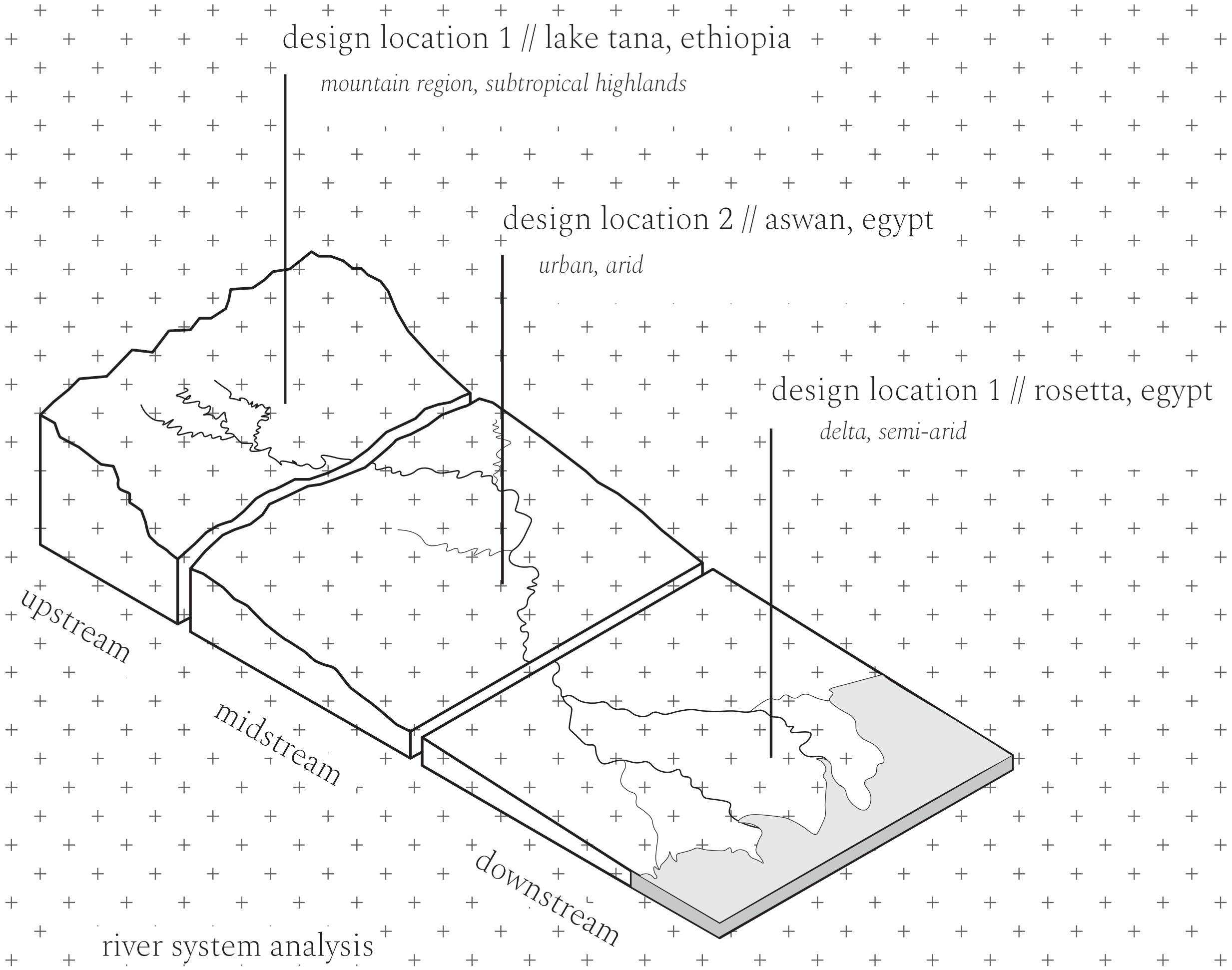
Midstream

The midstream section of a river system represents the transitional zone as the river progresses from its source toward its mouth. The gradient in the midstream section is less steep compared to the upstream, resulting in a decrease in speed. As the river flows downstream, it tends to widen its channel due to a decrease in slope and an increase in water volume from various tributaries. The river has more time to erode and pick up sediment as it flows through the midstream section, resulting in a higher sediment load compared to the upstream section of a river. The midstream section may have more human settlements, agriculture, and industrial activities compared to the upstream, but it might still be less densely populated than downstream areas. (Hopwood, et.al. , 2023).

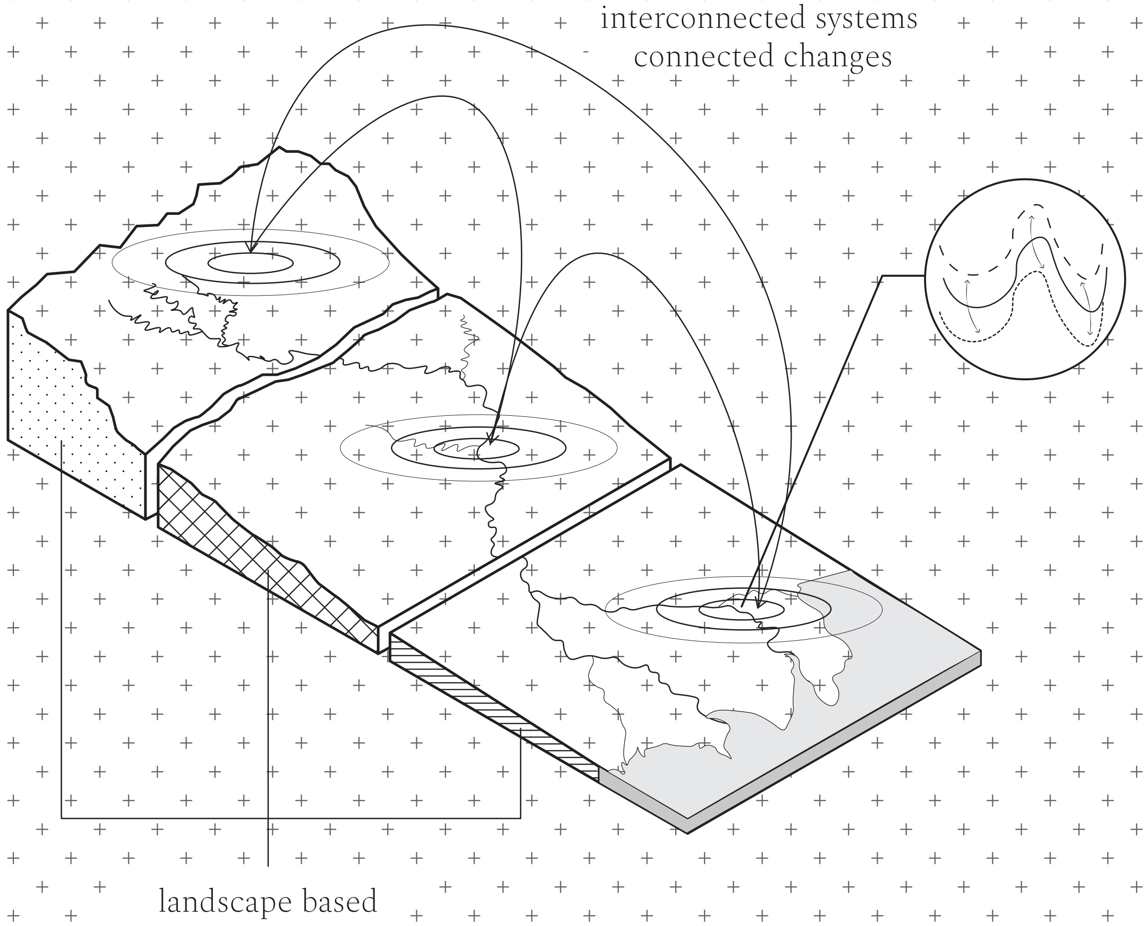
Downstream

The downstream section of a river system is the part that is closer to the river's mouth, where it meets a larger body of water like an ocean, sea, or lake. The gradient in the downstream section is usually very gentle, leading to slower water flow and decreased erosive power. Downstream channels are often at their widest due to the accumulated water volume and sediment deposition. The river has less energy to carry sediment, so deposition becomes more prominent. This contributes to the formation of features like floodplains, alluvial fans, and deltas. Downstream areas are often more densely populated and developed due to the availability of water and fertile land for agriculture (Prominski, et. al., 2012).

RIVER SYSTEM



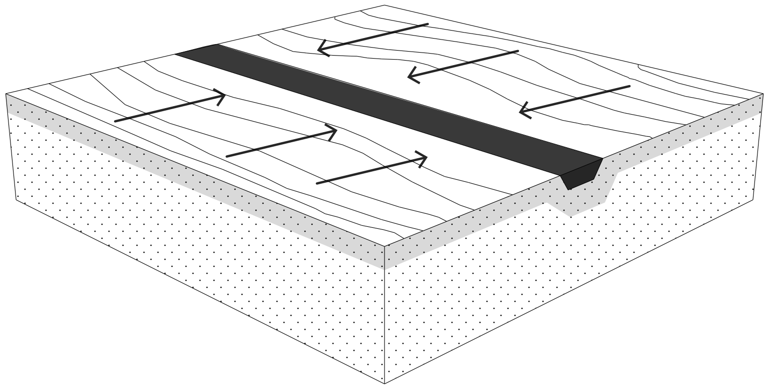
THEORY



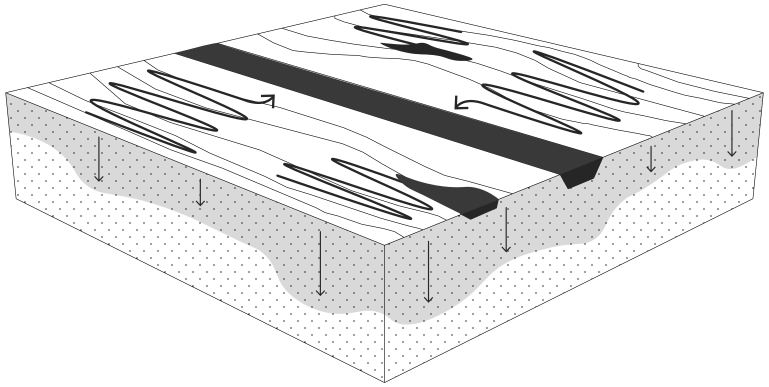
2.3 *To restore the flow*

Slow the flow

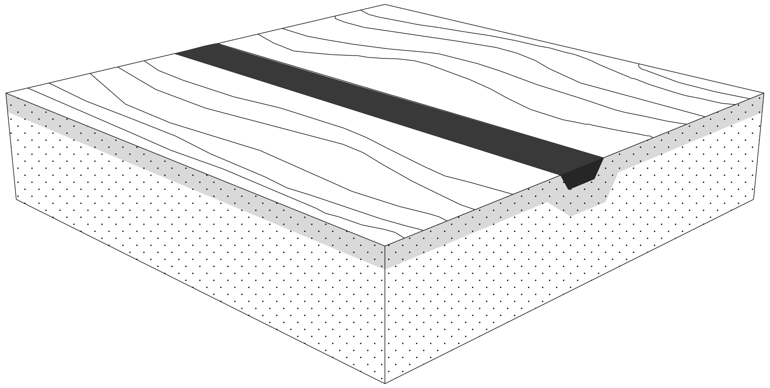
The first principle, 'Slow the flow', is a fundamental concept in restoring a healthy river system. By implementing measures to slow the flow of water during the wet season, the strategy involves the careful capture and retention of water, allowing it to be stored for future use. This not only reduces the risk of downstream flooding, but also provides a valuable water supply during the dry season. This seasonal approach acts as a lifeline for both the river system and the surrounding ecosystems, helping to maintain a steady flow of water even during periods of water scarcity. Slowing the flow allows water to percolate gently into the ground, reducing the risk of downstream flooding and recharging underground aquifers. This approach also reduces soil erosion, a major contributor to river pollution, and promotes the conservation of valuable soil and water resources. By embracing this principle, we can mitigate the harmful effects of rapid water flow and promote a more resilient and thriving river ecosystem.



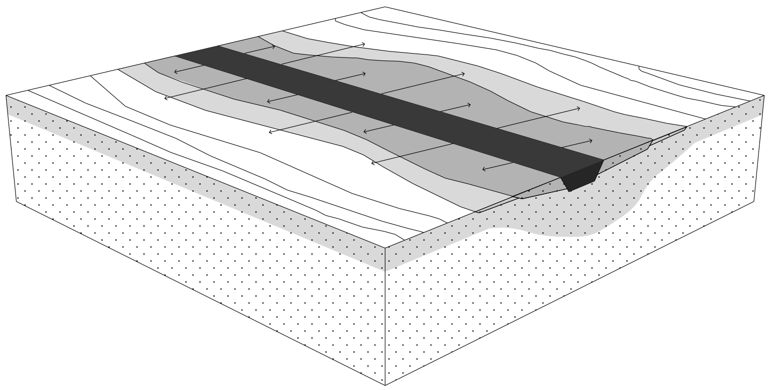
before



after



before



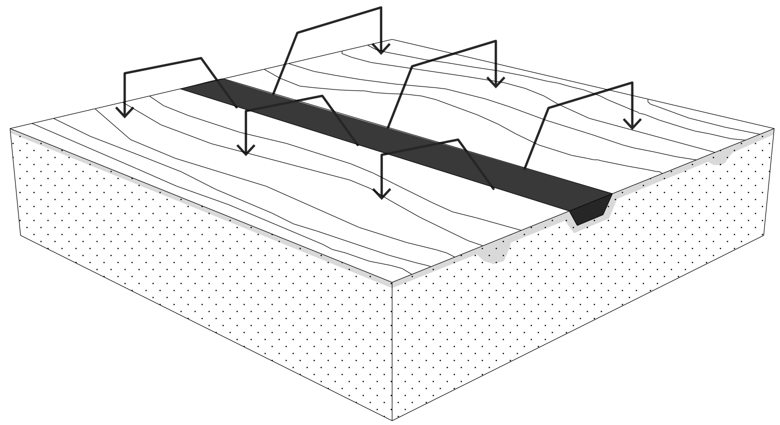
after

Allow the flow

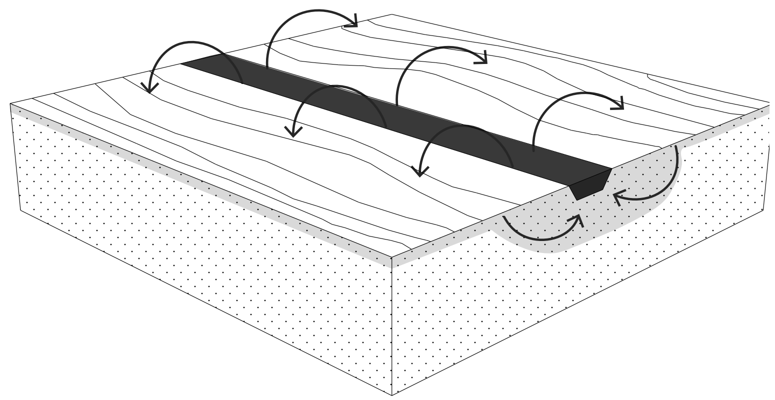
The second principle, 'allow the flow', is a key element in the restoration of river systems. This principle emphasises the importance of allowing natural fluctuations in water levels. By redesigning the landscape to accommodate these seasonal changes, we make it more receptive to the rise and fall of water, creating a dynamic and adaptable environment that increases overall resilience. Allowing the flow means embracing the inherent variability of river systems, recognising that they are not static entities but living ecosystems that depend on the natural tides of water. This approach encourages a more harmonious coexistence with the river's natural rhythm, promoting a healthier and more sustainable ecosystem, while reducing the impact of extreme events such as floods or droughts on surrounding communities. In essence, "allow the flow" promotes the restoration of a river system that can thrive in an ever-changing world.

Balance the flow

The third principle, ‘balance the flow’, plays a key role in restoring the health of river systems. This principle focuses on achieving a balance in the flow of water, with a strong emphasis on creating circular water cycles. It goes beyond the concept of simply ‘taking’ from the river and emphasises the importance of giving back to the natural system. The idea is to use natural resources in a responsible and sustainable way, ensuring that the ecosystem is not only maintained, but enhanced. “Balance the flow” seeks to establish a two-way relationship with the river, emphasising the mutual benefits of conservation. It’s about using the river’s resources while adding value to the environment, whether through improved water quality, increased biodiversity or a more stable and resilient ecosystem. This principle embodies a holistic approach to river restoration, emphasising the need for a harmonious coexistence between human activities and the river’s natural processes, ultimately contributing to the well-being of both.



before



after

Part I

The Nile River Basin

an understanding of the Nile River basin and establishing principles for a strategic approach towards a resilient Nile River Basin.

Source: Carlos de Haes, Public domain, via Wikimedia Commons

3 *Understanding*

“No man ever steps in the same river twice, for it’s not the same river and he’s not the same man.”

Heraclitus

Introduction 3.1

To understand

The ‘Understanding’ chapter explains the river systems, processes and landscapes shaped by the river. This basic knowledge is the foundation upon which the exploration of the Nile and its basin is built. The Nile River Basin is one of the largest in the world, resulting in a great diversity of landscapes. The physiography of the basin is thoroughly analysed. A structural map provides an overview and summarises the findings. In addition, the challenges and potentials are summarised in a map as a starting point for understanding the problems.

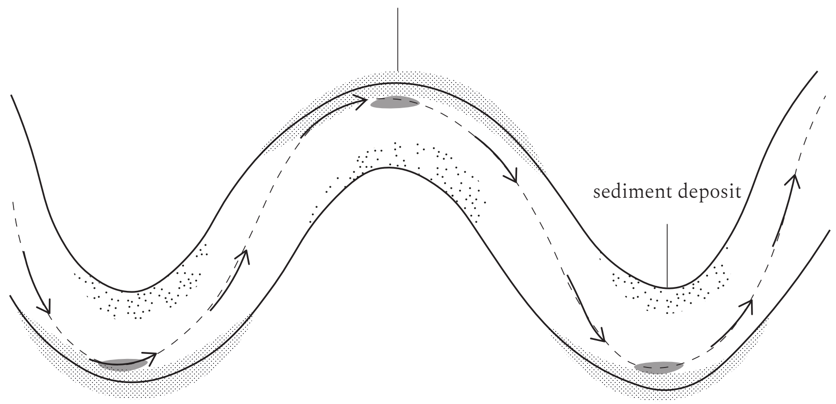
3.1 The River

River processes

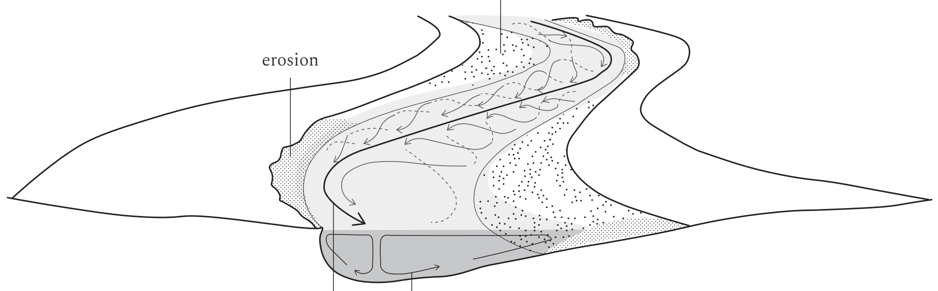
A river and processes can never be regarded as separate. water is dynamic, it has movement, it is a process.

The river's dynamic can be difficult to comprehend upon first observation. Short observations include the river's currents and eddies as well as the noticeable fluctuations in water level. Longer observations show that the entire river is in a constant state of advancement and continuous change, shaping the surrounding landscapes.

The sun is the source of these river processes, as water evaporates and rises to heights where it condenses and turns into rain or snow. When rain falls and flows downhill, energy can be unleashed. Water comes into contact with earth or rock, and the energy of water can erode materials and shape the terrain. The flowing water carries the materials downstream. Through erosion and sedimentation, rivers continually shape the landscape, wearing down high lying landscapes and raising the lower-lying river landscapes by erosion and sedimentation (Prominski, et. al., 2012).



Erosion and sedimetation processes causing a meandering river, figure edited by author, derived from Martin Prominski, Antje Stokman, Daniel Stimberg, Hinnerk Voermanek, & Susanne Zeller. (2012). River.Space.Design : Planning Strategies, Methods and Projects for Urban Rivers. Birkhäuser.



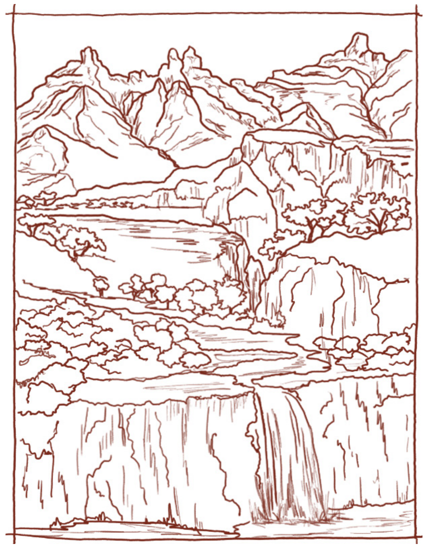
Morphodynamic processes, figure edited by author, derived from Martin Prominski, Antje Stokman, Daniel Stimberg, Hinnerk Voermanek, & Susanne Zeller. (2012). River.Space.Design : Planning Strategies, Methods and Projects for Urban Rivers. Birkhäuser.

River landscapes

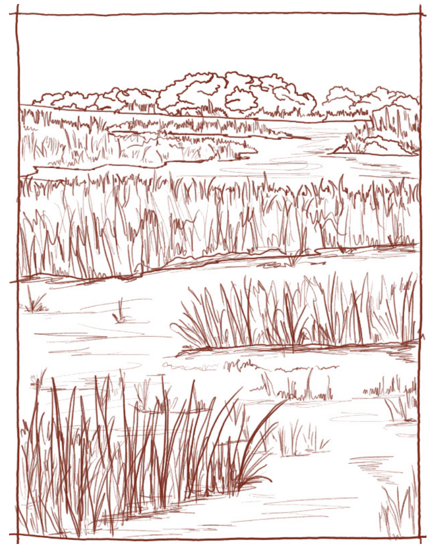
Each river forms the surrounding landscape in diverse ways. Through erosion and sedimentation processes, different river landscapes are formed. On the other hand, the landscapes influence the shape of the river course, creating ecosystems and habitats. The river forms the land caused by an interplay of topography, geology, climatic conditions and the erosive and accumalative activity of the current. The relation to the geology of the local substratum and discharge dynamics.

Generally, the river landscape can be divided into several landscape types: mountains, wetlands, rivers, deltas and coastal landscapes. Mountains are elevated landforms with slopes and peaks, often the source or headwaters of a river, providing freshwater supply through rainfall and snowmelt that feed the streams. Wetlands refer to low-lying areas where the water table is at or near the surface. The middle section of a river is the course that runs between the headwaters and the downstream section. The middle river landscape can take on different forms, but it usually has a moderate flow and a more stable riverbed compared to the upstream regions. The river may meander here and pass through canyons. The delta is the landform at the mouth of a river where it meets other water, such as a sea, ocean or large lake. The river flow slows down, dropping its sediment load and gradually expanding the landform. The coastal landscape is the location where a river meets the sea or ocean. This is where freshwater and saltwater mix, resulting in a diverse environment. The coastal landform is created by various processes, such as waves, tides, and coastal erosion ((Hopwood, et.al. , 2023).

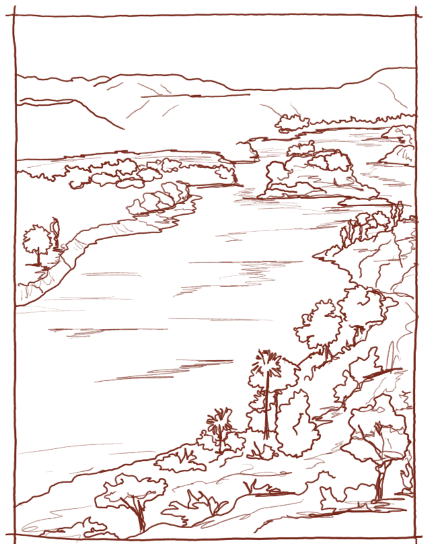
Mountains



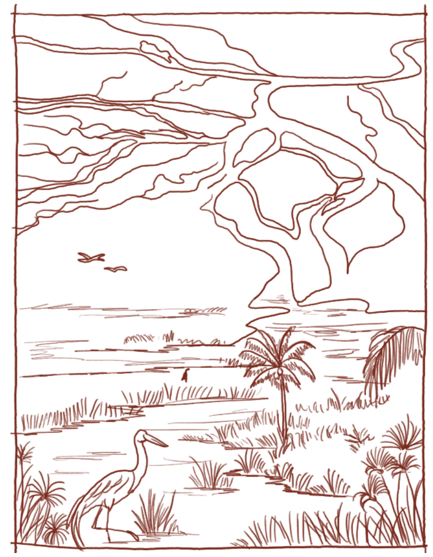
Wetlands



River



Delta/Coast

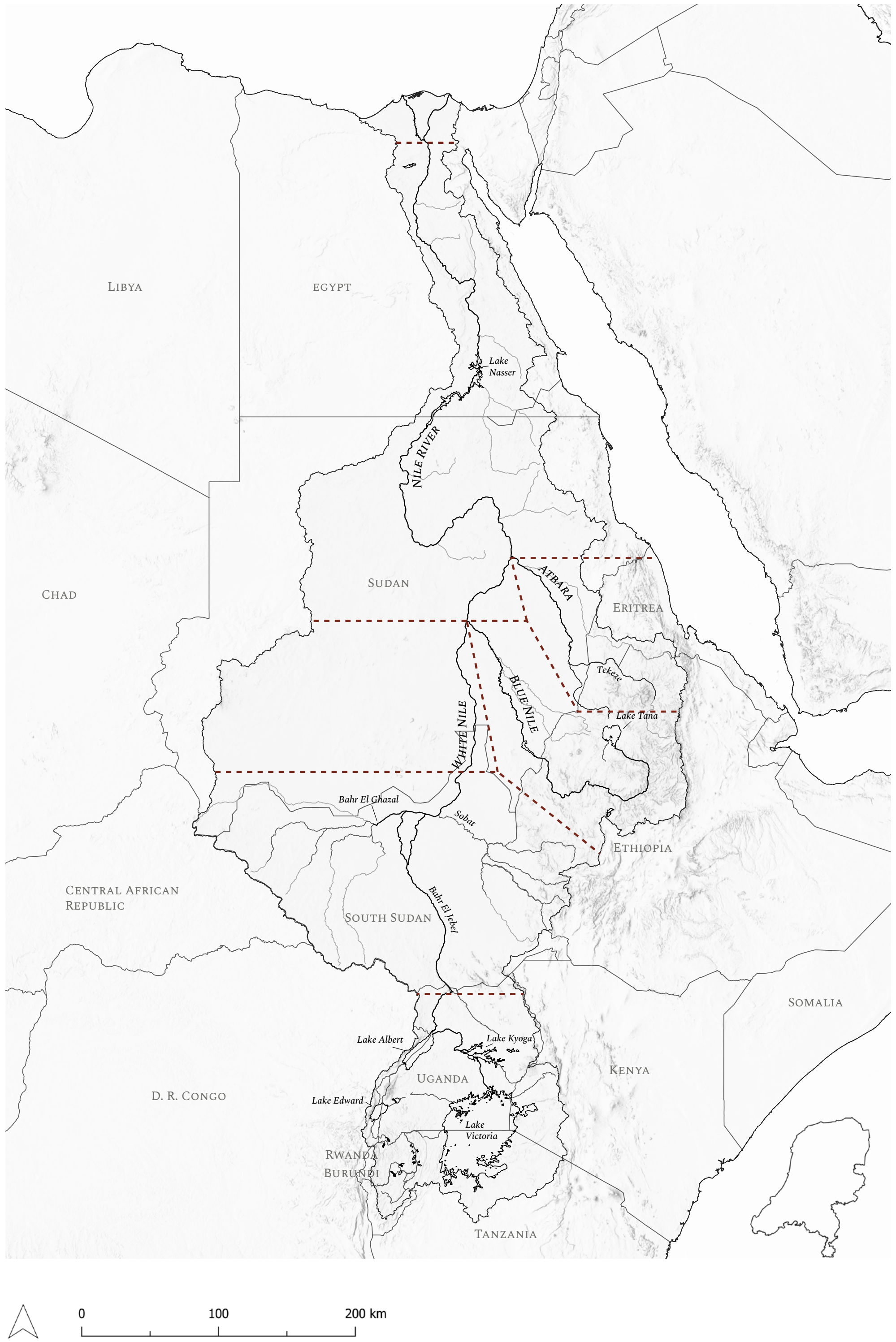


3.2 *The River Nile*

Diverse Nile

Partly due to its length (the longest worldwide), the Nile River basin is rich in diversity. The Nile basin has unique combinations of surface, slope, soils, topography, and vegetation, creating an extensive diversity in different physiographic regions. The interrelationship and interdependence of different natural and human-made components create patterns within the landscape (Nile Basin Innitiative, n.d.).

The basin can be divided into seven major regions with it's own landscape characteristics: the Lake Plateau of East Africa, the Al-Jabal, the White Nile, the Blue Nile, the Atbara, the Nile north of Khartoum in Sudan and Egypt, and the Nile delta (Hopwood, et.al. , 2023).



Physiography

Topography (a)

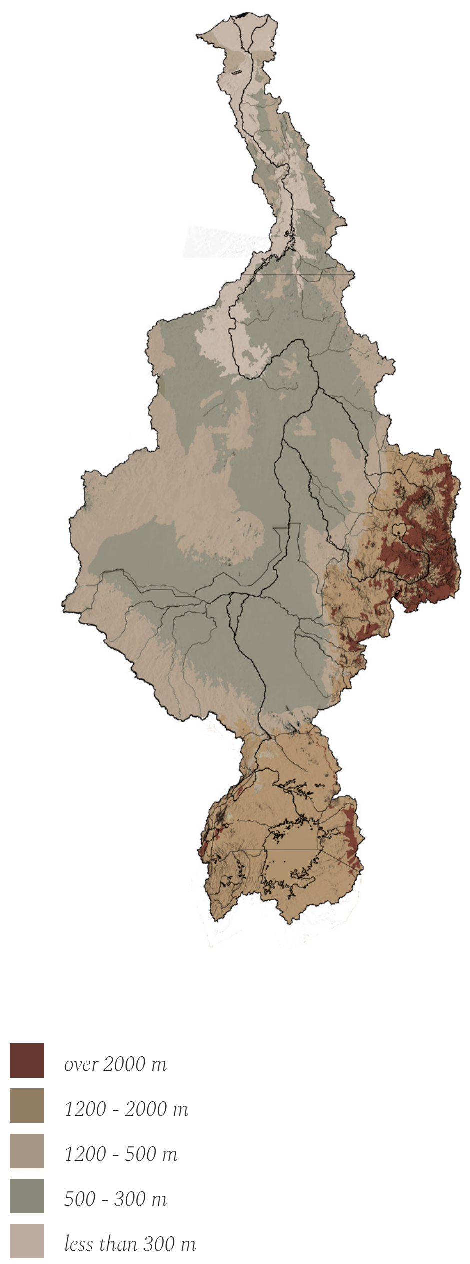
The highest parts of the basin have steep slopes and a rugged landscape. Large plateau areas are found along the middle parts of the basin, while broad floodplains extend from the lower parts to the delta (Nile Basin Water Resources Atlas, 2016).

Slope range (b)

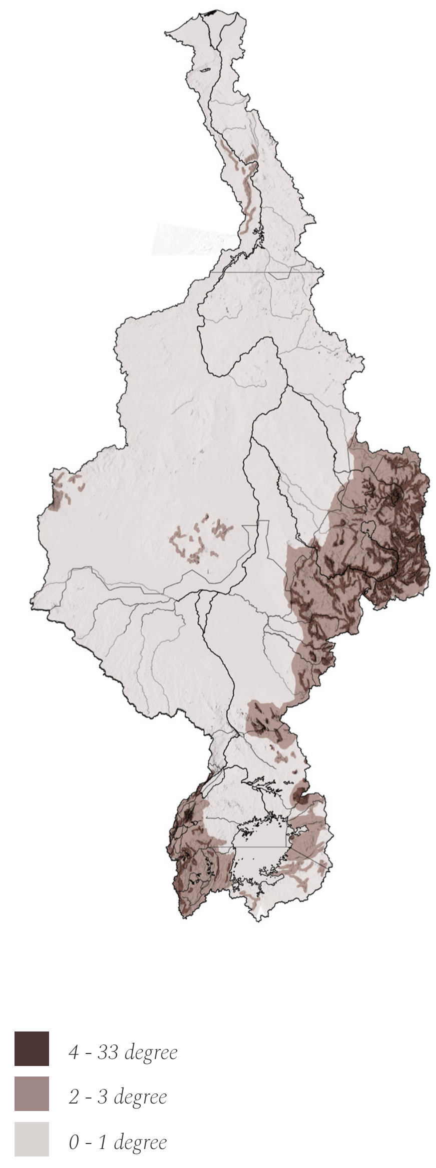
One of the most important elements affecting soil erosion by surface runoff is the slope. The basin has a slope that ranges from 0 to 33 degrees. Compared to the rivers that originate in the Equatorial Lakes region, most of the rivers in the Eastern Nile have a much steeper slope in their upper reaches. As in the case of rivers originating in the Ethiopian highlands, the rivers have large energy gradients in their steep-slope sections and can transport high sediment loads. The Victoria Nile, Albert Nile and Bahr El-Jebel rivers, which originate in the Equatorial Lakes region, have disruptions in the slope of the riverbed where the river passes through lakes and swamps (Nile Basin Water Resources Atlas, 2016).

>>
a) topography, b) slope range, Nile Basin Water Resources Atlas, 2016).

(a)



(b)



Geology (c)

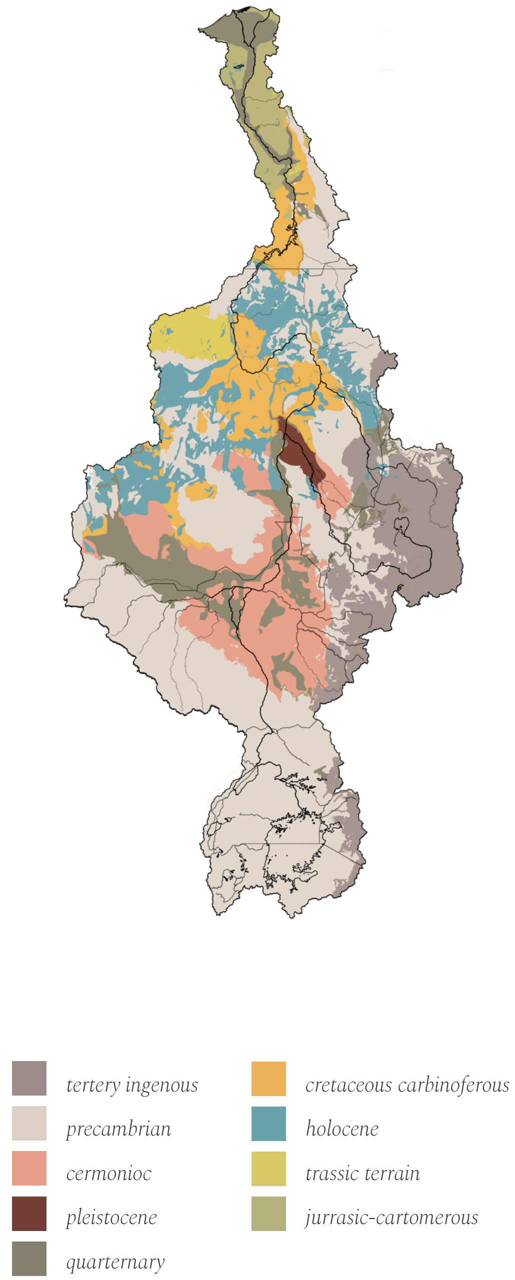
The geology of the Nile River Basin is a complex interplay of ancient Precambrian basement rocks, tectonic activity associated with the East African Rift System, volcanic processes, and sediment transport. The geology of the Nile Basin is made up of Precambrian rocks, which date back more than 600 million years. These rocks are the building blocks onto which following geological activities have acted. The basin consists of a complex mosaic of granites, gneisses, schists and other metamorphic rocks, indicating a history of intense tectonic activity and mountain building during the Precambrian era. The lower portions of the basin are mostly filled with Tertiary and Pleistocene sedimentary infill (Nile Basin Water Resources Atlas, 2016).

Soil types (d)

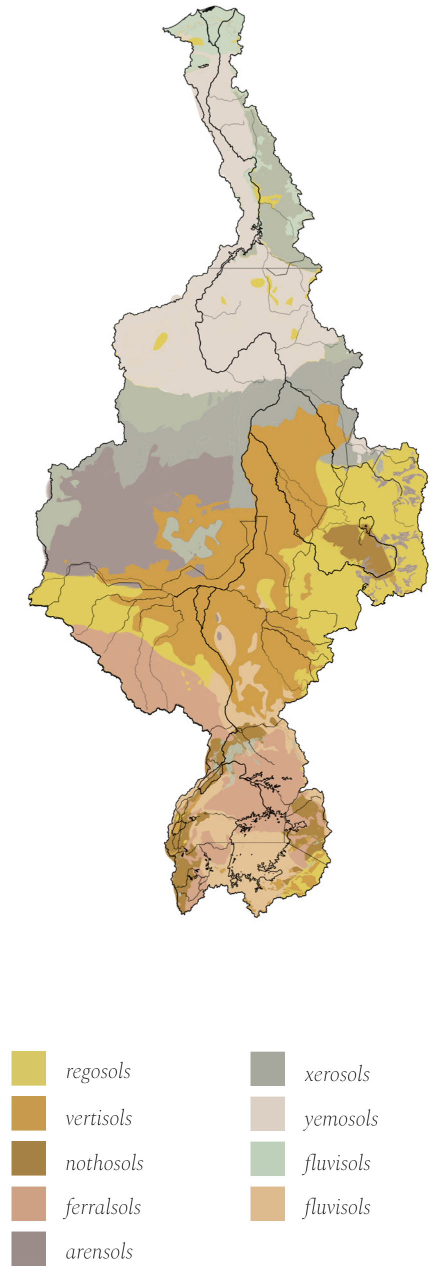
The alluvial soil, is one of the dominant soil types in the basin and is created by silt deposition from the Nile's watercourses. These nutrient-rich soils have historically been the foundation of agricultural productivity in the floodplains of the area. Volcanic activity affects some areas of the Nile Basin, particularly in East Africa. High fertility is provided by volcanic soils that have been enhanced with minerals from volcanic ash deposits. Laterite soils are common in tropical locations characterized by significant rainfall. Clay-rich soils called vertisols are known for their volumetric variations in response to changes in moisture. Frequently found in areas with different rainy and dry seasons (Nile Basin Water Resources Atlas, 2016).

>>
c) geology, d) soil types
Nile Basin Water Resources Atlas, 2016).

