Remaking "Nature"

An Ecological Transition Towards A Sustainable Landscape



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"If we knew what it was we were doing, it would not be called research, would it?"

- Albert Einstein

ABSTRACT

Wetlands are the most important ecosystems on Earth, which can be found in many parts of the world. However, demand for food and economic development in the last century had driven many wetlands in the world being completely drained for cultivation and to the extent that no longer retain any natural wetland characteristics such as the Everglades Agricultural Area (EAA) in the United States. The ongoing drainage results in large amounts of peat soil loss and following the decrease of crop production, which has brought the sunset to the agriculture in the EAA. At the same time, it is urgent in South Florida to stop the damaging discharges to the coastal estuaries, to restore the flow of clean water to the Everglades preservation area and to guarantee the freshwater supply in the whole region, which also requires the transformation of the EAA.

This thesis develops an integrated approach for returning the Everglades agricultural lands to nature in order to recover the lost ecological assets in South Florida while balancing the economic value and improving spatial quality. Water is conveyed from lake Okeechobee and adjacent agricultural lands into the restoration area to be retained and purified through bioremediation process. The purified water will be further recharged into the aquifer and restored as sheet flow into the southern Everglades. Raising the water level and connecting with the local topography create conditions for the natural occurrences. The typical landscape of subtleties varies by the centimetre of water level change is brought back and becomes a space for people to seek experience and to engage themselves with the restored natural rhythms, changing over time. This project demonstrates its potential to be expanded and replicated across a variety of agricultural contexts. It is crucial to balance the ecological and economic value, design through different scales, and include a spatial and experiential dimension during the transformation.

Keywords: *sustainable landscape design, ecological restoration, Everglades, building with nature, peat loss, land subsidence, water management, landscape ecology*

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Landscape of Subtlety

"If you think of the ground level as 0, that's the bottom of a deep water slough. If I go up 30 or 40 cm from that, I'm in a sawgrass ridge, and if I go up a bit more, I'm on a tree island. We have drastically different environments that are separated in topography by a meter. This is a landscape of subtleties."

- Len Scinto

CHAPTER I
INTRODUCTION

1. Wetland in Transition
2. Area of Interests: EAA
3. Problem Statement
4. Research Objective
5. Scale of the Thesis
6. Research Design Framework
7. Methods
8. Project Relevance
9. Reading Itinerary

1.1 Wetland in Transition

SIGNIFICANCE OF WETLAND

Wetlands are the most important ecosystems on Earth, which can be found in many parts of the world. They are described as "Nature's Supermarket" because of the extensive food chain and rich biodiversity that they support (Mitsch & Gosselink, 2015). Wetlands provide unique habits for a wide variety of flora and fauna. On a global scale, wetlands are also important carbon sinks and climate stabilizers. Meanwhile, wetlands are often referred to as "Earth's kidneys" because they are the downstream receivers of water and waste from both natural and human sources, where the water and waste are filtered. They help protect shorelines, recharge groundwater aquifers and stabilize water supplies, thus mitigating both floods and drought (Mitsch & Gosselink, 2015).

THREATS TO WETLAND

Despite the significance of wetlands to nature and society, wetlands are also the most threatened environmental resources. Wetlands have been disappearing at alarming rates particularly from the industrial revolution onwards. According to the Millennium Ecosystem Assessment (2005b), more than 50% of wetland types in North America, Europe, Australia and New Zealand were lost, converted or degraded during the 21st century.

WETLAND TO AGRICULTURE

The wetland loss has been primarily driven by agricultural use. There are many wetlands in the world being completely drained for cultivation and to the extent that no longer retain any natural wetland characteristics such as the Everglades Agricultural Area in the United States, and Sanjiang Plain in China (Wood & van Halsema, 2008; Zhang, Ma & Fu, 2010).

Population pressure, demand for food and economic development have driven more wetland agriculture all over the world, which result in the overexploitation and pollution of wetland resources. The increased demands on wetlands, together with a global shift towards intensive mone-agriculture and scales of economics, are leading to the more complete conversion of wetlands to agricultural use through drainage and water management at a large scale with more freshwater being abstracted for irrigation, and a growing propensity for agricultural pollution (Wood & van Halsema, 2008).

The transformation from wetlands to agricultural lands brings benefits for people in terms of food production while it is at the cost of the natural environment. Wood and van Halsema (2008) mentioned in the scoping report that there is growing concern about whether or not this is sustainable, given the way regulating and supporting ecosystem services of the wetland environment have been altered or destroyed.

The following is a quote from works by Wood & van Halsema, 2008, page 6

"Increasingly, it is recognized that these production systems have a negative impact on their natural environment, and on the natural resource base on which they depend. This recognition of the interconnectedness of these wetland ecosystem

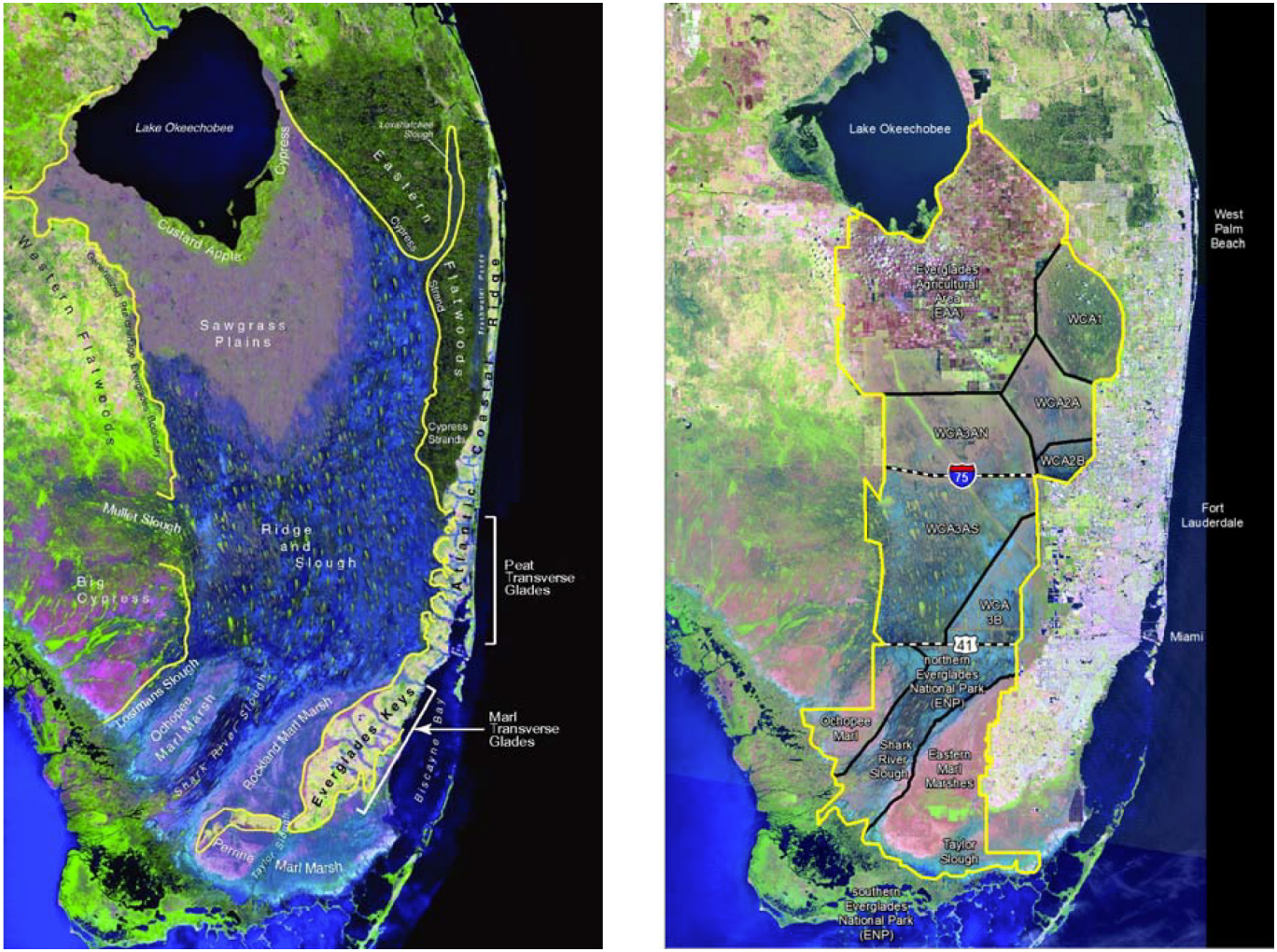


Figure 1. Simulated Satellite Maps of the Everglades before and after drainage (A reconstructed predrainage (1880) "satellite" image from McVoy et al. (2011) (left) and a modern (1994) Landsat image (right).

services has led to attempts to conserve and rehabilitate wetland areas. For example, recognition of the way that regulating services of wetlands can mitigate flood events has led to the implementation of river basin management plans to restore and conserve wetlands. Moreover, as evidence of the ability of wetlands to purify contaminated water increases, more rehabilitation of existing wetlands and construction of new "artificial" wetlands has taken place (Denny, 1997; Gopal, 1999; Kivaisi, 2001).

However, a key challenge for wetland conservation and rehabilitation, which is focused on regulating services, is the need to appreciate the wider socio-economic importance of wetland resources for provisioning services, particularly through wetland agriculture. This has been stressed recently in the Comprehensive Assessment of Water Management in Agriculture, which noted the need to pay more attention to how ecosystem services can contribute to agriculture and how agriculture should recognize the need to contribute to ecosystem functioning (Comprehensive Assessment of Water Management in Agriculture, 2007)."

1.2 Area of Interests: Everglades and Everglades Agricultural Area (EAA)

At the time of settlement by Europeans (mid-1800's), the landscape of south Florida region was dominated by wetlands, which was a lush, subtropical wilderness of pine forest, hardwood hammocks, swamps, marshes, estuaries, and bays (Davis, 1943). The region contained one of the largest wetlands in the United States, the Everglades. They experience a wide range of weather patterns, from frequent flooding in the wet season to drought in the dry season and is home to scores of interesting plants and animals, many of them found only in the Everglades.

The Everglades was part of a larger watershed: the Kissimmee-Okeechobee-Everglades (figure 2) that extended for more than half the length of the Florida Peninsula (McPherson & Halley, 1996).

However, the current Everglades covers approximately only half the original area (50.9%). Less than a quarter of the pre-drainage peat volume (23.5 %) and carbon (19.1%) remained in 2015, and more than 80% of the carbon was released into the atmosphere (Hohner & Dreschel, 2015). The Florida Everglades has been gradually shifting from carbon sink to carbon source, which leads to the acceleration of climate change.

The degradation of the Everglades was triggered by the drainage of the wetland for commerce and safety, which was firstly considered in the early 1900s. Today, South Florida is intensively managed by one of the largest water management systems in the world (Harwell, 1999), with 2100 miles of canals and 2000 miles of encircling levees/berms. With the support of water management infrastructures, the northern Everglades was transformed into the Everglades Agricultural Area(EAA) for sugarcane production.

Because of drainage and agricultural development, the south Florida ecosystem has experienced a variety of environmental problems such as loss of soil, nutrient enrichment, contamination by pesticides, loss of wetlands and wetland functions, increased algal blooming in coastal waters, and declines in fishing resources (McPherson & Halley, 1996). These issues have seriously degraded native wildlife communities and threaten the long term sustainability of local economies dependent on tourism, fishing, and adequate freshwater supplies (Aillery, Shoemaker, & Caswell, 2001). Facing this challenge, the American Congress has carried out a Comprehensive Everglades Restoration Plan (CERP) authorized in 2000 as a plan to "restore, preserve, and protect the south Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection" (NPS, 2019).

A major restoration effort (figure. 3) is now underway to restore the integrity of natural systems by recreating, to the extent practicable, essential functions of the pre-development regional hydrology. Central to hydrologic restoration is the need to retain wet-season water flows in the northern watershed, many of which are now diverted to sea, to meet dry-season water demands for environmental, urban, and agricultural purposes (Aillery et al., 2001).

To reach this goal, EAA is the most strategic site, considering its location between the northern watershed and the Everglades. Agricultural development in the EAA involving extensive wetland transformation, irrigation/drainage development, and flow-regime modification--has substantially restricted the capacity to retain wet season runoff in the northern Everglades region. However, EAA is an important production region accounting for 10.5 billion dollars in annual profits. Measures to increase water retention could impact the agricultural economy. Significant reductions in the scale and profitability of agricultural production may lessen the viability of the sector, reducing direct and secondary benefits from agricultural activity while increasing the potential for land conversion to environmentally benign nonfarm uses.

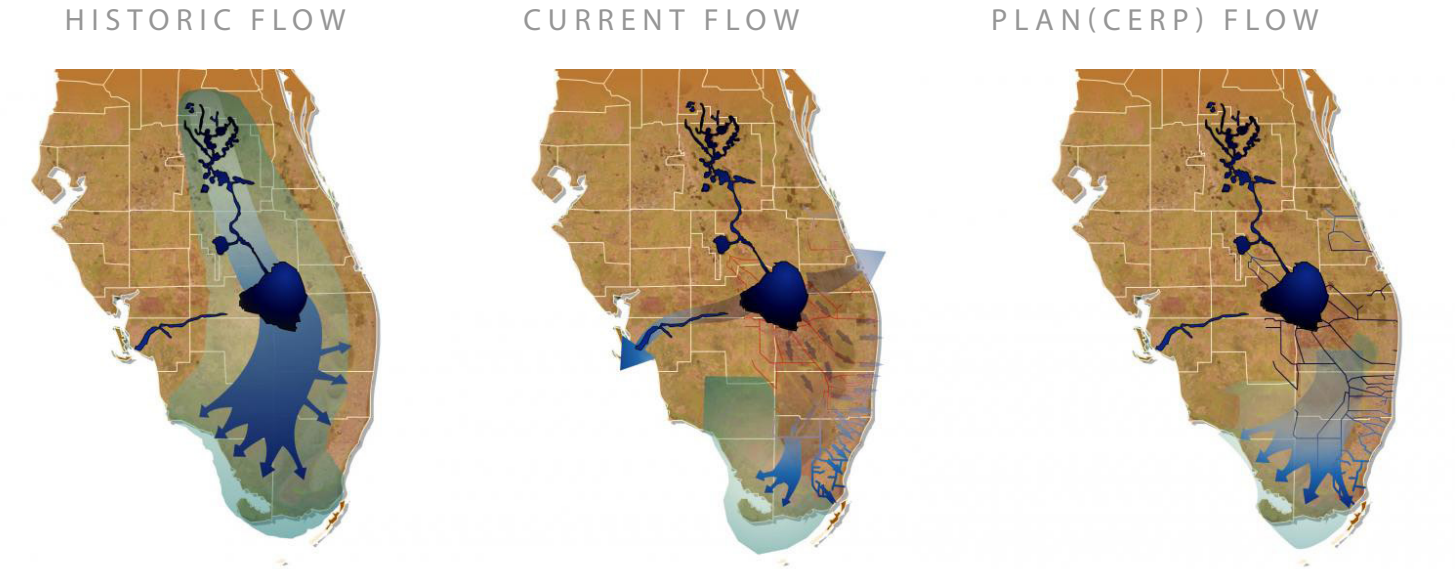


Figure 2. Comprehensive Everglades Restoration Plan (CERP) Image Courtesy of Everglades Plan

1.3 Problem Statement



Figure 3. Water Pollution (https://news.nationalgeographic.com/2016/07/toxic-algae-florida-beaches-climate-swamp-environment/)
Figure 4. Land Subsidence (Author)
Figure 5. Ecological Decline (Davis, 2016)
Figure 6. Loss of Nature Experience (Author)

SIGNIFICANCE

EAA is the most problematic and strategic site, separating the Florida Bay and the remaining Everglades from Lake Okeechobee. Management of land and water in EAA affects multiple areas: the Lake Okeechobee, coastal estuaries, the Everglades, and Florida Bay. EAA is fundamentally important to a sustainable Everglades ecosystem. The EAA can be managed for both farms and the enhancement of Everglades restoration goals.

Now, under the pressure of climate change, rapid urbanization, loss of biodiversity and decreased crops production, the landscapes in EAA have been pushed to their limit and those landscapes need to be adapted for the future. There needs to be an adaptive framework and designs integrated multidisciplinary knowledge for EAA that takes long-term sustainability into consideration, not only to recover natural and ecological assets for Everglades restoration, but also to create new sustainable landscape between human and nature to enhance the spatial and living quality.

PROBLEM FIELD

This large region formerly experienced water depths ranging from 1-5 feet but is now pumped dry. Lake Okeechobee holds unnaturally high amounts of water during the wet season, and is often over drained unnaturally fast in the dry season. The area is fundamentally unsuitable to grow crops, now not only degrades the water quality, but also faces the most severe land subsidence (90% of peat is gone inside this area), which could no longer support the sugarcane cultivation activities in the future without further intervention. The problems raised by this area threaten the tourism, ecological restoration to the Everglades and further economic growth.

At the same time, the designs of infrastructures were made without consideration of spatial and life quality. As a contrast to the bright and crowded beaches, what Florida is famous for, most of the inland lowlands are conquered by grey concrete infrastructures and inaccessible nature conservation areas. For instance, lake Okeechobee, the second largest freshwater lake in the U.S., is enclosed by Herbert Hoover Dike. Florida owns abundant natural resources and beautiful landscapes, while they are totally separated from people. The loss of nature experience would further result in the decline of life quality, which is also related to health and personal identity. (Kaplan, 1989).

In general, contemporary water management infrastructures in South Florida are mainly built to shield agriculture and urban development without ecological and cultural concerns. These measures being taken are creating mono-functional zones, spatially separated from each other, promoting mostly economic activities and creating dysfunctional ecologies without considering the dynamics of existing natural processes, spatial quality and long-term sustainable plans.

From Carbon Sink To Carbon Sources



Figure 7. Sugarcane harvest, photos taken by author

50% Everglades disappear

75% Peat was lost (90% in EAA)

80% Carbon was released

Land Subsidence



Figure 8. Sinking landsurface, photos taken by author

Land sinking
1 inch (2.5cm)
per year



Economics of scales



Spatial Homogenization





Figure 9. Spatial homogenization, photos taken by author

1.4 Research Objective

How to develop an integrated approach to recover lost ecological assets in South Florida through transforming the Everglades Agricultural Area?

SUB RESEARCH QUESTION

A series of sub-research questions are listed to help examine the main research question.

1. How to understand the landscape system in South Florida through scales and how it is related to EAA?

2. How can major environmental problems, like the land subsidence and water pollution be mitigated through the transformation of EAA?

3. How can an adaptive design framework be developed to transform the landscape in EAA?

4. What spatial and systemic landscape designs with multi-functions could be elaborated on the most crucial areas?

5. How can the framework of ecological transition developed in this research design be applied in other wetlands facing the similar complexity of ecological, social and economic challenges?

PURPOSE

- Help achieve the regional ecosystem restoration goal for water storage, water quality, peat accumulation while improving the nature-related spatial and experiential quality of EAA, and balancing the agricultural interests and other sectors of the regional economy

- Increase South Florida's capability to cope with uncertainties related to climate change in a sustainable way by integrating the dynamics of natural processes.

1.5 Scale of the Thesis

SPATIAL SCALES

The design intervention in EAA not only impacts its own sustainability but also influences the coastal estuaries, the everglades ecosystem and urban areas. The facing challenges are present through all scales, which are highly connected to each other. A small intervention at the local scale will have an impact on the whole region. Alternately, the regional intervention will influence the small parcel. For instance, if the wastewater from the agricultural land is purified before releasing to the southern Everglades, it will increase the conditions of the whole environment in south Florida. Therefore, it is important to think and design on different scales. There are four general spatial scales: mega scales, macro scales, meso scales and micro scales. From mega to micro scale is a continuous sequence. In this project, the mega scale concerns the whole Kissimmee-Okeechobee Everglades (KOE) watershed on the scale of South Florida, the macro scale concerns the EAA, the meso scale concerns for example, one water compartment or water corridor and the micro scale concerns for example, a waterfront or a peat bog.

1.6 Research Design Framework

This thesis aims to find nature-based solutions to rebalance the ecological value with the economic and experimental values on different spatial scales.
The research consists of four stages: understanding landscape, experimenting landscape, designing landscape and reflecting landscape.

I. UNDERSTANDING LANDSCAPE

- The landscape of south Florida is analyzed as a whole system to discover the relationship of EAA with other systems.
- Soil, water, biotic and anthropic dynamics are further analyzed on the scale of EAA to understand the current and past conditions.
- Expected outcomes from this stage are the site analysis of landscape system of Florida and four dynamics of EAA.

II. EXPERIMENTING LANDSCAPE

- The analysis of the four dynamics is utilized to create a set of landscape principles.
- Based on landscape principles, adaptive design strategies are experimented and developed.
- Expected outcomes from this stage are design principles, design strategies.

III.DESIGNING LANDSCAPE

- The landscape strategies are translated into a consistent series of designs at mega, macro, meso and micro scales.
- At the scale of EAA, the starting points are defined in order to find the crucial locations for further intervention at meso scale.
- The spatial implication and landscape qualities are elaborated at the micro scale.
- Expected outcomes from this stage are a series of designs through four scales and the elaborated spatial design at the micro scales.

IV. REFLECTING LANDSCAPE

- Results of this research design are reflected upon the main research objective and its implication on the future sustainable landscape development.
- Conclusions are drawn which might influence the future transition between agricultural land and wetland.
- Lessons learnt during this research are summarized.
- The remaining questions are formulated for future research on this topic.
- Expected outcomes from this stage are the reflection, conclusion, discussion and remaining question.

1.7 Methods

Among the four research stages, the methods of research by design, layer model, mapping, case study and literature review are applied throughout the thesis.

2.3.1 Research by design
Research by design can be regarded as a powerful synthesising journey of discovery. The design is the vehicle to draw up hypotheses of possible spatial futures and to test their local and regional consequences.

2.3.2 Layer Model
Layer approach is an approach developed in the last decade in the Dutch planning praxis in which the layers stand for aspects of concern in the domain of urban and regional design and planning on the basis of the differing spatial dynamics of substratum, networks and occupation patterns/layers. In this project, the "layer approach" is utilized as a tool to understand and guide the landscape development, where different processes and systems influence each other and have different dynamics of change.

2.3.3 Mapping
Mapping is doubly operative: digging, finding and exposing on the one hand, and relating, connecting and structuring on the other (Corner, 1999). Through visual disclosure, mapping both sets up and puts into effect complex sets of relationships that remain to be more fully actualized. A creative view of mapping in the context of architectural, landscape and urban production is rendered all the more relevant by the changing nature of spatial and temporal structures in today's world (Corner, 1999). Through rendering visible multiple and sometimes disparate field conditions, mapping allows for an understanding of landscape. Mapping is used in this research design as a productive and liberating instrument to discover the inner relations, to explore and shape new realities.

2.3.4 Case study
Through interdisciplinary design-based case studies at different spatial scale-levels, a better understanding of the dynamic between social and ecological processes and typo-morphological aspects is gained. The cases of existing strategies and methods applied in similar problems areas related to a sustainable landscape development facing the similar complexity of ecological, social and economic challenges are analyzed and utilized to further generate the design principles.

2.3.5 Literature Review
A study and interpretation of literature that addresses the research topic is applied from the beginning of the research design until the reflection process. The theories of landscape as system, landscape urbanism, landscape infrastructure and building with nature are studied in order to build the theoretical framework based on the current discourse of landscape architecture.

The targeted literature review about water dynamics, soil dynamics, biotic dynamics and anthropic dynamics at the site is also a robust self-learning way to bridge the knowledge gap among different disciplines in order to understand, experiment and design the landscape of Everglades Agricultural Area, which consists of the foundation part of the research design.

" Understanding why and how this system has evolved to create this kind of micro-typography is one of the true wonders of the world. "

- Fred Sklar

CHAPTER II
UNDERSTANDING LANDSCAPE THROUGH SCALES

1. Hydrology
2. Geology
3. Ecology
4. Agriculture
5. Recreation

2.1 Hydrology

Kissimmee-Okeechobee Everglades (KOE) Watershed

The prosperity of the regions within south Florida is closely interconnected because of the water system. The Everglades and EAA were part of the Kissimmee-Okeechobee Everglades (KOE) watershed. Figure 10 maps the water system of south Florida. One mainstream is the water from the Kissimmee river that flows south into Lake Okeechobee, and further reaches across the Everglades Agricultural Area, Water Conservation Area, Shark River Slough (Everglades National Park) and finally into the gulf of Mexico or Florida Bay.

If we take a close look at the direction of the water flow between lake Okeechobee and the EAA, it can be found that the water from the EAA also flows back to lake Okeechobee O, which is called 'back pumping'. The water that flows from the EAA into lake Okeechobee contains high amounts of nutrients, the main source of which are the fertilizers that are used in the agriculture. The wastewater from agricultural land is pumped into lake Okeechobee without treatment. Furthermore, lake Okeechobee discharges excessive water into two estuaries along the west Caloosahatchee River and east St. Lucie canal during the wet season. This means that the polluted water ends up at the coastal cities, resulting in the algae boom affecting local tourism and fishing industries.

Through the constructed regional canals, the water from lake Okeechobee also flows through the EAA to lower east-coast areas like the city of Miami. To guarantee the safety of the coastal cities during storms, the large amounts of water need to be pumped into the sea intensively to lower the risk of coastal flooding.

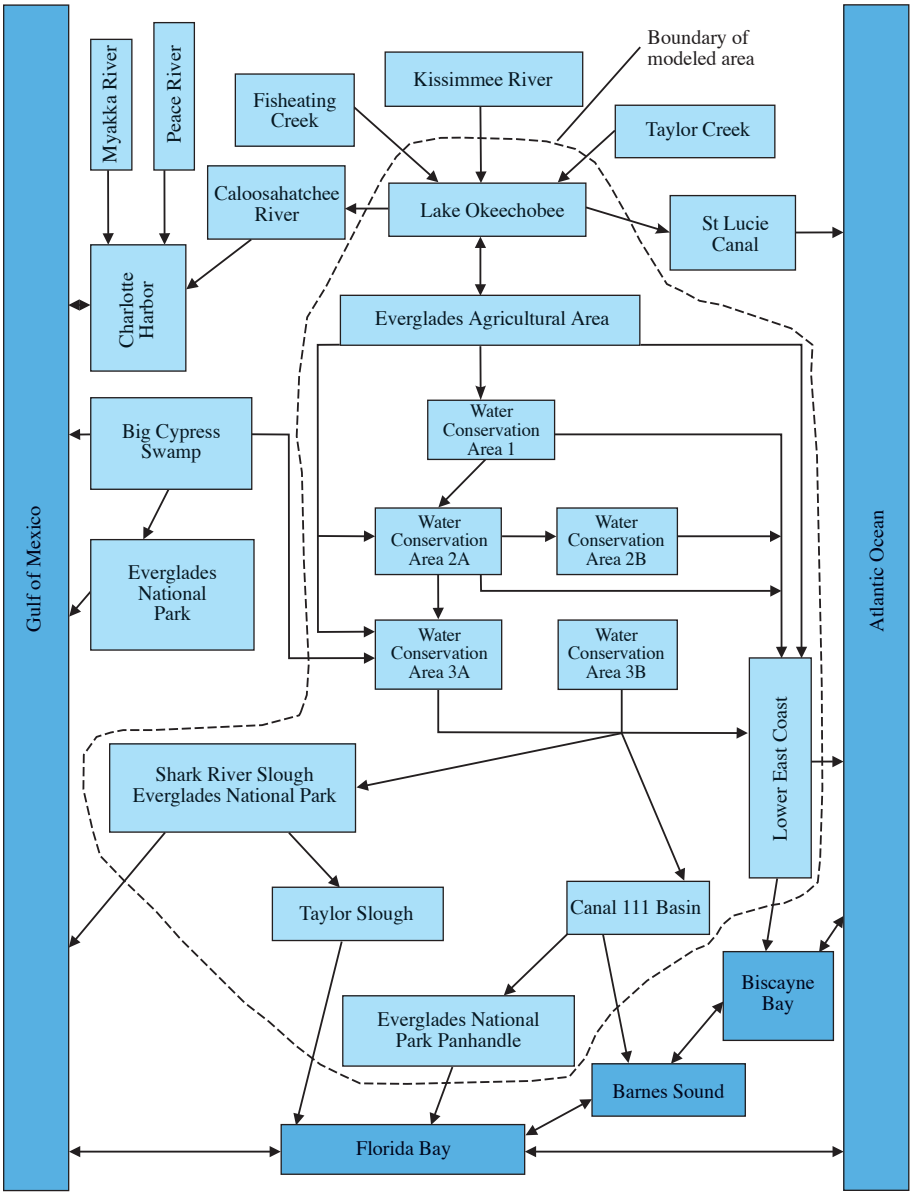


Figure 10. South Florida Water System (McPherson & Halley, 1997)

2.1 Hydrology

Drainage of Everglades: "reclaim the vast, useless swamp"

During the last century, land development was the main drive for the drainage of the Everglades. The swamp was considered useless and toxic. At that time no one doubted the proposal to drain the swamp because nobody understood how the Everglades functions. Ignorance of these natural processes ultimately resulted in extensive damage to the environment.

Huge amounts of infrastructures were built to drain, dike and redirect water. The drainage of the Everglades provided favorable conditions for the agricultural use. As mapped out in figure11, the agricultural zone experienced the fastest expansion between 1960s to 1980s, when the Central and Southern Florida (C&SF) Flood Control Project was implemented. By the end of the 1980, the area of the EAA reached its current size (around 700,000 acres, 40% of Everglades).

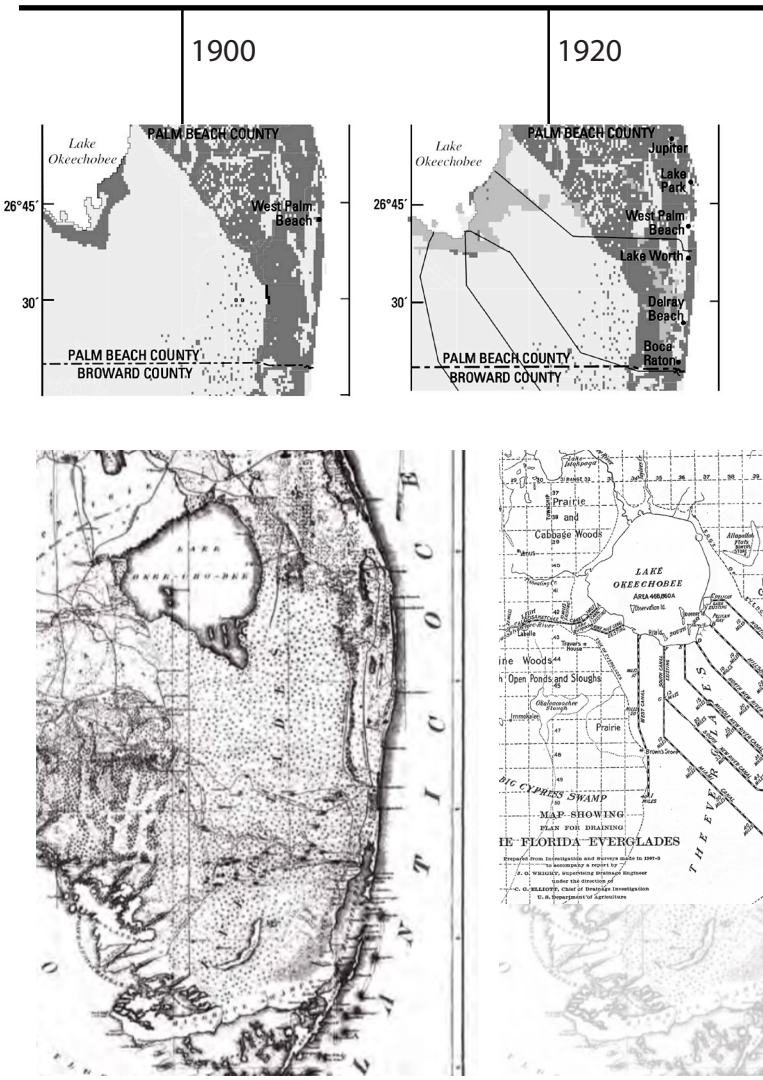
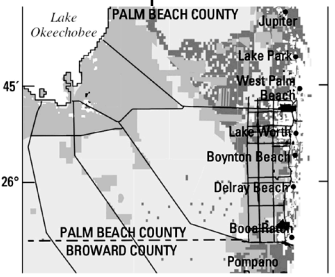
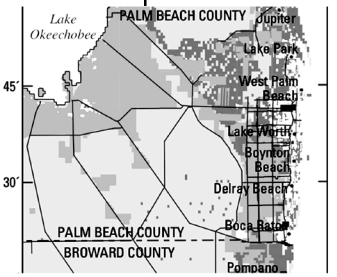


Figure 11. Mutual relationship between water management and the growth of agricultural land from 1900 to 2000 (Drawn by Author, data from Rankin et al., 2005)

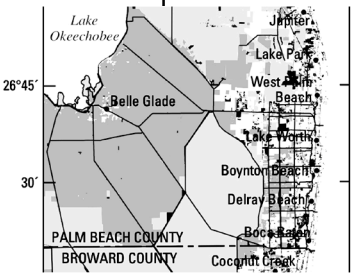
1940



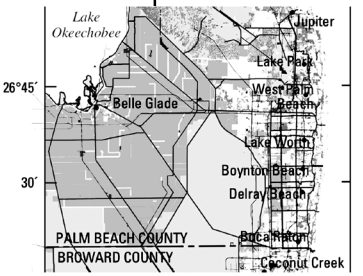
1960



1980

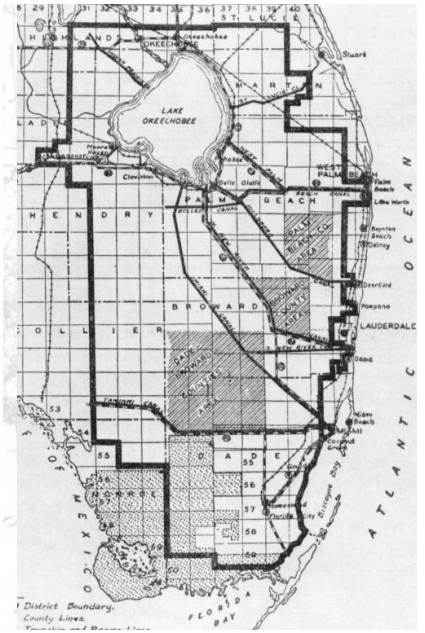


2000

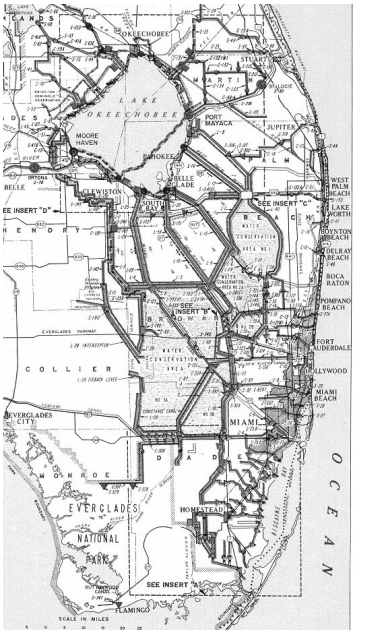


- Expansion of agricultural field









- Development of Water Infratructures

- The first successful farming ventures in the Everglades began in about 1913.
- The EAA experienced the sharpest growth during 1960-1980. This is related to the implementation of C& SF Flood Control Project (1950s- 1960s).

2.1 Hydrology

South Florida Water Management Infrastructures

- South Florida water management infrastructures provide flood control and protect regional water supplies

- The water of the Everglades comes from lake Okeechobee and upstream of the KOE watershed. Vast water management infrastructures direct the water from lake Okeechobee into the EAA. The water is pumped out for use in irrigation during the dry season. During the wet season, the water is discharged into the sea to keep the fields dry. At that point most of the untreated water is pumped into the two estuaries sites of Caloosahatchee River and east St. Lucie canal.

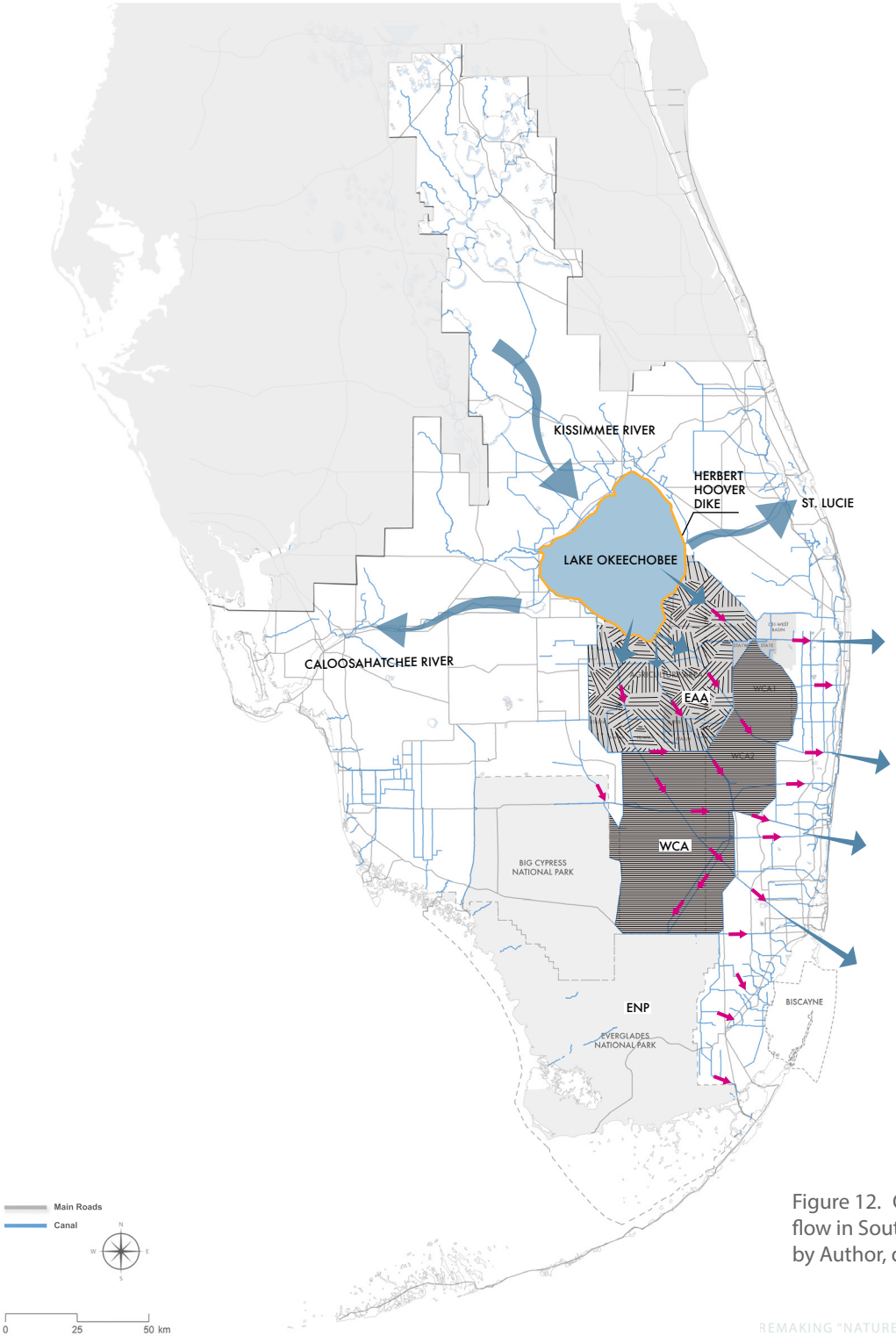
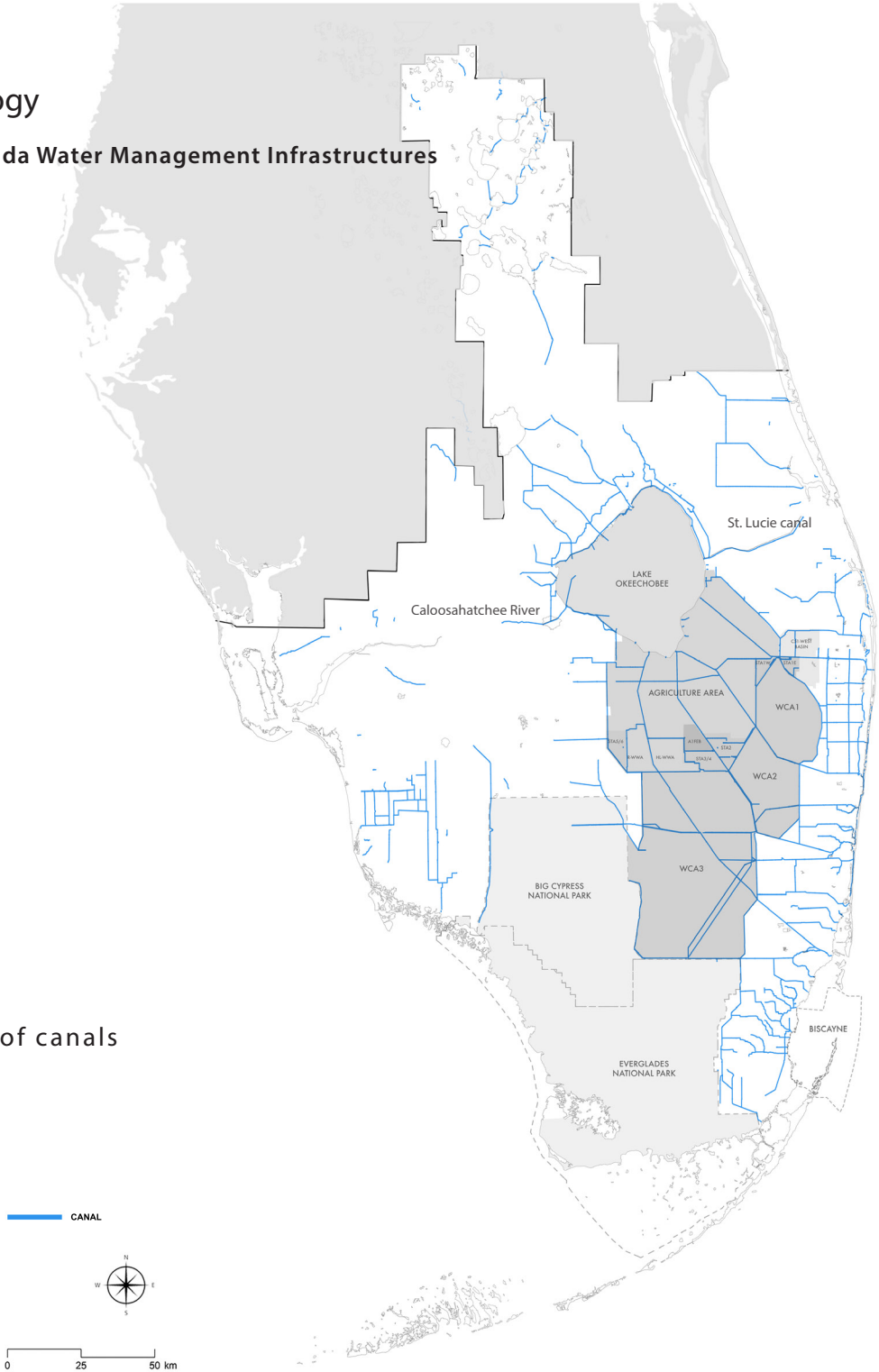


Figure 12. Controlling water flow in South Florida (Drawn by Author, data from SFWMD)

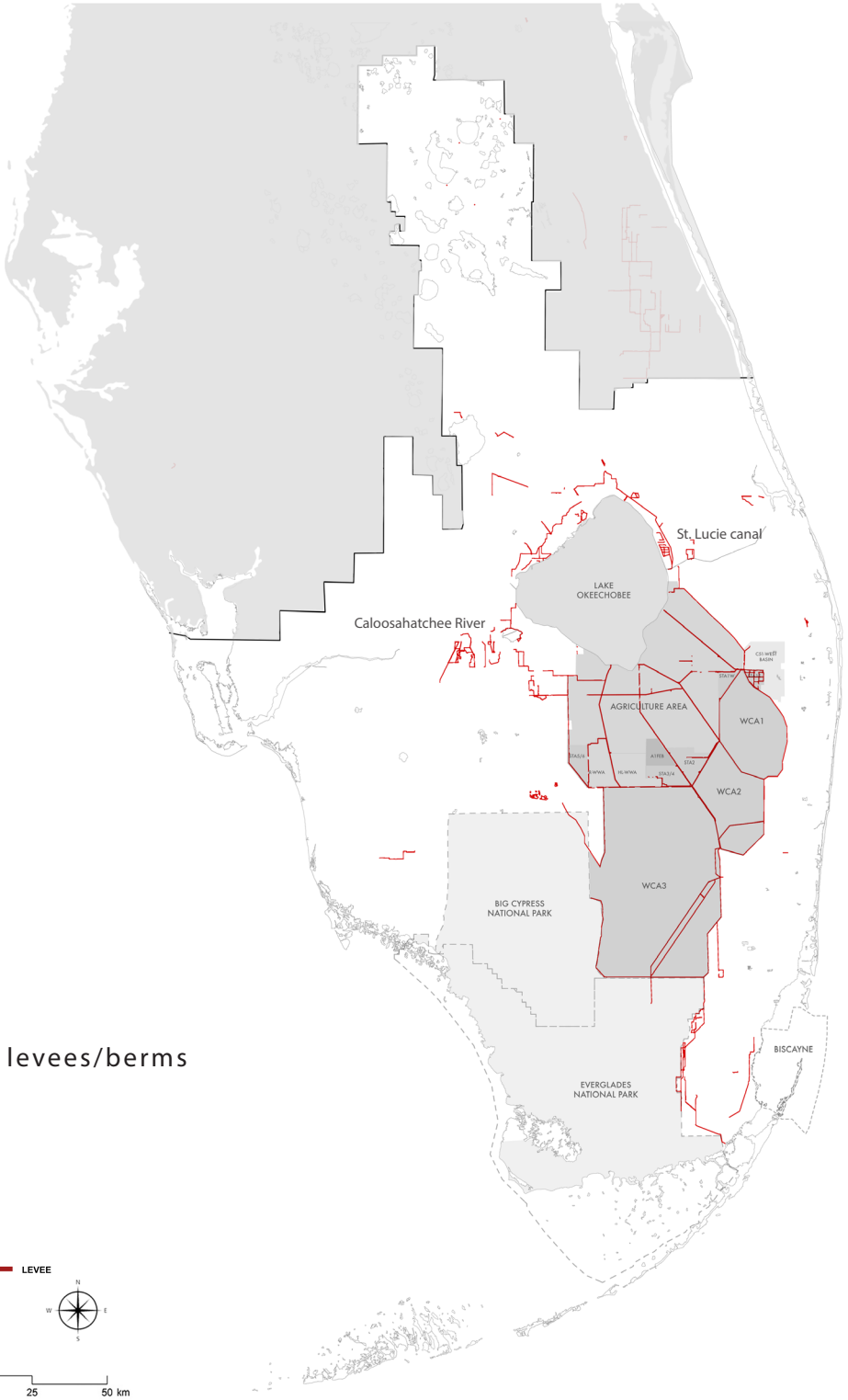
2.1 Hydrology

South Florida Water Management Infrastructures



CANAL

2,100 miles of canals

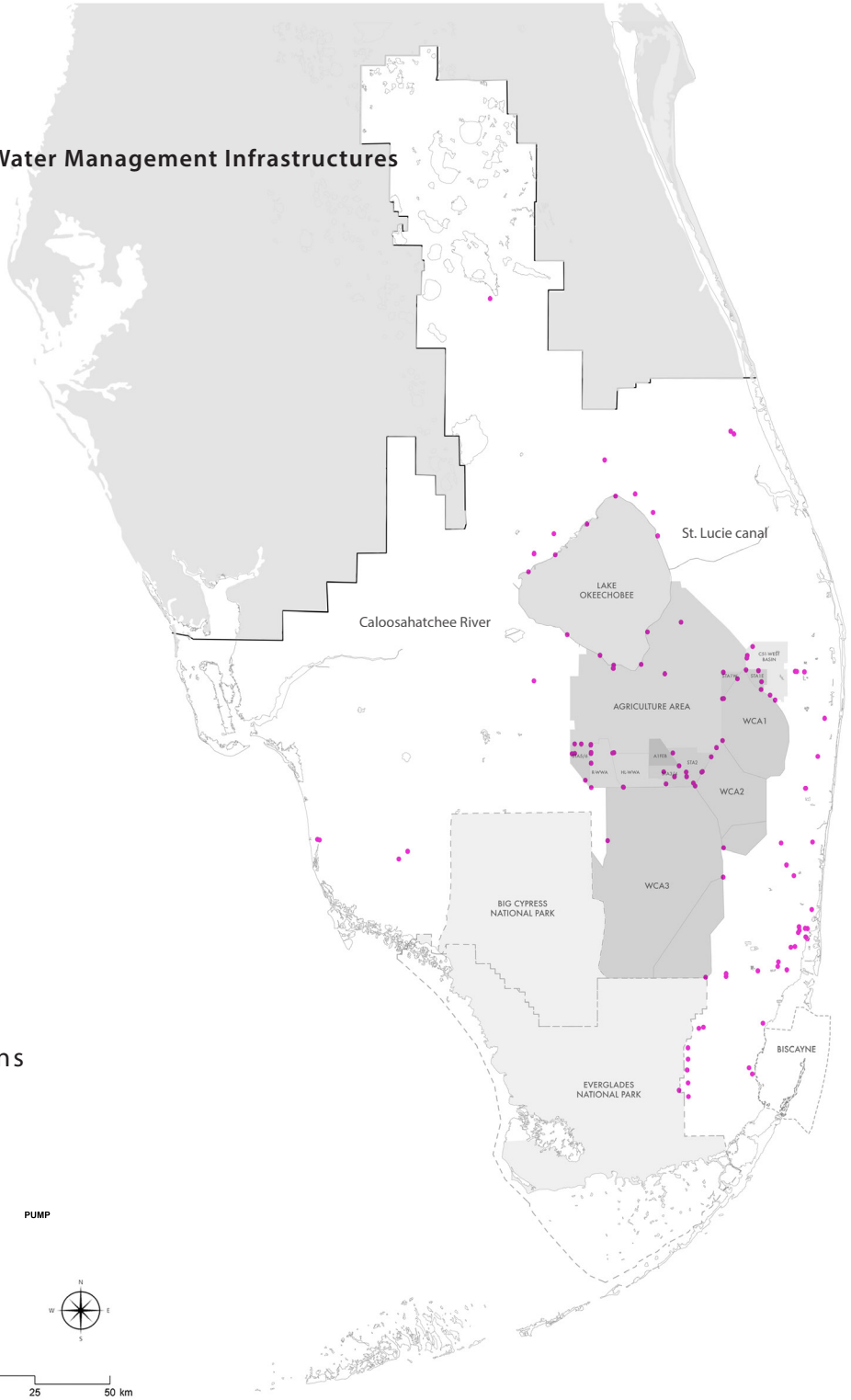


LEVEE/BERM

2,000 miles of levees/berms

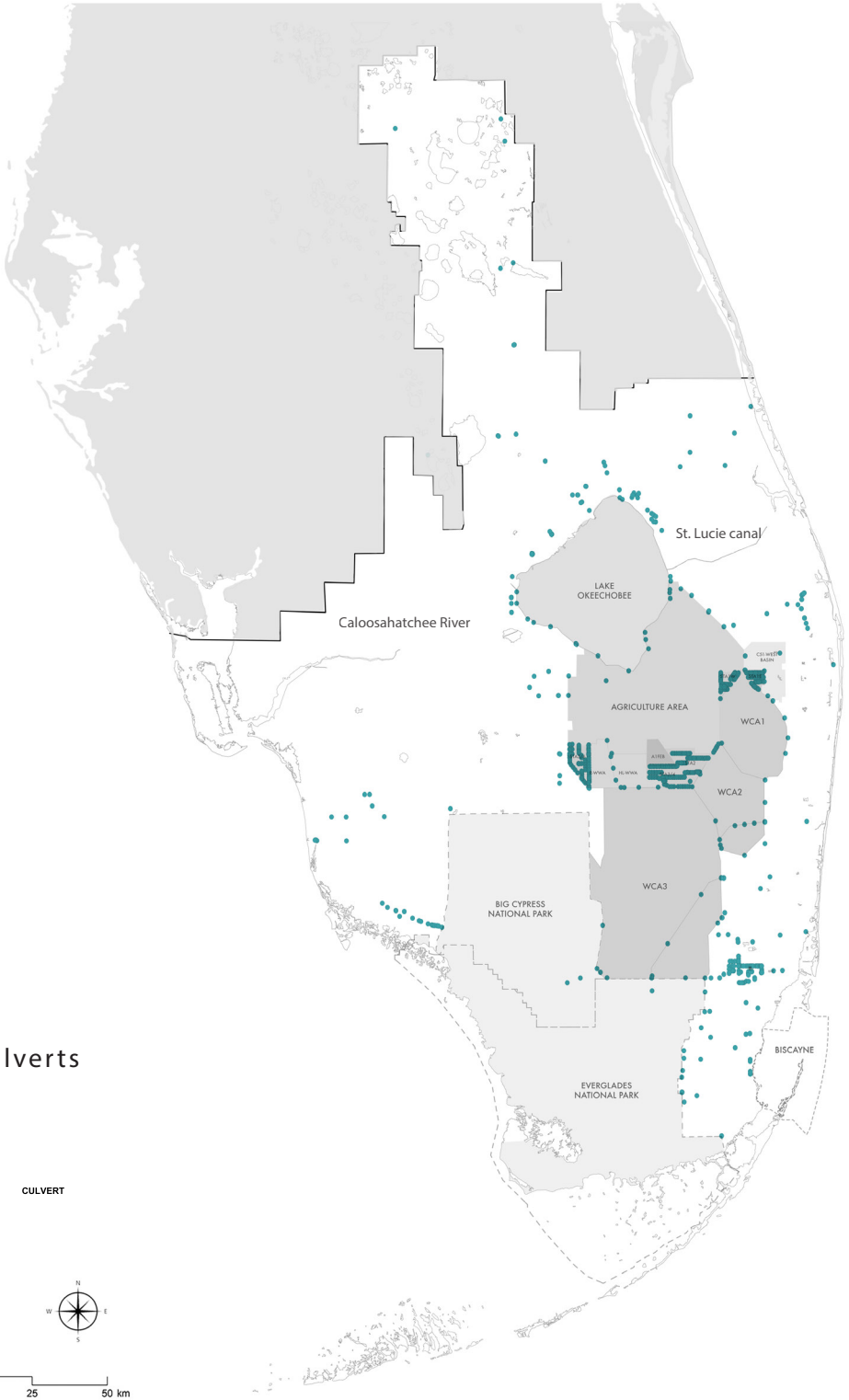
2.1 Hydrology

South Florida Water Management Infrastructures



PUMP

77 pump stations



CULVERT

620 project culverts

2.1 Hydrology

South Florida Water Management Infrastructures

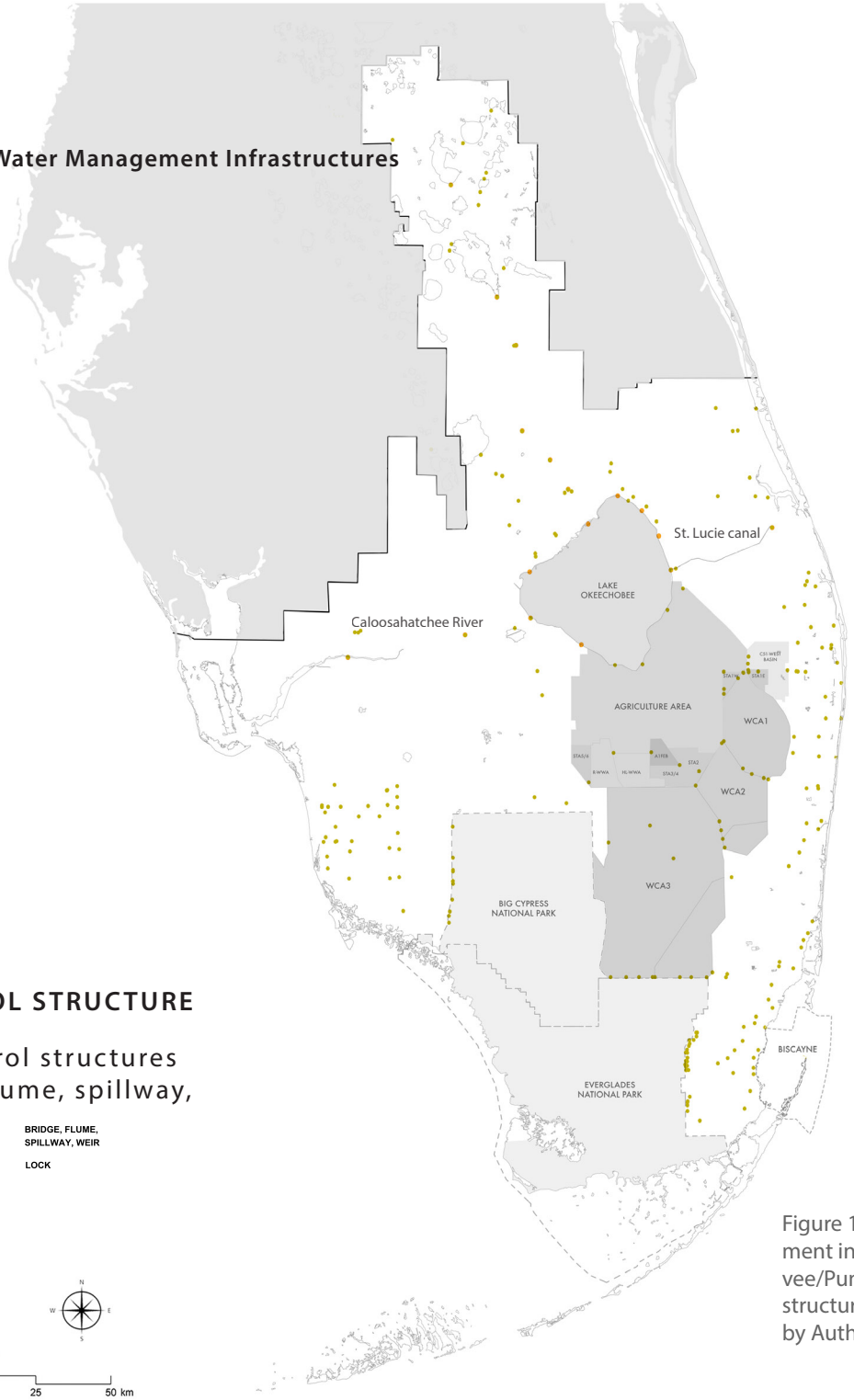
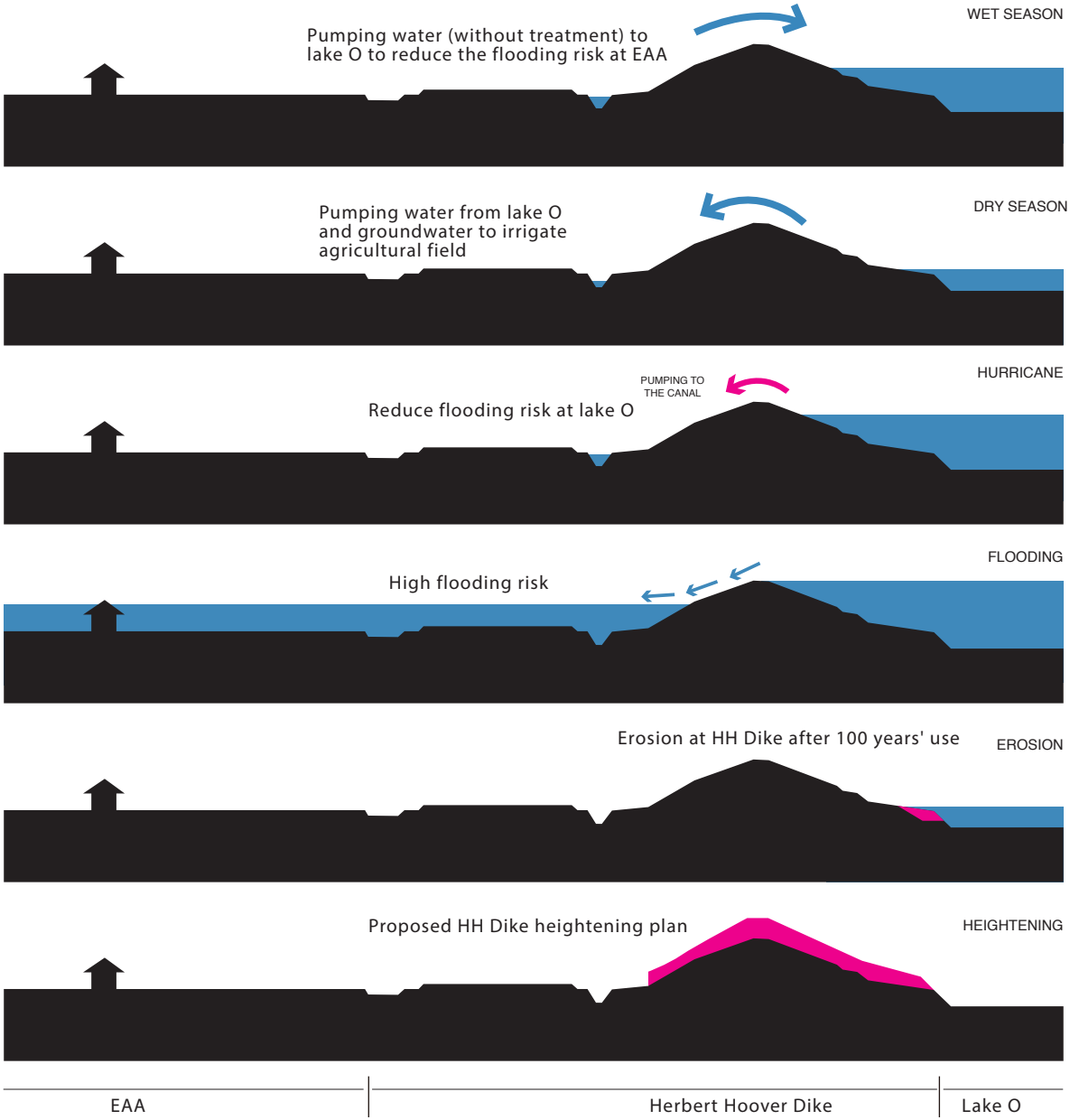


Figure 13. Main water management infrastructures - Canal/Levee/Pump/Culvert/Water control structure in South Florida (Drawn by Author, data from SFWMD)

Water Control Between EAA and Lake O



2.1 Hydrology

Severed Sheet Flow: 70% water flow reduced

- Water management has brought significant changes to natural overland flow patterns.