(c)



(d)



Climate zones (e)

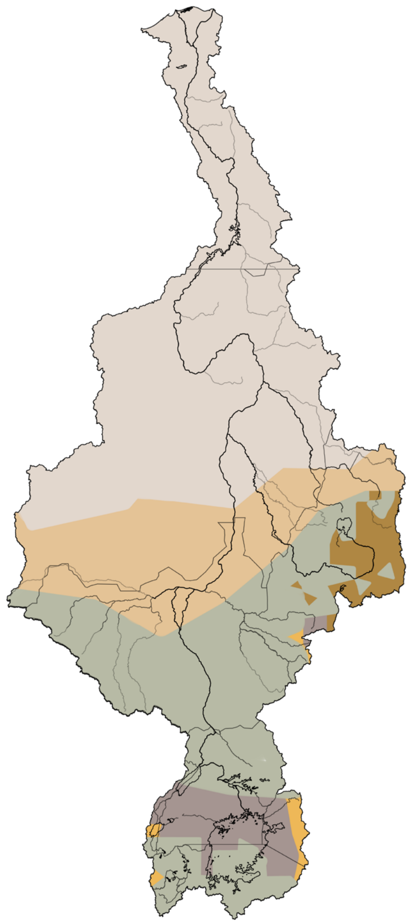
Temperature and precipitation are the two leading indicators of climate. The subtropical dry arid (desert) climate of Sudan and Egypt, the subtropical dry semi-arid climate of southern Sudan, the tropical wet and tropical monsoon climate around Lake Victoria and some parts of the Ethiopian highlands are the main climatic features of the basin (Nile Basin Water Resources Atlas, 2016).

Eco regions (f)

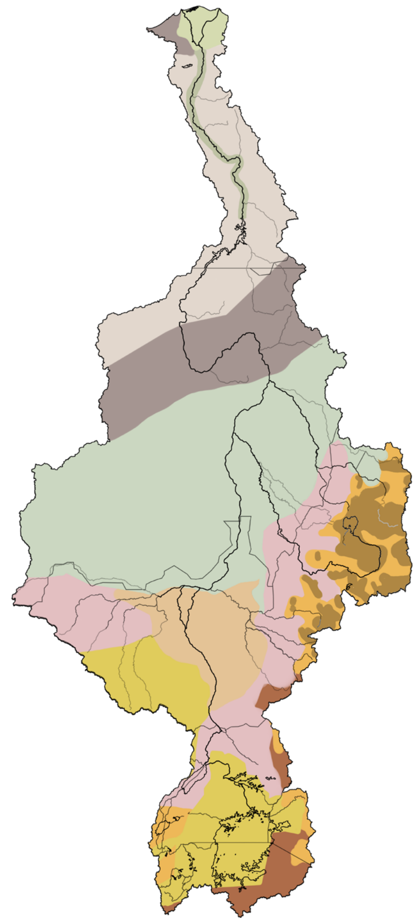
There are sixteen terrestrial ecoregions in the Nile Basin. The gradual change in elevation and climate that occurs as one moves through the basin from south to north causes a significant latitudinal gradation in vegetation and fauna. With this gradation in ecoregions, the richness of plant and animal species has decreased significantly (Nile Basin Water Resources Atlas, 2016).

>>
e) climate zones, f) eco regions
Nile Basin Water Resources Atlas, 2016).

(e)



(f)



Cwb
Aw
m
Cfb
BSh
BWh

grass- and woodlands
lowland forest
sudanian savanna
grasslands
forest-savanna mosaic
bushland
sahelian acacia savanna
woodlands and steppe
sahara desert
flooded savanna

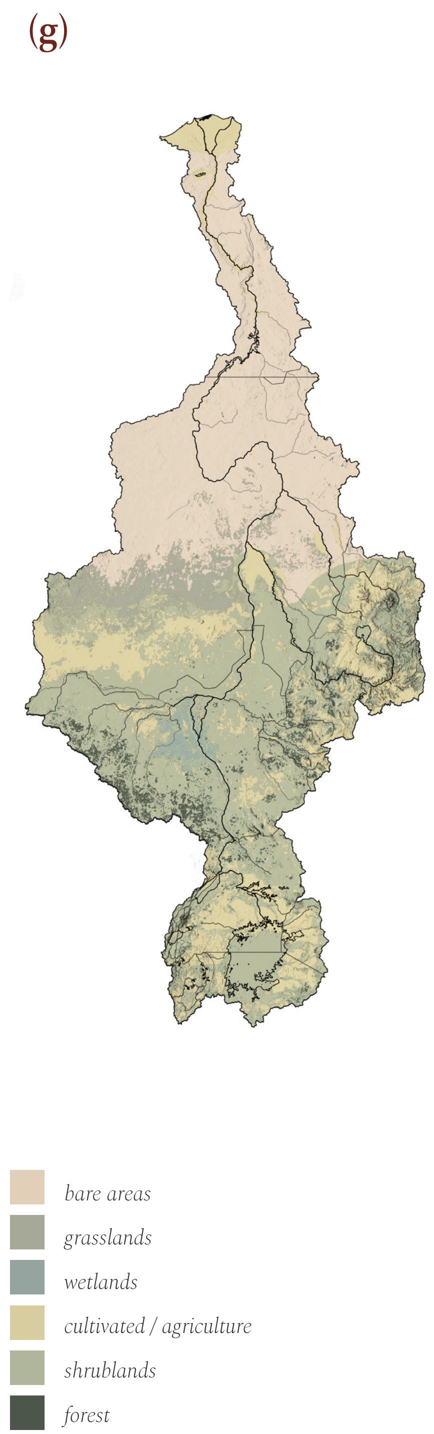
Land use (g)

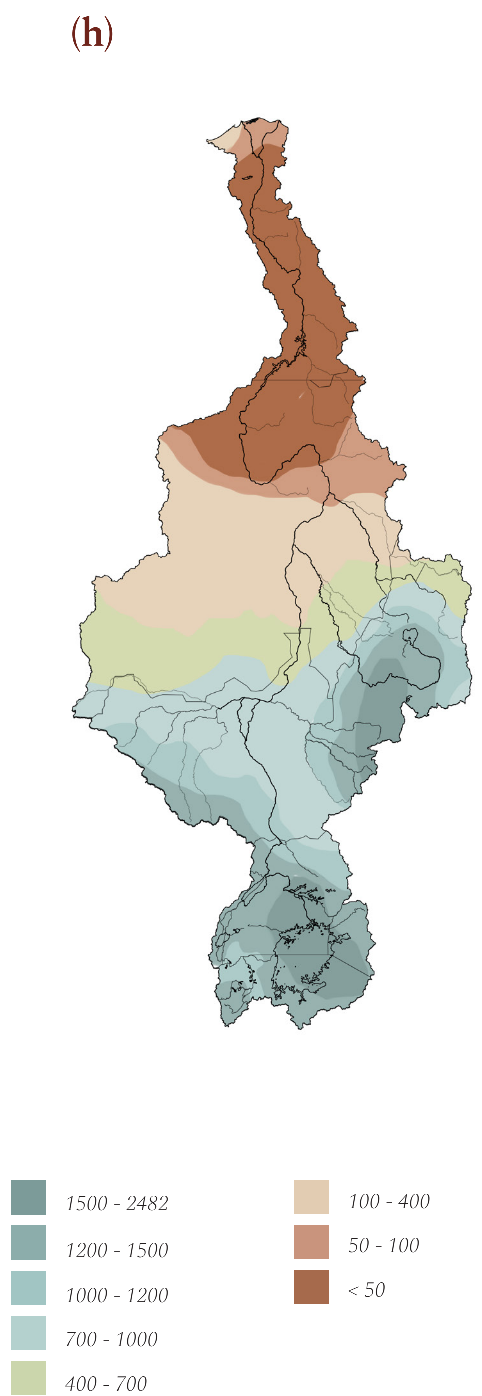
In the basin, bare regions make up 31% of the land, followed by shrublands (29%), cultivated land (23%), forests (7%), and grasslands (6%). Topography is one of the environmental factors that is very significant. Agriculture is practiced across the Nile Basin, but it is most prevalent in low lying areas (less than 502 m) and medium height areas (890 - 1,454 m), and it is also done on certain high slopes. The majority of bare areas are found in low-lying regions, primarily in the desert region of the Main Nile, though there are also notable bare areas on steep hills (Nile Basin Water Resources Atlas, 2016).

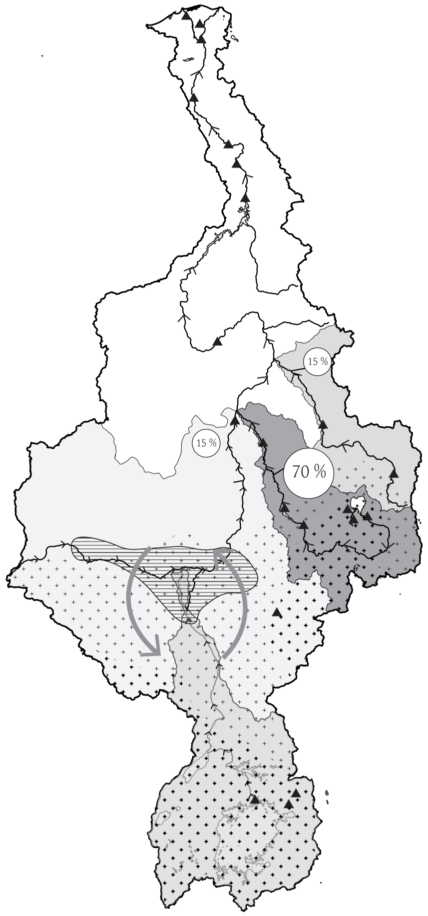
Annual rainfall (h)

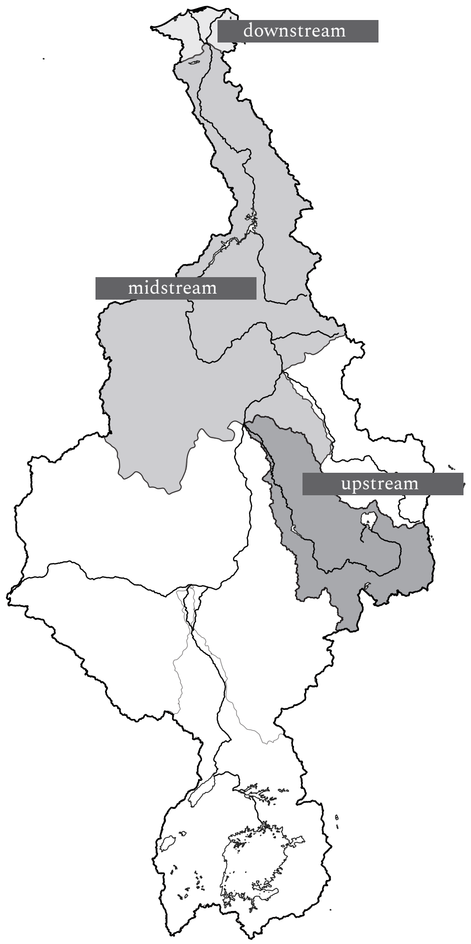
Like many other regions of the world, the Nile basin has several locations where rainfall data is either scarce, unevenly distributed, or nonexistent. The Rwenzori Mountains in western Uganda, Mount Elgon, and the Ethiopian Highlands are high altitude regions that get rainfall totals above 1,500 mm and are regarded as the water towers of the basin. In contrast, the other regions of the basin receive less than 700 mm. The minimum is seen to be less than 50 mm in the arid areas of the northern part of the Sudan and in Egypt (Nile Basin Water Resources Atlas, 2016).

>>
g) land use , h) average annual rainfall
Nile Basin Water Resources Atlas, 2016).









< schematic overview of tributories of the Nile

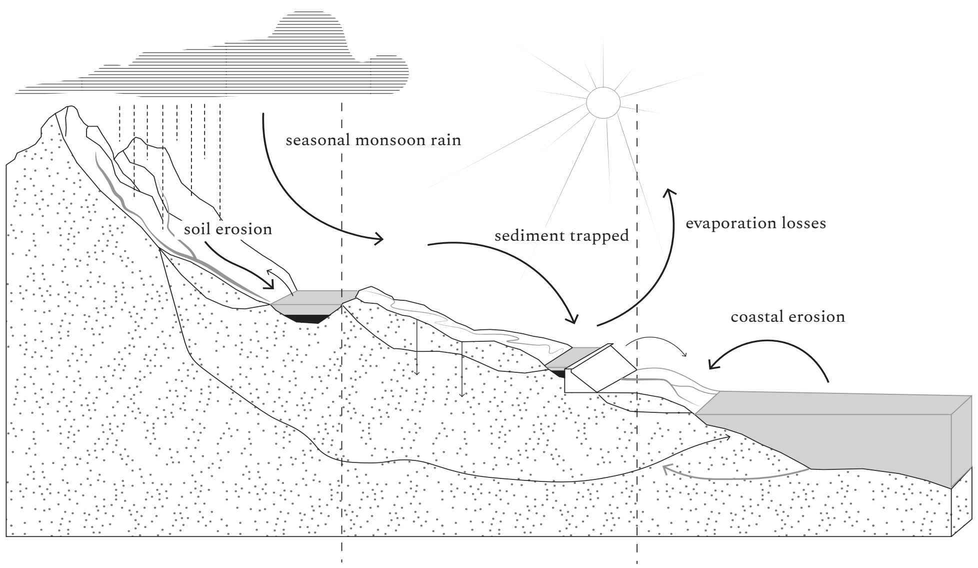
> corresponding map with upstream, midstream and downstrem section of the river Nile

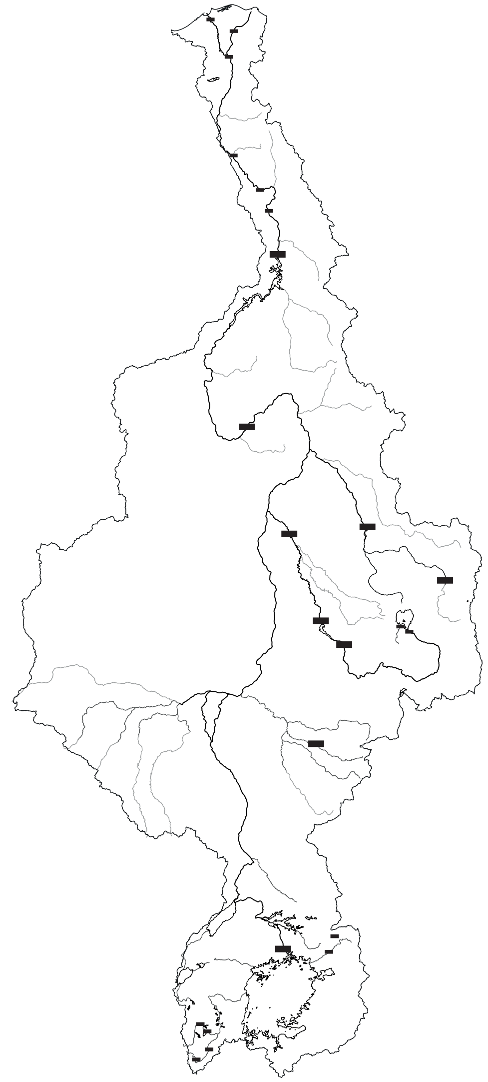
Nile hydrology

The Nile flows through a wide range of climatic regions on its journey through north-eastern Africa. Starting in the equatorial highlands of Uganda, Rwanda and Burundi, the river encounters a hot and consistently humid climate characterised by two distinct rainy seasons. In contrast, the subtropical Ethiopian highlands experience a more seasonal climate pattern, characterised by a main rainy season coinciding with the summer monsoon from June to September, and a shorter rainy season occurring earlier in the year from March to April. The vital flow of the Nile is maintained by its three main tributaries: the White Nile, the Blue Nile and the Atbara River. In particular, the Blue Nile and the Atbara both originate in the Ethiopian highlands and contribute about 85% of the Nile's annual flow, making these tributaries central to the river's hydrology.

Nile dams

Dams in the Nile basin have played a key role in harnessing the river's water resources for a variety of purposes, including irrigation, hydropower generation and flood control. However, these structures have also created challenges, particularly in relation to sediment trapping in their storage lakes. As water is retained behind these dams, sediment that would naturally flow downstream is deposited in the reservoirs. This sedimentation can cause several problems downstream in the river. Firstly, the sediment build-up reduces the storage capacity of the reservoirs, reducing their long-term effectiveness. Secondly, it can lead to increased erosion downstream as the river tries to compensate for the reduced sediment transport.





< schematic overview disruption of the river flow by dams in the Nile River basin

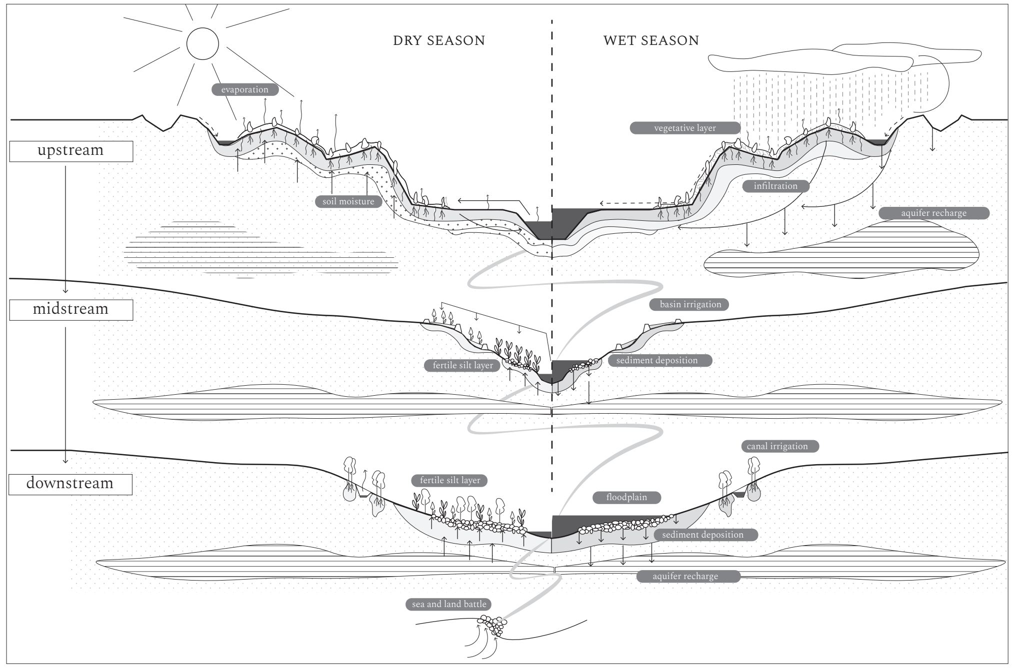
^ schematic overview of dams and barrages in the Nile River basin

3.3 *Challenges*

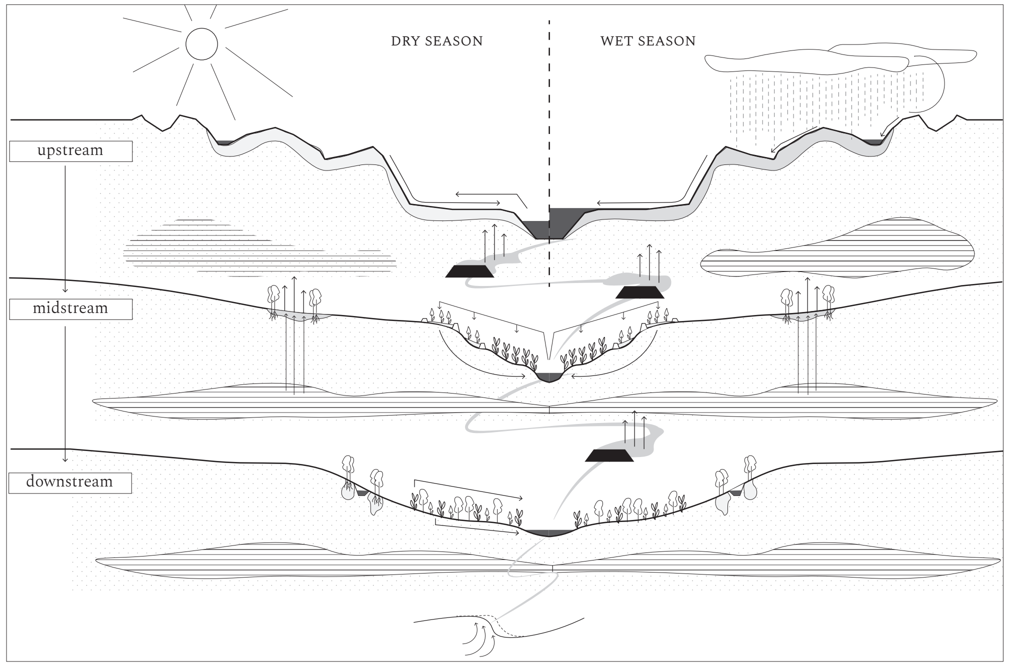
Disruption of river system

Human impact on the Nile Basin and its river system has been profound and diverse. The construction of large dams, such as the Aswan High Dam, has tamed the river in its upper reaches, providing vital benefits such as hydropower and controlled irrigation, but also disrupting the natural river system and water cycle. Deforestation and land degradation along the riverbanks have reduced rainwater infiltration, exacerbating soil erosion and degrading water quality. Perhaps most importantly, the trapping of sediments behind dams has resulted in the depletion of nutrient-rich silt that historically replenished the Nile Delta, contributing to increased coastal erosion in the Nile Delta and coastal region. These human-driven changes highlight the complex interplay between the use of the Nile's resources for development and the ecological consequences, with significant implications for the sustainability of the Nile Basin and the communities that depend on it.

Historical Nile river system



Current Nile river system



Population growth

The current total population of Nile Basin countries stands at approximately 487.3 million, with Ethiopia leading the count at 99.4 million, followed closely by Egypt with 91.5 million and the Democratic Republic of Congo at 72.1 million. In contrast, Eritrea, Burundi, and Rwanda have the smallest populations within the basin, with 5.2 million, 11.2 million, and 11.7 million, respectively. A substantial portion of this population, totaling around 257 million or 53% of the total population of Nile Basin countries, resides within the Nile Basin. Egypt boasts the highest population living within the basin, with 85.8 million residents (Nile Basin Water Resources Atlas, 2016).

Projections show that urbanisation is increasing in all Nile Basin countries. By 2050, the urban population is expected to exceed 50% of the total population in four of the 11 Nile Basin countries. In seven of these countries, the urban population will account for more than 40% of the total population. At the same time, the rural population is expected to decline as urbanisation accelerates. This shift towards urban living will lead to increased demand for improved water supply, sanitation, electricity, communications and various other services. However, it also poses challenges, as urban expansion often encroaches on forests and threatens to pollute water resources, putting additional pressure on the natural environment (Nile Basin Water Resources Atlas, 2016).

Water stress

Water stress in the Nile Basin is a pressing issue, as the region's water resources play a vital role in sustaining life, driving economic activities and maintaining a healthy environment. These resources are used in a variety of ways, including off-stream uses such as agriculture and domestic consumption, in-stream uses such as hydropower and fisheries, and on-stream activities such as transport and tourism. Projections for 2030 indicate a staggering fivefold increase in water demand, and the collective population of the Nile Basin is expected to struggle to meet this growing demand. Without proactive measures to augment water supplies and manage rising consumptive demands, the Nile Basin faces the imminent risk of critical water scarcity. In such a scenario, increases in consumptive use in one sub-basin may require compensatory reductions in another, making negotiations on water sharing a likely outcome. In addition, the threat of climate change threatens to worsen an already fragile situation (Nile Basin Water Resources Atlas, 2016).

Climate change

Climate change poses a huge challenge in the context of the Nile Basin, acting as an additional pressure factor and risk multiplier, intensifying the impact of existing challenges (Link et al., 2013). It is increasing water stress in the region and intensifying competition for increasingly scarce water resources. With changing rainfall patterns and increased evaporation due to rising temperatures, the flow of the Nile becomes more uncertain, affecting not only the availability of water for agriculture, domestic use and industry, but also complicating negotiations between the riparian states of the basin. Climate change also increases the risk of extreme weather events such as floods and droughts, which can disrupt communities, damage infrastructure and stress resources. In this already complex and politically sensitive environment, climate change underscores the importance of adaptive strategies and international cooperation to address the many challenges facing the Nile Basin (Link et al., 2013).

Capability to adapt

The Nile River Basin, one of the world's most iconic river systems, stretches across north-eastern Africa. The Nile River Basin is of great historical and cultural significance, having been home to some of the world's earliest civilisations. Today, it plays a vital role in the livelihoods and economies of the eleven riparian countries that share its waters. The basin's water resources are essential for agriculture, industry and energy production, but they face challenges from increasing population pressure, climate change and competition between riparian countries. The ability of the Basin countries to respond to and prepare for the challenges ahead is a key determinant of their sustainability. With increasing water stress, population growth and the compounding effects of climate change, the Nile Basin faces a web of problems. Testing its adaptive capacity means assessing the effectiveness of policies, infrastructure and cooperation mechanisms aimed at securing water resources.

Painting oil on canvas: Crossing the Wadi by Rudolf Hellgrewe, via Sotheby's

4 *Principles & Strategy*

^ *Life on the Nile during the flood. Nilotic mosaic, floor of the artifical cave of Praeneste, Italy. End of 2nd century BCE. Public domain United States {{PD-USGov}} , via Wikimedia Commons*

Introduction 4.1

Towards a resilient Nile River basin

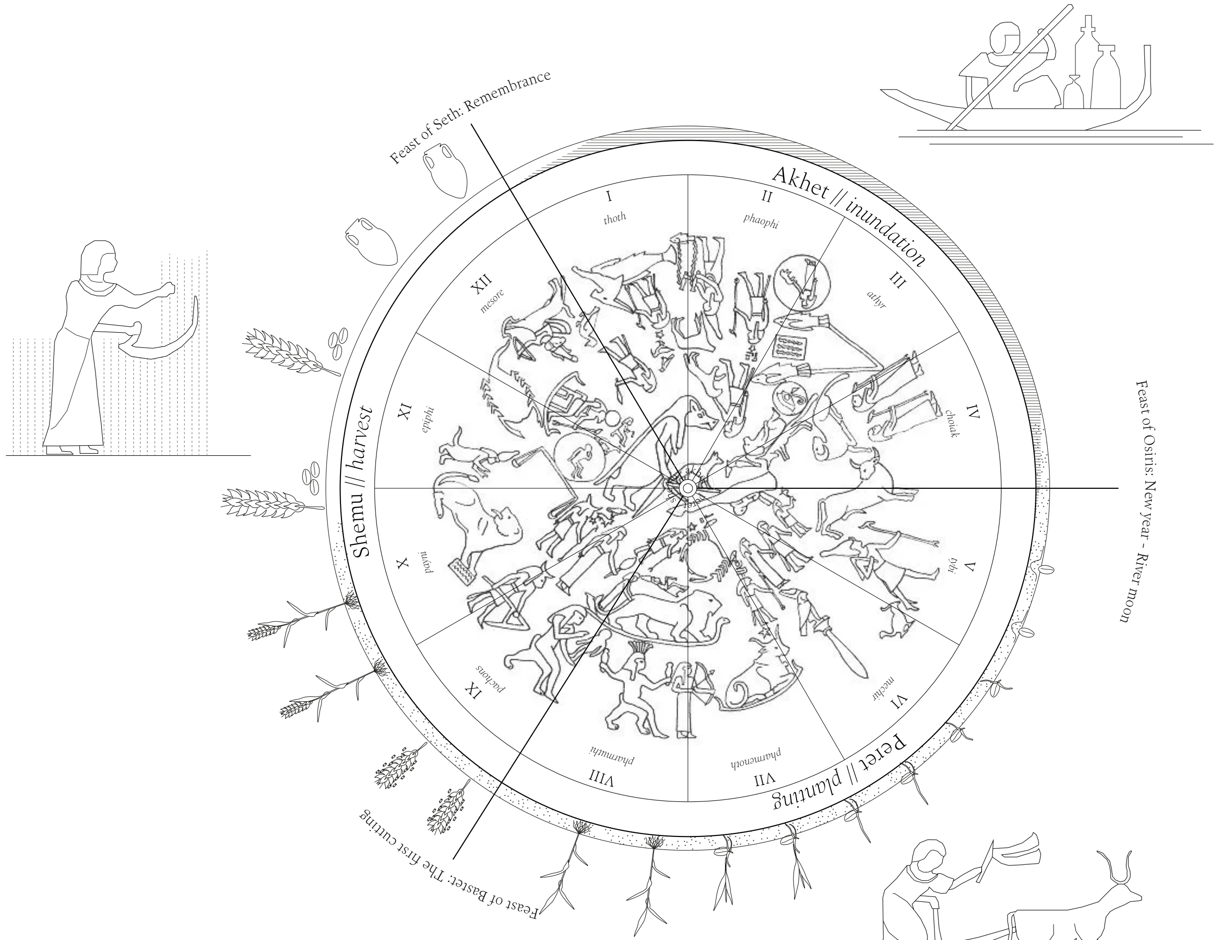
The following chapter provides an exploration of the strategies and (design) principles that form the basis of the designs. This chapter provides an overview of the inspiration drawn from a wide range of examples, theories, philosophies and practices. These inspirations are translated into a set of principles that provide a basic framework for working towards a resilient Nile Basin. The general principles are translated into design principles for landscape architecture.

4.2 *Learning from ...*

Ancient Wisdom

The past holds an immense amount of knowledge, and ancient wisdom offers insights into how to create a harmonious relationship between man and nature. Looking back into the past teaches us the importance of symbiotic coexistence, recognising that humans and the natural world are intertwined and interdependent. Ancient civilisations such as the Egyptians show us an understanding of interconnectedness. Their farming practices were in harmony with the cycles of the earth. A great example of this is the seasonal calendar of the ancient Egyptians. Their calendar consists of three seasons based on the cycle of the Nile River. The civilisation relied heavily on the annual flooding of the Nile, which defined the agricultural cycle. The three main seasons are Akhet (flooding), Peret (growing) and Shemu (harvest) (Abdou, 2022).

During Akhet, the season of inundation, the Nile would flood the land. Depending on rainfall in the Ethiopian highlands, the river would overflow its banks and deposit nutrient-rich silt on the floodplains. During the Peret season, the floodwaters would recede, leaving behind a layer of moist and fertile soil, perfect for planting seeds. The harvest season, Shemu, was the time when the crops were ripe and ready to be harvested and stored for consumption throughout the year.
The ancient Egyptian civilisation had a deep appreciation for the natural cycle of the seasons and developed a symbiotic relationship with the Nile. This was reflected in their religious beliefs, where the flooding of the Nile was often associated with the god Hapi (Tvedt, 2015).



^ Schematic collage of seasons of ancient Egypt, including growth patterns of common crop, figure by author

Radical Indigenism // Lo-TEK

The concept of radical indigenism derives from the Latin root 'radix', which means root. Radical indigenism in design envisions a movement that aims to re-establish an appreciation of indigenous philosophies within the field of design, with a specific focus on creating sustainable and climate-resilient infrastructure (Watson, et. al., 2020).

In contrast to the uniformity of the modern world, Indigenism reconceptualises indigeneity as an extension of life, characterised by symbiosis with the natural environment. It aims to promote a holistic relationship between humanity and nature, in which indigenous knowledge systems play a vital role in shaping design principles (Watson, et. al., 2020).

"Every culture is by definition a vital branch of our family tree, a repository of knowedge and experience, and, if given the opportunity, a source of inspiration and promise for the future."

Wade Davis, *The Wayfinders*

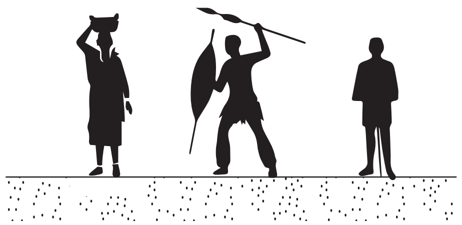
One manifestation of this approach is the Lo-TEK design movement, which seeks to reconstruct an understanding of indigenous philosophy and vernacular architecture. It aims to create infrastructures that are sustainable and able to withstand the challenges of the present.

This movement begins with TEK, Traditional Ecological Knowledge. TEK represents a body of knowledge, practices and beliefs that have been passed down through generations through songs, origin stories and daily life experiences. Using TEK, designers and communities can create a soft, symbiotic living system that connects with the energy of ecosystems while adapting to environmental challenges. TEK evolves through direct interaction with nature, it is inherently designed to sustain resources rather than exploit them, thereby fostering a symbiosis between species. TEK prioritises biodiversity as the fundamental element for building green technologies, emphasising the interconnectedness of all living beings in the natural world. (Watson, et. al., 2020).

Local knowledge of animals, plants, soils, and landscapes.

Land and resource managament systems

Community and social institutions



Worldview

Explained through four interrelated levels of ecosystem management:

At the first and fundamental level of ecosystem management, we delve into the realm of local knowledge. of flora, fauna and soil. It's the fundamental building block on which effective ecosystem management is built.

Moving up to the second level is resource management. This stage involves not only local environmental knowledge, but also the application of practices, tools and techniques that have evolved over time. Here an appreciation of ecological processes and services comes into play as we seek to harmonise human activities with the delicate balance of nature.

Community and social organisation become central as we move to the third level. This level of ecosystem management emphasises the importance of coordination, cooperation and governance. Within the community, people come together to collectively manage and protect the environment, creating a collaborative network that enhances the resilience and vitality of ecosystems.

The fourth and final stage is the view of the world. This is where broader concepts of religion, ethics and belief systems come into play. A deep understanding of our place in the natural world emerges, guiding our actions and decisions. This holistic perspective emphasises the interconnectedness of all life forms and fosters a sense of responsibility towards the environment, ensuring sustainable practices for generations to come. (Watson, et. al., 2020).

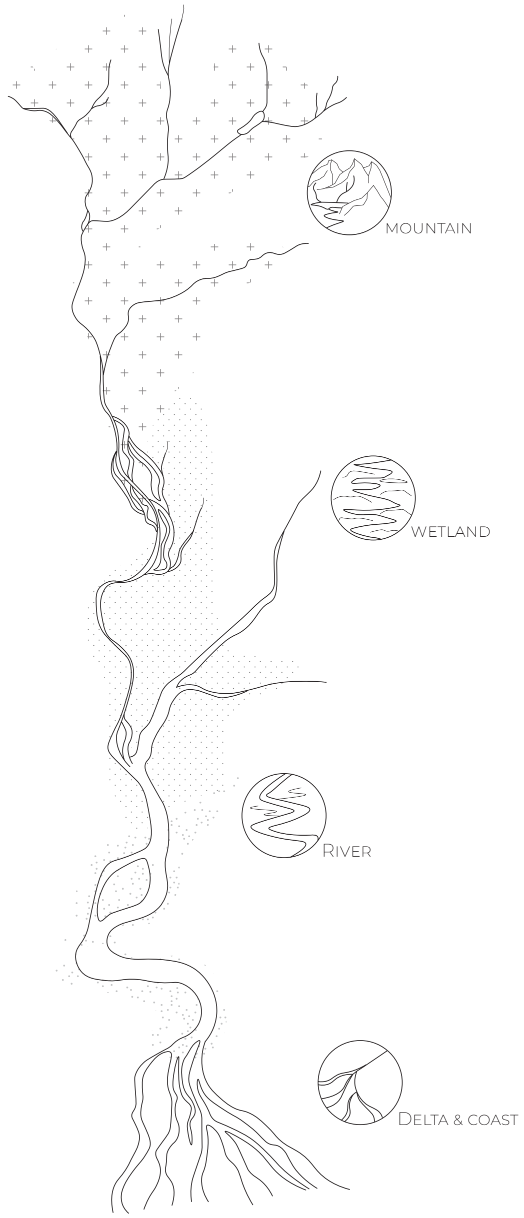
Nature Based Solutions

Nature-based solutions are approaches that use nature and natural processes to meet the growing challenge of resilience.

Not designed independently, but rather to complement and strengthen existing risk management interventions.

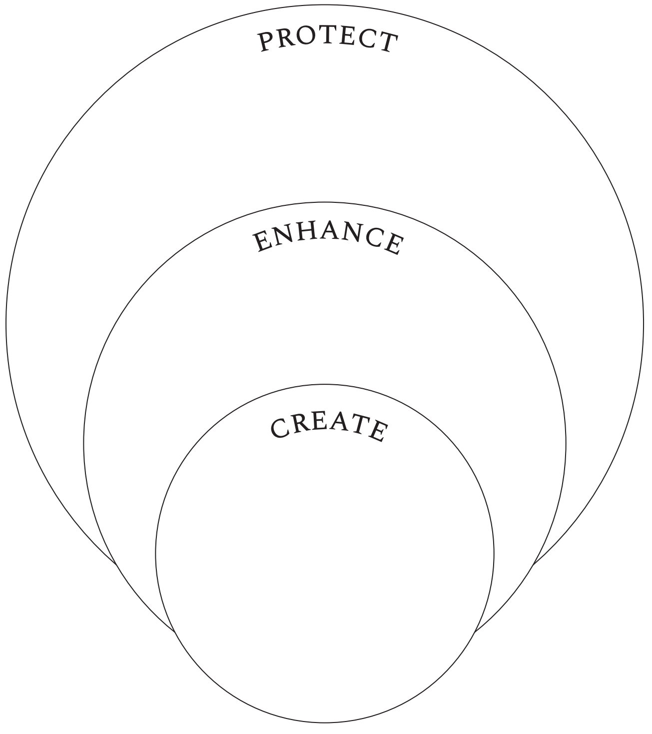
require an understanding of local ecology, including temperature, rainfall, soils, and the selection of naturalyy occuring plant species.

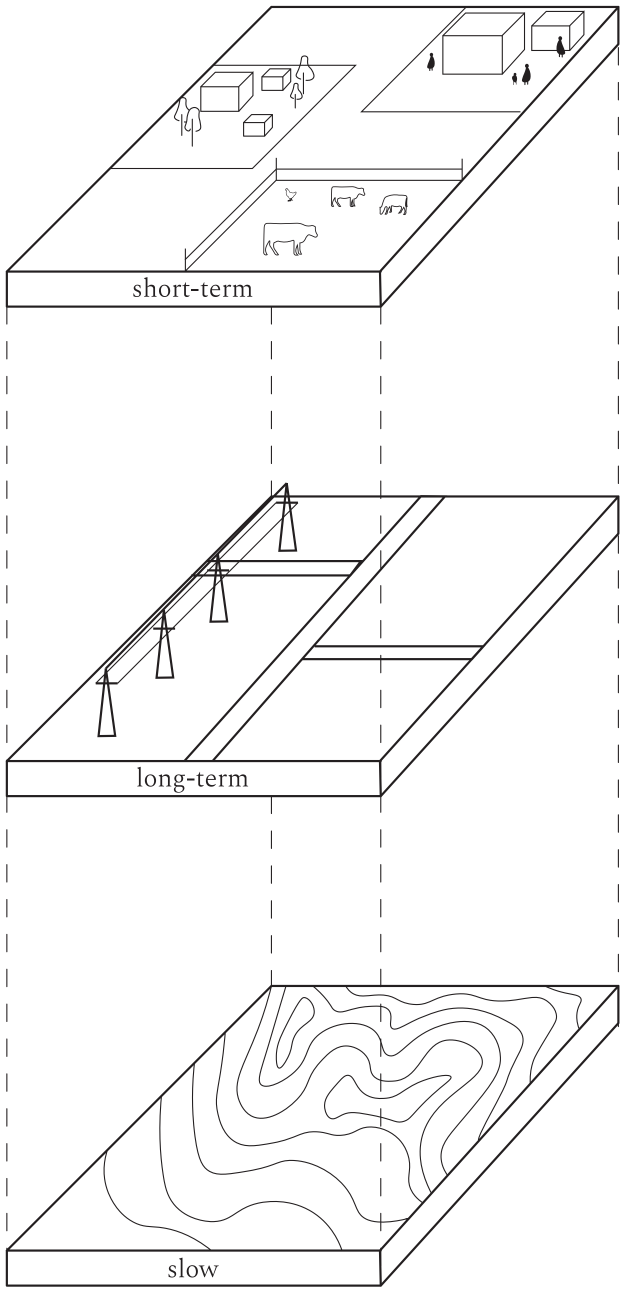
The position within a river system determines the suitability and main characteristics of the NBS. The positions can be divided into four different typologies, naming, mountain, wetland, river, delta, and coast. NBS at the river basin scale recognizes the connectedness of the river system, understanding the different areas and their codependence on one another (World Bank, 2021).



Ecosystem-based strategies

Nature Based Solutions interventions cross boundaries. Cohen-Shacham et al. (2019), “nature-based solutions” refers to a broad category of ecosystem-based strategies, including preservation, sustainable management, restoration, and the development of natural or green infrastructure. These strategies can be ranked in a hierarchy, with the preservation of current ecosystems being given priority over improved management, rehabilitation, and restoration, or the development of new NBS.





Layered approach // Longue Durée

The concept of longue durée recognizes the landscape as a long-term, slowly changing structure. The landscape is a system where various systems and processes interact with one another and have varying dynamics of change.

The first level of dynamics is a slow, nearly undetectable process of change, repetition and natural cycles. The first level is connected to the natural environment the substratum and climate, these are layers that change slowly. These environmental conditions are thought to have the most influence on how the land is used.

The second layer is the long-term social, economic, and cultural historical dynamics.This layer consists of infrastructural networks for transportation, water management and energy supply. The conditions grow and change more quickly than the environmental conditions of the first level.

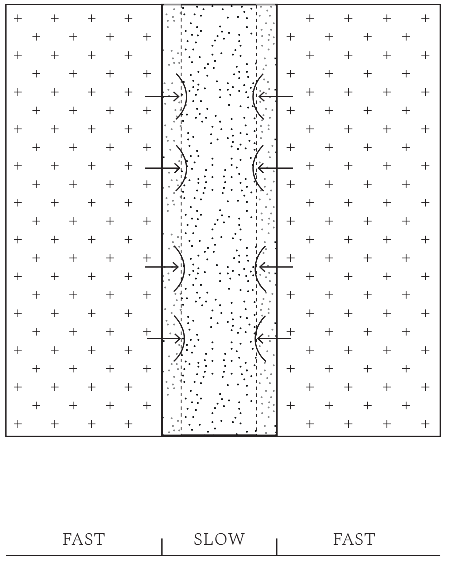
The third level are the short-term events, evolving people and politics. The first and second level form the conditions for development like agricultural land use and urban settlements (Braudel, 1996) Nijhuis and Pouderoijen, 2014).

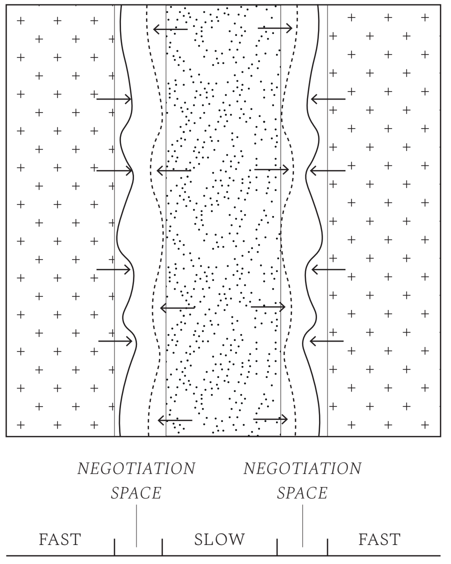
It is crucial to characterize and categorize these dynamics in order to compare them and discover correlations between them, which will help to better understand them and the effects they have (Nijhuis and Pouderoijen, 2014).

Casco concept

The Casco Concept uses three analytical perspectives that distinguish between a framework and use space: dealing with time, uncertainties and the context. It separates the space into a framework or use space, based on time. Slow dynamic functions, such as a river system and nature is part of the framework. High dynamic processes, for example, agriculture, is a fast development and are part of the user space.

Slow dynamic functions, such as river systems, should be given time to develop. High dynamic processes can crowd out the space of slow dynamic functions. Therefore there should be space for slow functions to develop. That is why a third space is proposed, this is a flexible shell around a framework, which provides space for development, it can be called the negotiation space (H+N+S Landscapsarchitecten & Team TU Delft and PBL, 2023).





LEARNING FROM ... — MAIN TAKE-WAY — NILE RIVER BASIN STRATEGY

Learning from ...

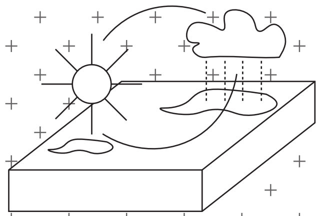
Ancient wisdom

Lo-TEK

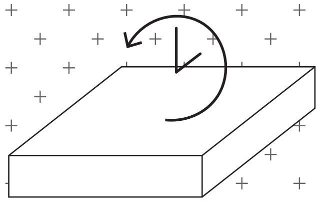
Main take-way

local knowledge
vernacular practices
human understanding of natural processes

Nile River basin strategy



seasonal design



reintroduce vernacular practice to promote relationship human with nature

Learning from ...

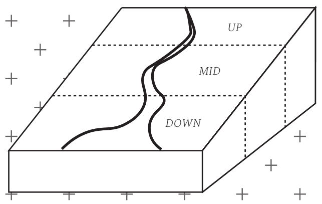
Nature Based Solutions

Ecosystem-based strategies

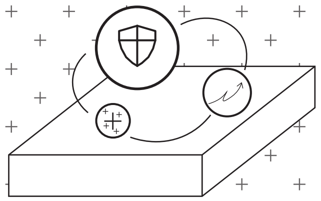
Main take-way

lanscape as a system, solution as a system.
carefull consideration of the (local) context.

Nile River basin strategy



design based on position within the river system: up-mid-downstream



protect - enhance - create

Learning from ...

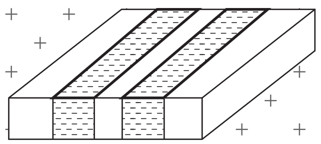
Layered approach // Longue Durée

Casco concept

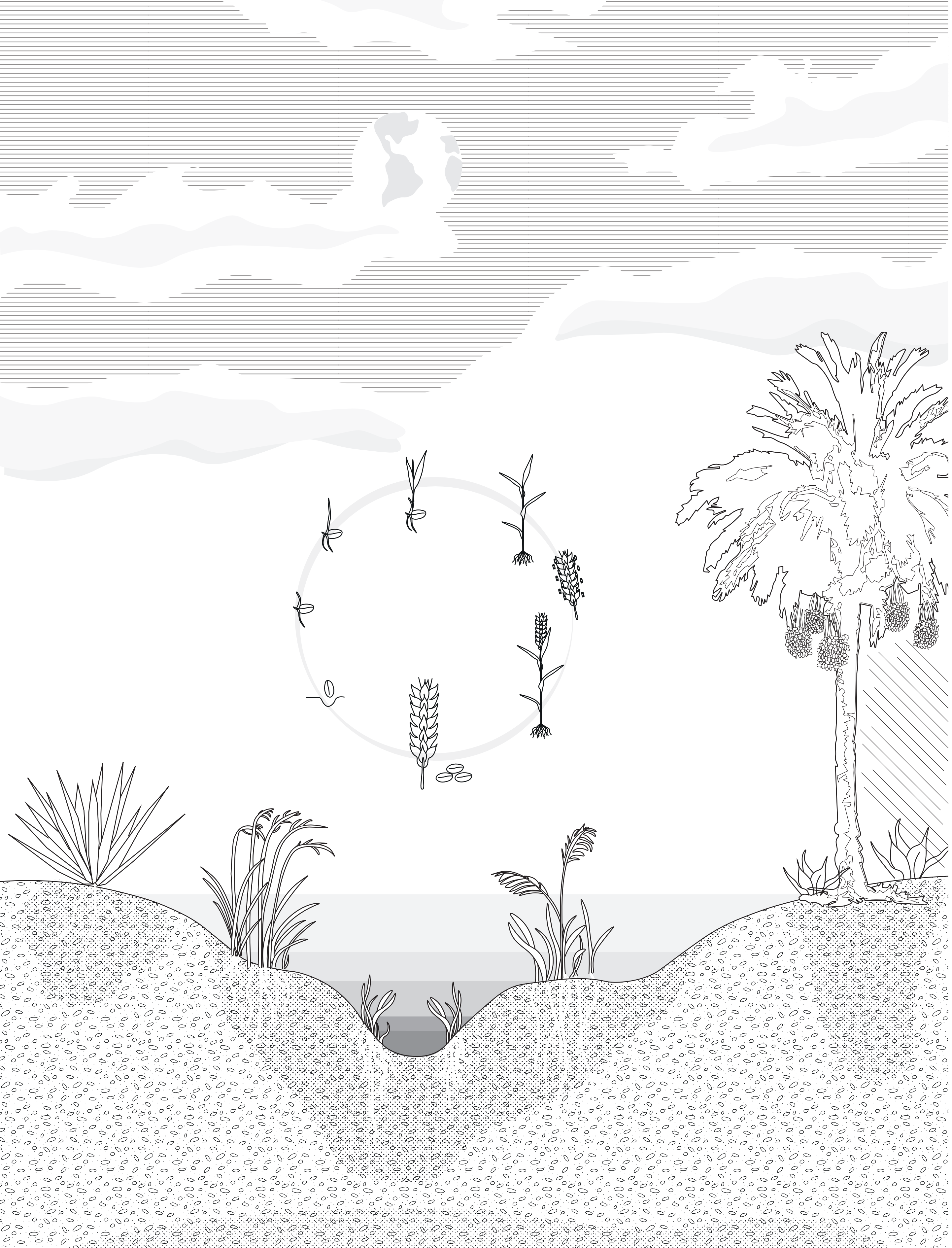
Main take-way

landscape is a complex system
fast and slow dynamics
slow dynamics identified and nurtured

Nile River basin strategy



introduce negotiation space



Seasonal sensitive design

Seasonally sensitive design in landscape architecture can help mitigate the challenges associated with different climatic conditions. An important aspect of seasonal design is the integration of water management strategies. During the rainy season, the focus is on effective rainwater harvesting, retention and detention. During the rainy seasons, excess rainfall can be captured, flooding should be prevented and soil erosion should be controlled, while at the same time groundwater resources should be recharged. During the dry season, the focus is on water conservation. Drought-tolerant plant species, efficient irrigation systems and water-saving designs can help conserve scarce water.

Design principles

Some design principles that can be used to design with seasonal sensitivity:

- Native and adaptive planting: planting can thrive in specific climatic conditions, for example drought-resistance: xeriscaping.
- Seasonal planting: seasonal variation in plants.
- Rainwater harvesting: cisterns, rain gardens, swales to capture and store excess rainwater during rainy season for later use.
- Permeable materials: when designing hardscapes, use permeable materials to allow rainwater to infiltrate and recharge groundwater.
- Retention and detention: basins and ponds to provide space for rainwater, prevent flooding and create gradual water release.
- Microclimate: create microclimates by placing trees , water features, provide shade, reduce wind exposure.
- Irrigation: irrigation that adjust watering schedules based on weather conditions.

Vernacular practices

Vernacular practices in landscape architecture design introduce a culturally sensitive approach to shaping the built environment. It embraces regionally specific, traditional design methods, techniques and management strategies that have evolved over generations based on context. These practices are based on indigenous knowledge and wisdom, are sustainable, in harmony with nature, nurture the place and contribute to ecological resilience.

Design principles

Some design principles that can be used to design with vernacular practices:

- Landscape management: consideration of vernacular practices of landscape management, adapting it to make it manageable for current times.
- Material authenticity: use of local materials and traditional construction techniques.
- Adaptive reuse: repurpose of existing structures or materials, integrateing them into the design.
- Community engagement: involvement of local communicties to ensure that their needs and aspirations are reflected in the design.
- Aesthetic integration: blending the vernacular practices into the design to achieve a balanced aesthetic that avoids superficial or tokenistic appareance.

Protect - Enhance - Create

The hierarchical framework of three approaches can be used in the development and management of landscape architecture. First, protecting existing ecosystems and structures is essential to mitigate the loss and degradation of ecosystems and ecological services. Second, the enhancement, restoration and rehabilitation of ecosystems is a strategy that aims to undo the damage that has already been done to the environment. Finally, the development of new techniques, solutions and interventions. The framework recognises the importance of conserving what is left and adopts a proactive strategy to restore and create ecosystems and ecosystem strategies.

Design principles

Some design principles that can be used to design the hierarchical framework:

- Conservation: design interventions that minimize disturbances and impact on the local biodiversity, species and habitats.
- Protected areas: integrate protected areas into land-use planning to reduce habitat fragmentation and promote connectivity.
- Native species: use native species to ensure and maintain local biodiversity.
- Ecological engineering: in the creation phase, apply ecological engirneering to create self-sustaining ecosystems, for example water purification.
- Long-term planning: integrate long-term management and maintenance.

Negotiation space

The environment can be categorised into a fast developing process and a slow developing process. A third space, the negotiation space, can be introduced to intersect with the fast and slow developing spaces. The negotiation space harmonises the demand for fast development, which belongs to modern society, while protecting the slow-developing processes.

Design principles

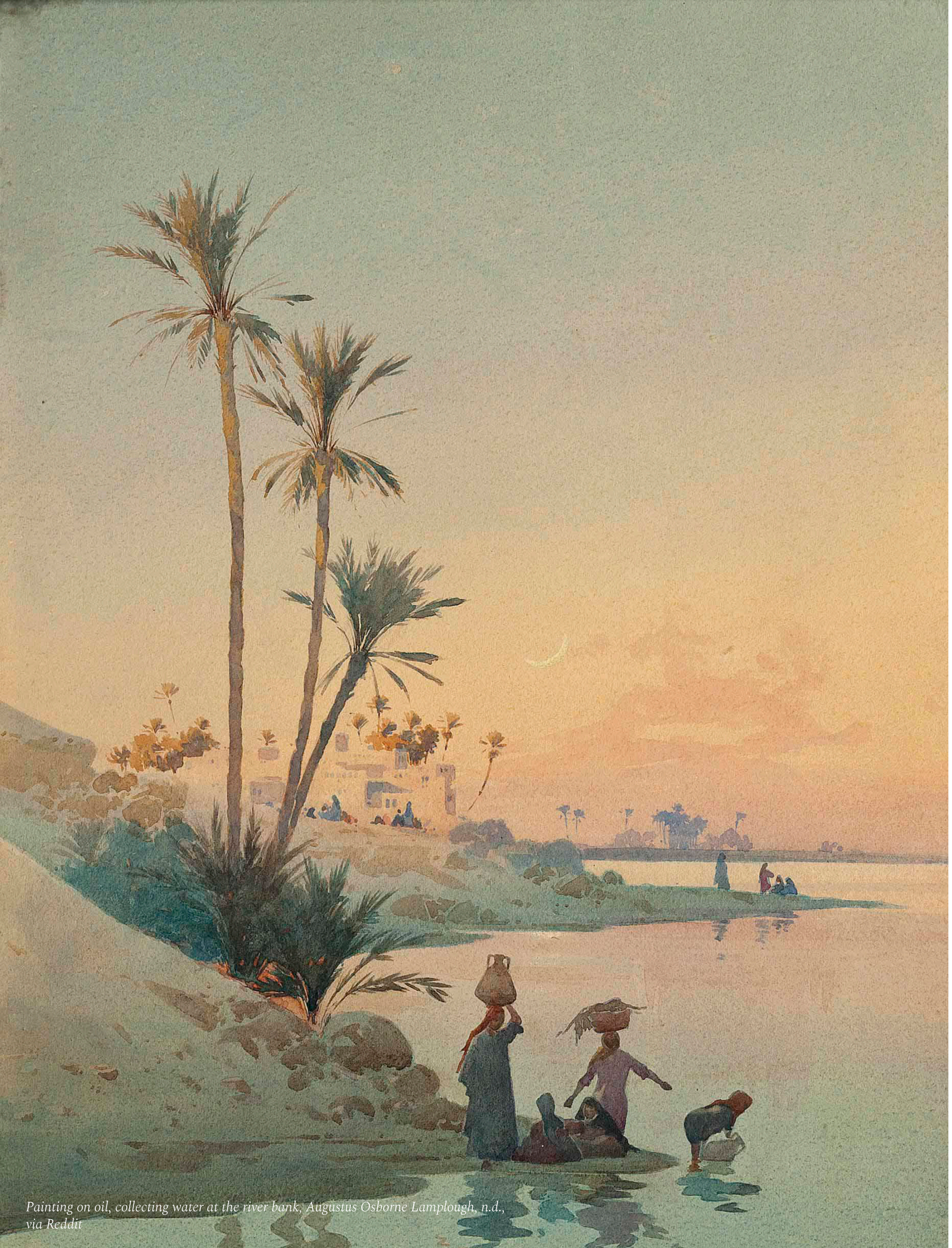
Some design principles that can be used to design the negotiation space:

- Buffer zone: design a space open to planning and can be multifunctional.
- Public space: design the negotiation space as a public space to facilitate engagement and participation. It can serve as a valuable space for both humans and ecosystems.
- Restrictions and protected areas: place restrictions in the negotiation space to maintain space free from fast developing elements.
- Connection: reduce fragmentation by taking into account the local context, for example, creating wildlife corridors, migrating bird routes etc.

Part II

Up - Mid - Down

For three locations, designs are made, considering the knowledge and principles from Part I, the Nile River basin.



Painting on oil, collecting water at the river bank, Augustus Osborne Lamplough, n.d., via Reddit

5 *Design*

"Water is the gift of God
to man and the earth"

Qur'an

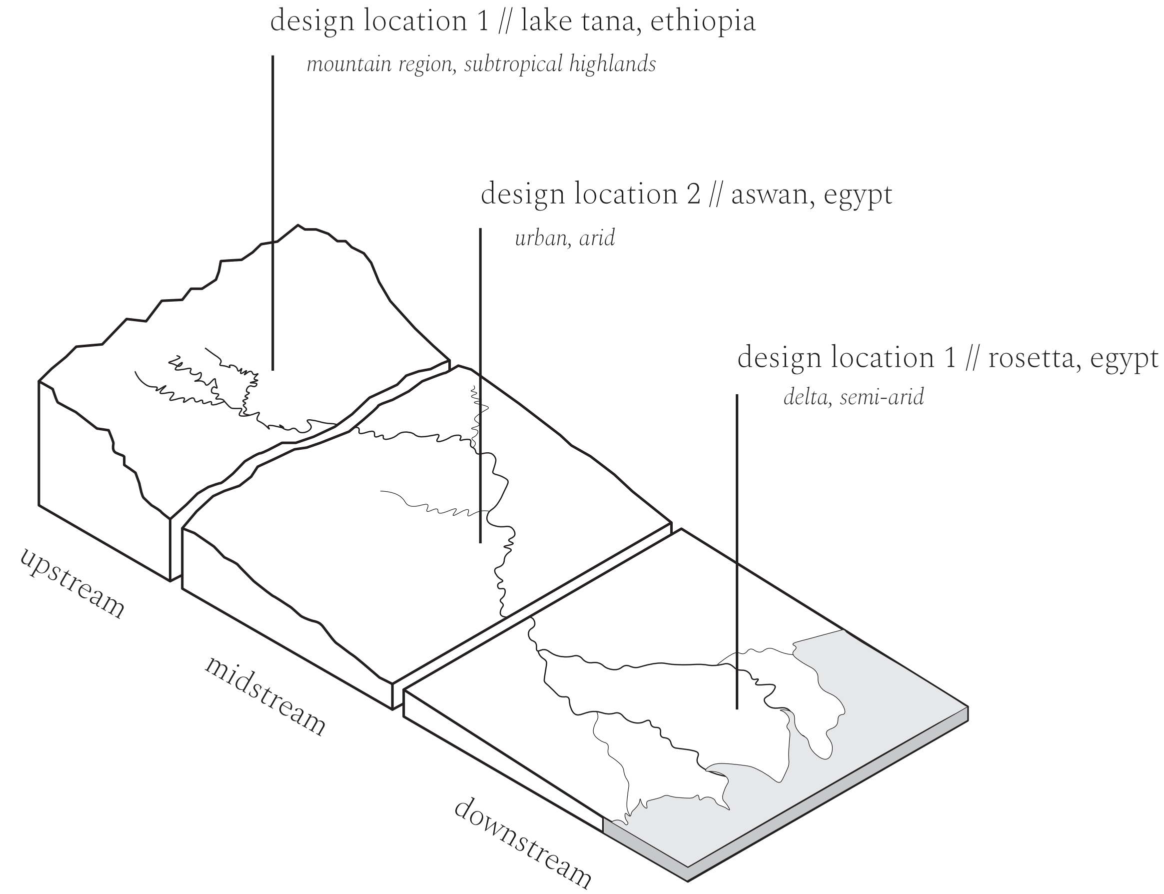
5.1 *Introduction*

Designing up-, mid- and downstream

In this chapter, the design principles and strategy of Chapter 4 are translated into three situated designs. The three sites are chosen based on their location within the watershed, so one site is designed upstream, one midstream and one downstream of the river. In addition to their sequence in the river system, the sites have their own strong landscape typology.

The first site is an area near Lake Tana in the Ethiopian highlands. This area, experiencing monsoon rains, is one of the main sources of the river. The second site is the urban city of Aswan (or Assuan), Egypt. The city lies north of the Aswan Dam in an arid region and is surrounded by desert. The third site is in the Nile Delta, along the Rosetta Promontory. The Delta is a rich agricultural region.

For each site, an analysis is conducted to understand the site-specific challenges and opportunities. This is followed by an overview of inspirations, case studies and principles, both site-specific at a detailed level as well as focused on their place within the whole basin and river system.

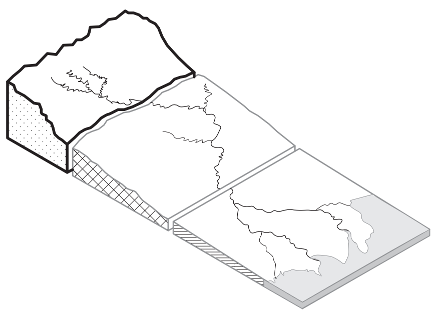


5.2 *Upstream*

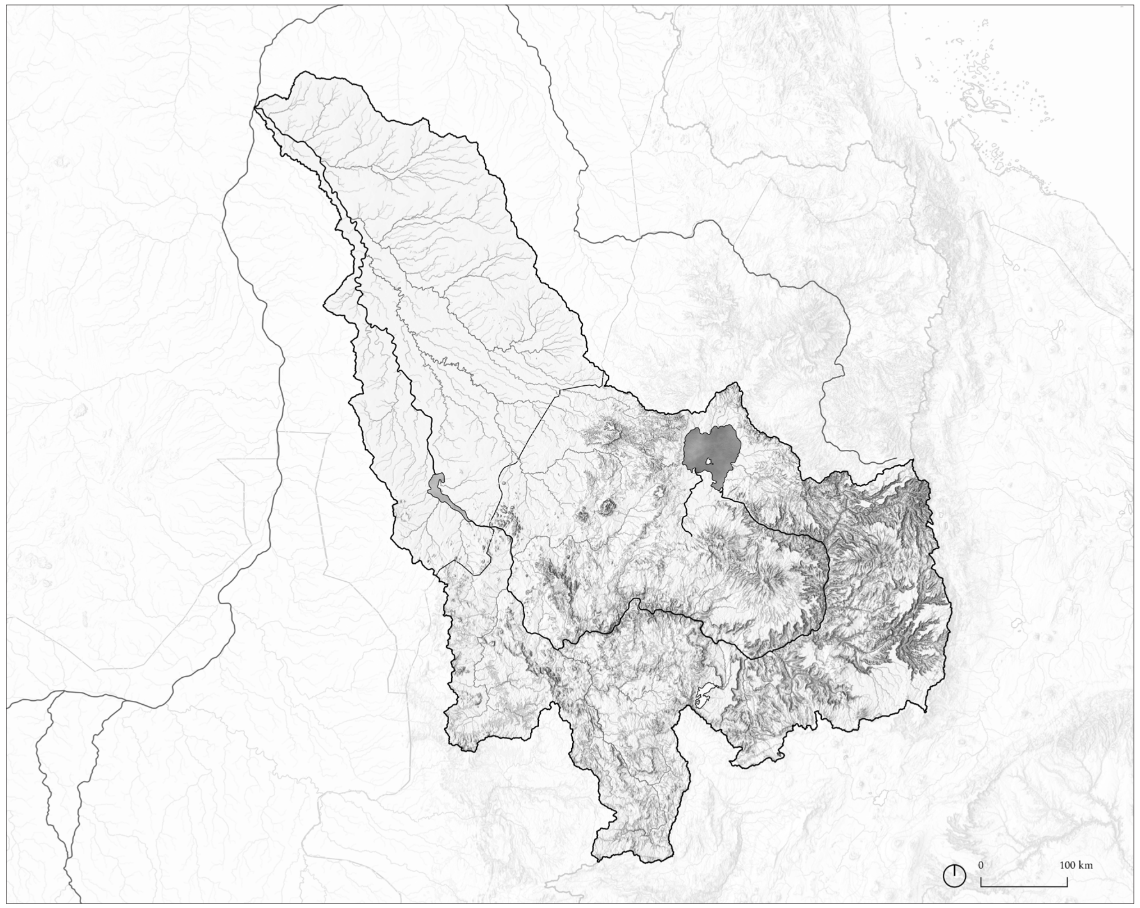
Ethiopian Highlands

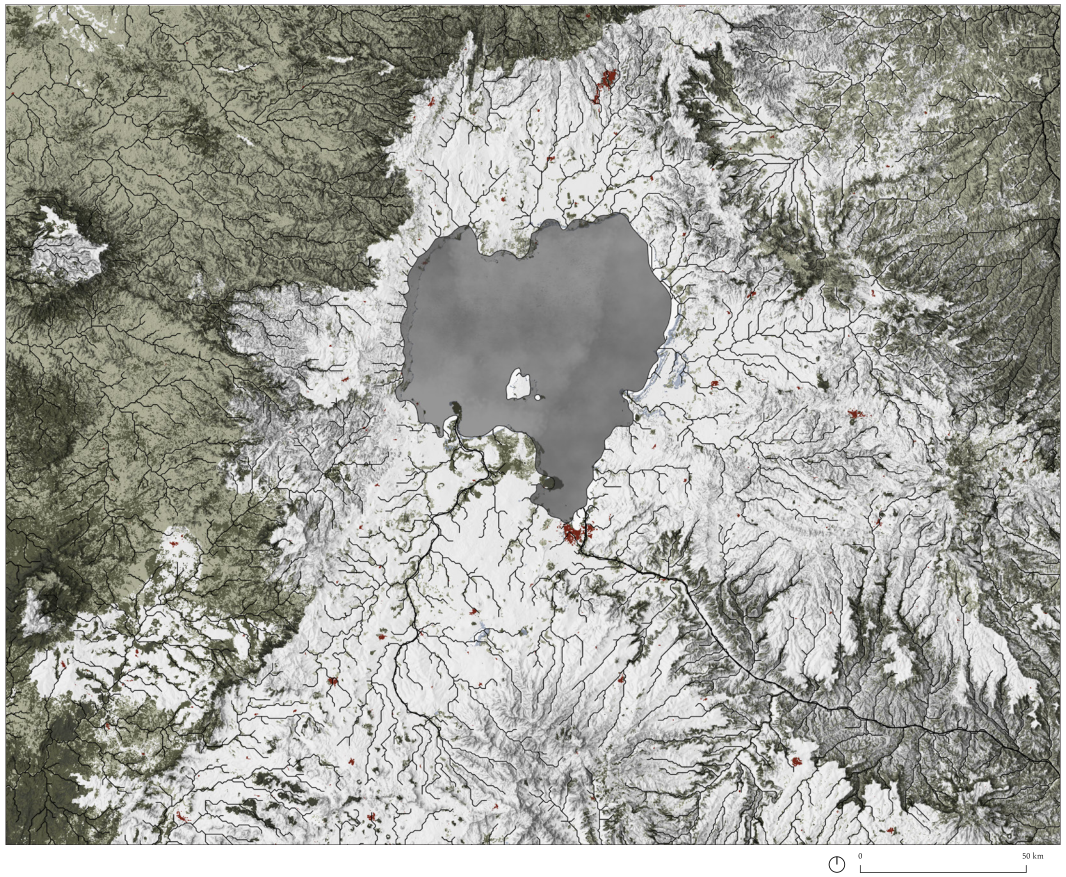
Ethiopia is one of the world's oldest countries in the Horn of Africa. It is one of the largest and most populated countries in the Horn of Africa. Ethiopia is located in the tropical latitudes, with tropical savanna or desert climatic conditions in the lower lying areas. The higher lying areas experience temperate climatic conditions. Ethiopia has three seasons, 'bega' is the long dry season which lasts from September to February. This is followed by 'belg', the short rainy season, in March and April. May is usually a hot and dry month, followed by 'kremt', the long rainy season, from June to August (Hopwood, et.al. , 2023).

One fifth of the population lives in an urban area, with most Ethiopians living in scattered rural communities. Ethiopia's most important resource is its agricultural land. Almost half of the highland arable land is still in use, despite soil erosion, overgrazing and deforestation. The majority of Ethiopia's gross domestic product (GDP) comes from agriculture. The main form of agriculture is subsistence smallholder farming, with small plots of land growing mainly staple cereals and legumes (Hopwood, et.al. , 2023).



>
location within the watershed: upstream





water

agriculture / cropland

forest

urban

Lake Tana

Lake Tana is located in the northwestern part of Ethiopia, in the Amhara region. The lake covers an area of approximately 3000 to 3500 square kilometres, depending on the season and amount of rainfall, making it the largest lake in Ethiopia. The lake is relatively shallow due to high sediment content, with a maximum depth of 15 metres (ESA, 2004).

Lake Tana was formed by volcanic activity about 5 million years ago. The lake is fed by seven large perennial rivers and 40 small seasonal rivers. Seasonal variations cause the water level of Lake Tana to fluctuate, just after the main rainy season the water level is high, the plains are often flooded and permanent swamps in the region are connected to the lake (Brittanica, 2019).

Lake Tana is used for fishing, agriculture and transport. The local ancient papyrus reed boat called 'Tanqua' is used for fishing and transportation. The lake region produces cereals, oilseeds and coffee. Livestock farming is also important.

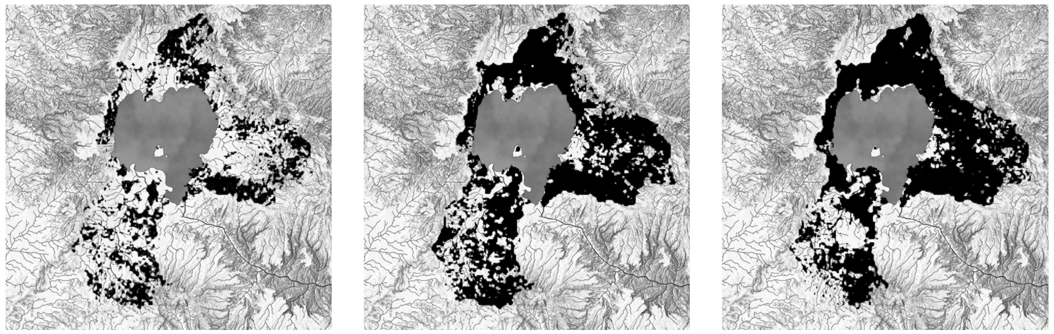
In 2015, the Lake Tana region was nominated as a UNESCO Biosphere Reserve for its cultural, historical and ecological importance. The islands contain the remains of ancient Ethiopian emperors and the treasures of the Ethiopian Church (UNESCO, z.d.).

^ *Fisherman in Lake Tana, A. Davey (2007) via Wikimedia Commons*

^ *Deforestation in the Ethiopian Highlands, Graham Maclachlan (2011), via Wikimedia Commons*

Challenges

Ethiopia has a current population of approximately 115 million and is projected to exceed 200 million by 2050, bringing along all sorts of challenges. These challenges affect the local scale, but also have far-reaching effects on the broader scale of the Nile Basin. One of the most pressing issues is the change in land use, particularly deforestation for agricultural purposes. The removal of trees and vegetation leads to increased soil erosion during monsoon rains, which, in turn, hinders water infiltration into the ground. The reduced water absorption exacerbates the problem of drought, as rainwater simply runs off, leaving the land parched. Furthermore, during the monsoon season, the lack of vegetation cover increases the risk of flooding as there are no roots to help water infiltrate into the ground and hold the soil in place. Throughout the Nile Basin, this is effecting the availability of water resources.



1989 *2005* *2019*

^ Change in farmland in the years 1989, 2005 and, 2019. Content available from Global Challenges. Figure based on Tikuye et al., 2022. Figure edited by author.

Land-cover change

Land use in Ethiopia has been highly influenced by the increase in the population in urban areas and the depopulation of rural areas (Hamza and Iyela, 2012). The population is overgrowing, and even the rural population is growing rapidly. This has all kinds of effects on the natural resources and land cover in Ethiopia and around lake Tana (Ellis et al., 2010). More agricultural land is created to accommodate for the fast-growing population, leading to a deteriorated environment (Wu and Zhang, 2012). As the demand for agricultural land and grazing areas keeps growing, the one -forested areas near lake Tana have been cleared, leading to a loss of crucial vegetation cover. The deforestation leads the soil to erode by wind and water and also diminishes the capacity of the land to absorb rainwater, leading to a risk of flooding and soil degradation. Over-grazing by livestock exacerbates the problem by compacting the soil, making it less fertile and more vulnerable to erosion.

About 90% of Ethiopian households' primary energy needs, particularly for cooking, are met by traditional biomass such fuelwood, charcoal, dung, and crop residue. Cutting down trees, splitting them into trunk pieces, and burning the resulting charcoal are the first steps in the production process. The nation's demand for charcoal surged more than 85 times. The rate of deforestation and forest degradation is significantly impacted by this.

Soil erosion

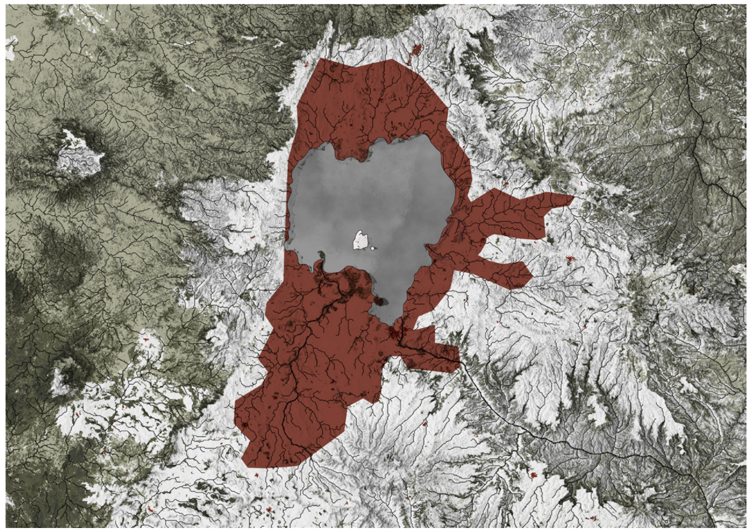
Ethiopia is a nation deeply rooted in agricultural traditions. The importance of soil health cannot be overstated. The fertile lands around Lake Tana have long been a vital part of Ethiopian agriculture. Soil degradation, erosion and rampant deforestation have led to an alarming increase in the risk of landslides around Lake Tana. Over-farming, extensive grazing and deforestation have eroded large areas of land. The consequences of the loss of topsoil are worrying. Excessive sedimentation ends up in the lake, clogging its waters and reducing its flow (Bogale, 2020). As a result, the once fertile agricultural lands are gradually turning into barren deserts, deprived of the essential nutrients needed for crops to thrive. This threatens the livelihoods of many local farmers.

Drought

Ethiopia has endured 10 major droughts for the last four decades since 1980 and the everage annual temperature has been increasing by 0.37 degrees per decade (Trocaire, 2021). Data from USAID shows that in the recent drought of 2022 more then 6.2 million people were affected and in need of urgent food assistance. The impact of the drought is visible in the diminishing of pasture lands, significant crop losses, severe water shortages and livestock deaths (USAID, 2022).

Flood risk

For the past three consecutive years, the Lake Tana Basin has experienced severe flooding. As reported by OCHA, these floods have left a trail of destruction, affecting the lives of 25,000 people in 2019 alone, killing 2 people and submerging 6,653 houses. The growing risk of flooding is linked to the problem of soil erosion. The loss of fertile topsoil due to over-farming, grazing and deforestation is causing Lake Tana to clog. As the eroded sediments find their way into the lake, they block the flow of water, reducing its capacity to absorb excess rainfall and discharge it effectively (Wubalem, et.al., 2021).



< flood prone areas around Lake Tana, OCHA (2006) edited by author

Water Hyacinth in lake Tana, source: Les Voix du Nil from InfoNile, 2021

Water Hyacinth

Eichhornia crassipes = water hyacinth. is one of the top ten invasive species in the world, given its extremely quick expansion rate of doubling its biomass every five days. every plant contains 4700 seeds, with dynamic movement, the weed moves quickly. Extremely damaging to the aquatic ecosystem because it forms a thick floating mat on the water surface that tends to reduce sunlight and the exchange of gasses between the water surface and atmosphere, according to researchers at Bahir Dar University in Ethiopia (Sive, 2023).

reduces the water storage of the lake. Destroying fisheries, maie and rice crops. negative impact on tourism, irrigation, transporation, water quality, aquatic biodiversity, and animal grazing on the flood plains.

The study also showed that the post-rainy season is the peak season for water hyacinth expansion, since when the lake level increases, the lake water expands to the floodplain. The Northeast shore of the lake is the most suitable area for the growth and expansion of water hyacinth, because the floodplain is shallow and rich in sediment deposit (Sive, 2023).

The problem isn't Lake Tana, he said. The source of the problem is in the catchments in the mountains – an area where all the water flows into a single stream, as pollutants get into the watershed via urban pollution or agricultural runoff (pesticides and fertilizers) (Sive, 2023).

^ drawing of water hyacinth, by author.

Nutrient pollution

The presence of faecal contamination and toxigenic cyanobacteria, particularly along the lake's shores and estuaries, indicates the detoriation of Lake Tana's water quality. Water quality has been deteriorating for years, affecting agriculture, industry, hydropower generation, ecosystem, water supply and recreational activities (Goshu et al., 2017).

Nutrient-rich runoff from agricultural lands and industrialised and urbanised cities results in high concentrations of phosphorus in Lake Tana. The excessive nutrient pollution has led to algal blooms, causing euthrophication and detoriation of water quality (Ayele & Atlabachew, 2021).

The consequences of water quality degradation do not only affect the environment. Local communities depend on the lake for most of their daily needs. For many people living around Lake Tana, the lake is a vital source of water for washing clothes and bathing. Some rely on the lake's raw water for drinking, putting them at risk of waterborne diseases (Goshu et al., 2017).