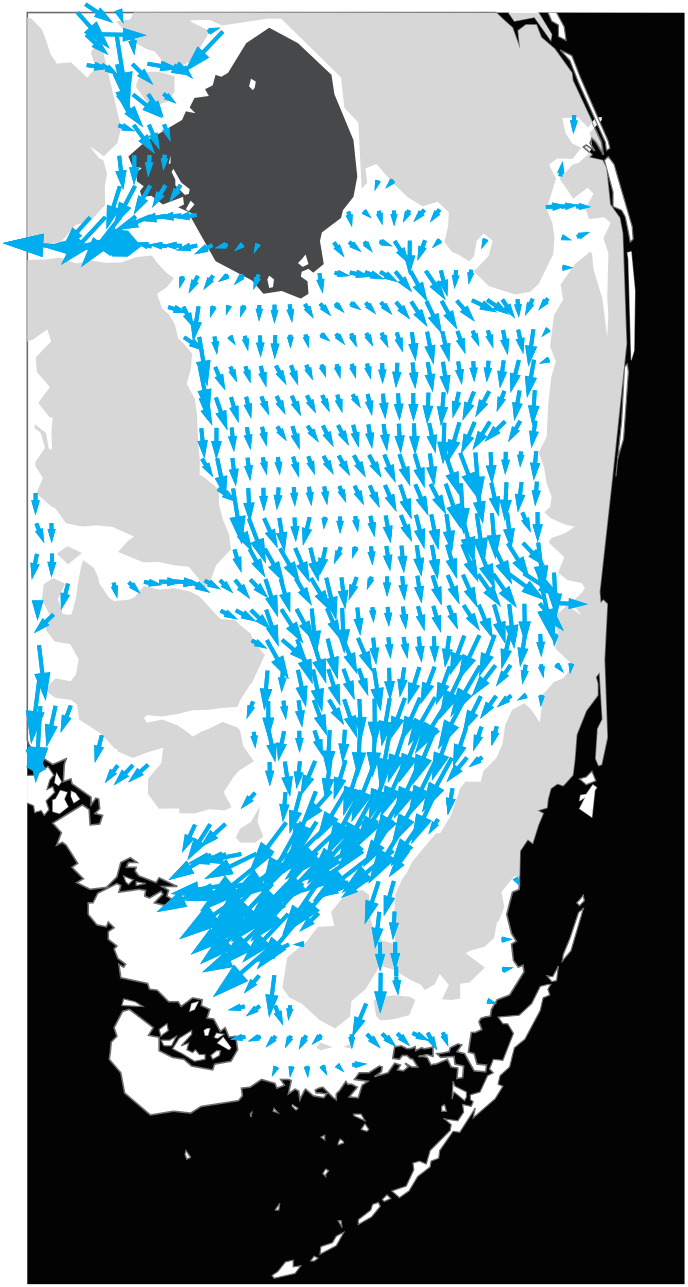
- Under natural conditions in the past, surface water moved from lake Okeechobee southward. The landscape of South Florida was dominated by the wet swamps.

- After canals and dikes were constructed for the agricultural and urban development, sheet flow practically disappeared from the northern Everglades and diminished in the south. The northern part was fully drained, and the original vegetation was cleared, after which it was used for planting sugarcane.

- More than 100 years of drainage destroyed over half of the historic Everglades, reducing the flow of water by more than 70 percent.

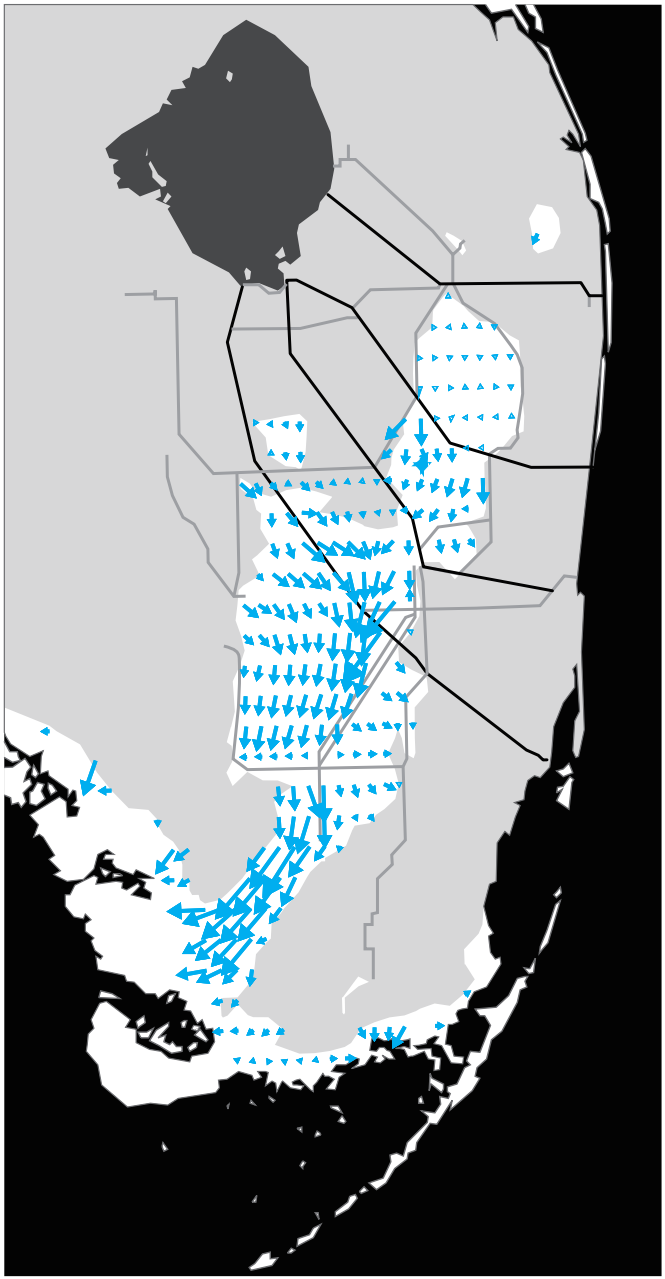
Figure 14. Water flow pattern of current & past situation (Drawn by Author)

Past Sheet Flow



0 30 60 KM

Current Sheet Flow



0 30 60 KM

2.1 Hydrology

Water Control in EAA: Anti natural water dynamics

Zooming in on the EAA, the water control system mainly consists of four regional canals starting from lake Okeechobee passing through the EAA, and ending up in the estuary site (Miami Canal, North New River Canal, Hillsboro Canal, and West Palm Beach Canal), pumps, culverts, spillways, local canals, and ditches. These main water infrastructures provide the drainage of excess water during the wet season to keep the land dry for sugarcane growth as well as supplying water for irrigation during the dry season. These water control actions go against the natural water dynamics so that the water is not able to be stored, since it is not able to permeate into the aquifer. This threatens the regional freshwater supply as well as the ecosystem of the Everglades.

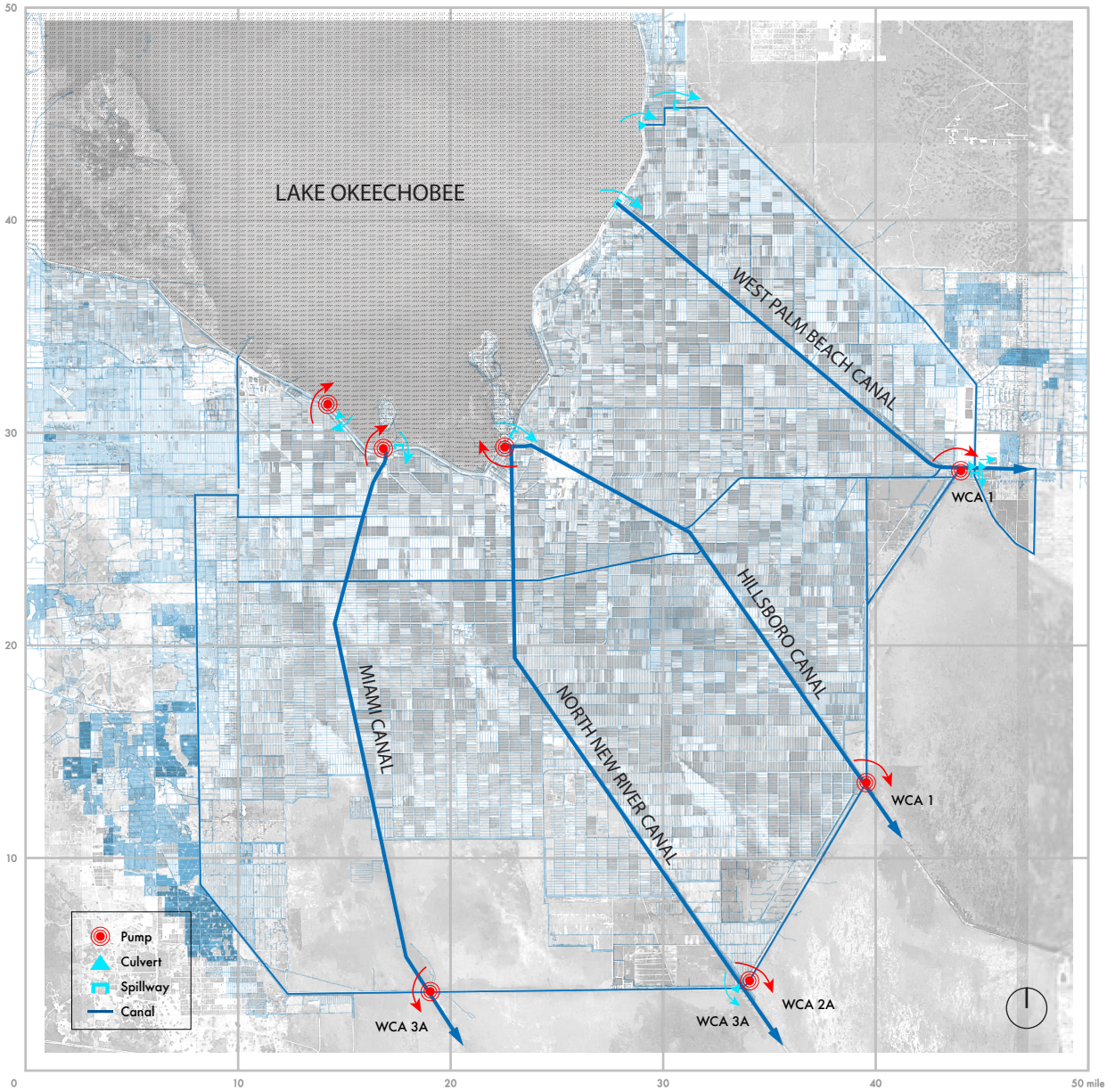


Figure 15. Main Water Control Infrastructures in EAA, drawn by author

2.1 Hydrology

Water Management District: Expansion needs & Reductionist approach

Beside the water infrastructures, the water management districts are another tool to manage the water flow in the EAA. Most of the areas are created within the CERP to control the water and increase the water quality.

Stormwater treatment Areas (STA) were built to purify the water from agricultural use before it was discharged into the southern Everglades. The first STA (STA1) was built in 1994, which has been put to use for 15 years. Some of the existing STAs are going to **reach their capacity** in the next few years. To address the increasing water inflow and achieve the CERP goal, it is becoming an urgent issue to **construct more water treatment areas**.

The current approach of constructing wetlands **ignores the difference in topography** by simply clearing crops and filling the whole field with water. The water management districts that are created this way are inaccessible for the public use. This reductionist method creates **mono-functional spaces** and reduced their social and cultural value like community benefits (eg. recreation, connection).

C&SF Project

"A combination of dry years which resulted in major peat fires in the Everglades and very wet years which flooded agricultural land and towns south of the lake led to implementation of the Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project) in 1948 (USACE & SFWMD 1999).

This project built 2,300 kilometres of levees (man-made embankments of soil and rock), canals and structures to enclose large areas of the Everglades, creating the so-called Water Conservation Areas (WCAs) - shallow reservoirs in which water levels could be controlled so that water could be stored or released as required. "

Everglades National Park (ENP)

"The Everglades National Park (ENP) was established in 1947, just before the C&SF Project, to protect the southern portion of the Everglades. These activities resulted in the current landscape of what is now termed the Everglades Protection Area (EPA), which is the combination of WCAs and ENP. "

Central Everglades Planning Project (CERP)

"Present-day planning provisions such as the Central Everglades Planning Project (CEPP) are designed to accelerate restoration of the Everglades peatland by allowing additional water to flow through it.

According to the CEPP Fact Sheet (USACE & SFWMD 2014), this will be accomplished by: increasing storage, treatment and conveyance of water south of Lake Okeechobee; removing and/or plugging canals and levées within the central Everglades; and retaining water within the ENP whilst protecting urban and agricultural areas to the east from flooding. More water in the Everglades should help prevent further peat loss by oxidation, encourage the accretion of new peat to replace some of that lost since 1948 and, thus, result in the beneficial sequestration of atmospheric carbon."

built time of STA: (https://www.researchgate.net/publication/259383964_Synopsis_of_the_Everglades_Stormwater_Treatment_Areas_Water_Year_1996-2012_Technical_Publication_ASB-WQTT-12-001/figures?lo=1)

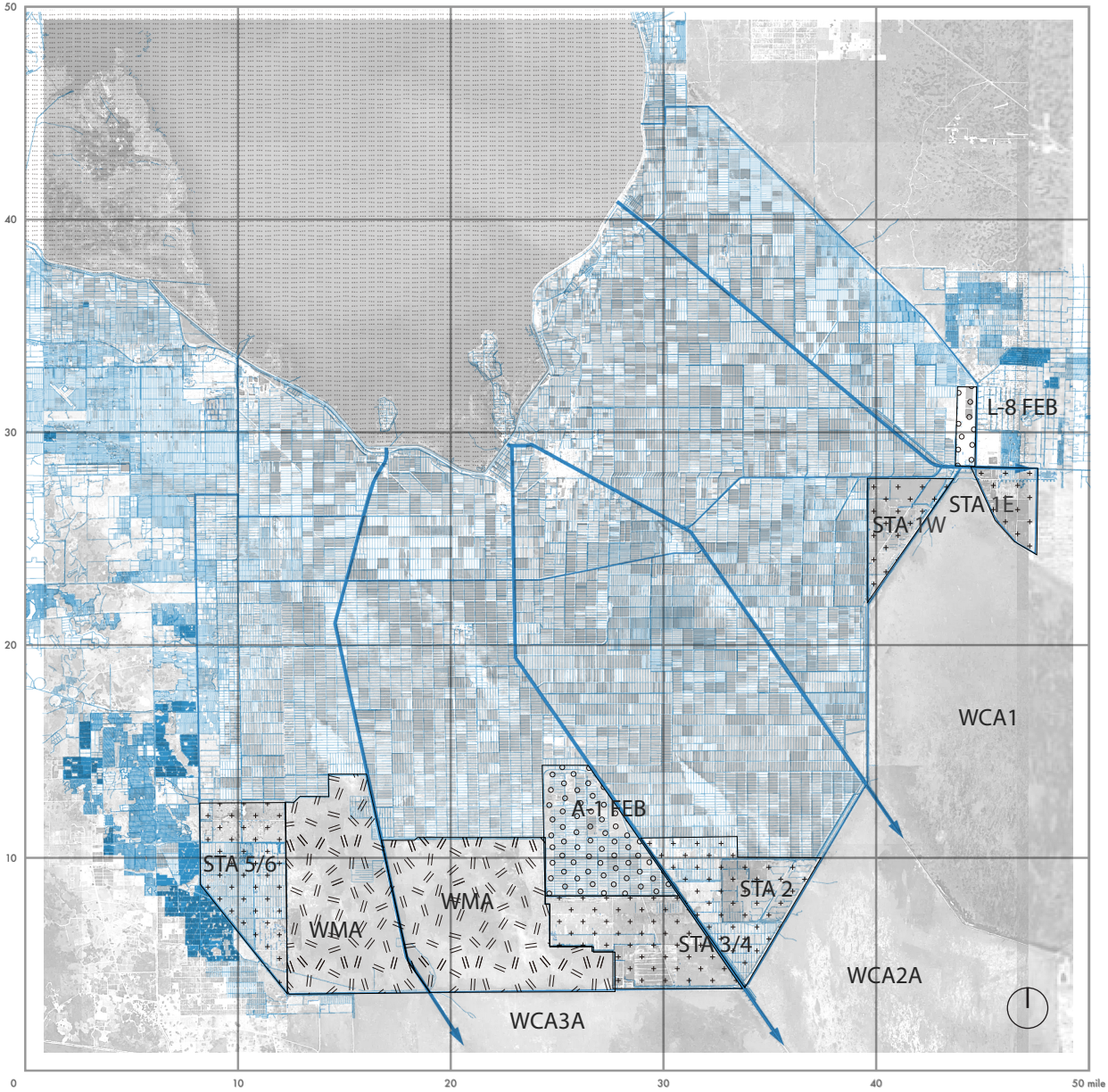
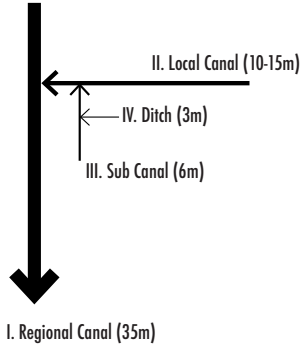


Figure 16. Drainage Network and Water Management Districts in EAA

2.1 Hydrology

Spatial Configuration of Regional Canal, Local Canal & Ditch



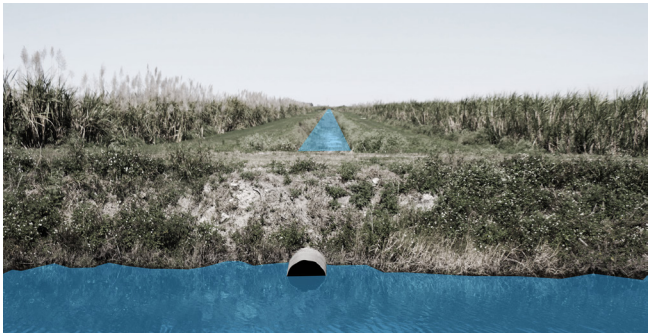
Hierarchy of Canals

There is a hierarchy of canals system from 4 main district canals (like the boezem in the Netherlands), local canals, sub-canals to ditches.

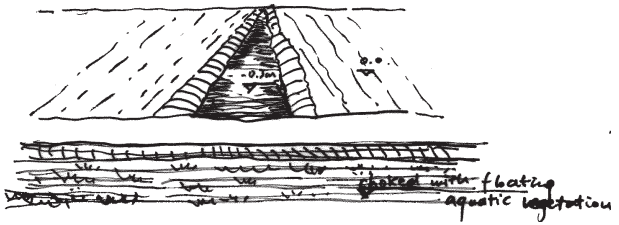


Regional Canal





Local Canal & Ditch



Hierarchy and Scale of Water Infrastructure



Figure 17. Hierarchy of water infrastructures in EAA (drawn by author)

2.1 Hydrology

Spatial Configuration of Regional Regional Pump & Local Pump



Figure 18. Regional pump, photo taken by author



Figure 19. Local pump, photo taken by author

2.1 Hydrology

Conclusions & Implications for Design

The current way of controlling water is against the natural process, which results in drought in the Everglades, shrinkage of Florida aquifer as well as flooding of the estuaries.

The current water system is on the edge of collapse. The way the water is managed needs to be changed to **adapt to water dynamics and accommodate natural process**. The mission for the future is to find a way to retain and store more fresh water on site, as well as finding the location where this can be done. Meanwhile, it is also crucial to leave more space for water to adapt to the future uncertainties, especially in the context of climate change.

- Deliver Water to Everglades
Currently, most of the water in lake Okeechobee is pumped out to two estuaries sites during the rainy season. Also, a large amount of water is directed to the southeast coast. The water no longer stays above the soil. In the past, the surface water would seep through the soil and refill the ground water (groundwater recharge). The water which was discharged to sea could not enter an aquifer, which would result in a shortage of fresh water for the whole region. Additionally, storing water in the soil during wet periods would improve the performance of the ecosystem during dry periods. Many areas of the Everglades which were among the furthest destinations of the water flow before are currently too dry.
The above details show that it is really important to store as much water as possible in the EAA , first purifying the polluted water in order to recharge the aquifer and direct it to the Everglades.

-Reduce discharge & Increase Water storage
(Recharge aquifer)

-Hierarchy of Canals
There exists a hierarchy of canals. There are 4 main district canals (like the boezem in the Netherlands), then smaller canals that are used by individual farms. Each of them further connects to a network of farm ditches that feed into the farm canals.

- Sufficient space for Water
Based on the analysis of the current water infrastructures, it could be found that the current levees and dikes have already aged. Moreover, the increasing precipitation resulting from climate change is adding pressure to these infrastructures. The government has planned to heighten the dike, which will create even more mono-tone space. More sufficient space for water should be prepared.

- Levees and berms as Unique Area for Activity Stimulation
The whole EAA is relatively flat. Within the EAA, levees and berms are the only features that provide the higher-ground platform, and they provide the possibility to generate new spatial experiences such as hiking routes or a bird watching deck.

- Change of Border between EAA & Everglades
In 1950 the EAA was all used as cultivation field. Gradually, some of the fields in the south were transformed into treatment wetland like the construction of STA1 in 1994. More and more agricultural land has been changed into water treatment fields or water reservoirs. The current trend is that the border of the restored Everglades is being expanded northward.



2.2 Geology

Peat surface and Limestone Bedrock

The bedrock geology of South Florida primarily consists of porous limestone. Sitting on top of the limestone bedrock in the Everglades is a peat layer.

The topography was tilted slightly from north to south. The water in the marsh was driven by the water levels in Lake Okeechobee and local rainfall, and flowed slowly through the Everglades under topographic and hydraulic gradients of only about 2 inches per mile in the past (Ingebritsen et al., 1994).

Topography

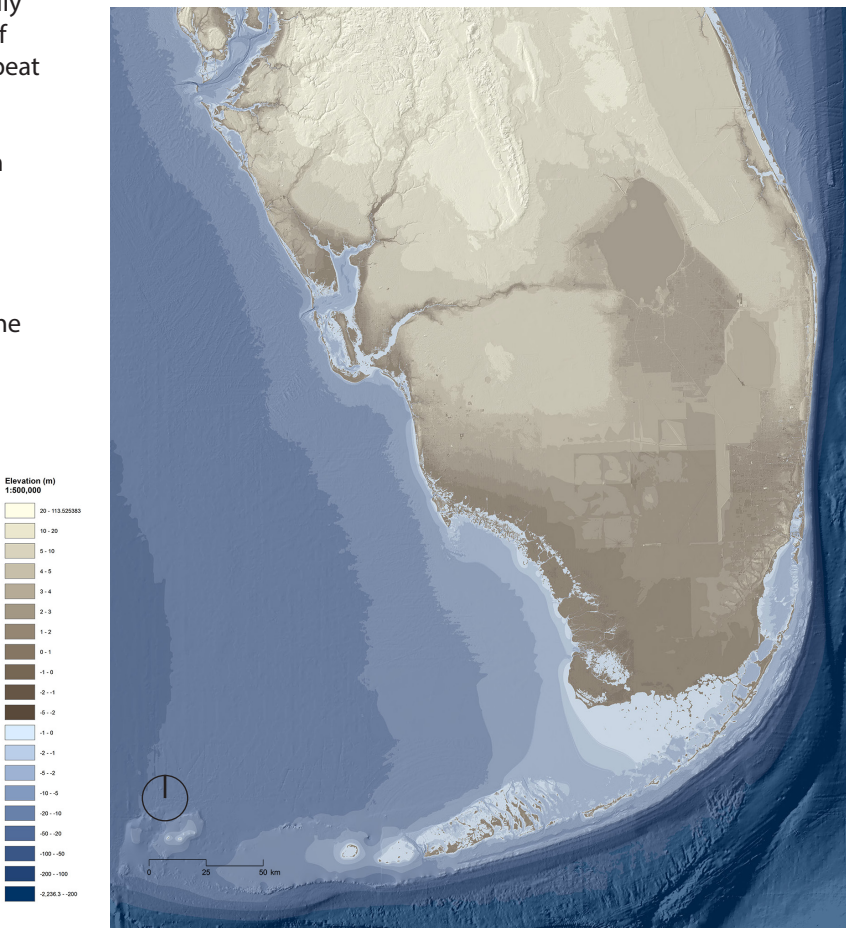
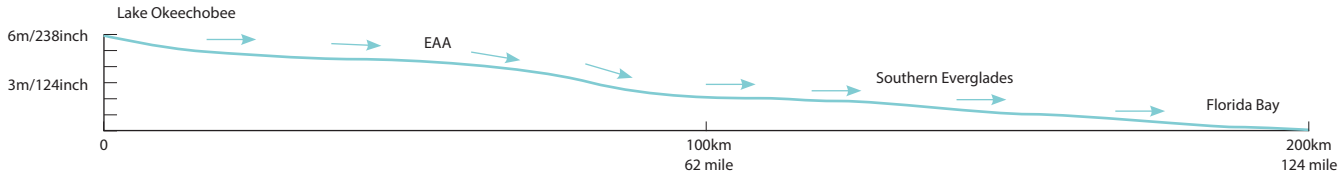


Figure 20. Topography of South Florida (Adapted from GIS data provides by the Flowscapes studio)

Subtle Topographic & Hydraulic Gradient (past):
2 Inch(2.54cm) per mile (1.6km)



Shelly Sand And Clay



Peat



Limestone



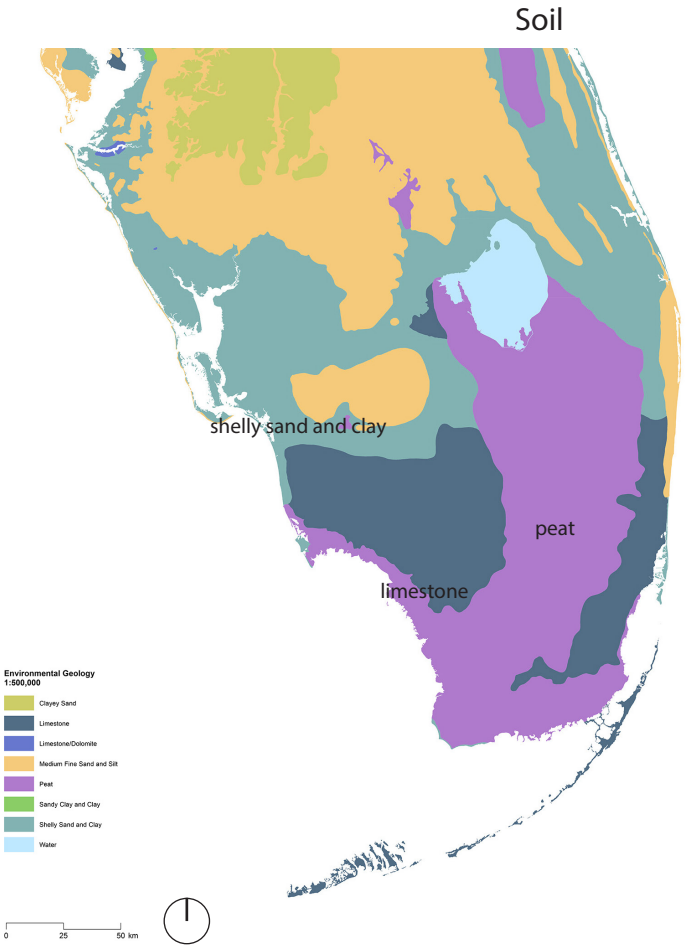


Figure 21. Soil of South Florida (Adapted from GIS data provides by the Flowscapes studio)

2.2 Geology

Topography of EAA (Before Drainage)

The topograhy of EAA before drainage had a gradual spread of gradient between 21ft (6.4m) to 14ft (4.3m) from North to South (figure 22). This gradient provides various abiotic conditions for corresponding biotic groups.

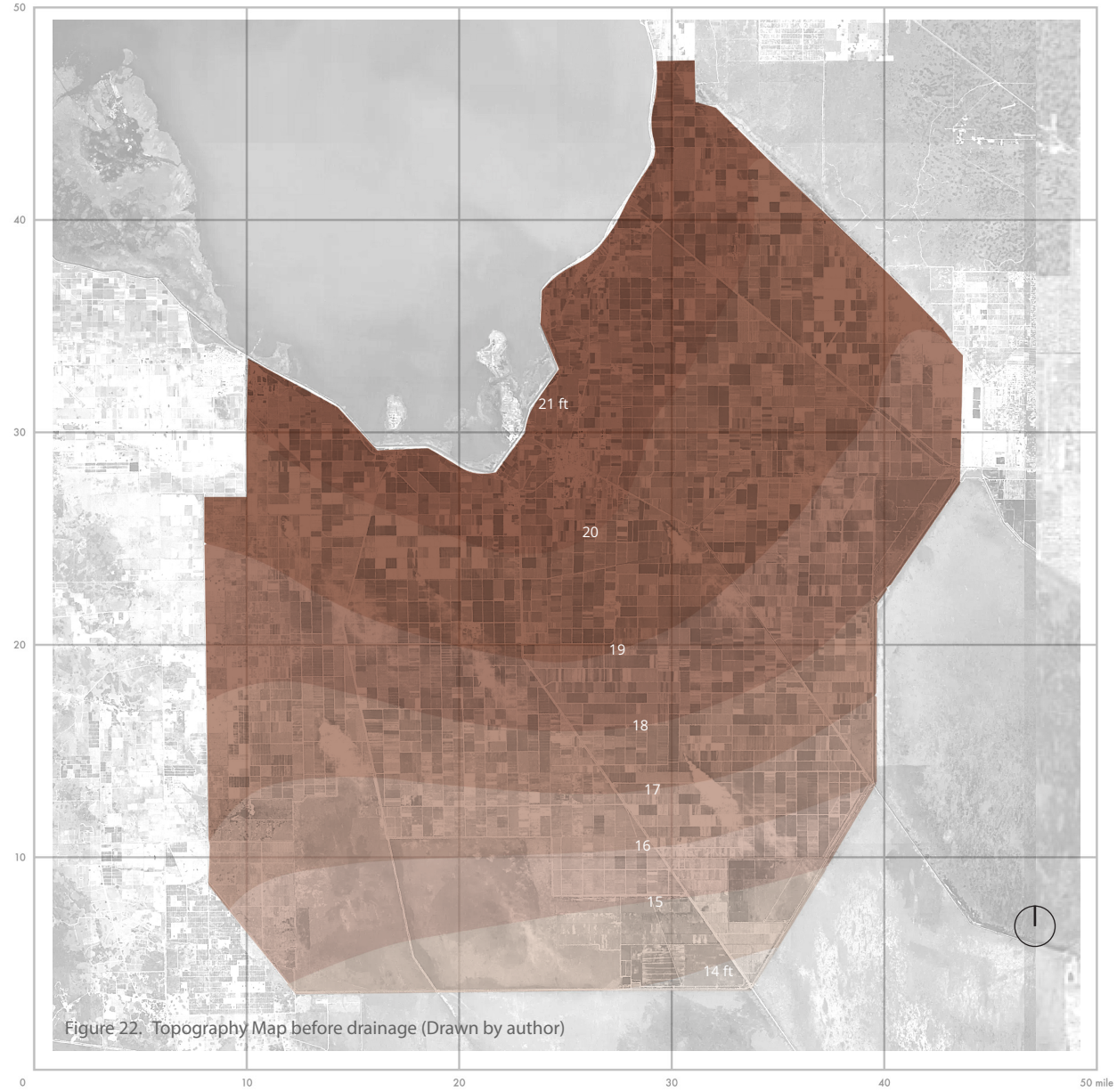


Figure 22. Topography Map before drainage (Drawn by author)

Topography of EAA (After Drainage)

After drainage, the land sinks at different speed, resulting in the scattered topography (figure 23). The original gradient could no longer be found in EAA. The average land subsidence rate is of 1inch (2.5cm) per year.

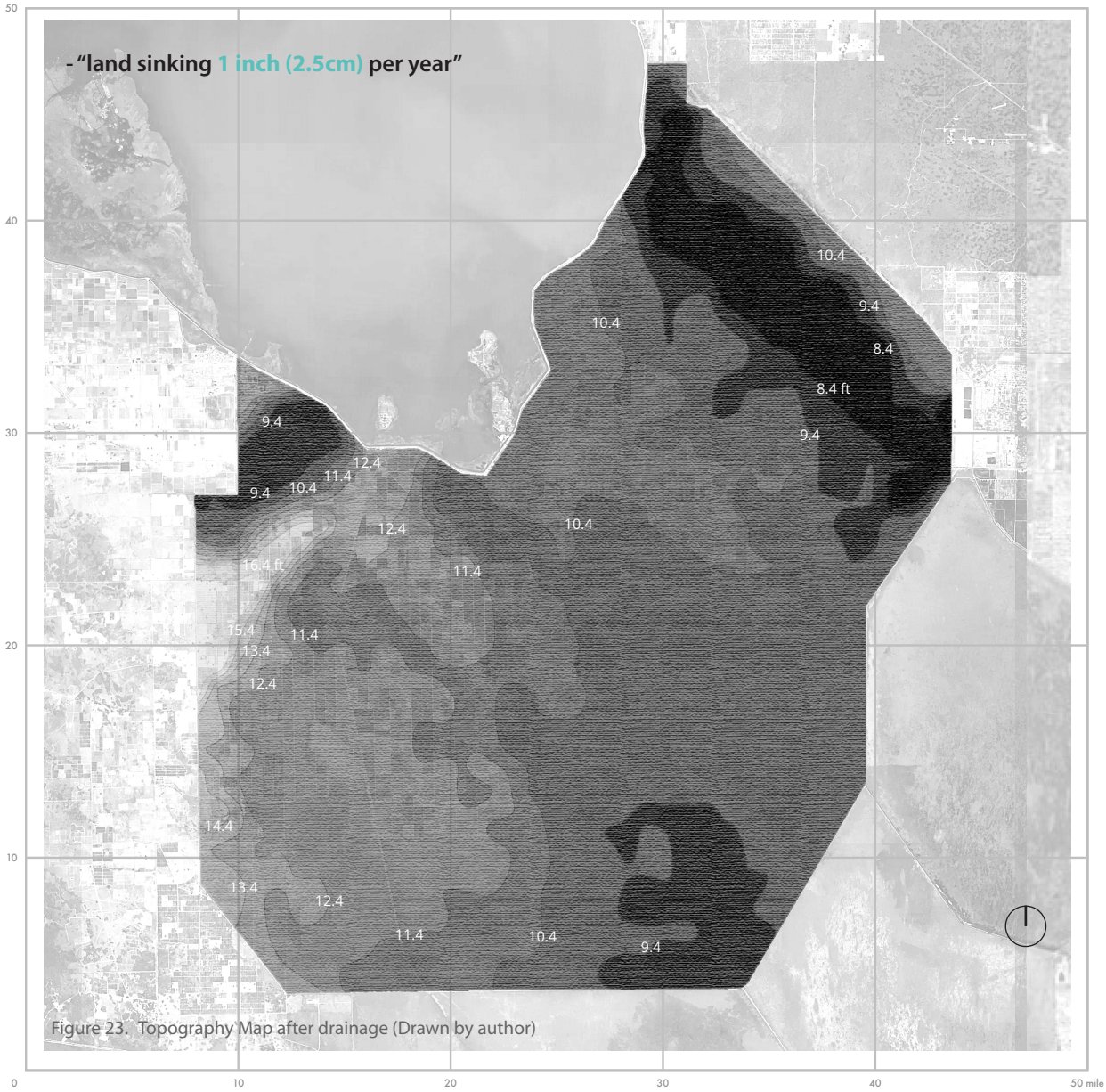


Figure 23. Topography Map after drainage (Drawn by author)

2.2 Geology

Peat Depth of EAA (Before Drainage)

The peat depth of EAA before drainage was between 2 ft (60.96 cm) to 12 ft (365.76cm) (figure 24).

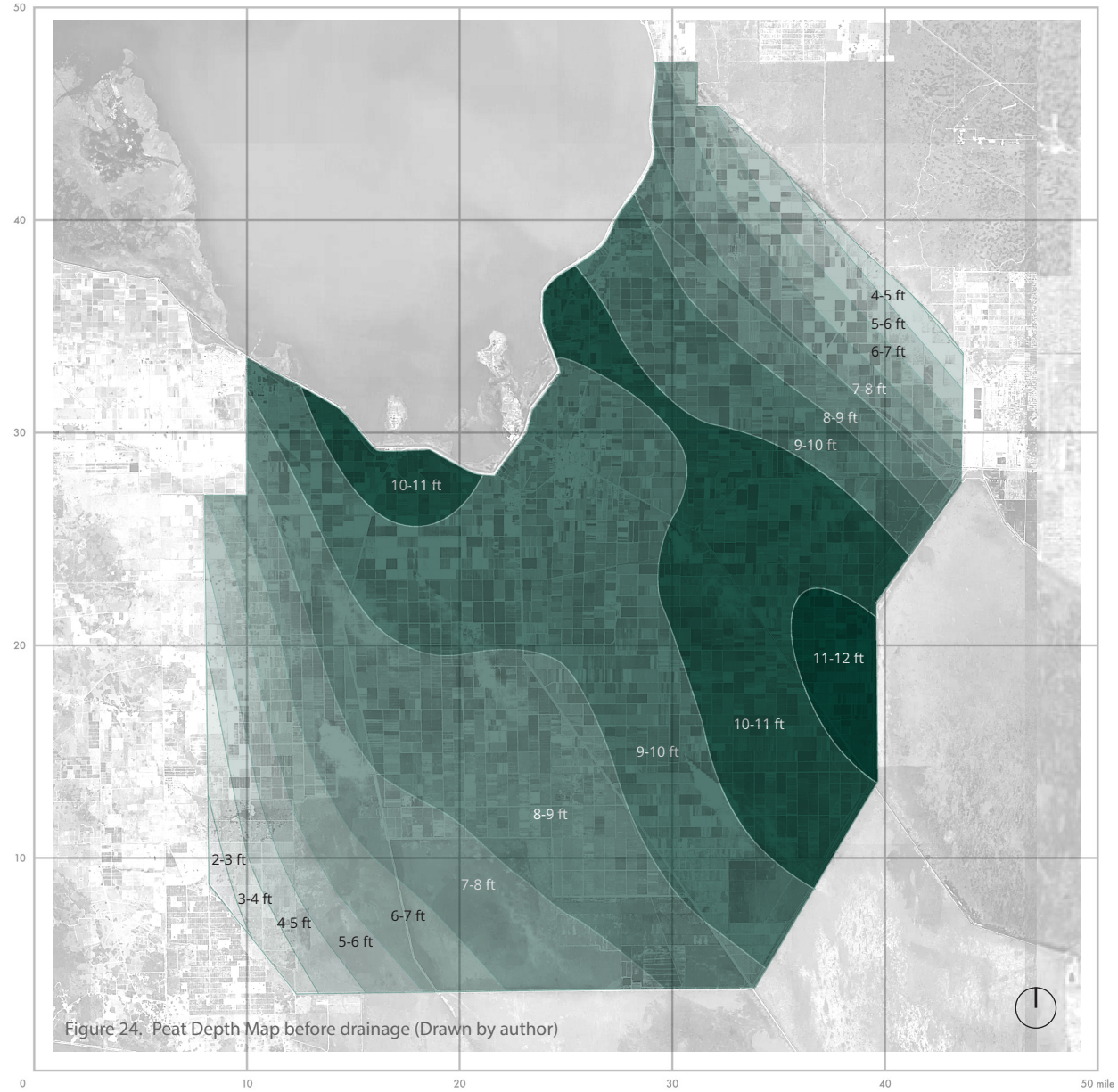


Figure 24. Peat Depth Map before drainage (Drawn by author)

Peat Depth of EAA (After Drainage)

The peat depth of EAA after drainage was between 1 ft (30.48 cm) to 10 ft (304.8 cm) from Southwest to Northeast (figure 25). One third of the area's peat depth is less than 3 ft (91.44 cm).

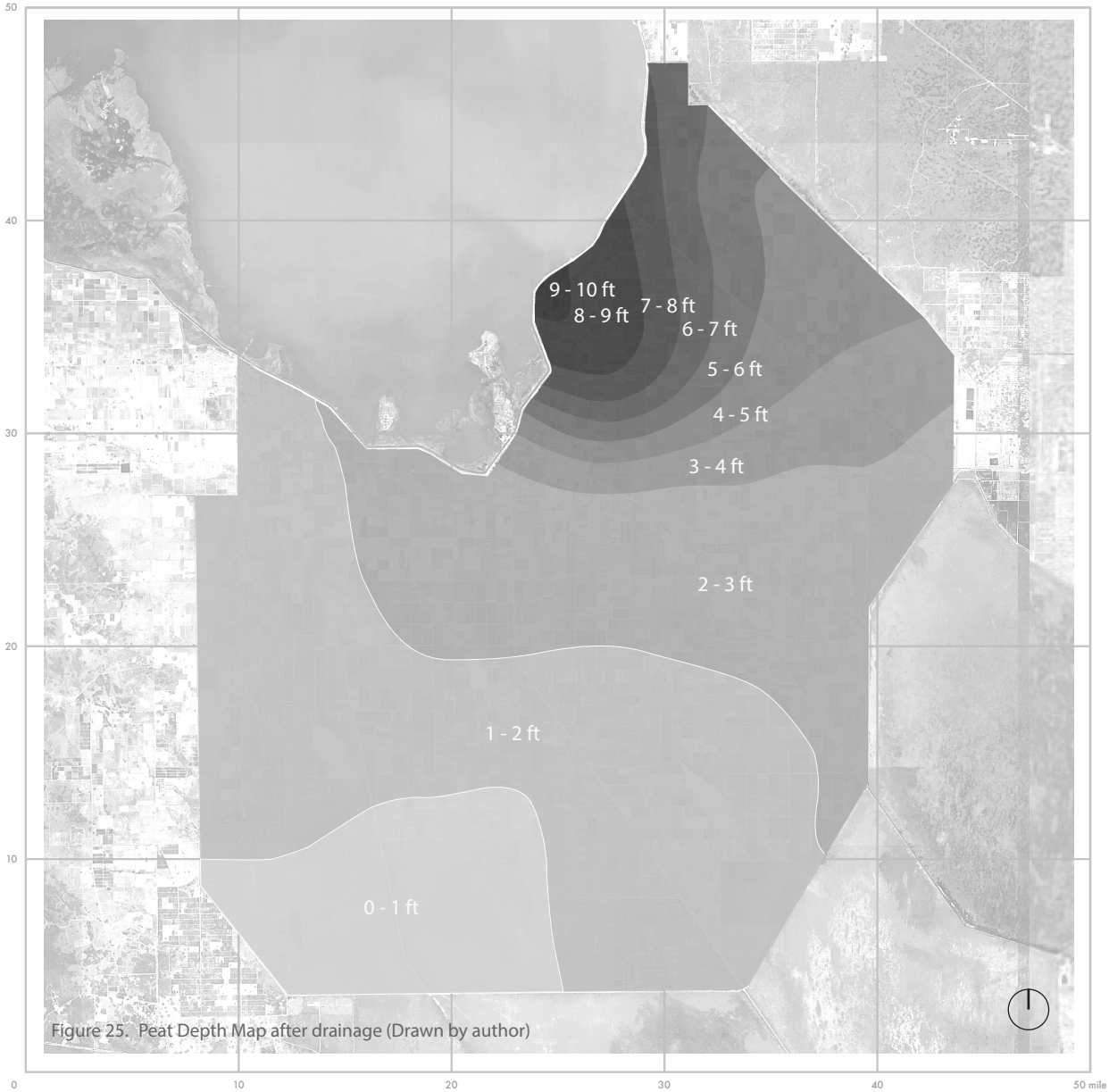


Figure 25. Peat Depth Map after drainage (Drawn by author)

2.2 Geology

Formation & Degradation of Peat: Water is the key driver

DIMINISHED PEATLAND

In the past, the EAA region was drained for agricultural development by lowering the water table of lake Okeechobee and draining the land. Deep (3m or more), highly organic peat soils were identified in this area by surveys conducted in the late 1800s (Hohner & Dreschel, 2015).

The EAA covered by peat is part of a vast peatland covering much of southern Florida as shown in the soil morphology figure 26.

McVoy et al. (2011) estimate the Everglades to be about five thousand years old. The patterned peatland once covered about 1.1×10^4 km^2 of south Florida (McVoy et al. 2011) and now covers approximately 5.6×10^3 km^2.

PEAT FORMATION

Peat soil, also called muck soil, blankets the limestone bedrock across much of the Everglades and is the foundation upon which key habitats exist. Peat soil is made up of dead and partly decomposed plants and develops very slowly (over centuries to millennia) in the presence of water.

The peat of the Everglades is formed from sawgrass (Cladium jamaicense Crantz) and other aquatic plant material, with decomposition limited by inundation (McVoy et al., 2011).

PEAT DEGRADATION

When drained, peat soil degrades rapidly resulting in elevation loss and habitat change. Peat degradation also releases atmospheric carbon dioxide and polluting nutrients such as nitrogen and phosphorus. In addition to the impact of drainage, drought exacerbates peat soil degradation. The fact that wet-season water flows are now diverted to sea decreases the amounts of water retained in the area, which in turn could not meet dry-season water demands. This cycle might intensify the frequency of drought and related peat oxidization.

The **lowering of natural water tables** on drained croplands has accelerated oxidation and decomposition of organic peat soils, resulting in widescale land-elevation decline due to soil subsidence. Soil subsidence is a serious concern in the EAA, resulting in loss of water retention capacity, reduced hydraulic gradients, release of soil nutrients in drainage flows, and productivity loss/increased costs for agriculture.

EAA soils are predominantly peat soils composed largely of decayed plant matter, with low mineral content. Loss of organic soil depth in the EAA is attributable primarily to **biochemical oxidization**. Other factors include **soil shrinkage, compaction, burning, and erosion**.

"It is impossible to consider the geology of the Everglades without also considering the hydrology. "

- nps.gov/ever

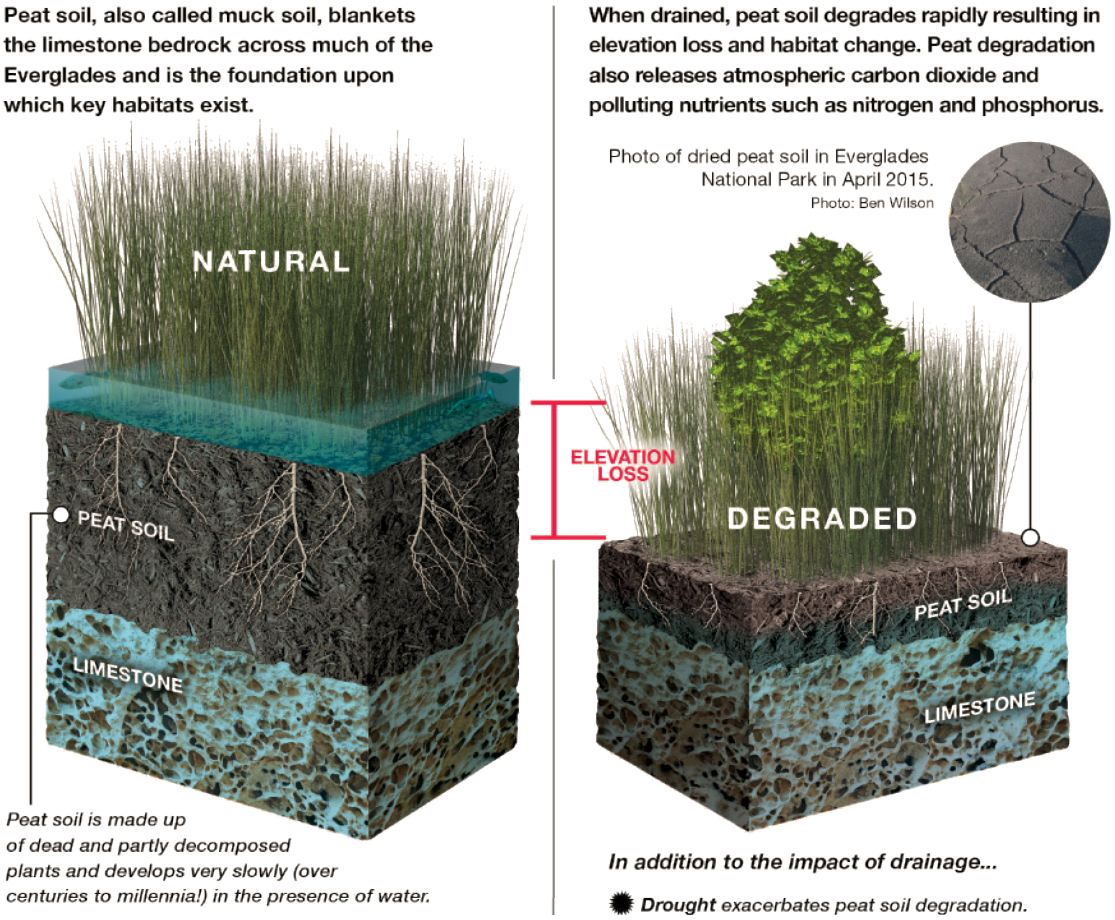


Figure 26. Peat Morphology (Davis et al., 2016)

2.2 Geology

Conclusions & Implications for Design

- Importance of the accretion of peat (Keep Water Above the Peat)

The existence of peat and the presence of water together play an essential role to the environment. The degradation of peat results in the emission of carbon dioxide to the air and the release of nitrogen and phosphorus in the water. It also leads to continuous loss of groundwater stored in peats. The loss of the peat soils in South Florida is an impact that has affected aspects of hydrology, landscapes, habitats and atmospheric chemistry, namely the increase in carbon dioxide and other greenhouse gases.

Once the peat surface is gone, the result is irreversible. At that moment it becomes too late to accumulate peat because the limestone is porous and permeable. The surface water will have chemical reaction with the limestone, and it will be unable to go down to re-fill the aquifer.

To mitigate peat oxidization and peat loss, it is crucial to keep water above the peat. The **current draining of the land should be halted** in the near future, especially in the areas that have less peat.

Therefore, the first transformation of EAA should start from the area that has the least remaining peat.



2.3 Ecology

Degraded Ecosystem: as a result of altered watersystem

The geology of South Florida together with a warm, wet and subtropical climate, in the past provided conditions well-suited for a large freshwater wetland ecosystem. This slow-moving "River of Grass" is home to a remarkable diversity of species of plants, birds, mammals, fish and reptiles.

The climate of Florida decides that the Everglades and EAA experience the cycle of dry and wet seasons yearly. Wet season is from June 1 through October 31. Dry Season is from 1 November through May 31.

Water is the dominant force in the Everglades, shaping the land, vegetation and animal life.

The food resources for the wildlife change according to the water cycle. When the water level rises, food disperses, while in the dry season when water level drops, and food concentrates in pools across the landscape. When food is available, the amount of breeding birds will increase and thus the rate of successful nesting is increased.

However, a large surface of the Everglades is currently too dry (ENP) or too wet (WCA-3A).

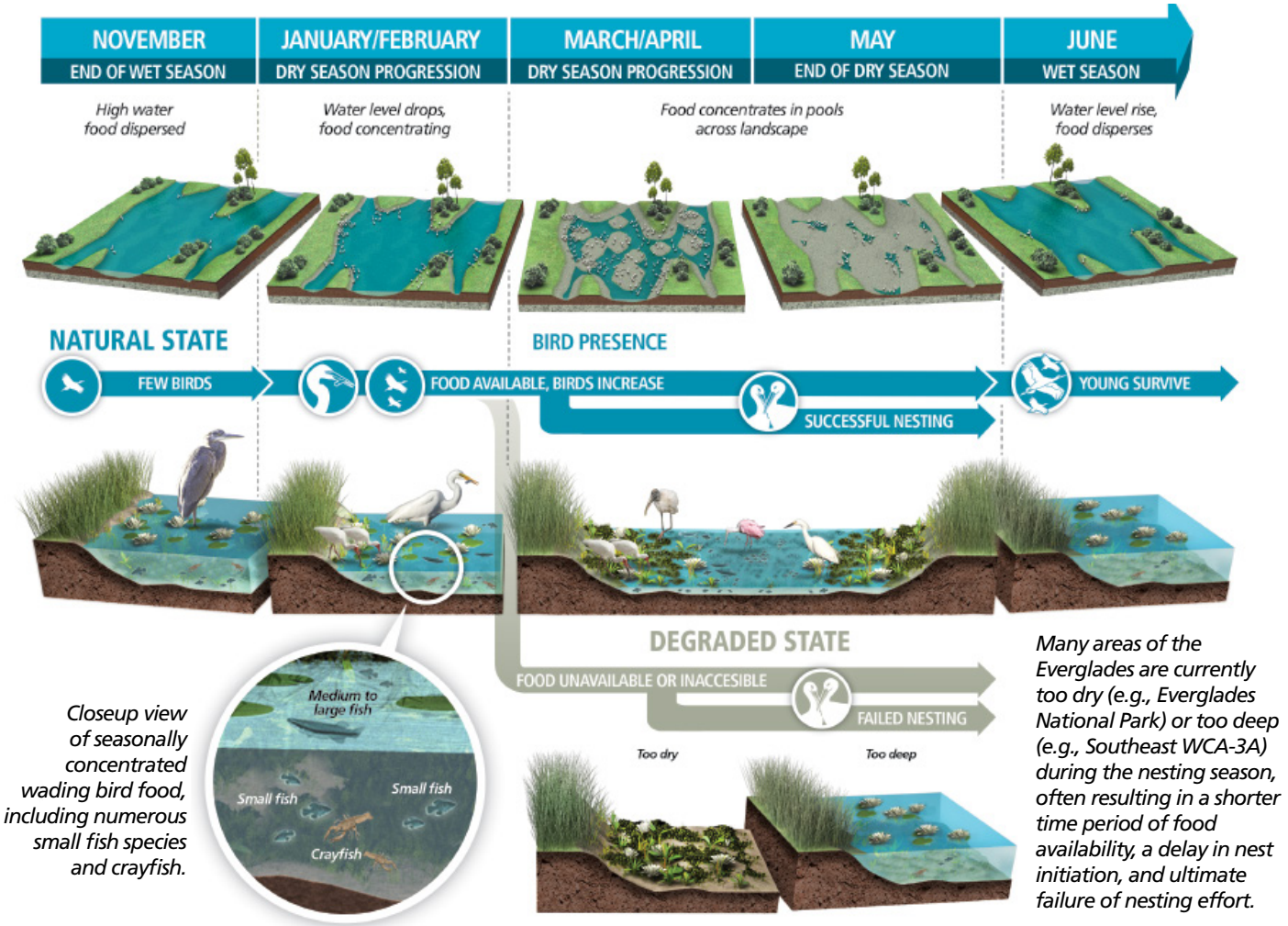
There is a shorter time period of food availability, a delay in nest initiation and ultimate failure of nesting effort during the dry season which is also the nesting season.

INVESTIGATION OF THE DRIVING FORCE

The main reason of this situation is that the sheetflow is severed in the northern Everglades where the EAA is located. Under natural conditions sheetflow flowed continuously towards the south, where part of the water was stored on site as well as re-charged into the aquifer. However, nowadays this water is drained from the land and discharged directly into the sea.

At the same time, excess water from the EAA is being pumped into the southern Everglades and lake Okeechobee to keep the land dry for sugarcane growth during the wet season, resulting in the Southern Everglades being too wet, as well as flooding in the northern estuaries. Conversely, water being pumped out for irrigation during the dry season, letting the Everglades slowing die of thirst.

Note: From July to October, it is still part of the wet season and the state remains the same as described in June.



Closeup view of seasonally concentrated wading bird food, including numerous small fish species and crayfish.

Many areas of the Everglades are currently too dry (e.g., Everglades National Park) or too deep (e.g., Southeast WCA-3A) during the nesting season, often resulting in a shorter time period of food availability, a delay in nest initiation, and ultimate failure of nesting effort.

Figure 27. Time line of water cycle and comparison of before drainage state and after drainage state (Davis et al., 2016),

2.3 Ecology

Centimeters Makes Huge Differences: Landscape varying with subtle topographic changes

"There is relatively little difference in elevation between the lowest and highest parts of the swamp. Imagine standing at the bottom of a creek in Wisconsin. The surrounding landscape would change sharply, by 10, 20, even 30 meter, over a short distance. The pattern is even more extreme on a mountain slope in Wyoming, where elevation varies by hundreds of meters very quickly. However, ***in the Everglades, such topographic changes are measured in centimeters instead of meters****.*

The Everglades, or at least large portions of it, vary by about 1m in elevation.

<u>If you think of the ground level as 0, that's the bottom of a deep water slough. If I go up 30 or 40 cm from that, I'm in a sawgrass ridge, and if I go up a bit more, I'm on a tree island.</u> We have drastically different environments that are separated in topography by a meter. This is a landscape of subtleties."

- Len Scinto (2015)

LAYERS COME IN ALL SIZES

Ecosystems from the Everglades swamp to the Rocky mountains have layers of life but the difference in elevation from one habitat to another is vast. In the Rockies, you would need to climb 500 meters or more to find the next plant community. In the swamp, the habitats change in a matter of centimeters. Knowing what to expect at each elevation helps to monitor the restoration of the ecosystem.

Before drainage the EAA was occupied by custard apple zones, willow and elderberry zone, and sawgrass plains before following the gradients from 6.4 meter (21 feet) to 4.3 meter (14 feet) (north to south). The original vegetation was all cleared during the land requisition process. Currently there is no vegetation left. The clearing of the vegetation intensified the drought and deceased the dynamics.