Wetland deforestation

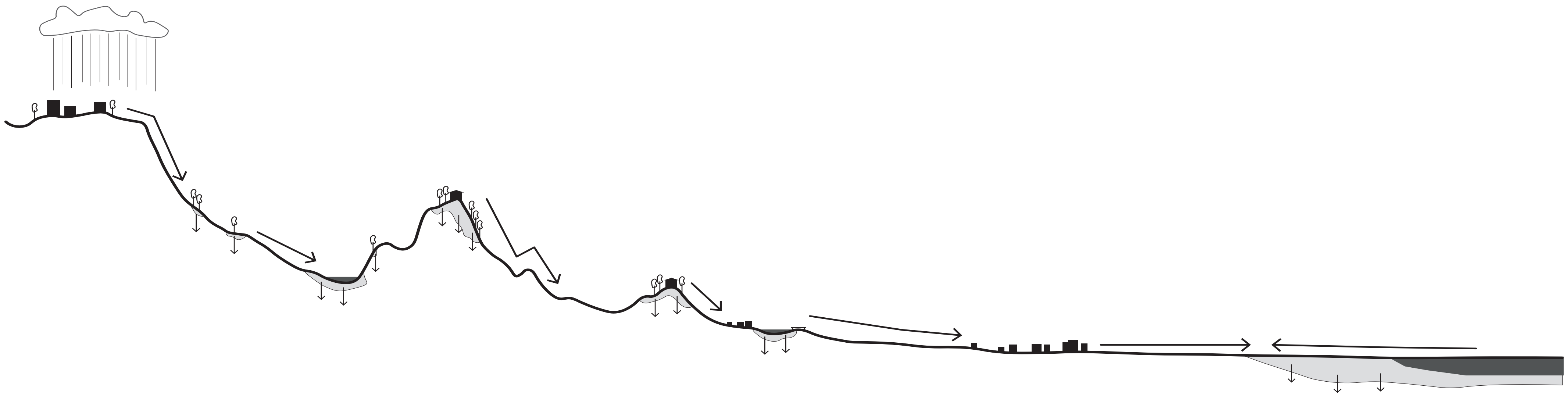
Lake Tana has a diverse range of wetlands, including lacustrine, riverine, floodplain, marsh and swamp, each with its own unique ecological significance. These wetlands are subject to seasonal flooding during the rainy months and have historically been characterised by iconic papyrus beds. However, the papyrus beds, an iconic feature of the Lake Tana landscape, have been in rapid decline due to a combination of factors. Catchment degradation, over-exploitation, the spread of invasive weed species and habitat fragmentation have combined to cause a significant loss of these wetlands. As the dry season arrives, these once-flooded areas become available for agricultural use, but the consequence of such conversion is a marked degradation of wetland ecosystems. Siltation, land conversion for cultivation and overgrazing have all contributed to the worrying deterioration of these vital wetlands (Goshu & Aynalem, 2017).

Towards a resilient Nile River basin

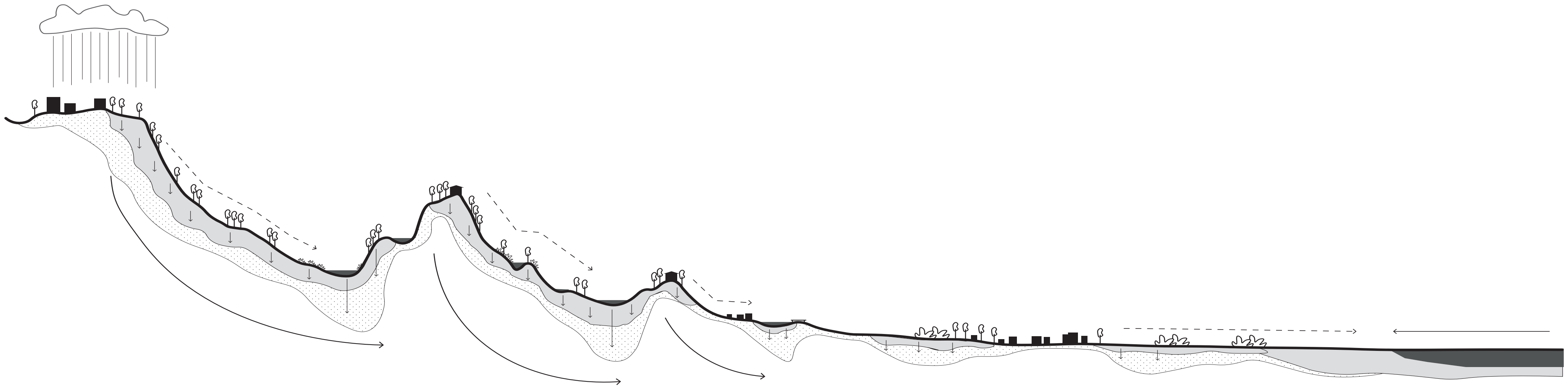
The site is located upstream in the basin near one of the river's main sources, Lake Tana in Ethiopia. This site faces some local challenges such as soil erosion, land degradation, droughts and floods. While this has a major impact on the local scale of the region, it also affects the river system and thus the basin as a whole. Currently, during the rainy season, water flows directly into the lake, which empties into the Blue Nile. Due to poor land management, soil erodes rapidly and flows into the lake, increasing the risk of flooding. During the dry season, there is little rainfall, but the water from previous months has already been drained, causing the land to experience extreme drought. By increasing the sponge capacity of the Lake Tana region and managing the retention, detention and discharge of water, the flow can become more gradual rather than a high peak and long low. If the water from Lake Tana can be released more gradually into the Blue Nile, this would mean a reduction in the risk of flooding and drought further down the river system. A more gradual flow could encourage an acceptance of river dynamics and fluctuations, as they are more gradual and therefore less impactful changes.

^ Amhara shepherd boy, Damien Halleux Radermecker, via Wikimedia Commons

current situation



desired situation



^Mursi woman in Ethiopia, Dr. Ondřej Havelka (cestovatel), via Wikimedia Commons

Learning from ...

In this chapter, an exploration on how to work towards a more resilient Lake Tana is done. This is done by learning from local practices, real-life examples, and new methods that contribute to a resilient Lake Tana and therefore helpt the Nile River Basin to become more resilient.

Many indigenous communities in Ethiopia have thrived for centuries by living in harmony with nature. They have developed sustainable practices that serve as valuable lessons for the rest of the world. These indigenous groups often rely on traditional farming methods that work with the land, rather than against it. They understand the importance of crop rotation and leaving fallow periods to allow the soil to regenerate naturally. This intimate relationship with nature is a reminder of the importance of preserving traditional knowledge and practices, as we can learn valuable lessons from these indigenous communities about maintaining ecological balance and sustainability.

Moreover, there is immense potential in combining these time-tested methods with new, innovative technologies and approaches. By building forward on the wisdom of indigenous people, we can develop modern, sustainable solutions that not only preserve the environment but also enhance livelihoods, all while respecting and celebrating the indigenous communities that have been the stewards of these lands for generations.

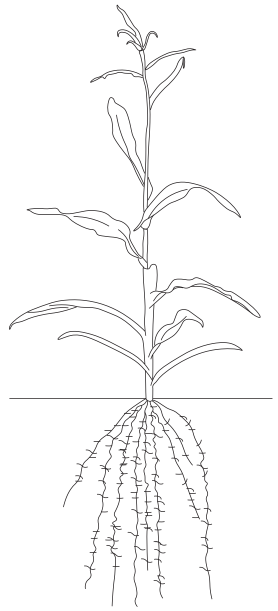
^ Mamitu's homestead garden
Photo: CRS Ethiopia

Home gardens

Ethiopian households have been practising homestead agriculture for centuries. This small-scale 'backyard' production has traditionally focused on calorie-rich but nutrient-poor crops such as maize and enset, or stimulants such as coffee or khat (Hivonen, 2018).

Often a multi-storey agro-forestry system is used: trees, shrubs and annual crops are grown together in a forest-like system. Trees provide fruit, fodder or soil-building properties and shade for mid-story crops such as coffee and enset (ventricosum), while vegetables and medicinal herbs grow on the forest floor (Bourne, z.d.).

Homestead gardening can help improve household nutrition, especially in rural areas of Ethiopia. Surplus produce can be sold at local markets to generate additional income (Bourne, z.d.).



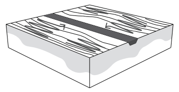
Water Hyacinth harvesting

Dr Ayalew Wondie, Associate Professor of Aquatic and Wetland Sciences at Bahir-Dar University, works to empower communities to protect and conserve Lake Tana. One of the key issues he is addressing is the underutilisation of water hyacinth dry matter by farmers, a valuable resource that can be converted into fertiliser. Currently, water hyacinth dry matter is disposed of by burning.

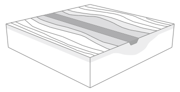
Dr Wondie says the source of the lake's problem with invasive water hyacinth growth lies in the mountainous catchment areas, where urban pollution and agricultural run-off, including pesticides and fertilisers, introduce pollutants into the watershed. To combat these problems, integrated watershed management is being used, which includes soil restoration through reforestation, the reintroduction of native plants and community involvement. It is recommended that the weed is removed during the dry season, from February to April, when its cover is minimal (Castanha, 2021).

^ Water Hyacinth clearing
Photo: Les Voix du Nil from InfoNile, 2021

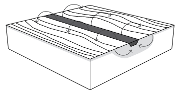
home garden



slow the flow



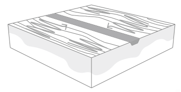
allow the flow



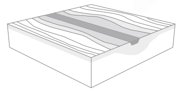
balance the flow

erosion prevention	●○○○○
water harvesting	●●○○○
increase vegetation	●●●●○
improve soil health	●●○○○
pollution	●●●○○

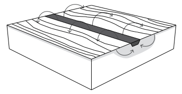
organic fertilizer



slow the flow



allow the flow



balance the flow

erosion prevention	○○○○○
water harvesting	○○○○○
increase vegetation	○○○○○
improve soil health	○○○○○
pollution	●●●●●

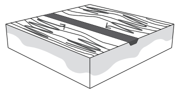
Greener Land

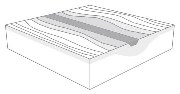
Greener.Land is an open source toolbox driven by a mission to combat landscape degradation through restoration. Its creators are committed to raising awareness and inspiring action to tackle the problem of landscape degradation. By empowering individuals and communities to choose the most appropriate method to restore their landscapes. The toolbox offers practical filters such as aridity, slope and budget.

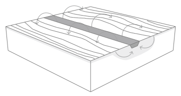
The following pages provide an overview of some of the principles that can be applied in the Lake Tana region to combat landscape degradation by restoring the landscape and revitalising the health of the land, soils and local ecosystems.

^ digging bunds
Photo: Justdiggit

eyebrow terrace

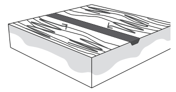

slow the flow

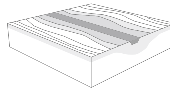

allow the flow

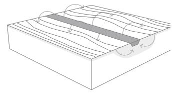

balance the flow

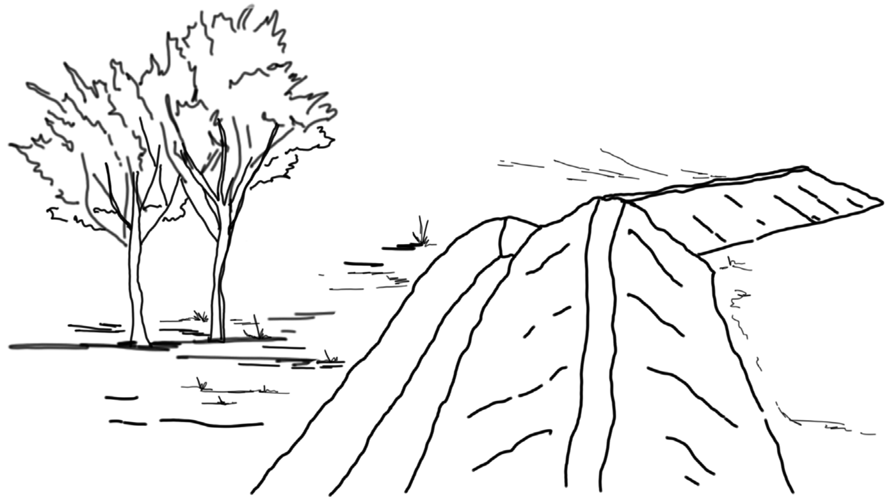
erosion prevention	●●●○○
water harvesting	●●○○○
increase vegetation	●●●●○
improve soil health	●○○○○
pollution	○○○○○

fanya chini


slow the flow

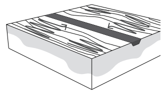

allow the flow


balance the flow

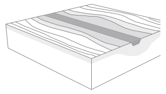


erosion prevention	●●●●○
water harvesting	●●●○○
increase vegetation	●●●●○
improve soil health	●●○○○
pollution	●○○○○

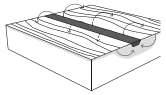
vetiver grasses



slow the flow



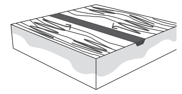
allow the flow



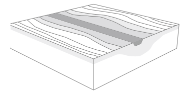
balance the flow

erosion prevention	●●●○○
water harvesting	●●●●○
increase vegetation	●●●●○
improve soil health	●●●○○
pollution	●●○○○

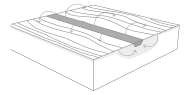
terracing



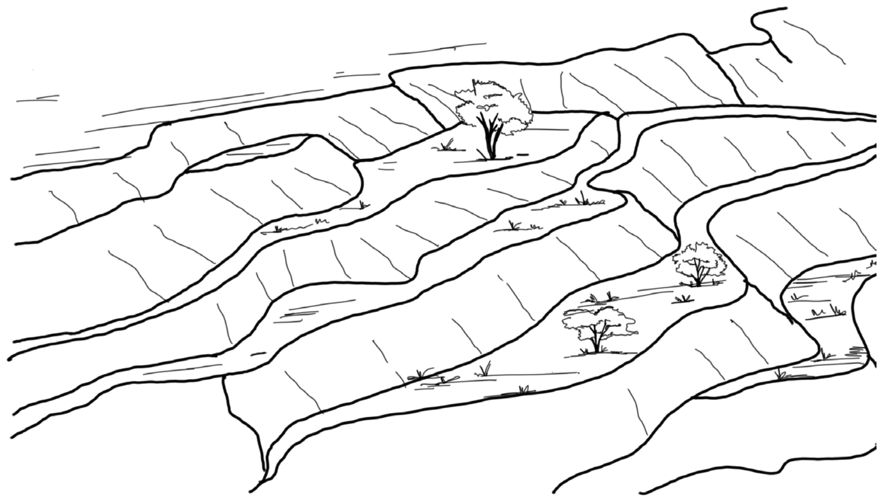
slow the flow



allow the flow

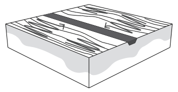


balance the flow

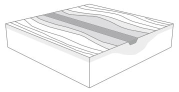


erosion prevention	●●●○○
water harvesting	●○○○○
increase vegetation	●●●○○
improve soil health	●○○○○
pollution	○○○○○

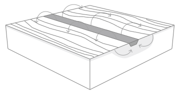
semi circular bunds



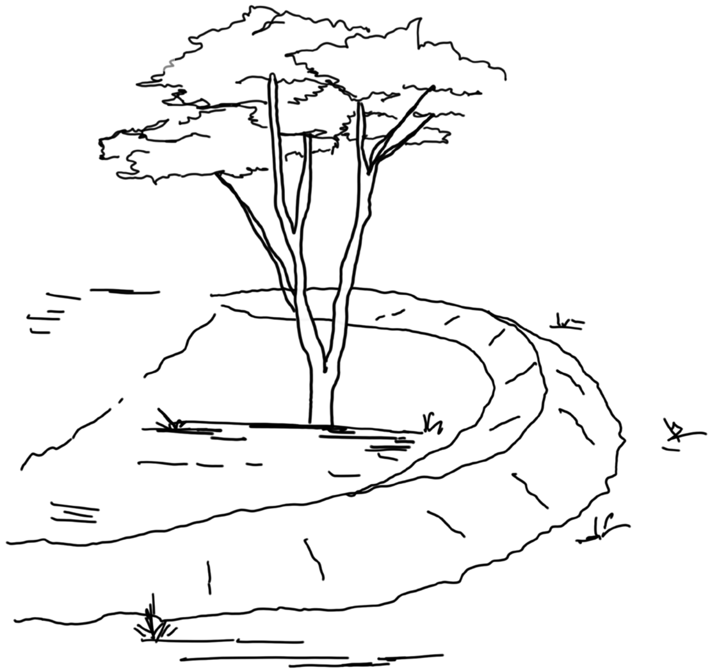
slow the flow



allow the flow

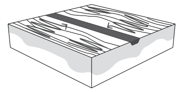


balance the flow

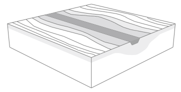


erosion prevention	●●●○○
water harvesting	●●○○○
increase vegetation	●●●●○
improve soil health	●○○○○
pollution	○○○○○

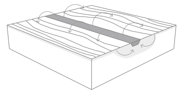
negarim



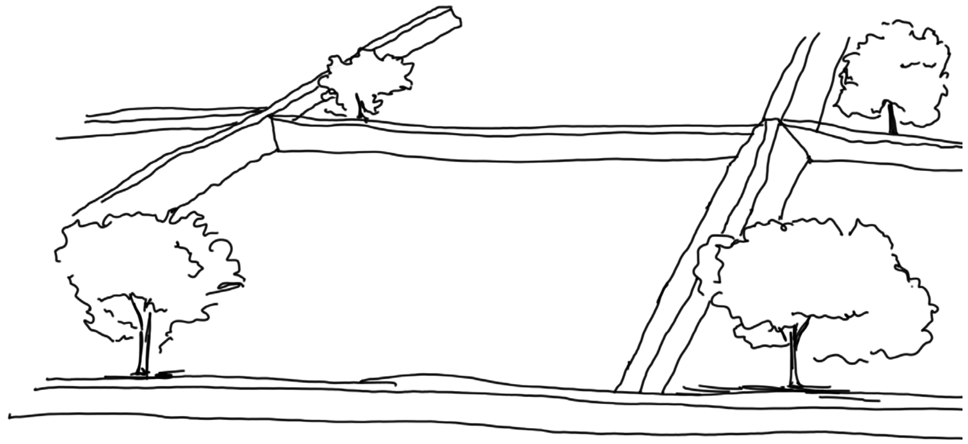
slow the flow



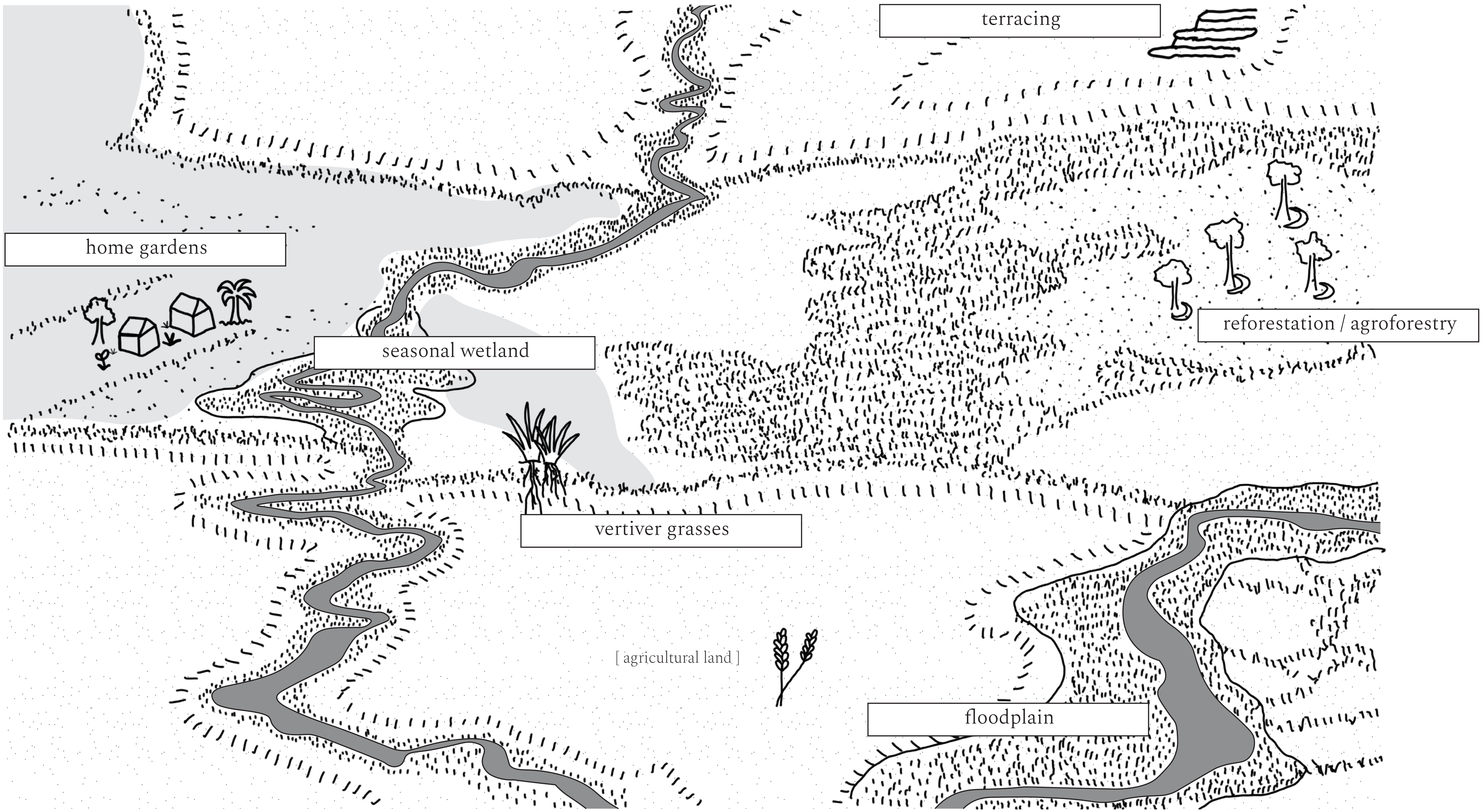
allow the flow



balance the flow

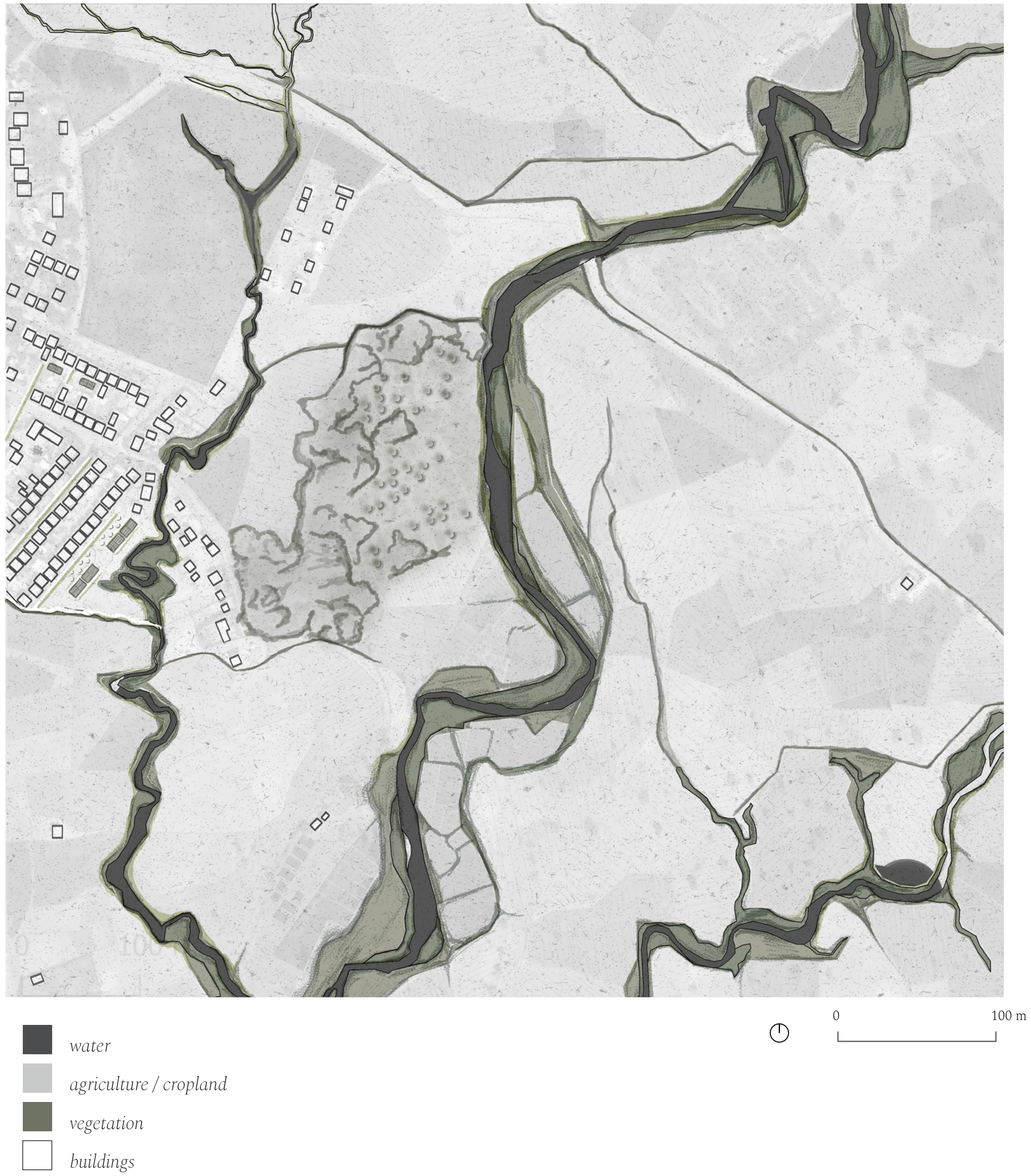


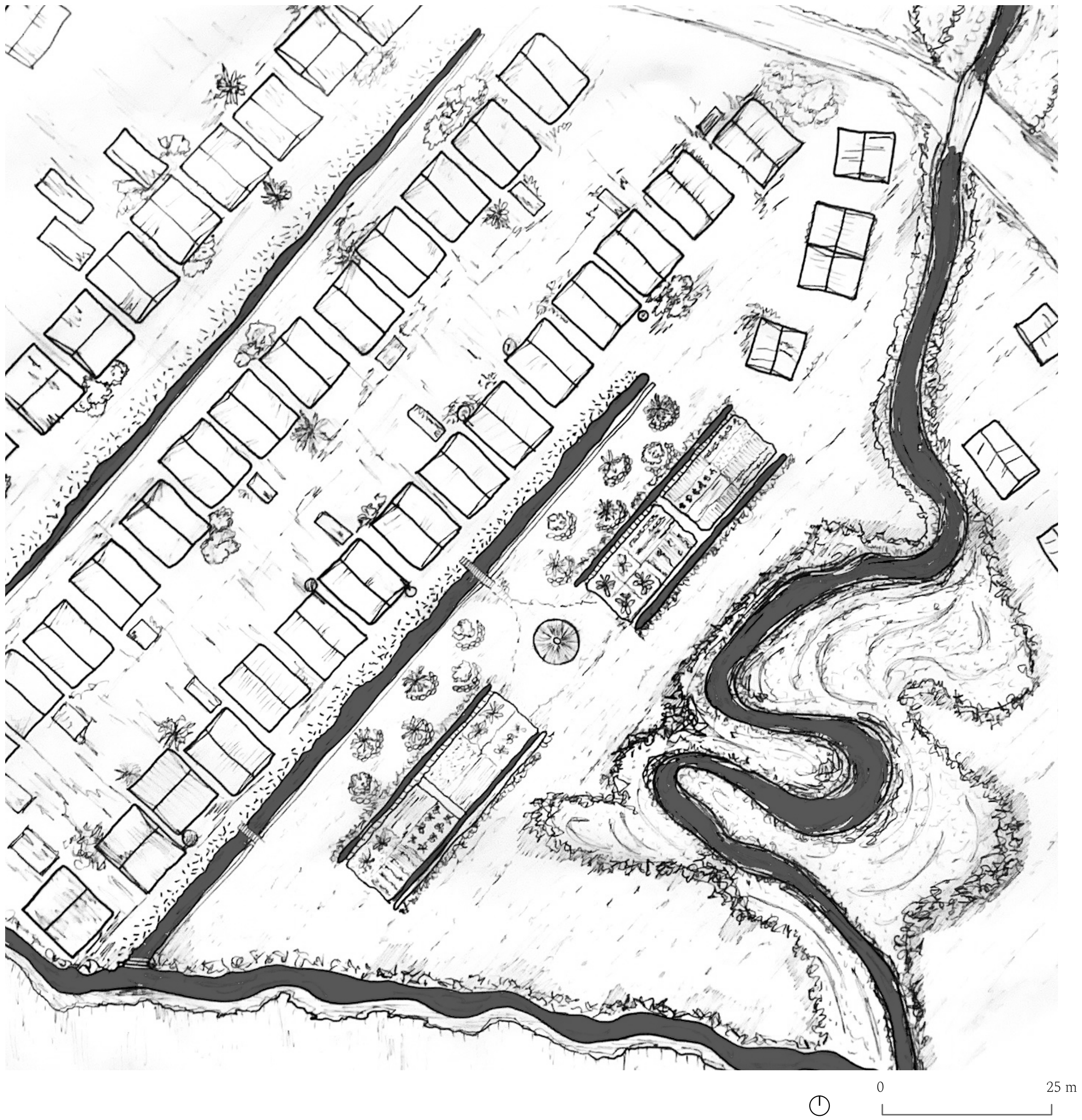
erosion prevention	●●●○○
water harvesting	●●●●○
increase vegetation	●●○○○
improve soil health	●○○○○
pollution	○○○○○


terracing
home gardens
reforestation / agroforestry
seasonal wetland
vertiver grasses
[agricultural land]
floodplain

Implementing strategy

The strategic design for the site near Lake Tana in the Ethiopian highlands takes a whole-systems approach to creating a sustainable and environmentally conscious space. The plan introduces a negotiation space that integrates several key elements to harmonise the relationship between the community and its natural environment. Vertiver grasses will be planted along the waterways to stabilise the soil and prevent erosion. There is a strong emphasis on the expansion of floodplains, which serve a dual purpose: they store water during the rainy season and create temporary wetlands that enhance biodiversity. In addition, these floodplains play a crucial role in maintaining water and soil quality. The inclusion of a buffer zone of native papyrus reed not only serves as a vital resource for the construction of the traditional boats used on Lake Tana, but also helps to purify the water, reduce chemical run-off from agriculture and grazing, and control the excessive growth of water hyacinth in the lake. To further protect the ecosystem, reforestation efforts are being made to protect and enhance the existing forest structure, while contour planting techniques are being used to conserve soil and water resources. Homegardens are being established on the outskirts of the village to store water in ditches and to produce fruit, vegetables and cereals. The introduction of productive trees not only increases the sponge capacity but also combats soil erosion. In addition, community spaces are created for food storage, reed processing and social interaction, strengthening bonds within the local population and promoting sustainability within the ecosystem.

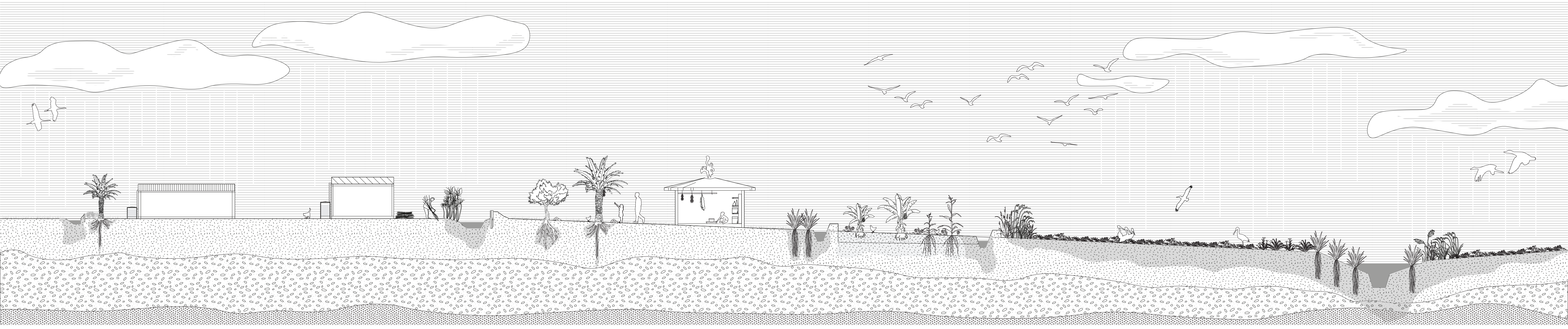




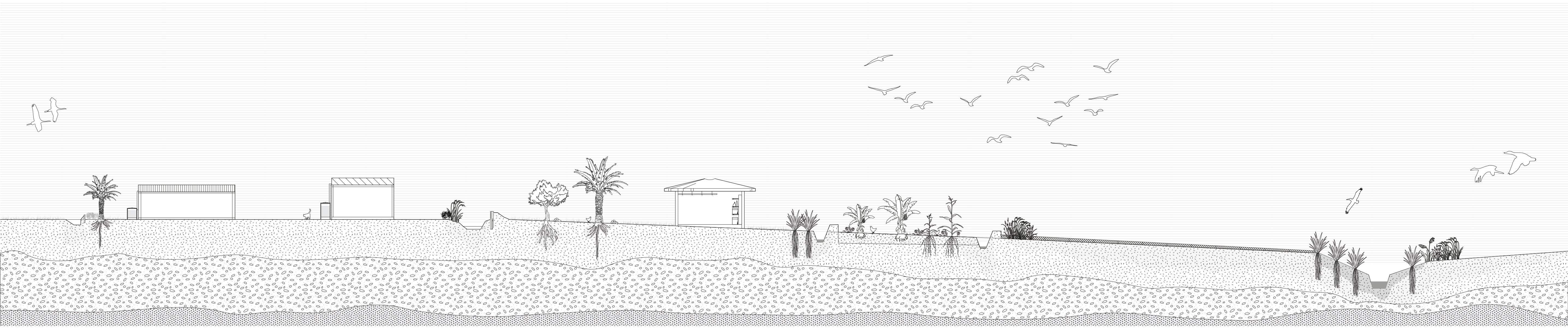
Local design

At the local level, the strategic design focuses on optimising the use of the land throughout the seasons. During the rainy season, the area is strategically designated as a flood plain to efficiently manage excess water. During the dry season, it is converted to wetlands and agricultural land, allowing for a multifunctional approach to land use. The introduction of home gardens is a key component of this strategy, serving the dual purpose of providing a source of food for the community and enhancing the local ecosystem. To manage water resources effectively, a system of water buffers is being implemented to allow the area to release excess water during peak rainfall periods and retain it during low rainfall periods. This not only helps to prevent flooding, but also increases the sponge capacity of the land, promoting sustainable water use. The protection and introduction of trees, both productive and traditional, play a vital role in maintaining the health and resilience of the ecosystem. Along waterways, vegetation is strategically placed to prevent soil erosion and promote soil and water conservation. This local implementation is in line with the larger strategy, combining different land uses to ensure sustainable and efficient use of the land while protecting the local environment.

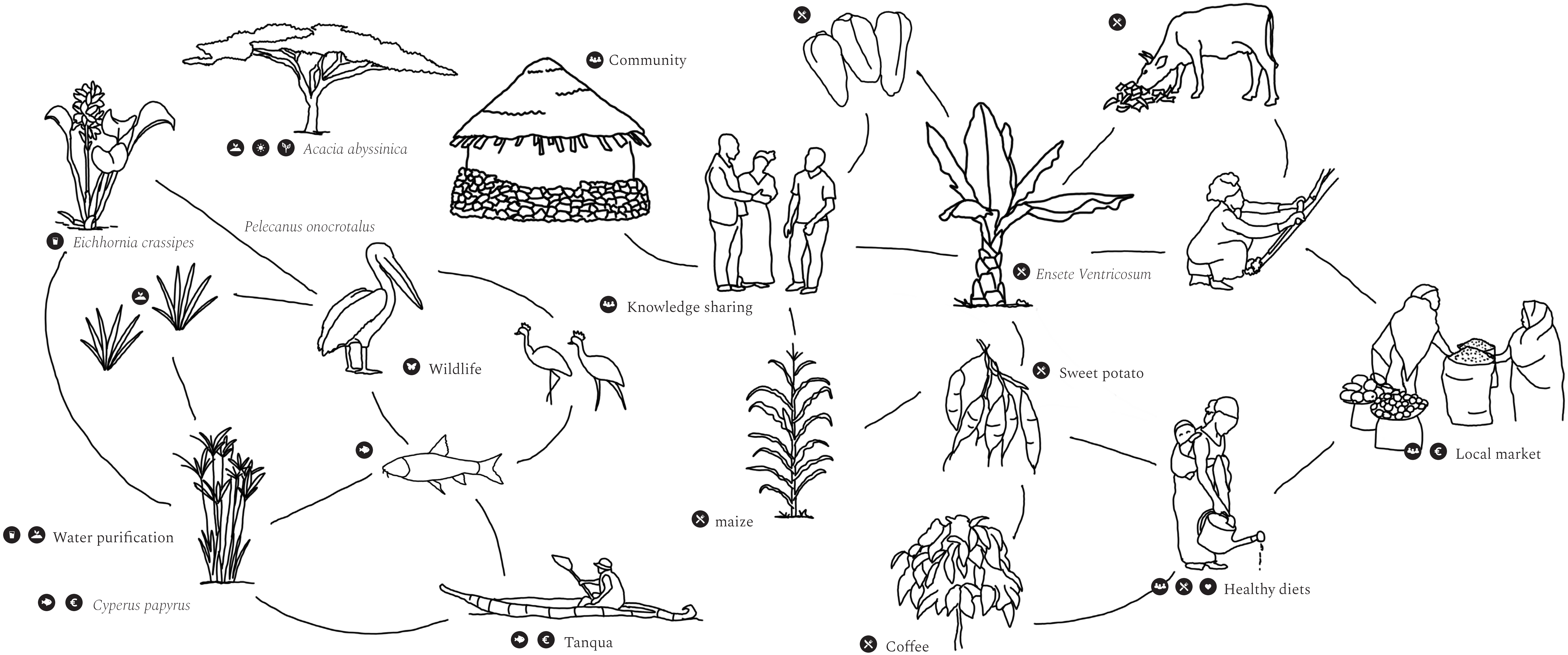
Wet season



Dry season



Stakeholders



5.3 *Midstream*

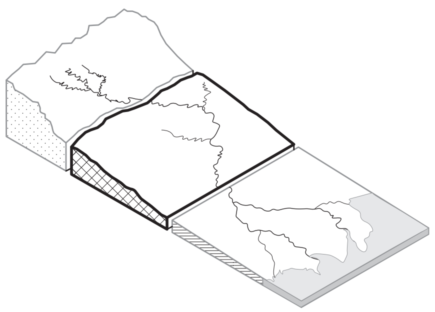
Midstream

Aswan (also spelled Assuan or Assouan) is a desert city in the southern region of Egypt. The city lies on the banks of the Nile and is surrounded by desert.

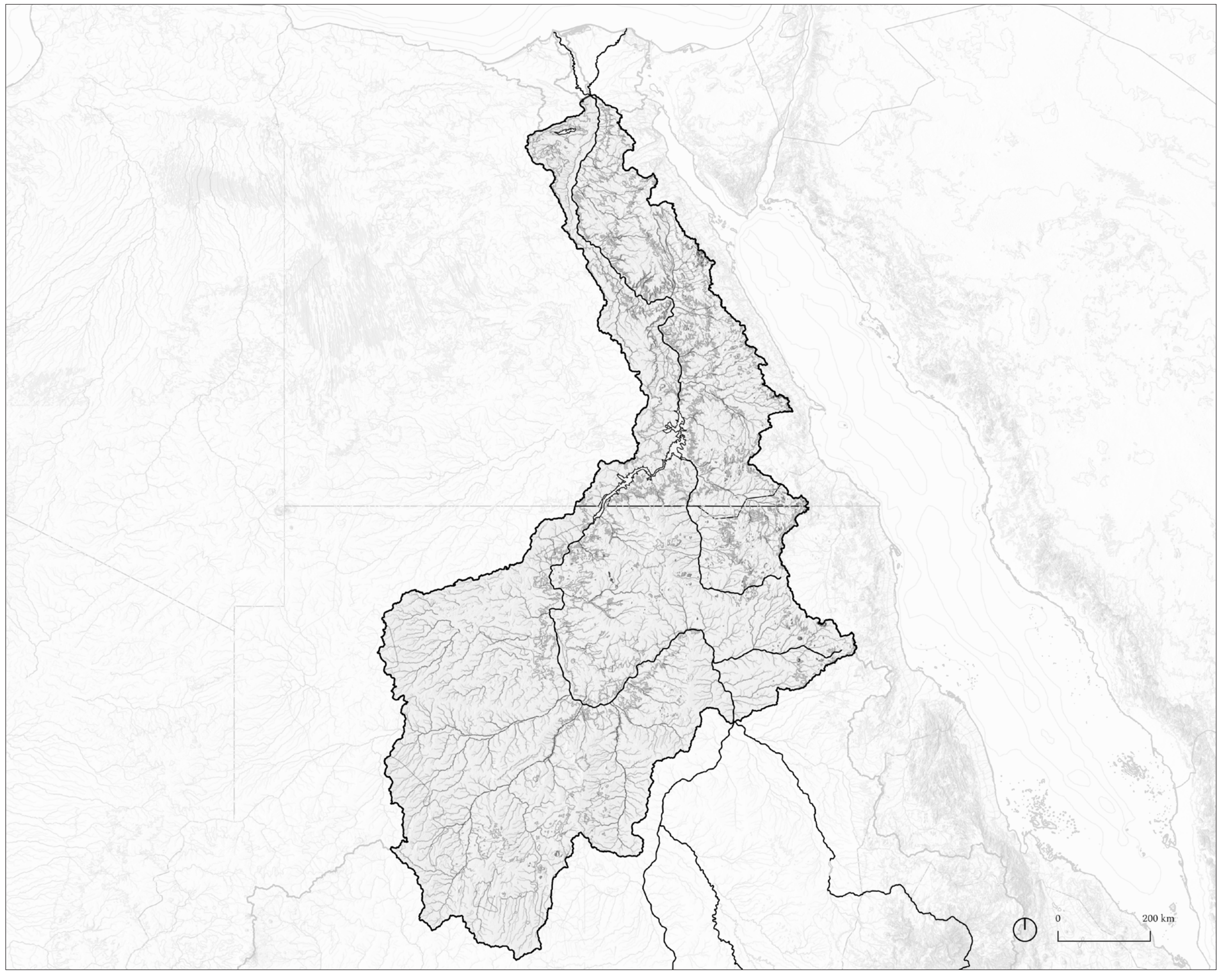
Like the rest of Egypt, Aswan has a hot desert climate. Aswan is one of the hottest, sunniest and driest cities in the world. Aswan is extremely dry all year round, with an average annual rainfall of less than 1mm, and even years with no rainfall. When it rains heavily, the chance of flash floods is high.

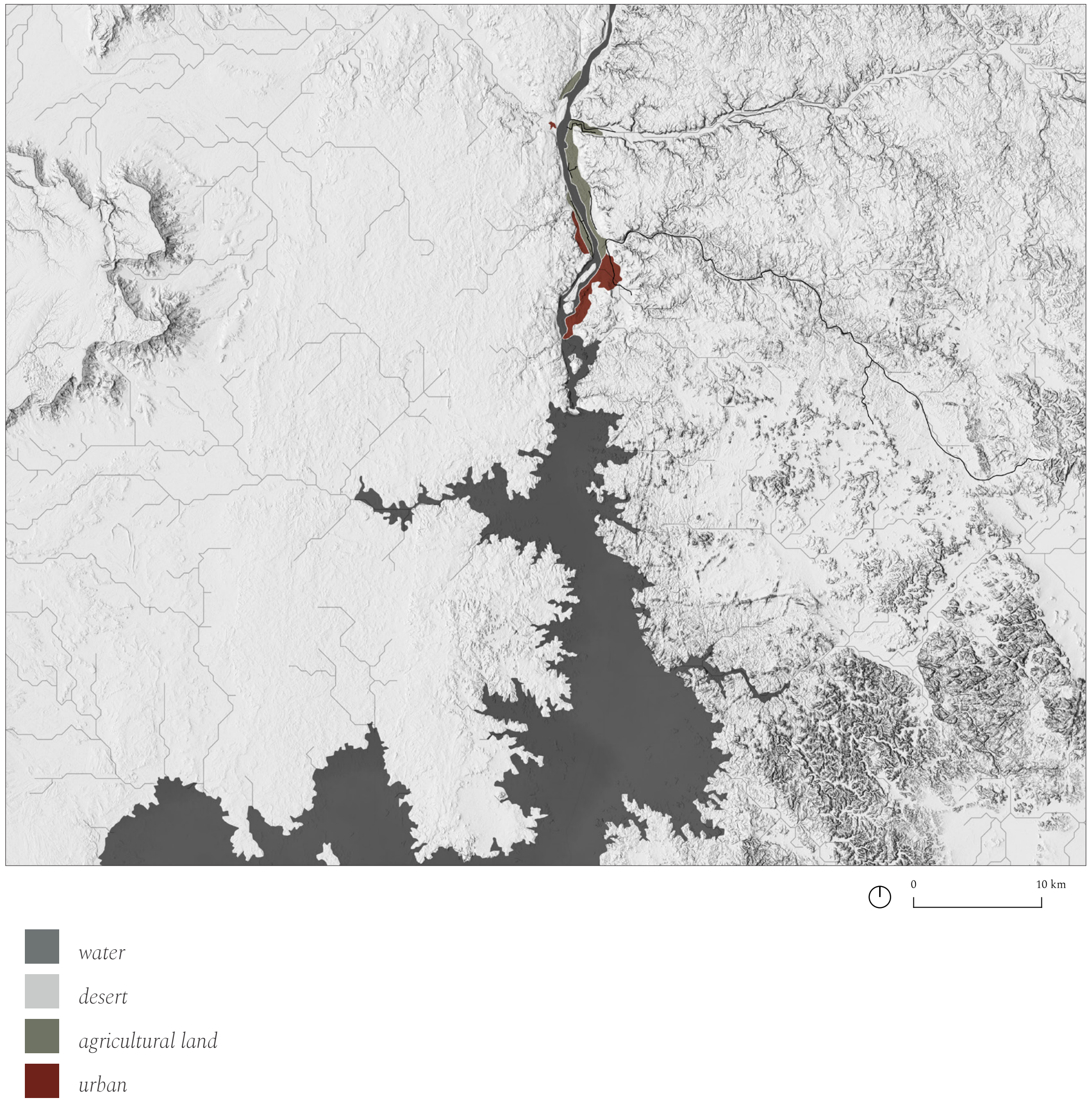
Just above the city of Aswan is the old Aswan Dam, and a little further south is the Aswan High Dam, one of the largest dams, completed in 1970. The Aswan High Dam has allowed the Egyptians to irrigate the Aswan governorate all year round. The dam has tamed the Nile, controlling the annual flood and generating enormous amounts of hydroelectric power.

The dam has created a reservoir, Lake Nasser, which supports the fishing industry. The creation of the dam's reservoir led to the resettlement of ninety thousand Egyptian fellahin and Sudanese Nubian nomads.



>
location within the watershed: midstream



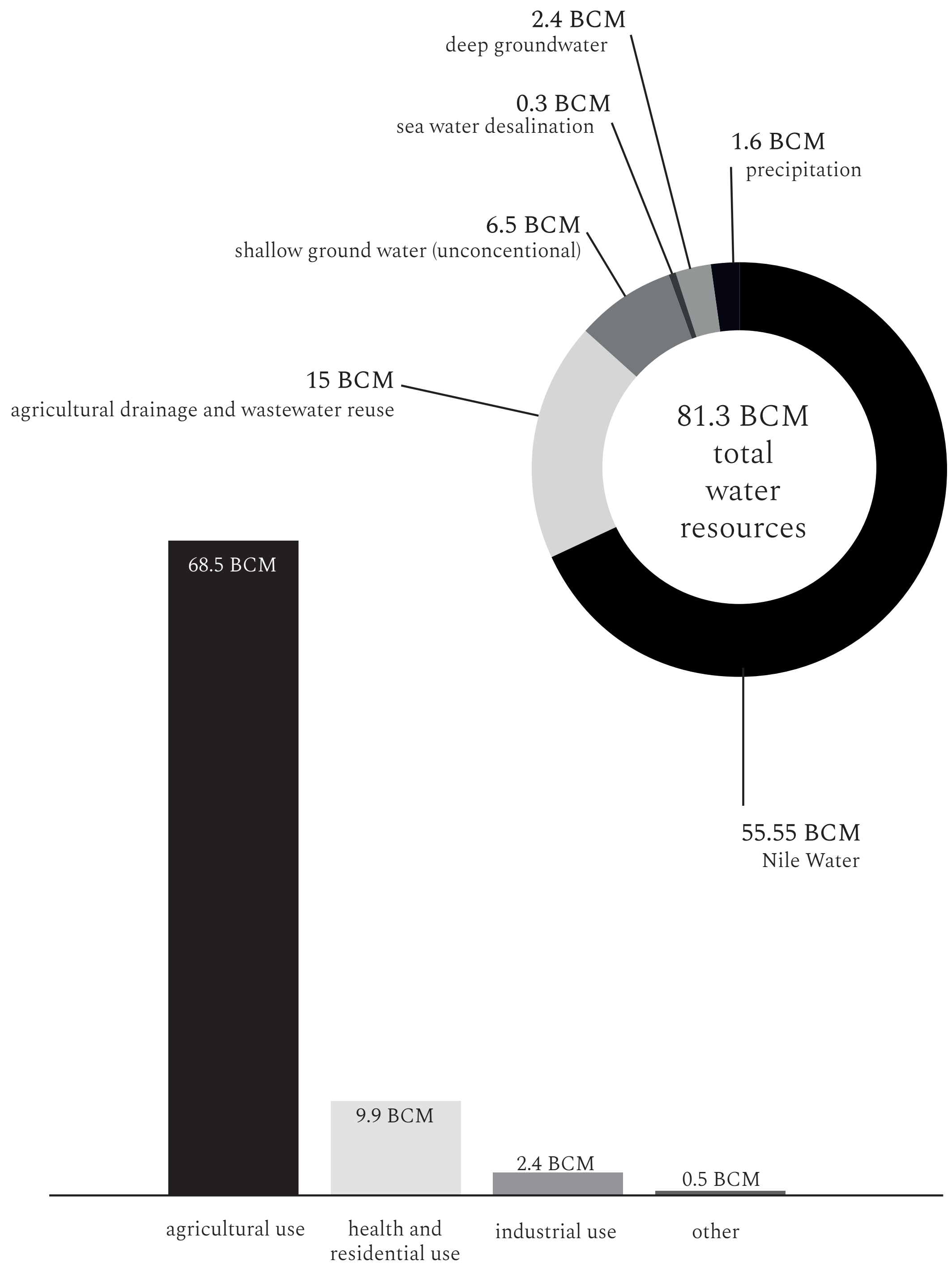


Regional context

Aswan, a city in Egypt, is a place of contrasts. Nestled in the vast Nile Valley, it boasts a rich tapestry of history and culture. However, the city is not without its challenges as it grapples with the scorching high temperatures that are characteristic of the region. In the midst of its arid climate, Aswan serves as a vital hub for the nearly 97% of Egypt's population who live along the confined space of the Nile Valley, which stretches from Aswan to Cairo in the fertile delta region.

Challenges

The Aswan region of Egypt faces a number of pressing challenges, with uncertainty about the future at its most prominent. One of the most alarming issues is the relentless impact of climate change. In recent years, Aswan has witnessed a trend of rising temperatures and shifting rainfall patterns. These changes in weather patterns are projected to become more frequent and severe, exacerbating the region's existing vulnerabilities. Annual increases in temperature and decreases in rainfall pose a significant threat to Aswan's agricultural practices and water resources. The region is also experiencing an increase in extreme climate events, including droughts and floods, adding to the uncertainty surrounding its future (Redeker et.al., 2021).



Water balance, figure by Redeker et. al., 2021. Edited by author

Water challenges

The Aswan region of Egypt faces a critical imbalance in its water resources. Agriculture, a vital sector for the region, places significant demands on water resources. Similarly, the provision of drinking water to the population and the water requirements of various industrial processes place significant demands on available water sources. In addition, water is essential for power generation, navigation and the preservation of environmental habitats.

Currently, Egypt's primary conventional water resources, which include the Nile River, effective rainfall and non-renewable deep groundwater, amount to 59.8 billion cubic metres (BCM) per year. In contrast, the total water demand in Aswan is 81.3 BCM per year, indicating a significant deficit of about 21.5 BCM per year. This discrepancy has led to the implementation of various measures to address the shortfall, including the reuse of drainage and wastewater and the extraction of shallow groundwater (Redeker et. al., 2021). Egypt is currently considered to be in a region of "severe water stress," with yearly water resources dropping below 500 m3 per person, which is considered to be alarmingly near to "absolute scarcity."

Flash floods

In modern Egypt, flash floods have become a common natural disaster. These floods are caused by heavy rainfall that falls suddenly and unexpectedly, or by a powerful surge of water. In the past, floods in Egypt were most often caused by the Nile, as the annual heavy rains occur further south at the headwaters of the Blue and White Nile, when the extra water is flooded and moves northwards through the rivers. Following the completion and operation of the Aswan High Dam in the 1970s, heavy rainfall resulting in flash floods caused by climate change has become a frequent and widespread type of flooding in Egypt over the last forty years (Hassan et. al., 2015). In November 2021, extreme rainfall, thunderstorms and snow hit several towns in the Aswan governorate. Several houses collapsed, three people died and 450 were injured after being stung by scorpions flushed out of their burrows during the storm (Ahram Online, 2021).

Urbanization

Population growth, combined with rural-urban migration and economic development, has led to a significant increase in urbanisation. Aswan has transformed from an agrarian society into an urban centre. The city has expanded to meet the needs of the growing population. The expansion of the city has put pressure on waste management and environmental sustainability.

Population growth

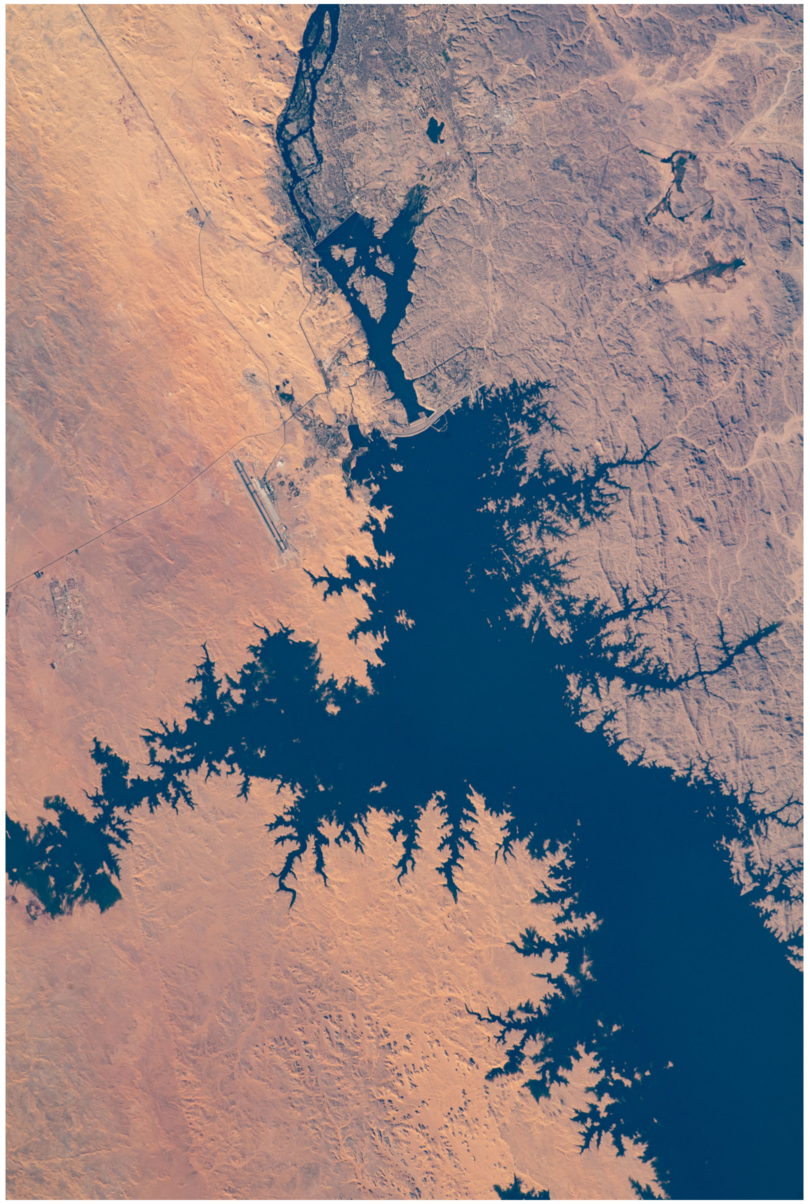
Egypt's population has been growing steadily, with high birth rates and improved healthcare leading to significant population growth in Egypt. Aswan is no exception. The population growth has put pressure on the city's housing, transport, health, education and infrastructure. In addition, Aswan is a desert city with limited local resources, and the increase in population has put pressure on the sustainability of local resources, particularly water and arable land.

Arid climate

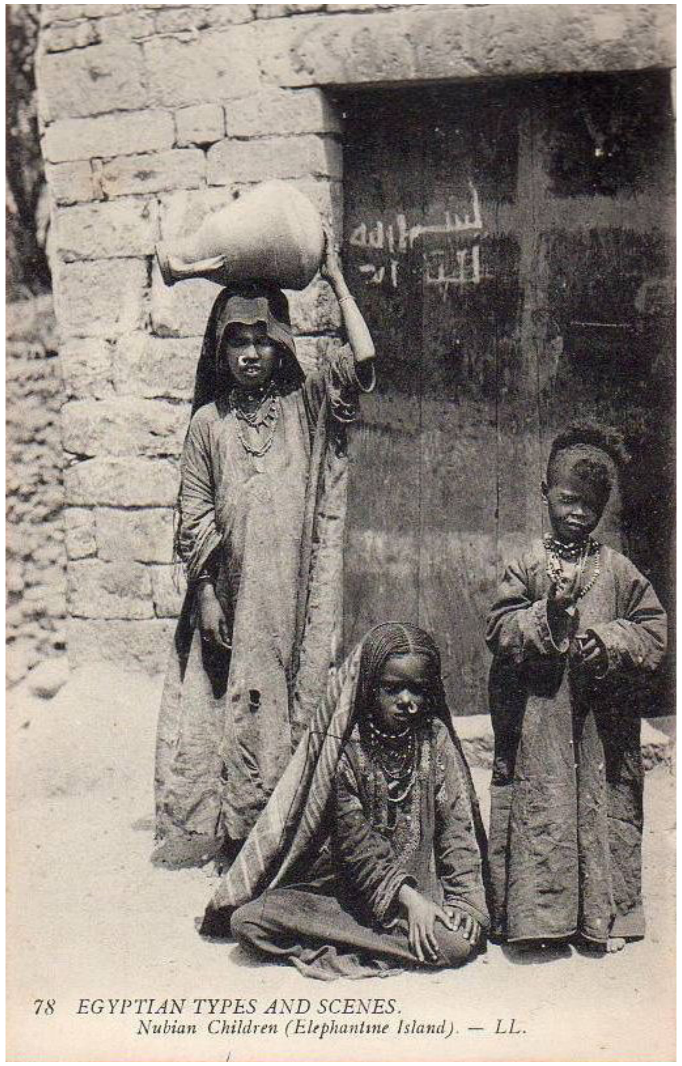
Aswan experiences an extreme desert climate with high temperatures, minimal rainfall and high evaporation rates. The arid conditions have a major impact on the quality of life in Aswan, agriculture and water resources in the city and surrounding area. The aridity has a great impact on the daily activities of the inhabitants, as people living in Aswan try to cope with the harsh arid climate.

Aswan High Dam

The Aswan High Dam, a rockfill structure located 7 kilometers south of Aswan, stands as a pivotal irrigation revolution, enabling the full harnessing of the Nile's waters. This monumental engineering feat yields a range of environmental consequences. Downstream of the dam, water levels decrease, observed at barrages in Esna, Nagga Hammadi, and Assiut. Consequently, bank erosion and meandering have extensively affected approximately 500 kilometers of the Nile's banks. Water quality shifts to nearly silt-free conditions, with reduced maximum discharge compared to pre-dam flood levels. However, heightened population growth and industrialization have further compromised the Nile's water quality for domestic, agricultural, and industrial purposes, fostering the growth of algae and macrophytes, contributing to eutrophication. Evaporation from the dam's desert-surrounded reservoir has added to the arid climate's challenges, exacerbating coastal erosion from silt deposition. These ramifications also extend to groundwater, social dynamics, fish production, soil fertility, and public health (Mahmoud Abu Zeid, 1989).



^ Aswan Dam pictured from the Internation Space Station, 2020, NASA via Wikimedia Commons

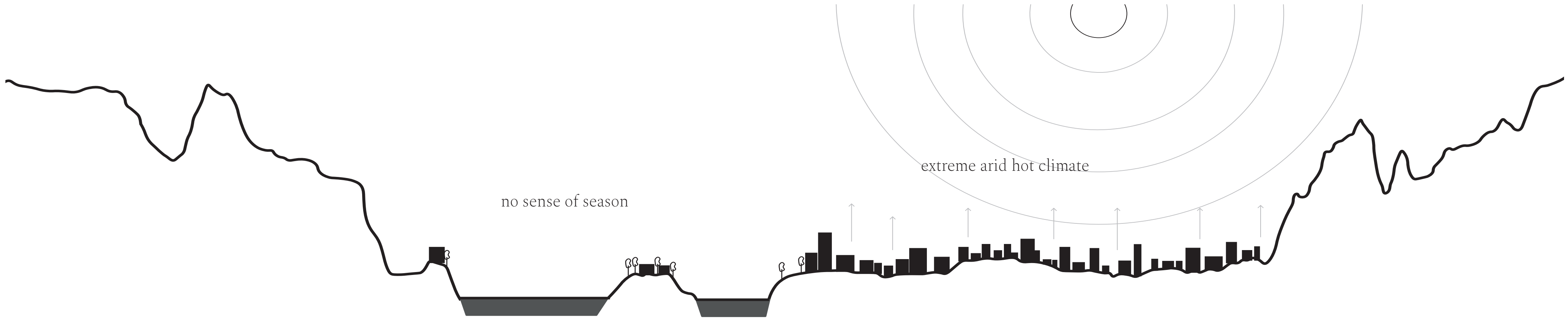


^ Nubian people are an indigenous ethnic minority group within Egypt. Nubian children (Elephantine Island), Oxford Photography Archive, via Wikimedia Commons

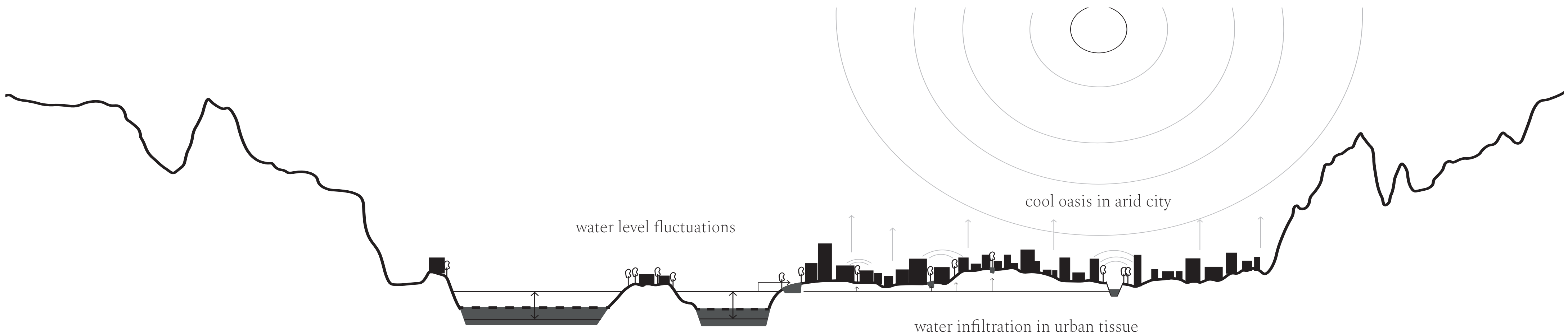
Towards a resilient Nile River basin

To explore landscape architecture design by integrating water into the urban context of Aswan, Egypt, creating a green-blue infrastructure, inspired by historical practices, to improve livability in the arid climate while increasing the overall resilience of the Nile River Basin.

current situation



desired situation



Learning from ...

To built knowledge of the site, an overview of site specific knowledge and interests is conducted. This chapter analysis the islamic garden as an example of landscape architecture design in the islamic world. The case study of the Al-Azhar Park in Caïro is an example of landscape architecture design in Egypt.

Islamic garden

Islamic gardens can be found all over the world, in many different types and styles, and in all sizes and shapes. They include tomb gardens, pleasure gardens, residential and palace gardens, courtyards, private gardens, medicinal or botanical gardens, mosque and oasis gardens, hillside gardens and hunting parks.

Islamic gardens are very diverse, but certain elements such as water and geometry, symmetry, hard surfaces and architectural elements dominate the Islamic garden. In Islamic culture, the garden is seen as man's addition to nature, not as an imitation or extension of it, leading to a relationship of use between soft and hard elements. Sculpture is absent from the Islamic garden. The illustration of vegetation is used as a decorative element in great variety.

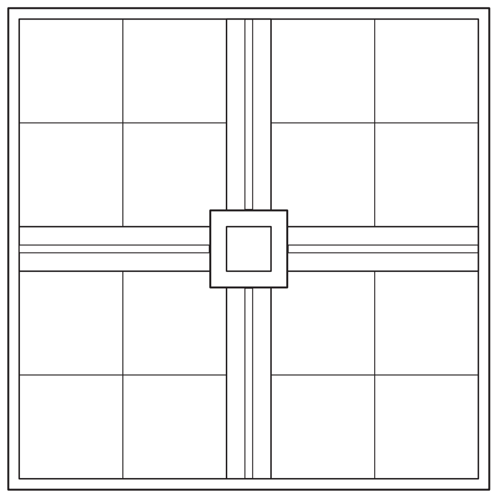
^ Garden on the Road to Heliopolis, Fiedler, Bernhard, via Wikimedia Commons

Ancient Egyptian civilisation was based on agriculture. A bustan is the Arabic word for an agricultural garden near a house, containing fruit trees, vegetables and spices. Arab farmers use the geometry of a grid, expressing the domestication of nature. Geometry is a typical element in the design of Islamic gardens. The Chahar-bagh is a geometric garden layout very common in the design of Islamic gardens, representing the four rivers and four gardens of paradise mentioned in the Qur'an.

The Islamic garden never lost its productive purpose, being both an orchard and a vegetable garden. Crops such as rice, citrus fruits, cotton, sugar cane, dates, durum wheat, carob, pistachios, mulberries, aubergines, spinach and melons are grown. The planting is based on the agricultural concept of the three levels: the date palm grows up to twelve metres high and forms an umbrella that provides a shady and humid environment for fruit trees (oranges and pomegranates) up to three metres high on the second level; the ground level is planted with irrigated crops.

The hydrology of the Islamic garden is rooted in agricultural structures. In desert areas, hydraulics connect the productive gardens and integrate them into a structural system. To optimise the distribution of water, the geometry of the grid is used to distribute the precious water and place plants at different distances for successful growth.

Water is a common element in the Islamic garden. Islamic culture is largely derived from agricultural societies. Much of its technology and law was therefore devoted to water. This is reflected in garden design. Artistic features such as the salsabil fountain (in Arabic, the fountain of paradise) are structures that demonstrate the movement, sound, reflection and refraction of water. Channels, runnels, waterfalls, cascades, riffles, bubblers, sheets, sprays, basins, tanks, pools, ponds and lakes are water elements common to the Islamic garden. (Aga Khan Trust for Culture, 2021).



Chahar-bagh // Charbagh

< A Persian quadrilateral garden layout based on the four gardens of Paradise mentioned in the Qur'an.

^ *Al-Azhar Park, Cairo, by Yasser.mahmoud (2017), via Wikimedia Commons*

“Parks and gardens can serve as symbols of “connection” (...). Among them are rich connections across time linking us to the past”.

His Highness the Aga Khan, 2015

Case study: Al-Azhar Park, Caïro

With a population approaching twenty million by 2017, Cairo is short on green space. With a staggering ratio of population to green space, roughly the size of one footprint per inhabitant, the need for an oasis of calm and nature in this urban sprawl has become clear.

The site of Al-Azhar Park holds a unique historical significance, as it was once a centuries-old rubbish dump hidden between the historic confines of Cairo’s Old City and the hauntingly named City of the Dead. Once abandoned and desolate, it now stands as a testament to the power of urban rejuvenation, offering Cairenes a lush and rejuvenating escape from the bustling streets of one of the world’s most populous cities (Aga Khan Trust for Culture, 2021).

The design of Al-Azhar Park in Cairo was a collaboration between Sites International and Sasaki Associates, among others. Located in Cairo's challenging climate of high temperatures, low humidity, low rainfall and relentless desert winds, the site required a planned approach to creating green space. The park relies on a vital pipeline to bring water from the Nile, followed by a highly efficient irrigation system. To further address water scarcity, the strategic use of xerophytic plants, which are able to thrive in drought-like conditions, is being planted. Experimental planting prototypes have been created on different terrains to assess the adaptability of the vegetation. he landscape of the park unfolds beautifully as it moves from dry, succulent plants on the western slopes, to green meadows with shade trees, to meticulously designed formal gardens, and finally to an orchard area. The selection of plants, particularly native Egyptian species, demonstrates the park's commitment to preserving the region's botanical heritage while creating a green oasis in a challenging arid climate (Aga Khan Trust for Culture, 2021).

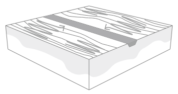
The formal gardens in Al-Azhar Park have been carefully arranged to showcase the intricacies and proportions inherent in traditional Islamic garden design. These gardens are a powerful reminder of historical models of Islamic garden aesthetics, where symmetrical layouts, inner and outer zones, tranquil pools, ornate fountains and clearly defined axes converge to create a harmonious and visually captivating space.

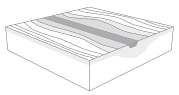
The park's water features, designed for both irrigation and ornamental purposes, play a vital role in maintaining the vitality of plant life in this otherwise challenging environment. They also help to create a microclimate that benefits both visitors and the vegetation, making it a welcoming and refreshing oasis in the heart of Cairo.

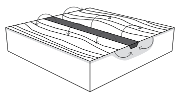
Beyond its aesthetic and environmental significance, Al-Azhar Park is an innovative urban park that has become a dynamic force in transforming the urban ecology. With over two million visitors a year, it serves not only as a recreational haven, but also as a mechanism for improving the city's living conditions. The park promotes social cohesion and communication, providing a beautifully designed environment for families and friends to gather, while encouraging civility among its diverse visitors. It stands as a symbol of civic responsibility, as people take pride in maintaining and keeping 'their' park clean, demonstrating a collective commitment to fostering a vibrant urban space, full of life and community spirit (Aga Khan Trust for Culture, 2021).

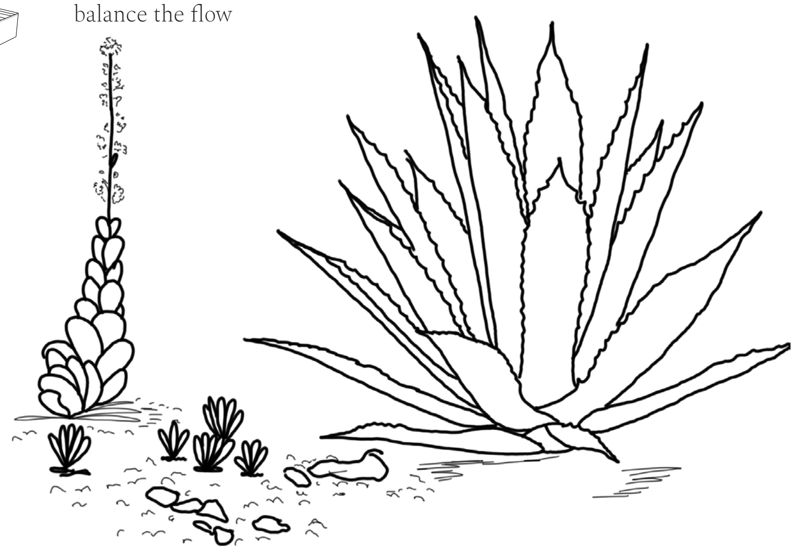
< Couple sitting in the shade in Al-Azhar Park, Cairo, by Synaps commons (2011), via Wikimedia Commons

xeriscape


slow the flow

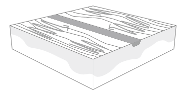

allow the flow

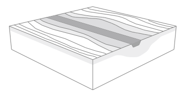

balance the flow

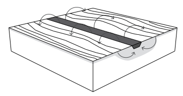


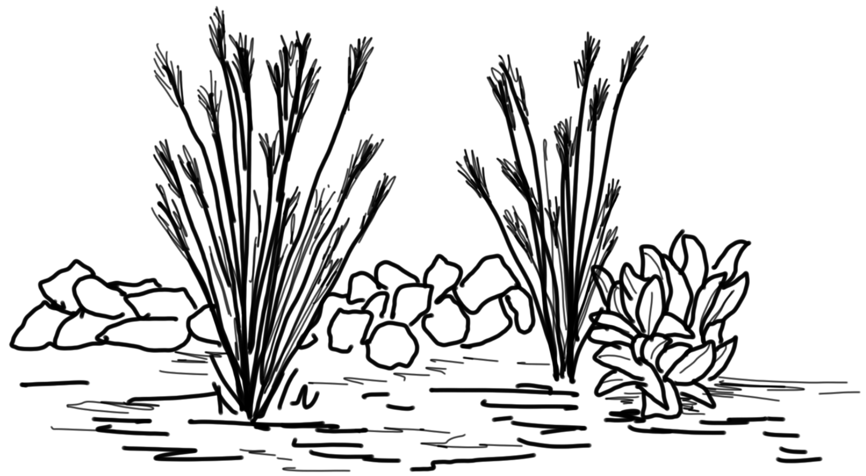
water fluctuation	●○○○○
sediment transport	●●○○○
water harvesting	●●●●○
increase vegetation	●●○○○
improve soil health	●●●○○
provide shade	●●○○○
minimize pollution	●●●○○

constructed wetlands

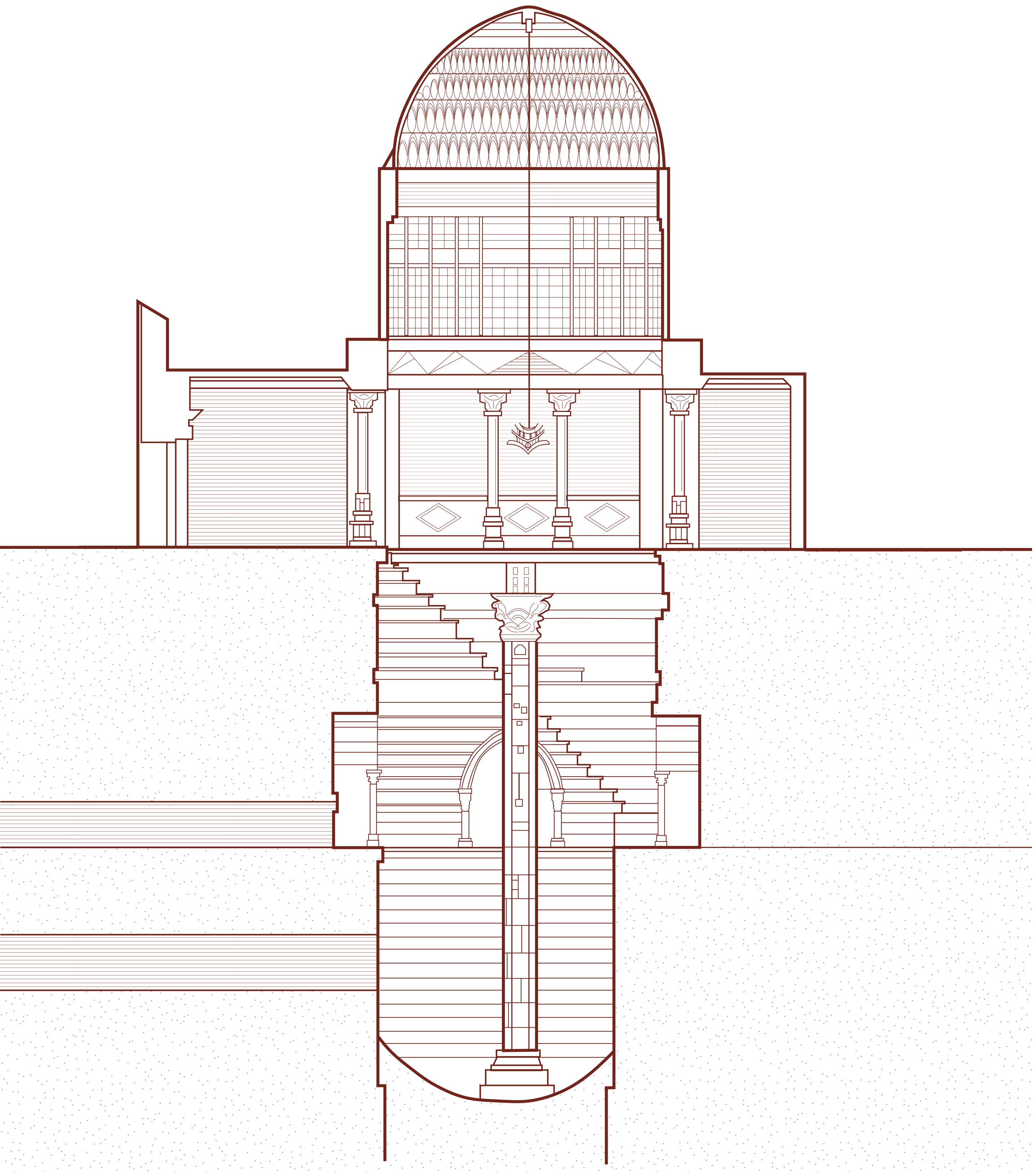

slow the flow


allow the flow


balance the flow



water fluctuation	●○○○○
sediment transport	●●○○○
water harvesting	●●●●○
increase vegetation	●●○○○
improve soil health	●●●○○
provide shade	●●○○○
minimize pollution	●●●○○



Nilometer

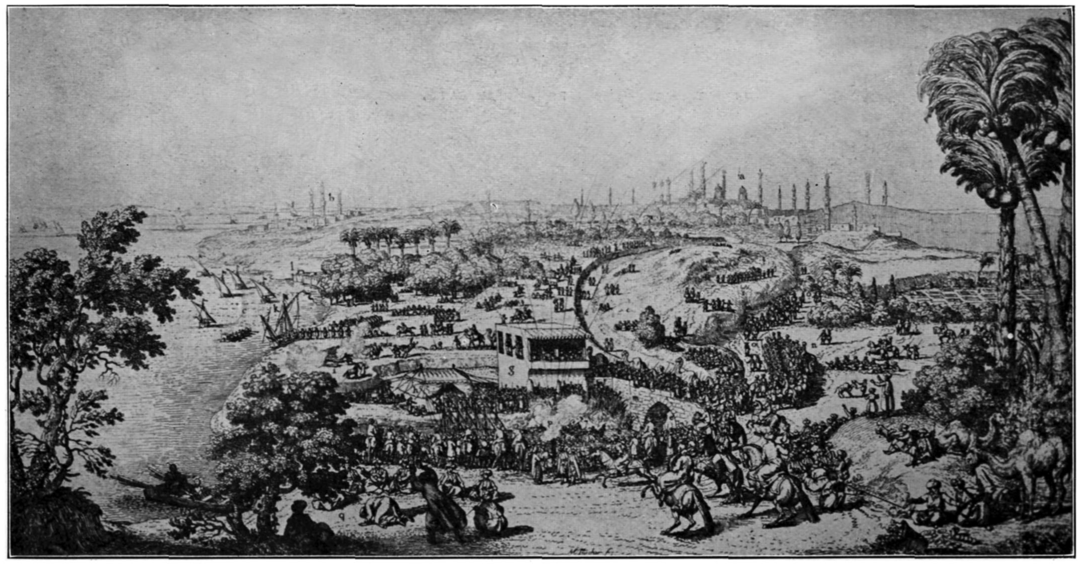
The Nilometer is an ancient Egyptian device used to measure the water level of the Nile. The annual flooding of the river brought fertile soil and was crucial to the successful agriculture and civilisation of ancient Egypt. The nilometer helped the Egyptians predict and monitor flood patterns and plan their agricultural activities and water resource management.