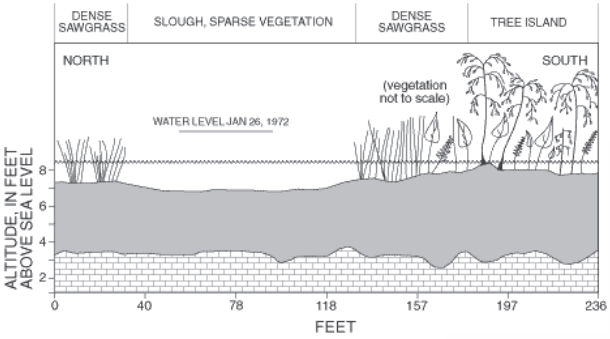
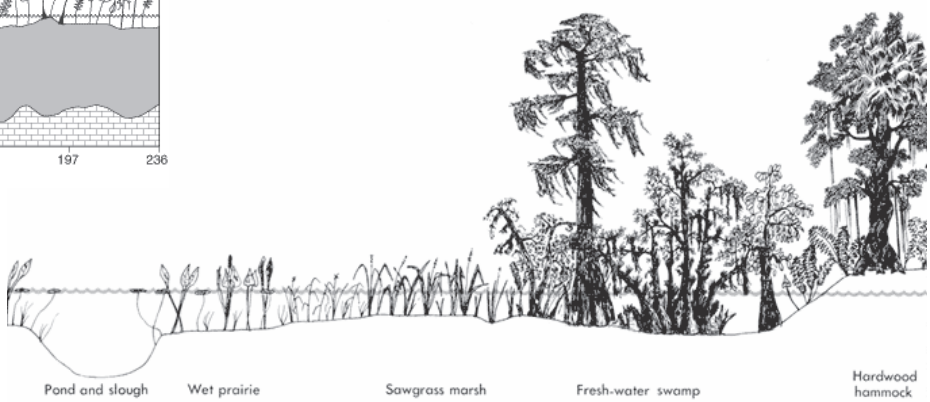


Figure 28. Relation between vegetation communities and water depth (McPherson et al., 1976)



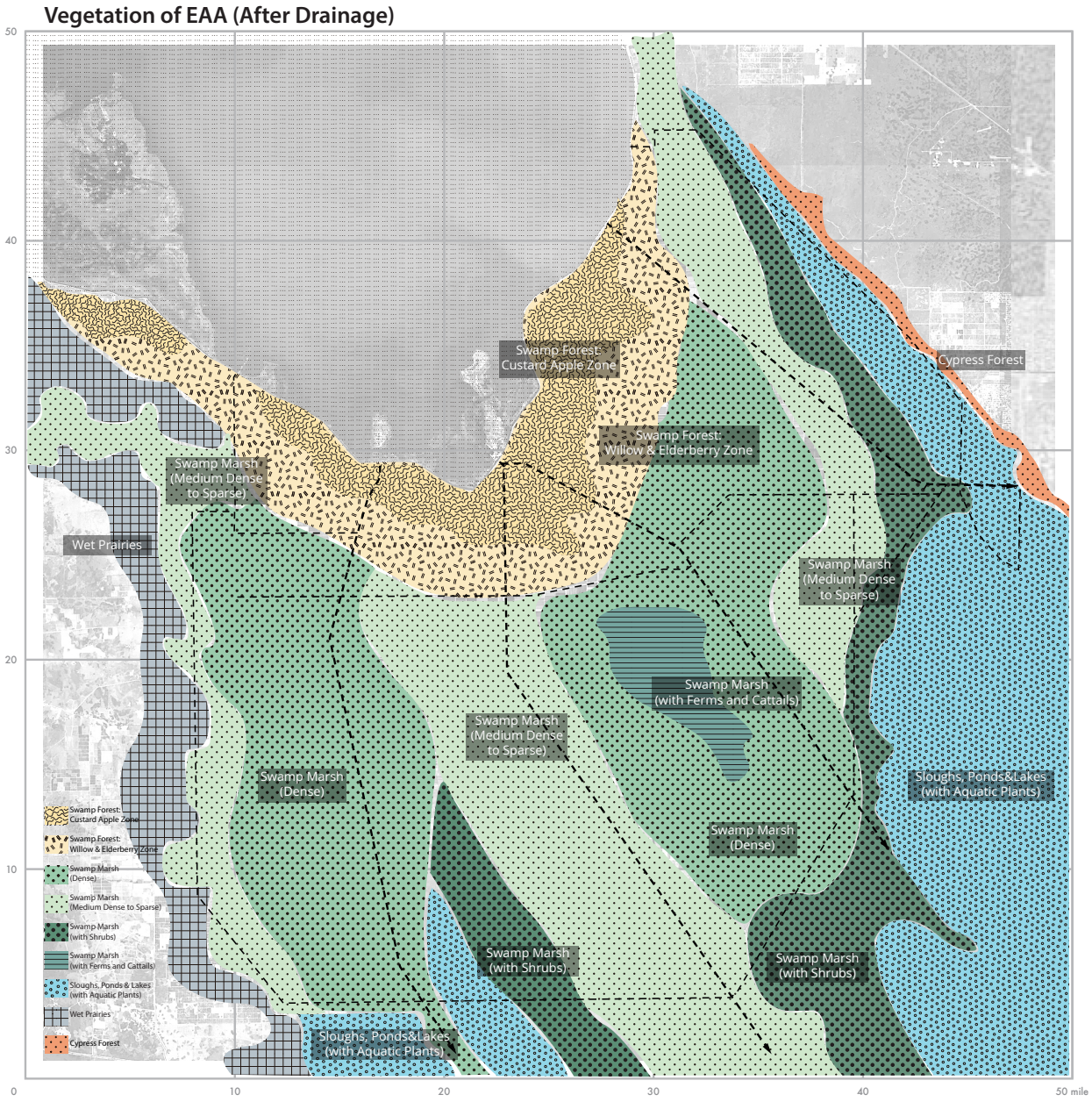


Figure 29. Vegetation of EAA before drainage (Drawn by author)

2.3 Ecology

Rice as Most Important Wildlife Crop

The objective of the analysis of wildlife dynamics is to:

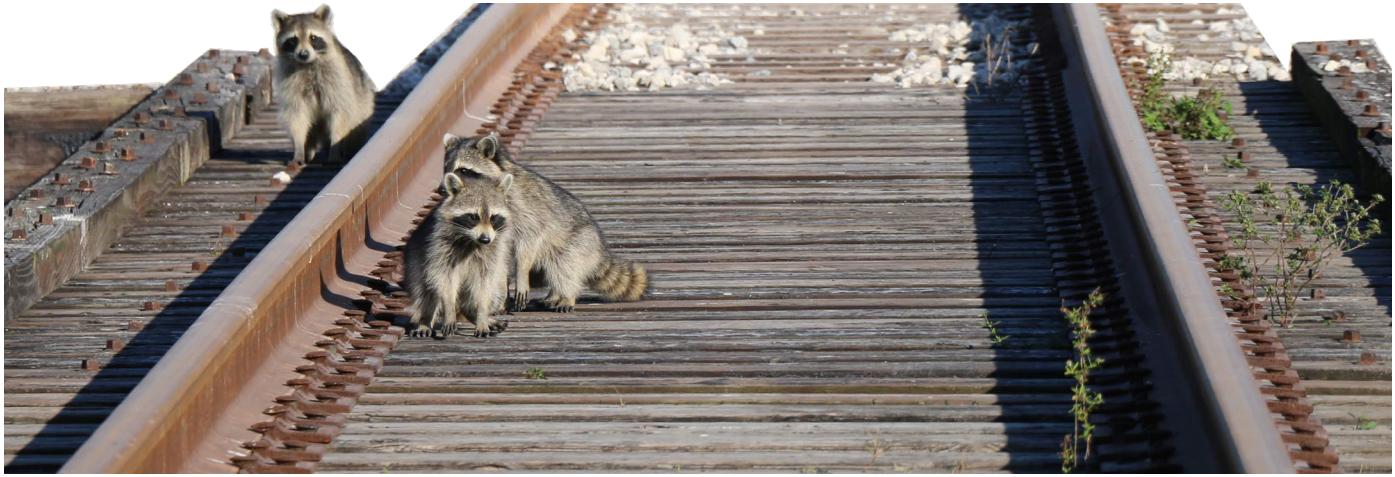
1. Determine the habitat relations of wildlife in EAA.
2. Discover the connection of EAA with Florida wildlife corridor

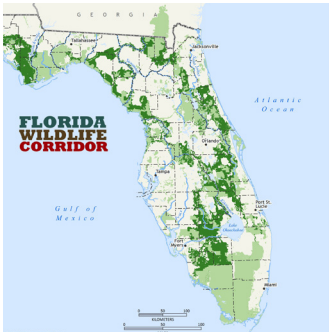
HABITAT RELATIONS OF WILDLIFE

Pearlstine et al. (2005) have conducted extensive surveys in both rice fields and sugarcane fields along with associated ditches, canals and edge habitat to document wildlife habitat use. They concluded that the EAA as an agricultural system provides an array of benefits as well as challenges to the wildlife that lives there. The findings about wildlife dynamics in relation to spatial configuration and crop selection are elaborated and discussed below.

- Rice is probably the most important wildlife crop in the EAA because it provides wetland habitat for a large number of birds and fish.
- Most of the EAA is adjacent to natural landscapes or reclaimed wetlands such as the Water Conservation Areas. Animals from these localities may find dispersal or migratory habitat in the EAA.
- Unplanted areas such as canals, ditches, non-agricultural areas and edges provide a large amount of habitat for a variety of wildlife.
- Flooded fields of the EAA provide surrogate wetland habitat for many birds and other animals. Canals and ditches are also important for aquatic animals.
- The ability to manage water flow and flooding of the fields is an opportunity to provide benefit for the wildlife.
- The presence of managers in the EAA limits the possibility of human disturbances such as hunting, harassment, collecting for pets, and littering/polluting.
- Cultivation of agricultural crops carries with it a set of intrinsic dangers to wildlife. The use of machinery is a disturbance and is often fatal to animals that live and breed in the fields.
- Heavy machinery compacts soil, plowing and sowing disturb soil and may contribute to erosion.
- Harvesting, especially using fire, is a high disturbance period in the cultivation cycle.
- Yearly growth and plowing cycles are detrimental to some species such as Round-tailed Muskrat that require longer periods of stable habitat.

Source:
http://crocdoc.ifas.ufl.edu/publications/reports/eaa_final.pdf (Wildlife Habitat Relations of the verglades Agricultural Area, Florida, A Final Report, 2002-2004)





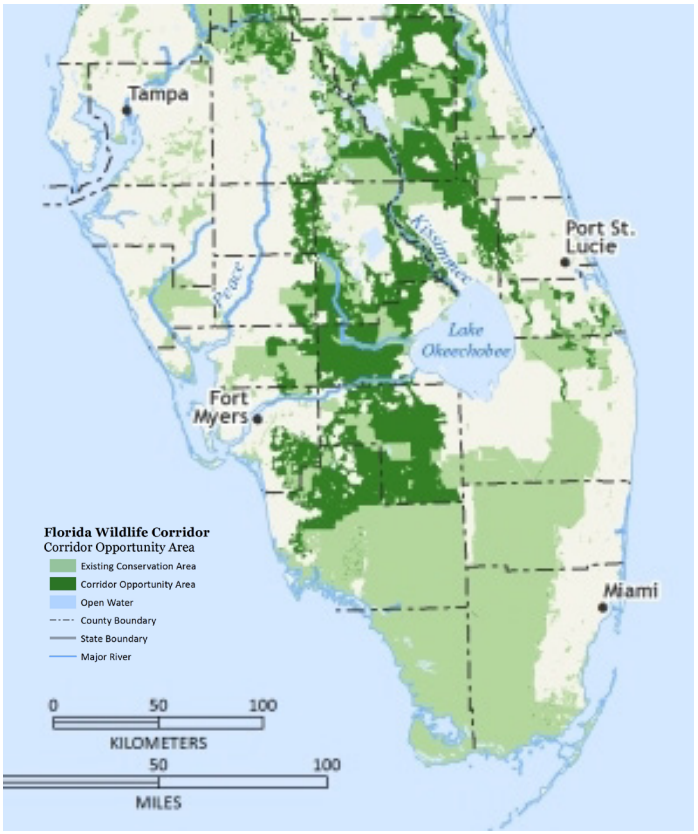


Figure 30. Florida Corridor (http://floridawildlifecorridor.org/)

Florida Wildlife Corridor

The Florida Wildlife Corridor organization made a future wildlife corridor plan (figure 30). The Florida Wildlife Corridor is a statewide network of lands and waters that supports wildlife and people.

The Florida Wildlife Corridor now embarks on its most important journey – to accelerate the rate of conservation in Florida by 10% annually in order to protect 300,000 acres within the Corridor by the end of 2020.

(http://crocdoc.ifas.ufl.edu/publications/reports/eaa_final.pdf)

This map (figure 30) shows the corridor opportunity area represented in dark-green, while the light green represents the existing conservation area.

This map shows that the EAA will be surrounded by the wildlife corridor in the future, which indicates the opportunity for the EAA as an important conservation area for wildlife. According to current research, the agricultural habitat of the EAA is large in scale, and contains an abundance of edge and aquatic habitat that support a large population of diverse wildlife (http://crocdoc.ifas.ufl.edu/publications/reports/eaa_final. pdf).

2.3 Ecology

Conclusions & Implications for Design

- Interactions between biotic dynamics and abiotic (soil, water) dynamics

- Benefits of vegetation on site
- Increase the ecosystem's resilience to climate change
- Buffer overflow from lake o during extreme rainfall events
- Stabilize soil
- Reverse subsidence
- Moderate the local environment during drought
- Provide critical habitat for everglades wildlife.
- Absorb nutrients and reduce eutrophication

- Restoration of Swamp (Custard Apple) Forest

- Revegetation based on gradients and water depth

- Create New Corridor for Wildlife







2.4 Agriculture

Enormous Chessboard on Earth: EAA Grid pattern

Zooming in on the satellite map of the EAA, the enormous squares spreading out all over the land looks like an enormous chessboard, which attracted my attention and raised curiosity for the following question: why was the land shaped into this grid pattern?

American Public Land Survey System reveals that this pattern is not only applied in the EAA but all over the U.S. It is a surveying method used to divide real property for sale. A section is 1 mile by 1 mile(1600m x 1600m), a quarter-section is 1/2 mile by 1/2 mile (800m x 800m) and a township is 6 mile by mile. This pattern can be found in many cities and community planning.



Figure 32. The pattern of EAA looks like an enormous chessboard. (Satellite map from Google earth)

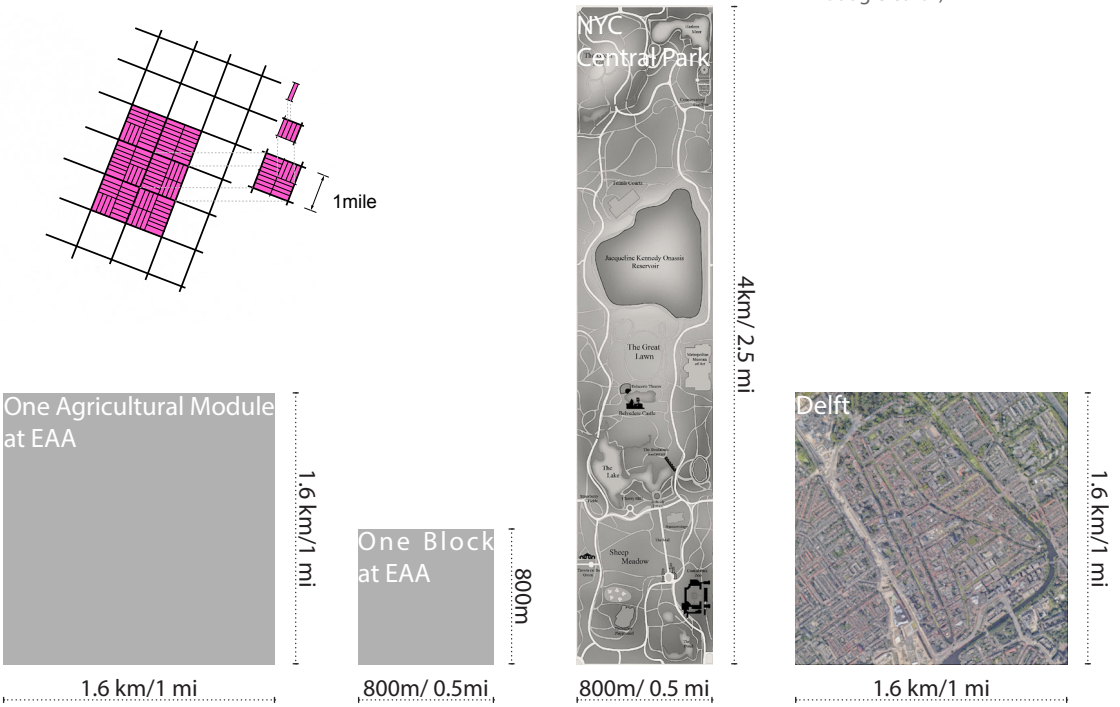


Figure 31. Scale comparison of EAA with NYC Central Park and Delft, drawn by author

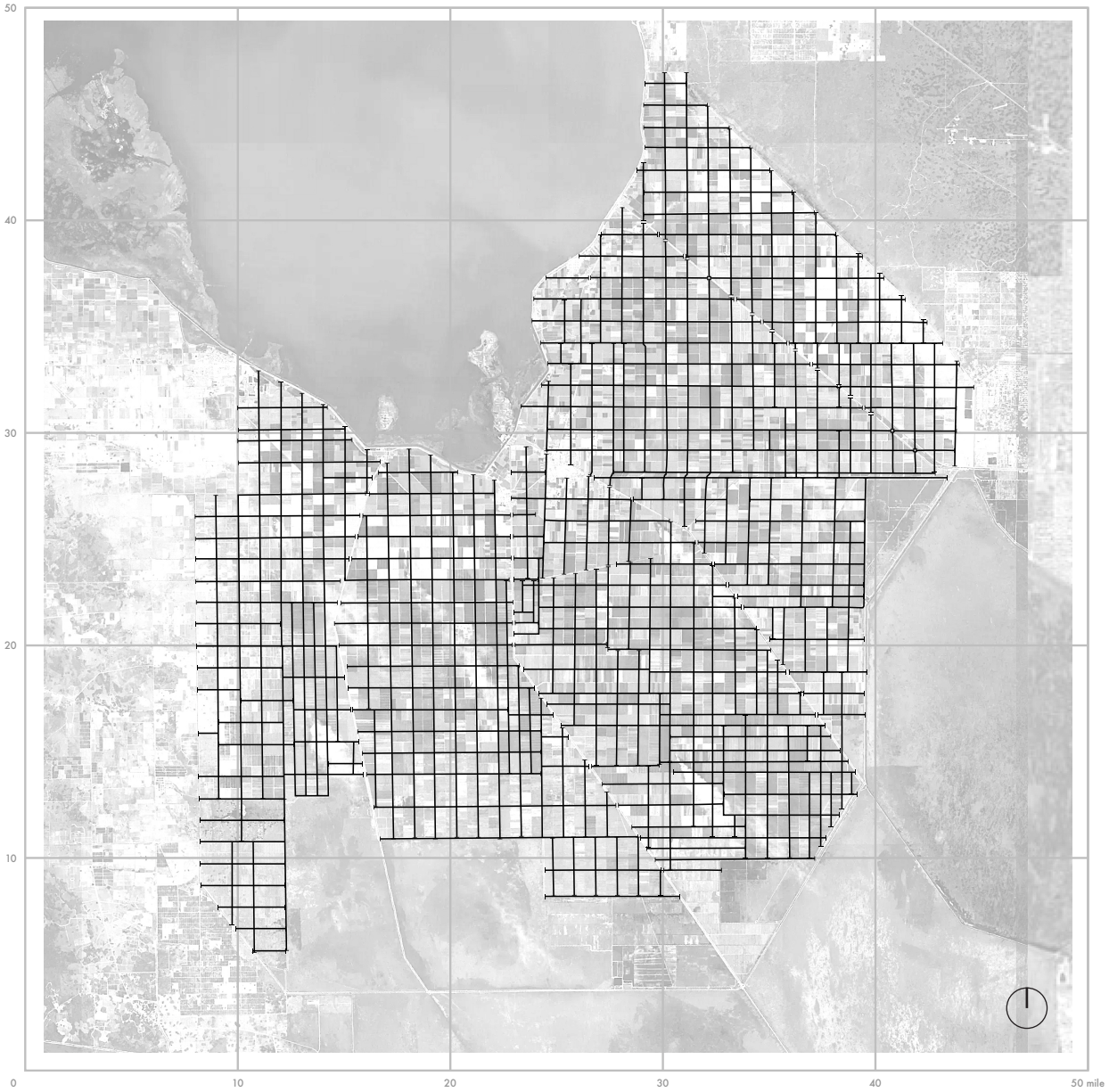


Figure 33. Grid pattern in EAA

2.4 Agriculture

From Sugarcane Empire to Rice Campaign: Future of Polyculture

The primary economic activity throughout the EAA is agriculture. The area consists of around 2.8×10^3 km^2 of productive agricultural land, the vast majority of which is under sugarcane cultivation (USACE, 2015). In addition to sugarcane, crops grown in the EAA include rice, citrus, and vegetables, while some of it is also used as pasture land.(Aich et al., 2013).

The introduction of nutrients for agriculture is an alteration of the natural Everglades system and has undoubtedly resulted in an artificial habitat and has encouraged the proliferation of weedy and non-native species of plants.

There are many researches and experiments going on in the EAA to find an alternative to sugarcane. With this purpose, lake Harbor Tract is built and managed to assess feasibility of a rice/crawfish polyculture, while at the same time provides recreational sits for waterfowl hunting.

In other areas of the EAA, rice is grown in rotation with sugarcane on a limited acreage. Moreover, rice has been recommended as a cost-effective means of controlling soil loss.

To conclude, rice will be planned as the crop for the EAA during the transition time to balance the economic value.

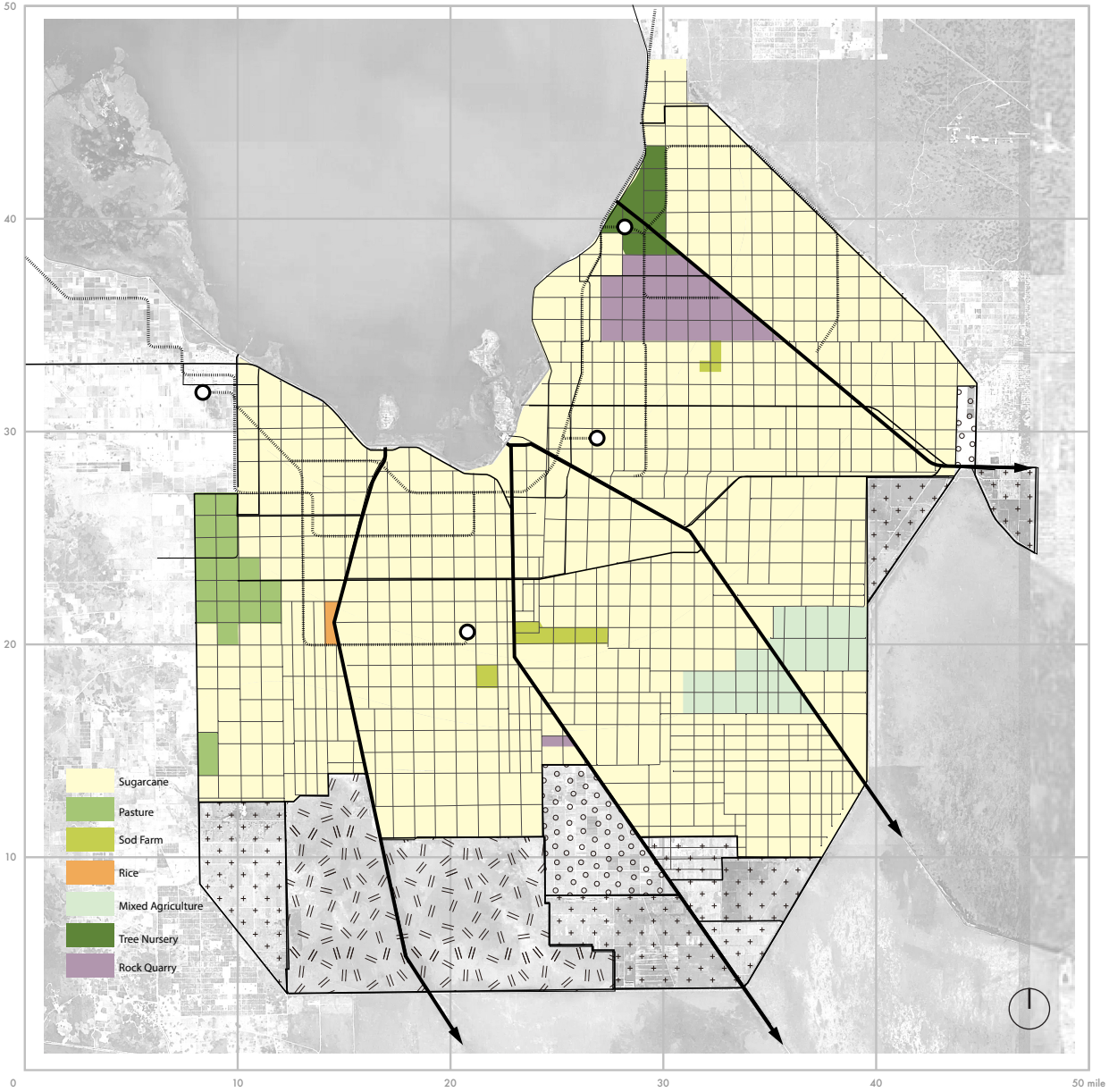


Figure 34. EAA Crops

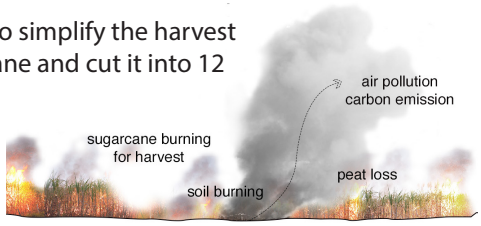
2.4 Agriculture

Post Sugarcane Industry Heritage: potential of transformation

Sugarcane Industry makes use of a series of processes from sugarcane growth, harvest, transporting, and milling. To accommodate for the processes vast infrastructures were built, such as the railway network for hauling sugarcanes, and the sugarcane mill factory.

When the land use of the EAA gradually changes, the remaining sugarcane infrastructures will lose their original function. **So what is the potential of the railway infrastructure and mill factories? In what way could they be transformed?** In order to answer these questions, the first step is to decompose and understand this artificial process.

1
- Burn the peat land to simplify the harvest
- Harvest the sugar cane and cut it into 12 Lengths



2
- Load the sugarcane to the truck



3
- Dumping the sugarcane from the trucks to the train



4
- Train hauls sugarcane from the fields to the mills



Figure 35. Decomposition of sugarcane industry

SUGARCANE INFRASTRUCTURES



Figure 36. Rail line and sugarcane Mill in EAA

2.4 Agriculture

Conclusions & Implications for Design

-Sugarcane Replacement

During the sugarcane harvest, the sugarcane is burned together with the surface peat, which is one of the main reasons of peat loss. It is an unsustainable way of cultivating this crop. As peat soil is subsiding year by year, sugarcane production will stop when the peat depth is less than half a feet (15cm), at which point it is too thin for crop production.

Growing alternative crops, such as rice, vegetables or sod, or making alternative use of land, such as wetland or woodland instead of cultivation field is proposed.

-Rice as Important Wildlife Crop

Rice is probably the most promising wildlife crop in the EAA because it provides wetland habitat for a large number of birds and fish.



2.5 Recreation

Inaccessible Agriculture Plot to the Public

Agricultural fields in the EAA are connected by unpaved roads that are usually gated. Most of those roads serve large farm machinery and sugarcane harvest trucks. They are not accessible to the public. The distance between any two roads is around half a mile (800m).

Beyond Agriculture: Recreation & Tourism as alternative economic proposition

A second major economic opportunity is recreation. Lake Okeechobee and stormwater treatment areas south of agricultural lands are two main regions that are open to the public for recreational use.

LAKE OKEECHOBEE

Lake Okeechobee and its associated waterways and shoreline provide water-based activities for local residents and tourists, including fishing, boating, hunting, hiking, picnicking, camping, birdwatching, sightseeing, swimming, air boating, biking, et cetera.

STORMWATER TREATMENT AREAS

The main purpose of the 52,000 acres of stormwater treatment areas (STAs) is to remove phosphorus from urban and agricultural runoff flowing into the Everglades, but they also provide habitat for native and non-native birds, fish, reptiles and plants. This makes stormwater treatment areas a recreational place for early morning birdwatching, an afternoon hikes or bicycling. Seasonal hunting, some of the best in the state, is permitted at select locations.

AGRITOURISM

Agritourism is a combination of agriculture and tourism (Florida's two largest industries). It brings visitors to the farmland to experience agricultural industry and participate in activities like farm stays, horse riding and waterfowl hunting. Agritourism provides alternative to the tourists who are looking beyond the beach visit in Florida. This is also an educational opportunity to connect people to the land.

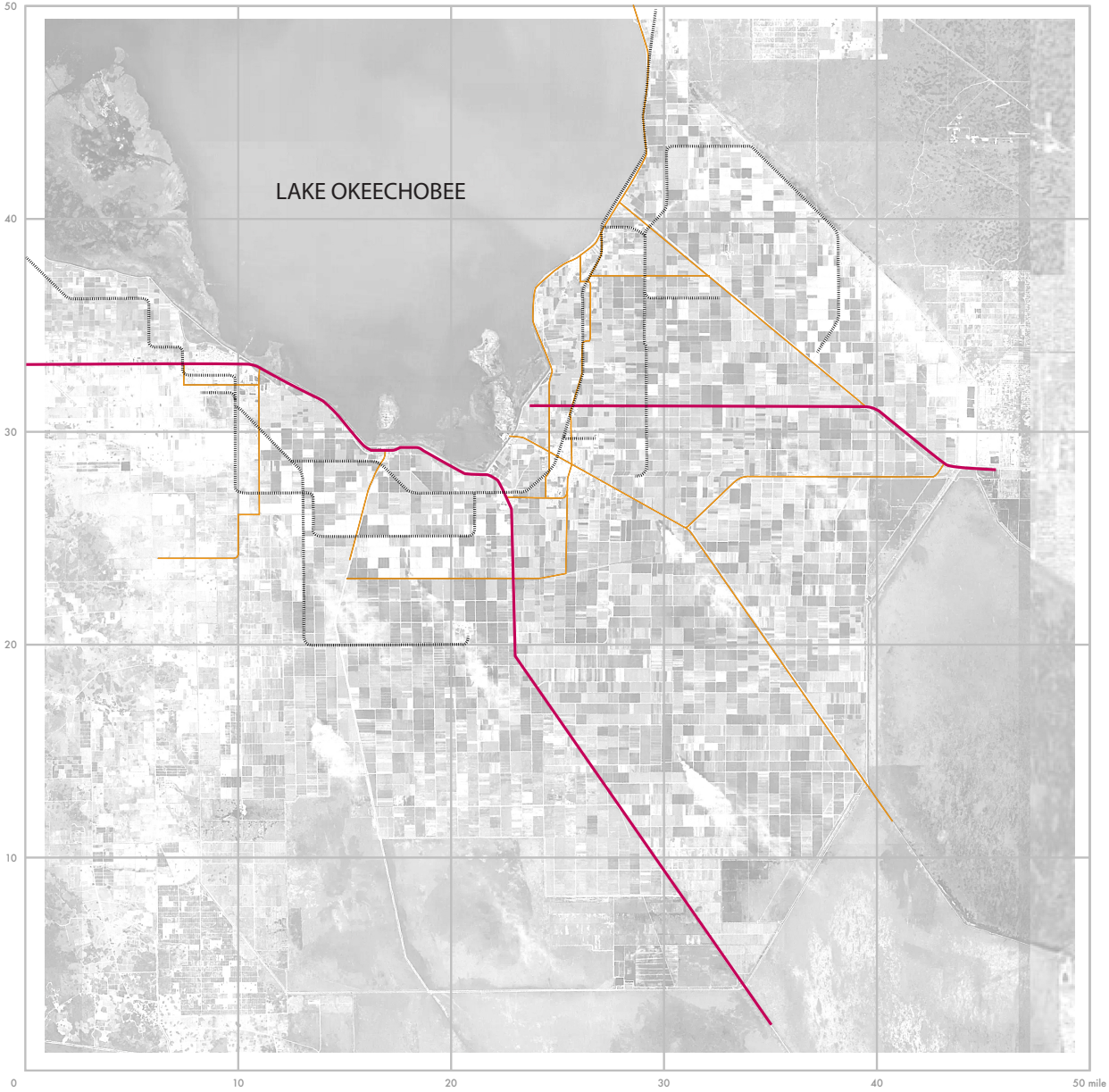


Figure 37. Main Public Roads Map

2.5 Recreation

Conclusions & Implications for Design

- Nature-Based Recreation

Fishing, hunting, boating, bird watching, hiking.

Most people go fishing for recreation instead of using the fish they catch as a source of food. They usually release the fish after they get them. Therefore, the design of a fishing area nearly the wetland is viable.

- Movement of People

Based on the analysis of the transportation network of the EAA and a site investigation, the conclusion could be drawn that most people visiting the EAA pass through without staying. The main transportation method is by car. It is quite rare to walk or cycle along the roads inside the EAA. The only public transportation within the EAA is by bus, and only covers a small area between towns like Belle Glade and South Bay. The primary bus passengers are the agricultural workers.

Therefore, the location of the main entrance of the redesigned EAA should be easily accessible by car.



"As the use of Everglades lands for agricultural purposes approaches the sunset of their experience in this field of production there is little about that transition into a wildlife area of ultimate world fame will follow, perhaps in an easy and natural manner...There can be no doubt that by the end of the present century the population of the coastal areas to the east and west will be getting very heavy indeed and that the "playground" outlook for these sections could be immeasurably benefited by having such a huntsman and fisherman's paradise spreading out in vast proportions within the main body of the Florida peninsula at this latitude..."

- R. V. Allison (1956)

CHAPTER III
VISION OF FUTURE EAA

Overview & Aims Of Chapter

1. Scenario Development
2. Implications for Design
3. Vision of EAA: Reverting to Nature | Enhancing Experience | Sustaining Economics
4. Priority of EAA Transformation Factors
5. Defining Pilot Area
6. State of Transition: Strategic Regional Plan

Overview & Aims Of Chapter

The aim of this chapter is to define the vision of the future EAA and select the pilot area for further design application.

Firstly, two extreme scenarios are developed in order to understand the constraints, limitations, and drives of the area development. One scenario places economic development at the highest priority to distinguish the constraints of prioritizing economic development. The other scenario is based on the current practice carried by the state to define the limitations of applying the command-and-control engineering approach through claiming the whole agricultural fields in the EAA.

From the scenario development the implication for design is drawn, followed by the summarized first step which entails setting up the conditions for a sustainable development through peat growth and water storage.

Secondly, the vision of the future EAA is presented. There are three aspects of the vision: reverting to Nature, enhancing experience, and sustaining Economics. To achieve each goal, a series of corresponding design principles are followed.

Before applying the principles on sites, there are still two questions remaining. ***What are the key transformation factors? What is the starting place of the transformation?***

Seven strategic layers are selected as key layers (factors) for the transformation. By mapping out the past development factors in the EAA and their impact, the priority of future EAA transformation factors is set. Next, two main criteria are determined in defining the pilot for the redesign of the EAA.

This chapter concludes with the strategic regional plan.

3.1 Scenario Development

A

Extreme Scenario
Supremacy of Economic Benefits

Economic development would be placed at the highest priority

The primary objective of this scenario is to work within the constraints of economic development in the EAA.

Internal Situation (EAA):
If the sugarcane agriculture and industry are still going on in the EAA, the peat surface will eventually be completely gone. At that moment, it will be impossible to grow sugarcane anymore. New crops might be introduced to be grown on the limestone soil. Another possible industry in this scenario is limestone mining, which has already been proposed by sugarcane farmers.

External Situation (Impact on South Florida Region):
Restoration of the Florida ecosystem will be difficult to achieve as the peat has fundamental function to retain the water and catch the carbon on site. The water dissipates through the permeable limestone, making the recharging of the aquifer inapplicable.

- Continued peat lost
- Zero sugarcane production
- Severe environmental deterioration
- Blooming limestone mining industry

B

Extreme Scenario
Managed Conservation

Ecological value would be placed at the highest priority

Scenario for the Ecological Conservation

The primary objective of this scenario is to understand the limitations of current practice carried by the state of applying the command-and-control engineering approach to claim whole agricultural fields in the EAA.

Internal Situation (EAA):
The state will claim more lands from sugarcane farmers, remove the above crops and transform the whole area into STA or FEB to store the excess water from Lake Okeechobee and purify it. The Herbert Hoover Dike around the lake will be heightened to reduce the flooding risk addressing more frequent and extreme storms. The EAA will become inaccessible to the public. The livability and quality of the space will decrease.

External Situation:
The goal of CERP will be accomplished better. There will be a loss of job opportunities due to the clearing of agricultural industry, which might become a societal problem impacting South Florida.

- Spatial homogenization
- Limited capacity for economic growth
- EAA as a segregated nature reserve site

3.2 Implications for Design

CERP has invested more than 10.5 billion dollars to "restore, preserve, and protect the south Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection"(CERP, 2019). At the same time, the ecological restoration goal is hard to achieve without transforming the EAA. Meanwhile, the EAA is facing the increased necessity for transformation, as the sugarcane production will drop to zero within 25 years due to the loss of peat.

The mindset of prioritizing economic development and continuation of developing large structural infrastructure to mitigate the following ecological degradation issues is insufficient and unsustainable. The proposed approach for transforming the EAA regards the preservation of ecological value as the basis for sustainable development. Only when the vitality of the ecosystem is guaranteed does the societal and economic development have room to happen.

Considering the needs for economic development, and the EAA having been designated as an agricultural field for nearly 100 years, the economic value is required to be rebalanced.

The transformation of EAA has the dual purpose of eco-restoration and improving spatial quality. The community benefits include recreation, connections, social space, and assistance in mitigating climate related risks like flooding and saltwater intrusion, and fresh water supply.

What's more, the transformation of EAA is a long-term and open-ended strategy. It requires a systematic plan that connects different scales, and a series of development processes.

0

Setting Up Conditions for A Sustainable Development

The priority of the design intervention is to preserve and restore the ecological value in the EAA.

In the case of EAA, stimulation of water and peat dynamics is fundamental. Setting up conditions of peat growth and water storage forms the basis of a sustainable development.

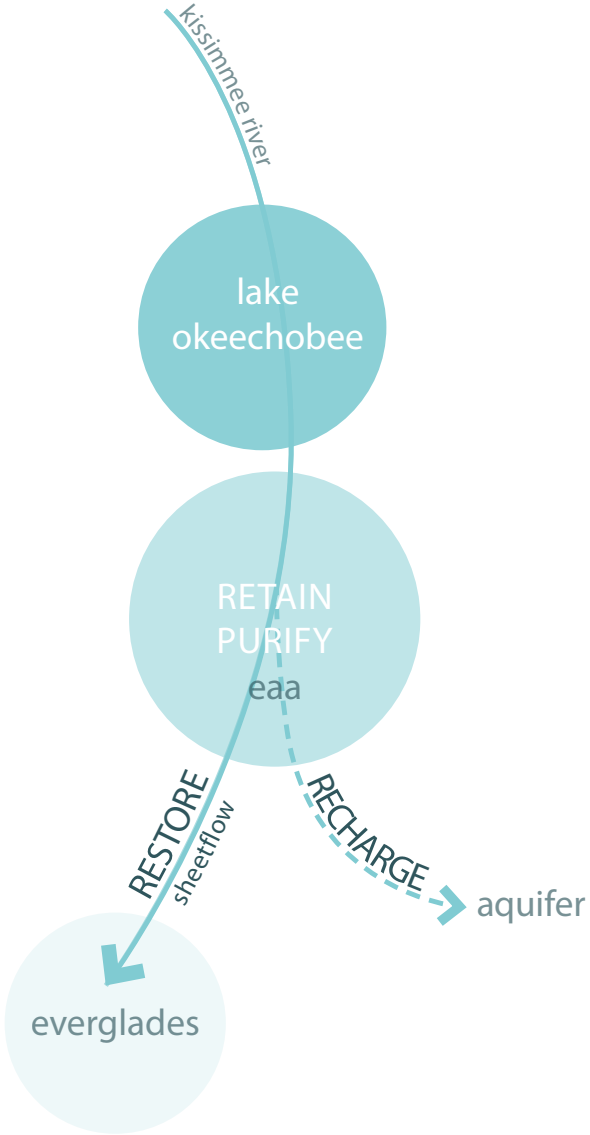
- The vigor of peat is dependent on the water level and the soil nutrient content. The peat needs to be inundated by water to prevent its oxidation and decomposition. Furthermore, the peat can only accumulate in a low-nutrient environment. So, to stimulate peat growth in the EAA, it requires elevating the water level and purification of the water. Elevating the water level will also contribute to the water storage.
- Another key to the stimulation of water dynamics is the restoration of historic water flows to the EAA. The water being stored and purified in the EAA will be released to the southern Everglades in the form of sheet flow.

ECOLOGY PRINCIPLE | *Retain, Purify, Recharge & Restore Water*

Water is the crucial agent in attempting to bring nature back. The water from kissimmee river and lake okeechobee will be retained and purified in EAA, which will be further recharged into Floridan Aquifer and restored as sheetlow into Everglades.

- The EAA is transformed into a resilient water infrastructure, **allowing more room for natural processes and freshwater retention**.
- More water is able to be conserved in South Florida, which helps to recharge aquifer and **replenish fresh water** instead of being discharged into the oceans without treatment.
- It will **reduce the polluted flows** from lake Okeechobee to the estuaries, bring back the estuary wildlife and bring **benefit to the water-related economics** at St. Lucie and Caloosahatchee estuaries, such as fishery.
- This measure will lower the water level in lake Okeechobee and contribute to the **reduction of the failure risk of the Herbert Hoover dike** around lake Okeechobee.
- Part of the water conserved on site will be transported to the south Everglades to **restore the ecosystem** there, especially during the dry season.

Other added benefits include the improvement of regional water security, restoration of the wetlands lost to over-drainage, and reduction of carbon emissions.



ECOLOGY PRINCIPLE | Retain, Purify, Recharge & Restore Water



Figure 38. EAA as a resilient water infrastructure, drawn by author

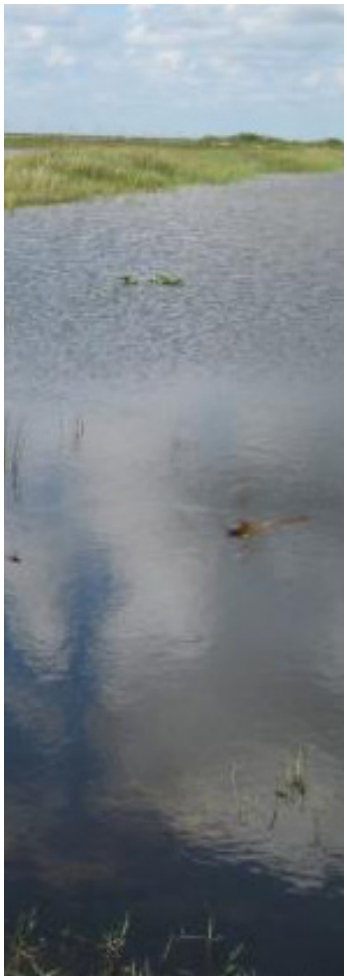
EXPERIENCE PRINCIPLE | ***Vary Landscape, Enrich Experience, Connect People***

The first thing that needs to be clear is that the spatial experience is tightly linked to ecological values. For example, no one wants to visit a stinking lake.

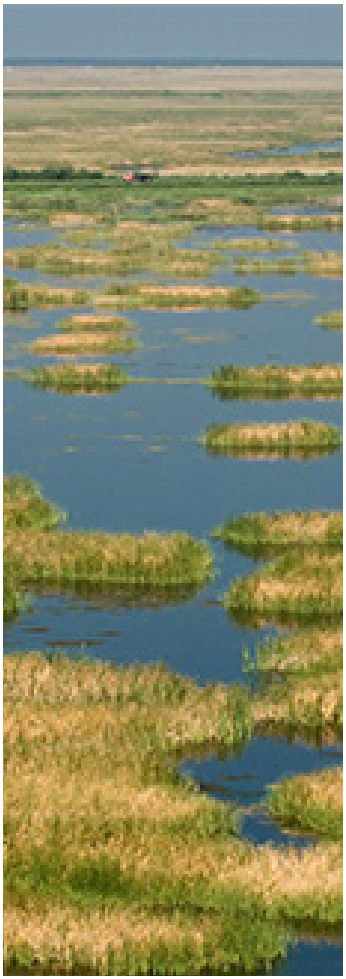
However, reverting to nature is not enough to generate an experience of beauty. Several questions arise here, including: how to provide rich experiences in the process of ecological restoration? How to make people aware of the changes that have taken place here? In particular, the transformation that EAA is undergoing is of historic importance. This current agricultural area was originally a wetland and is now returning to be a wetland again.

Everglades itself has a variety of landscapes. As mentioned in the previous analysis of the ecology, subtle topographic changes can generate diverse landscapes. The guiding principle of enhancing experience is to:

- *"Varying Landscape"* | Utilize the natural conditions in South Florida to create diverse landscapes (pond, marsh, sawgrass prairie, meadow, swamp forest and rice field) in the process of ecological restoration to provide a variety of spatial experiences.
- *"Enriching Experience"* | Create rich cultural, recreational and leisure nature-related experience rotated to local features and identities, like recreational fishing, birdwatching, hunting, camping and hiking.
- *"Connecting People"* | Improve the accessibility of the area, invite people to witness the changes in this venue and increase their environmental awareness.



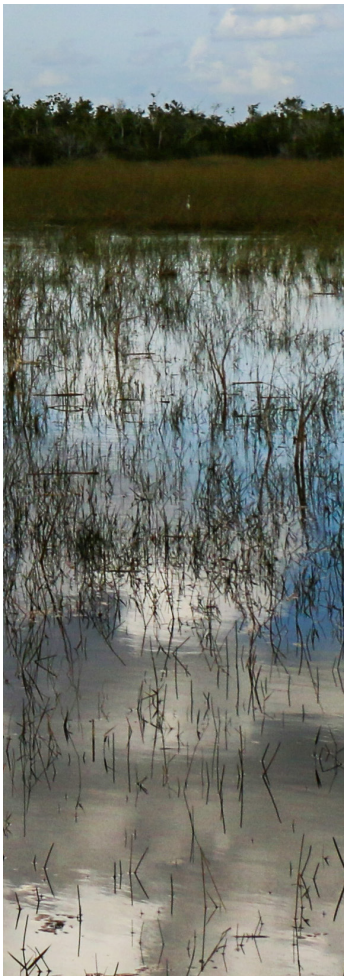
Pond



Marsh

"The experience of designed landscape can be a spatial practice of noticing, wandering and wondering in, and caring about the environment. The experience of landscape can be a mode of learning and inculcating values. "

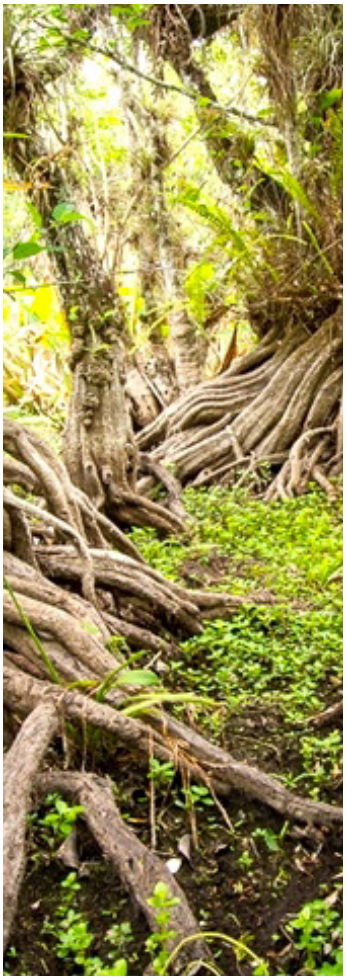
- Elizabeth K. Meyer



Sawgrass prairie



Meadow



Swamp Forest



Rice Field

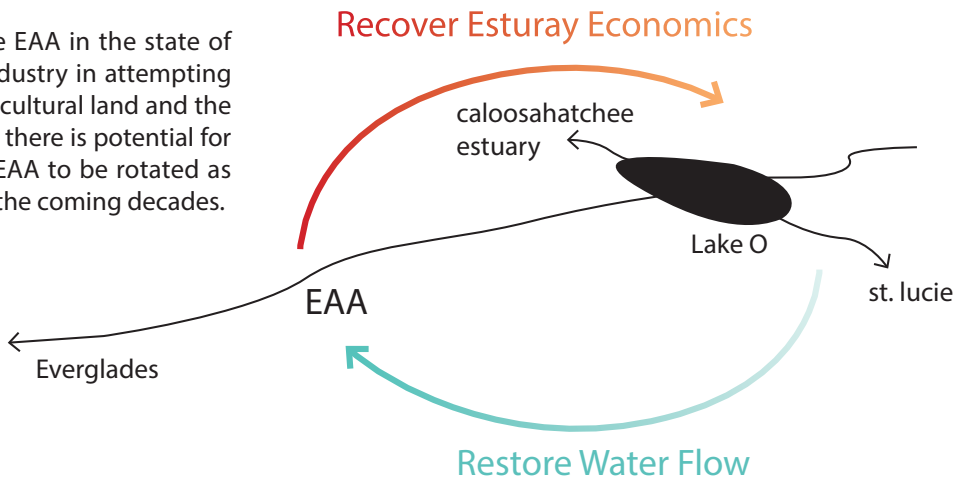
Figure 39. Diverse landscapes are created and provide a variety of spatial experiences, adapted from online images

SOCIO - ECONOMIC SUSTAINABILITY PRINCIPLE | ***Recovery, Multi-function, Rotation***

The need for economic development is driving resistance to transforming agricultural areas into ecological protection areas. The question that arises then is how to balance economic factors while transforming agricultural areas. One of the goals of the future transformation of the EAA is to turn this economic resistance into an opportunity to achieve socio-economic sustainability.

The improved capability of the EAA to store the excess water from lake Okeechobee will have a direct benefit on the water-related economics at the St. Lucie and Caloosahatchee estuaries, which in total accounts for 840 million dollars yearly. It will help recover the commercial fishing, recreational fishing and tourism by attracting visitors to the estuary once again.

The proposed principle for the future EAA in the state of transition is to develop the service industry in attempting to integrate tourism with adapted agricultural land and the ecological restoration site. Meanwhile, there is potential for part of the restored wetlands in the EAA to be rotated as low-intensity-use agricultural fields in the coming decades.



Land Rotation

"Land rotation is not nearly as crop rotation, but it involves the same principle: the land is allowed to rest after a period of demanding use (cultivation) by putting it to a use that is less demanding. "

- Hart, 1977

Recreation/ Tourism



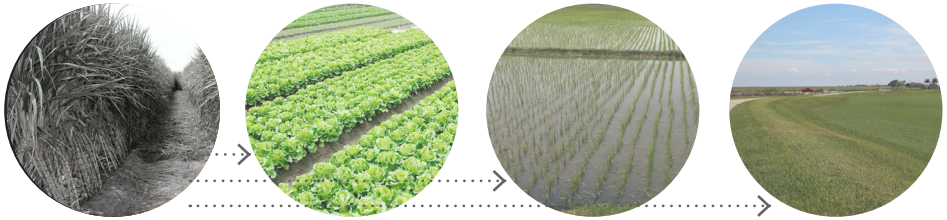




Agritourism



Adapted Agriculture

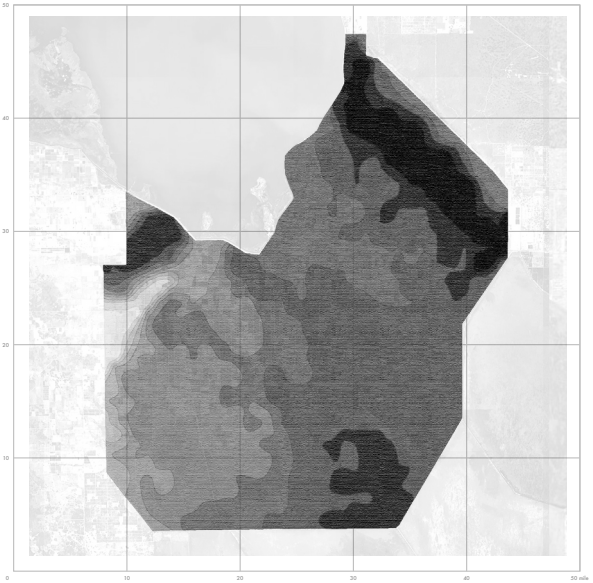


sugarcane vegetables rice pasture

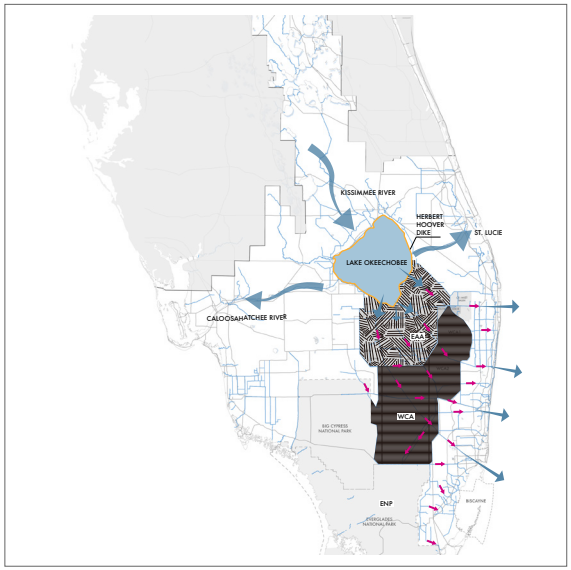
3.4 Priority of EAA Transformation Factors

Key Layers of the transformation

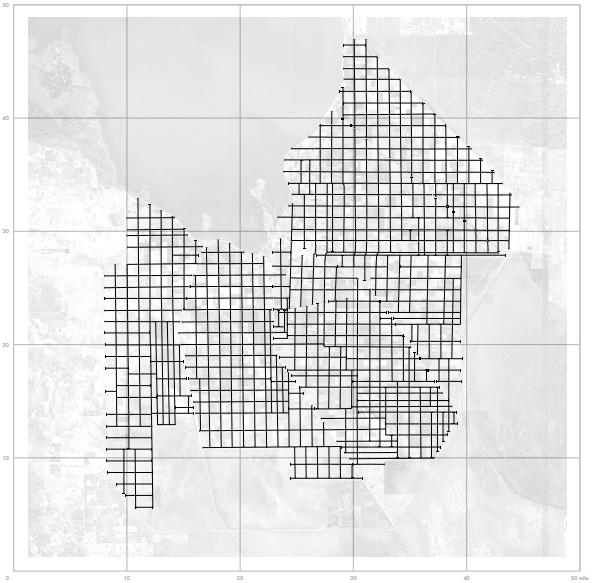
7 strategic layers are selected as key layers (factors) of the transformation: topography, peat depth, canals system, grid pattern, sugarcane mill with rail line, water management districts and regional water connection.



Topography



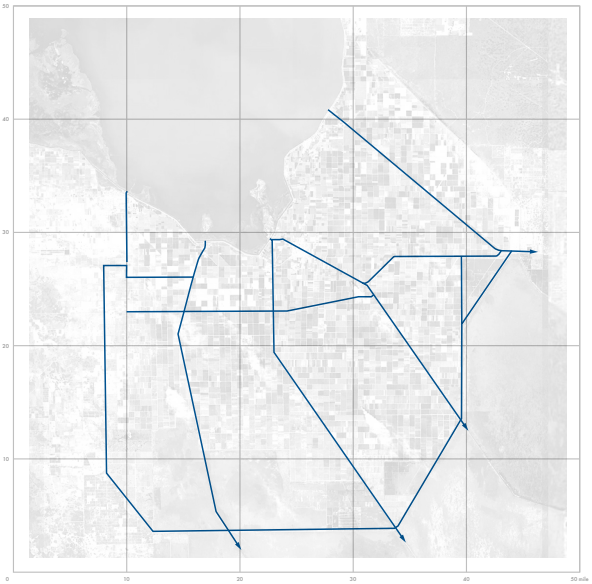
Regional Water Connection



Grid Pattern



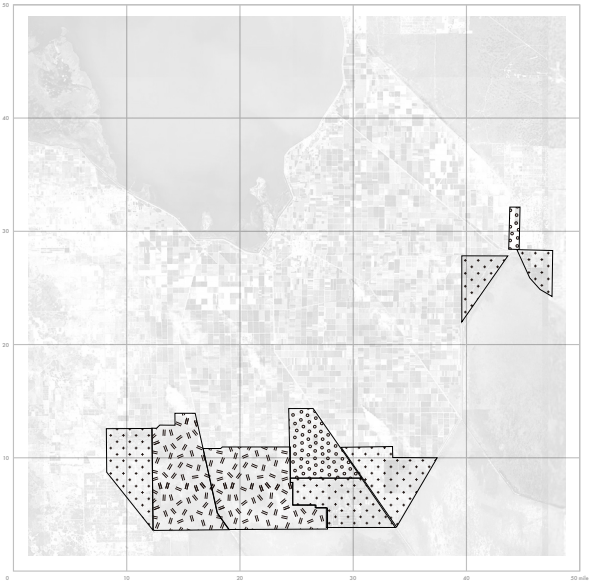
Peat Depth



Canal



Sugarcane Mill & Rail Line



Water Management Areas

Figure 40. Seven strategic layers, drawn by author

3.4 Priority of EAA Transformation Factors

PAST

In the past, the development of the EAA was highly artificial, without consideration for the natural conditions. These seven layers shaped the landscape of the EAA, with different hierarchy.

- Sugarcane agriculture and industry played a dominant role in the EAA.
- The canals system was mainly built to serve the agriculture.
- Land was divided into plots.
- Constructed wetlands were built as a mitigation solution to treat the agricultural run-off under the CERP.
- Within the scope of prioritizing economic developments, the topography was being ignored, followed by the rapid lowering of the peat surface.
- The regional water connection between Lake Okeechobee and the Everglades was cut off.

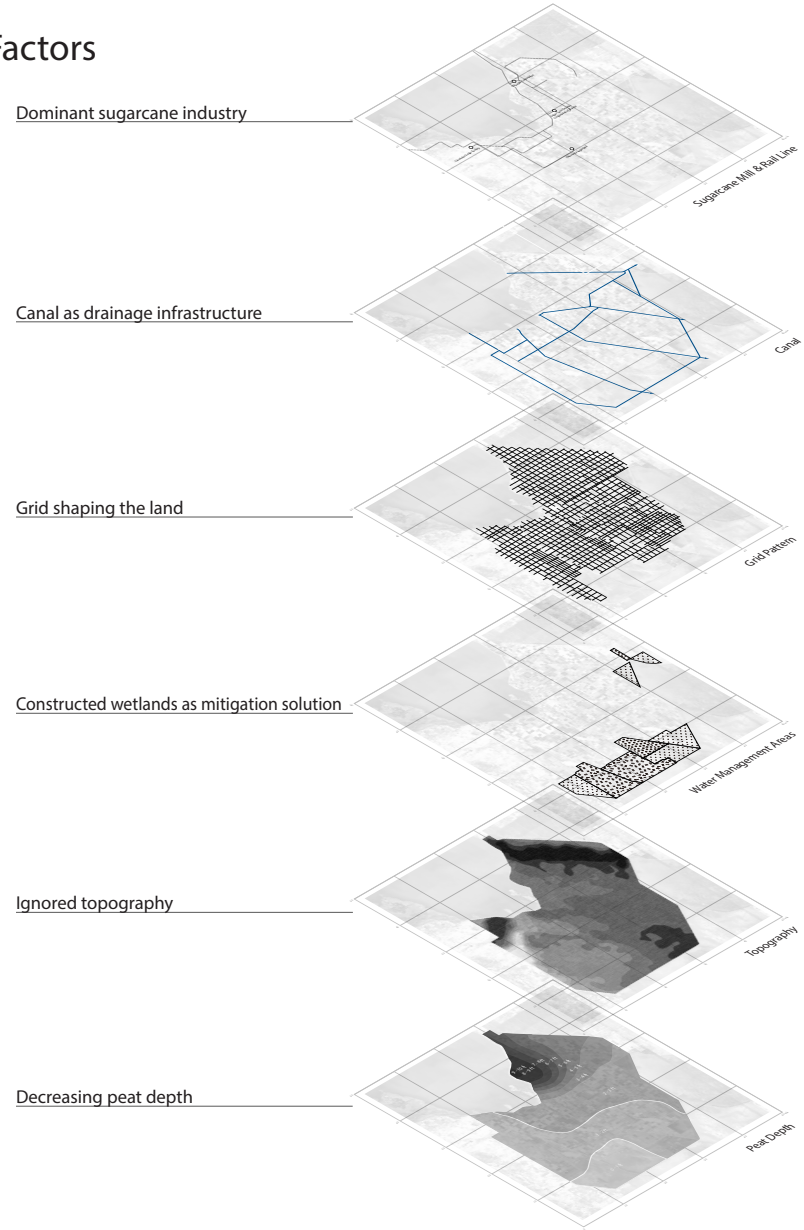
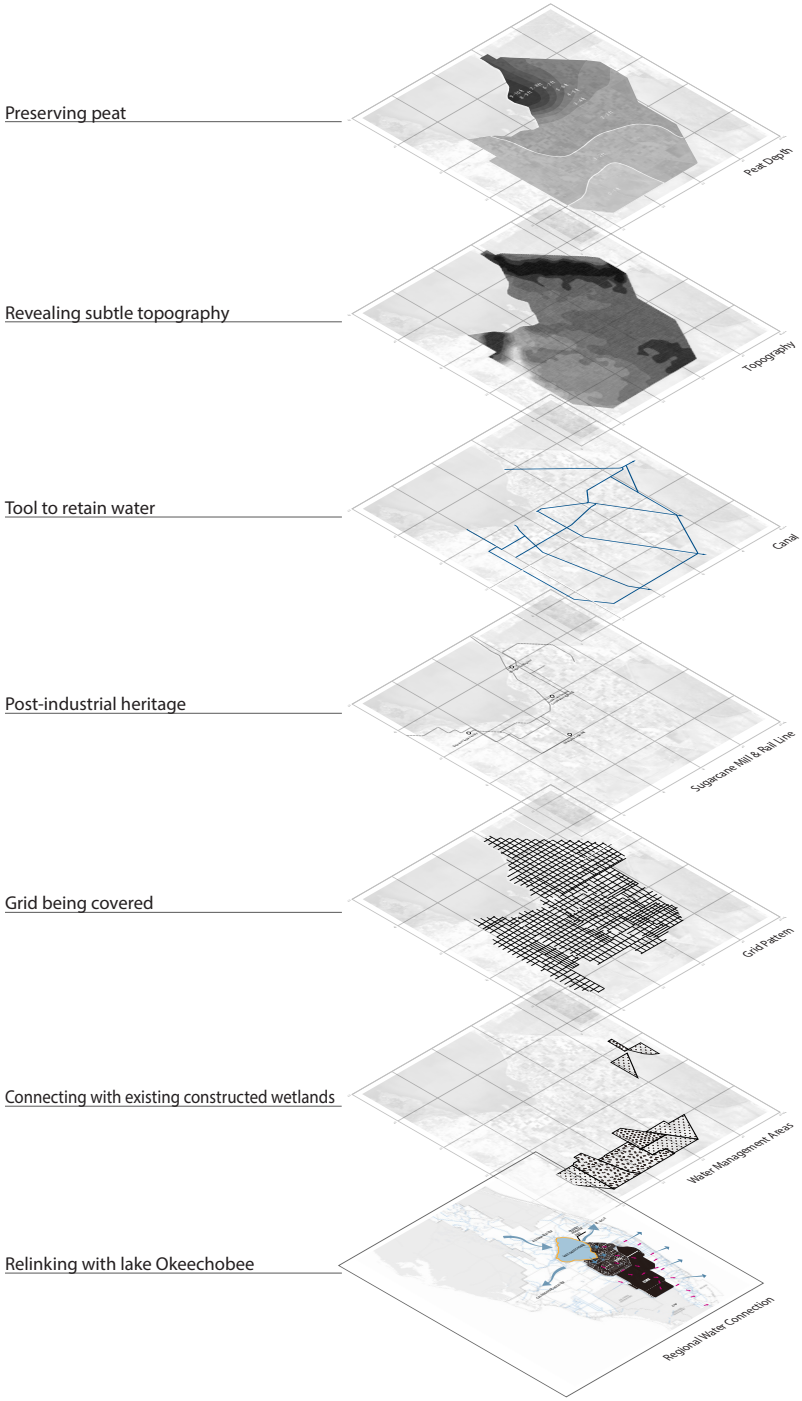


Figure 41. Reforming the Landscape through revealing the topography, drawn by author

FUTURE

Soil and water conditions are the essential basis for a sustainable development. The future transformation will adapt to the natural processes and assign those layers with new hierarchy.