The nilometer typically consisted of a well or chamber built near the banks of the Nile and connected to the river by a canal or tunnel. As the water level rose or fell, this would affect the water level in the nilometer. By observing the rise and fall of the water level, the Egyptians could measure the intensity of the coming flood or recession, helping them to plan the timing of planting and harvesting.

The quality of the year's flood was used to determine the amount of tax to be paid. In addition to the practical function of the nilometer, priests used the data from the nilometer to make predictions and offerings to the gods.

Nilometers originated in Pharaonic times and lost their importance when the Aswan Dam introduced modern methods of water management and agricultural planning.

< Diagram of the Nilometer on Roda Island
figure made by author.



FESTIVAL OF THE NILE AT CAIRO.
(From Norden's "Travels in Egypt and Nubia," 1757.)

Nile festivals

In ancient Egypt, the annual flooding of the Nile River was a momentous event of profound importance to civilisation. This natural phenomenon, which occurred predictably every year between June and September, was critical to the civilisation of ancient Egypt. To honour this event, the ancient Egyptians celebrated a series of festivals. The festival Wafaa-el-Nil, which marked the beginning of the Nile's rise and was dedicated to the goddess Hathor, often depicted as a cow. People offered prayers and performed rituals to ensure a bountiful harvest and to appease the gods who controlled the flooding of the Nile. These festivals were not only religious events, but also a time of great social and community gatherings, marked by music, dance, feasting and vibrant processions, reflecting the connection between the people of ancient Egypt and the Nile that sustained their civilisation (Maadi, 2023).

Another notable festival was the 'Wepet-Renpet Festival', celebrating the Opening of the Year. This was the New Year's Day celebration in Ancient Egypt. It celebrated the death and rebirth of Osiris. Osiris is the god of fertility, agriculture, afterlife, dead, resurrection, life and vegetation. The festival celebrated the rejuvenation and rebirth of the land and the people (Mark, 2023).

< Festival of the Nile at Cairo. Published in 1757 in Norden's Travels in Egypt and Nubia. Frederic Louis Norden (1708-1742), Public domain, via Wikimedia Commons

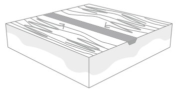
Paraty, Brazil

During full moon, once a month, there is a high tide. Seawater rises above its normal levels and pours into the historic center district through special openings in the seawalls. The steets get flooded for a short time until the tide recedes. The streets also flood when it rains. The streets were delibrerately designed to flood to act as a street cleaning strategy. (Kellahan, 2019).

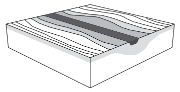
^ historical center of Paraty, Yamenm via Wikimedia Commons

^ historical center of Paraty during high tide, Yamenm via Wikimedia Commons

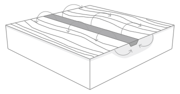
bypass



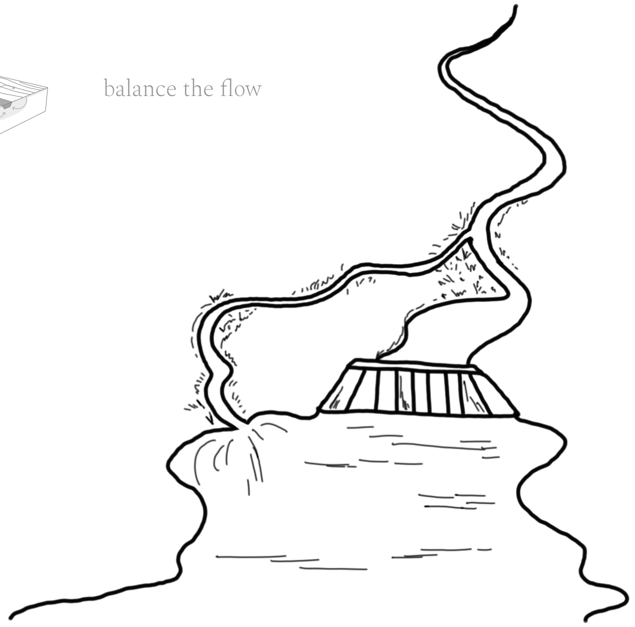
slow the flow



allow the flow

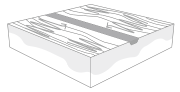


balance the flow

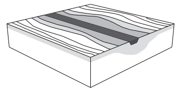


water fluctuation ●●●●●
sediment transport ●●●●○
water harvesting ○○○○○
increase vegetation ●●○○○
improve soil health ●●○○○
provide shade ○○○○○
minimize pollution ○○○○○

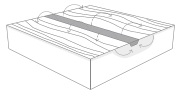
water-sensitive open design



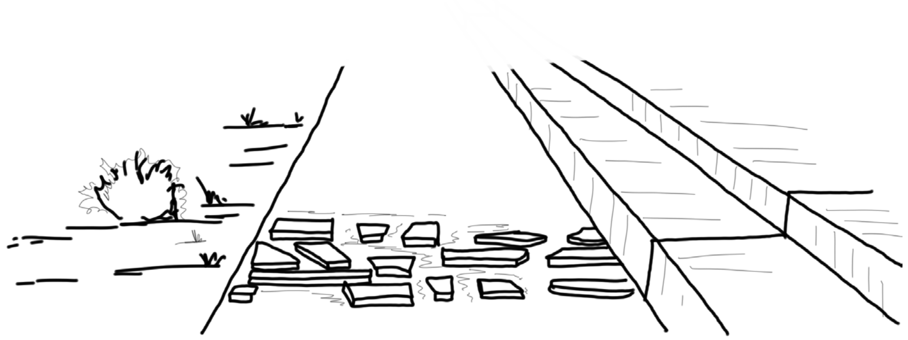
slow the flow



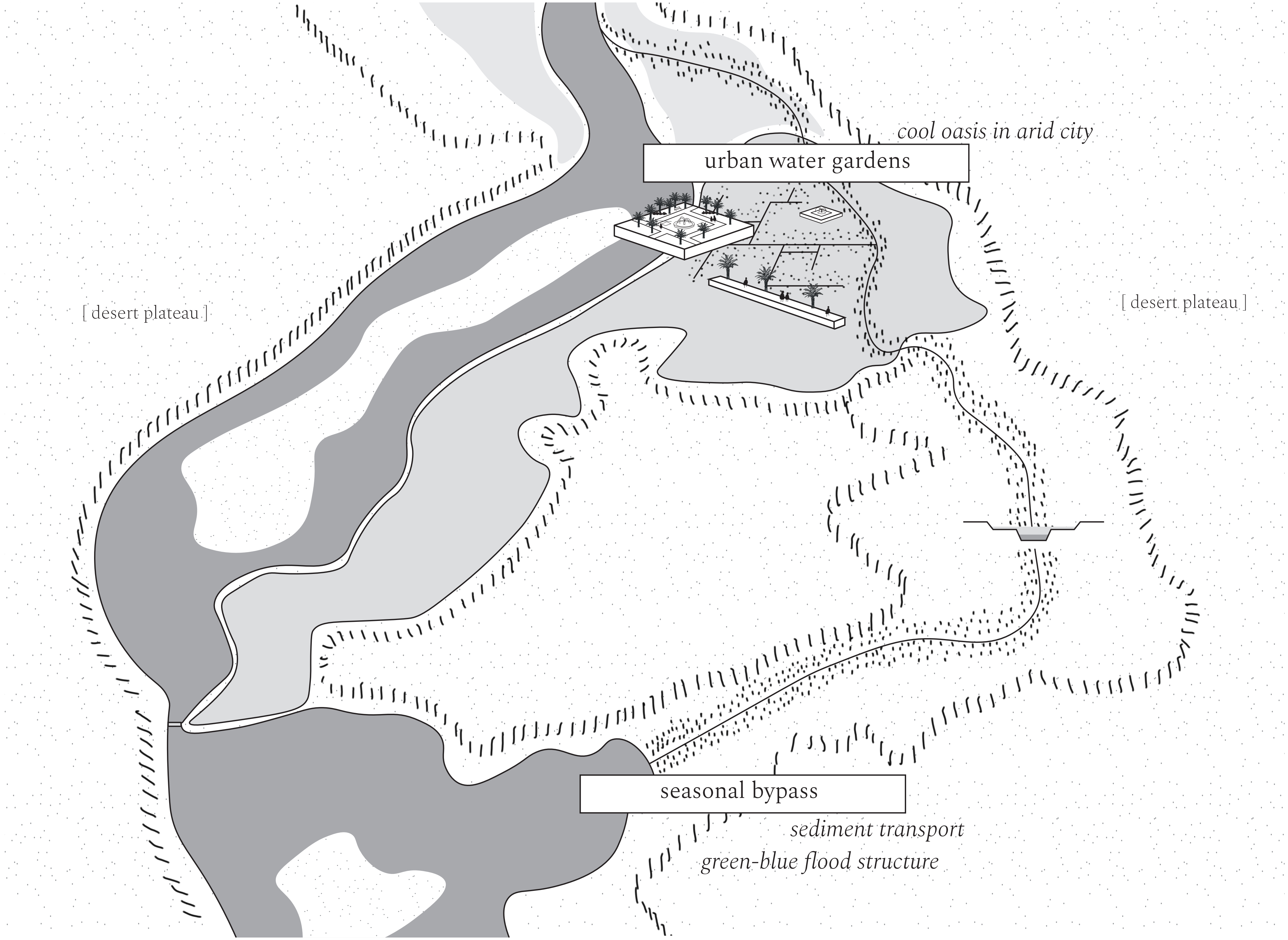
allow the flow



balance the flow



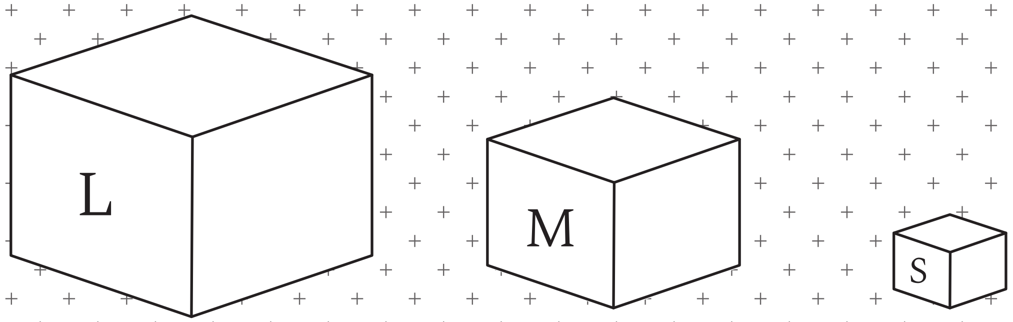
water fluctuation ●○○○○
sediment transport ●●○○○
water harvesting ●●●●○
increase vegetation ●●○○○
improve soil health ●●●○○
provide shade ●●○○○
minimize pollution ●●●○○


cool oasis in arid city
urban water gardens
[desert plateau]
[desert plateau]
seasonal bypass
sediment transport
green-blue flood structure

Urban structure

green-blue structure

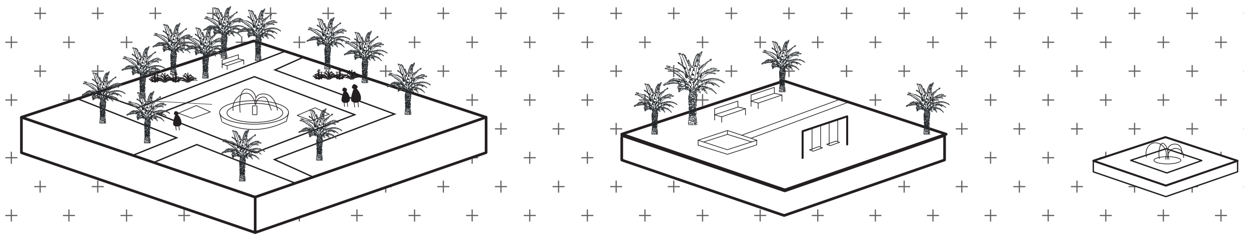
BLOCKS
ASSEMBLY



neighbourhood
district
large public park
sub-urb

building block
sqaure
small park
playground
roundabout
intersection

courtyard
garden
building
house
street corner

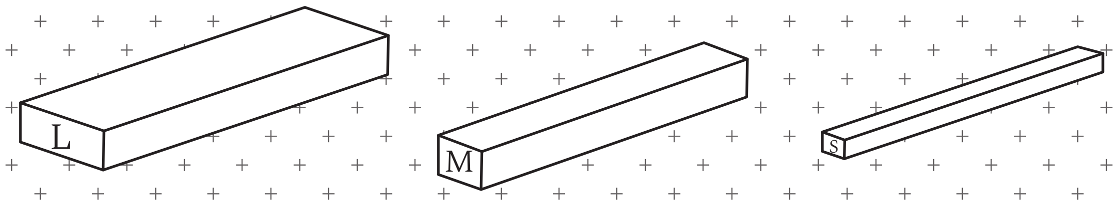


public parks where water plays a consistent role, creating hight differences for different water levels, wet and dry seasons

public squares, medium sized connection nodes, where blue and green structure meets

small courtyards and gardens, mostly private, a small (hidden) oasis in the city

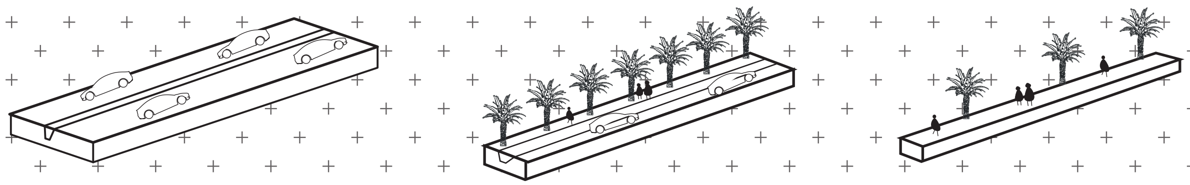
LINES
CARRIERS



highway
regional connecting roads
large infrastructure
train rails

shopping street
promonade
neighbourbood street
collector roads

corridor
path
residential access road



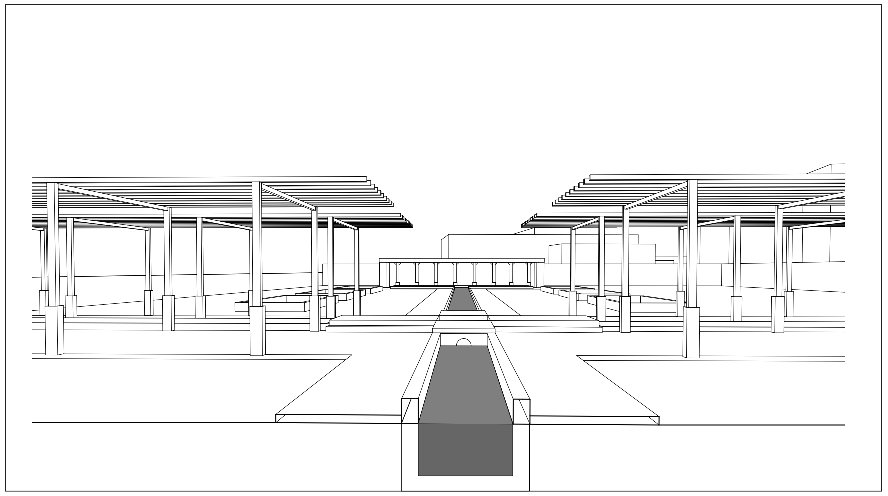
large streets where main blue and/or green infrastucture mixes with transpor-tation infrastructure.

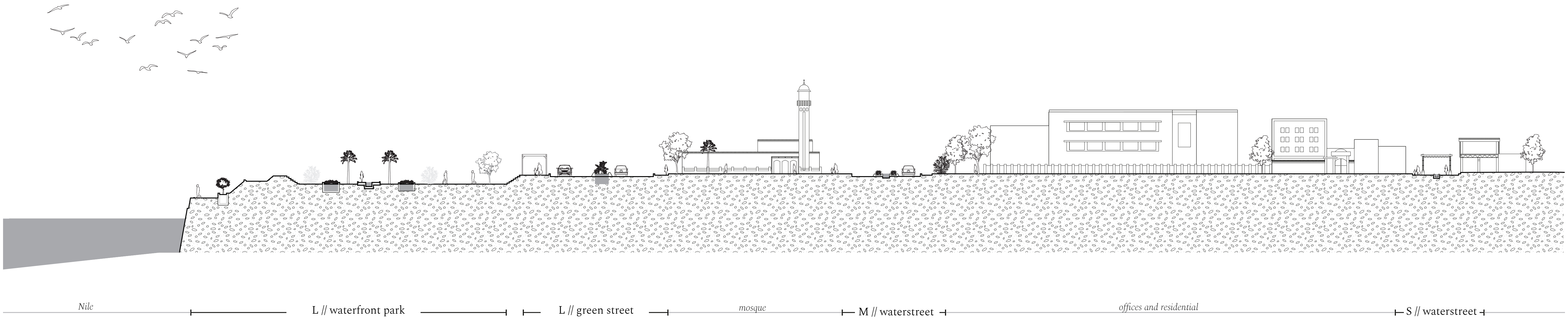
green and/or blue structure is present in excisting infrastructurem mixed program

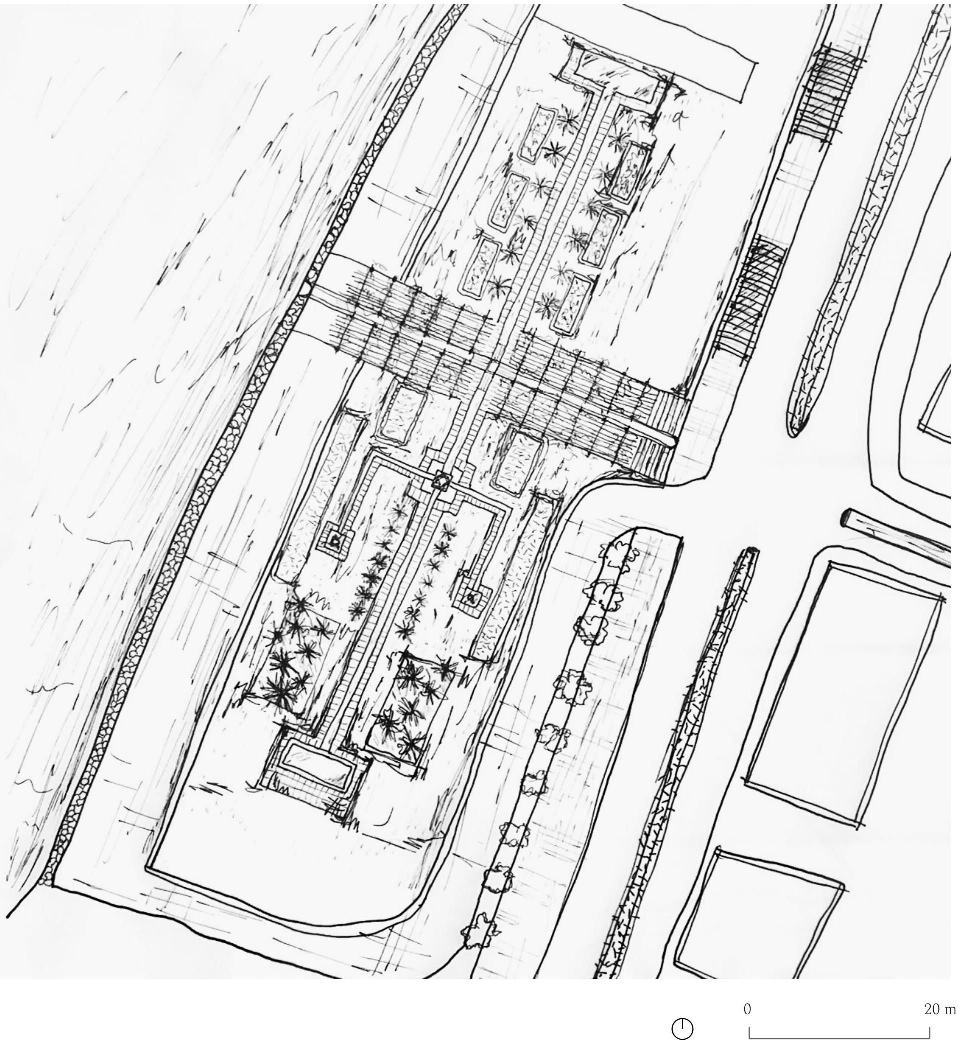
small corridors and walking treets are cooled down by blue and/or green infrastructure

Aswan's watergardens for resilience

Aswan's Watergardens for Resilience is an innovative urban strategy to transform the hyper-arid cityscape of Aswan, Egypt. The plan introduces a network of green and blue structures throughout the city, creating urban oases that offer both environmental benefits and improved quality of life. The strategy includes the development of public parks, inviting courtyards and vibrant squares, all thoughtfully integrated into the city's existing grid structure. The green and blue elements are seamlessly woven into the urban fabric, making the most of the limited space available in this arid environment. Roads are ingeniously repurposed to accommodate these green and blue structures, ensuring that the city's infrastructure contributes to its resilience. This strategic design aims to improve the quality of life for Aswan's residents by providing spaces for relaxation, recreation and community engagement, while mitigating the challenges posed by the arid climate. Aswan's Watergardens for Resilience not only addresses the urban challenges of the present, but also paves the way for a more sustainable and resilient future.



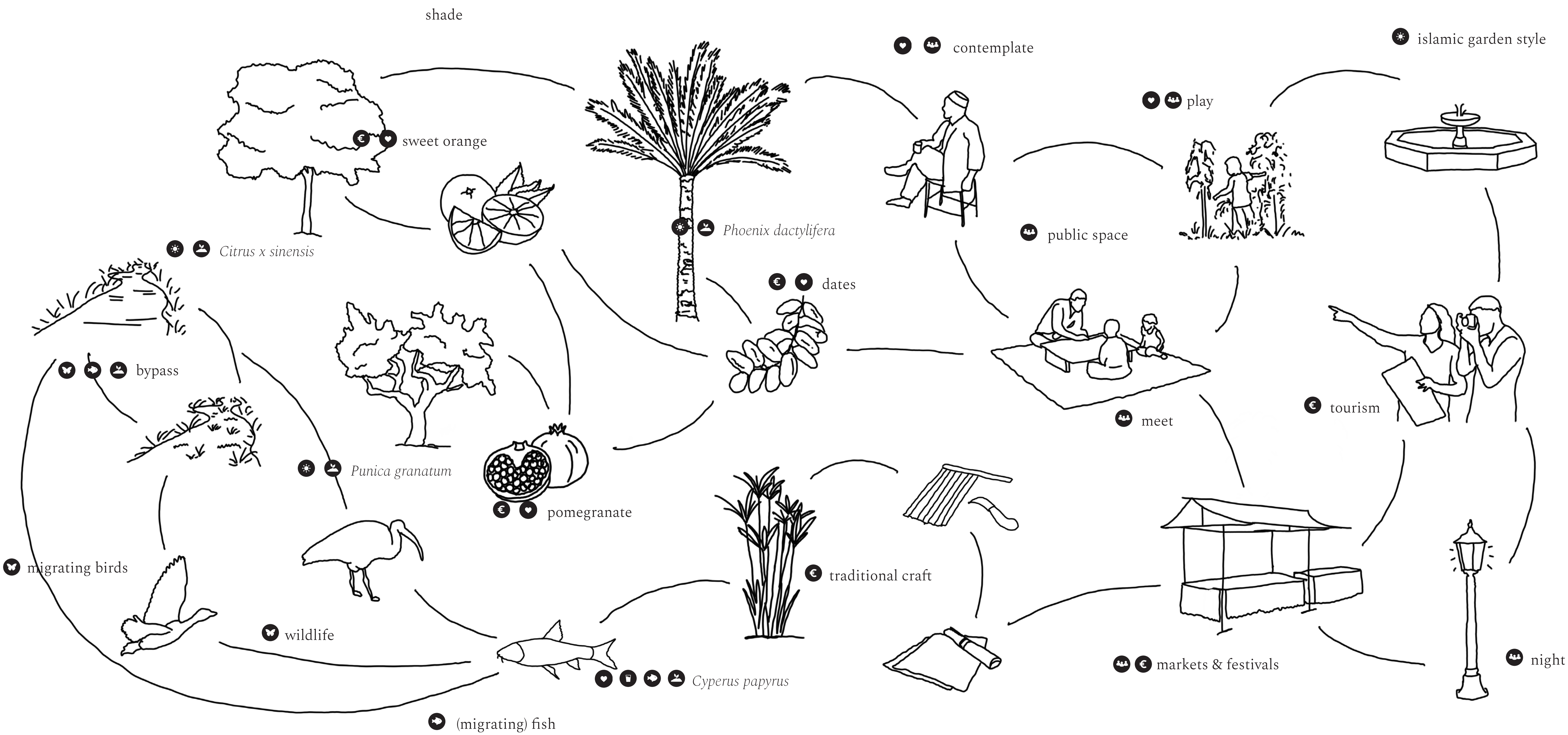

Nile
L // waterfront park
L // green street
mosque
M // waterstreet
offices and residential
S // waterstreet

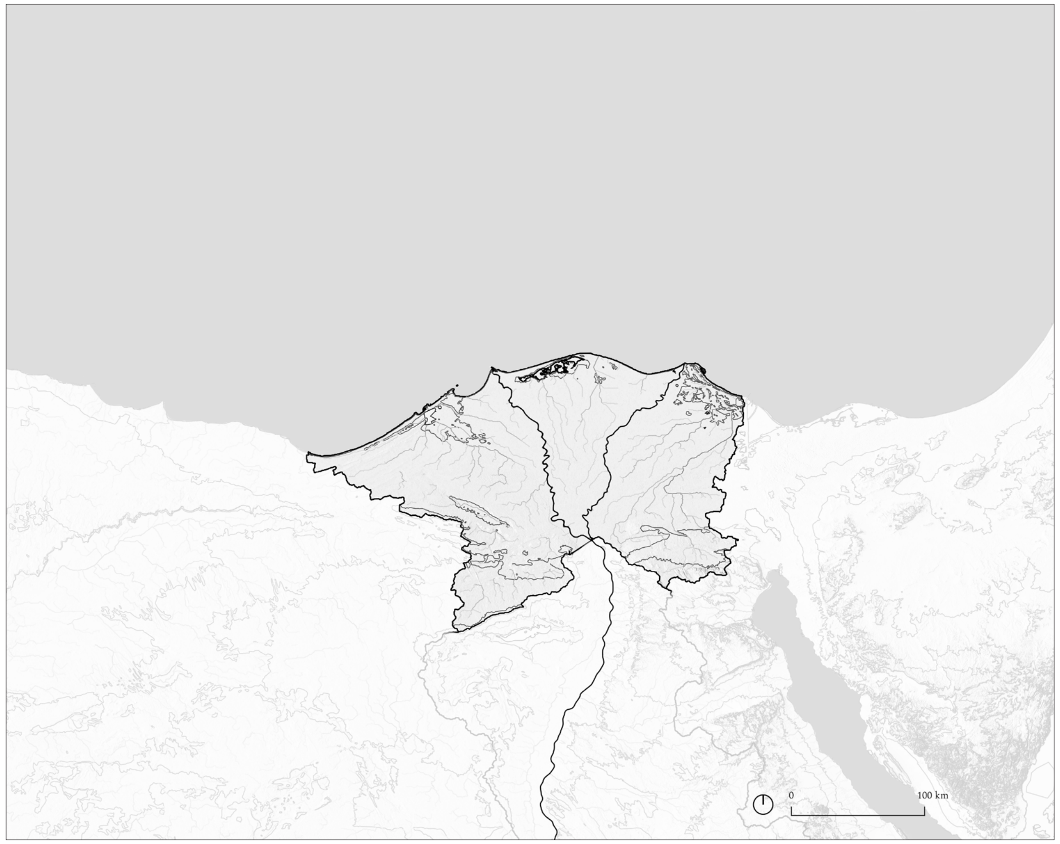


Local design

Locally, the Water Garden Public Park, located on the Nile waterfront near the old city of Aswan, provides a unique and diverse oasis for the community. The park serves as a dynamic interface where the water of the Nile can be directed to create an ever-changing landscape. During periods of high water, much of the park is carefully designed to flood, taking advantage of its lower elevation compared to other parts of the city. During normal flow, water from the Nile can be cleverly diverted into the park, cooling the city and encouraging lush vegetation. The park is not only a functional space, but also a hub for tourism, a public park for relaxation and a captivating showcase of Islamic garden design. It offers residents and visitors a place to relax, contemplate and connect with Aswan's natural and cultural heritage. The layout of the park pays homage to the Nile itself, with three main tributaries in the southern part, symbolising the convergence at the Fountain, which represents Lake Nasser. From here the water flows north, flanked by date palms and lush vegetation, reflecting the iconic irrigated landscape of Egypt. As it continues north, it culminates in a representation of the Nile Delta, beautifully reflecting the intricate tapestry of Egypt's diverse landscapes and cultural heritage.

Stakeholders

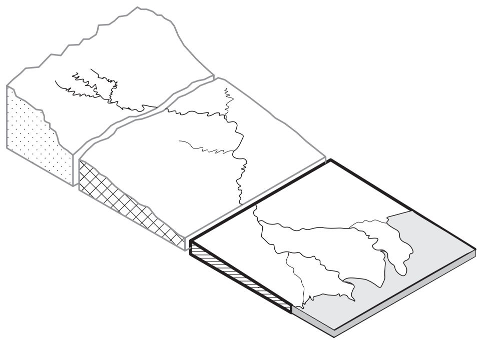


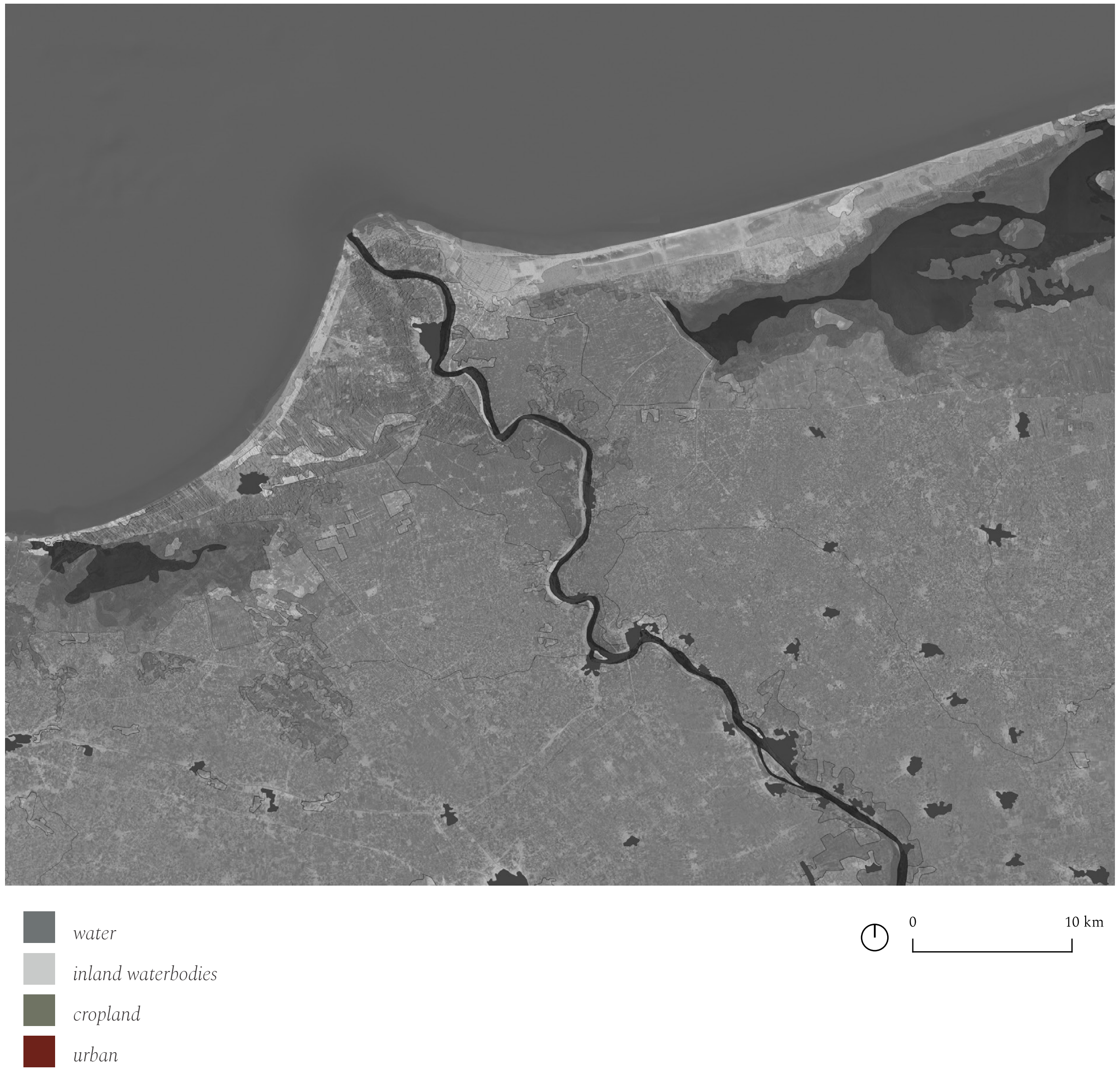


The Nile Delta

Now we have reached the end of the Nile river. At the start of the Nile Delta, just above Caïro, the river splits into two rivers, one of them is the Rosetta Branch.

Rosetta is a city near the coast. along the rosetta branch. It is where the stone of Rosetta was found, which was major for the understanding of the ancient civilization: now it was possible to decode the ancient hieroglyphics. This part of delta suffers a lot from coastal erosion, since there is no new supply of sediments, due to baracades and the Aswan High Dam.





Regional context

Situated in the fertile expanse of the Nile Delta, the Rosetta Promontory plays a crucial role in the regional context of agricultural productivity. This prominent region is characterised by its vast areas of irrigated agricultural land, which benefit from the nutrient-rich soils of the Nile Delta. Close to the city of Rosetta, a historically important centre, this area is known for its abundant date palm orchards and an array of both large-scale farms and smaller family plots. The blend of centuries-old agricultural practices and modern farming techniques has made the Rosetta Promontory a cornerstone of Egypt's agricultural landscape, not only contributing to the nation's food production, but also preserving its historical significance as a key region for sustainable cultivation in the Nile Delta.

Challenges

The downstream Nile region, particularly the Nile Delta, faces a complex series of challenges that have significant environmental and social impacts. One of the most critical issues is the degradation of the canals that are the lifeblood of the region's agricultural activity. These canals, which have historically played a vital role in distributing water for irrigation, have deteriorated over time, leading to inefficiencies in the distribution of water among farmers. In addition, the region's soil is suffering from degradation due to the lack of a regular supply of fertile silt as a result of changes in the Nile's flow patterns. To compensate, farmers are increasingly turning to chemical fertilisers, which not only affect soil quality but also contribute to the pollution of waterways, including the very canals they depend on for irrigation. Furthermore, the once symbiotic relationship between the people of the Nile Delta and their life-giving river is eroding, reflecting the complex challenges of balancing agriculture, conservation and sustainability in this vital region.

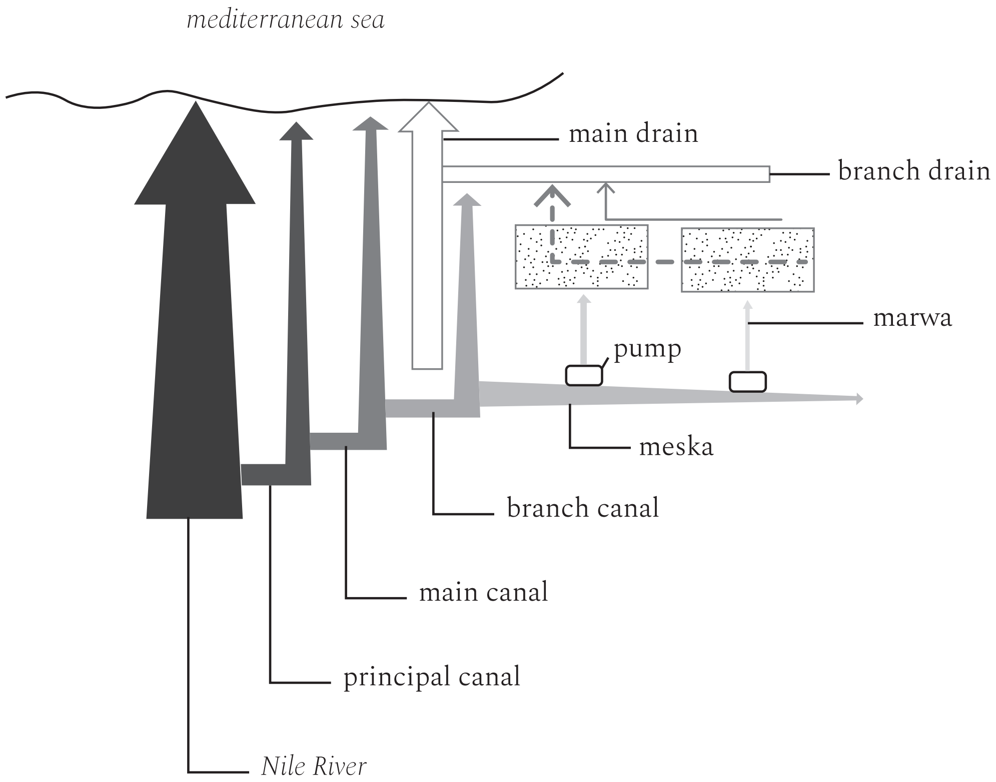
Canal degredation

The degradation of waterways in the Nile Delta has become a pressing issue, with canals turning into unintentional sewers, creating a vicious cycle of littering, pollution and a worrying neglect of conservation. This disturbing trend presents a significant threat to both public health and the fragile ecosystem. These challenges are worsened by the presence of heavy metal pollution in these waterways, further exacerbating the environmental crisis (Fouad et. al., 2022)

The reasons for this littering and public abuse of the Nile waterways remain largely unquantified and not fully understood. Historically, Egyptians have demonstrated a deep sense of concern for the Nile, rooted in cultural and socio-economic ties to the river ecosystem. However, it is theorised, based on Maslow's (1943) hierarchy of needs, that people tend to focus on more complex needs only when their basic needs are met. Unfortunately, rapid population growth, escalating food costs, stagnating GDP and increased poverty rates in Egypt over the past decade have reduced the protective feelings Egyptians once had for the river ecosystem, creating a challenging transition in their relationship with the Nile (Fouad et. al., 2022).

^ Drain in the Nile delta, littered with garbage and clogged up by water hyacinth, François Molle, 2015, via Flickr

^ Severe pollution of a brach canal in the Nile Delta, François Molle, 2017, via Flickr



^ schematic overview of typical irrigation and drainage canals in the Nile Delta, by Satoh et al. (2017). Edited by author.

Water distribution in canals

A notable feature of the irrigation and drainage canal system in the Delta is the complete separation of the irrigation and drainage components. Water released from the Aswan High Dam (AHD) travels through a network of canals, including main canals, branch canals, meskas (distributaries) and marwas (field ditches), to reach agricultural land. In this system, the water level in the meskas tends to remain lower than in the fields, so individual farmers use small diesel-powered pumps to lift water to the marwas, which then distribute the water to specific fields. Historically, animal-powered saqias were used for this purpose and were shared by related farmers who owned the animals individually. In the present context, however, there is no clear control over the distribution of water within the meskas along the branch canals. Instead, it relies on the operation of individual pumps due to the lack of gates in the branch canals for meskas. The flow of water into the meskas depends on the hydraulic conditions created by the gentle slope of the land. This often leeds to conflict over inequal water distribution. It's important to note that water crises and severe shortages can hinder farmers' cooperation and lead to conflicts. Conversely, when conditions allow, farmers can coordinate their efforts and find ways to resolve conflicts in their mutual interest (Satoh et al., 2017).

^ Huge group of individual pumps, Nile delta. François Molle, taken on March 20, 2013, via Flickr

^ Farmers building an obstacle to keep water in Nile Delta, (When canals dry up farmers sometimes build small earth obstacles in order to raise the water level near the inlet of their pump station. François Molle, 2017, via Flickr

Use of chemical fertilizers

Historically, one of the defining characteristics of the Nile has been its high silt content, with the river transporting an astonishing 134.0 million tonnes of silt annually, the majority of which, around 125.0 million tonnes, is transported during the flood months. A significant proportion of this sediment, around 12%, used to settle on the fertile farmland along the riverbanks, increasing its agricultural productivity. A monumental change occurred with the construction of the Aswan High Dam (AHD). The dam effectively trapped the majority of these suspended sediments, allowing only 3% to flow downstream. This change has had a profound impact on local farmers, who are now forced to resort to chemical fertilisers to compensate for the loss of natural siltation in their fields. This change in farming practices highlights the far-reaching impact of the dam on the agricultural landscape and sustainability of the region (Khalifa & Moussa, 2017).

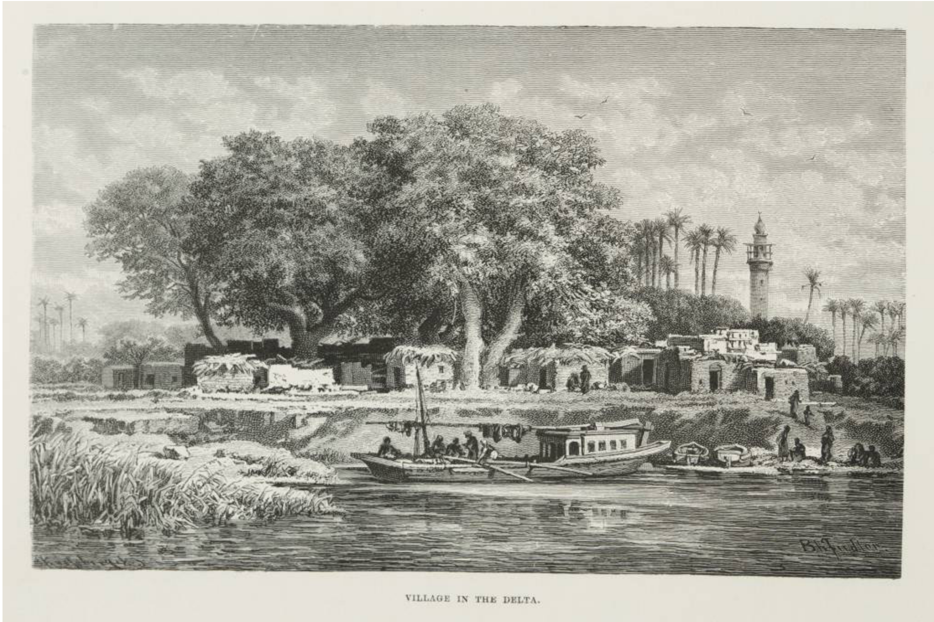
Water borne health crisis

The Nile water is still for many a crucial source of drinking water. However, recent studies carried out downstream along the Nile have shown alarming results. The water in these regions is heavily contaminated with dangerous levels of heavy metals, making it unsafe for human consumption. This has led to a public health crisis, with the local population suffering an increase in various diseases, many of which affect vital organs. One notable example is the rising incidence of bladder cancer, a transitional cell cancer that indicates increased exposure to pollutants. Dr Yasser Osman, Professor of Urology and a kidney transplant surgeon, has shed light on this disturbing issue. While the government has taken some steps to reduce industrial dumping by periodically shutting down factories that engage in the practice, monitoring remains inconsistent. As a result, vast quantities of sewage continue to flow into the Nile and its intricate network of canals, eventually reaching the Mediterranean Sea and exacerbating this environmental and public health crisis. (Bossone, 2015).

Towards a resilient Nile River basin

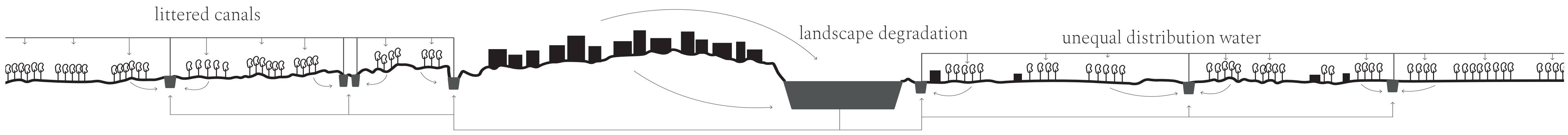
The downstream design is located in the Nile Delta, at the agricultural land along the Rosetta branch in the Rosetta promontory. The delta has been a vital and historically significant region in Egypt. Before the completion of the Aswan High Dam each year the Nile would flood, leaving the fertile silt and sediment. The delta is known for its fertile soil, which results from the deposition of silt and sediment carried down from the Nile River. The fertile soil makes the delta perfect for productive agriculture and it is therefore a crucial source of food for Egypt. Nowadays, the soil is degrading, the soil is being exploited by agriculture and chemical fertilizers are needed to be able to grow crops. The chemical fertilizers and run-off from cities and industry lead the river and irrigation canals to deteriorate.

The public is able to observe the levels of water stress thanks to changes in the flow dynamics of waterways. Historically, the public's perception of the seasonal state of the Nile waterways has been an important part of their awareness of wet, normal or dry conditions in the Nile Basin. Changes in flow levels and water quality (colour, odour and vegetation) formed the public's perception of the sustainability of their water resources and associated conservation schemes (Fouad, 2022).

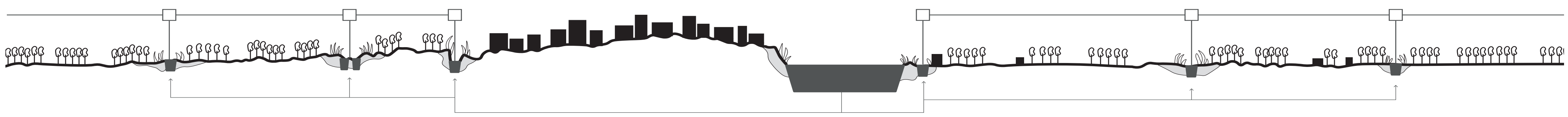


^ A small village in the Nile delta, by Strassberger, B. (1878), via wikimedia commons

current situation



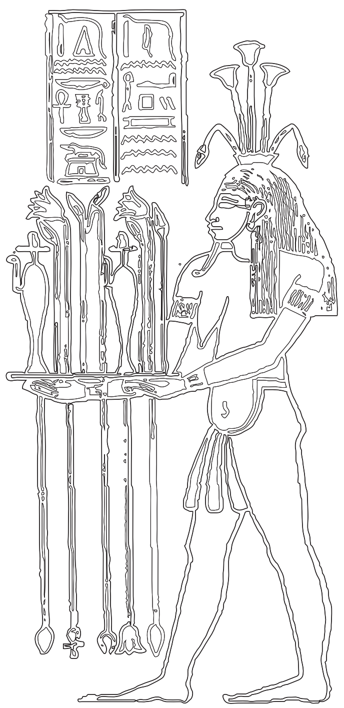
desired situation



Learning from...

From approximately 3100 BC to 30BC, ancient Egypt civilization existed along the Nile River in northeastern Africa. The river Nile played a central role in their daily lives. The river provided water for drinking, bathing, and irrigation. Besides, fish was hunted for food and papyrus was grown to make paper. The river also played an important role in religion. The Nile was seen as a powerful force. The annual flooding of the Nile was worshiped and celebrated with festivals and ceremonies, as it was seen as the work of the gods. Ancient Egyptians believed in many gods and goddesses. Hapi was the god of the annual flooding, he was given the title, 'Lord of the River Bringing Vegetation' and 'Lord of the Fish and Birds of the Marshes'.

The ancient Egyptians were skilled people, they are known for their architecture, art, and religion. The most famous example is the Great Pyramids of Giza, it was built around 4.500 years ago. It is still uncertain how the Pyramids were built, but it is believed that the annual flooding of the Nile was used to transport the building material to the Giza plateau (Britannica, 2023).



Hapi, god of the inundation

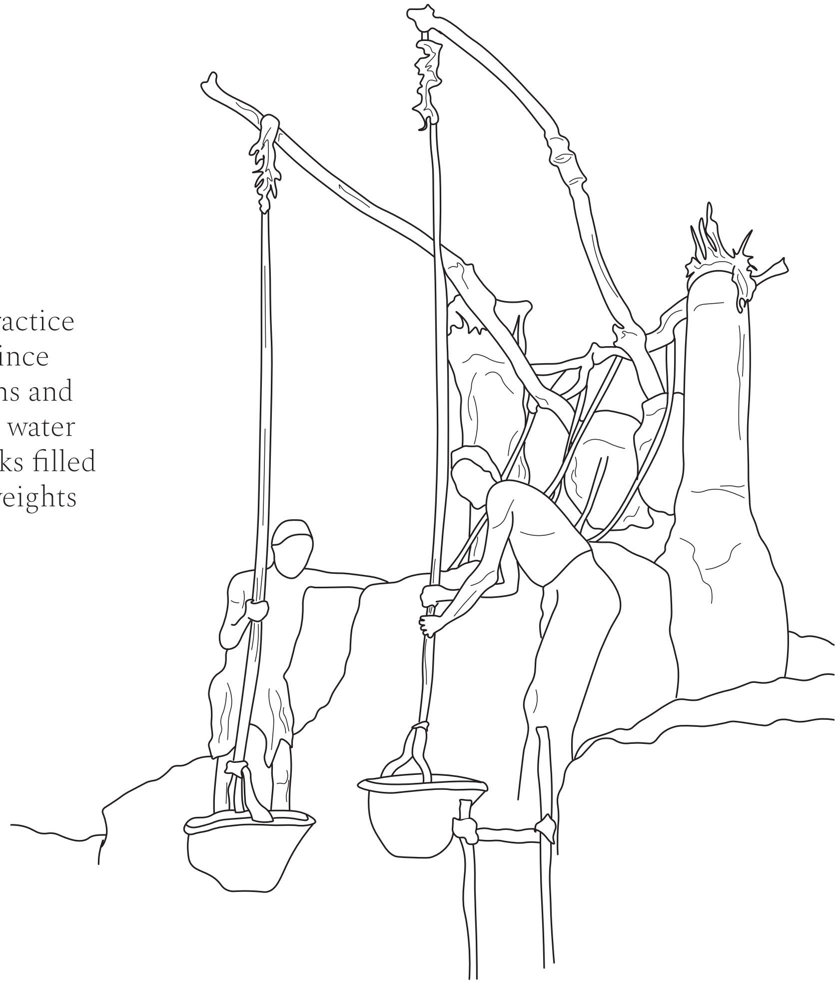
Encyclopaedia Biblica edited by author)

Agriculture

Ancient Egypt's culture owed a lot to the Nile River and its periodic seasonal floods. The Egyptians were able to create an empire built on abundant agriculture thanks to the river's regularity and lush soils. One of the first populations to engage in extensive agricultural activity is the Egyptians. This was made possible by the Egyptians' ingenuity in developing basin irrigation. They were able to grow both industrial crops like flax and papyrus as well as common food crops like grains like wheat and barley thanks to their agricultural methods (Noaman et. al., 2017). Because the Egyptians maintained a single season of planting, the soils were not overly depleted and fertility was naturally restored each year by the return of the floodwaters leaving a natural silt layer. In some basins, farmers planted grains and nitrogen-fixing legumes which helped to maintain the soil's productivity. During the summer, the water table remained at least 3-4m below the surface in most basins. The flooding prior to the planting pushed the accumulated salt in the upper soil below the root zone. The naturally controlled accumulation of salt and the ever-renewal of fertility have enabled Egyptian farmers to be productive in a sustainable system (Noaman et. al., 2017)

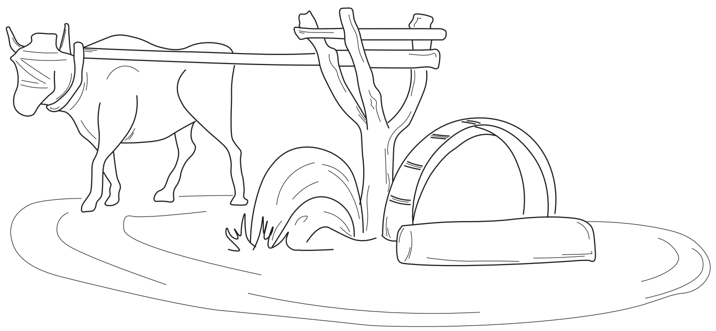
Shaduf

Shaduf is an ancient practice that has been around since the time of the Pharaohs and entails manually lifting water out of a river using flasks filled with water as counterweights to the levers.



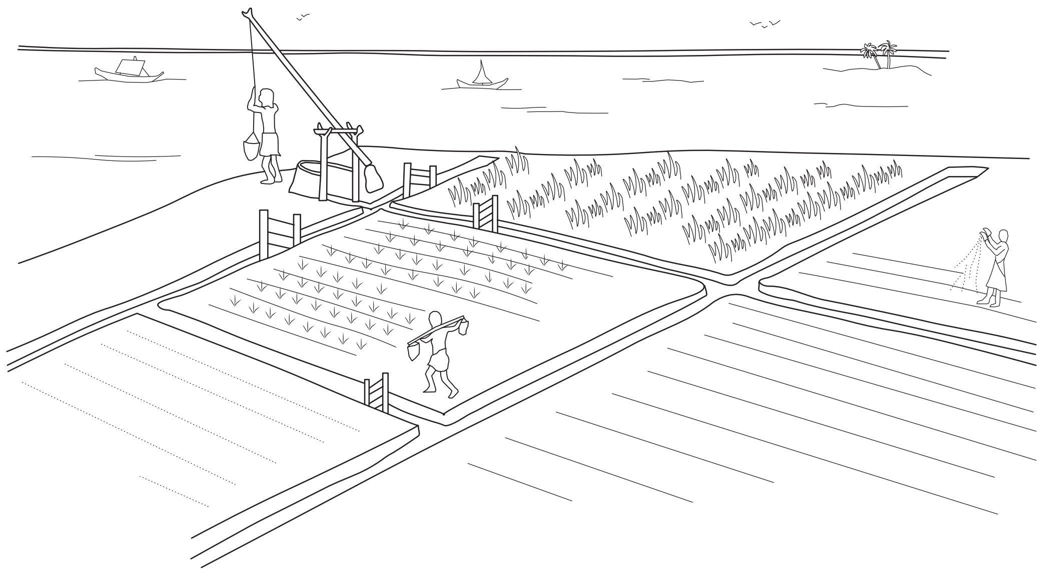
Saqia

Saqia, or a water wheel, is another example of an Egyptian ancient technique. It is powered by animals or, in earlier times, slaves.



Basin Irrigation

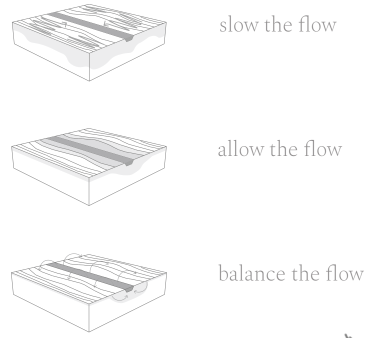
Egyptians began implementing controlled basin irrigation during the nomadic Stone Age by cultivating the area of the river's flood plain where fertile sediments accumulate on both banks of the river (Egyptian Commission for Irrigation and Drainage, 1983). Levees were built around these locations to further protect them from floodwater; tail escapes were also built at the ends of many plots to allow excess water to go back into the river when the flood subsided. The water was then kept inside the basin by sealing the tail exit using stone and earth. Small communities could continue this process, but in order to establish numerous basins of wider areas, governments helped in exchange for a higher standard of living (Noaman et. Al., 2017).



Lining canals

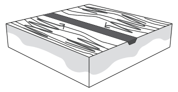
Improving the quality of waterway landscapes offers a promising way to strengthen their sustainability and foster a deeper connection with local communities through a network of green and blue infrastructure. This integrated network of green open spaces connected by waterways plays a key role in protecting Egypt's threatened natural ecosystems while providing a range of benefits to the community, including aesthetic and recreational enjoyment (Benedict et al., 2006). Urban green spaces have characteristics that provide co-benefits and help to forge strong societal bonds, fostering a genuine sense of place within the community. In the search for sustainable water conservation, the reduction of water evaporation and pollution is of importance, and this requires the integration of environmental landscaping techniques into restoration efforts. This approach, utilises natural elements such as soil, water and native plant species adapted to the Mediterranean climate such as *Tamarix aphylla, Populus nigra* and *Salix babylonica*. In addition, soil rejuvenation is a key component of nature-based solutions that comprehensively address environmental, economic, social and climate challenges. The natural flow of water is used to create more liveable urban environments (Scottish Government, 2021). Strips of water-efficient, drought-resistant vegetation along watercourses cast cooling shadows, effectively reducing evaporation at high flow rates and helping to minimise water budget losses (Fouad et al., 2022).

waterway landscapes

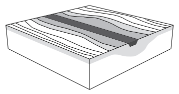


water fluctuation	●○○○○
sediment transport	●●○○○
water harvesting	●●●●○
increase vegetation	●●○○○
improve soil health	●●●○○
provide shade	●●○○○
minimize pollution	●●●○○

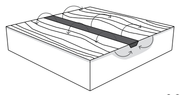
riparian buffer zone



slow the flow



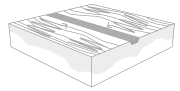
allow the flow



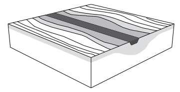
balance the flow

water fluctuation	●○○○○
sediment transport	●●○○○
water harvesting	●●●●○
increase vegetation	●●○○○
improve soil health	●●●○○
provide shade	●●○○○
minimize pollution	●●●○○

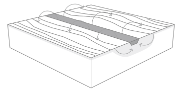
multi storied-water edge



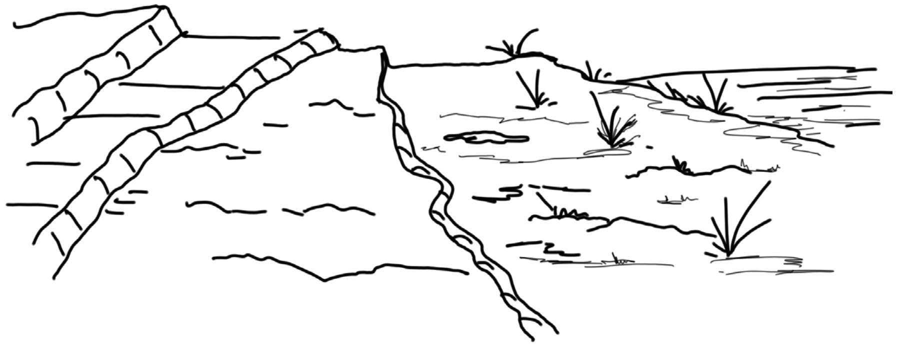
slow the flow



allow the flow



balance the flow

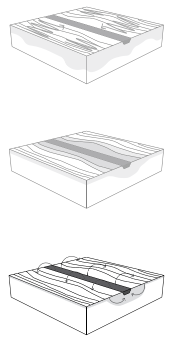


water fluctuation	●○○○○
sediment transport	●●○○○
water harvesting	●●●●○
increase vegetation	●●○○○
improve soil health	●●●○○
provide shade	●●○○○
minimize pollution	●●●○○

Collective pumping

Nestled in the Nile Delta, a collective pumping system acts as a central irrigation point. A constant hive of activity, the pump house serves as a link between the locals and their agricultural lifeline, channeling the vital waters of the Nile to their fields. People come and go, water flows, and the energy of this bustling hub reflects the harmonious complexity of nature (Marais, 1937). The main purpose of this collective pumping station is to curb unregulated pumping and excessive irrigation, ensuring a more sustainable and balanced use of the region's precious water resources (Rap et al., 2022).

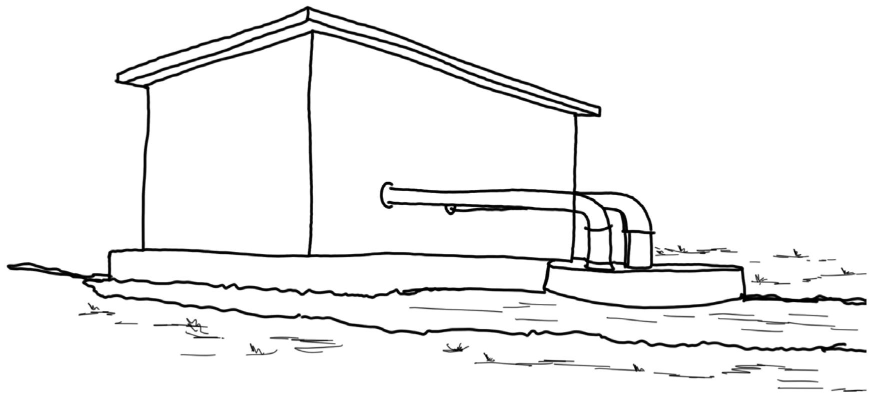
collective pumping



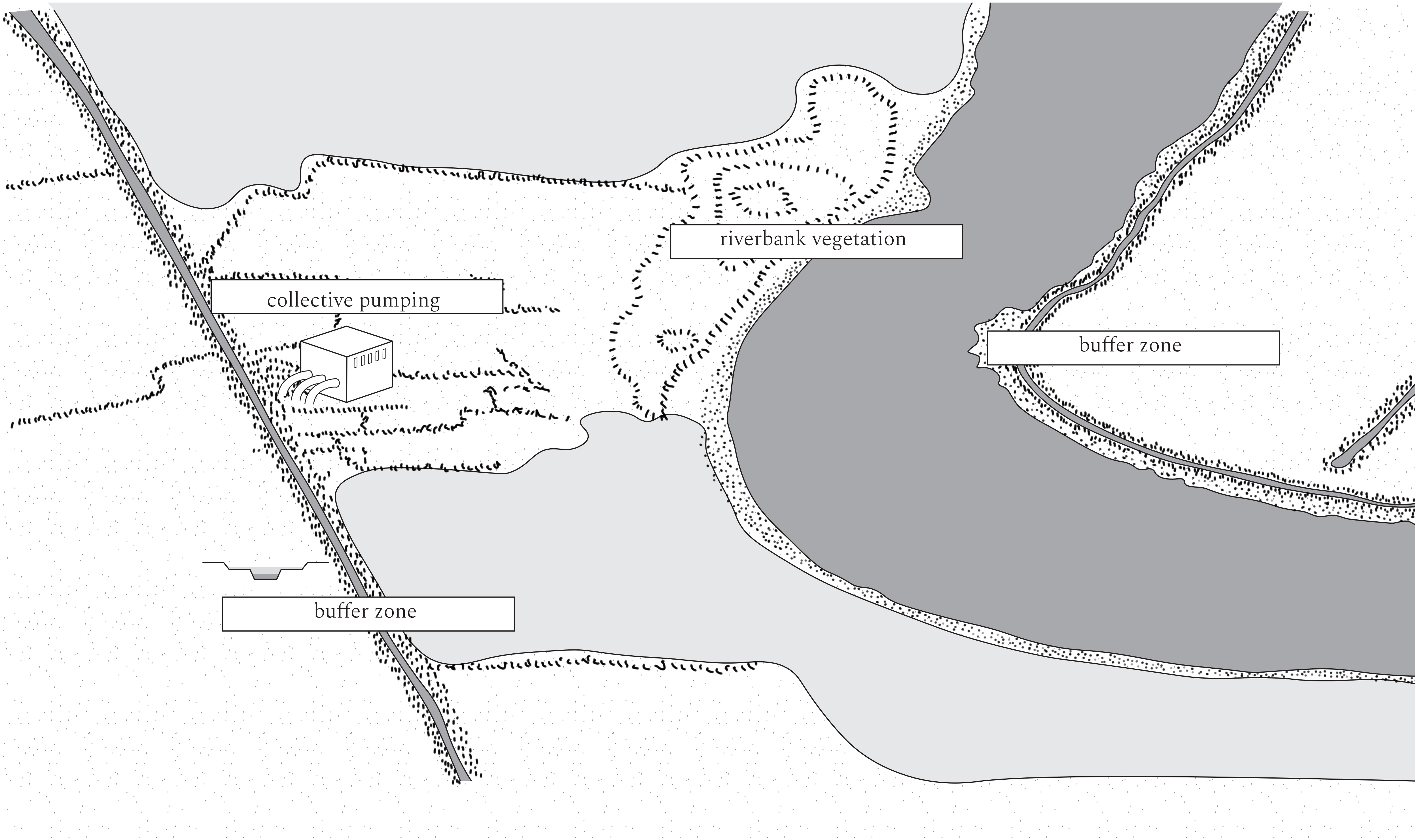
slow the flow

allow the flow

balance the flow



water fluctuation	●○○○○
sediment transport	●●○○○
water harvesting	●●●●○
increase vegetation	●●○○○
improve soil health	●●●○○
provide shade	●●○○○
minimize pollution	●●●○○

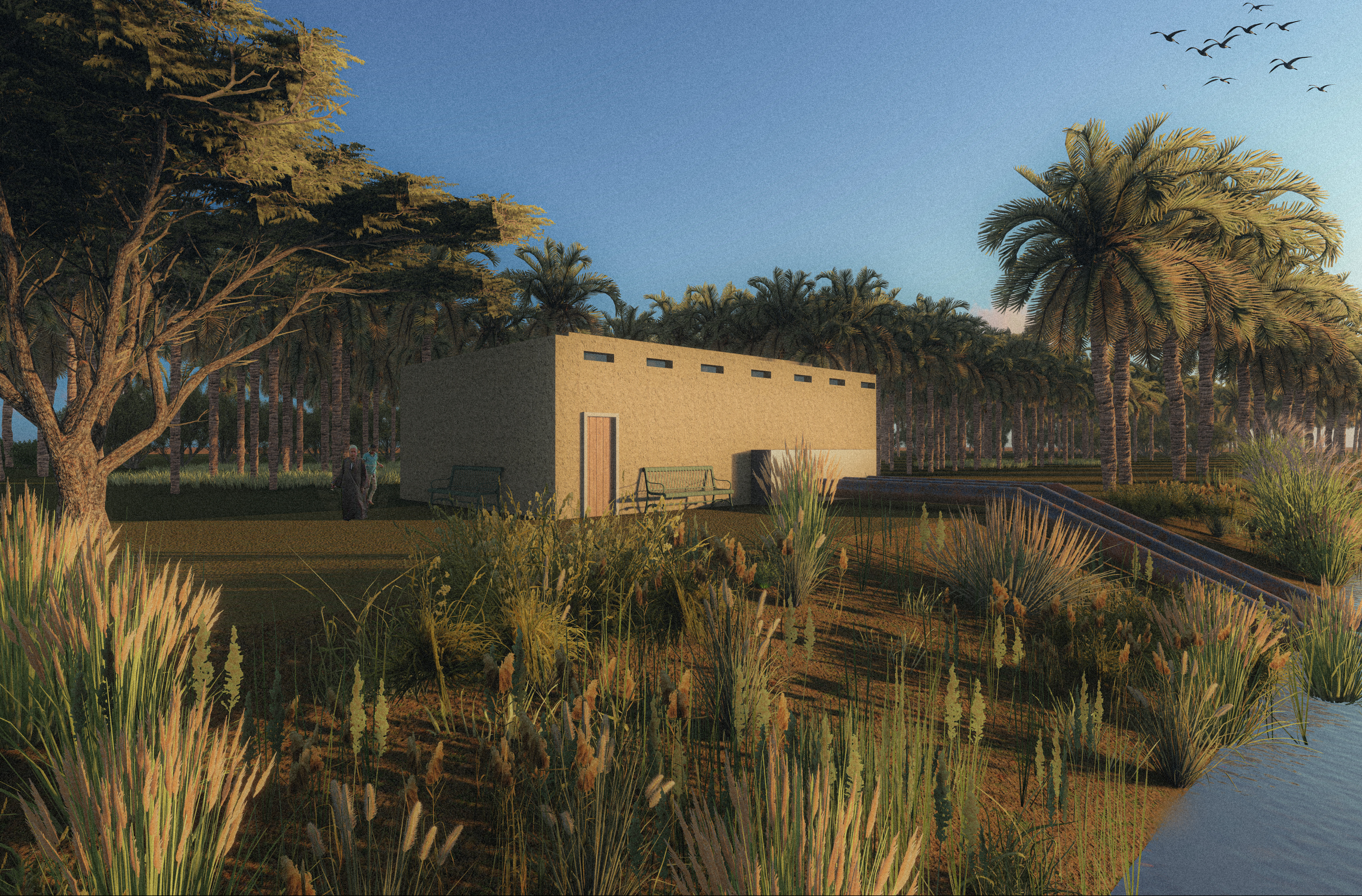

riverbank vegetation
collective pumping
buffer zone
buffer zone

Implementing strategy

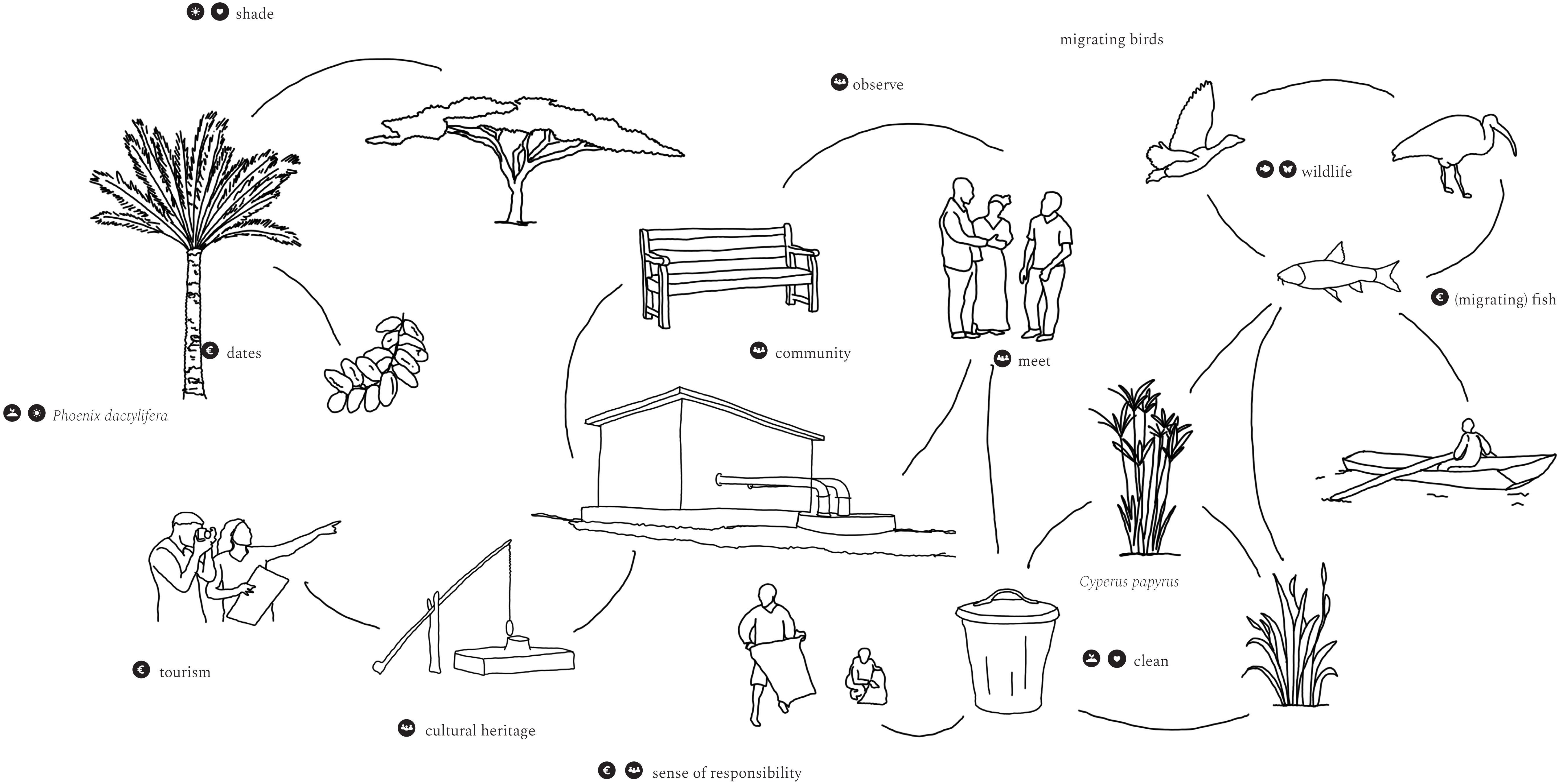
The strategic design for the area south of Rosetta in the Nile Delta takes a multi-faceted approach to harmonising the delicate relationship between the local community and the region's vital waterways. The implementation of a buffer zone around the irrigation canals plays a central role in this strategy. This buffer zone not only provides essential shade to minimise water evaporation, but also acts as a natural filtration system, cleansing the water of chemical pollutants, safeguarding water quality and maintaining the ecological balance of the Delta. It also seeks to restore the historic link between the local people and the waterways, fostering a sense of ownership and responsibility. To ensure a fair and equitable distribution of water among farmers, the introduction of communal pumping stations is proposed. These communal sites not only facilitate efficient water allocation, but also encourage cooperation among the farming community. This collaborative approach builds relationships, creates a sense of unity and contributes to the overall sustainability and well-being of the region, making it a model for water management and community engagement in the Nile Delta.

Local design

In the agricultural context of Rosetta, the local design project around the collective pumping station represents an innovative approach to agricultural and community development. In addition to serving as a practical resource, the community pumping station fosters a sense of community and knowledge sharing among farmers. Strategically located in the buffer zone where water is filtered from chemicals, the design addresses critical environmental concerns and ensures the quality and safety of Nile water. It also renews and strengthens the historically rich relationship between local communities and the life-giving waters of the Nile. This initiative demonstrates a forward-looking commitment to sustainable agriculture and community building, ultimately contributing to the resilience and prosperity of the Rosetta Promontory agricultural landscape, while emphasising the importance of collective action and environmental responsibility.



Stakeholders



5.5 *Conclusion*

Three designs for a resilient basin

The three landscape architecture designs for the Nile Basin collectively aim to increase the resilience of the basin by focusing on the restoration of the natural river system.

Sponge Lake Land of Tana

The Sponge Lake Land of Tana design is an approach to ecological restoration and sustainable land management. At the heart of the plan is the revival and improvement of soil quality. To combat soil erosion and its effects, a multi-faceted strategy will be implemented, including reforestation initiatives to increase the protective cover of vegetation, home gardens to provide both food and further soil stabilisation, and the strategic planting of a variety of flora to increase the resilience of the land. In addition, the expansion of floodplains to create wetlands not only mitigates the effects of flooding, but also acts as a natural filtration system for the soil, removing impurities and replenishing nutrients. The integration of vetiver grass, known for its remarkable erosion control properties, further enhances the sustainability of this rejuvenated landscape, making the Sponge Lake Land of Tana a model of soil conservation and ecological rejuvenation.

Watergardens of Aswan

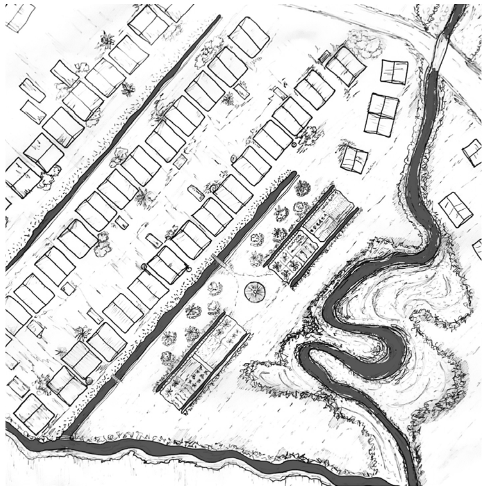
The Watergardens of Aswan design, located in Aswan, Egypt, is a design that focuses on the middle section of the river. With the addition of a bypass system, this design allows for seasonal fluctuations in river flow, creating the conditions for a sustainable and harmonious relationship with the river. It also seamlessly blends green and blue infrastructure, introducing water into the urban landscape. It not only introduces new public spaces, but also cultivates oasis-like environments in the midst of the city's arid environment. This innovative approach to urban planning not only transforms the city, but also creates the conditions for natural river dynamics to return to the middle reaches of the Nile.