- In the future transformation, the preservation of peat will get the highest priority.
- The subtle topography difference will be revealed and become the basis for the restoration of the ecosystem.
- The canals will be utilized as the tool to introduce the water from lake Okeechobee and retain it on site.
- During the transformation, the current sugarcane mills will gradually lose their original use. They will become the post-industrial heritage of the EAA with potential for being adapted for sightseeing and visitor center.
- The topography will be revealed on top of the grid pattern and form into a mosaic.
- The transformed area will be connected with existing constructed wetlands.
- In the end, the water will be restored as sheetflow running towards the Everglades.



3.5 Defining Pilot Area

After structuring the EAA transformation factors, the next step is to select the pilot area for implementing the design.

There are two main criteria in defining the pilot area in the EAA:

- The subsurface domains approach: where developments considering peat depth are the main driver.
- The mainstreaming approach: where changes benefiting larger ecosystem are the main driver.

In figure 43, the relatively low areas are mapped out as the lower the area, the sooner it is submerged by water the moment the pumping is stopped. Currently, the southwestern area of the EAA only has 30 to 60cm (1 to 2 feet) of peat left.

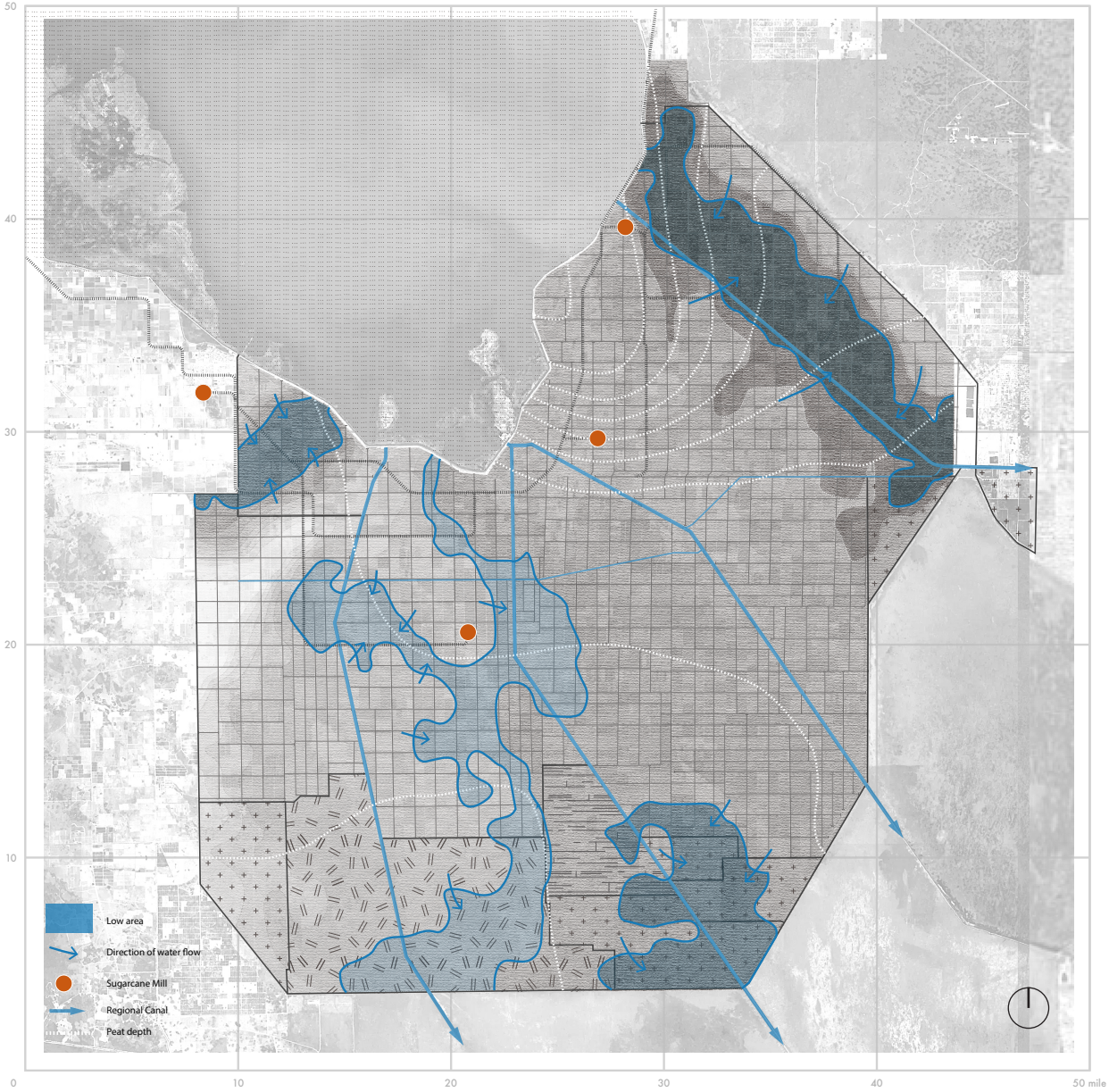


Figure 42. Gradient as crucial transformation factor, drawn by author

3.5 Defining Pilot Area

Least Peat + Crucial Water Corridor + Low Topography

The area between the Miami canal and the North New River Canal where the peat depth is lower than 60cm (2 feet) is selected.

The selected pilot area has the least peat left of the remaining agricultural plots, with the peat depth of between 30 to 60cm (1-2 feet), though it is not the lowest site among the low areas present in figure 43. What's more, this area was an important water corridor between lake Okeechobee and south Everglades in the past. It has the most direct connection with the remaining Everglades.

Considering that there is not much peat left, this area has a stronger urgency to be converted. At the same time, transforming this area will make a greater contribution to the restoration of South Florida ecosystem.

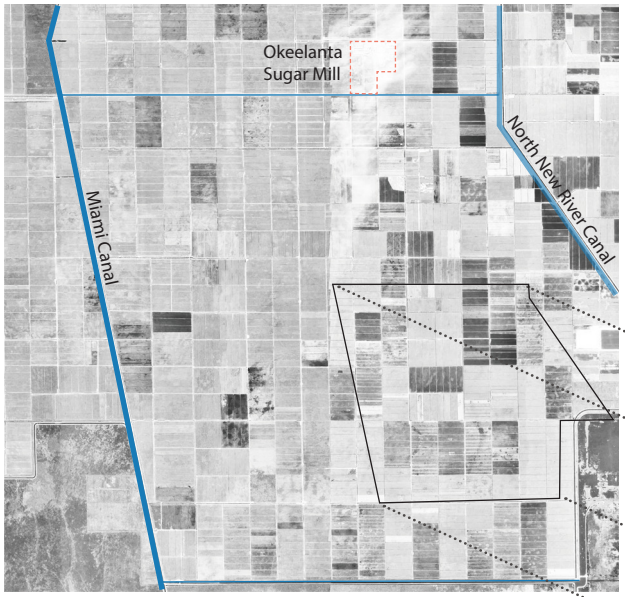


Figure 43. Satellite map of the selected pilot area, google map

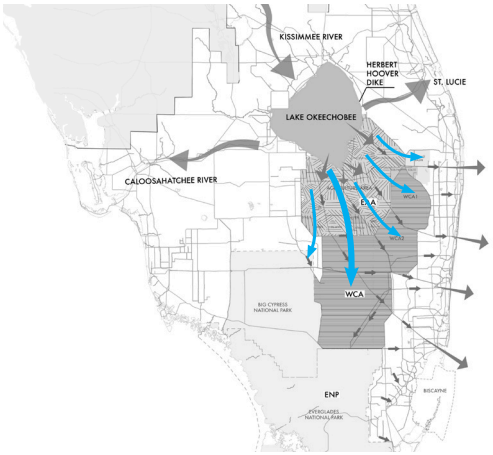
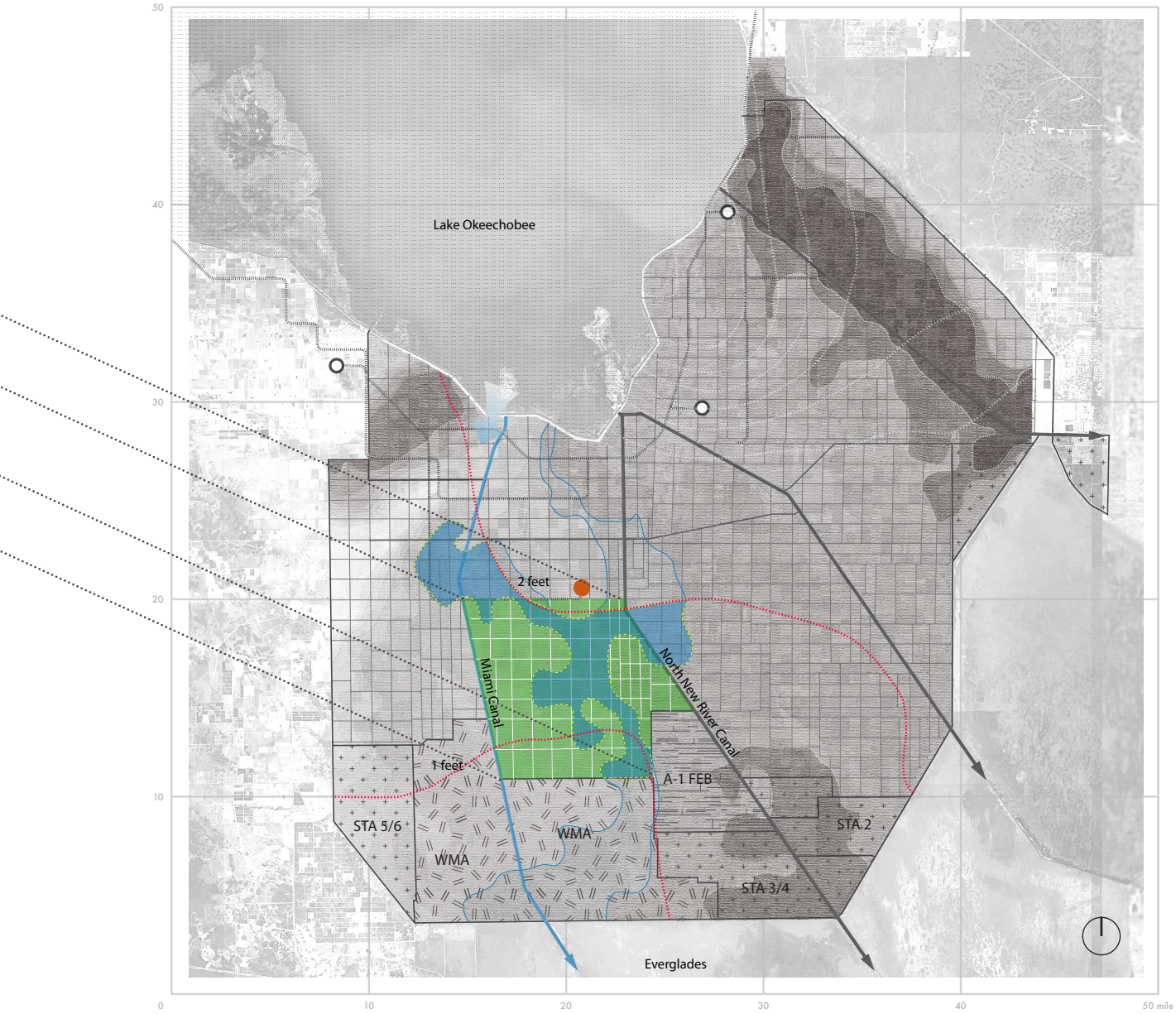


Figure 44. Regional water corridor, drawn by author



(The areas where the peat depth are less than 30.48 cm (1 feet) are already transferred into water management districts under the CERP.)

Figure 45. Defining the pilot area, drawn by author

3.6 State of Transition: Strategic Regional Plan

The strategic regional plan (figure 47) illustrates the vision for the EAA: its future connections with Lake Okeechobee, Water Conservation Area (WCA) and Everglades National Park (ENP), and it presents the situation at the moment that the crucial ecological corridor is restored.

The transformation of the EAA is a long-term and regional strategy. The transition takes place during the coming decades. The implementation and the successful contribution to the restoration of the southern Everglades (ENP) also requires a series of actions being taken in WCA, such as the removal of canals and levees. More room for the water flow is created under this plan, together with the improvement of the water quality.

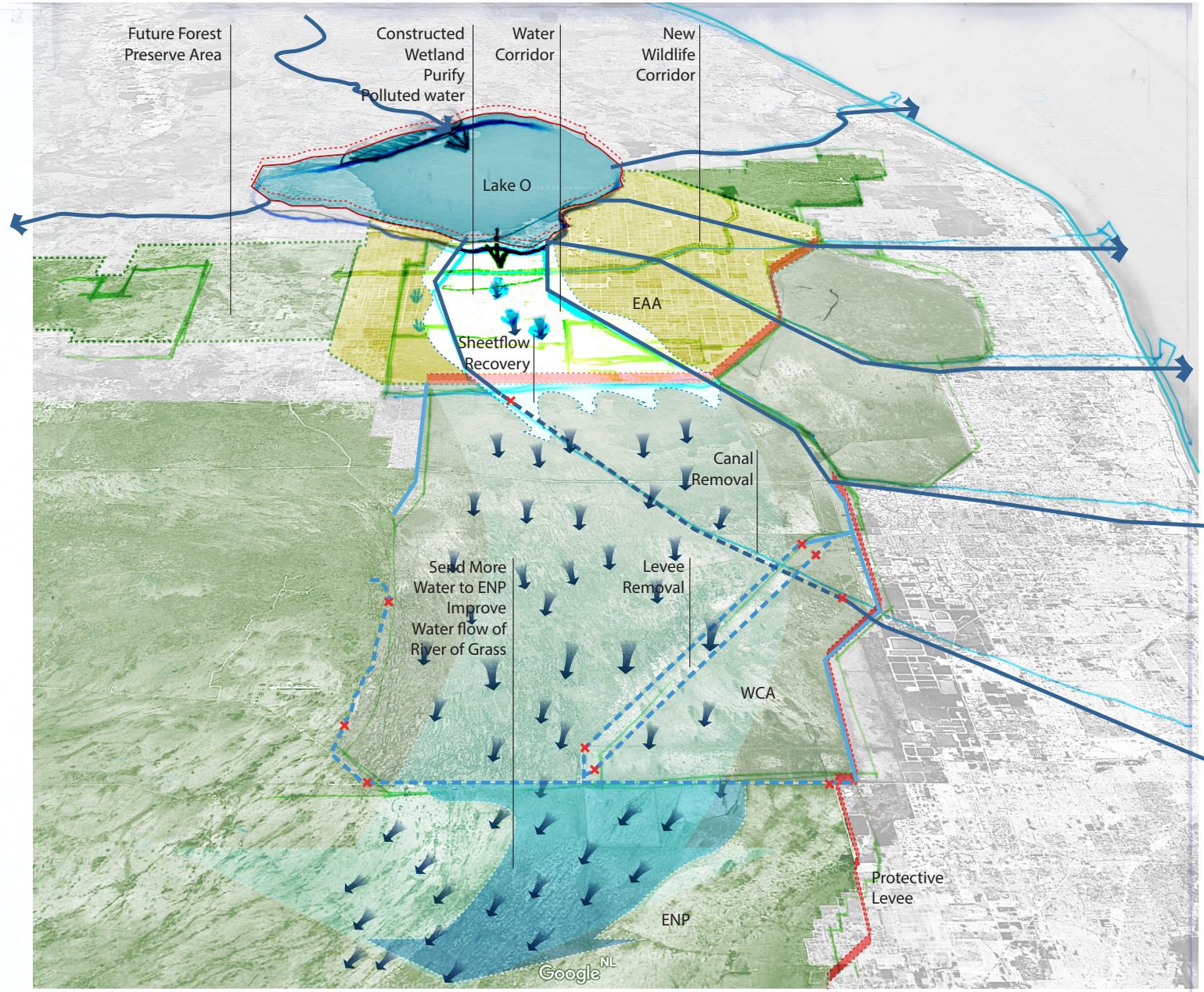


Figure 46. Strategic Regional Plan, drawn by author

“Let us green the earth, restore the earth, heal the earth. ”

-Ian McHarg

CHAPTER IV
DESIGN OF PILOT AREA

Design framework
Zoom-in Units
Change in Time
Change in Space

Overview & Aims Of Chapter

This chapter is about the design application.

Firstly, the design framework will be elaborated on. The design framework mainly consists of two parts. First of all, it is about how to restore the land based on the subtle landscape characteristics/topography. The second part is about infrastructure for recreation and purification.

Imagine the EAA as a grid system. The squares inside the grid represent the agricultural plots with the size of 800m by 800m. The grid itself could represent infrastructure systems like the canal and road parallel to the canal.

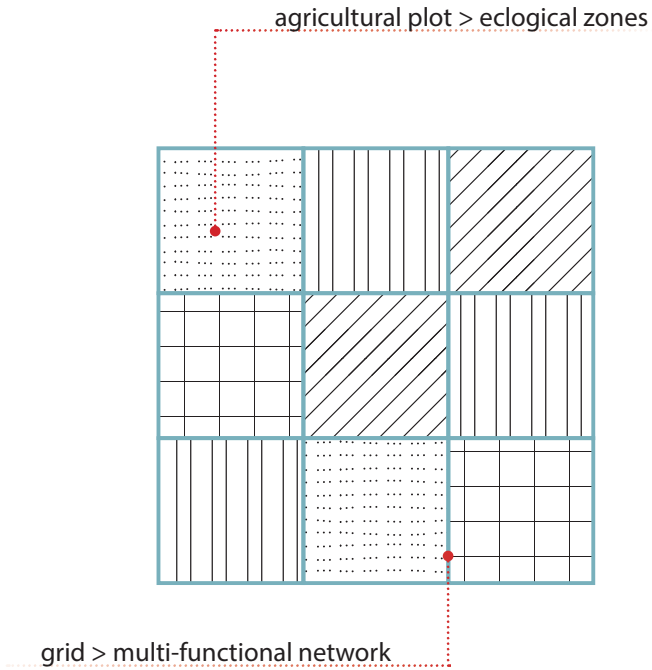
So the main questions are:

How to transform the agricultural plot with scattered topography into zones?

How to transform the grid system into a network for the new development?

Under this framework, there are a series of strategies and interventions across different scales. These layered strategies incorporate manipulating land use, repurposing existing infrastructures and building recreational facilities.

This framework and its strategies are tested and elaborated within three Zoom-In Units.


agricultural plot > eclogical zones
grid > multi-functional network

1. DESIGN FRAMEWORK

1.1 From Plot to Zones
1.2 From Edge to Network

The design framework is set up to achieve the vision and guide the spatial intervention. The agricultural plots with scattered topography are connected by using subtle landscape characters into five ecological zones: pond, marsh, meadow swamp forest, and rice field. The edge surrounding the agricultural plot which refers to the berm and canal is transformed into a multi-functional network composed of ecological network and recreational network.

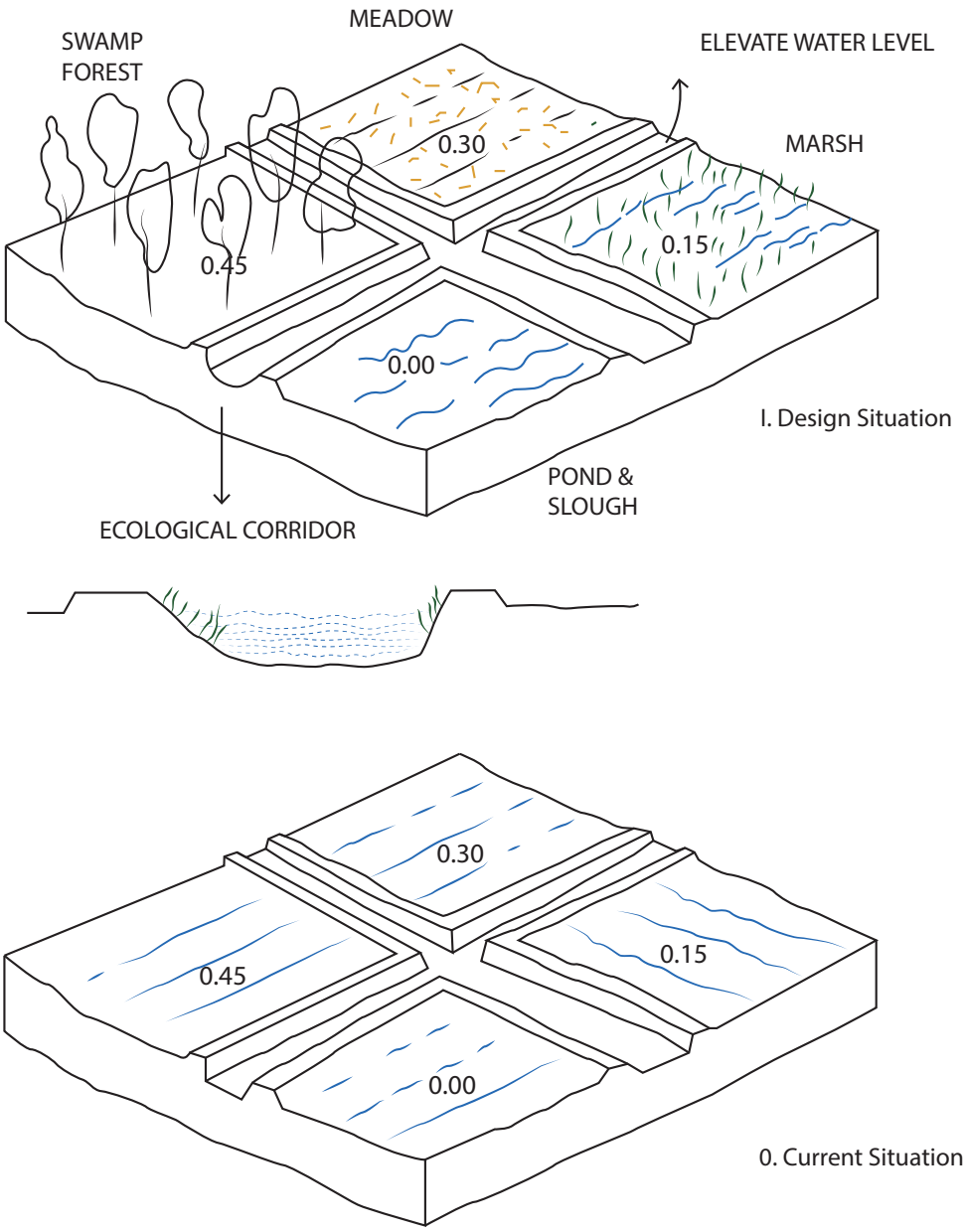
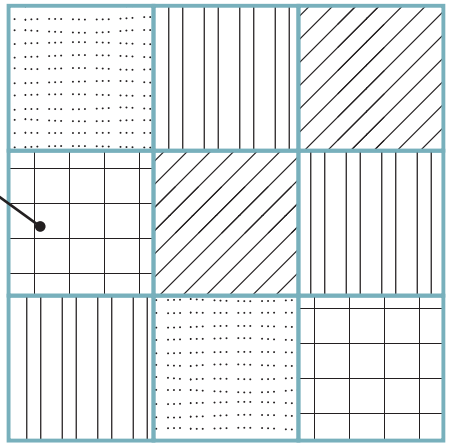


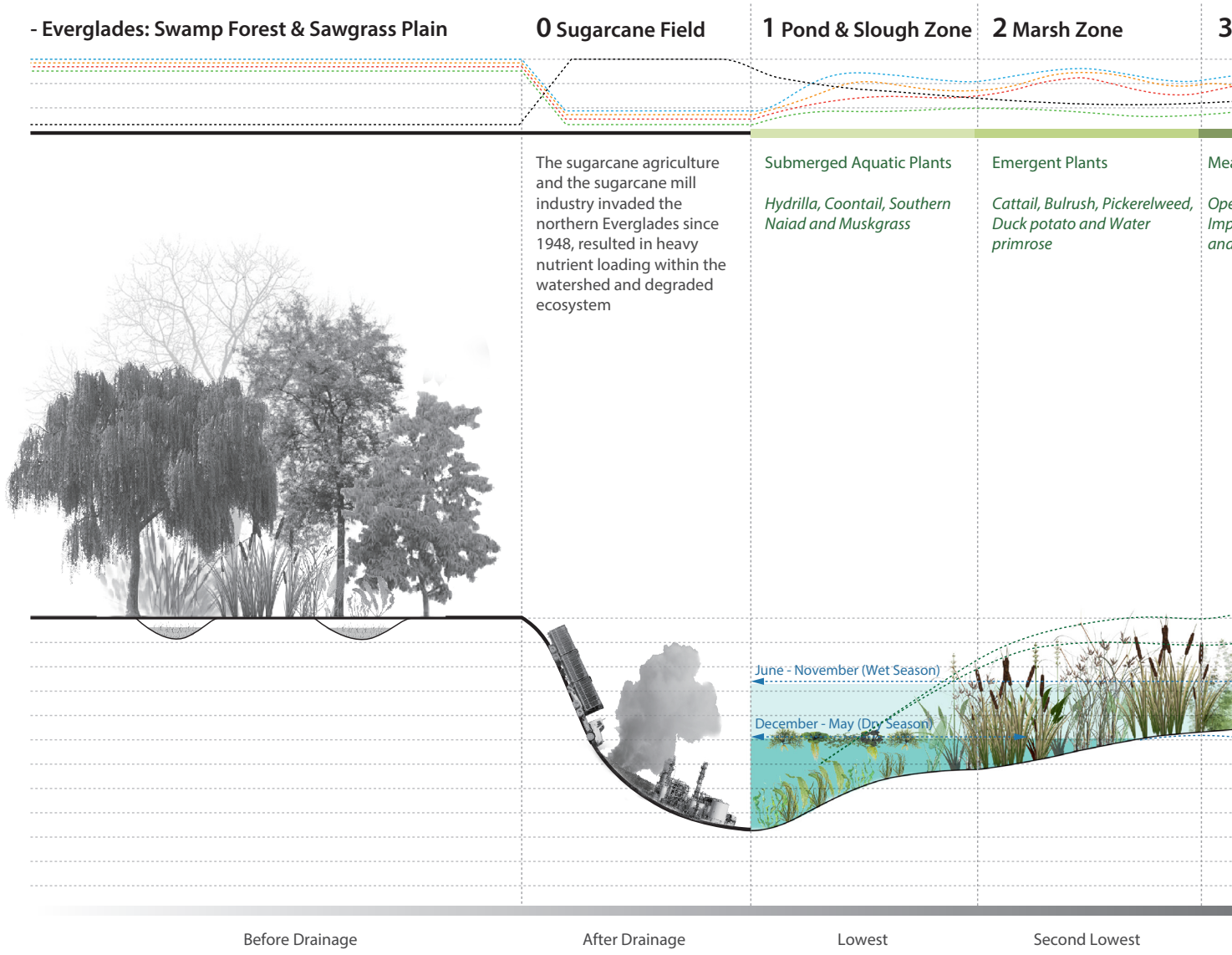
Figure 47. Design Framework, drawn by author

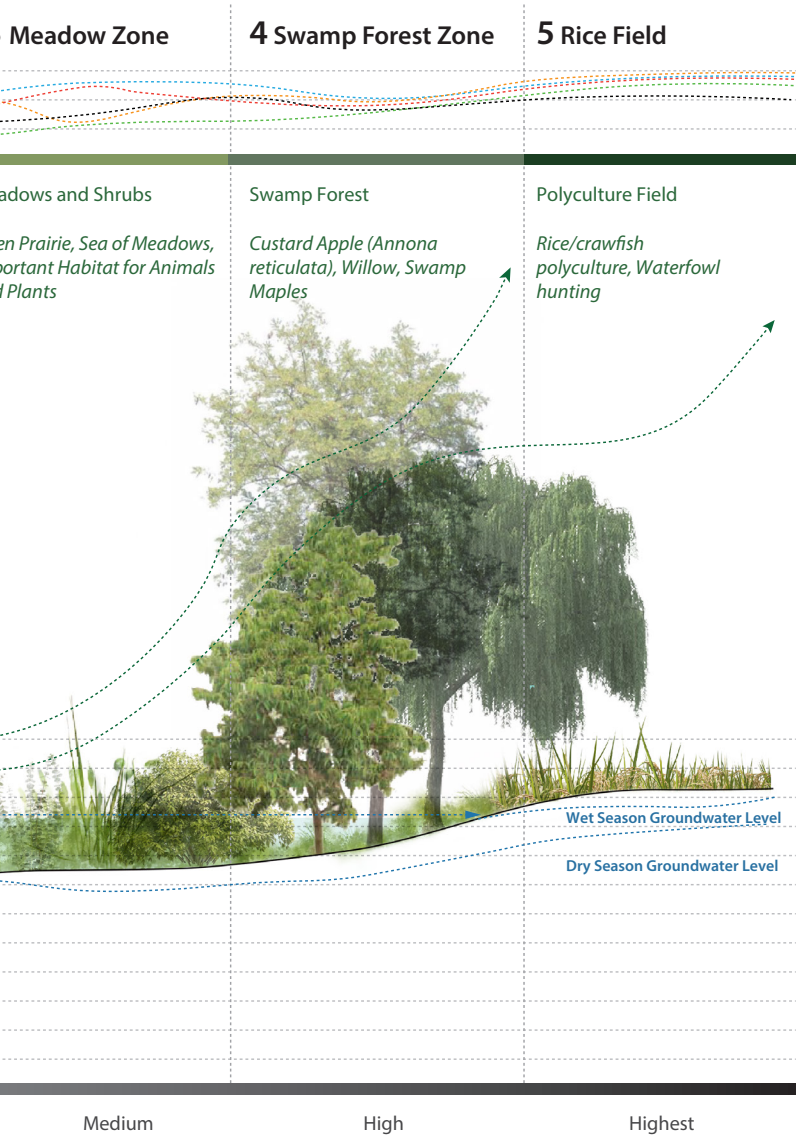
1. DESIGN FRAMEWORK

1.1 From Plot to Zones



1.1 DESIGN FRAMEWORK | FROM PLOT TO ZONES





Current Situation:

- The current land use is disconnected from the landscape character
- The human experience is disconnected from nature

how to transform the agricultural plot with scattered topography into a zone?

Designed Situation:

- Connecting by using subtle landscape characters
- Create conditions for the restoration of ecosystem
- Reconnect people with the site

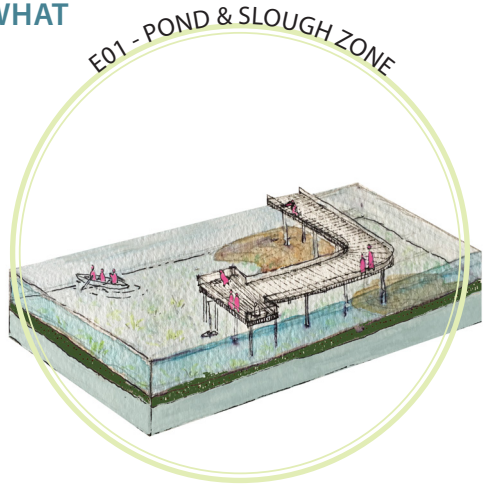
The agricultural plots with scattered topography are connected by using subtle landscape characters into five ecological zones: pond, marsh, meadow swamp forest, and rice field.

The lowest plots will be transformed into pond & slough zone. The second lowest plots will be transformed into marsh zone. Following is the medium high plots that will be transformed into a meadow zone, and the high plots will be transformed into a swamp forest zone. Meanwhile, the highest plots will be adapted into rice fields situated in the wet area that is created when pumping stops.

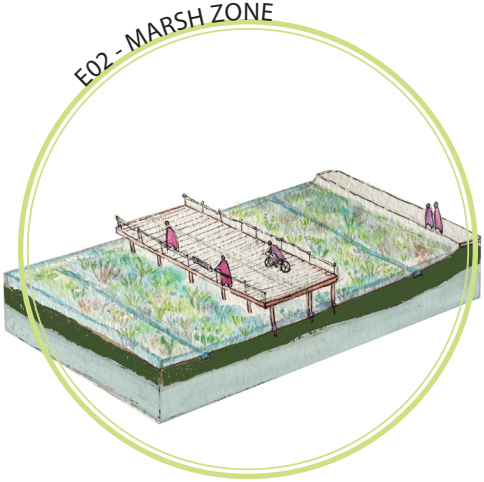
1.1 DESIGN FRAMEWORK | FROM PLOT TO ZONES

Toolkit for the transformation from plot to zones

WHAT



E01: Pond & Slough Zone: Planned and Designed For Purification, Peat Growth, Recreational Use Related To Water Bodies.



E02: Marsh Zone: Planned and Designed for Purification, Peat Growth, Recreational Use.

HOW

Stop pumping, elevate water level, create new culverts to release water, flood the current sugarcane field, introduce certain vegetation spe

- Elevation: Lowest & Wettest
- Water: Most Water
- Vegetation: Submerged Aquatic Plants For Purification

- Elevation: 2nd Lowest & Moist
- Water: Water Level High to Low
- Vegetation: Emergent Plants for Purification

BENEFITS

- Bring New Sediment For Peat Growth
- Form Tree Island
- Water Purification
- Water storage

- Peat Growth
- Water Purification
- Water storage

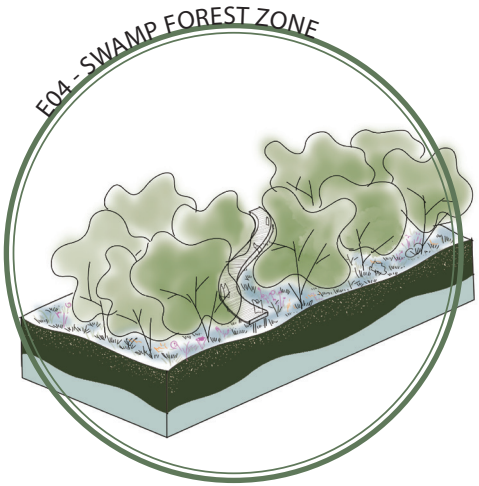
USE

- Fishing
- Canoing

- Fishing



E03: Meadow Zone: Planned and Designed for Purification, Peat Growth, Recreational Use.



E04: Swamp Forest Zone: Planned and Designed for Peat Growth, Conservation, Economic, Recreational Use.

cies, introduce new programs, build up recreational space, envolve and interact and interpenetrate with the surrounding area.

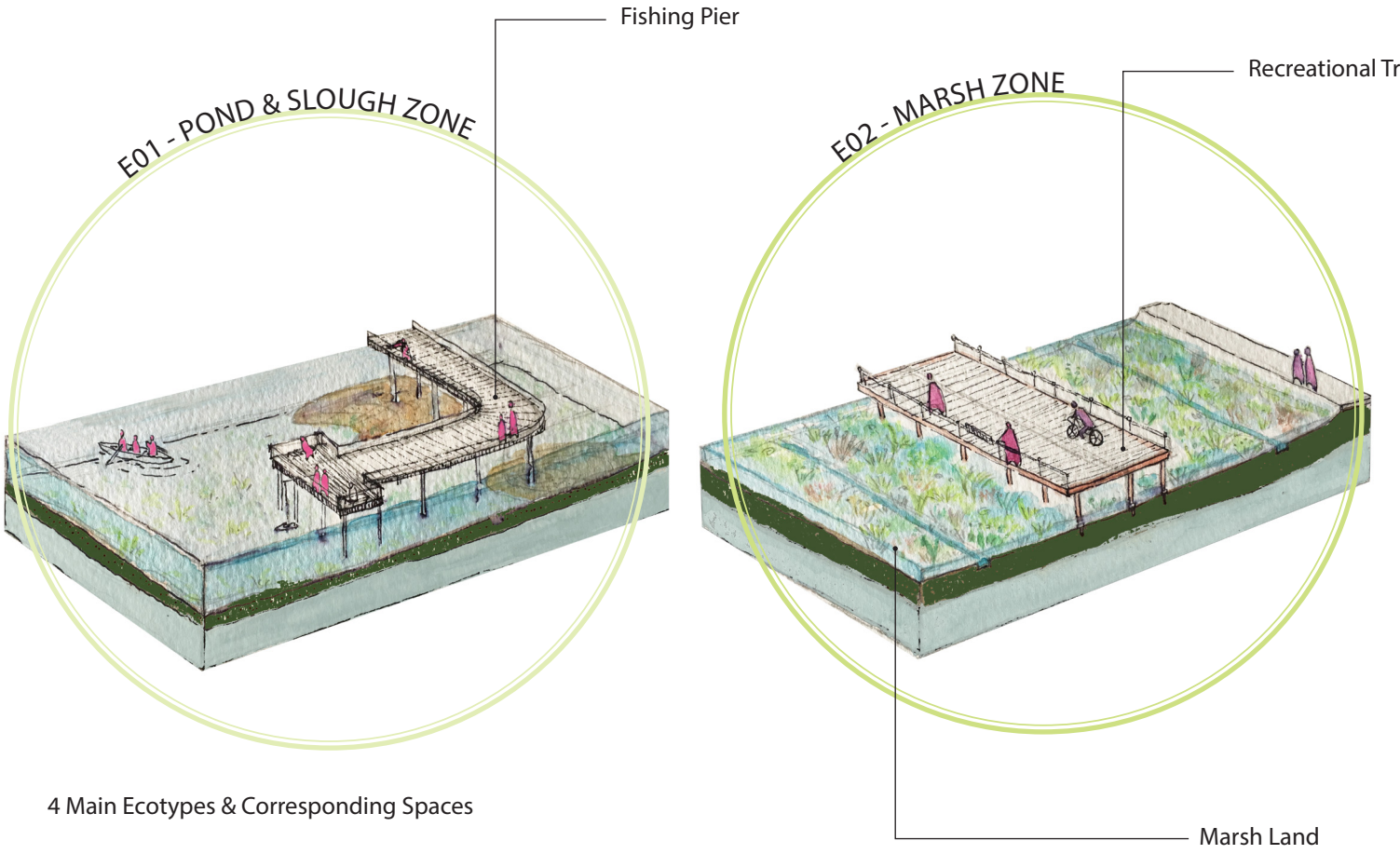
• Elevation: 2nd High • Water: Relatively Dry • Vegetation: Meadows	• Elevation: Highest & Dry • Water: Season Buffer • Vegetation: Swamp Forest
• Peat Growth • Water storage • Habitat for birds and mammals	• Soil Stabilization • Peat Growth • Water storage • Carbon capture & storage
• Camping • Bird Watching • Organised Sports	• Hiking • Agroforestry

1.1 DESIGN FRAMEWORK | FROM PLOT TO ZONES

Informed by elevation, slope, past vegetation type and watershed region, the pilot area is categorized as four green zones with varying land use types. Each zone has a unique strategy intervention with development based on land context.

E01: Pond & Slough Zone: *Planned and Designed For Purification, Peat Growth, Recreational Use Related To Water Bodies.*

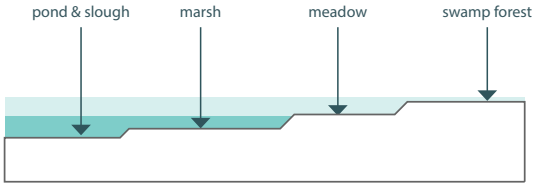
E02: Marsh Zone: *Planned and Designed for Purification, Peat Growth, Recreational Use.*



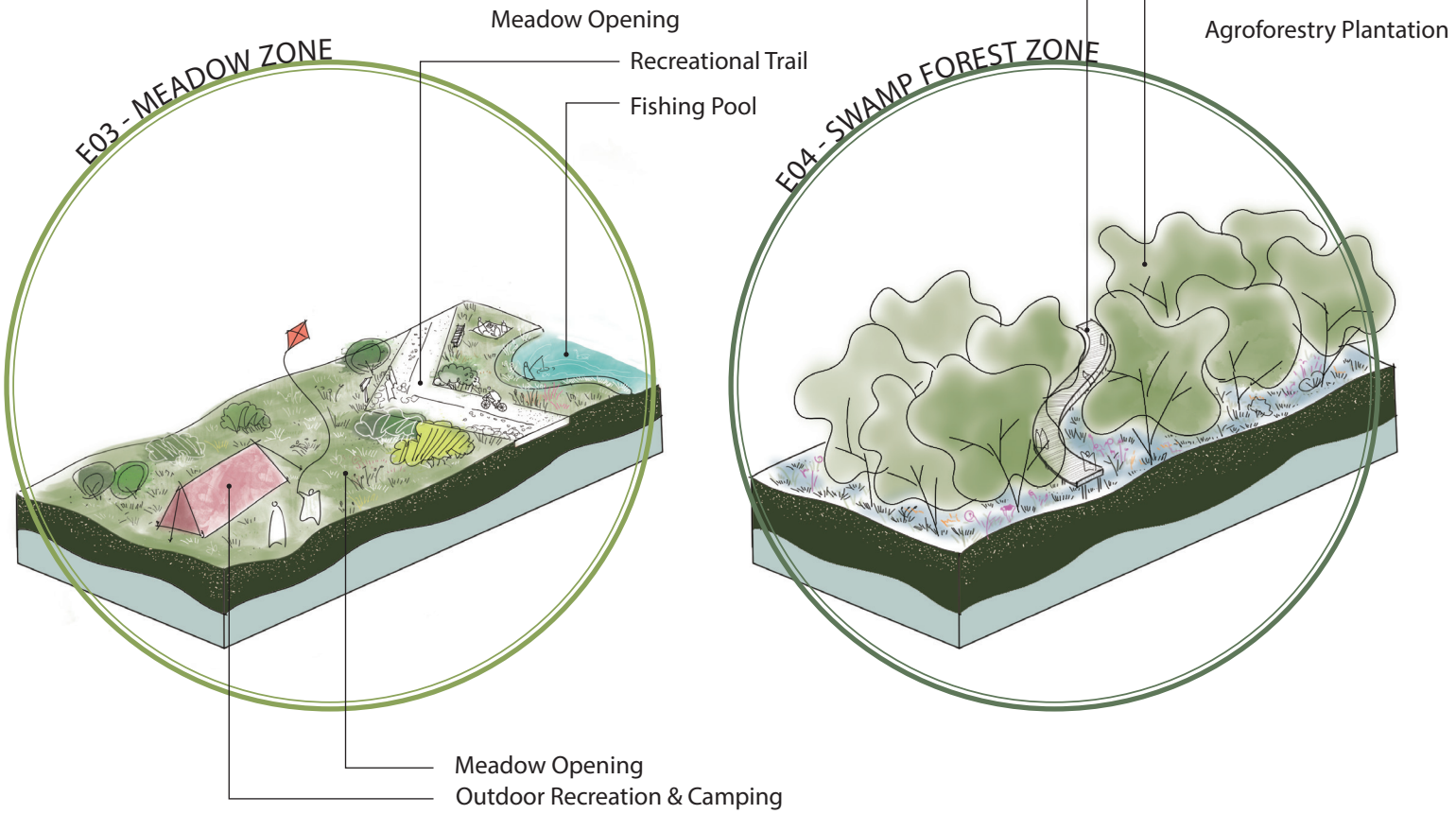
4 Main Ecotypes & Corresponding Spaces

E03: Meadow Zone: *Planned and Designed for Purification, Peat Growth, Recreational Use.*

E04: Swamp Forest Zone: *Planned and Designed for Peat Growth, Conservation, Economic, Recreational Use.*



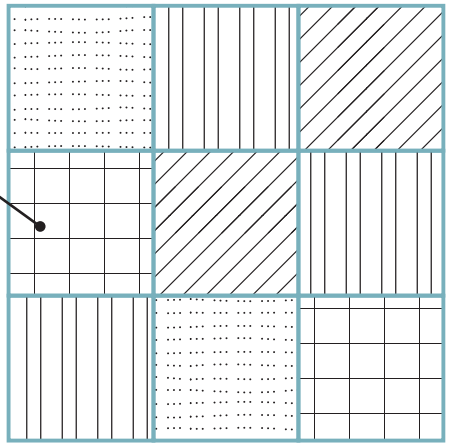
ail



1. DESIGN FRAMEWORK

1.1 From Plot to Zones

- Application



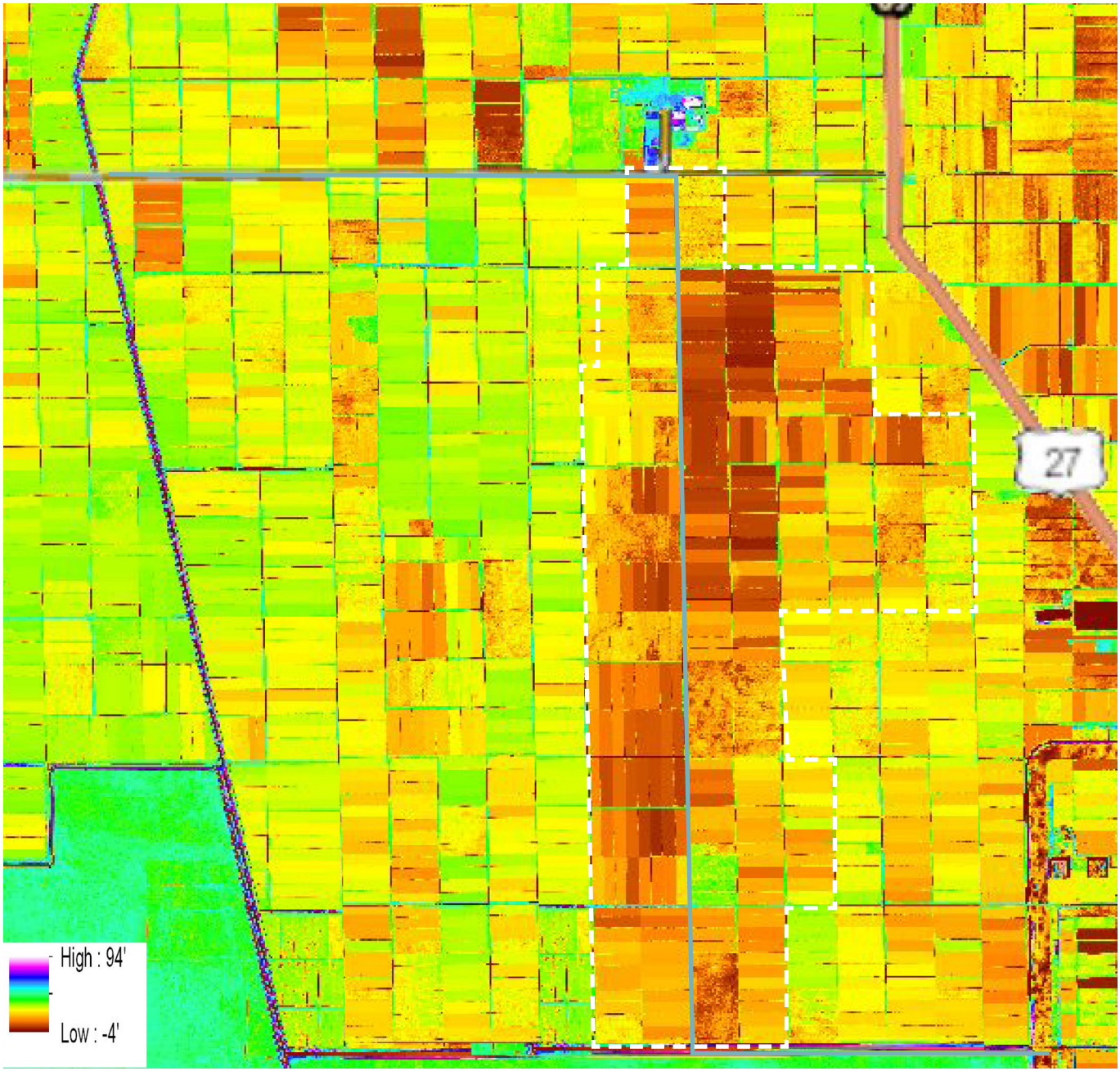
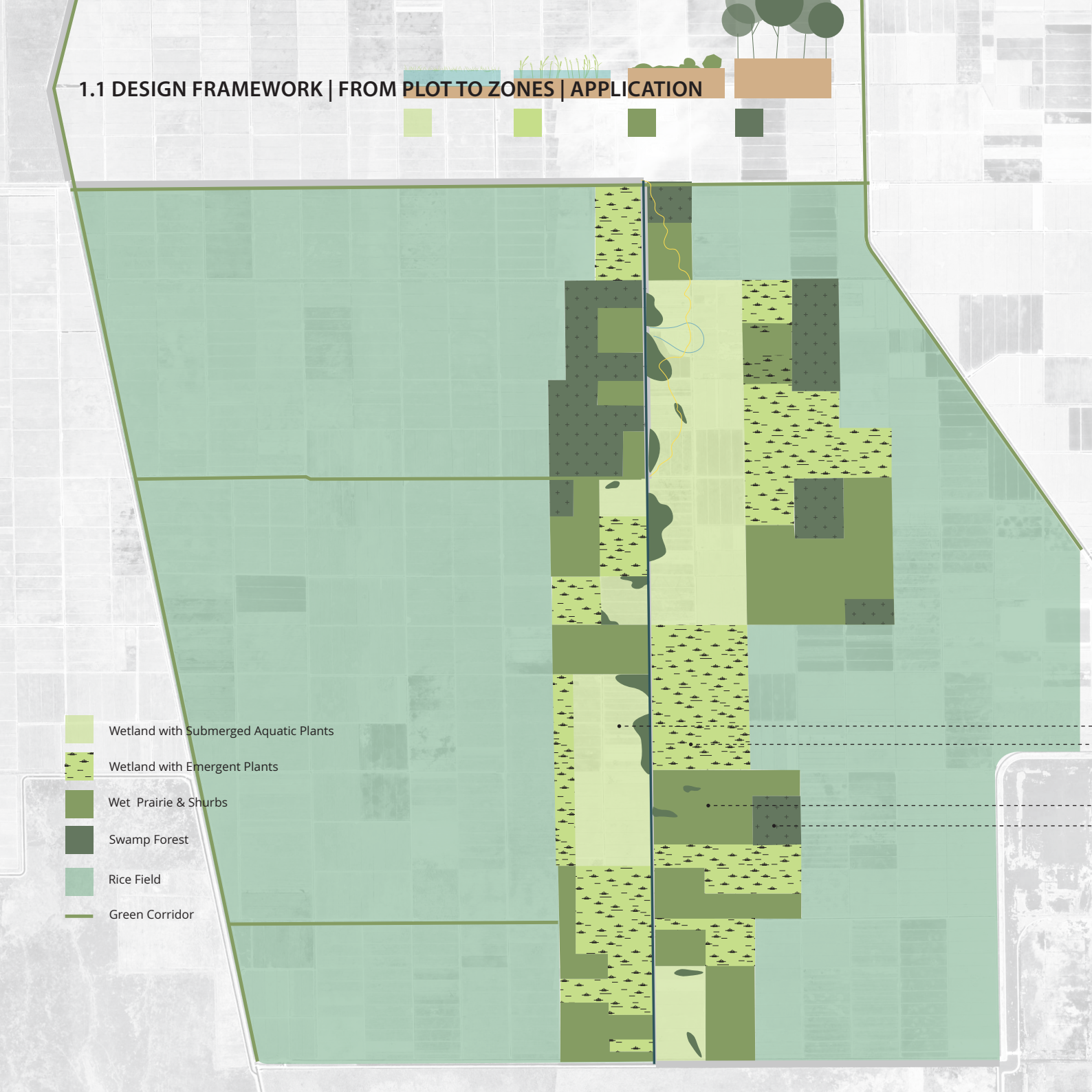


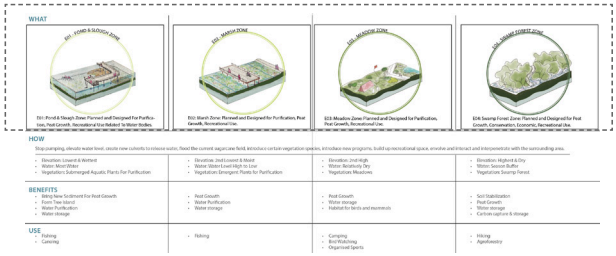
Figure 48. Elevation Map of Pilot Area, EAA

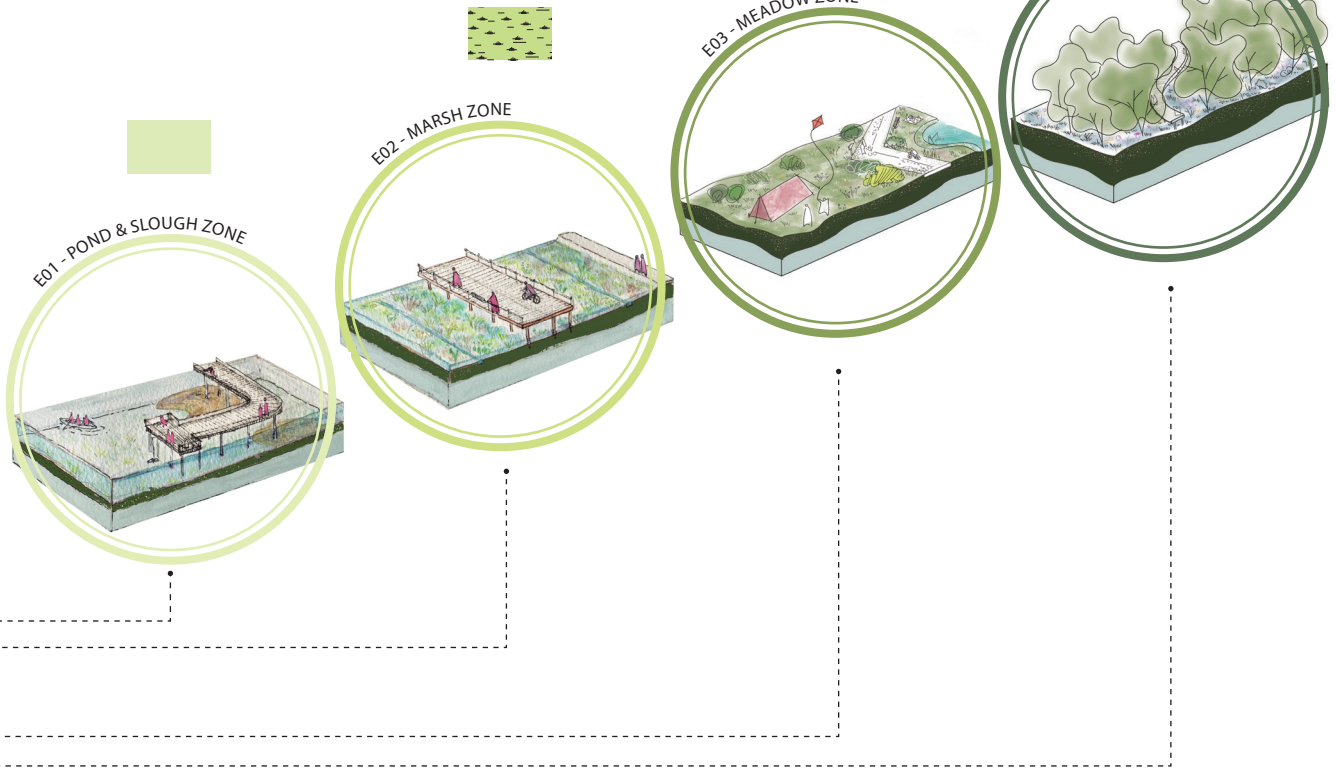
The intervention is based on the topography of the pilot area. The elevation data is derived from 2007-2009 FDEM (Florida Department of Emergency Management) HHDEAA (Herbert Hoover Dike Everglades Agricultural Area) LiDAR dataset (OCM Partners, 2019).

1.1 DESIGN FRAMEWORK | FROM PLOT TO ZONES | APPLICATION



WHAT

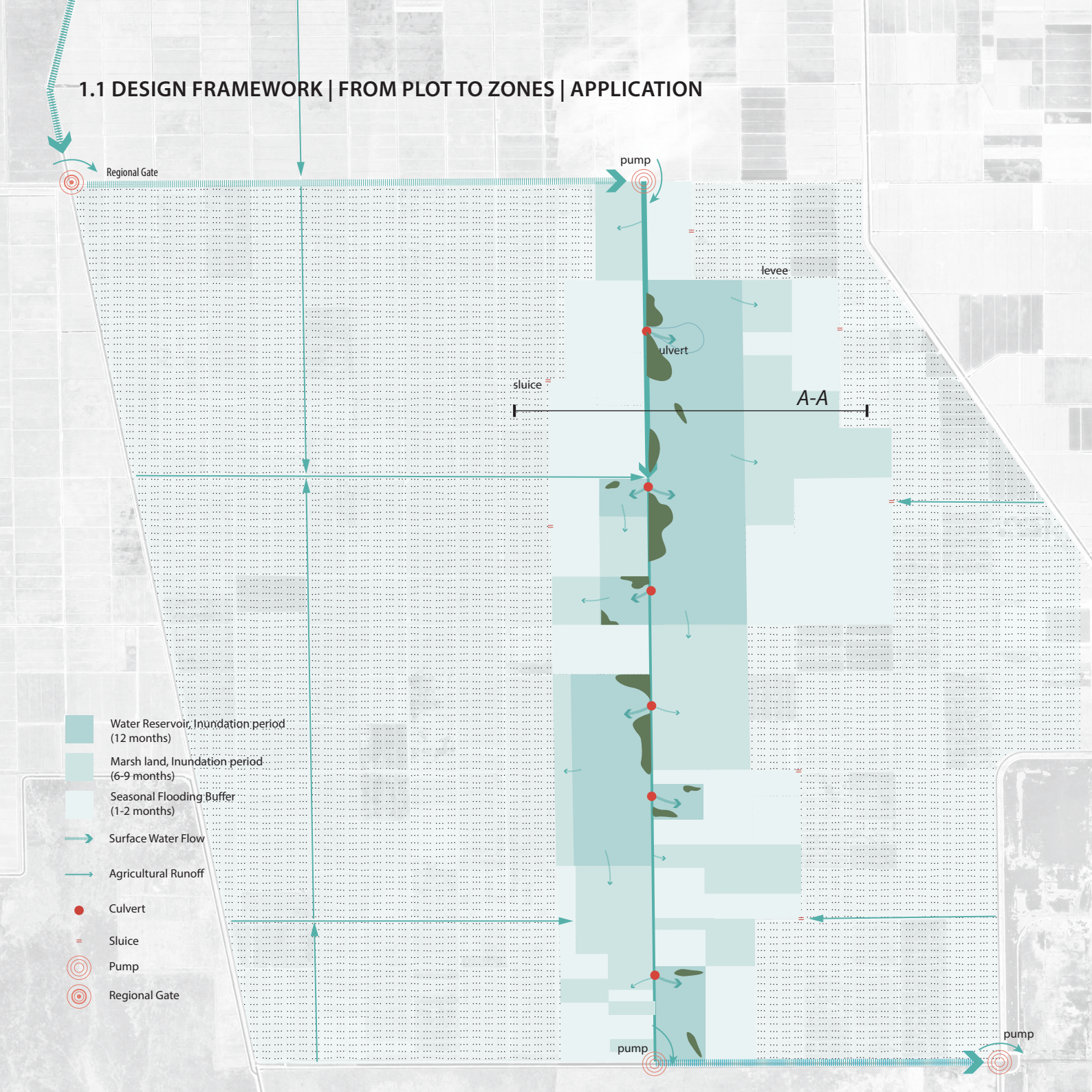




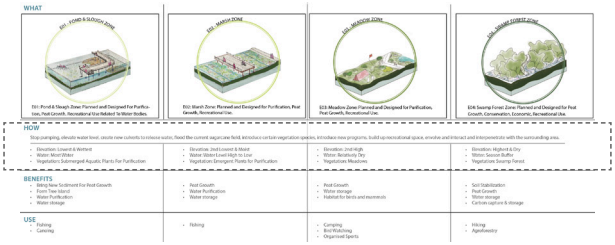
Ecological Consevation & Connectivity

Five zones are defined based on the topography. The main canals are designed into the green corridors, together with five zones to deliver the ecological services and values.

1.1 DESIGN FRAMEWORK | FROM PLOT TO ZONES | APPLICATION



HOW



Water Management Strategy

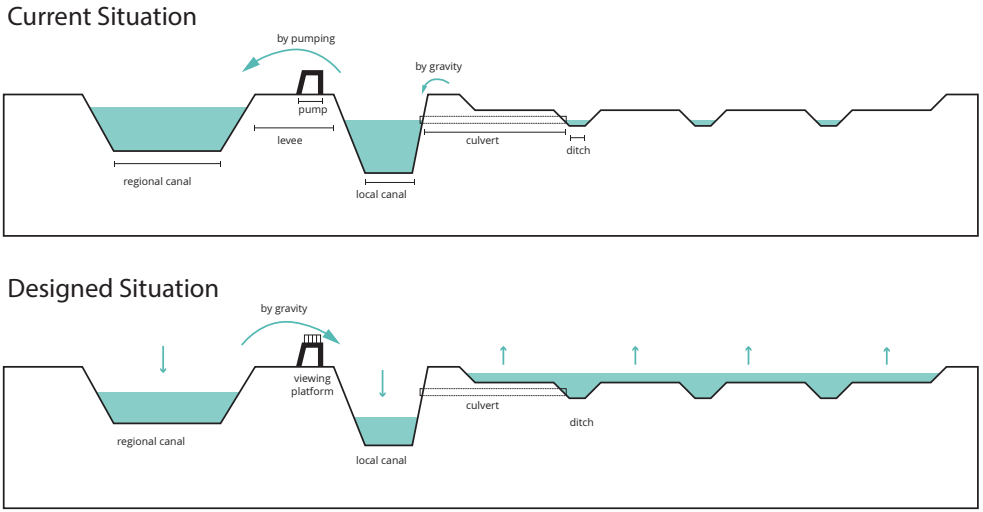
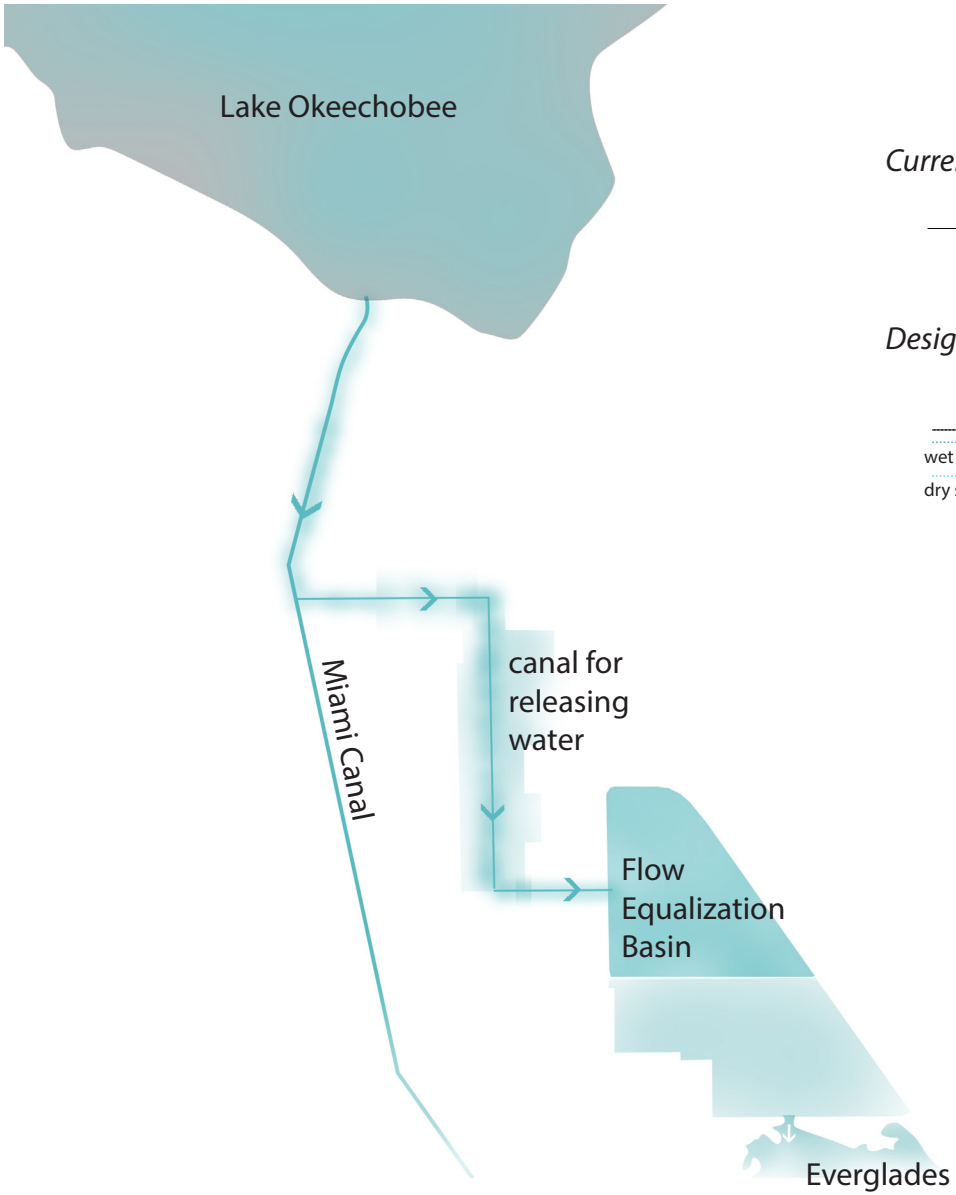


Figure 49. Elevation of water level, drawn by author

Instead of draining water out of the site, water is introduced from lake Okeechobee through the regional canal, Miami Canal, into the restoration area, retained and purified on site.

Pumping water out is stopped, and the water level is raised up and linked with subtle topography to create differnt eco-zones.



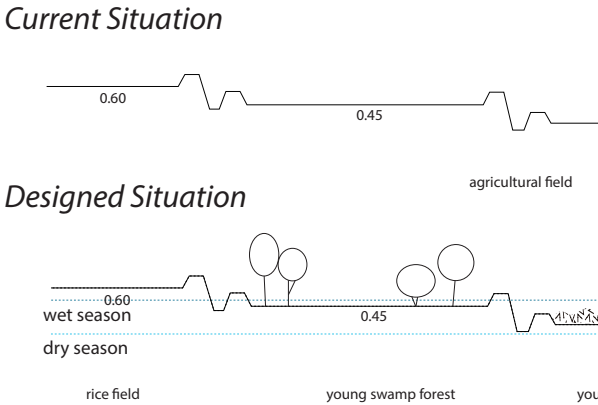


Figure 50. Regional Water Flow

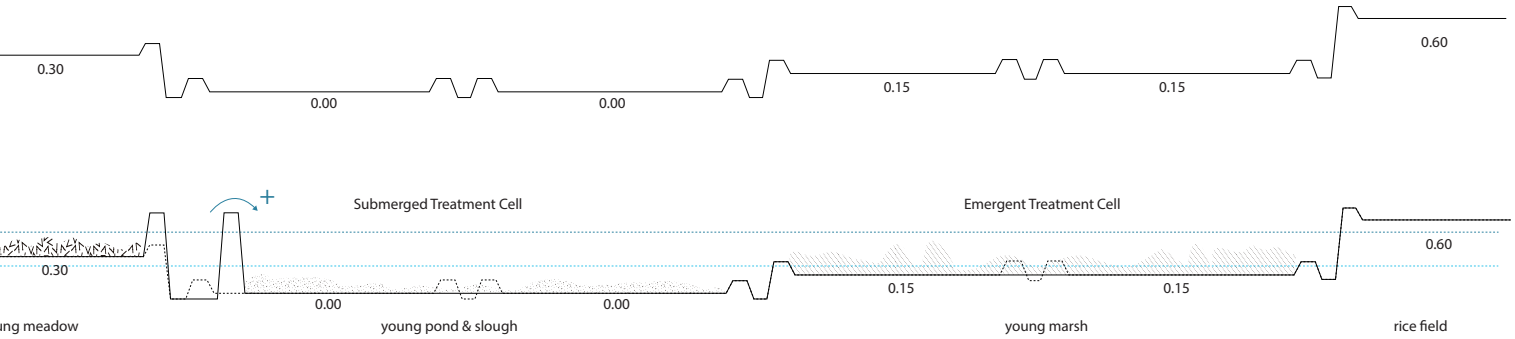
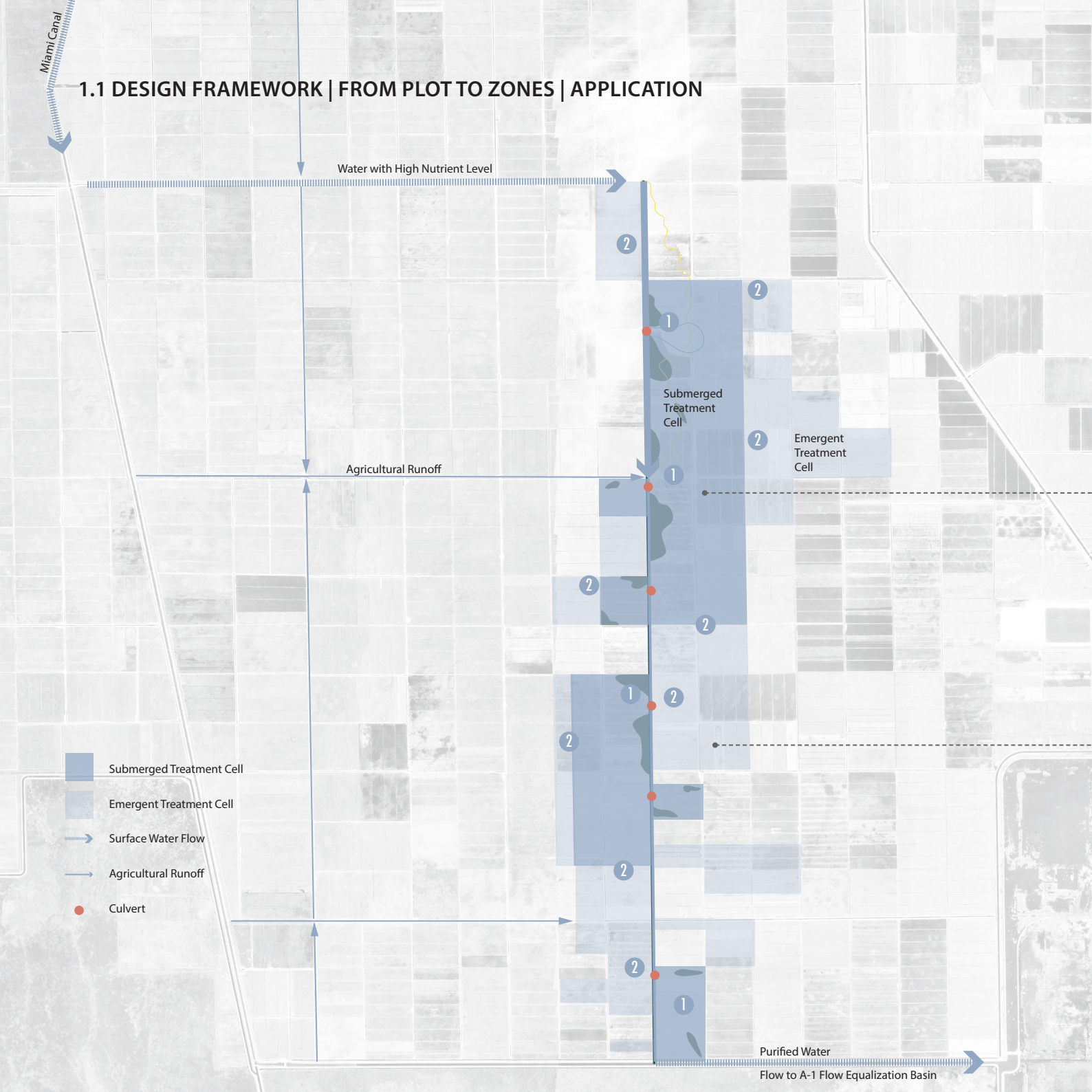


Figure 51. Section A-A

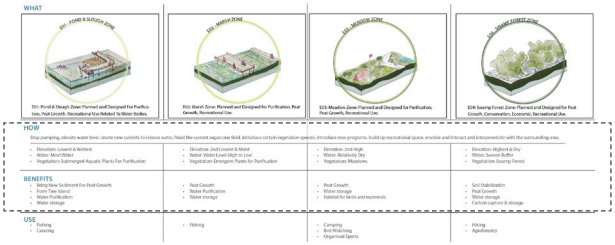
Water Management Strategy

Water from lake Okeechobee flows into Miami Canal and being released into the restoration site, where it is retained and purified. At the end of the process, the water is pumped into the flow equalisation basin. After this, the water will move to the Everglades in the form of sheetflow. The canal will be expanded as shown in the figure above to introduce the water from Miami Canal. Six culverts will be constructed along the canal to release the water into the site. Between the restoration area and the rice fields there are sluices to manage the differing water levels.

1.1 DESIGN FRAMEWORK | FROM PLOT TO ZONES | APPLICATION



HOW, BENEFIT



Water Purifcation

The generated Pond & Slough Zone and Marsh Zone will function as filtration marsh: the lowest pond & slough zone with the deepest water is the submerged treatment cell and the second lowest marsh zone is the emergent treatment cell. They will together purify the water, while at the same time providing a new habitat for native species.

Submerged Treatment Cell



Emergent Treatment Cell





Hydrilla



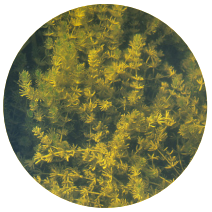
Southern Naiad

Phytoremediation:

Purification vegetation are planted to remove contamination from soils and surface water



Coontail



Muskgrass



Cattail



Bulrush



Pickerelweed



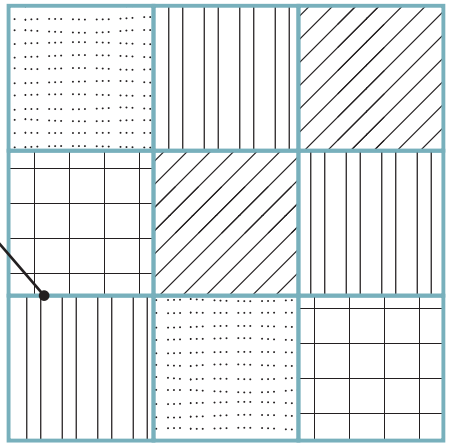
Duck potato



Water primrose

1. DESIGN FRAMEWORK

1.2 From Edge to Network



1.2 DESIGN FRAMEWORK | FROM EDGE TO NETWORK

The current agricultural plots in EAA are bordered by water and transportation infrastructures like canals and roads. Those infrastructures will be reshaped into various morphology according to different needs.

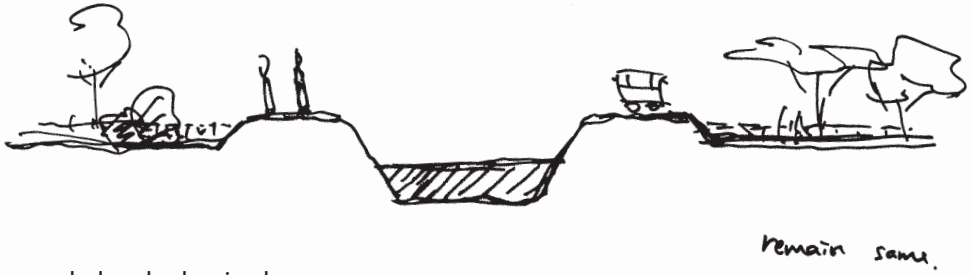
-Edge being covered by vegetation



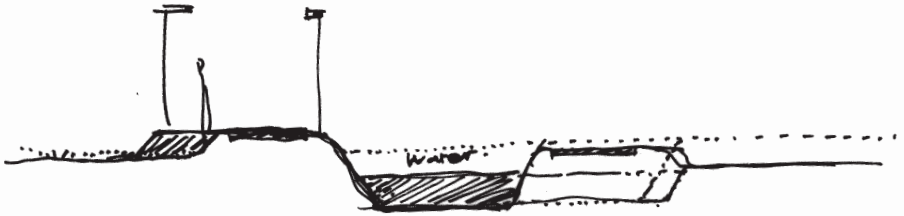
- Edge under water integrating into the zone



- Edge as sightseeing path



- Edge being expanded and urbanised



How to transform the grid system into a network for the new development?

Connecting Edges to Build up Network

The past edges of agricultural plot are segregated and inaccessible to the public.

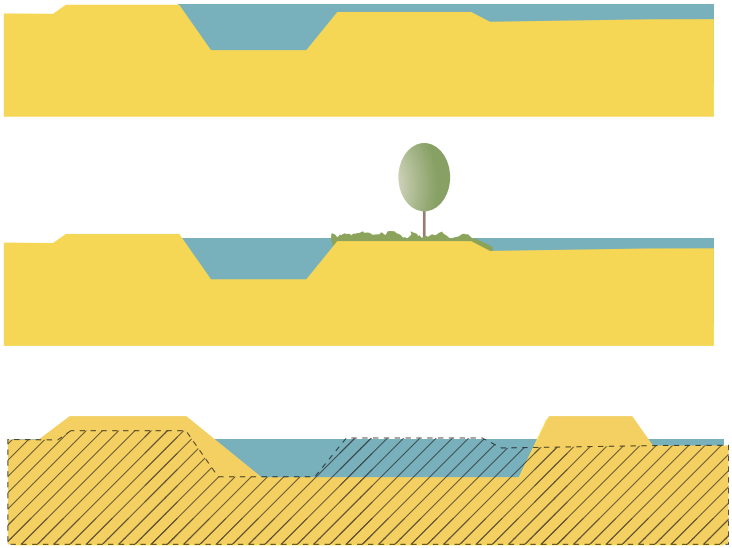
During the transformation, the form of edge will be changed differently to accommodate the natural processes and variou needs.

Edges will be connected to build up the network of recreational route, parkway and rail experiential route.

Current Situation

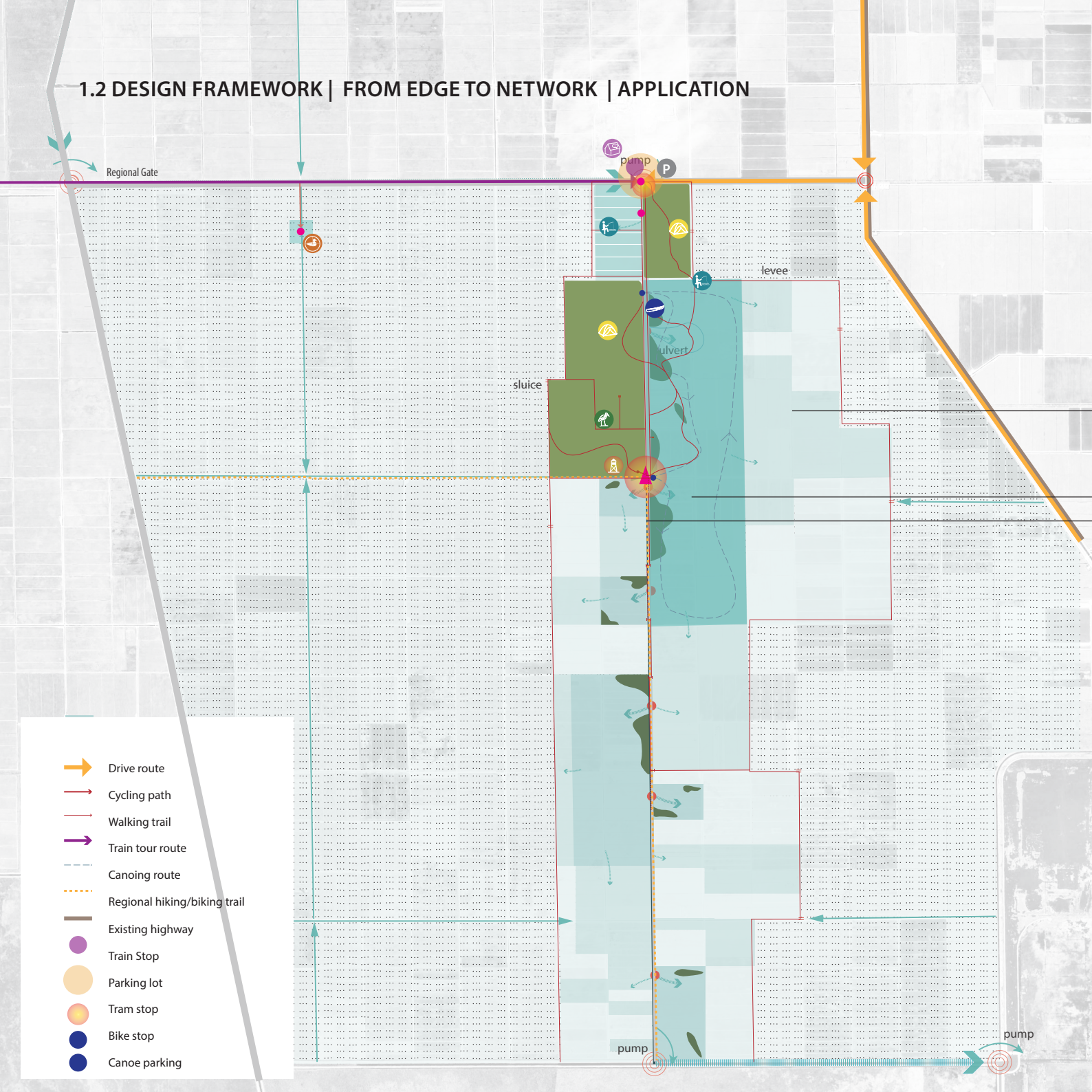


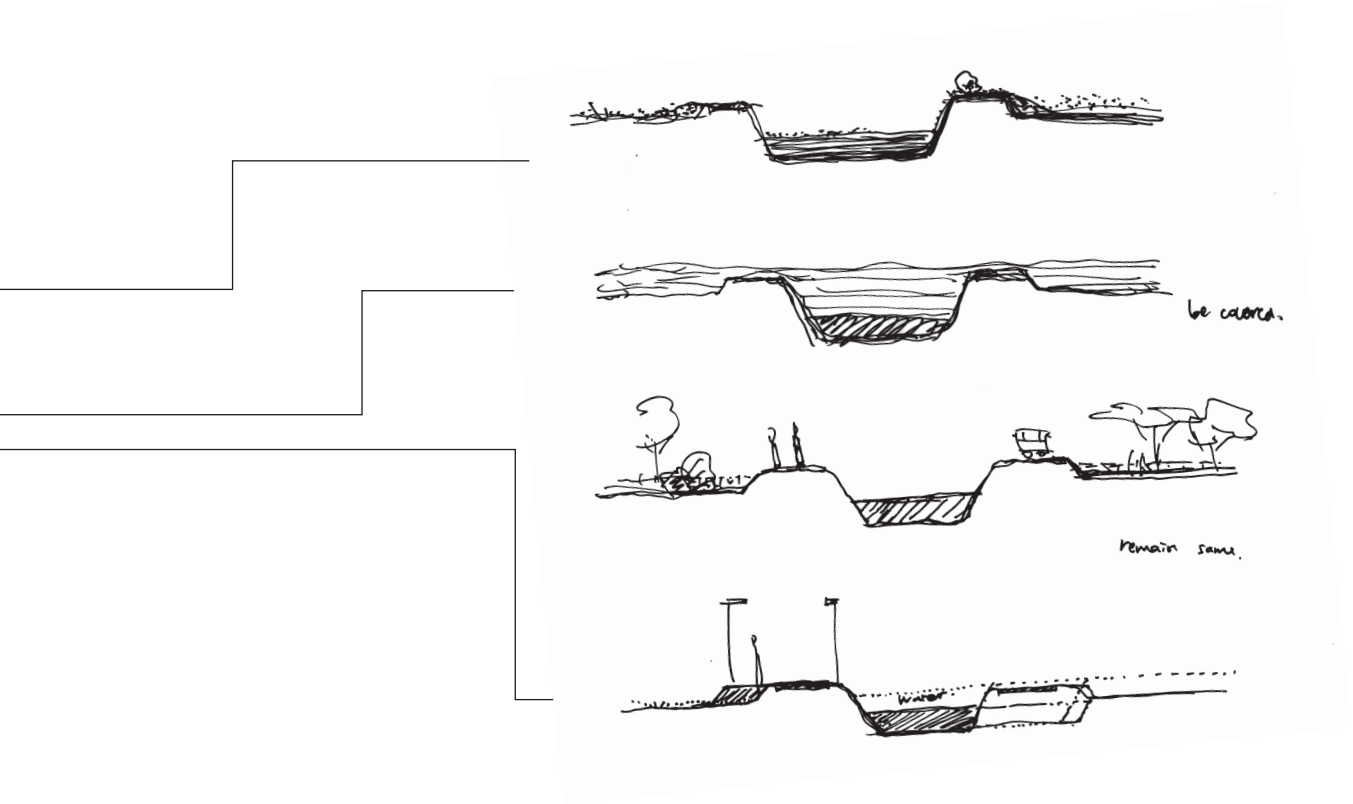
New Situation



1:500

1.2 DESIGN FRAMEWORK | FROM EDGE TO NETWORK | APPLICATION





- Network of route: rail line/parkway/ cycling route/ hiking route
- Network of ecological corridors: purification corridor

Accessibility Strategy

The plots with the similar topography will be connected into a zone. The original edges of the agriculture plots will have a different transformation. Some of them will be allowed to collapse and return to a more natural state. Others will be completely flooded, while some will be upgraded to become a recreational trail. Finally, some of them will be removed completely. Which of these is applied is dependant on the topography of the zone.

1.2 DESIGN FRAMEWORK | FROM EDGE TO NETWORK

The design of the recreational network is inspired by the gradient from the Everglades to the agriculture area to the city in South Florida. From the Everglades, the form is one of freedom, expressing undefined areas, which spread uncontained. When approaching the EAA, the unused green space becomes more defined, digressing into fields of agriculture. Once over the line between the EAA and the city, the grid is divided into smaller, more miniscule streets. The spaces of vegetation and open use become scattered and sparse. The feelings and experiences of natural space are for people to seek experience.

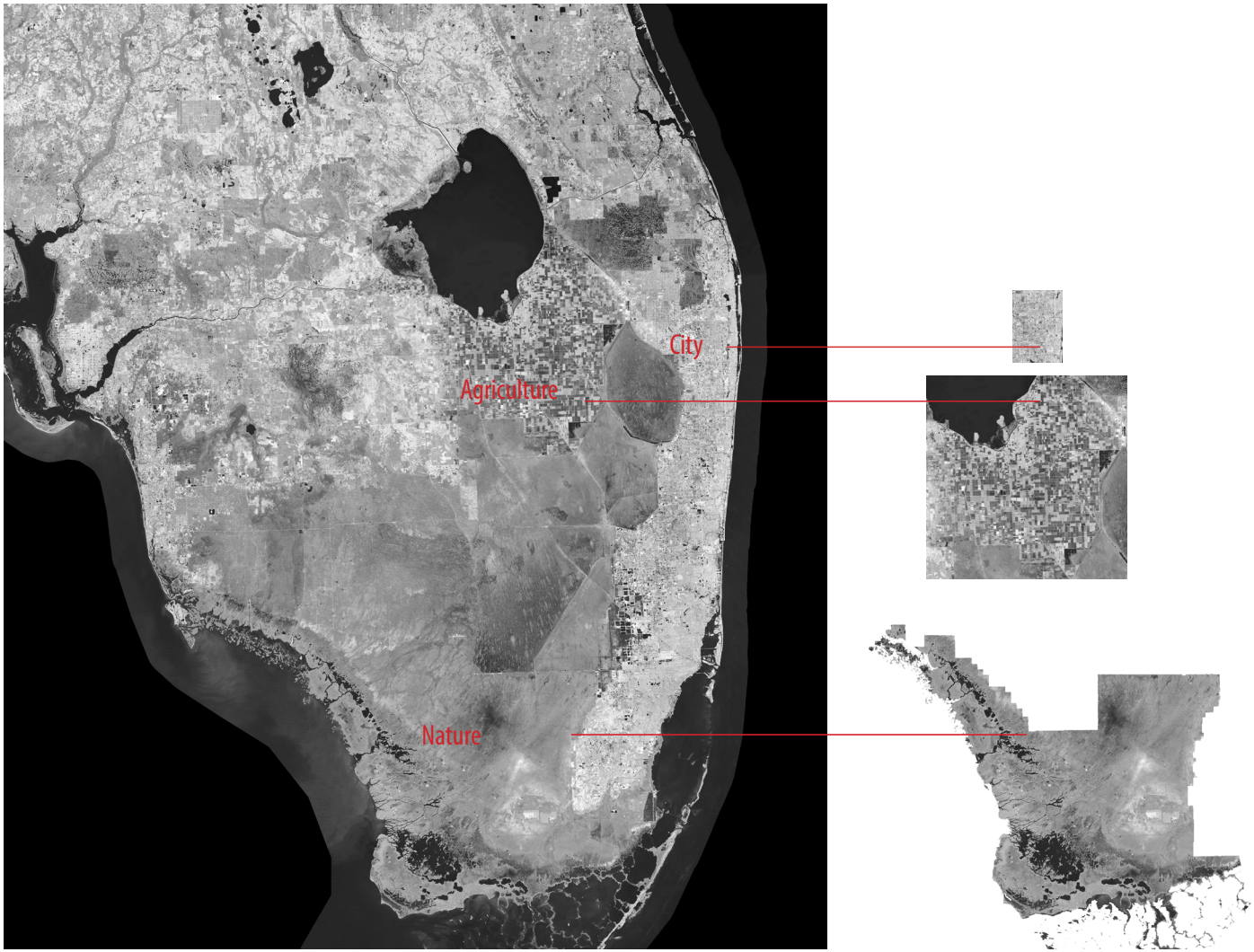


Figure 52. gradient from the Everglades to the agriculture area to the city in South Florida

Human & Environment Relationship in scale and Sensation

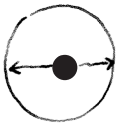
City



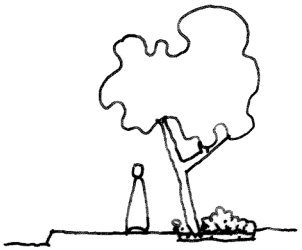
80 m



Scale/ Sensation:
Human - Environment



Large - Small





City, the grid is divided into smaller, more miniscule streets
The spaces of vegetation and open use become scattered and sparse

Agriculture



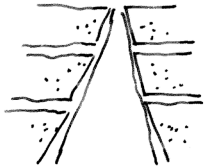
800 m





Medium - Medium





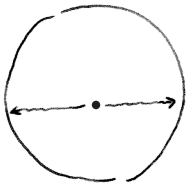
EAA, the green space is defined into grids

Nature

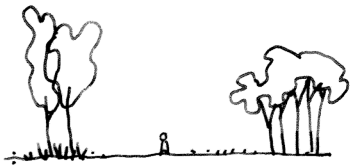


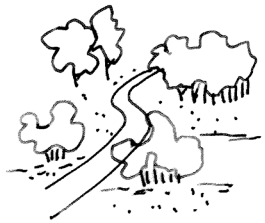
8000 m





Small - Lagre

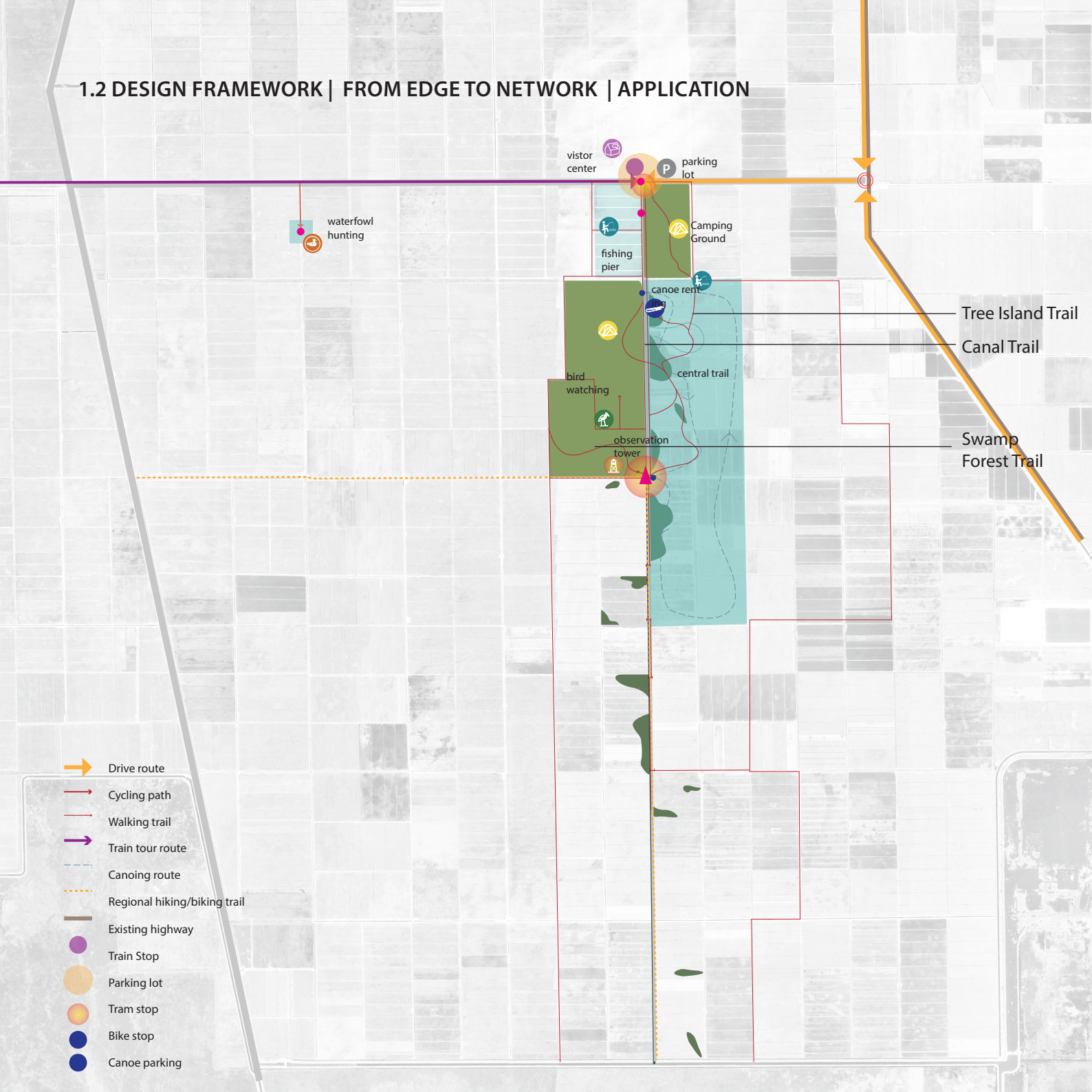




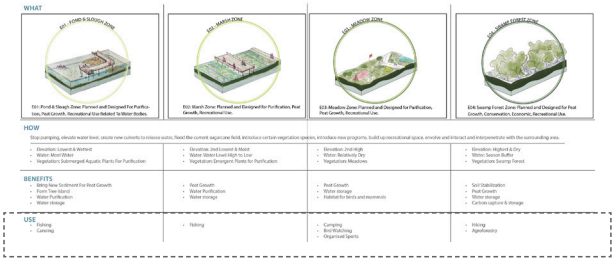
Everglades, the form is one of freedom, expressing undefined areas, which spread uncontained

When the agriculture land is restored to nature, the intervention frees the power of the natural force (water) and breaks the grid. The natural order of the Everglades is brought back and shapes new landscape where people could engage themselves with the natural occurrences.

1.2 DESIGN FRAMEWORK | FROM EDGE TO NETWORK | APPLICATION



USE



The Central Trail: Canal Trail + Tree Island Trail
- 10.4 km | 6.5 mile

Cycle:
Speed: 20 km/h
Time: 30 min

Walk:
Speed: 5 km/h
Time: 2 h

New Program Strategy



Fishing



Camping



Canoeing



Hunting



Bird Watching



Hiking

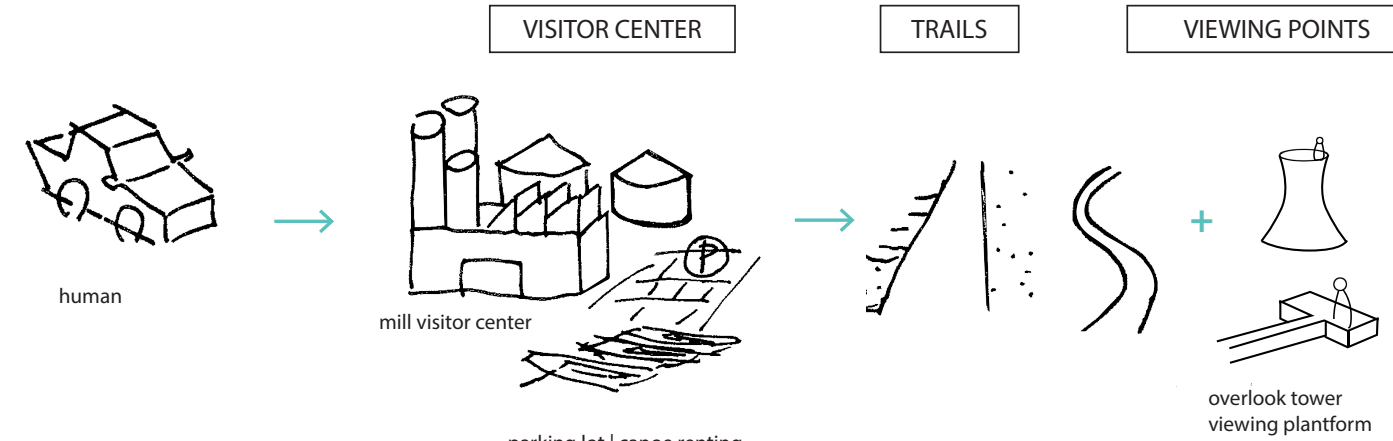
The main recreational trail will be constructed along the main canal, starting from the visitor's centre going southward. A series of recreational spaces are designed next to the trail, including: Fishing, Camping, Bird Watching Canoeing, Hiking and Hunting.

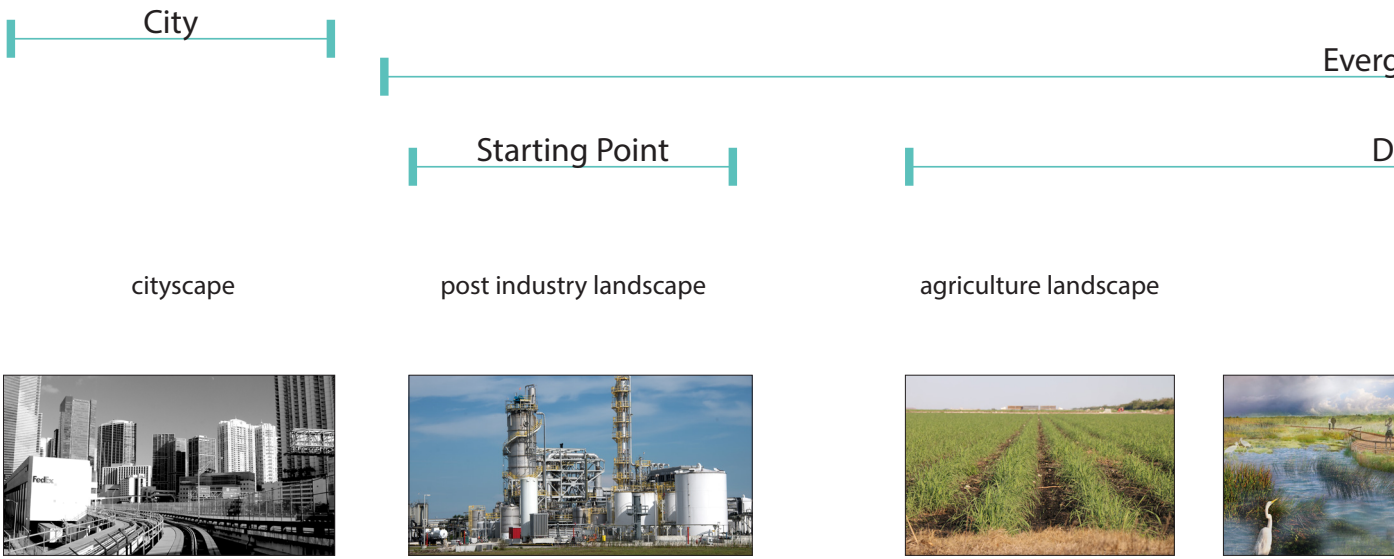
The design of the path aims to bring people to the site for them to experience two different forms of landscape: natural landscape and cultural landscape. The sequence of the landscape experience starts from the cultural state and gradually returns to a natural state. The design aims to preserve and highlight the open and endless line of the horizon

The new lanscape will enable the visitors:
to experience the **spatial characteristics of Everglades agriculture area: canal, ditch, pump**
to experience the **variety of natural landscape: pond, marsh, meadow, forest**
to experience the **landscape changing in time**
to experience **different scales of nature**
to experience **the contrast between the agriculture and restored nature**

1.2 DESIGN FRAMEWORK | FROM EDGE TO NETWORK | APPLICATION

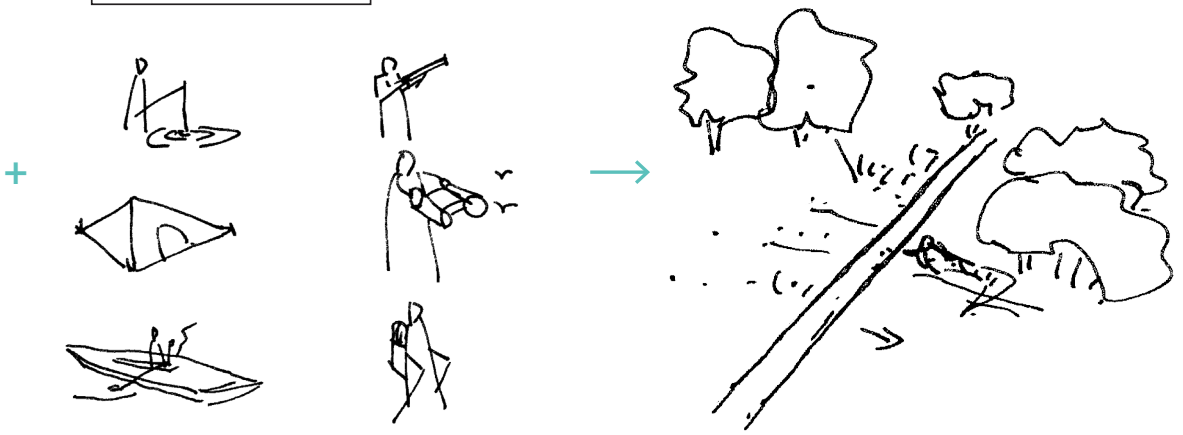
Sequence of Experience





The sequence of experience in the restoration area represents the spatial gradient in South Florida.

ACTIVITIES



glades Restoration Area (ERA)

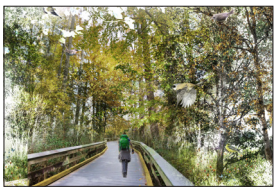
ensified Experience

Into the Wild

various restored-nature landscape

wild/less managed landscape







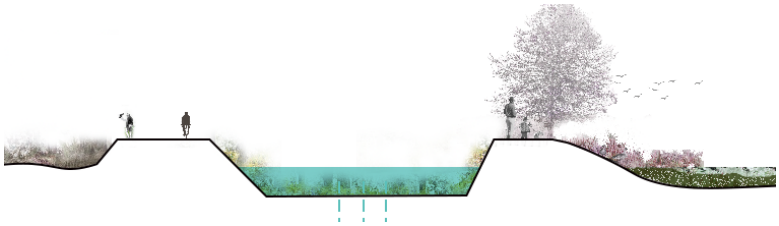


1.2 DESIGN FRAMEWORK | FROM EDGE TO NETWORK | APPLICATION

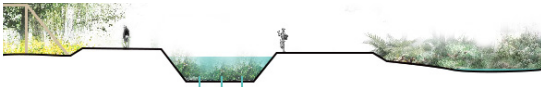
Trails & Viewing Points Design

The route design reflecting the subtle change of the water level and topography, aiming to provide diverse experience varying in heights, widths and views.

- **Upgrade Berm into Promenade**

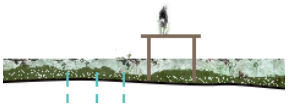


- Elevated

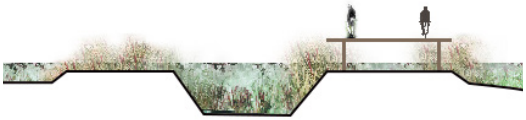


- Orginal Height

- **Trail in Pond Zone**



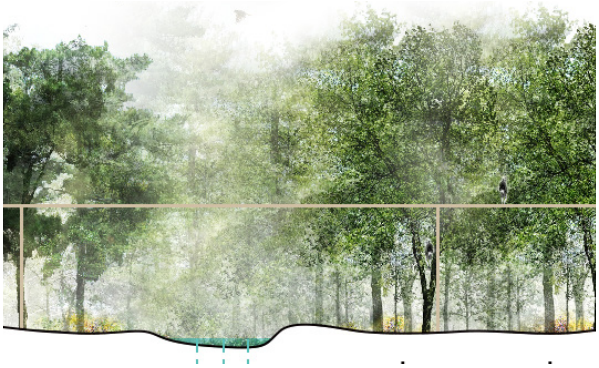
- **Trail in Marsh Zone**



- **Trail in Meadow Zone**



- **Boardwalk in Swamp Forest Zone**

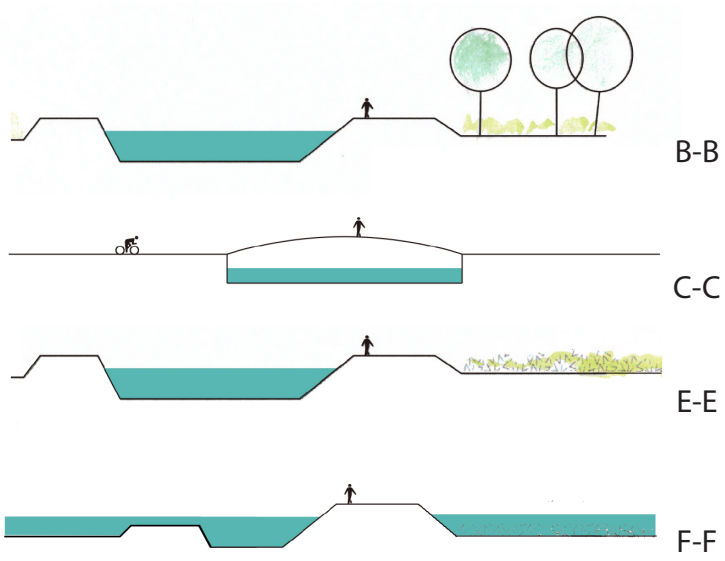


- **Oberservation Tower**



provide a view from higher ground and create a full 360 degree range of vision, observing a larger area

I. Linear Canal Trail



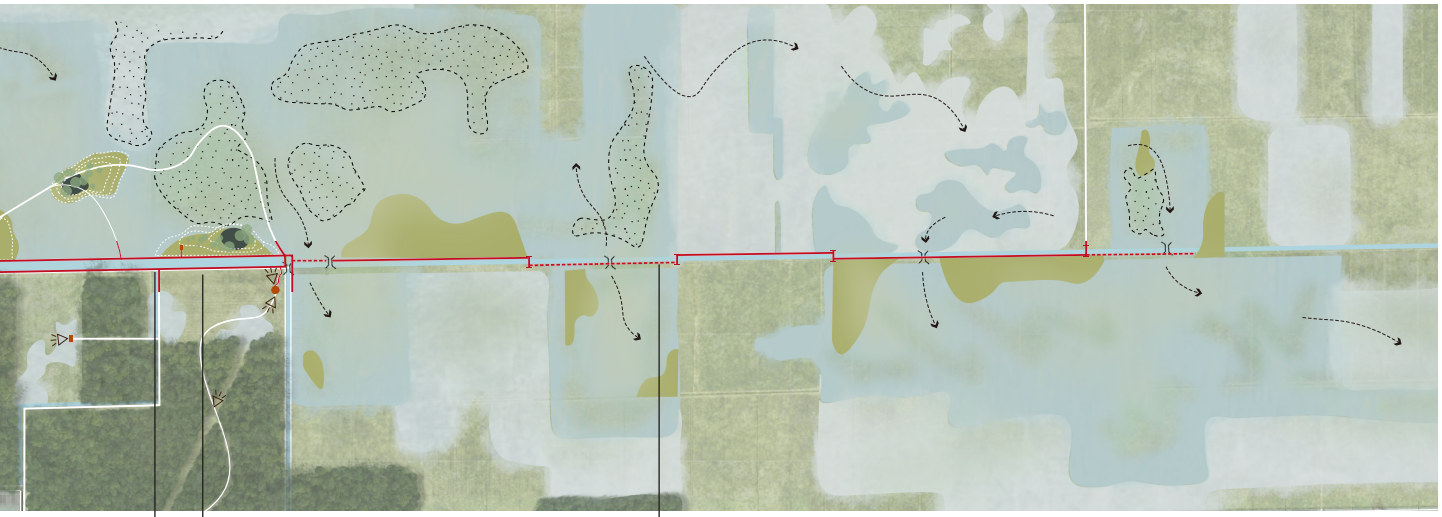




A



B



D E F

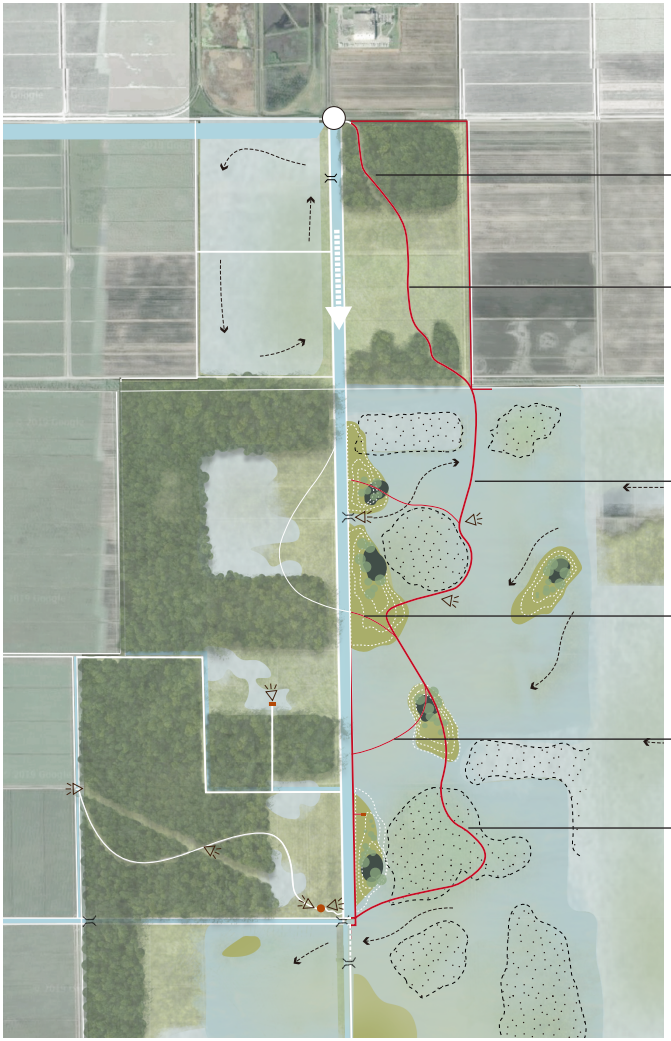


D



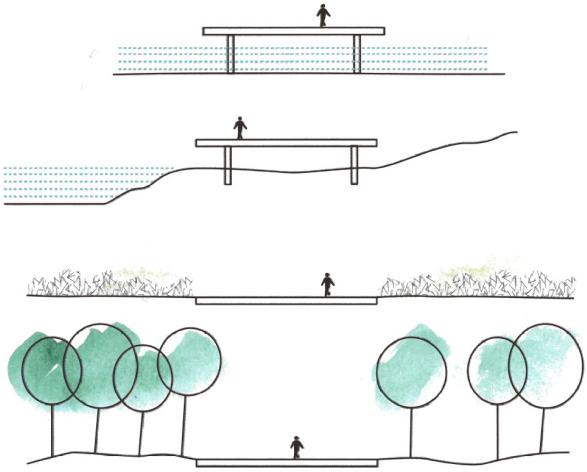
F

II. Tree Island Trail





A



B-B

C-C

E-E

F-F



C

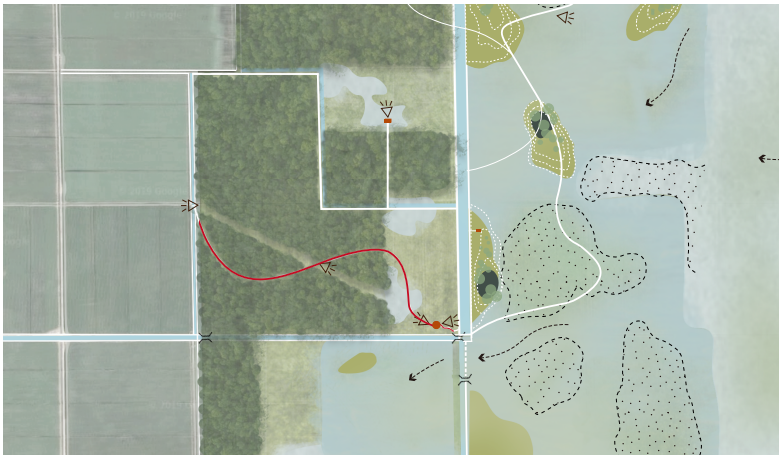


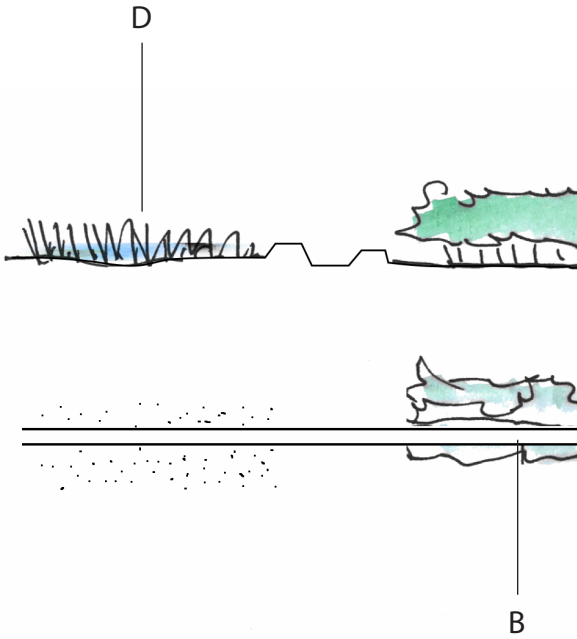
D

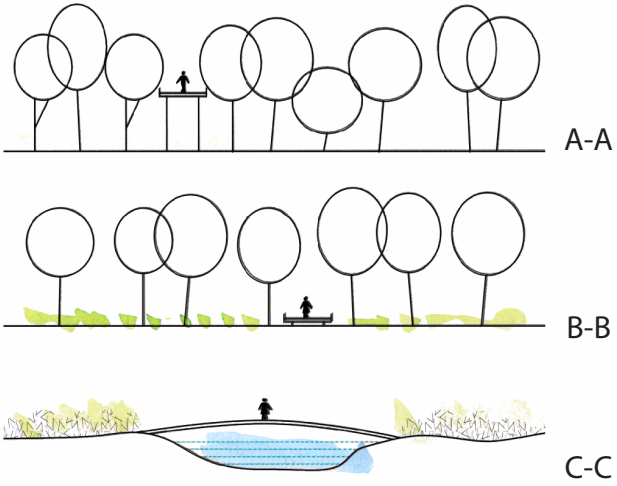


E

III. Swamp Forest Trail

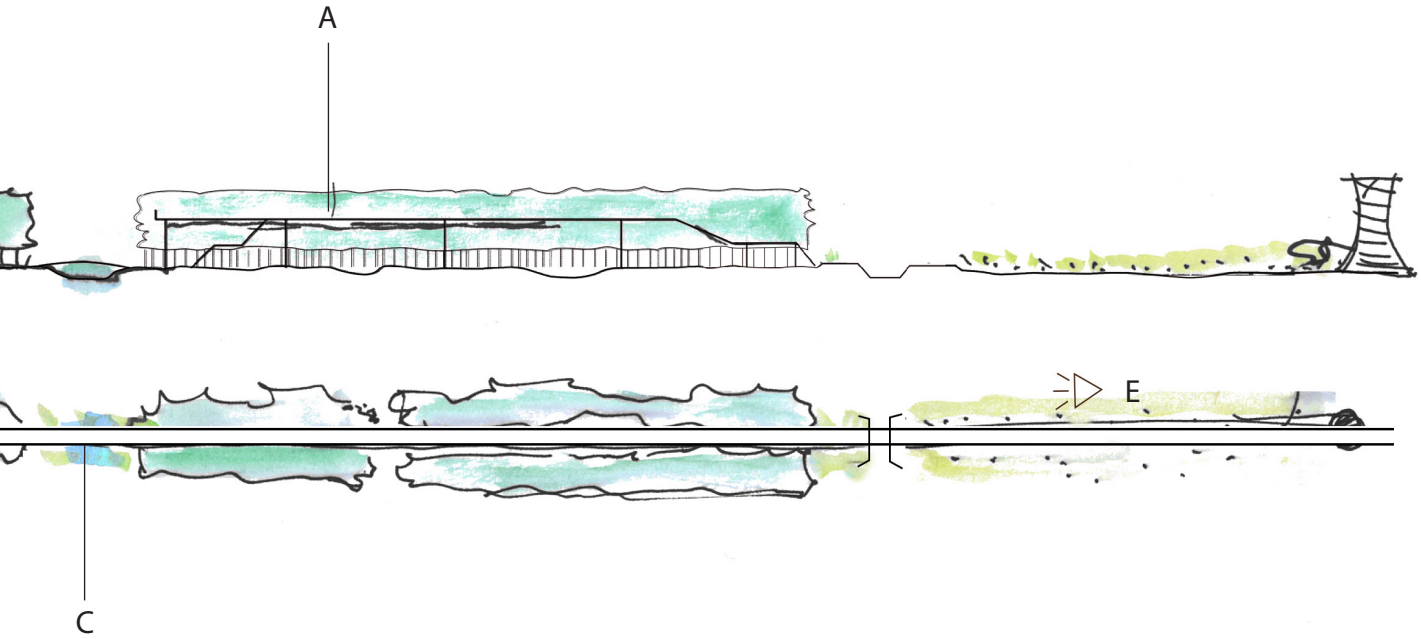








A





B



D

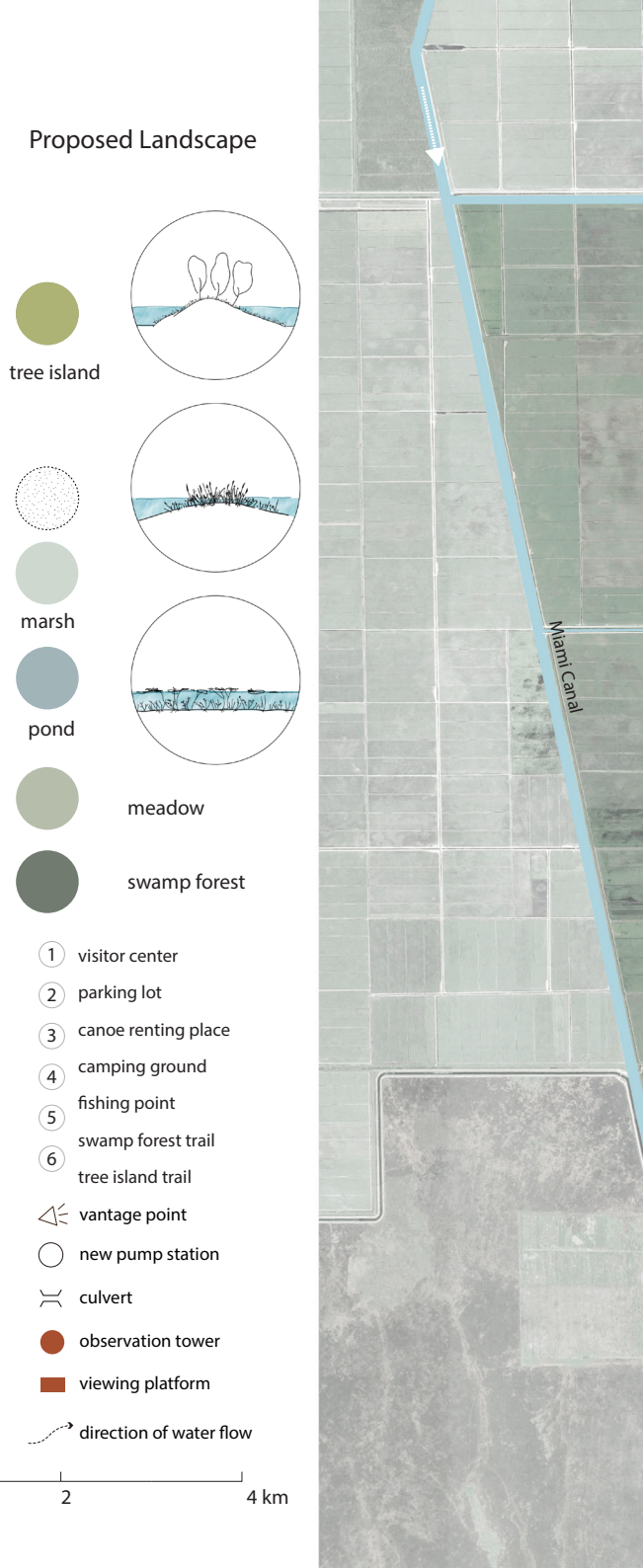


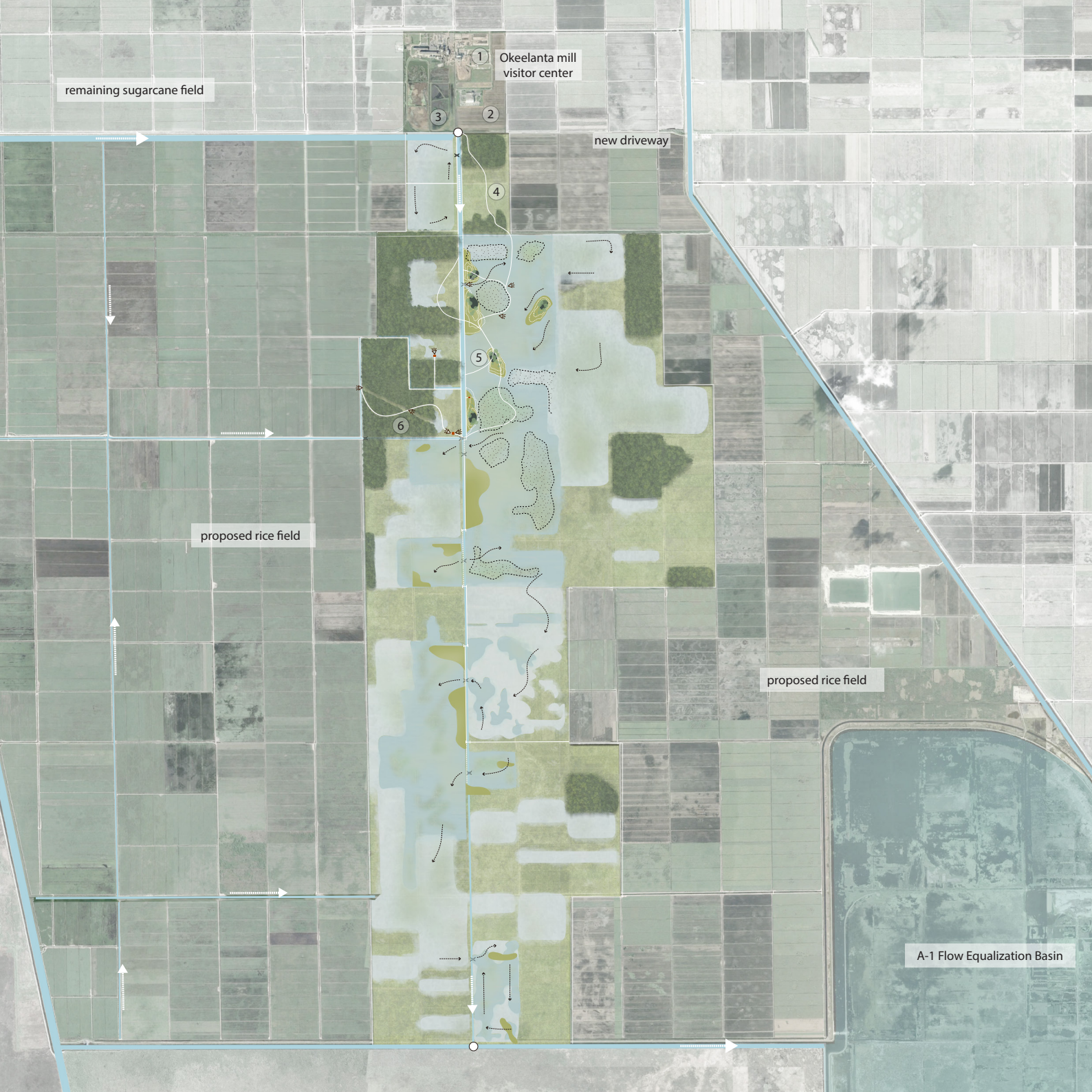
E

1. DESIGN FRAMEWORK | APPLICATION OVERVIEW

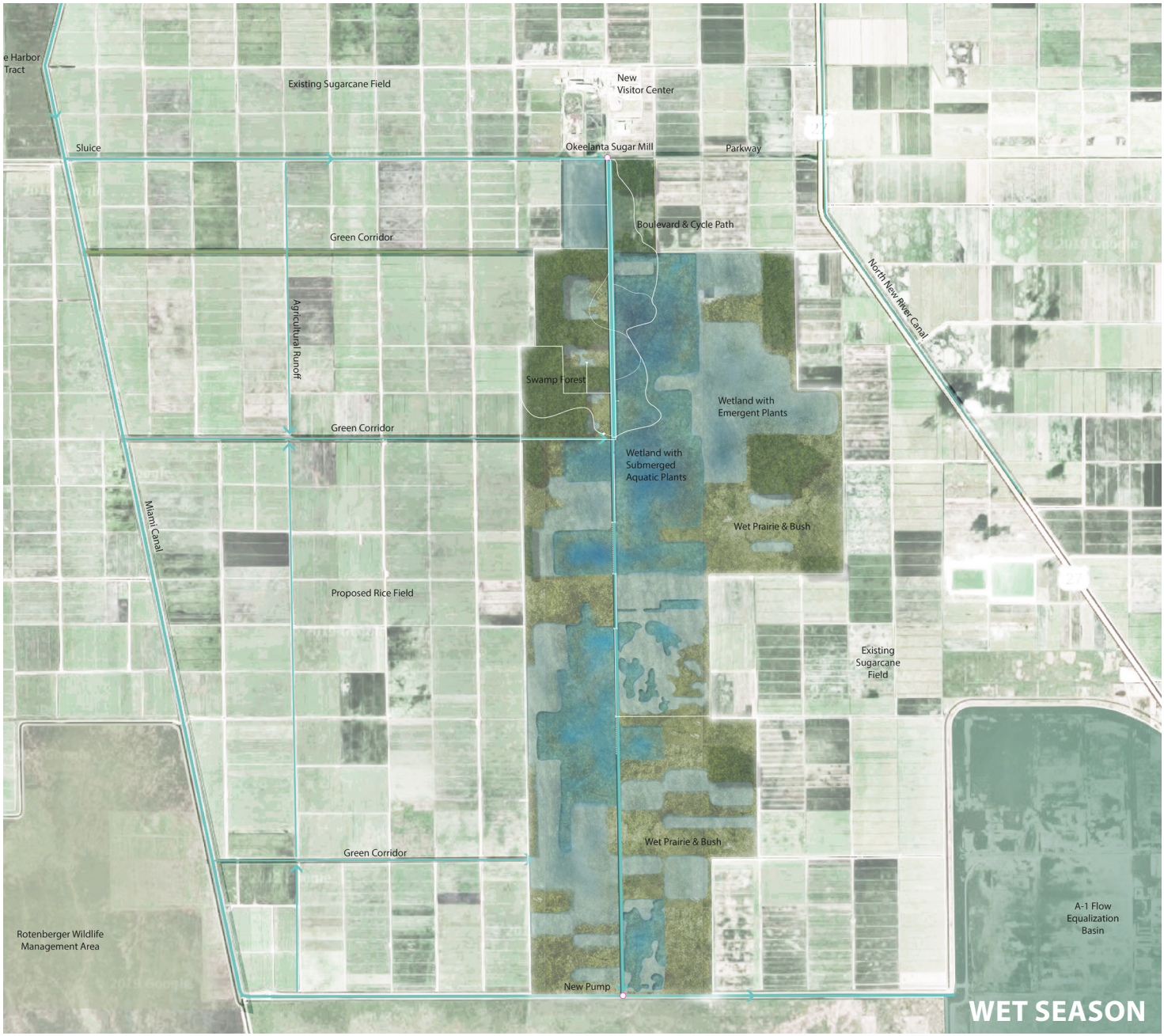
By applying the design framework in the pilot area, the design plan was created. It combines the different layers that were discussed before, such as the creation of the zones, the recreational network and the generated landscapes.