Canal Connection of Rosetta

The third design, "Canal Connections in Rosetta", is located downstream in the landscape of the Rosetta promontory in the Nile Delta. This design revolves around the creation of buffer zones along the irrigation canals that serve the dual purpose of improving water quality through filtration and reducing evaporation losses. By weaving these green corridors into the fabric of the delta, the design not only increases the region's environmental resilience, but also strengthens the deep bond between the local community and the life-giving waterways. At the heart of the project is a collective pumping station, where modern technology meets traditional wisdom. The station's primary function is to distribute water equitably between farmers, ensuring fairness and sustainability, but it also acts as a hub for knowledge sharing, promoting best practice and fostering a strong sense of community.

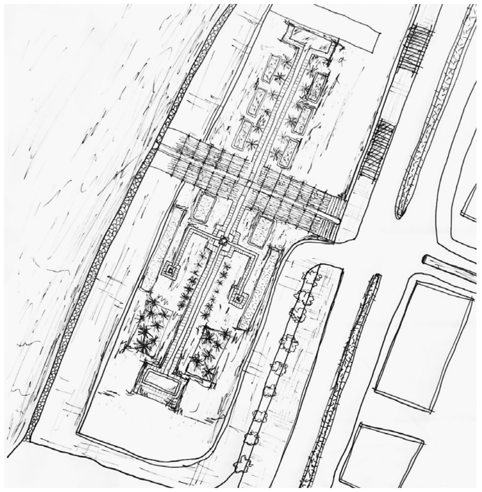
Upstream

Sponge Lake Land of Tana



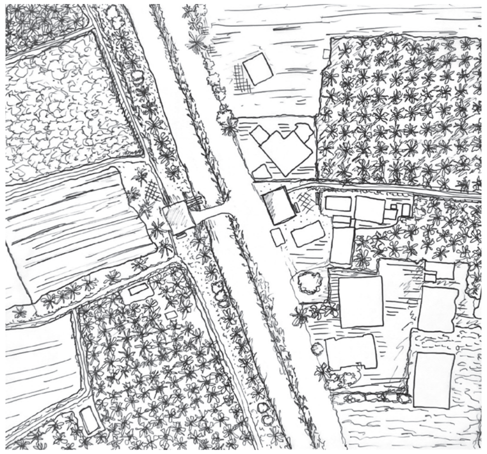
Midstream

Watergardens of Aswan



Downstream

Canal Connections of Rosetta



Designs for the a resilient Nile River Basin

Together, these designs not only address local challenges, but are interconnected as part of the wider Nile River system. They promote a harmonious coexistence with the river and the water, emphasising balance and symbiosis over opposites. Through these innovative approaches, the Nile Basin becomes more resilient, allowing natural processes and dynamics to flourish, ultimately contributing to the long-term sustainability and vitality of the basin.


Oil on canvas, the palm grove, Frederick Goodall (1894), via MutualArt

6 *Conclusion*

6.1 *Conclusion*

RQ 1: How to understand the current Nile River basin from a landscape perspective and what challenges and potentials belong to the current natural and cultural condition of the river and basin?

The Nile River Basin is one of the world's largest river basins, covers an immense area of land, almost 10% of Africa, stretching over 11 countries in northeastern Africa. The Nile is formed by three main rivers, namely the Blue Nile, White Nile, and the Atbara River. The Nile River is rich in diversity, diverse combinations of climates, topographies, soils and vegetation make the Nile River basin have an extensive diversity in regions.

A river is a dominant land-shaping element. Therefore within a river system, different landscape typologies can be categorized. In broad terms, you have the upstream, midstream, and downstream sections in a river system. The upstream region is the catchment area, where the source of the river is usually located. Most of the time this is located on the highest elevations of the basin, such as a mountain peak. The water may emerge from aquifers, melting water from glaciers, rainfall, and snowmelt. The water flows from small streams and channels towards the headwaters. Usually, it is fast-flowing, as it descends from higher elevations. A landscape typology that fits the upstream section is mountains.

The midstream section of the river system is characterized by generally wider riverbeds with a more gentle gradient. Mostly, this is the part where the river meanders into curves as it flows through valleys or plains. In this section, tributaries often join the main river. The river has more time to erode and pick up sediment as it flows through the midstream section, resulting in a higher sediment load compared to the upstream section of a river. Landscape typologies that fit the midstream section are wetlands, valleys, and gorges.
The downstream section of the river is a section where the stream is typically wider, flatter, and has a lower gradient. In this section, the river flows to its mouth, where it empties into an ocean, sea, or lake. The water velocity has reduced, leading to a calmer and slower-moving flow. The sediment that has been carried by the river tends to settle in the downstream section, resulting in the formation of deltas and floodplains.

To get a grip on the massive Nile River Basin the Nile Basin can be broadly categorized into seven major regions:

1) the Lake Plateau of East Africa, which is a mountainous region that produces headstreams and lakes that feed into the White Nile. The Lake Plateau of East Africa is a part of the upstream region of the Nile.

2) The AL-Jabal, is a section of the river where it descends through narrow gorges and over a series of rapids, then flowing into the Al-Sudd, a massive wetland in South Sudan. During the rainy season, the water overflows the river and the entire plain becomes inundated. The Al-Jabal is part of the midstream region of the Nile.

3) The White Nile begins at Malakal and flows northwards to Khartoum, where it meets the Blue Nile. Throughout this stretch of the White Nile is a broad and steady stream, often flowing through narrow fringes and swamps. This section of the river is part of the midstream part of the Nile.

. 4) The Blue Nile drains from the Ethiopian Plateau, which is a mountain region in northern Ethiopia. Streams flow into Lake Tana, and from there the Blue Nile drains in a southeasterly direction. The river flows through steep elevations, flowing through a series of rapids, and through a deep gorge. Multiple tributaries are feeding into the Blue Nile. The river flows towards Khartoum where it is joining the White Nile. The Blue Nile is considered one of the headwaters of the Nile, being the upstream region of the Nile Basin river system.

5) The Atbara River is the last tributary of the Nile. It originates in Ethiopia, north of Lake Tana. The Atbara is fed by two main tributaries, the Angereb and the Tekeze. The Tekeze rises from the high peaks of the Ethiopian Highlands and then flows through a deep gorge towards the Atbara river in Sudan. The Atbara River is part of the upstream section of the Nile Basin river system.

6) the Nile north of Khartoum, is the part where the Blue and White Nile have merged and formed the United Nile. The river flows through the desert towards Lake Nasser, which is the reservoir of the Aswan High Dam in Egypt. The river has mainly a gentle flow, with a series of cataracts, where the river suddenly drops, forming a waterfall. This part of the river is considered the midstream section.

7) the Nile Delta starts north of Cairo. The delta is a triangular-shaped lowland, where the river splits into two different distributaries, the Rosetta and the Damietta branches. The land has a gentle slope towards the Mediterranean Sea, where it empties into. Along the coast, multiple shallow brackish lagoons and salt marshes can be found. The Delta and the coast are the end of the river, forming the downstream section of the river system (Brittanica, z.d.).

The Nile River is the lifeline for many, since ancient times the Nile has provided conditions to establish civilizations along the banks of the river, providing water for agriculture, drinking, and transportation. Nowadays, the Nile is still considered the lifeline for many, as many depend on the water of the Nile as the main source of their livelihood. While the population of the basin keeps growing, urbanization is increasing and the pressure on the water of the Nile is growing, the Nile is also facing environmental challenges. Climate change, ambitious water management, and human resistance towards natural river processes have led to problems related to water scarcity, droughts and flooding, erosion and soil degradation, and biodiversity loss.

RQ2: What specific landscape architecture strategies and (design)principles, aligned with the watershed approach and focused on the natural river system and processes, can be employed to enhance overall resilience in the Nile River Basin?

Learning from different studies, beliefs, case studies, and theories, four main principles and related landscape-based design principles specifically for the Nile River basin, are formulated. The four main principles are 1) seasonal sensitive design, 2) learning and use of vernacular practices, 3) hierarchical framework of protect, enhance, create, and, 4) introducing a negotiation space. The four main principles all include landscape architecture-based design principles to show a practical approach to enhancing the resilience of the Nile River Basin.

Seasonal sensitive design can help to mitigate the challenges associated with different climatic conditions. For example, water management strategies that relate to rainfall patterns. During the rainy season, water harvesting, retention, and detention strategies can be implemented. In the case of the Nile Basin, a seasonal sensitive design approach mainly plays a role in the upstream regions and some midstream regions. For the reason that a large part of the Nile flows through an arid region experiencing almost no differences in climatic seasons. In the upstream region of the Nile, in the

the mountainous region of the Ethiopian Plateau, the climate is subtropical. Here they experience periods of extreme rainfall, followed by a longer period of drought. For this part of the Nile, a design that is seasonal sensitive is extremely beneficial.

The learning and use of vernacular practices in landscape architecture design introduces a culturally sensitive approach. It shows regional specificness by embracing the traditional design methods, techniques, and management strategies that have evolved over generations. These practices are based on long-term experiences and are handed down over generations. The Nile is home to multiple ancient civilizations. The most prominent, are the ancient Egyptians, but let's not forget about the kingdom of Aksum in Ethiopia, the Nubian inhabitants of the Nile Valley in Sudan, and the multiple indigenous tribes the basin is rich in, for example, the Dinka, living in the swamps of South Sudan. All of this local knowledge, of generations long, is site-specific and originates in a belief in living in balance with nature.

The hierarchical framework of protect, enhance, and create relates to the development and management of landscape architecture. It starts with protecting existing ecosystems and structures that are essential to mitigate the loss and degradation of ecosystems and ecosystem services. Secondly, enhancing, restoring, and rehabilitating the ecosystems is a strategy that aims to undo the damage that has been done. Finally, the development of new techniques and solutions can be implemented. An example of the Nile basin could be the upstream region near Lake Tana, where deforestation is happening at an exhilarating rate, leading to soil degradation affecting the local livelihood of many. In order to fight the degradation, reforestation could be the solution. By following the hierarchical framework, first, the still existing forest should be protected, second current remaining scattered patches could be enhanced to restore the previous forest structure. Lastly, new interventions, such as agroforestry could be implemented.

The introduction of a negotiation space starts with acknowledging that certain elements in a landscape are following a slow development, while most elements in modern landscapes are fast developing, they tend to take over, leaving no space and time for slow-developing processes to grow and thrive. By introducing a negotiation space, a third space is introduced. This space can serve as a buffer to allow space for slow-developing processes to develop while answering the demand for fast development. A river is a perfect example of a slow-developing element within a landscape. At first glance, you see almost no change, but by letting it develop over time, the river can shape the whole surrounding landscape. A zone around the river, which is multifunctional and adaptive can fulfil the requirements of the river system while also providing space for the development of modern times. For example, a riverfront park, where the river can take space to develop over time, but in the meantime, the space can be utilized as a public space serving urban demands.

RQ3: How can landscape architecture design be implemented on a local scale on three locations; upstream, midstream and downstream of the River Nile, evaluating the interconnection and influence of the designs based on their place within the river system?

Upstream

Landscape architecture design can play an important role in improving the resilience of the Nile River Basin. The design is located upstream in the basin near one of the river's main sources, Lake Tana in Ethiopia. This site faces some local challenges such as soil erosion, land degradation, droughts and floods. While this has a major impact on the local scale of the region, it also affects the river system and thus the basin as a whole. Currently, during the rainy season, water flows directly into the lake, which empties into the Blue Nile. Due to poor land management, soil erodes rapidly and flows into the lake, increasing the risk of flooding. During the dry season, there is little rainfall, but the water from previous months has already been drained, causing the land to experience extreme drought.

A local design is made to showcase how landscape architecture can play a role in increasing the overall resilience of the basin. The site is located on the northeastern side of Lake Tana, at the edge of a village (Enferaz), with high steep mountains in the north. In the design, a series of design principles are implemented and blended into a community space in between the edge of the village and a seasonal stream. The community space includes a series of home gardens, providing food and products for the local inhabitants. The home gardens can play an important role in improving the nutrient intake of the inhabitants of Enferaz. To provide the home gardens with water and to prevent flooding during monsoon rains additional waterways are dug out following the fanya juu strategy, to conserve soil and water. The waterways are lined with papyrus reed, which helps to build soil solidity and conserve and purify the water. The papyrus reed can be harvested and can be used to make the local fisherman boat called Tanqua. A community building is introduced in the middle of the site, to serve as a place where food and products can be stored and processed. A negotiant space is introduced along the seasonal waterway, which serves as a floodplain during the peak rain season, merging into a wetland area, providing a home and shelter to wildlife while fertilizing the soil during the low rain season, leaving the soil moist the land can be used for agricultural purposes during the dry season.

By increasing the sponge capacity of the Lake Tana region and managing the retention, detention and discharge of water, the flow can become more gradual rather than a high peak and long low. If the water from Lake Tana can be released more gradually into the Blue Nile, this would mean a reduction in the risk of flooding and drought further down the river system. A more gradual flow could encourage an acceptance of river dynamics and fluctuations, as they are more gradual and therefore less impactful changes.

Midstream

2 // The midstream design is located in the urban context of Aswan, Egypt, along the banks of the river. The city suffers from an extremely arid climate and receives almost no rainfall. The extreme climate creates harsh conditions for the city's inhabitants. The Nile is the source of life, providing water for agriculture, drinking and transport. The Nile at Aswan can be described as completely tamed, since the construction of the Aswan High Dam in 1970, the water level experiences almost no fluctuations and no seasonal differences. The dam has created a continuous flow of water, providing year-round irrigation and generating enormous amounts of hydroelectric power. On the downside, the dam has reduced the resilience of Aswan and the basin as a whole by preventing the natural processes of river dynamics.

The local design consists of a series of water gardens throughout the city of Aswan. The gardens have multiple scales and can be private, semi-private, or public. Waterways are connecting the gardens, forming a blue-green network throughout the city. The designs in the network allow water fluctuations. For example, the riverfront water garden. This water garden is a large public park. The park is designed to welcome water into the urban tissue. Straight lines of water flow into the garden, distributing along the park and further into the city's green-blue network. The park has different height levels, overall the park is lower than the rest of the city, paths are elevated from the ground, and trees and vegetation borders are slightly elevated from the ground. For the rare occurrence of flash floods, the park can completely overflow. For high water, some parts of the park will remain dry because of the elevation differences, and throughout the year, the park is a green oasis in the arid city.

By exploring the design of water gardens in Aswan, the city could increase its resilience by using landscape architecture design to allow water to flow into the city. This water can then be used to grow vegetation and cool the city, improving the quality of life for citizens.

The mid-stream design focuses on restoring the natural dynamics of the Nile. Increasing the ability to adapt to different seasons and water level fluctuations. The mid-stream design therefore helps to increase the overall resilience of the basin, creating conditions to accommodate for changes upstream. The design allows for the gradual reduction of hard, man-made structures that have caused the river to become fixed and not resilient.

Downstream

The downstream design is located in the Nile Delta, at the agricultural land along the Rosetta branch in the Rosetta promontory. The delta has been a vital and historically significant region in Egypt. Before the completion of the Aswan High Dam each year the Nile would flood, leaving the fertile silt and sediment. The delta is known for its fertile soil, which results from the deposition of silt and sediment carried down from the Nile River. The fertile soil makes the delta perfect for productive agriculture and it is therefore a crucial source of food for Egypt. Nowadays, the soil is degrading, the soil is being exploited by agriculture and chemical fertilizers are needed to be able to grow crops. The chemical fertilizers and run-off from cities and industry lead the river and irrigation canals to deteriorate.

The local design in the Rosetta promontory is focussing on the irrigation canals. The design introduces a negotiation space, a buffer zone, around the main irrigation canal. This buffer zone is designed to help mitigate certain local problems, like pollution, rebuild respect between humans and the water system, and introduce an equal distribution of water within the irrigation canals. On the other hand, the buffer zone could help allow back some natural river fluctuations and dynamics within the water system. By allowing a certain amount of flood, the soil can rebuild its fertility. The design includes a collective pumping place, where the water can be distributed among farmers equally and can serve as a meeting place for the local inhabitants, where ideas and knowledge can be shared. The buffer space is lined with native trees, like the date palm. It serves as an aesthetic and historical symbol, but also creates shade, thereby minimizing the evaporation rates within the canal.

6.2 Discussion

Dams

The river system can never be fully revitalized with allowing natural dynamics to happen when big dams are still largely present along the Nile river course. The dams obstruct the natural flow of the river, taming water levels and disrupting the balance of erosion and sedimentation. In this research and design, the dams and their benefits and problems are acknowledged. However, the dams are not actively a part in the designs. The designs are explorations on creating conditions that would allow river dynamics and processes. Eventual removal of a dam or multiple dams, would need a systematic shift of the whole basin towards a nature based approach, allowing river dynamics and processes.

Measurability

In this explorative research design, the relationships between three designs are assumptions. The assumption are derived from theory, case-studies and general logical thinking. In this research, the assumptions are not measured by data, models or scenario comparisons.

Politics

The Nile flows through eleven countries in northeastern Africa. The Nile flows for a great part through arid regions, where the Nile is the only source of life. Therefore, the water from the Nile is a conflict sensitive topic. Early in my research proposal, I have stated to conduct a transboundary, nature-based approach. I have neglected the political boundaries and regulations to truly design from a nature-based perspective to be able to let natural processes and systems be the basis.

6.3 *Reflection*

Reflection on methodology

The structure

The theoretical framework has helped me a lot to structure my research. The watershed approach has been found most helpful, by using the systematic approach of the watershed and the interconnection within a watershed. On top of that, the river as a system has helped me to structure the research. It helped me to define my design locations and understand the relationships on the bigger scale of the basin. I believe that it took me quite some time to figure out the theoretical framework. During my P2 presentation I had not been focussing much on the theoretical background. This led to the main critique during my P2, namely, adding a more structured approach. After diving further into the theory, I noticed that it helped me a lot to gain some clarity in my research approach. This has been a great learning experience for me. To realise that theory is a tool that can help me instead of a burden that I needed to tackle.

The process

During the process of the graduation project I have encountered a couple of difficulties. First and most of all, I have regretted not visiting the design location. Due to a set of circumstances I did not visit a part of the Nile. It is good to acknowledge that therefore I may have missed some sense of place, limiting my designs to become more site specific. Besides that, collecting data was sometimes harder. There has been a lot of research done on the Nile and the Nile River Basin, so there was enough information available. However, data on the local scale, especially in rural Ethiopia, was sometimes hard. For example, creating maps using GIS data was sometimes not possible. This has led me to making my own maps in AutoCAD, based on satellite data from google earth. Looking back, it may have been easier to choose a graduation topic in the Netherlands or western Europe. Nevertheless, I am still really pleased with my decision on the Nile, since I have found everyday working, reading and designing on it really interesting and exciting.

Reflection on design

Landscape architecture

The four central themes in landscape architecture all play a role in my research and design. Process, the complexity of processes and dynamics of systems within a landscape, is present in my research. The start of the project is the river system and processes, which is used as the building block for design in my project. Perception, the experience of space, is reflected into my project as one of the main challenges is restoring the relationship between humans and the Nile. By creating an aesthetic way of appreciating natural dynamics of the river. Palimpsest, reading the landscape as a biography, is present in my graduation project as I learn from vernacular practices, make us of historical knowledge by shaping them into (design) principles for modern times. Scale continuum, the affects, influences, connections and relationships that connects scales within a landscape is reflected into the project by the use of the watershed approach and working on multiple scales throughout the project, reflecting back on one another.

Scope and scale

In choosing this graduation lab and topic, I expressed my desire to work on a large scale. Over the last few months I have often felt overwhelmed by the immense scale of the Nile, the amount of different landscapes, cultures and climates has made this project very complex. The theoretical framework has helped me to structure the research and design and make it less overwhelming. I have learnt the importance of understanding a whole system before designing a local situation. I believe that by analysing the large context, the designs have become much better, as opposed to just researching the regional and local scale.

My role as a designer and researcher

Personal growth

The last year, I have developed myself further as a person, a student and as a landscape architect. It was a great challenge for me to work for a whole year, on one topic, on my own. The main challenge for me was to battle my own pressure of wanting to solve all problems and design 'everything'. With personal interests into history and local communities I have often felt lost in information and details, that on the bigger scope of my project, did not matter at all. I have learned to make a distinctions between the 'big' important parts that help the project further and what the little details are which can help create a nice story, but produce no big steps forward into the project.

Ethical considerations

My great interest in the culture and landscape of the Nile River and Africa has led me to choose the Nile as a graduation topic. I have always tried to handle this project with great respect towards the location. Nevertheless, it is good to acknowledge that along this graduation project there has been multiple occasions where I have doubted my capability to design for the Nile River Basin.

I am a Dutch, female, student born in Europe and have no direct relationship to the northeastern part of Africa. I have therefore often felt misplaced and I have doubted my ability to fully understand the local context, grasping the true local cultures, practices and believes. I have often felt like an outsider, telling people how to improve while not being part of the place I am trying to improve.

Lessons learned

The main take-away of my project is, in order to understand a place, the connected systems and processes should be understood. For example, when I started my graduation project, I wanted to work on the Nile in Egypt. But to fully understand the Egyptian landscape, the whole river system of the Nile should be understood. Where does the water come from?, At what time?, How did the river shaped the land?, Why is it flowing in this direction?, What is the connection of the place within the whole system?, etc. etc.. I believe that in my future projects, I will include this approach, to conduct a complete understanding of a place.

“The gift of the Nile”

“Αιγνπτο εοτι δωρον τον ποταμον”

Herodotus, 450 BCE*

** Griffiths, J. G., Feinman, P., Pelling, C., JORDAN, J., Jordan, J. M., & Griffith, R. D. (1966). Hecataeus and Herodotus on “A Gift of the River”. Journal of Near Eastern Studies, 25(1), 57-61. https://doi.org/543141*

Bibliography

Abdou, M. (2022, January 28). A Year in Three Seasons: Ancient Egypt's Calendar | Egyptian Streets. Egyptian Streets. https://egyptianstreets.com/2022/01/28/a-year-in-three-seasons-ancient-egypts-calendar/

Aga Khan Trust for Culture. Historic Cities Programme. (2021). A sustainable future : urban parks and gardens. (P. Jodidio, Ed.) (Trade). Prestel.

Ahmed El-Shazli & Georg Hoermann (2016) Development of storagecapacity and morphology of the Aswan High Dam Reservoir, Hydrological Sciences Journal, 61:14, 2639-2648, DOI: 10.1080/02626667.2016.1151979

Ayele, H. S., & Atlabachew, M. (2021). Review of Characterization, Factors, Impacts, and Solutions of Lake Eutrophication: Lesson for Lake Tana, Ethiopia. Environmental Science and Pollution Research, 28(12), 14233–14252. https://doi.org/10.1007/s11356-020-12081-4

Benedict, M., McMahon, E., Fund, T., & Bergen, L. (2006). Green Infrastructure: Linking Landscapes and Communities. Bibliovault OAI Repository, the University of Chicago Press, 22, 1-12.

Bogale, A. Review, impact of land use/cover change on soil erosion in the Lake Tana Basin, Upper Blue Nile, Ethiopia. Appl Water Sci 10, 235 (2020). https://doi.org/10.1007/s13201-020-01325-w

Bossone, A. (2015, 16 oktober). Egypt's Nile-borne health crisis. Middle East Eye. https://www.middleeasteye.net/features/egypts-nile-borne-health-crisis

Braudel, F. (1966). La Medtiterranee: La part du milieu. Paris, Librairie Armand Colin.

Britannica, T. Editors of Encyclopaedia (2019, April 15). Lake Tana. Encyclopedia Britannica. https://www.britannica.com/place/Lake-Tana

Cascao, A. E. (2013). Nile water governance. In The Nile River Basin (pp. 251-274). Routledge.

Castanha, A. (2021, 24 mei). The continual wrath of water hyacinth in Lake Tana - InfoNile. InfoNile. https://infonile.org/en/2021/05/the-continual-wrath-of-water-hyacinth/

Cohen-Shacham, E., Andrade, A., Dalton, J., Dudley, N., Jones, M., Kumar, C., Maginnis, S., Maynard, S., Nelson, C.R., Renaud, F.G. and Welling, R. 2019. Core principles for successfully implementing and upscaling Nature-based Solutions. Environmental Science & Policy, 98:20–29. https://www.iucn.org/sites/dev/files/content/documents/core_principles_for_successfully_implementing_and_upscaling_naturebasedsolutions.pdf

Dumont, H. J. (Ed.). (2009). The Nile: origin, environments, limnology and human use (Vol. 89). Springer Science & Business Media.

Edward Relph (1993). Place reclamation. In S. Swaffield (Ed.) Theory in Landscape Architecture; A Reader, (ser. Penn studies in landscape architecture). University of Pennsylvania Press.

Egyptian calendar. (2023, January 17). In Wikipedia. https://en.wikipedia.org/wiki/Egyptian_calendar

Egyptian Commission for Irrigation and Drainage (1983) The Nile and the History of Irrigation in Egypt. (in Arabic).

El-Kammash, M. M. , Smith, . Charles Gordon and Hurst, . Harold Edwin (2023, September 10). Nile River. Encyclopedia Britannica. https://www.britannica.com/place/Nile-River

Faoud et al. (2022) Landscape-based regeneration of the Nile Delta's waterways in support of water conservation and environmental protection

Food and Agriculture Organization of the United Nations [FAO]. (z.d.). Elevation map (Versie 1) [Dataset; GIS]. https://data.apps.fao.org/map/catalog/srv/eng/catalog.search#/search?resultType=details&sortBy=relevance&fast=index&_content_type=json&from=101&to=150&any=africa

Fred Pearce (2022, 28 June) Will a Nile Canal project dry up Africa's largest wetland? (z.d.). Yale E360. https://e360.yale.edu/features/will-a-nile-canal-project-dry-up-africas-largest-wetland

Galata, A.W. Analysis of land use/land cover changes and their causes using landsat data in hangar watershed, Abay basin, Ethiopia. J. Sediment. Environ. 5, 415–423 (2020). https://doi.org/10.1007/s43217-020-00025-4

Goshu, G., & Aynalem, S. (2017). Problem overview of the lake Tana basin. Social and ecological system dynamics: Characteristics, trends, and integration in the Lake Tana Basin, Ethiopia, 9-23.

Goshu, G., Koelmans, A. A., & de Klein, J. J. M. (2017). Water quality of Lake Tana basin, Upper Blue Nile, Ethiopia. A review of available data. Social and Ecological System Dynamics: Characteristics, Trends, and Integration in the Lake Tana Basin, Ethiopia, 127-141.
Gunderson, L. H. (2000). Ecological Resilience--In Theory and Application. Annual Review of Ecology and Systematics, 31, 425–439. http://www.jstor.org/stable/221739

Griffiths, J. G., Feinman, P., Pelling, C., JORDAN, J., Jordan, J. M., & Griffith, R. D. (1966). Hecataeus and Herodotus on "A Gift of the River". Journal of Near Eastern Studies, 25(1), 57-61. https://doi.org/543141

H+N+S Landscapsarchitecten & Team TU Delft en PBL. (2023). De lagenbenadering, het lagenmodel en het casco concept.

Haars, Christian & Winkelaar, Bram & Lönsjö, Emma & Mogos, Bianca. (2016). The uncertain future of the Nile Delta. 10.13140/RG.2.1.1837.0963.

Haddad, M. (2020, 23 januari). Could mega-Dams kill the mighty River Nile? (An interactive report). Al Jazeera English. https://interactive.aljazeera.com/aje/2020/saving-the-nile/index.html

Hammond, M. (2013, February). The Grand Ethiopian Renaissance Dam and the Blue Nile: implications for transboundary water governance. In Global Water Forum (Vol. 1307).

Harris, I., P.D. Jones, T.J. Osborn, and D.H. Lister (2014), Updated high-resolution grids of monthly climatic observations - the CRU TS3.10 Dataset. International Journal of Climatology 34, 623-642. doi:10.1002/joc.3711

Hirvonen, K., & Headey, D. (2018). Can governments promote homestead gardening at scale? Evidence from Ethiopia. Global food security, 19, 40-47.

History. (n.d.). The Nile River. Retrieved from https://www.history.com/topics/africa/the-nile-river

Holling, C. S. (1973). Resilience and stability of ecological systems. Annual review of ecology and systematics, 4(1), 1-23.

Hooimeijer, F. L., Kuzniecow Bacchin, T., Recubenis Sanchis, I., Meneses Di Gioia Ferreira, L., do Nascimento, L. F., Bijlsma, L., van Rijn, F., Bouwman, A., & Veerbeek, W. (2021). NBS in Vulnerable Geographies: Applicability of NBS in socio-economic unequal urban/peri-urban contexts with water-related challenges. Delft University of Technology.

Hopwood, D. , Little, . Donald P. , Goldschmidt, . Arthur Eduard , Holt, . Peter M. , Smith, . Charles Gordon and Baker, . Raymond William (2023, September 28). Egypt. Encyclopedia Britannica. https://www.britannica.com/place/Egypt
https://plus.google.com/+UNESCO. (2019, 5 augustus). Lake Tana Biosphere Reserve, Ethiopia. UNESCO. https://en.unesco.org/biosphere/africa/lake-tana

Joan Iverson Nassauer (1995). Messy ecosystems, orderly frames. In S. Swaffield (Ed.) Theory in Landscape Architecture; A Reader, (ser. Penn studies in landscape architecture). University of Pennsylvania Press.
Justdiggit. (2023, 20 juni). JustDiggit | Cooling Down the Planet. Justdiggit. https://justdiggit.org/nl/?gad=1&gclid=CjwKCAjwseSoBhBXEiwA9iZtxhK5-8QaAAIdO6bRuVTa9kfzBXVstBP97o4RU9RMEyLkwVqDML3DbBoCeJMQAvD_BwE

Kellahan, K. (2019, 1 november). Paraty, Brazil: the chilled-out coastal town that was once a historic and cultural epicentre. The Sydney Morning Herald. https://www.smh.com.au/traveller/inspiration/paraty-brazil-the-chilledout-coastal-town-that-was-once-a-historic-and-cultural-epicentre-20191022-h1j1fg.html

Khalifa, H. E., & Moussa, H. A. (2017). Soil and agriculture after the Aswan High Dam. Irrigated agriculture in Egypt: Past, present and future, 81-124.

Lehner, B., Grill G. (2013). Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15): 2171–2186. https://doi.org/10.1002/hyp.9740

Lehner, B., Grill G. (2013). Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15): 2171–2186. https://doi.org/10.1002/hyp.9740

Link, Peter & Piontek, Franziska & Scheffran, Jürgen & Schilling, Janpeter. (2013). On foes and flows: Water conflict and cooperation in the Nile River Basin in times of climate change.

M.Bourne. (z.d.). Home gardening enhances conservation and food security in Ethiopia | Regreening Africa. https://regreeningafrica.org/in-the-news/home-gardening-enhances-conservation-and-food-security-in-ethiopia/

Maadi, C. (2023, 17 augustus). The Flooding of the Nile Celebration (Wafaa El-Nil) — CSA Reviving community. CSA Reviving Community. https://csa-living.org/oasis-blog/the-flooding-of-the-nile-celebration-wafaa-el-nil

Mahmoud Abu Zeid (1989) Environmental impacts of the Aswan High Dam, International Journal of Water Resources Development, 5:3, 147-157, DOI: 10.1080/07900628908722428

Mahmoud Abu Zeid (1989) Environmental impacts of the Aswan High Dam, International Journal of Water Resources Development, 5:3, 147-157, DOI: 10.1080/07900628908722428

Mahmoud, S.H., Gan, T.Y., Allan, R.P. et al. Worsening drought of Nile basin under shift in atmospheric circulation, stronger ENSO and Indian Ocean dipole. Sci Rep 12, 8049 (2022). https://doi.org/10.1038/s41598-022-12008-8

Marais E (1937/1973) The soul of the white ant. Harmondsworth: Penguin.

Mark, J. J. (2023). Festivals in Ancient Egypt. World History Encyclopedia. https://www.worldhistory.org/article/1032/festivals-in-ancient-egypt/

Maslow, A. H. (1943). A theory of human motivation. Psychological Review, 50(4), 370–396. https://doi.org/10.1037/h0054346

Midekisa, Alemayehu & Senay, Gabriel & Henebry, Geoffrey & Semuniguse, Paulos & Wimberly, Michael. (2012). Remote sensing-based time series models for malaria early warning in the highlands of Ethiopia. Malaria journal. 11. 165. 10.1186/1475-2875-11-165.

Mohamed Helmy Mahmoud Moustafa ElsanabaryElsanabary, Mohamed Helmy Mahmoud Moustafa (2012), Teleconnection, Modeling, Climate Anomalies Impact and Forecasting of Rainfall and Streamflow of the Upper Blue Nile River Basin, Canada: University of Alberta, doi:10.7939/R3377641M, hdl:10402/era.28151

Morris GL. Classification of Managemevnt Alternatives to Combat Reservoir Sedimentation. Water. 2020; 12(3):861. https://doi.org/10.3390/w12030861

Nan Fairbrother (1970). New lives, new landscapes. In S. Swaffield (Ed.) Theory in Landscape Architecture; A Reader, (ser. Penn studies in landscape architecture). University of Pennsylvania Press.

Nijhuis et al. (2020). Towards a Landscape-based Regional Design Approach for Adaptive Transformation in Urbanizing Deltas

Nijhuis S., de Vries, (2019). Design as research in landscape architecture

Nijhuis, S (2019) 'Cultivating urban regions through design', in: Cattaneo, E, & Rocca, A. (eds.) Future landscapes. European experiences in landscape design and urbanism. Politechnico Milano, Dipartimento di Architettura e Studi Urbani / Regione Lombardia

Nijhuis, S. (2022). Landscape-Based Urbanism: Cultivating urban landscapes through design

Nijhuis, S., & Pouderoijen, MT. (2014). Mapping urbanized deltas. In VJ. Meyer, & S. Nijhuis (Eds.), Urbanized Deltas in transition (pp. 10-22). Technepress.

Nile Basin Water Resources Atlas. (z.d.). http://atlas.nilebasin.org/treatise/geology-of-the-nile-basin/

Nixon, S. W. (2004). The Artificial Nile: The Aswan High Dam blocked and diverted nutrients and destroyed a Mediterranean fishery, but human activities may have revived it. American Scientist, 92(2), 158–165. http://www.jstor.org/stable/27858364

Noaman, M. N., & El Quosy, D. (2017). Hydrology of the Nile and ancient agriculture. Irrigated Agriculture in Egypt: Past, Present and Future, 9-28.

Opperman, J., E. Oyare, H. Baleta, S. Fahrbach, and R. Camargo. 2021. Waterways to Resilience: Nature-based Solutions for Adaptation in Africa. WWF-International, Gland, Switzerland.

Oweis, T. (2004). Indigenous water harvesting systems in West Asia and North Africa. ... In West Asia and North Africa.
Post Aswan High Dam flash floods in Egypt: Causes, consequences and mitigation strategies. (z.d.). CORE Reader. https://core.ac.uk/reader/236638810

Prominski, M., & Stein, R. (2012). River, space, design : planning strategies, methods and projects for urban rivers. Birkhäuser.

Prominski, M., Stokman, A., Stimberg, D., Voermanek, H., & Zeller, S. (2012). River. Space. Design. In River. Space. Design. Birkhäuser.

Rap, E., de Bont, C., Molle, F., Bolding, A., & Ismail, A. (2022). Radical reassemblages: The life history of a Nile Delta pumping collective. Environment and Planning E: Nature and Space, 0(0). https://doi.org/10.1177/25148486221123701

Redeker, C., & Jüttner, M. (2020). Landscaping Egypt: from the aesthetic to the productive. Jovis Verlag GmbH.

Robert Thayer (1994). Gray world, green heart. In S. Swaffield (Ed.) Theory in Landscape Architecture; A Reader, (ser. Penn studies in landscape architecture). University of Pennsylvania Press.

Scottish Government. (2021). Consultation on National Litter and Flytipping Strategy Strategic Environmental Assessment Environmental Report. from https://www.gov.scot/publications/national-litter-flytipping-consultation-strategic-environmentalassessment/.

Sisay Ejigu, Kibruyesfa & Thurnher, Christopher & Belay, Beyene & Lindner, Gerald & Hasenauer, Hubert. (2017). Volume and Carbon Estimates for the Forest Area of the Amhara Region in Northwestern Ethiopia. Forests. 2017. 10.3390/f8040122.

Sive, D. (2023, 24 januari). Between clay and cement: Is Egypt's canal lining a solution or dilemma for farmers? - InfoNile. InfoNile. https://infonile.org/en/2023/01/is-egypts-canal-lining-a-solution-or-dilemma-for-farmers/

Teodoru, Cristian & Wuest, Alfred & Wehrli, Bernhard. (2006). Independent Review of the Environmental Impact Assessment for the Merowe Dam Project (Nile River, Sudan). Report.

The Project Gutenberg eBook of the Nile in 1904, by William Willcocks. (z.d.). https://www.gutenberg.org/files/57379/57379-h/57379-h.htm

Tikuye, Birhan Getachew & Manjunatha, Busnur. (2022). Impacts of Land-Use Change on the Hydrology of Lake Tana Basin, Upper Blue Nile River Basin, Ethiopia. Global Challenges. 6. 10.1002/gch2.202200041.

Trocaire. (2021, 17 juni). Extreme drought, worsened by global climate change rages through Ethiopia - Trócaire. Trócaire. https://www.trocaire.org/news/extreme-drought-worsened-by-global-climate-change-rages-through-ethiopia/

Tvedt, T. (2021). De Nijl: Biografie van een rivier (2nd ed.). Wereldbibliotheek.

Tvedt, T., & Oestigaard, T. (2015). A history of water: Water and humanity from ancient times to the modern era. I.B. Tauris.

UNESCO World Heritage Centre. (z.d.). Lake Tana Island Monasteries and its adjacent Wetland Natural and Cultural Heritages - UNESCO World Heritage Centre. https://whc.unesco.org/en/tentativvelists/6580/
USAID providing more than $39 million in humanitarian assistance to respond to drought in Ethiopia | Press release | U.S. Agency for International Development. (2022, 14 februari). U.S. Agency for International Development. https://www.usaid.gov/news-information/press-releases/feb-14-2022-usaid-providing-more-39-million-humanitarian-assistance-respond-drought-ethiopia

Watson, J., Robertson, A., & De Rosen, F. (2020). DESIGNING BY RADICAL INDIGENISM. Landscape Architecture Frontiers, 8(3), 148-155.

World Bank, 2021. A Catalogue of Nature-based Solutions for Urban Resilience. Washington, D.C. World Bank Group

World Bank. (2018). Nile Basin Countries. Retrieved Apr il 19, 2023, from https://www.worldbank.org/en/region/afr/brief/nile-basin-countries

WorldAtlas. (n.d.). Climate of Africa. Retrieved from https://www.worldatlas.com/articles/climate-of-africa.html

Wubalem, A., Tesfaw, G., Dawit, Z., Getahun, B., Mekuria, T. & Jothimani, M. (2021). Comparison of statistical and analytical hierarchy process methods on flood susceptibility mapping: In a case study of the Lake Tana sub-basin in northwestern Ethiopia. Open Geosciences, 13(1), 1668-1688. https://doi.org/10.1515/geo-2020-0329