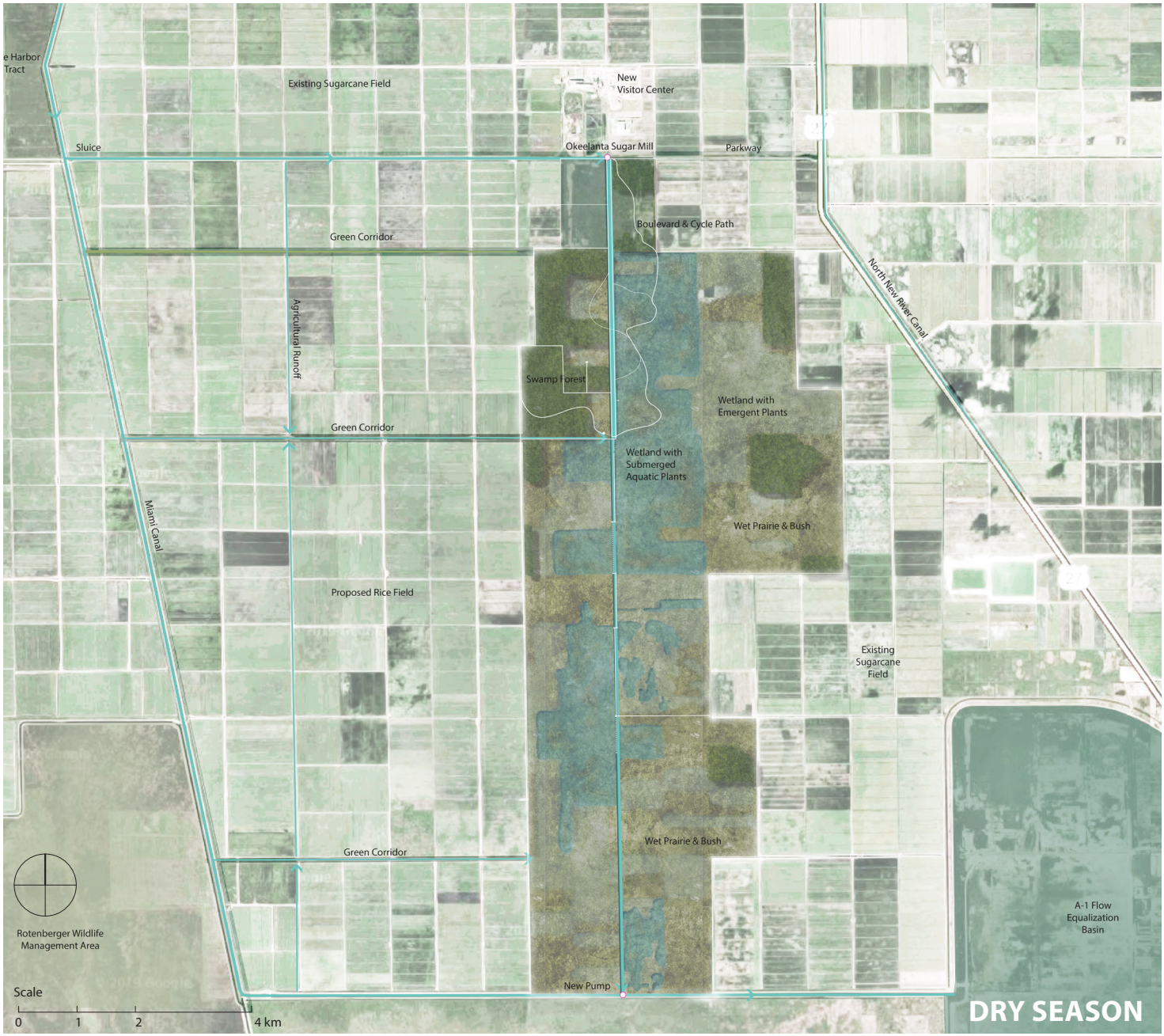
The next page shows the same area, highlighting the difference between the dry and wet seasons.




1
Okeelanta mill
visitor center
remaining sugarcane field
3
2
new driveway
4
5
6
proposed rice field
proposed rice field
A-1 Flow Equalization Basin

1. DESIGN FRAMEWORK | APPLICATION OVERVIEW




e Harbor
Tract
Existing Sugarcane Field
New
Visitor Center
Sluice
Okeelanta Sugar Mill
Parkway
Boulevard & Cycle Path
Green Corridor
North New River Canal
Agricultural Runoff
Swamp Forest
Wetland with
Emergent Plants
Green Corridor
Wetland with
Submerged
Aquatic Plants
Miami Canal
Wet Prairie & Bush
Proposed Rice Field
Existing
Sugarcane
Field
Wet Prairie & Bush
Green Corridor
A-1 Flow
Equalization
Basin
Rotenberger Wildlife
Management Area
New Pump
Scale
0
1
2
4 km
DRY SEASON

2. Zoom-In Units

2.1 Pond & Marsh

2.2 Meadow & Swamp Forest

2.3 Rice Field & Swampland



2. ZOOM-IN UNITS

This section applies the design framework in various locations. The spatial conditions of the ecosystems are integrated into the landscape architectonic design. The design interventions are elaborated through different scales from regional plan to eye-level spatial experience. The dynamic interaction between biotic, abiotic and anthropogenic factors is expressed in the landscape design. The scope of regarding landscape as a process rather than a product is highlighted in the design interventions.

Three units are elaborated in the next section: the unit of pond and marsh, meadow & swamp forest, and rice fields with transitional wetlands.

The choice for the zoom-in areas is based on the topography and water dynamics. Pond and marsh are a unit as these two zones, which are lowest, together play the role of purification cell and experience the most water dynamics with the inundation period of 6 to 12 months. Meadow & Swamp Forest are a unite as they are relatively higher than pond and marsh zones and function as the flooding buffer with the inundation period of 1 to 2 months. The last unit shows the borders between the restored swamplands and rice fields: swamp forest zone & rice field, marsh zone & rice field, and meadow zone & rice field.

Each unit shows two zones and the connection between two zones. Instead of explaining each zone individually, showing in a unit intends to show the holistic approach of the intervention and further explain the connection and transformation between different zones.

From each of the three units the most representative and characteristic places for elaboration are selected.

Unit 1: Pond & Marsh

Unit 2: Meadow & Swamp Forest

Unit3: Rice Field & Swampland


Scale
0
1
2
4 km

1

Pond & Slough and Marsh Unit

Zones: Pond & Slough Zone, Marsh Zone

The pond and marsh zones are a unit as these two together play the role of purification cell and experience the most water dynamics. In this unit, the following topics will be elaborated on: the strategic interventions of introducing water and its impact on space, and the construction of tree islands, culverts and recreational trails.

The Pond & Slough Zone and Marsh Zone will purify the water, while at the same time providing a new habitat for native species. The water quality is improved, providing conditions for the improvement of spatial quality and the development of recreational activities.

Experiential Value

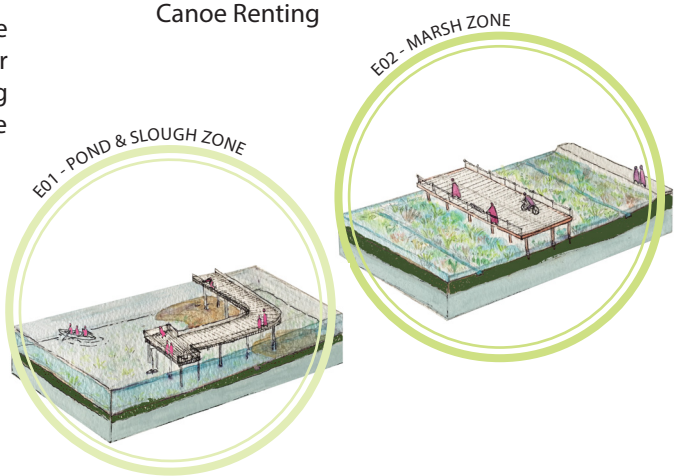
Sightseeing
Hiking
Recreational Fishing

Ecological Value

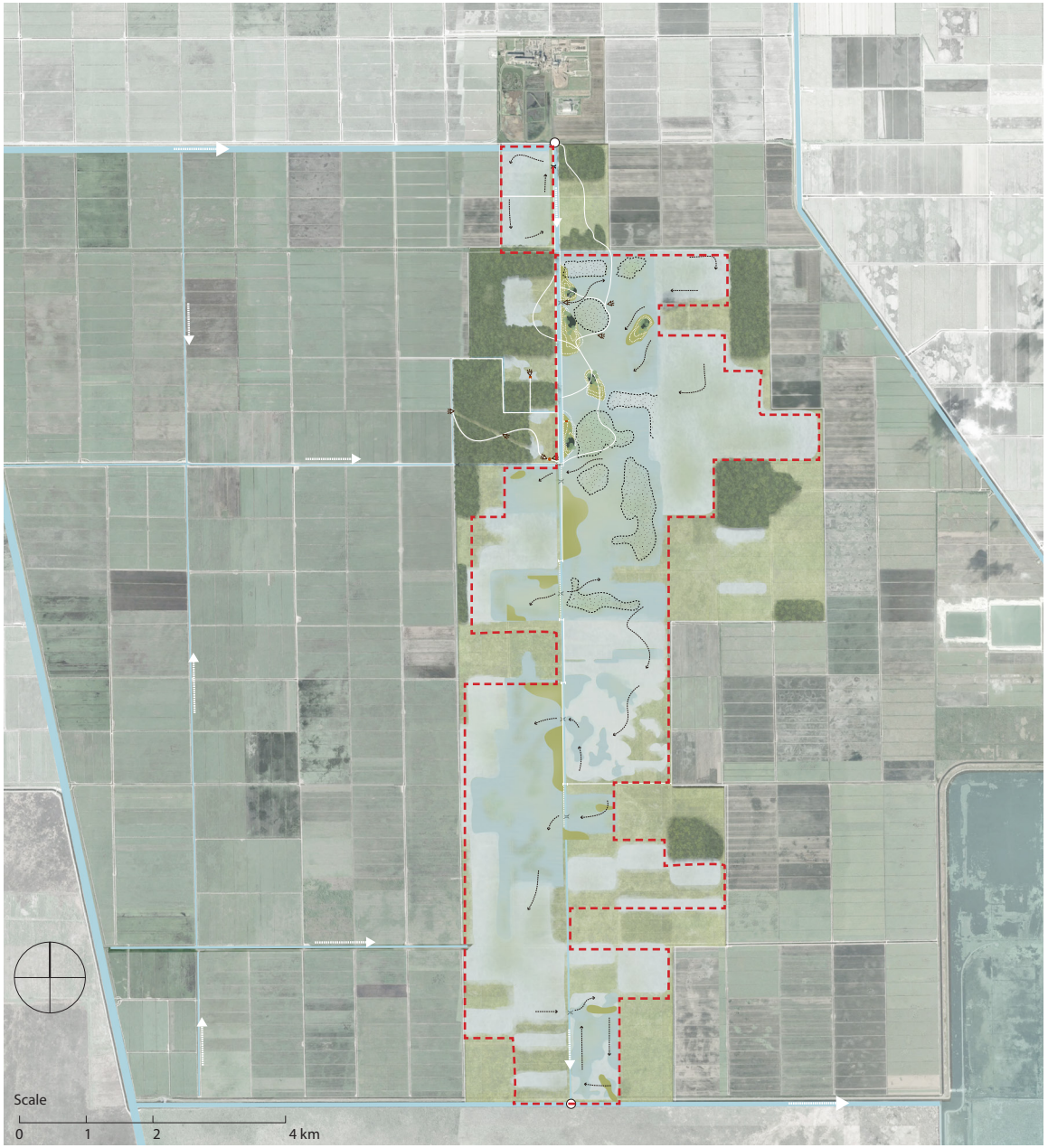
Water Purification
Water Storage
Peat Growth
Biodiversity
Nest Grounds
Wildlife Habitat

Economic Value

Tourism
Canoe Renting

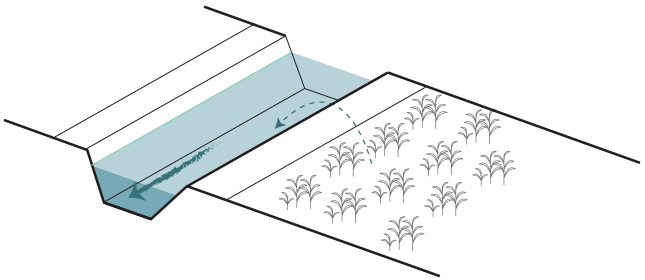


2.1 Zoom-In
Pond & Slough and Marsh Unit

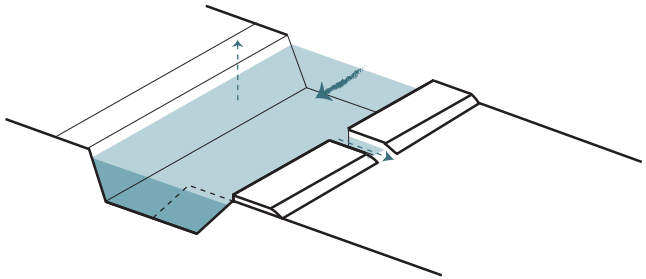


Strategic Interventions

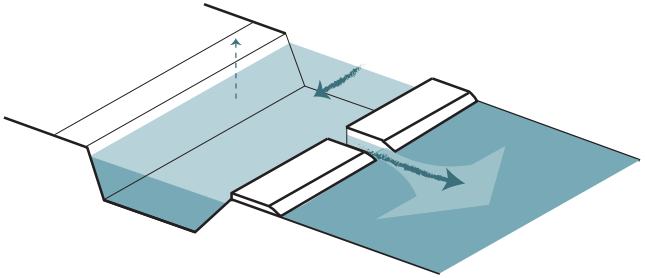
A series of steps should be taken in order to form the new landscapes.



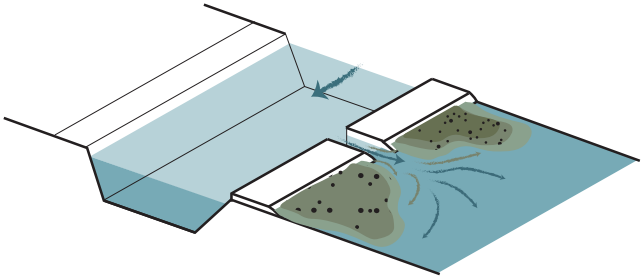
CURRENT: Drainage Canal



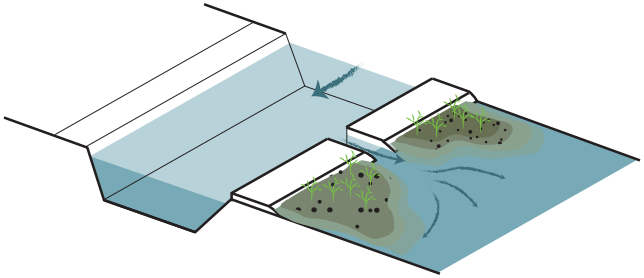
STEP 1: Expand Canal, Elevate Water Level



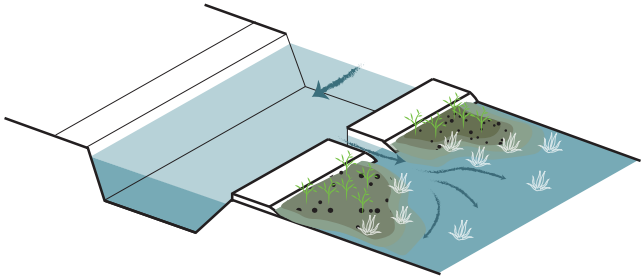
STEP 2: Restore Water Flow



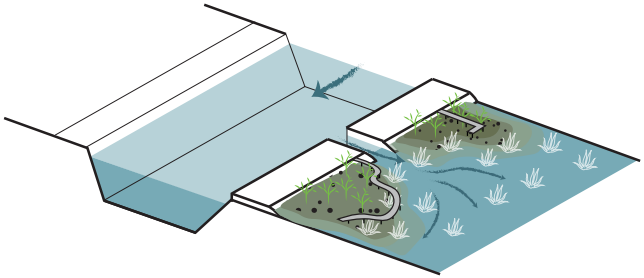
STEP3: Bring New Sediment



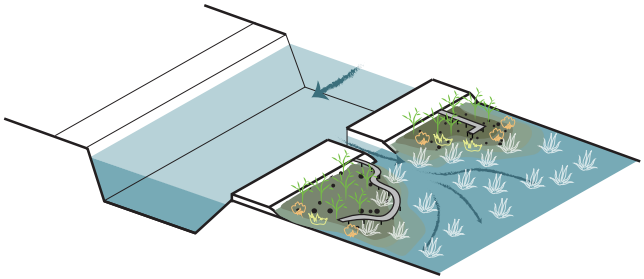
STEP 4: Form Tree Island



STEP 5: Purification Plants Introduced, Nutrient Closed By Plant

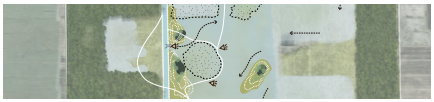


STEP 6: Upgrade Accessibility And Create Recreational Space

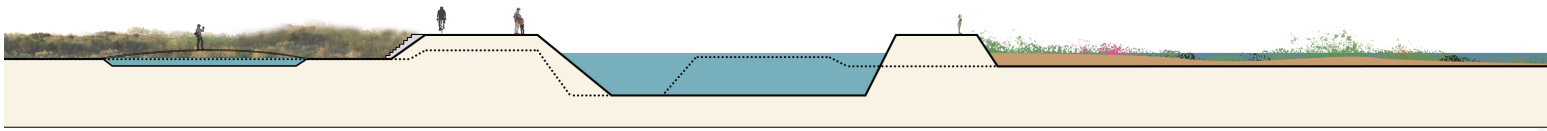


STEP 7: Guide Ecological Succession

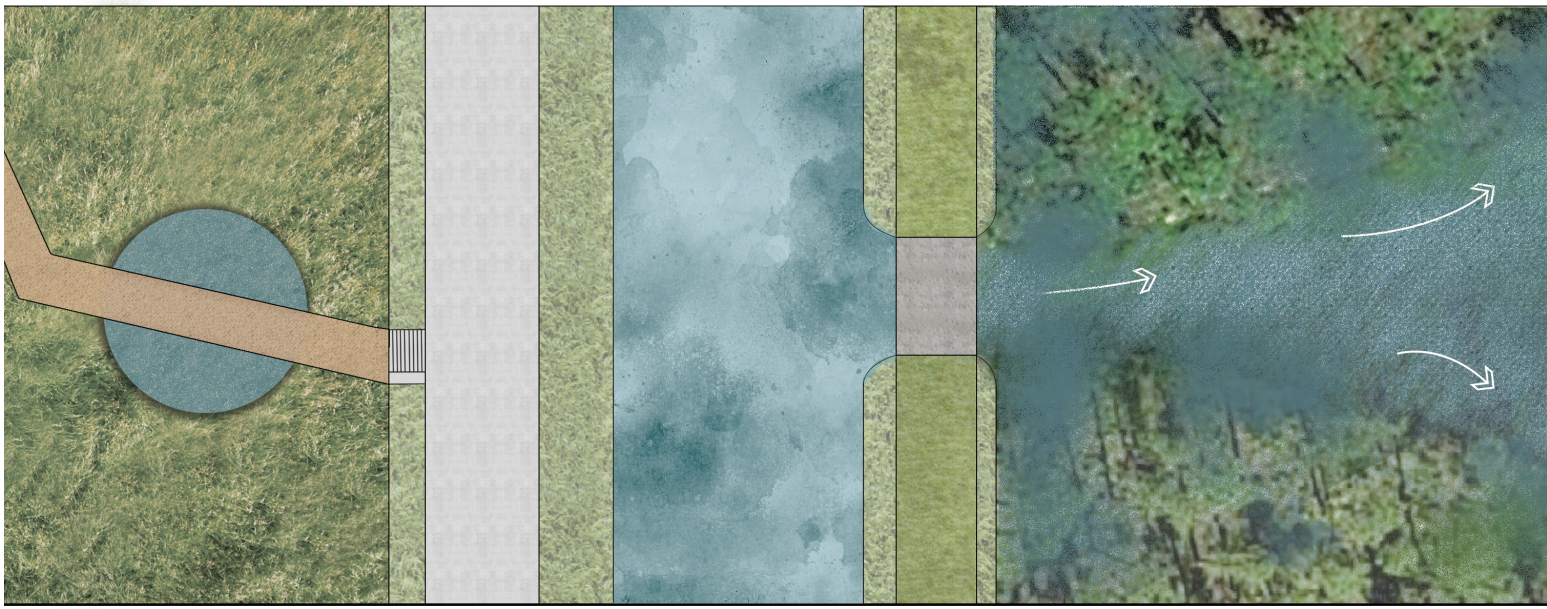
Proposed Situation



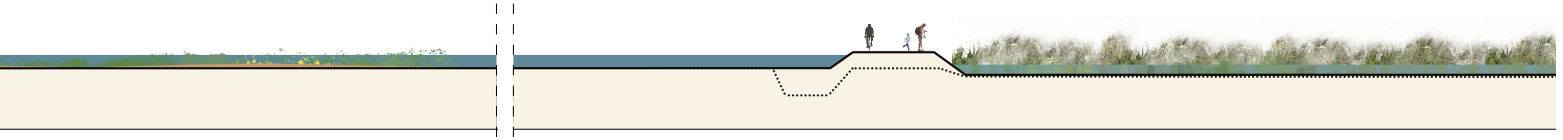
The gradient going from the meadow, to the pond and slough, to the marsh is reprented in the following setion and plan.



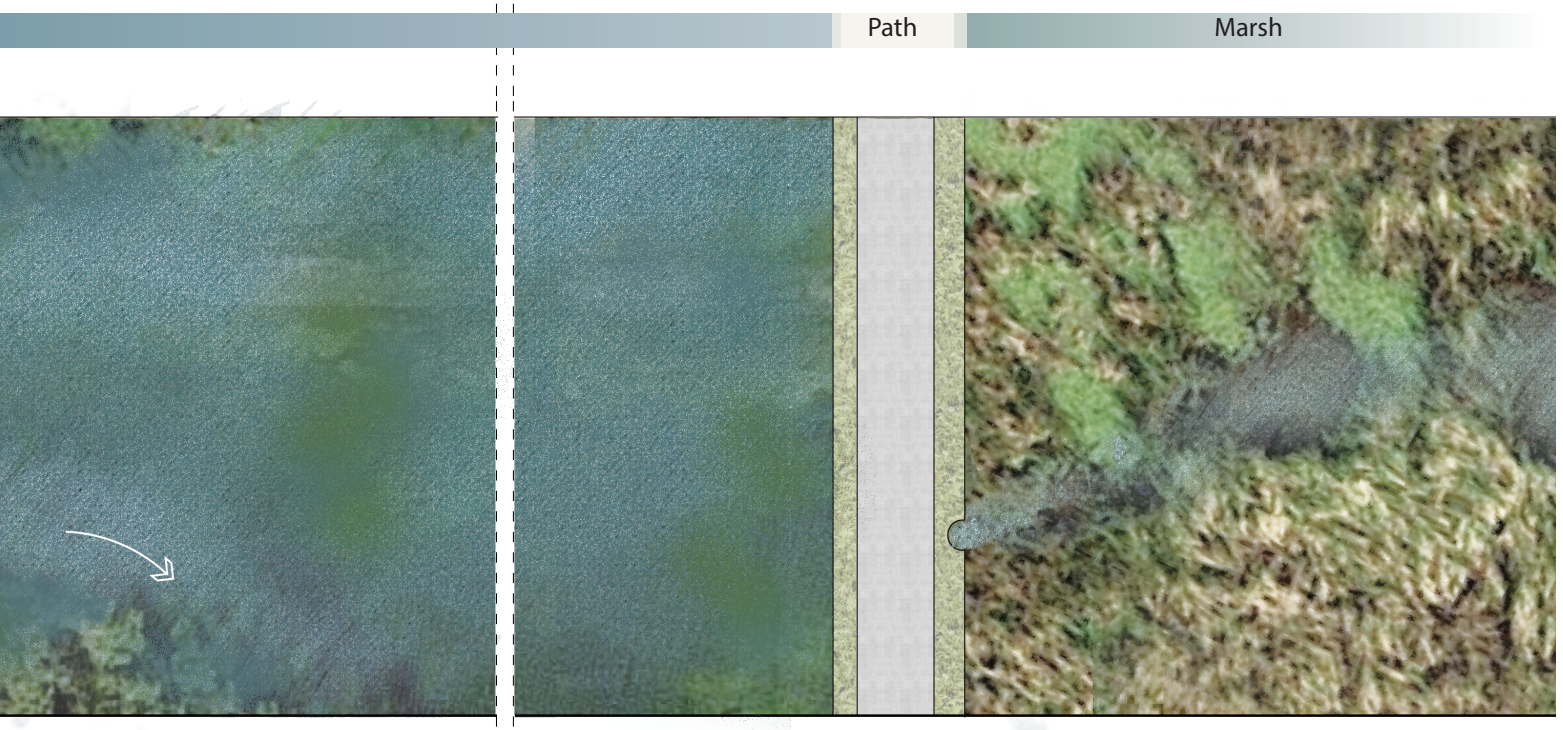
Meadow | Path | Canal | Path | Pond and Slough







A-A′ SECTION 1: 500



A-A′ PLAN 1: 500

Eye-level Spatial Implication

- Integrating spatial conditions of ecosystems into the landscape architectonic design





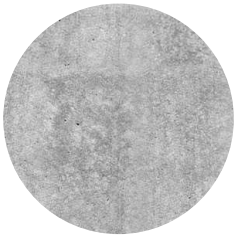

Cattail

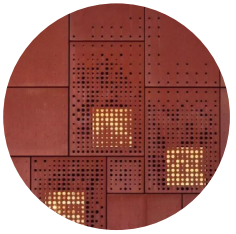

Bulrush


Hydrilla

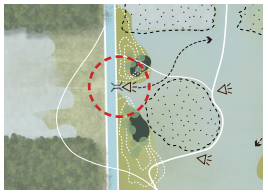

Southern Naiad


Coontail


concrete


Corten Steel

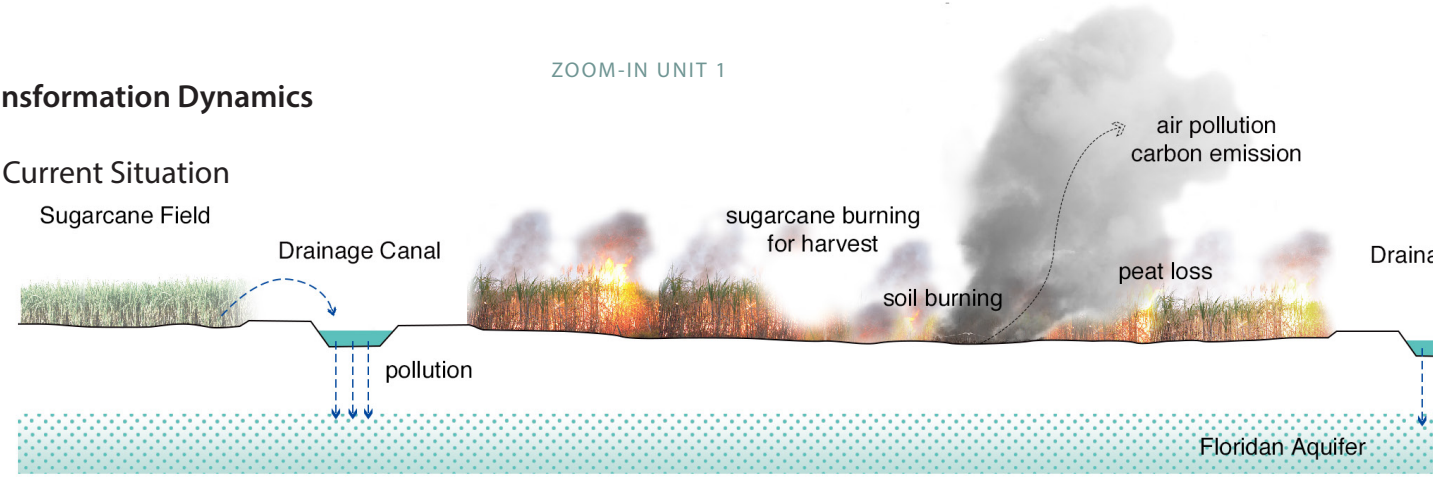
The bridge above the culvert provides the space for the visitors to experience the opening of the canals, where the sediment and the water come into the pond and slough zone. Cattail, bulrush, hydrilla, southern naiad and coontail are planted to purify the water. This natural process is visible to the public. After a few years, wading birds will return to this land.



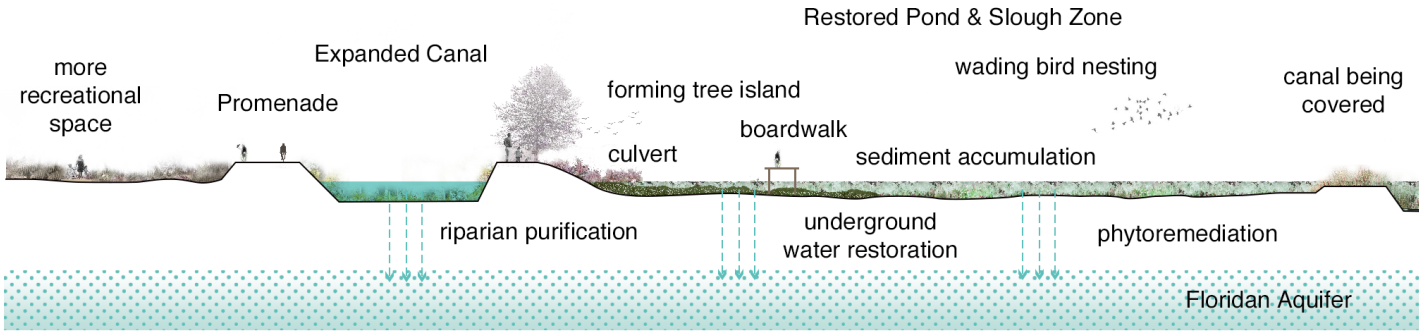
Location

Transformation Dynamics

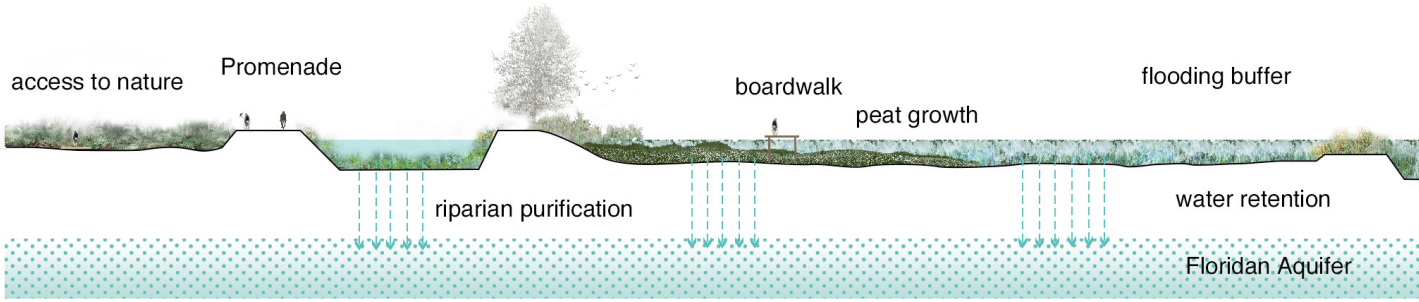
Current Situation



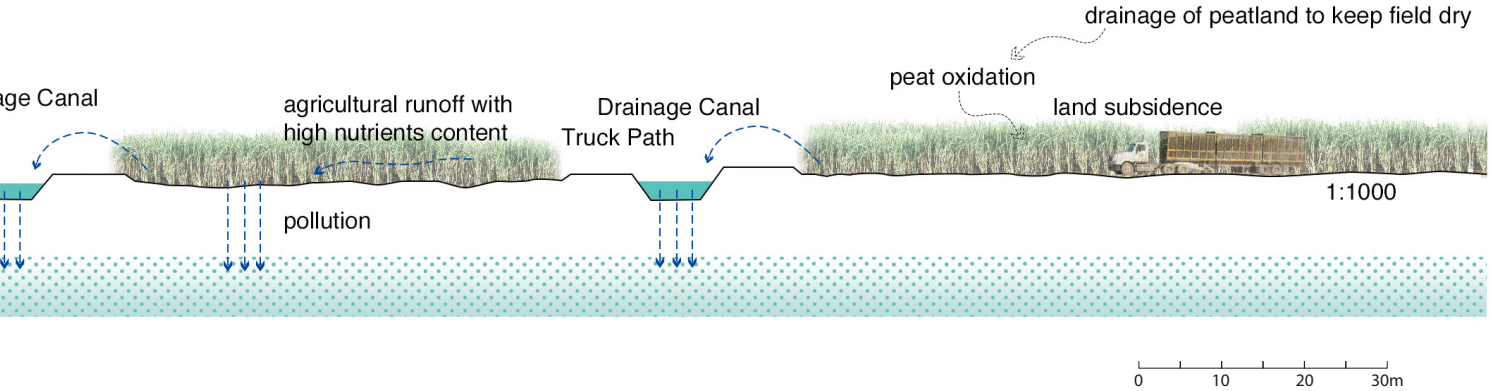
Designed Situation

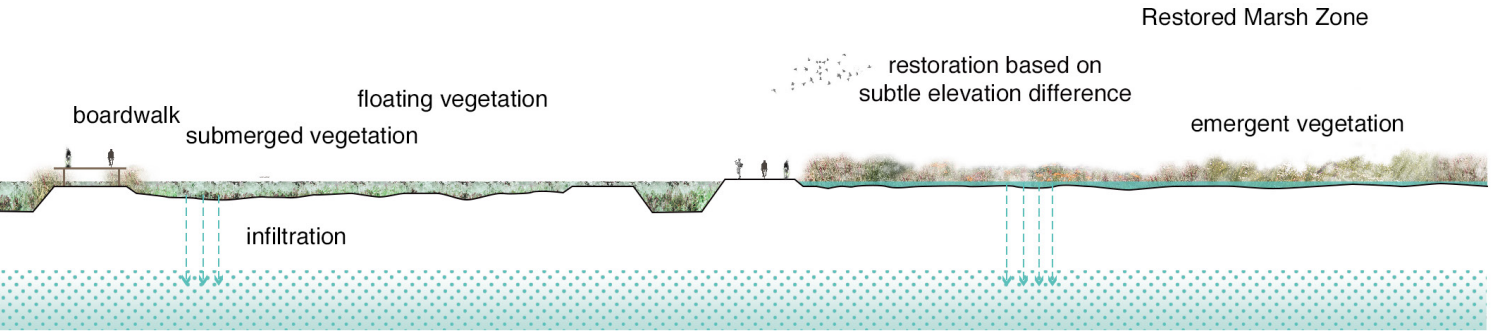


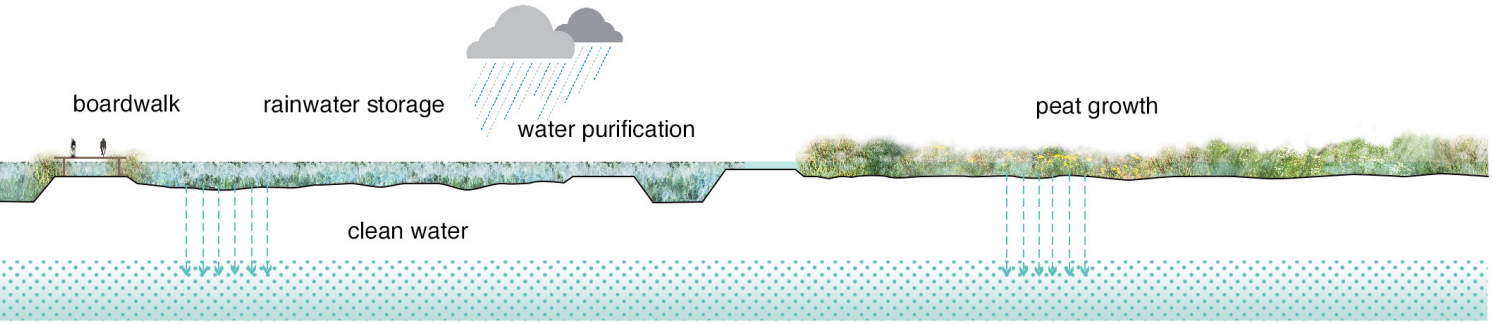
Dry Season



Wet Season

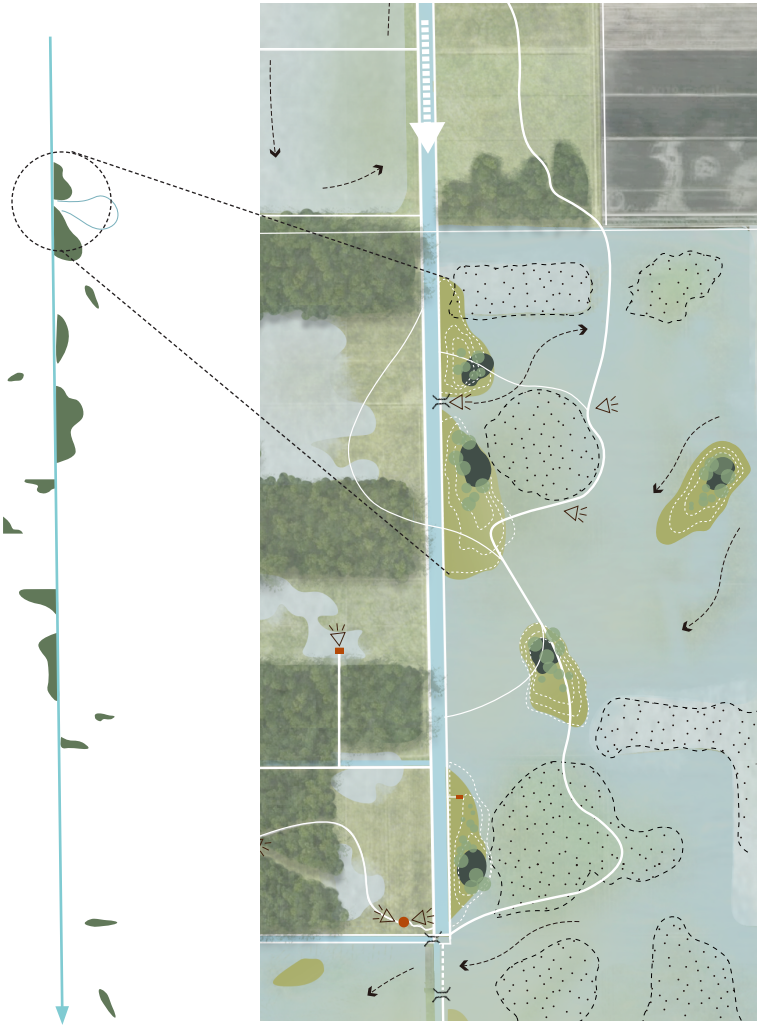

drainage of peatland to keep field dry
peat oxidation
land subsidence
age Canal
agricultural runoff with
high nutrients content
Drainage Canal
Truck Path
pollution
1:1000
0
10
20
30m


Restored Marsh Zone
restoration based on
subtle elevation difference
floating vegetation
boardwalk
submerged vegetation
emergent vegetation
infiltration


boardwalk
rainwater storage
water purification
peat growth
clean water

Restore Tree Island

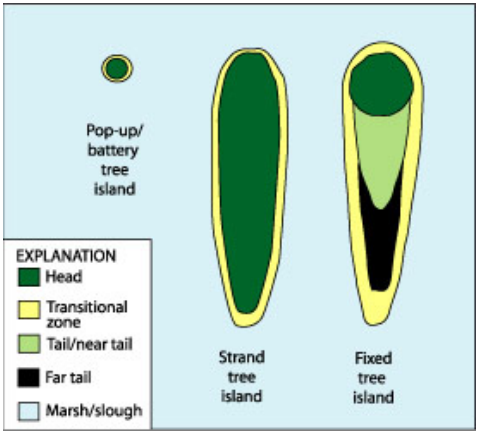
Map of 6 Tree Island



Characteristics of Tree Island

- Biodiversity hotspot: serve as a dry place of refuge for animals
- Nutrient hotspot: extremely high levels of the nutrient phosphorus, keeping the surrounding marsh low in nutrients





Structure of Tree Island

Figure 53. Fixed tree island in the central Everglades. Photo by Debra A. Willard.

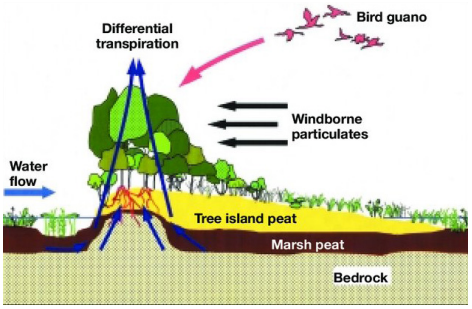
Figure 54. https://pubs.usgs.gov/fs/2004/3095/fs2004-3095.html

Tree Islands of Everglades - Long-Term Stability and Response to Hydrologic Change

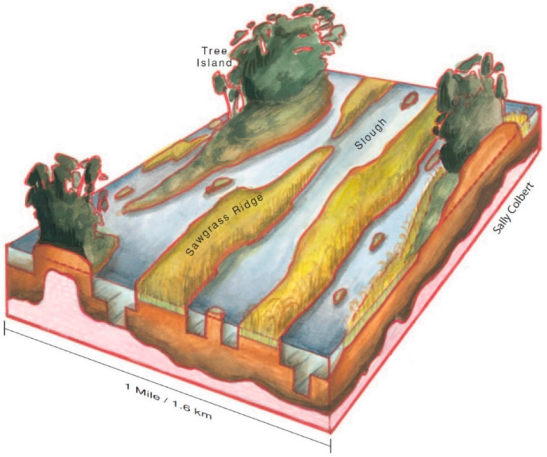
"Their ecological role, soil dynamics, and vulnerability to changes in water level combine to make them an extremely important—yet sensitive—feature of the landscape. "

"Tree islands are important centers of biodiversity in the Florida Everglades; they have two to three times the plant and animal diversity of the surrounding wetlands. This high diversity is due primarily to their higher elevation relative to the adjacent wetlands. In the natural Everglades system, water levels fluctuated seasonally with rainfall, and tree islands were the only sites that escaped flooding during the wet season. These seasonally dry sites provided refugia and nesting sites for animals and allowed tree and shrub communities to flourish."

https://pubs.usgs.gov/fs/2004/3095/fs2004-3095.html



Major mechanisms that redistribute nutrients from marshes and sloughs to tree islands in the Everglades



https://www.mdpi.com/2071-1050/8/9/940/htm
Impact and Mitigation of Nutrient Pollution and Overland Water Flow Change on the Florida Everglades, USA

Restore Tree Island


deer


rabbit


raccoon


alligator


white ibis


egret


heron


snal kite


willow

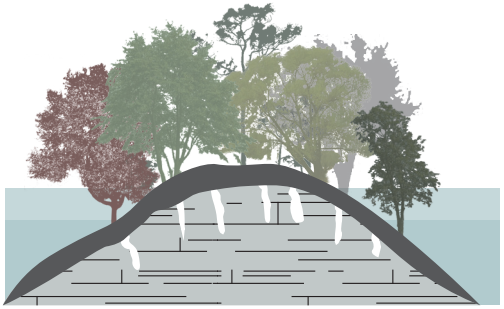

cocoplum


swamp maple

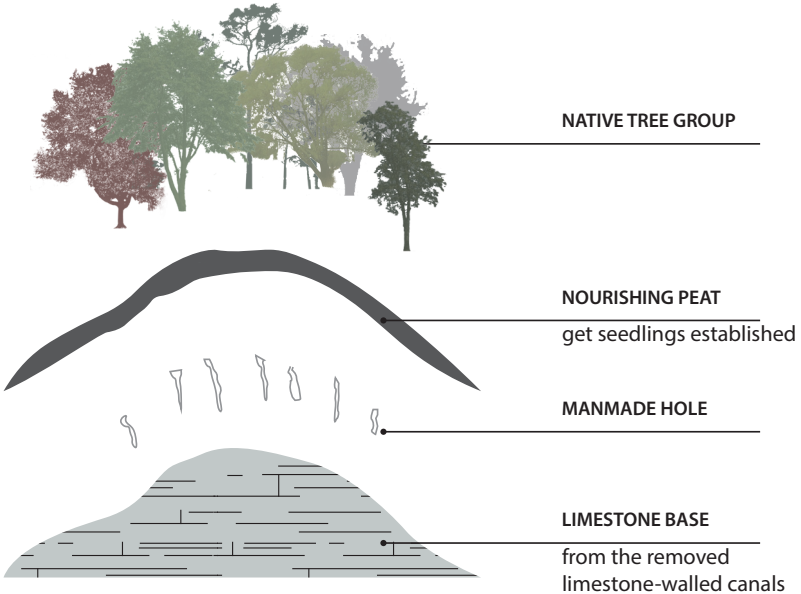

gumbo limbo

Species of Tree Island

Mammal & Reptile: Deer, rabbit, raccoons alligator
Bird: white ibis, egret, heron, snail kite
Vegetation: willow, cocoplum, swamp maple, gumbo limbo

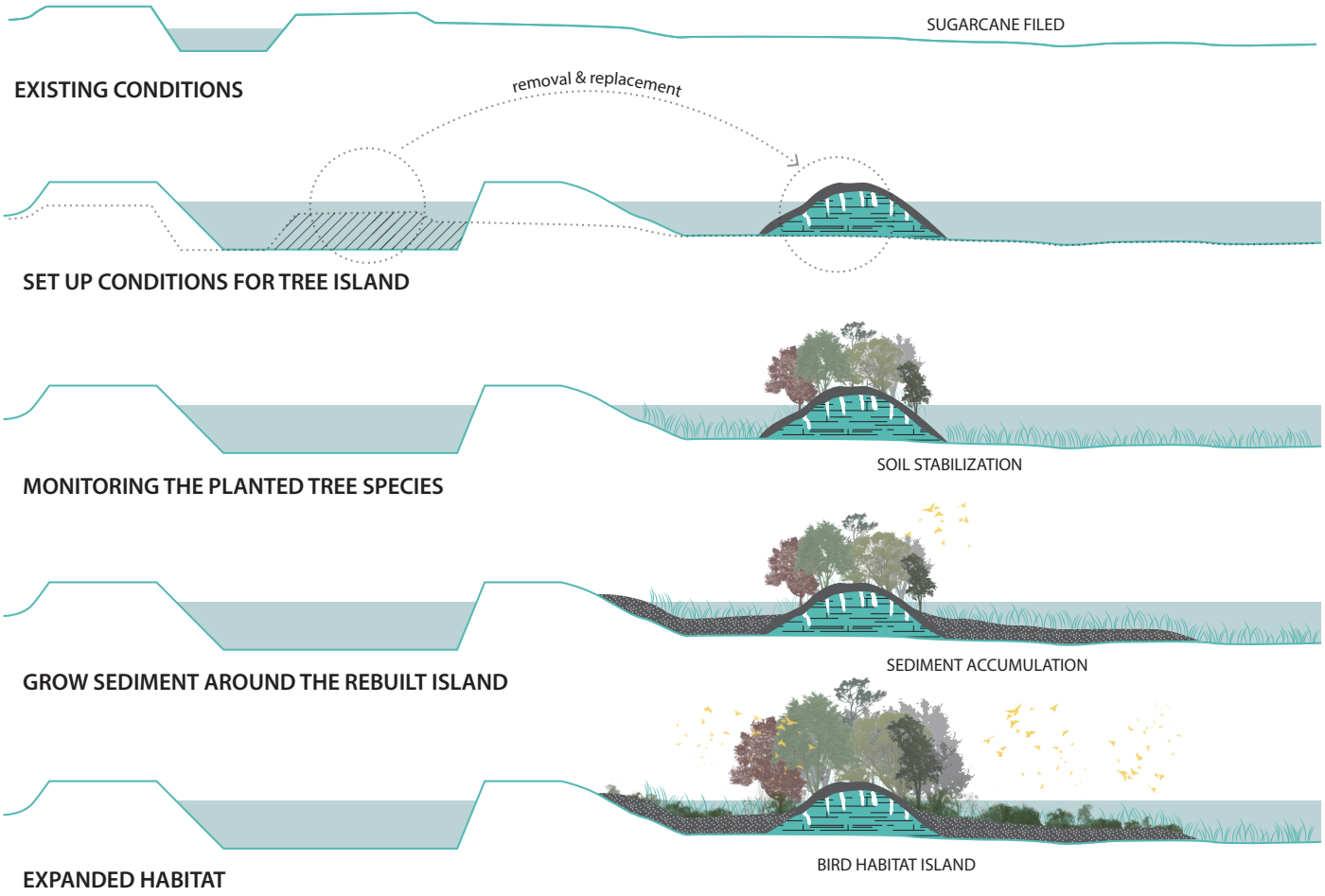


Components of Tree Island



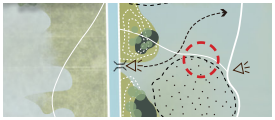
First Part: constructing tree island base
Second Part: monitoring the planted tree species
Third Part: grow sediment around the rebuilt island

Based on the experiment of constructed tree islands at the Loxahatchee Impoundment Landscape Assessment (LILA) experimental wetlands: The base of a constructed tree island is limestone. The material comes from the limestone-walled canals and levees composed of limestone sediments removal within the CERP. Afterwards, the holes are punched in the limestone and filled with nourishing peat. The limestone islands can mimic natural processes best and the peat is needed to get seedlings established.



Increase Accessibility & Awareness

Build up new connections with water and create space to witness natural processes, and experience seasonal water dynamics



Introducing purification plants to purify water



Cattail



Bulrush



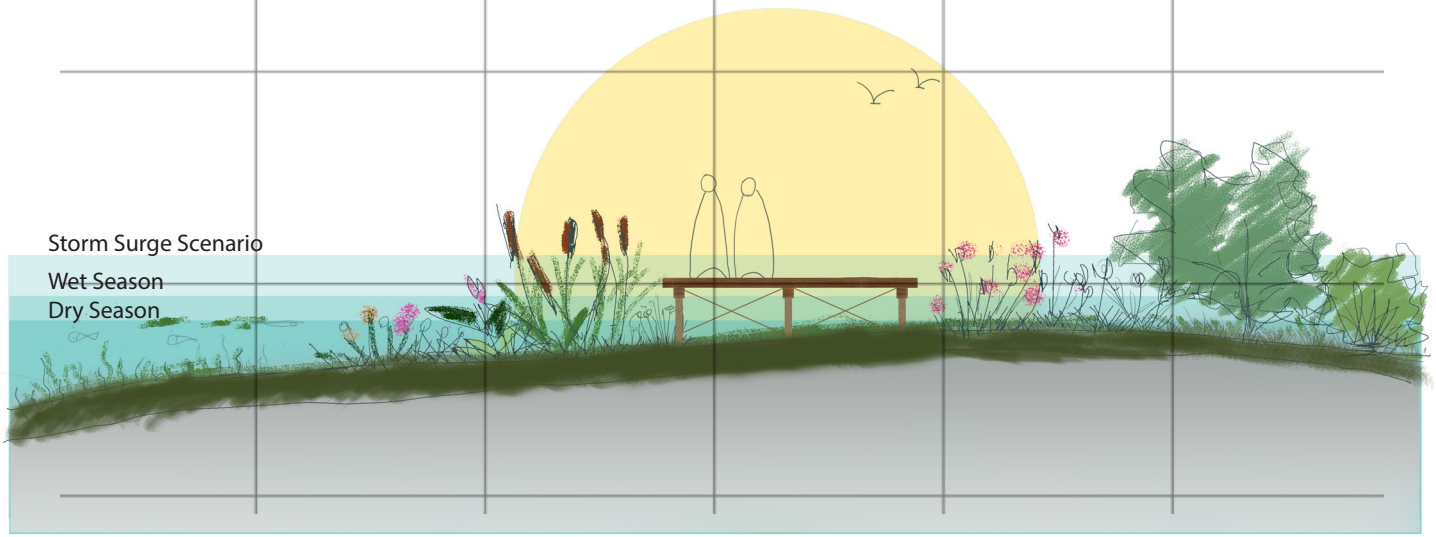
Pickerelweed



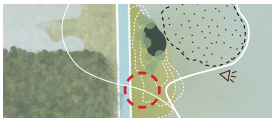
Duck potato

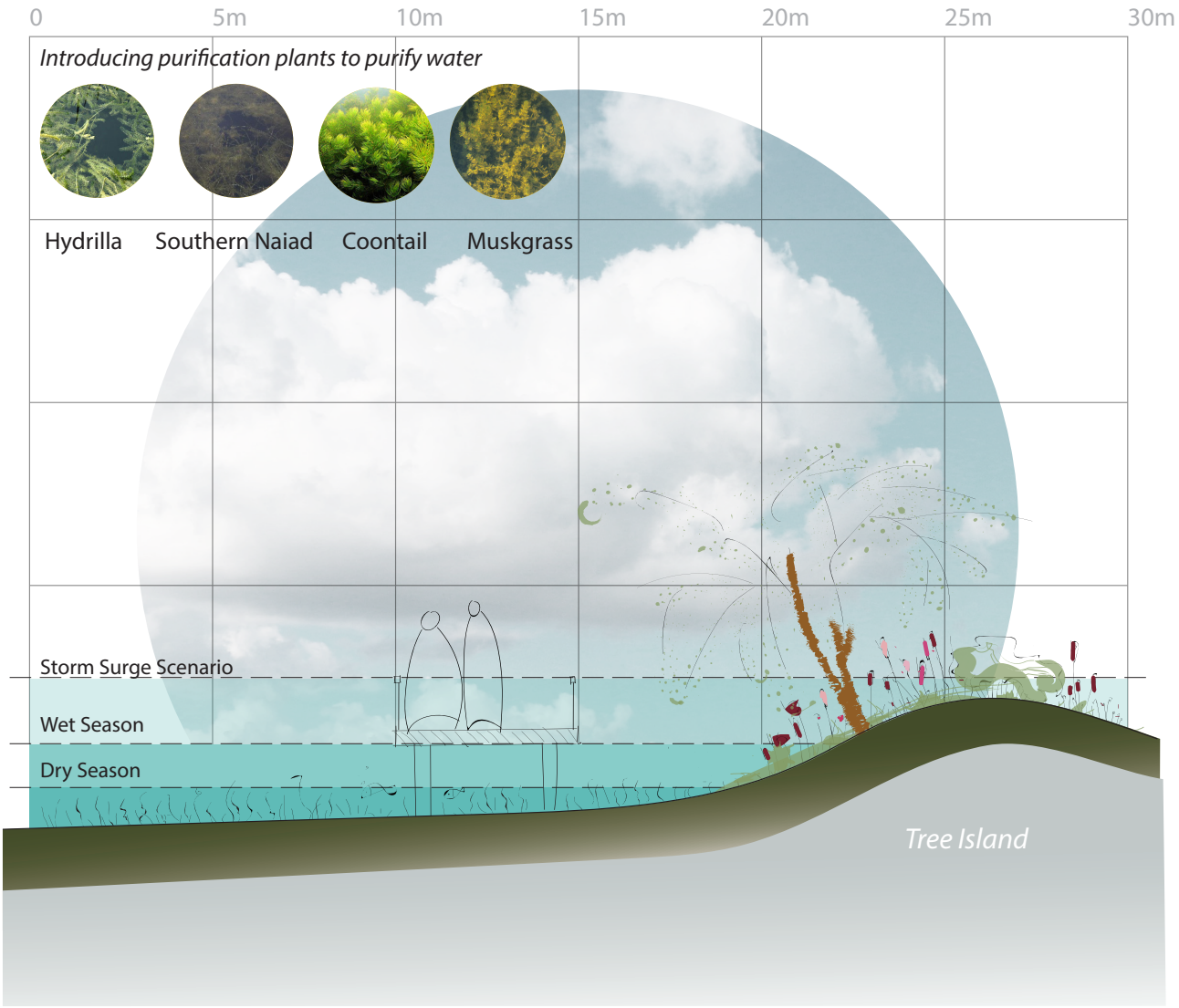


Water primrose



Proposed Trail in the Marsh Zone

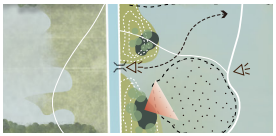




Proposed Trail in the Pond & Slough Zone

Eye-level Spatial Implication

Marsh Experience

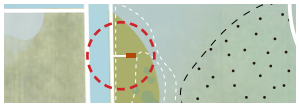


Location




Recreational Trail
of Birds
Purification Reed

Eye-level Spatial Implication



Viewing from the fishing platform in the pond and slough zone, along the recreational trail.



Dry Season



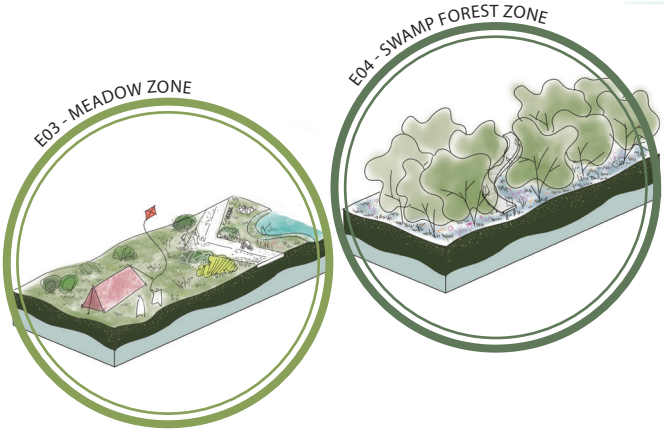
Wet Season

2

Meadow and Swamp Forest Unit

Zones: Meadow Zone, Swamp Forest Zone

This units explains the design situation of meadow zone, swamp forest zone, the connection between the two zones, the observation tower, hiking trail in the swamp forest and concludes with the construction process.



Experiential Value

Sightseeing

Hiking

Recreational Fishing

Ecological Value

Water Retaintion

Biodiversity

Peat Retaintion

Wildlife Habitat

Economic Value

Camping

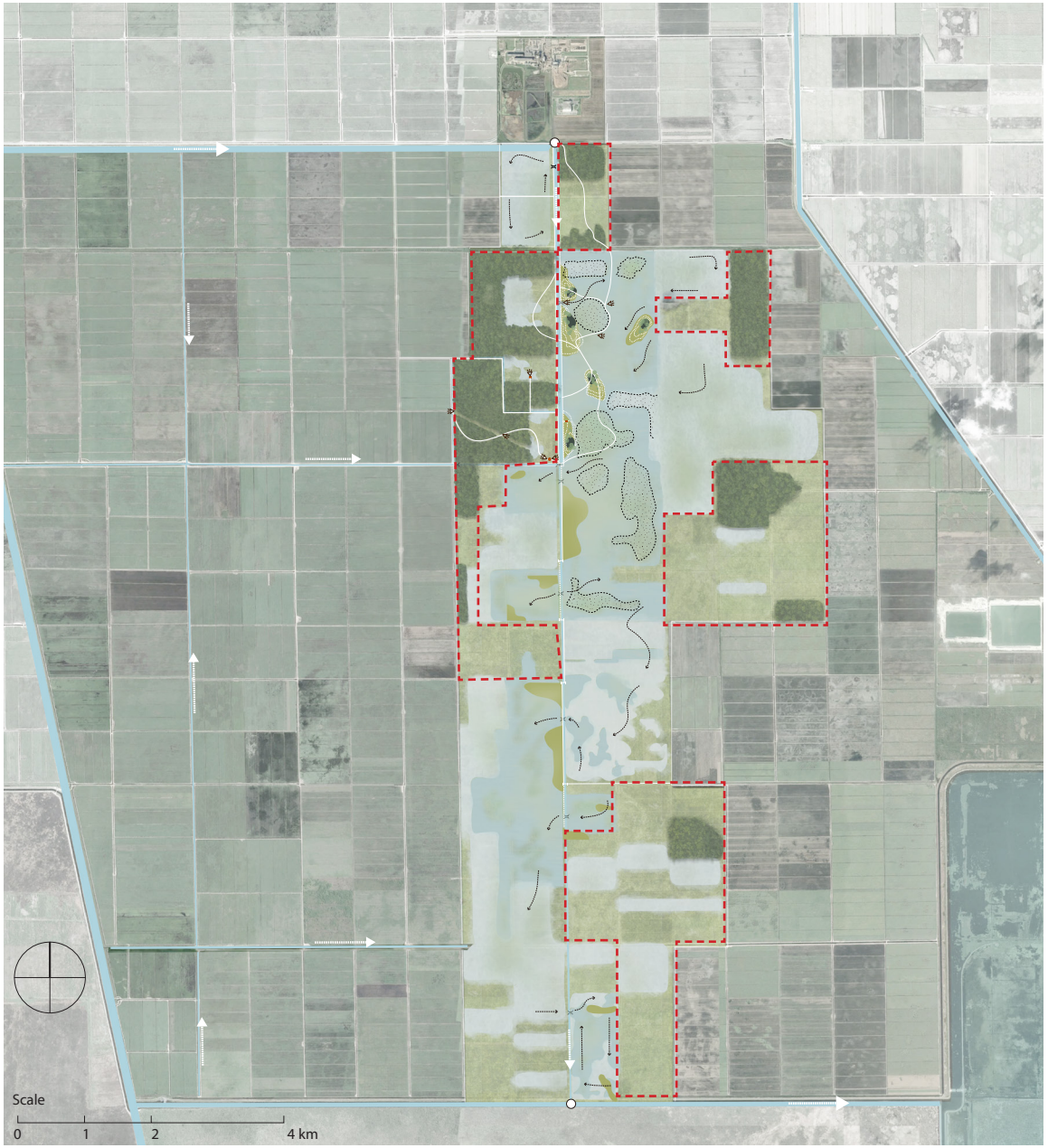
Agroforestry

Rice & Crawfish Polyculture

Waterfowl Hunting

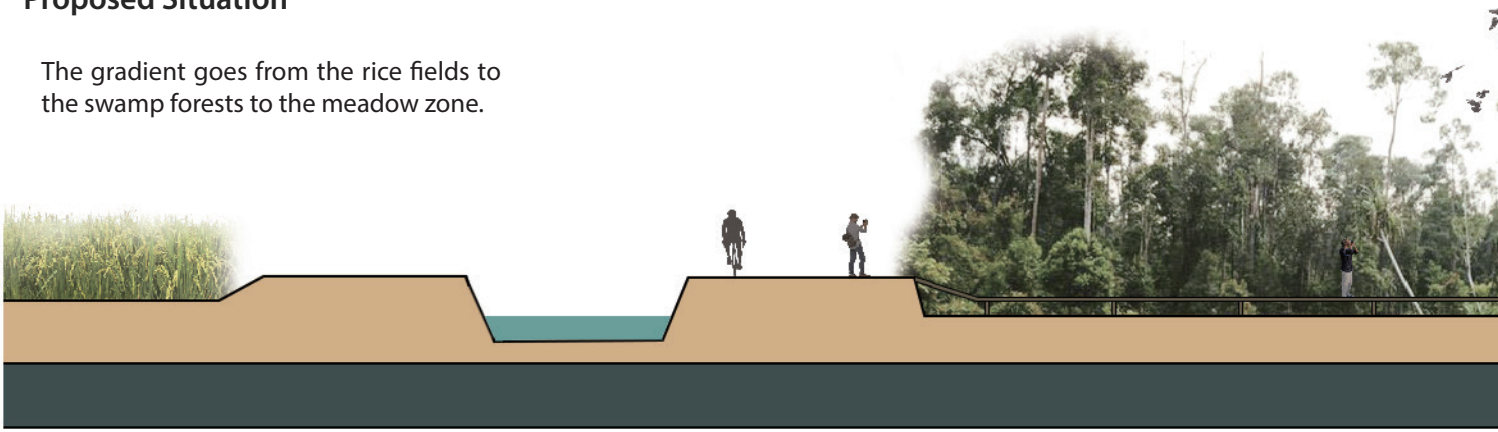
Agritourism

2.2 Zoom-In
Meadow and Swamp Forest Unit

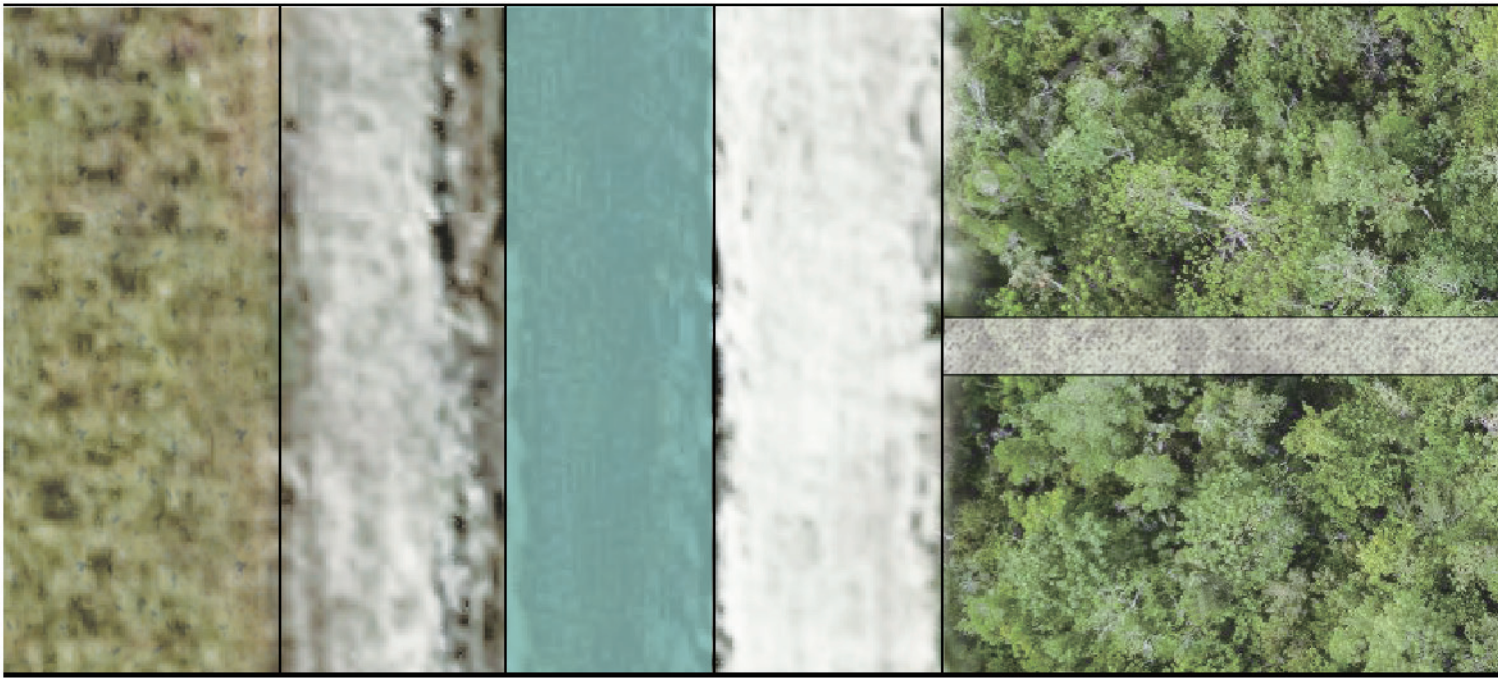


Proposed Situation

The gradient goes from the rice fields to the swamp forests to the meadow zone.



Rice Field | Path | Canal | Path | Swamp Forest



0 5 10 15m



SECTION 1:200

Path

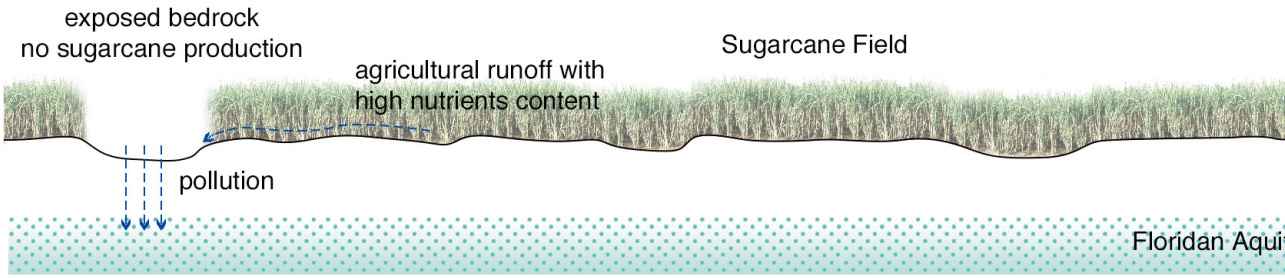
Meadow



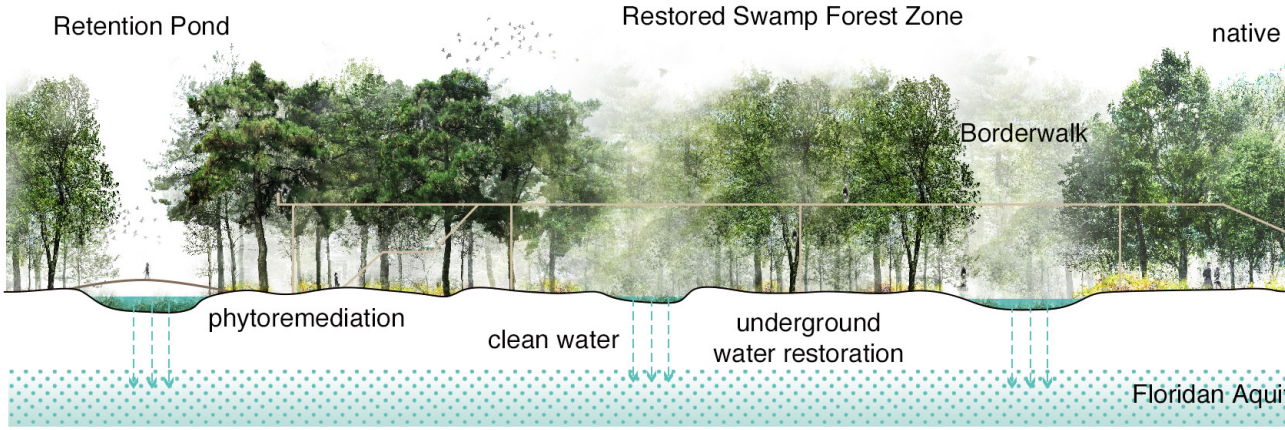
PLAN 1:200

Transformation Dynamics

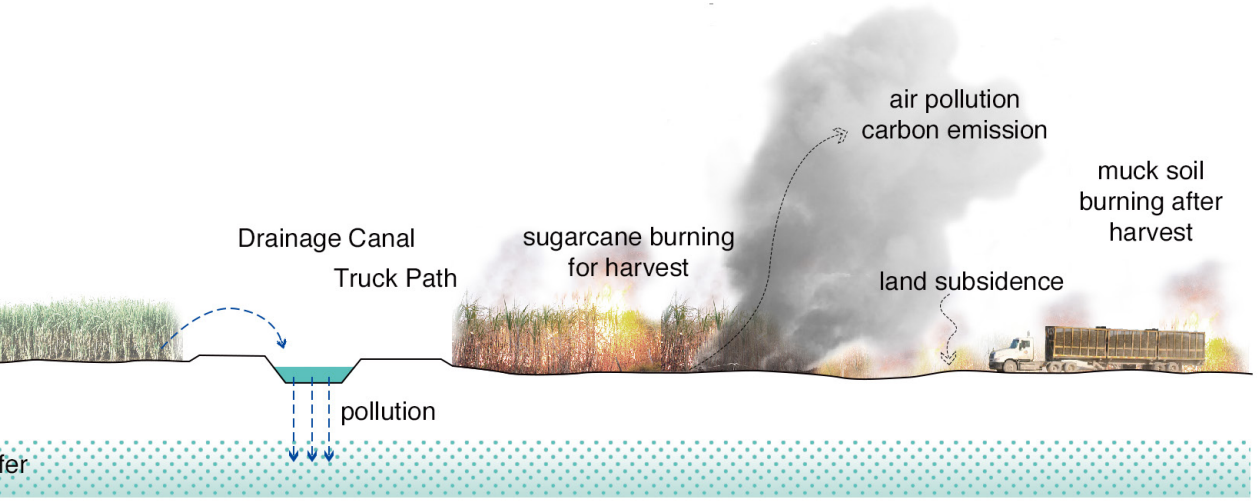


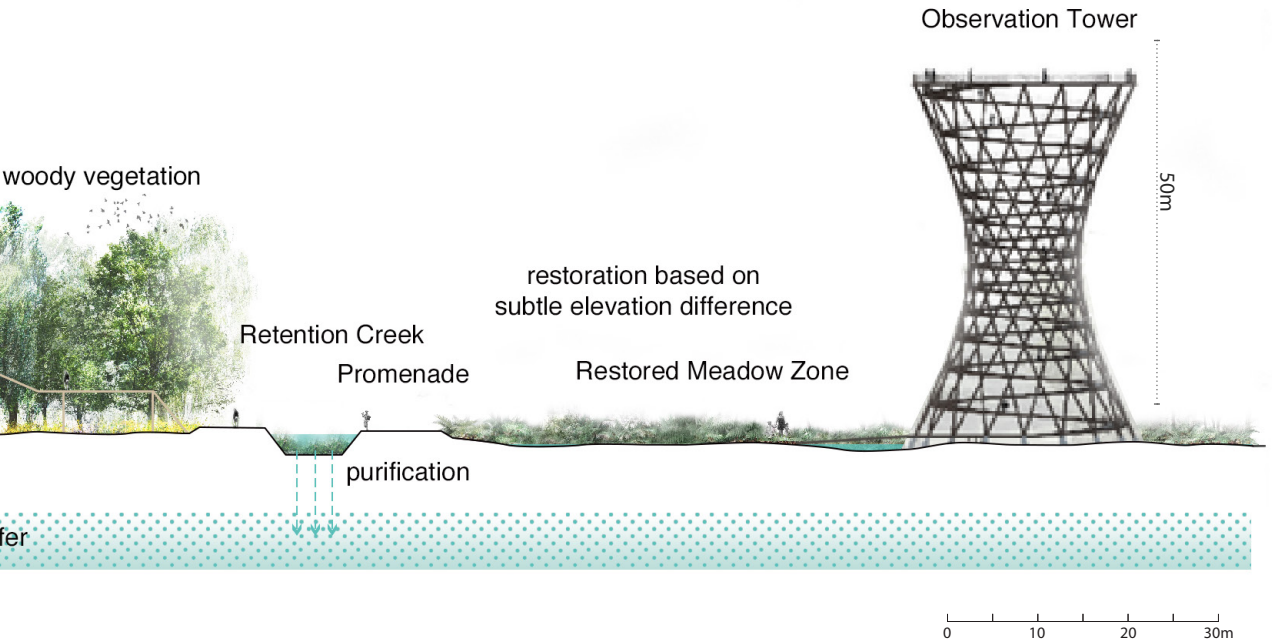


Current Situation



Designed Situation

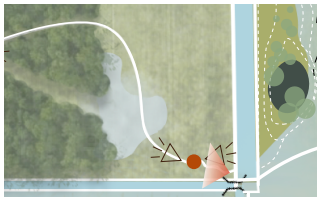

air pollution
carbon emission
muck soil
burning after
harvest
Drainage Canal
Truck Path
sugarcane burning
for harvest
land subsidence
pollution
fer


Observation Tower
50m
woody vegetation
restoration based on
subtle elevation difference
Retention Creek
Promenade
Restored Meadow Zone
purification
fer
0
10
20
30m

Increase Accessibility & Awareness

Views varying in heights and openness are created. Visitors are invited to the site to experience the change of the landscape along the trail from the open meadow to the enclosed forest and in the end reaching the top of the observation tower with 50m height, where the view is opened again and they can overlook the whole Everglades lands and amaze at the natural order of the Everglades.

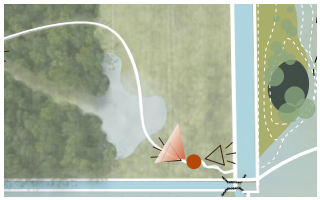




Cycling trail to the observation tower

Location



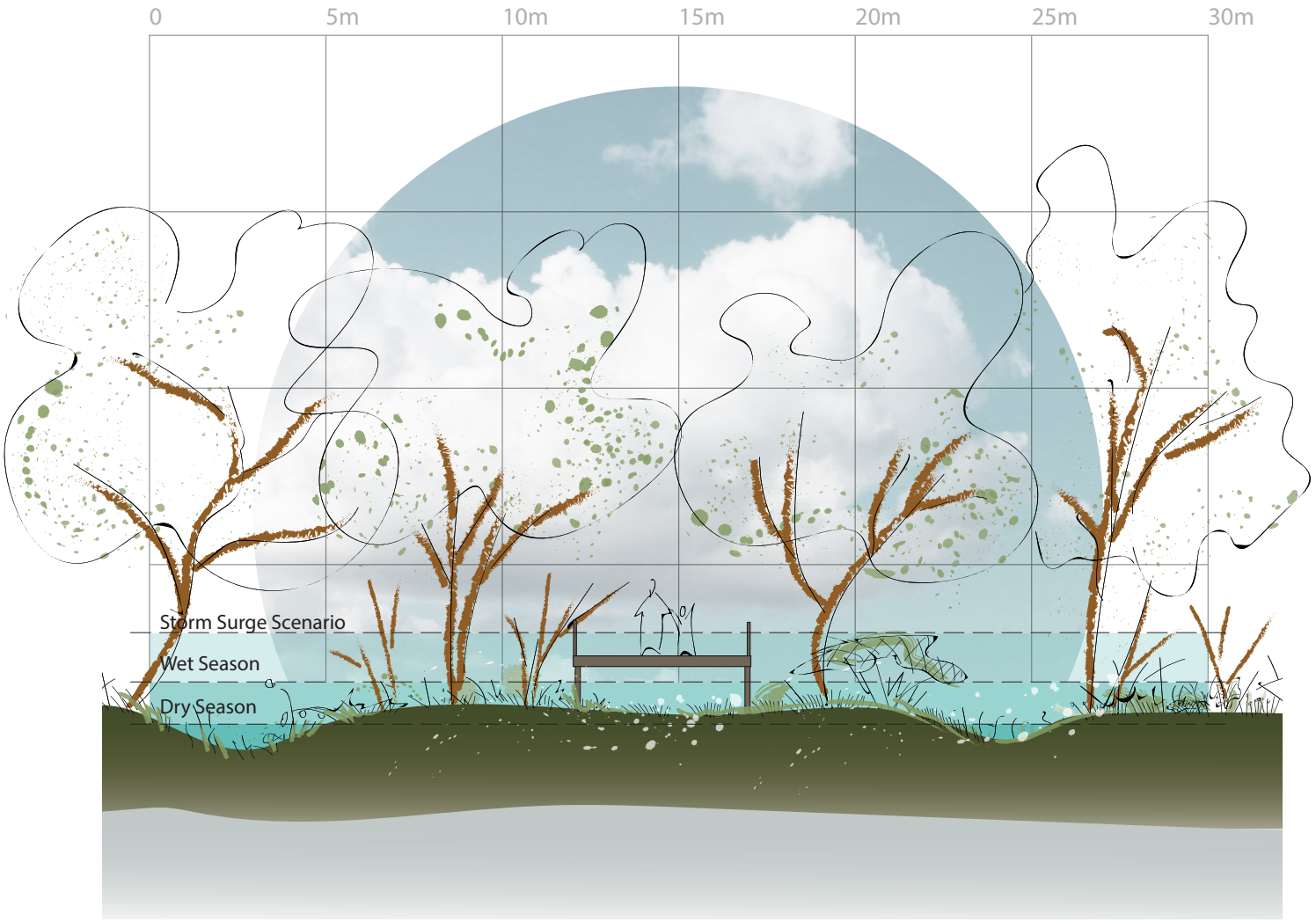


Overlook from the tower

Location

Increase Accessibility & Awareness

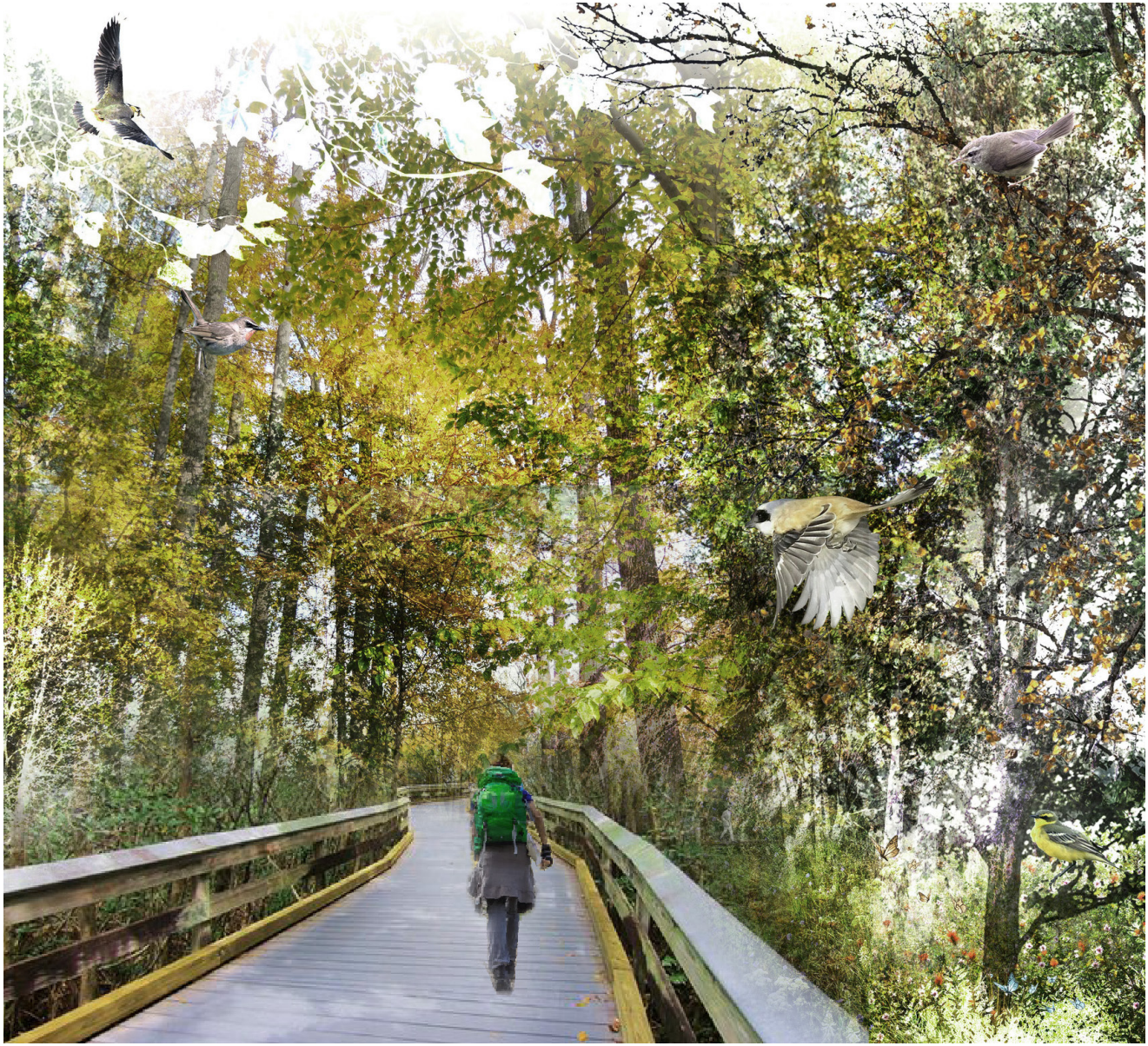
Hiking trail in the swamp forest





Location

Eye-level Spatial Implication



Landscape as Process



The landscape is regarded as a process, rather than a product. The water comes from the canals and the local precipitation. The seeds of native meadow species will be spread, and the ditches will be kept and transformed into purification waterways. The site will be facilitated with recreational activities. New programmes will be introduced such as fishing, camping and hiking.

1

Current situation



2

Flood Sugarcane Field



3

Seed wet field



4

Introduce new programs






precipitation
agricultural runoff


seed the prepared field with
native meadow species
keep the ditch
seed with purification plants


plants grow & evolve into
sustainable meadow
landscape

3

This unit mainly explores the border between the restoration area and the ricefields: Those between the ricefields and the meadow, swamp forest, and marsh zones.

Designed Situation
- Swamp Forest & Rice Field
- Meadow & Rice Field
- Marsh & Rice Field

Zones: Swamp Forest Zone, Meadow Zone, Marsh Zone, Rice Field

Experiential Value

Sightseeing

Hiking

Recreational Fishing

Ecological Value

Water Retaintion

Biodiversity

Peat Retaintion

Wildlife Habitat

Economic Value

Camping

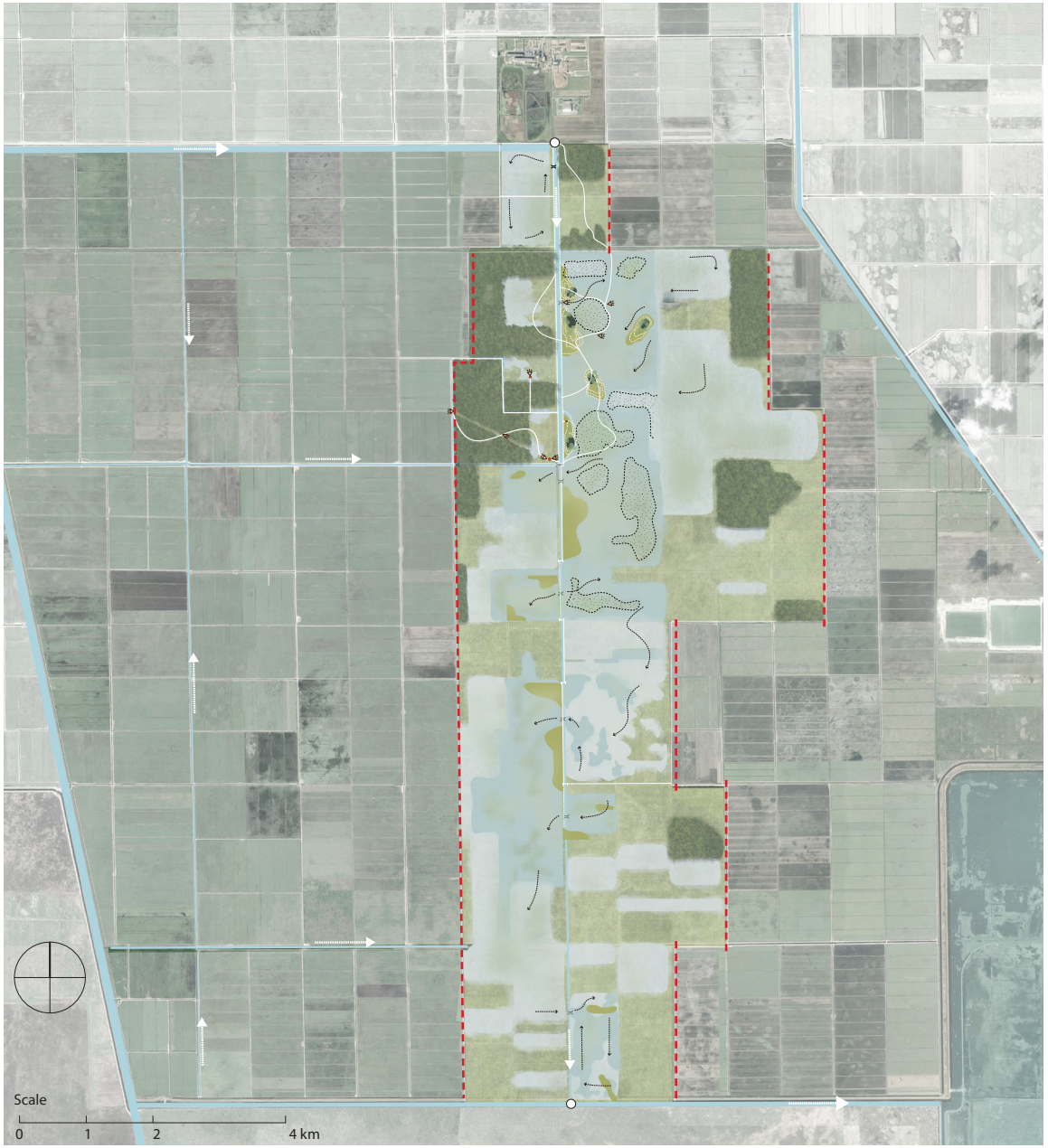
Agroforestry

Rice & Crawfish Polyculture

Waterfowl Hunting

Agritourism

2.3 Zoom-In
Rice Field & Swampland Unit

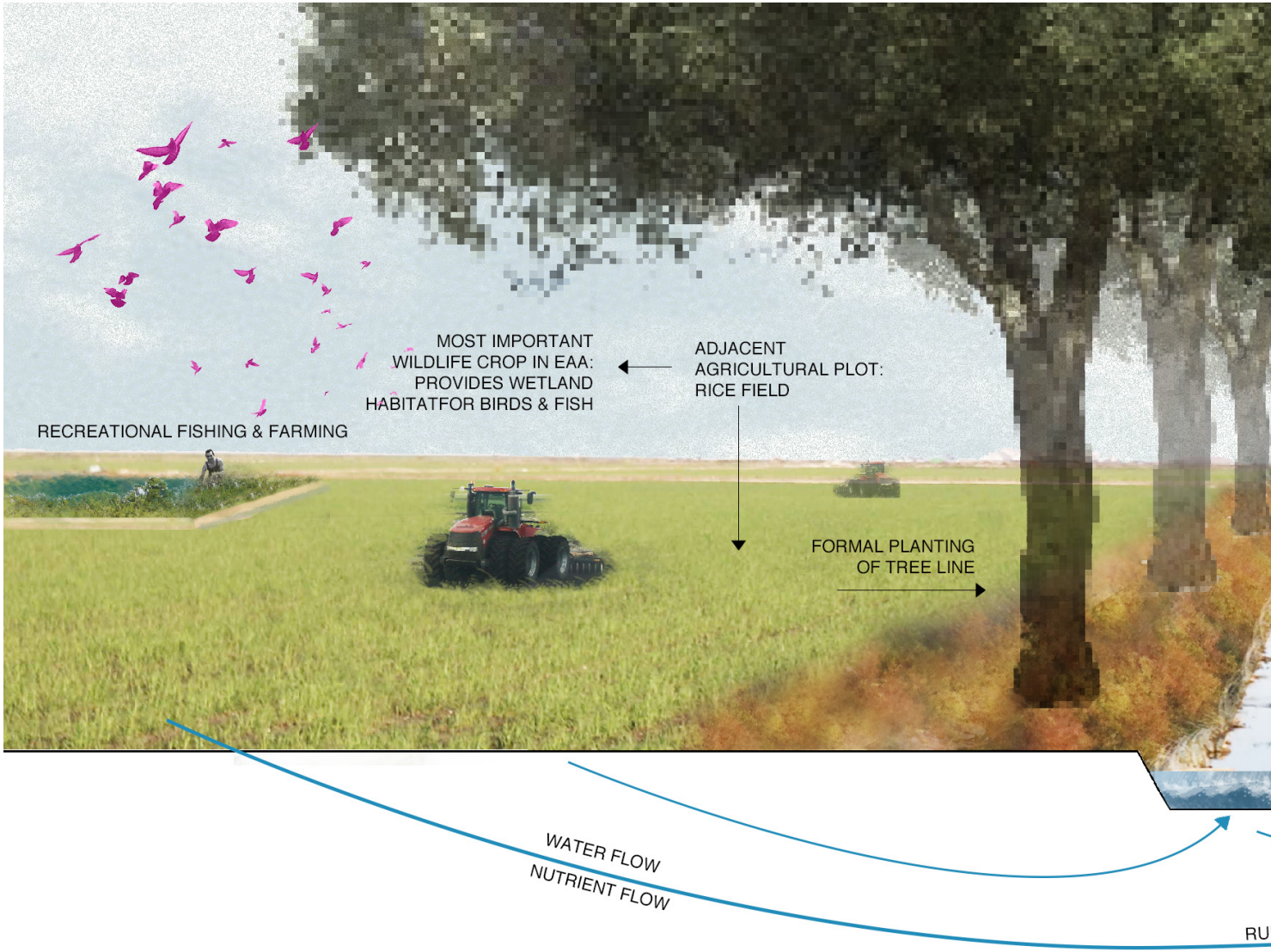


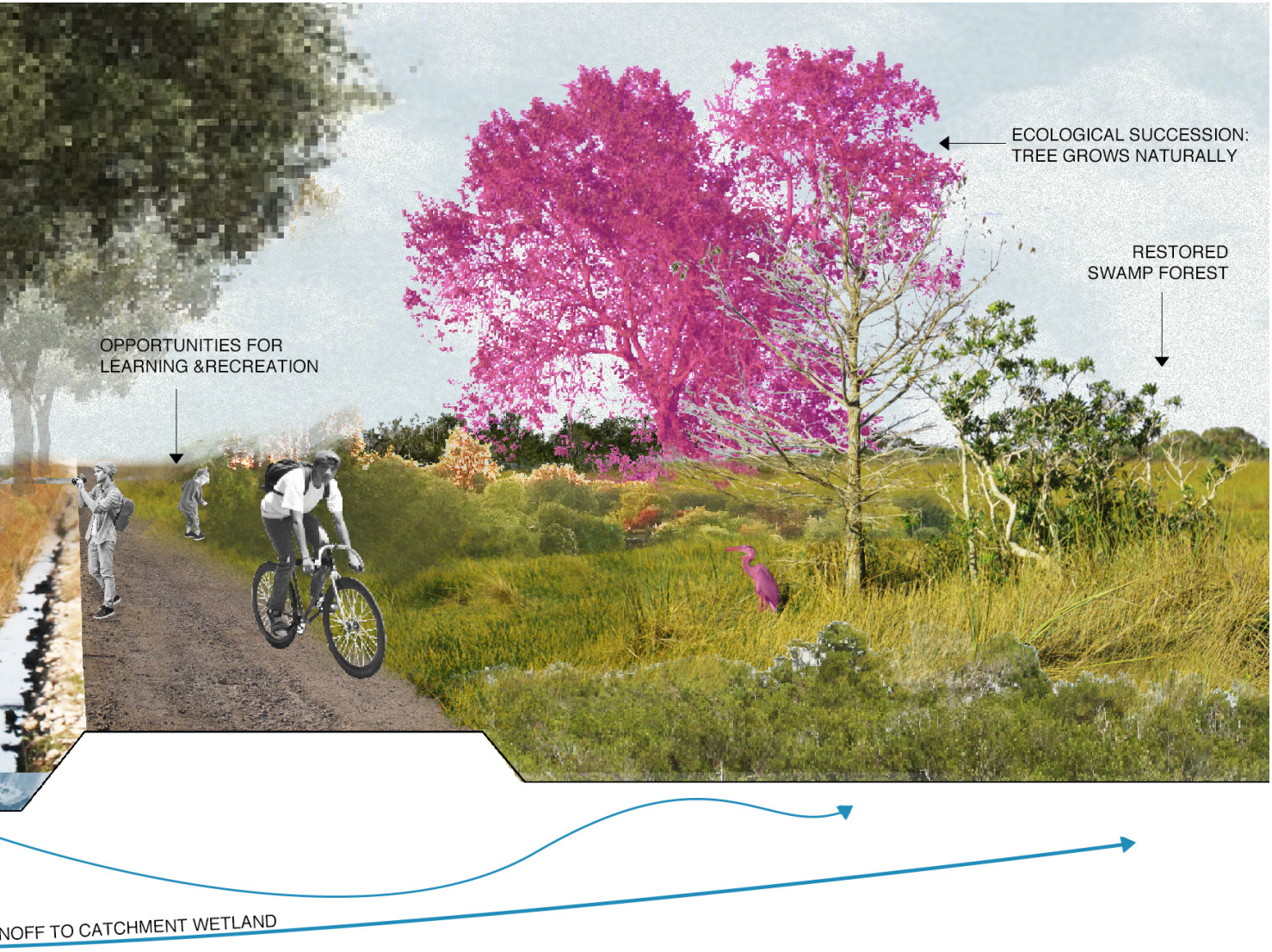
Current Situation: Spatial Homogenization



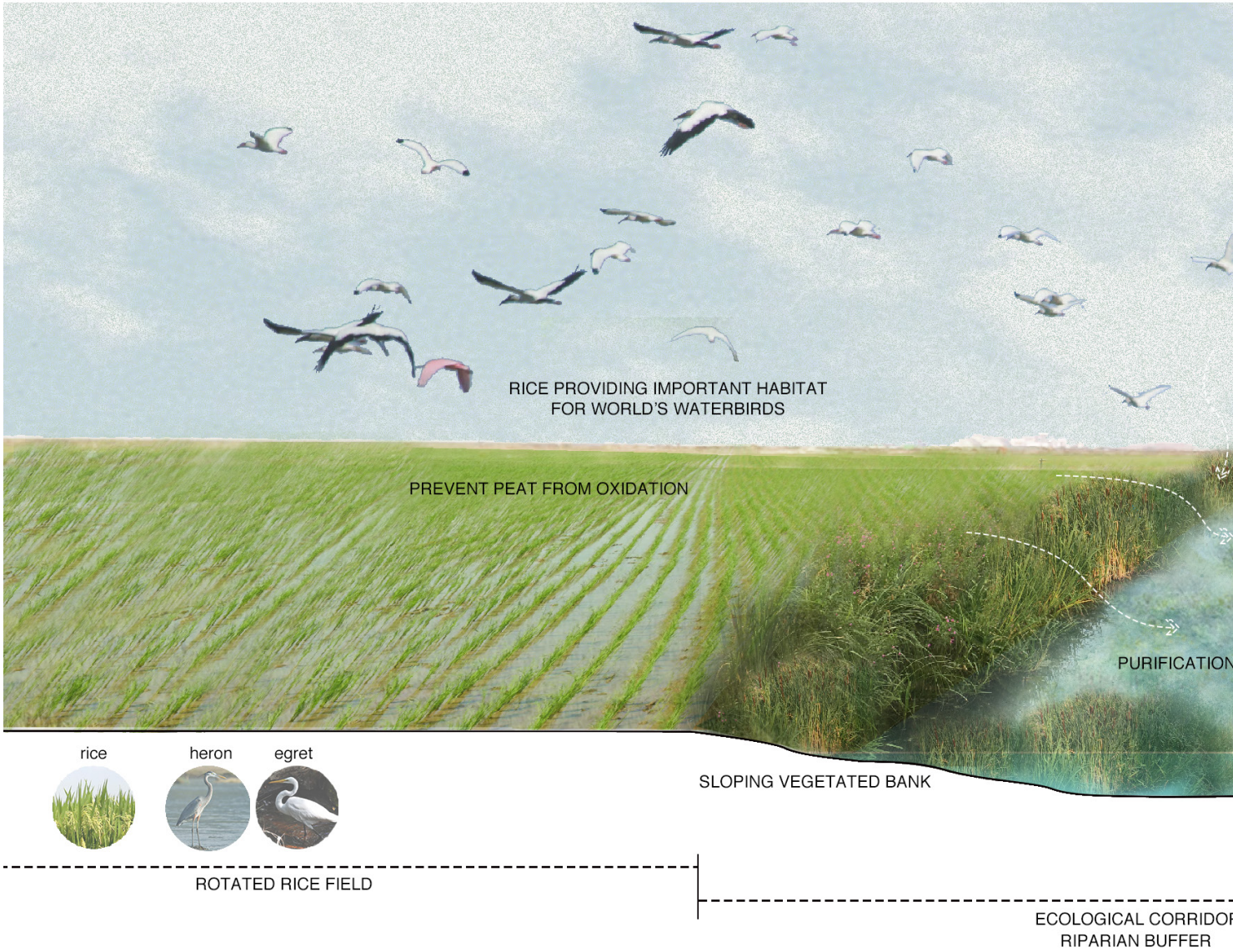


Designed Situation - Swamp Forest & Rice Field




ECOLOGICAL SUCCESSION:
TREE GROWS NATURALLY
RESTORED
SWAMP FOREST
OPPORTUNITIES FOR
LEARNING &RECREATION
NOFF TO CATCHMENT WETLAND

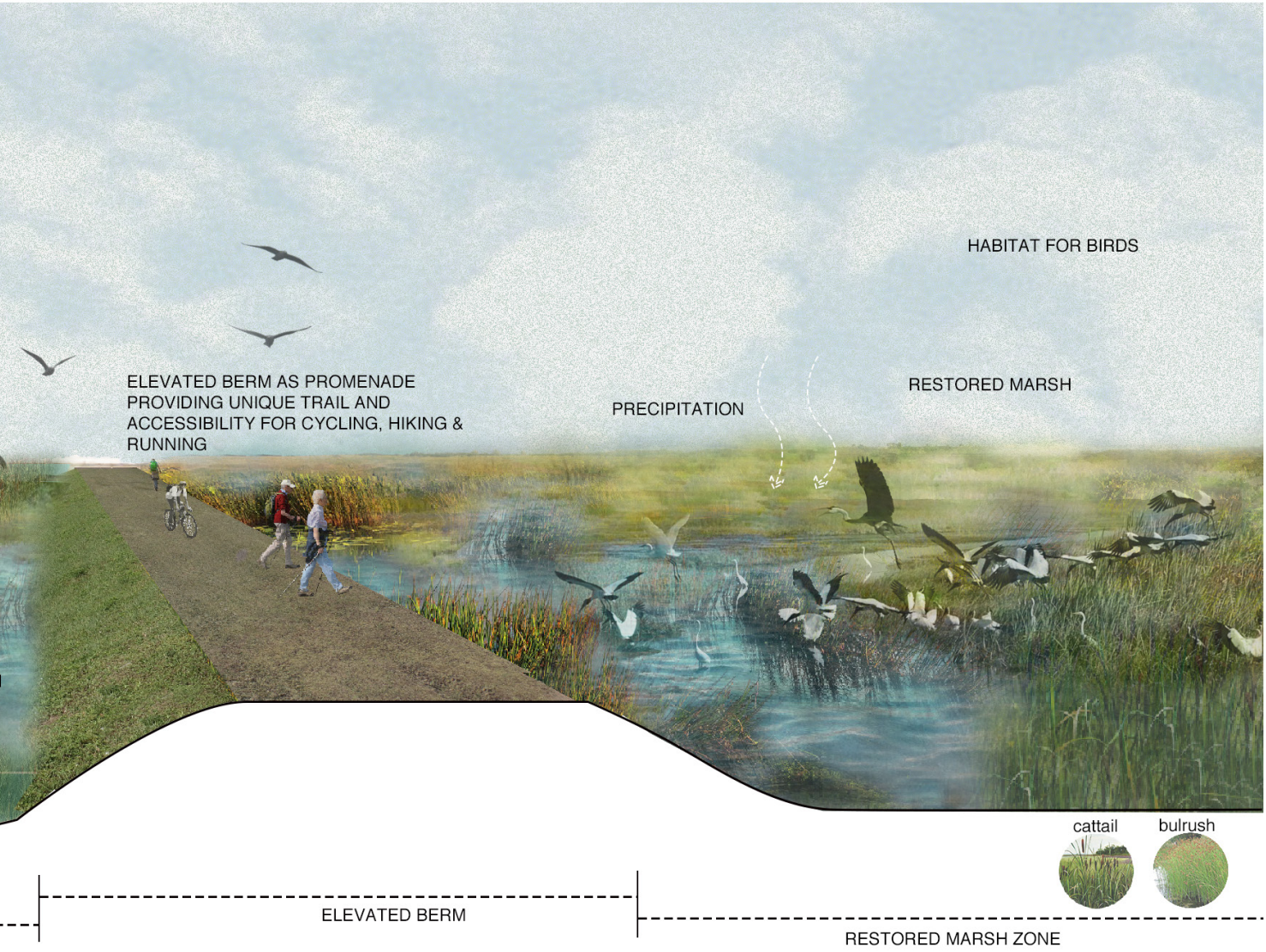
Designed Situation - Meadow & Rice Field




HABITAT FOR BIRDS
RESTORED MEADOW
PRECIPITATION
ACCESSIBLE TO THE PUBLIC FOR
EDUCATION &RECREATION
SURFACE RUN-OFF
TERRACED BANK
cattail
bulrush
sawgrass
HIKING TRAIL
RESTORED MEADOW ZONE

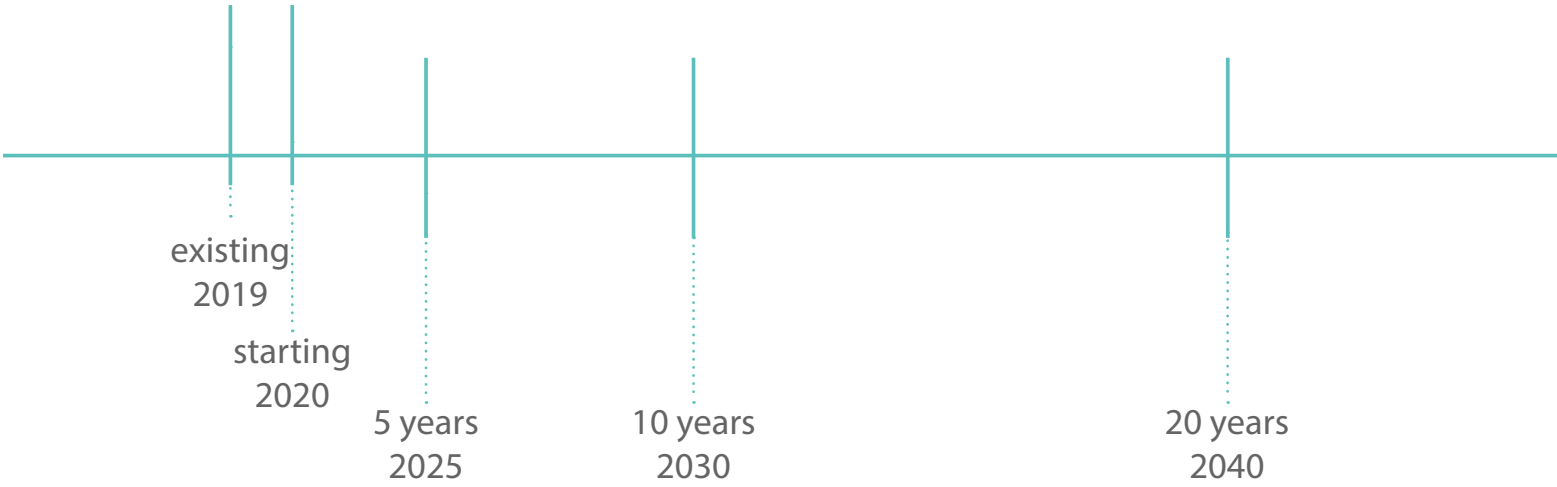
Designed Situation - Marsh & Rice Field




HABITAT FOR BIRDS
ELEVATED BERM AS PROMENADE PROVIDING UNIQUE TRAIL AND ACCESSIBILITY FOR CYCLING, HIKING & RUNNING
PRECIPITATION
RESTORED MARSH
cattail
bulrush
ELEVATED BERM
RESTORED MARSH ZONE

3. CHANGE IN TIME

3.1 Development Strategy
3.2 Phasing and Development



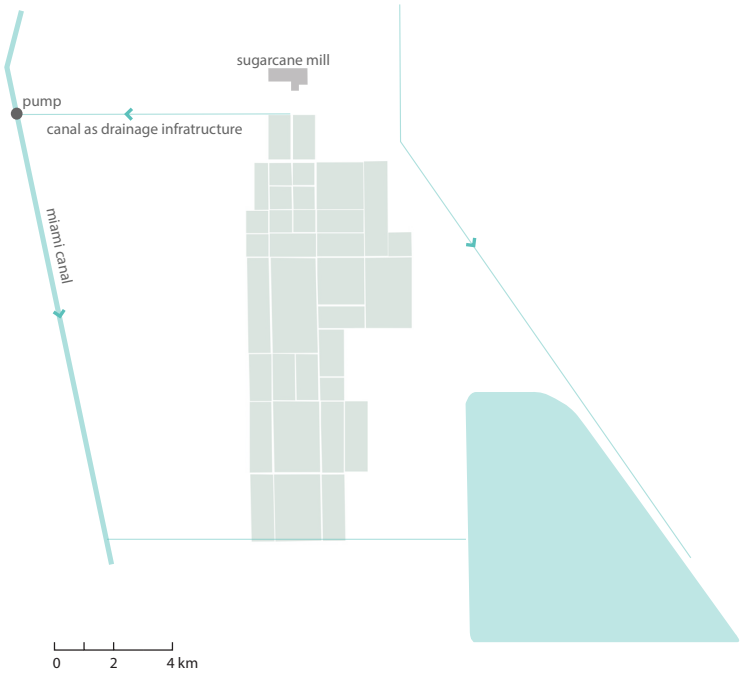
TIME +



3.1 DEVELOPMENT STRATEGY | Ecological Conservation & Holistic Interaction

1

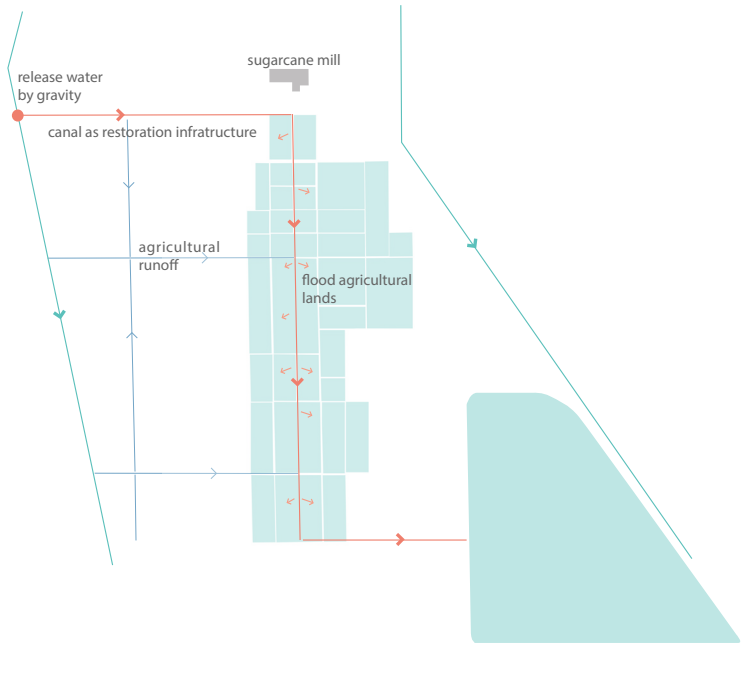
Existing Conditions



2019

2

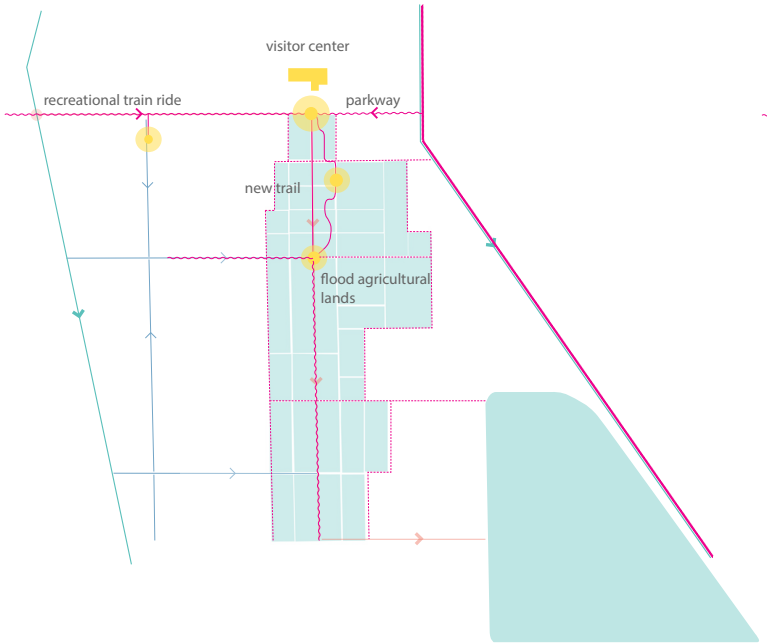
Retain & Purify Water
Tranform Agricultural Land into Wetland
Adjust Adjacent Sugarcane Field into Rice Field



Starting, 2020

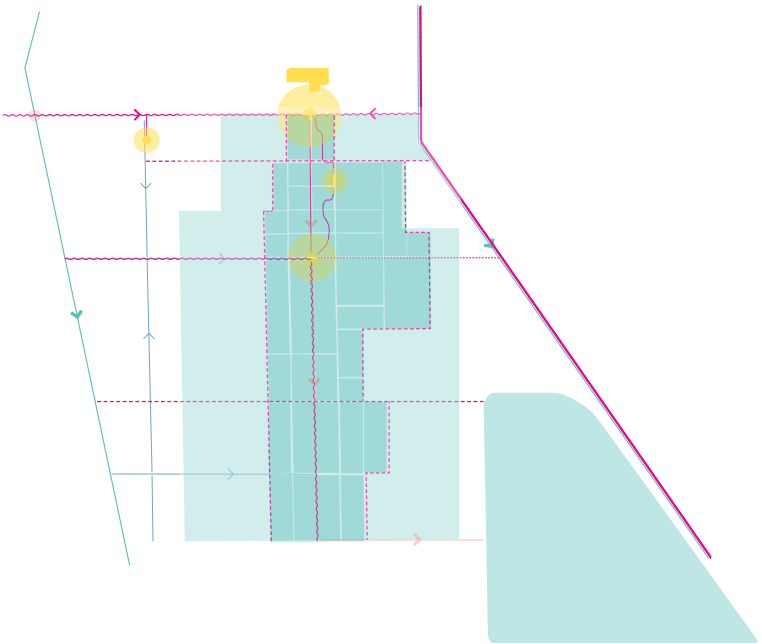
3

Grow 4 Main Habitats Based on Gradients
Introduce New Programs
Connect with the Public



4

Evolve, Interact & Expand



5 years, 2025

30 years, 2050

3.2 PHASING AND DEVELOPMENT

The transformation brings the past plant communities back based on the difference of topography and water level, and creates conditions for ecological succession.

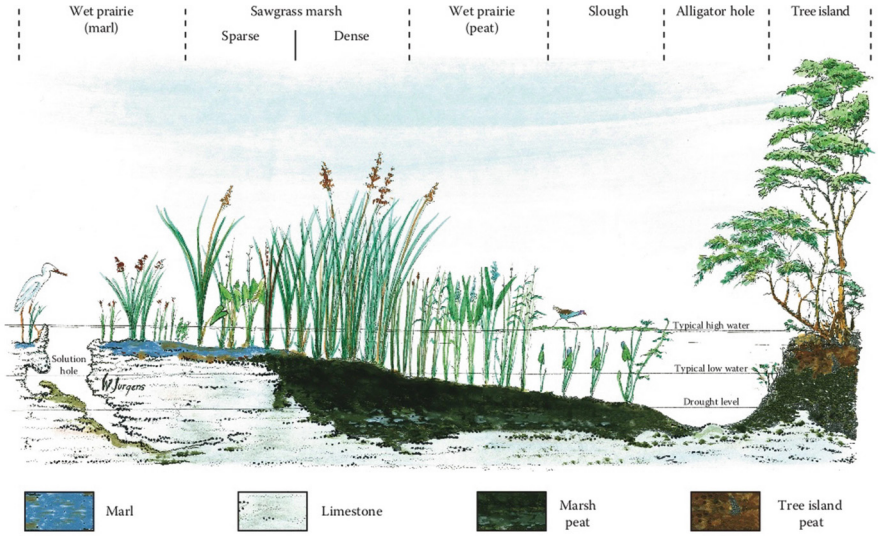


Figure 55. Cross section of typical Everglades plant communities, water levels, and underlying soils and bedrock (https://link.springer.com/chapter/10.1007/978-3-030-20070-1_1)

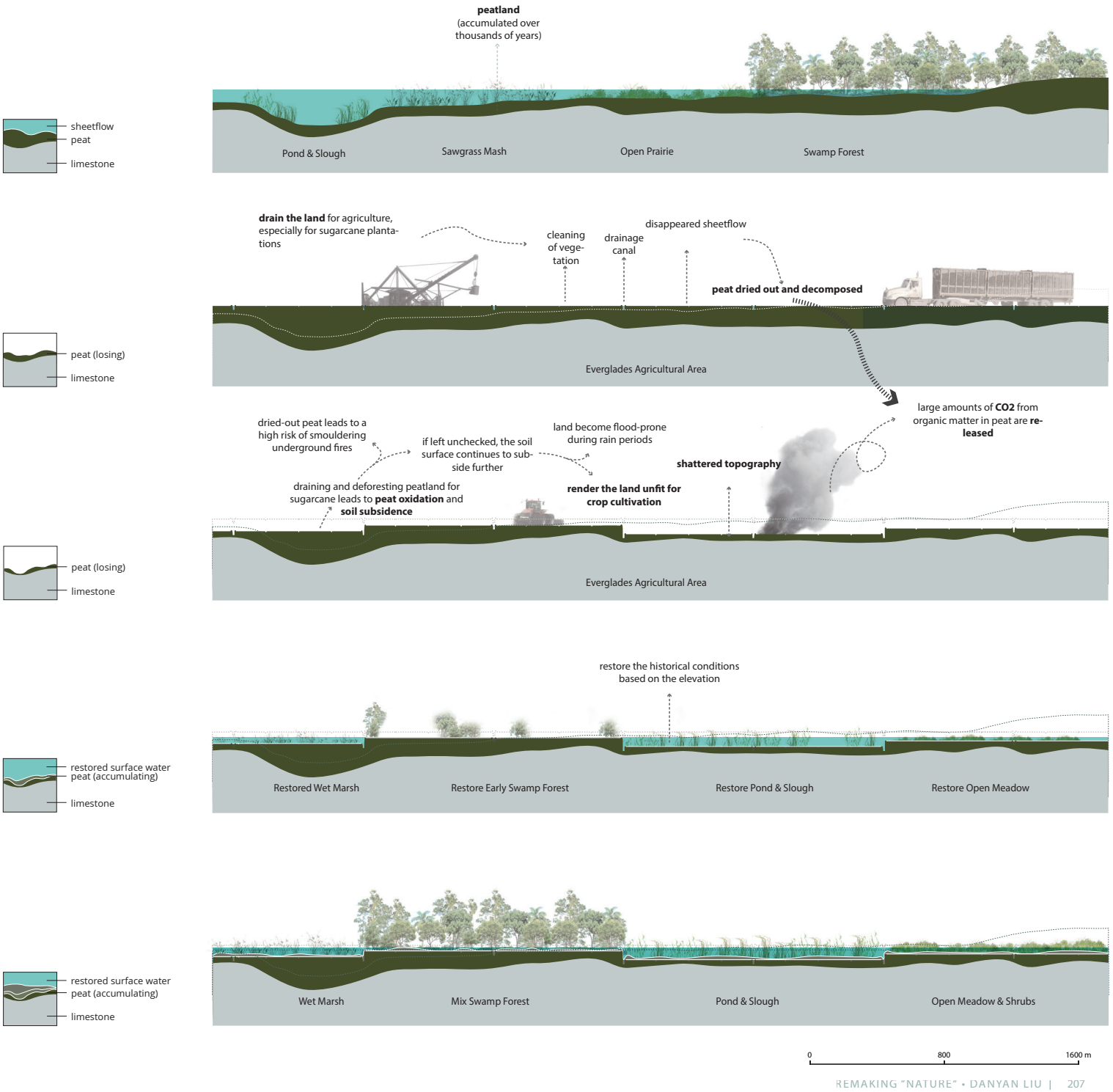
Before Drainage
1900

After Drainage
1950

Existing Conditions
2019

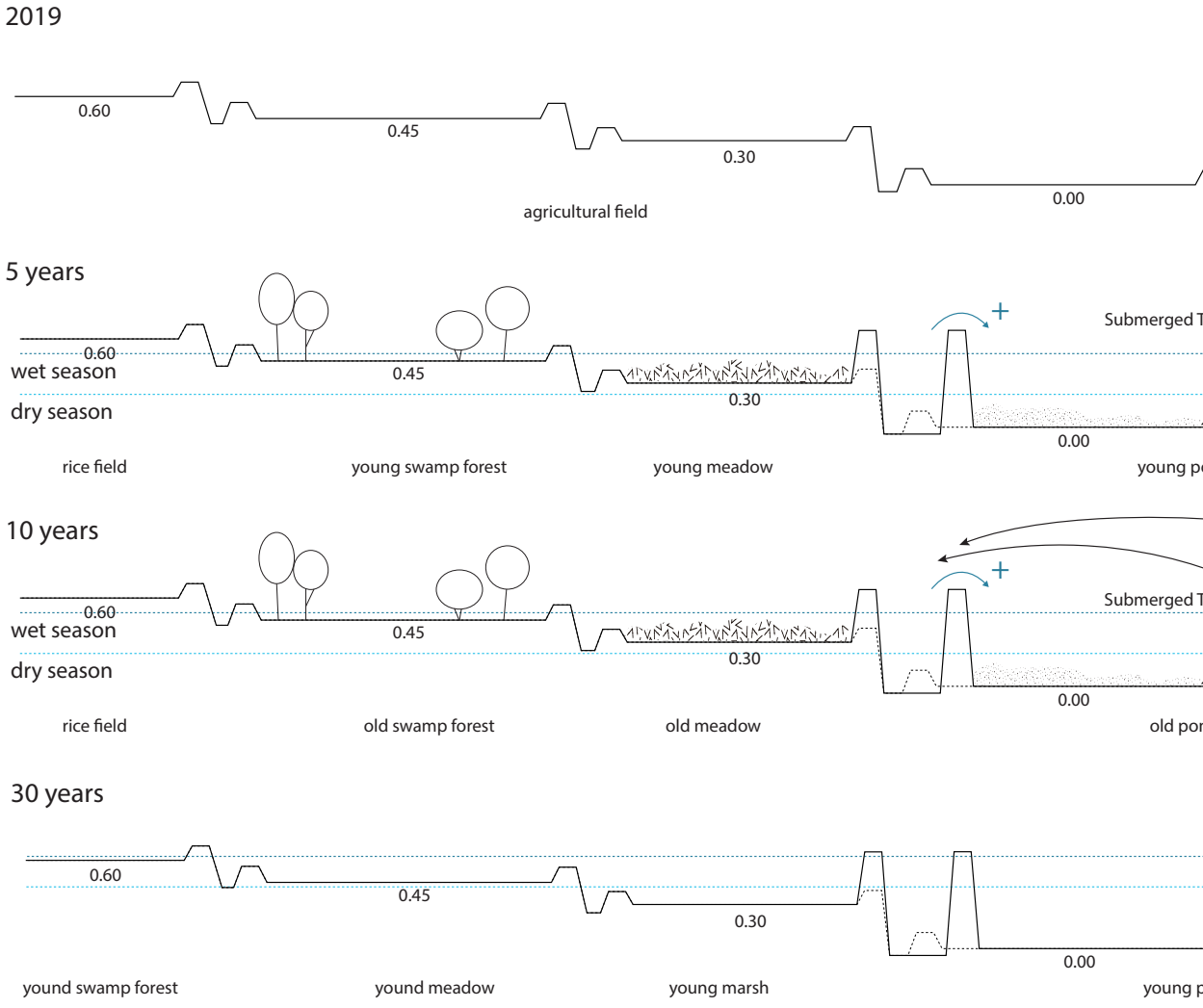
Restoration
5 years, 2025

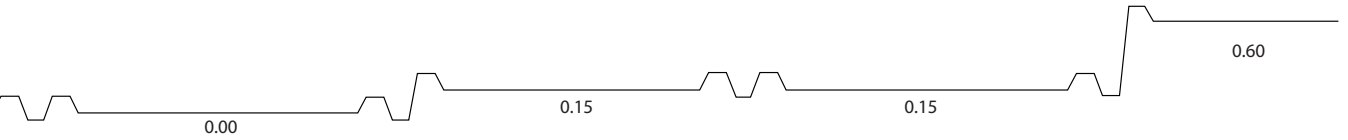
Evolution
30 years, 2050

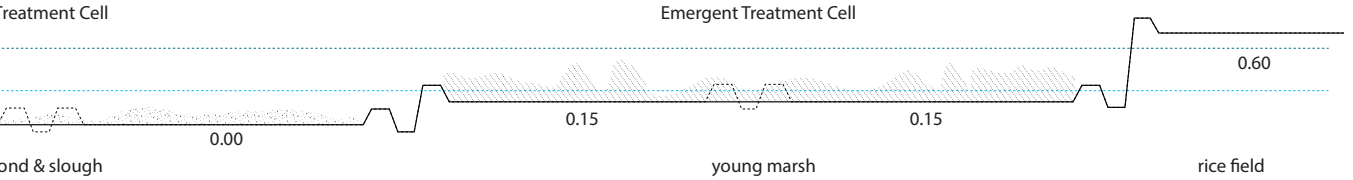

peatland
(accumulated over
thousands of years)
sheetflow
peat
limestone
Pond & Slough
Sawgrass Mash
Open Prairie
Swamp Forest
drain the land for agriculture, especially for sugarcane plantations
cleaning of vegetation
drainage canal
disappeared sheetflow
peat dried out and decomposed
peat (losing)
limestone
Everglades Agricultural Area
large amounts of CO2 from organic matter in peat are released
dried-out peat leads to a high risk of smouldering underground fires
if left unchecked, the soil surface continues to subside further
land become flood-prone during rain periods
shattered topography
draining and deforesting peatland for sugarcane leads to peat oxidation and soil subsidence
render the land unfit for crop cultivation
peat (losing)
limestone
Everglades Agricultural Area
restore the historical conditions based on the elevation
restored surface water
peat (accumulating)
limestone
Restored Wet Marsh
Restore Early Swamp Forest
Restore Pond & Slough
Restore Open Meadow
restored surface water
peat (accumulating)
limestone
Wet Marsh
Mix Swamp Forest
Pond & Slough
Open Meadow & Shrubs
0
800
1600 m

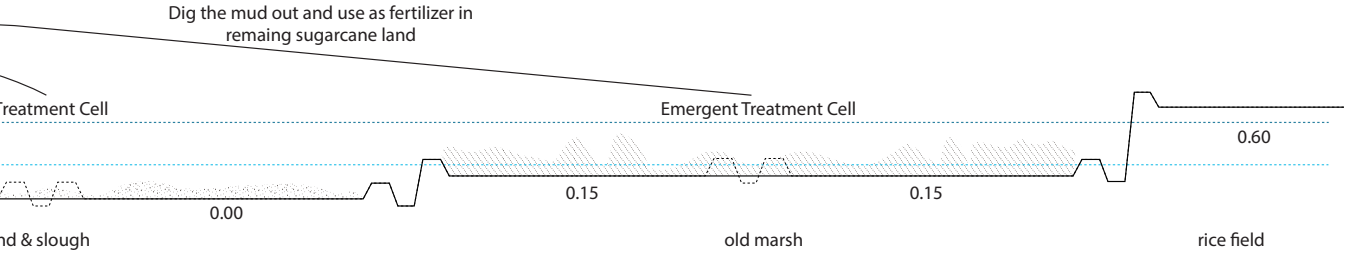
3.2 PHASING AND DEVELOPMENT

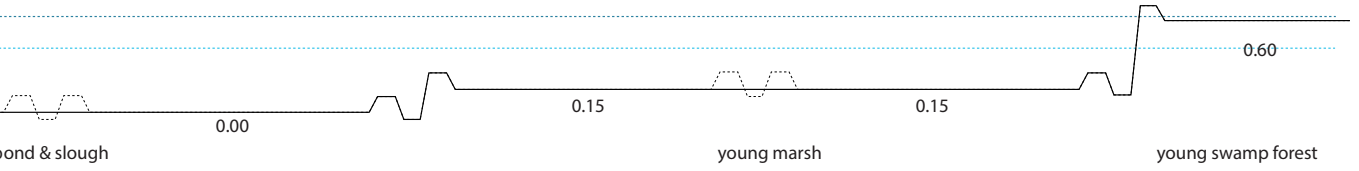
In the future, the storage of water might become increasingly vital. In this case, the rice fields surrounding the restoration zone should be flooded to become part of the latter. The water level would be raised further using the same canal to expand the restoration area. The levees along the Miami Canal and North New River Canal will stop the water from flooding other areas.




0.60
0.15
0.15
0.00


Treatment Cell
Emergent Treatment Cell
0.60
0.15
0.15
0.00
ond & slough
young marsh
rice field


Dig the mud out and use as fertilizer in
remaing sugarcane land
Treatment Cell
Emergent Treatment Cell
0.60
0.15
0.15
0.00
nd & slough
old marsh
rice field


0.60
0.15
0.15
0.00
ond & slough
young marsh
young swamp forest

3.2 PHASING AND DEVELOPMENT

Existing Land Evaluation

- Elevation & Peat Depth
- Existing Plantations
- Agriculture / Industry
- Fallow Fields

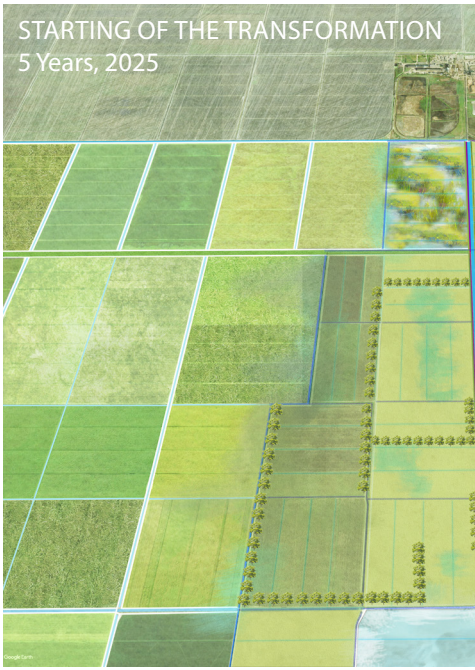
Prioritization of Conservation Parcel Boundaries

- Stop Pumping
- Crops Removal
- Diverse Land-Use
- Flood the Agricultural Field
- Spread Diverse Seeds
- Plant Diverse Tree Saplings

Public-Private Partnerships For EAA Conservation

- Form Transformation
- Sustainable Agricultural Practices
- New Economic Agroforestry
- Incentives for transformation

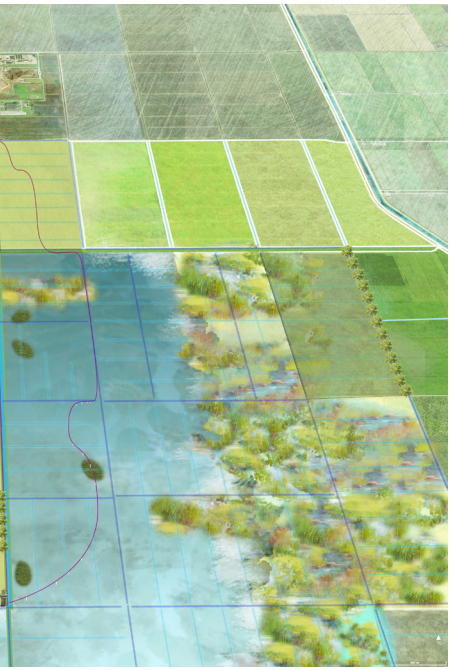


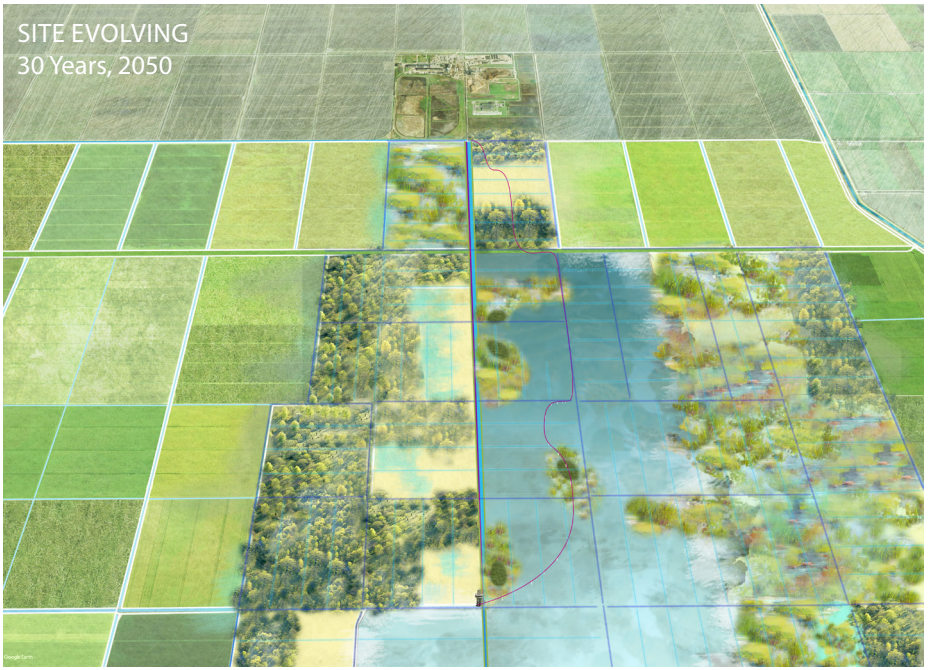


Education & Recreation & Tourism Programming

Habitat Monitoring & Research

- Eco-Tourism
- Camping and Hiking
- Native Plant Nurseries
- Educational Landscapes
- Community Outreach





4. CHANGE IN SPACE

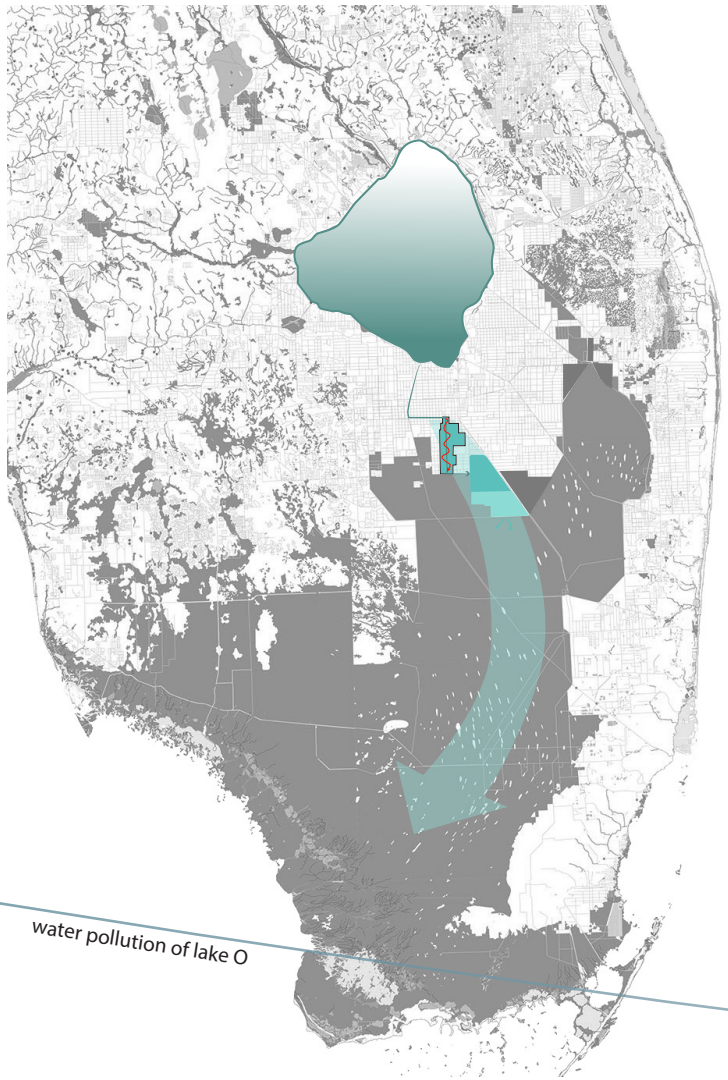
4.1 Future Strategic Transformation Plan
4.2 Impact of transforming EAA on CERP
4.3 Impact of the EAA Transformation on the Region

SPACE +

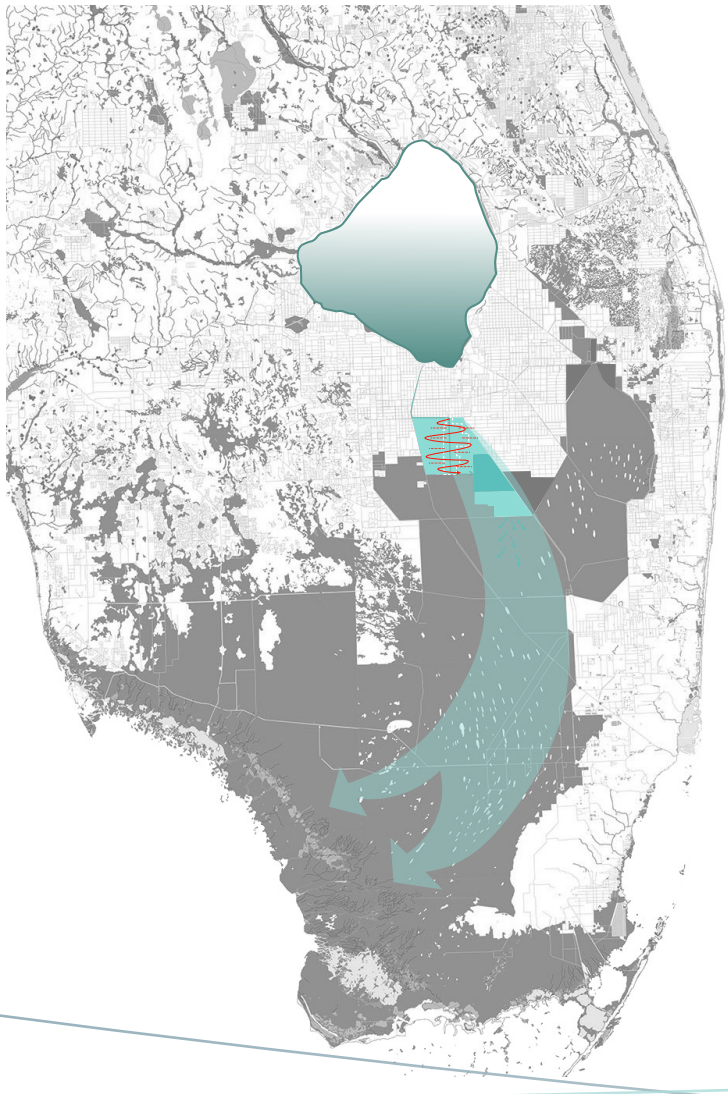
4.1 Future Strategic Transformation Plan

Firstly, the design of the pilot areas will help restore the first healthy peatland in the EAA. Then the priority of the restoration will be on establishing the crucial water corridor. When there is more need for water storage and the sake of the Everglades ecosystem in the future, this intervention can be replicated in other areas.

1+ Restore the First Healthy Peatland in EAA



2+ Site Evolve & Expand



water pollution of lake O

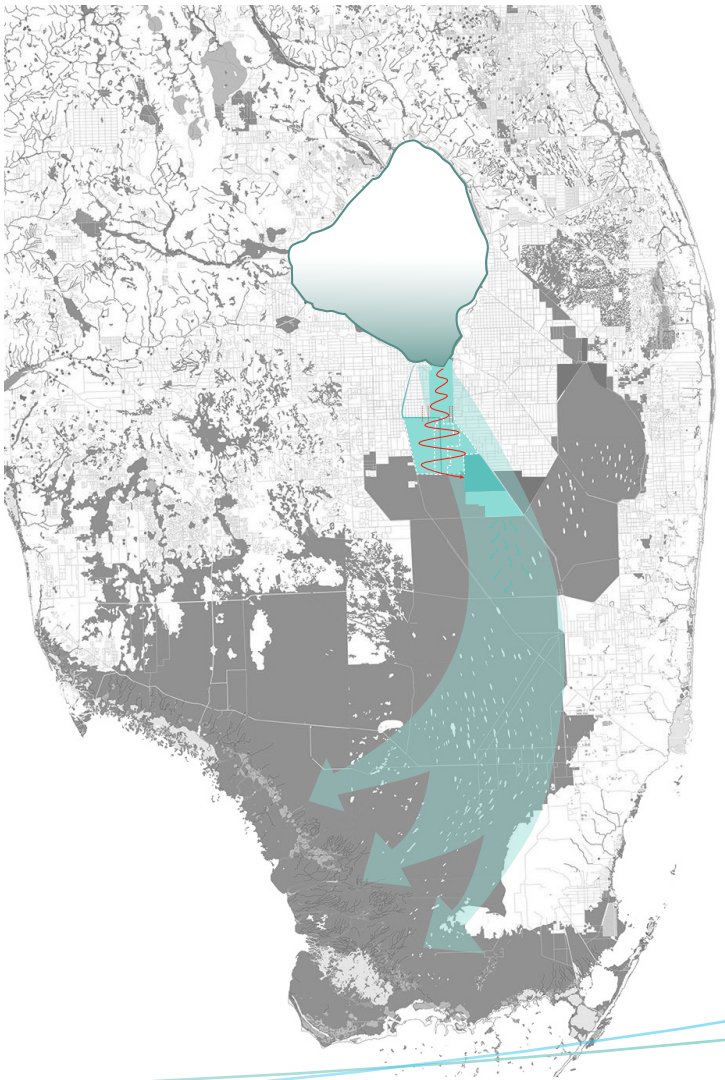
water storage in Floridan aquifer

water restoration in Everglades

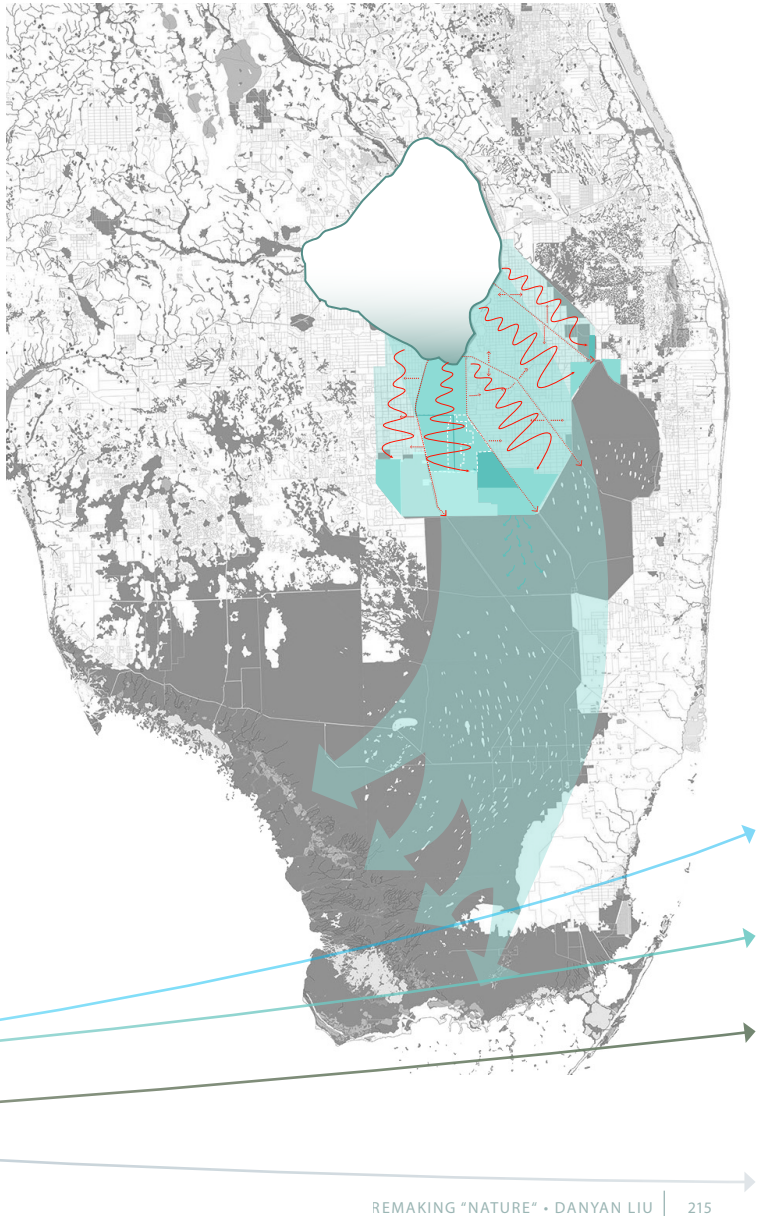
peat depth in EAA

Gradually transform the EAA to purify polluted water from agricultural runoff, to increase water storage, to recover the sheet flow of the Everglades, to restore more healthy peatlands and to increase regional safety of the freshwater supply.

3+ Connect Crucial Water Corridor



4+ Stimulate Other Interventions in the Whole Region

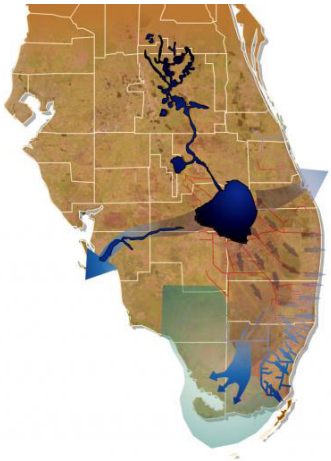


4.2 Impact of transforming EAA on CERP

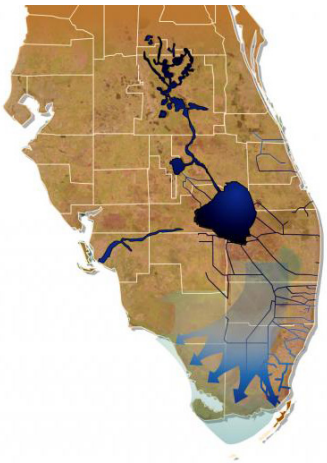
Transforming the EAA contributes to CERP and helps to achieve a more holistic restoration. The following figures show the gradual transition of the Everglades Agricultural Area into the Everglades Restoration Area.



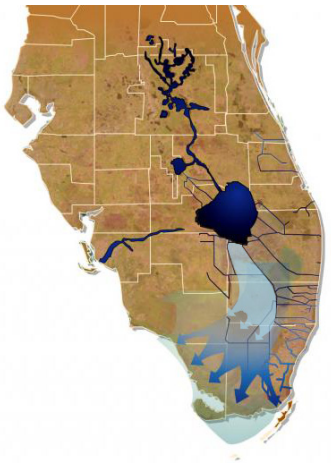
Historic Flow



Current Flow



CERP Flow



Proposed Flow (1st Stage)



Proposed Flow (2nd Stage)

4.3 Impact of the EAA Transformation on the Region

Comparison Matrix From An Eclogocial & Social Perspective

xxx before / xxx After

	Dry Season	Wet Season
EAA	Before: pump water out for irrigation Send water to Everglade	Before: drain all the excess water to lake O or to the southern estuaries Retain water on site, and purify
Everglades	Before: drought, lack of fresh water Restore the natural condition	
City		Before: flooding at the estuaries, algae bloom Reduced water flow and clean water, revitalized economy (fishing, tourism)
Lake Okeechobee		Before: high flooding risk, water pollution Reduced flooding risk, clean lake
Floridan Aquifer	Before: shrinking Regrowing	Before: shrinking Regrowing
Others	Increased freshwater supply, reduction of carbon emissions	

The impact of the EAA transformation on the region of South Florida is evaluated in the comparison matrix.

"It is not the strongest of the species that survive, nor the most intelligent, but the ones most responsive to change."

- Charles Darwin

CHAPTER V

DISCUSSION & CONCLUSION

5. Discussion & Conclusion

Manifesto for An Ecological Transition in 1956

"As the use of Everglades lands for agricultural purposes approaches the sunset of their experience in this field of production there is little about that transition into a wildlife area of ultimate world fame will follow, perhaps in an easy and natural manner...

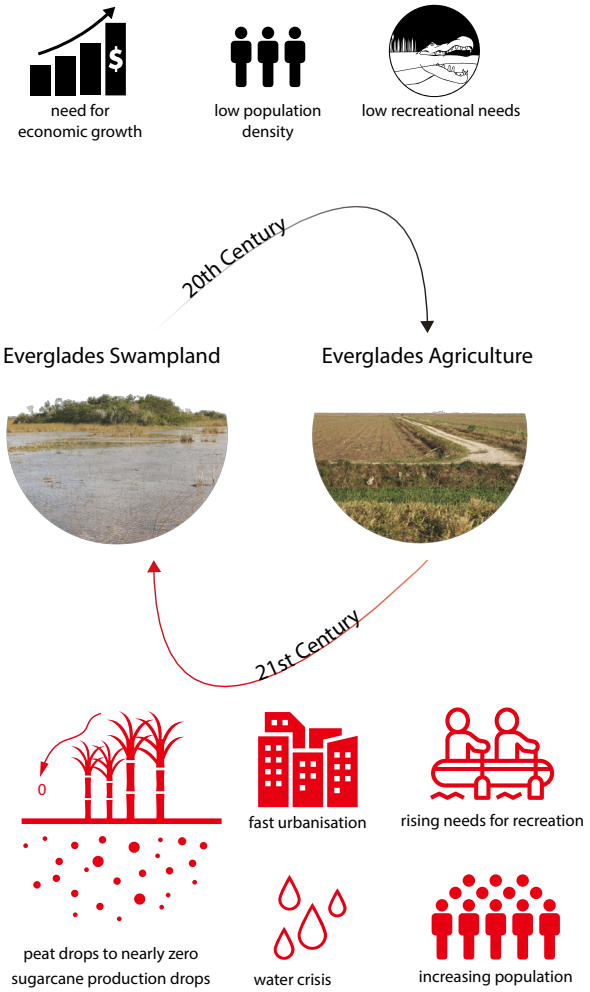
There can be no doubt that by the end of the present century the population of the coastal areas to the east and west will be getting very heavy indeed and that the "playground" outlook for these sections could be immeasurably benefited by having such a huntsman and fisherman's paradise spreading out in vast proportions within the main body of the Florida peninsula at this latitude...

It is also quite certain that demands for water will increase several times over during the next few decades in south Florida...

Naturally, as the Everglades returns to an essentially wild life area in the years to come, its capacity for receiving and holding water...would be tremendous.

Such a visualization for the area in the future then, becomes simply a gradual change of duty for this great peat and muck land section of the State that will enable it to deliver a diversity of services and values which, while substantially different from the agricultural types of the present and of the immediate future, may prove to be of equal or even greater importance to the economy of the State at that not too distant time."

- R. V. Allison (1956)



Changing Mission through time:

The social and cultural change impacted the mission of Everglades lands.

From Everglades Swampland to Everglades Agriculture: Sunrise of EAA

In the last century, Everglades swampland was designated by congress as Everglades agriculture land for its soils and potential to grow crops and increase economic growth. At that time, there was low population density and low recreational needs.

From Everglades Agriculture to Everglades Swampland: Sunset of EAA

When the clock ticks to the 21st century, ongoing peat loss due to draining results in the decreasing sugarcane production. The use of Everglades lands for agricultural purposes nearly approaches the sunset. At the same time, dramatically increasing population and fast urbanization bring huge challenges to South Florida accompanied by the degraded ecosystem, water crisis, and increasing needs for recreation.

It is time to return this agriculture land to the swampland. It will increase the capacity for water storage and provide vast recreational space. This trend could be tracked from 1998 when the first stormwater treatment area (STA1) was built. Nowadays, around 1/5 of agricultural lands are already transformed into the water reservoir or purification marsh.



Figure 56. Sattelite map of EAA in 1984

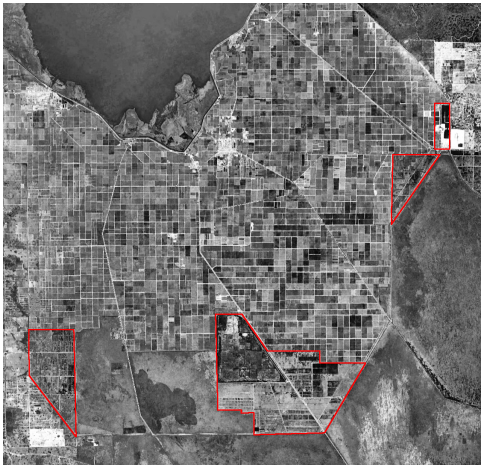


Figure 57. Sattelite map of EAA in 2019

From EAA to ERA

The transformation from Everglades agriculture area (EAA) to Everglades restoration area (ERA) requires to perform the functions of water purification and water storage, meanwhile, providing recreational space and improving quality of life.

Here two sets of the toolkit are concluded: first is transforming the sugarcane field into filtration marshes and then returning it to the wildlife area. Second is transforming the sugarcane field into the rice field and then into filtration marshes and wildlife area. Transforming the sugarcane field into the rice field will mitigate the soil loss, and leave time for farmers to adapt to the change.

The South Florida ecosystem creates conditions for generating diverse landscapes and allowing natural succession. The restoration plan is based on an intervention that will change the landscape: raising the water level and linking it to the subtle difference of elevation. At the new transition from land to water, the place where natural processes are manifest and which will be sought out by all sorts of flora and fauna, the recreational paths interact with the surrounding nature and the constantly changing blue skies.



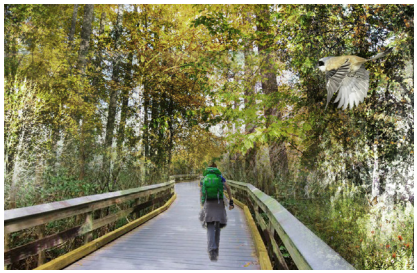
Birdwating in filtration marsh



Overlook the ERA from obserbation tower



Cycling on the recreational trail



Hiking into Swamp Forest

Figure 58. Potential Spatial Experience

Toolkit

I.

Everglades Swampland

Everglades Agriculture

Water Filtration Marshes
(gradual bridge)
(backbone)

Wildlife Area

II.

Everglades Swampland

Sugarcane Agriculture

Rice Agriculture

Water Filtration Marshes
(gradual bridge)
(backbone)

Wildlife Area

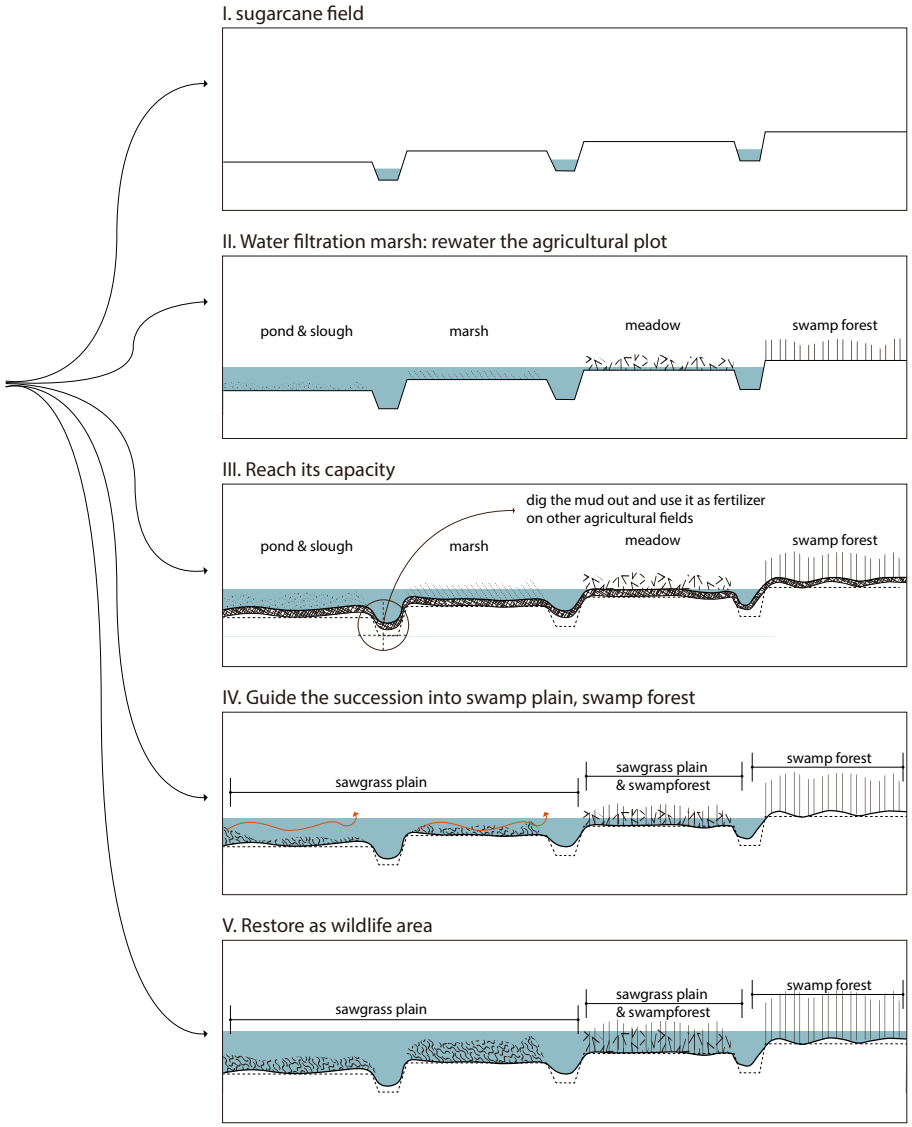


Figure 59. Sequence of transforming EAA

5. Discussion & Conclusion

Answer to the Research Question

1. How to understand the landscape system in South Florida through scales and how it is related to EAA?

The landscape system of South Florida and its relationship with the EAA is analyzed through deconstructing it into five layers: hydrology, geology, ecology, agriculture, and recreation. As the research progresses, the cause of the problem becomes more evident. The development of South Florida has an ongoing interaction with the water system. From 1900s to 1950s, half of the Everglades was drained to make room for agricultural use. 70% of sheet flow which was used to stay in site, vitalize the ecosystem and recharge the aquifer is now diverted to the ocean with a high concentration of nitrogen and phosphorus from the fertilizers used in EAA.

The changing water flow pattern does not only disturb the state of nature, but also leads to an enormous economic loss: red tide/algae bloom in the estuaries, the heavy toxic levels of Lake Okeechobee, and the decline in recreational fishing and tourism. The state invested billions of dollars in the Comprehensive Everglades Restoration Plan to restore the South Florida ecosystem. This restoration plan would be difficult to achieve without the coordination of the EAA because it is situated between the source of Everglades water - Lake Okeechobee, and the Everglades. The external and internal drivers for transforming the EAA are clarified.

The main internal driver is the decreasing sugarcane production due to peat loss in the EAA. The external drivers are the ecological degradation in the Everglades and the huge loss of economic benefits of St. Lucie and Caloosahatchee estuaries due to water pollution.

Main Research Question:

How to develop an integrated approach to recover lost ecological assets in South Florida through transforming the Everglades Agricultural Area?

Sub Questions
1. How to understand the landscape system in South Florida through scales and how it is related to EAA?

2. How can major environmental problems, like the land subsidence and water pollution be mitigated through the transformation of EAA?

3. How can an adaptive design framework be developed to transform the landscape in EAA?

4. What spatial and systemic landscape designs with multi-functions could be elaborated on the most crucial areas?

5. How can the framework of ecological transition developed in this research design be applied in other wetlands facing the similar complexity of ecological, social and economic challenges?

Transforming EAA is an urgent task for the benefits of the whole region as well as EAA itself.

The artificial control of water flow for the agricultural use in EAA is against natural water dynamics. During dry season, surface water and groundwater is pumped out for irrigation. During wet season, water is drained out at a fast speed to Lake Okeechobee and to the estuaries. Meanwhile, agricultural wastewater is either pumped directly back into the lake or sent to the Everglades without treatment, which further results in the red tide and decline of Everglades ecosystem.

2. How can major environmental problems, like the land subsidence and water pollution be mitigated through the transformation of EAA?

Subsidence of drained peat soils is caused by oxidation of the organic matter of the peat soil, consolidation of the peat layer and permanent shrinkage of the upper part of the peat soil above the groundwater level (Querner et al., 2012). To prevent this, water must be supplied to keep the water tables sufficiently high.

Adapting to natural processes is an indispensable necessity for the ecological restoration of South Florida. In this project, the area with the minimum peat left and most important water corridor is selected as pilot area for transformation. The water level is raised in this area to avoid rapid subsidence of peat soils. The lowest area is firstly developed into an attractive nature and recreational area. The adjacent area is transformed into a rice field. The excess water from lake Okeechobee and surrounding agricultural runoff is retained and purified in site through bioremediation process. The submerged and emergent plants are introduced to lower the nutrient level in water. The purified water is recharged into the aquifer and restored as sheet flow to the southern Everglades.

Recovering the surface water and improving the water quality create conditions for peat growth and increase in regional freshwater supply. This measure will mitigate the situation of southern Everglades being too dry, reduce the toxic water flow to the estuaries and help rejuvenate the economics there. Moreover, multiple opportunities are grasped for EAA's future development. More sustainable agriculture usages in the EAA such as the cultivation of rice, nature-based recreation and tourism could be applied in this area. Consequently, the main mission is formulated, which is bringing the EAA back to the nature, while enhancing the spatial experiences, and developing a circular and sustainable economics.

3. How can an adaptive design framework be developed to transform the landscape in EAA?

The design framework is set up to achieve the vision and guide the spatial intervention. The agricultural plots with scattered topography are connected by using subtle landscape characters into five ecological zones: pond, marsh, meadow swamp forest, and rice field.

The edge surrounding the agricultural plot which refers to the berm and canal is transformed into a multi-functional network composed of an ecological network with water purification corridors and recreational network. The main recreational trail will be constructed along the main canal, starting from the visitor's centre going southward. A series of recreational spaces are designed next to the trail, including: fishing, camping, birdwatching canoeing, hiking and hunting.

5. Discussion & Conclusion

4. What spatial and systemic landscape designs with multi-functions could be elaborated on the most crucial areas?

In the zoom-in units, multiple sites are elaborated to show how the spatial conditions of ecological restoration are integrated into the landscape architectonic design. The restoration also serves as an environmental basis for the improvement of spatial quality.

The design of trails aims to bring people to the site to experience a sequence of change from post-industry landscape of the sugarcane mill to adapted rice field to the restoration ecological zones to more wild landscape.

The visitor center that transformed from the old sugarcane mill could be reached via U.S highway 27. Different types of paths run from the visitor center into the restoration area. There are comfortable high-altitude paths, easily accessible for everyone, that promise a varied walk along the pond, marsh lands, open meadow and swamp forest. For the experienced explorer there are paths that can only be walked with boots on and depending on the water levels.

Spatial landscape designs are elaborated at the eye-level experience, such as landscape architectonic moments with local features and identities. This includes designing the culverts, elevated levees and the observation tower.

5. How can the framework of ecological transition developed in this research design be applied in other wetlands facing the similar complexity of ecological, social and economic challenges?

The approach developed in the EAA could also be applied in other wetlands. But it requires the careful inquiry of the local contexts, especially the soil, water and ecosystem conditions, also need to adapt the agricultural practice, and integrate the spatial conditions of the new vision into landscape architectonic design.

Main Research Question:
How to develop an integrated approach to recover lost ecological assets in South Florida through transforming the Everglades Agricultural Area?

The thesis establishes an integrated approach to transform the EAA in order to recover lost ecological assets by analysing drivers of change, analysing the landscape system through scales, clarifying the goal of transformation, identifying the area of intervention, developing design framework and drawing up possible spatial interventions. Natural processes are integrated into environments across all scales, from the built culvert to the regional ecological plan through designing spaces, planning frameworks, and research with the ultimate goal of creating a dynamic, adaptive and sustainable landscape of the future, and connecting people to their immediate environment.

The landscape in this context is regarded as a process rather than as a product. As time changes, the ecological zones evolve, interact with the surrounding areas and expand. While the generated recreational network remains, it continues to provide accessibility and invites people to witness changes such as: water being purified, wading birds returning to nest, trees growing and etc. Experiencing the landscape at EAA will become a model of learning and inculcating values. A sustainable landscape is created alongside the ecological transition in improving water security, quality of space and livability.

Global Challenge of Ecological Crisis and Climate Change: Value of the Developed Approach for Practice

Arresting the rapid reduction of wetlands is a global challenge. The consequences of this reduction will accelerate the speed of climate change and bring about an ecological crisis. Currently, there are needs to make room for nature through transforming agricultural areas and to raise public consciousness and actions being taken. This research topic has significant value in attempting to address the global challenge of ecological crisis and climate change.

The thesis emphasizes in developing an integrated approach to recover the lost ecological assets in South Florida through transforming the Everglades Agricultural Area.

The proposed processes and methods create opportunities for designers to actively participate in the restoration of nature and this has resulted in achieving a systematic approach. Moreover, the results of the thesis demonstrate the needs and possibility of designing through different scales. The restoration of the ecosystem is the task of engineers as well as the designers. The spatial conditions of ecosystems should be integrated into the landscape architectonic design. The intervention is designed in such a way that they improve the water safety, quality of space and security.

CHAPTER VI

REFLECTION

6. Reflection

1. Reflecting on the Research and Design Process

In order for this methodology to be applicable in other contexts, the process of the thesis could be concluded as a series of steps:

- Analysis of drivers of change: external and internal drive
- Analysis of the landscape system through scales
- Clarifying the goal of transformation
- Identifying the area of intervention
- Developing design framework
- Design implementation: drawing up possible spatial interventions

In the following sections, the approaches that were used within the thesis will be reflected on, while outlining the constraints, lessons learned and how it could be improved.

Application of Layer Model

The Layer Model is developed by Hoog, Sijmons and Verschuuren (1998) as a conceptual framework to guide Dutch spatial policy, which was based on the triple layer model by Ian McHarg (1969). This model contains three layers: the natural subsoil layer (changing over the course of centuries), the network layer (changing over the course of 50-100 years) and the occupation layer (changing over the course of 25-50 years) (dRO Amsterdam 1996; Hoog, Sijmons en Verschuuren 1998).

The "layer model" is used as a theory in this study to understand the context of the EAA. During the application, there is a gap between the changing time described in the layer model theory and the frequency of change observed. The soil layer is usually regarded as the layer with the slowest frequency of change. In this case, the altitude of the soil which refers to the peat in the EAA has actually experienced the fastest speed of subsiding due to drainage over the course of decades. On the other hand, the historic buildings like the sugarcane mills which are part of the most flexible layer, occupation layer, are in reality being preserved for centuries.

The natural layers are highly intervened in by infrastructures and occupation layers due to human interventions, especially under the context of climate change, and they are undergoing tremendous changes at a radical speed.

When applying the layer model as a theoretical framework, the awareness of the discrepancy between theory and reality would make it more beneficial to understand the contemporary landscape as a system and the interaction between different factors.

Moreover, the transferability of this method requires the clarification of the research goal and the goal of the intervention. In this research and design, these layers are interpreted as the 5 layers of hydrology, geology, ecology, agriculture and recreation. When applied to other contexts, the layer model needs to be tailored to define the crucial layers related to the design.



Synthesis of Multi-disciplinary Knowledge

Transforming part of the agricultural fields to make way for nature, water and recreation is a comprehensive task which requires the synthesis of multi-disciplinary knowledge of spatial planning and design, water management, hydrology, ecology, geomorphology, agricultural sciences etc. The literature review was planned as the main method in this thesis to grasp the knowledge. This process consumed lots of time, especially when trying to understand totally unfamiliar disciplines. This situation also occurred when the purpose of reading certain literature was not clearly defined, effort was wasted on reading literature that was not directly related to the research topic. If the goal of the research is clarified at the beginning, part of the time could be used to proceed into the stage of design implementation earlier. This would mean that the quality of space could be explored more in depth.

Combining literature review with the discussion with fellows and professors from various fields of study, with clearly defined question to inquiry, would help to bridge the knowledge gap and grasping the multi-disciplinary knowledge in an intelligible way. It would also contribute to improve the efficiency of research and design.

Data Collection and Synthesis

Data collection is an important process to inquiry the context and test the hypothesis. Most of the data for the project was collected by myself through literature review and inquiry into the GIS database. There are many researches going on around the Everglades and the EAA. This is beneficial for gathering information, however at the same time making it difficult to align the data. The data sometimes differed among various sources. For example, the current height data of the EAA is crucial for the design intervention, but there is no consistent height data between different scales. Therefore, certain decisions to select, combine and translate the data into maps, and make assumptions in order to continue the research and design are important.

Scenario planning

At the beginning of the thesis, It was intended to develop scenarios. However, the scenario planning was left aside due to lack of knowledge of both scenario building and the relation of scenario building to spatial design. After getting deeper into the research and design, the need for scenario building is realized, since building the scenario helps to predict the possible future and understand the constraints and drive of the area development.

Research by Design & Design with Research

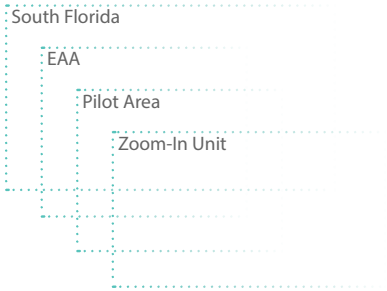
The research and design are systematically combined within the thesis in a way that the design is the vehicle to draw up hypotheses in attempting to research the possible future.

The division of research and design into two stages of working could help structure the process of the thesis and improve efficiency, while the awareness regarding research and design as a holistic approach is important. The design process is similar to the research process in that it requires careful consideration, arguing, and thinking. There are often new questions pumping out during the design implementation that requires a returning to a former step to further complete the

analysis. The order of research and design is usually not linear. Realizing this will help to accept this "detour" and reduce the frustration of making this repetition. To reduce the chance of repeating procedures and improve efficiency, the key is to draw conclusions of the findings at each step and move forward.

Landscape Design Through scales

In order to address the challenge of ecological crisis and its related spatial and cultural challenges, it is crucial to understand that the landscape is a continuum across scales, and it is crucial to design through scales.



For example, the environmental issues at the regional scale have an impact on the local scale. At the same time, a specific spatial intervention like the opening of the canal contributing to the water storage is connected to the broader context. It requires the designer to not only analyze and understand the biotic, abiotic and anthropogenic conditions required for ecological restoration, but also to clearly identify what related physical change will be implemented.

2. Uncertainty over Societal Preference for Ecosystem Restoration

The thesis proposes a new alternative future for transforming the agricultural land. However, realizing the design vision of the inherent trade-off in agricultural benefits for environmental value in practice remains an empirical question, reflecting uncertainty over societal preference for ecosystem restoration, especially if the results are not immediately tangible. The government of Florida has been investing billions of dollars to restore the South Florida ecosystem (CERP), which is a crucial external factor to drive the transformation. The great news is that a larger amount of wading birds returned to the Everglades in 2018 than any other year in the last 80 years, with more than 140,000 nests found, the most since counting began in 1995, compared with an average of around 40,000 a year in the past decade. The number of wading birds is an indicator of the health of the Everglades. To some extent, this return demonstrates the effectiveness of the restoration plan.

If this approach is transferred into other areas where the central government does not owe much power, the transformation of agricultural area requires a close cooperation of farmers, who are the internal stakeholders. The design proposal involves the consideration of livelihood. In the case of the EAA, the rotation of crops, developing recreation and tourism industry are proposed as the alternative livelihood to the sugarcane industry. However, the feasibility of this approach still needs to be tested and explored by comparing the economic benefits of the proposed industry with sugarcane industry.

Furthermore, the mindset of prioritizing economic development and continuation of developing large

structural infrastructure to mitigate the following ecological degradation issues is insufficient and unsustainable. The benefits of returning the agricultural field back to nature include the recovery of the economic benefits that were lost due to the degradation of the environment are more realized in the future. The spatial design can be a model of inculcating values to gradually change the mindset.

3. Relevance to the Flowscapes Studio

This graduation project is conducted in the studio Flowscapes. The studio Flowscapes explores infrastructure as a type of landscape and landscape as a type of infrastructure (cf. Strang, 1996). The explanation found in the studio guide that "the hybridisation of the two concepts is sought to redefine infrastructure beyond its strictly utilitarian definition, while allowing landscape design to gain operative force in territorial transformation processes. The studio aims to develop innovative spatial armatures that guide urban and rural development and represent their civic and cultural significance "(Flowscapes, 2018).

In relevance with this studio, this project can be one of the research and design case studies that demonstrates a fundamental review of the agency of landscape architectonic design:

- It highlights that landscape is regarded as a process rather than as a product. The project of transforming of agricultural land into wetland plays a role as a long-term and open-ended strategy, as in setting up the conditions for ecological restoration, which refers to the adaptation of water and topography in the case.
- Moreover, ecological, economic and experiential entities are integrated into the landscape during the transformation processes.
- This thesis addresses that the extremely large interventions like the restoration of the regional ecosystem is interrelated with very small interventions like the designing of the berm profile at the transformed agricultural land.
- The newly generated landscapes in the EAA function as a resilient hybrid infrastructure to constantly deliver ecological, social and aesthetic value.

4. Scientific Relevance

Having started with the comparison of water management systems between Netherlands and Florida, the graduation project establishes a critical reflection on the traditional water management system and related problems as a representation of the current relationship between human and nature - the anthropogenic impacts on earth. Through the research and design in the Everglades agricultural area, the thesis is geared by an ecological and ethical thinking towards an innovative future vision - a transition towards a more ecologically balanced system.

This ecological transition in the case of the Everglades agricultural area indicates an ecological turn in the way the water management could be transformed facing future climate change challenges and ongoing degradation of ecosystems. Furthermore, the outcome of this project shows possibilities of landscape architecture design which could play an important role to guide sustainable development, taking ecological, social and

economic issues into consideration, and could also be applied in other agricultural lands facing a similar complexity of challenges.

5. A Personal Evaluation: Lessons Learned & Problem Encountered

Emphasis on the technical solution

I was fascinated by the water management system in South Florida and its impact on the Everglades. The thesis started with the research from a technical and ecological perspective. A lot of effort and time were put into understanding the water system of South Florida, and finding the technical solution for the Everglades Restoration. The old version of the design was mainly around the technical and ecological aspect, such as the selection of the vegetation used in the bioremediation process.

Gradual process of grasping spatial and experiential aspect

After many discussions with tutors, reflecting on my design and studying other landscape cases, I gradually realized the weak part of my project: the spatial and experiential aspect. Now I understand that thinking about the experience of the built space is the task of every spatial designer. This requires a different perspective which is oriented on human/user experience.

This spatial and experiential aspect was gradually grasped in the late stage of the thesis development. This obstacle was mainly caused by the lack of the awareness. If it had been realized at the beginning, many detours through the thesis development would have been avoided, and much time would have been saved.

An integrated approach

During the two years' study at faculty of architecture I observed that what architecture and landscape students highlight in their projects is usually experience and programme oriented, and not so much the technical solution addressing the environmental degradation issue. In contrast, the spatial experience is usually not the perspective of hydraulic engineering students. For example, a hydraulic engineering student's focus would be on the dimension and capacity of a dike but not on the spatial experience of it.

I think a successful project needs both perspectives. In practice, the restoration of wetland is usually a multidisciplinary project which involves experts in different fields. The modern trend in education is to train the student to have the expertise to perform more specific tasks, while resulting in the lack of capacity to integrate and synthesize.

This thesis explores an integrated approach for the wetland restoration in the agricultural field, which is the result of thinking from different perspectives and integration of multi-disciplinary knowledge.

Lessons learned

Through the whole process of the thesis, large amounts of knowledge about the Everglades ecosystem and water management in agriculture field are gained.

My personal interests and strengths are in integrating the different knowledge and developing a systematic approach. However, I am still somewhat weak in generating expressive form of the space. I am grateful that I got the chance to realize it and sharpen my spatial design skills throughout the thesis.

Colvin (2010) has written in his book that: "A study of figure skaters found that sub-elite skaters spent lots of time working on the jumps they could already do, while skaters at the highest levels spent more time on the jumps they couldn't do, the kind that ultimately win Olympic medals and that involve lots of falling down before they're mastered. "

The thesis for me is not a final product but an open learning process. The key is to keep trying and practicing. I would tell myself: never be afraid of failing, that is where you start to get stronger. When I looked back at the designs that I made and the reports I wrote half a year ago, I laughed at myself for how underdeveloped they were. I think that is the most apparent evidence of how much and how fast I learned in this year.

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ABBREVIATION LIST

Abbreviation List

CERP	Comprehensive Everglades Restoration Plan
cm	Centimeter (unit)
EAA	Everglades Agricultural Area
ENP	Everglades National Park
FEB	Flow Equalization Basin
FL	Florida
Ft	Feet (unit)
HH Dike	Herbert Hoover Dike
KOE	Kissimmee-Okeechobee Everglades Watershed
Lake O	Lake Okeechobee
m	Meter (unit)
mi	Mile (unit)
SFWMD	South Florida Water Management District
STA	Stormwater Treatment Area
SF	South Florida
WCA	Water Conservation Area
WMA	Wildlife Management Area

Annotations:

1 ft = 30.48 cm
1 mile = 1609.34 m
0.5 mile = 804.67 m



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Master Thesis

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