# Remaking "Nature"

## An Ecological Transition Towards A Sustainable Landscape



**Danyan Liu**

28 Oct 2019

# I. INTRODUCTION

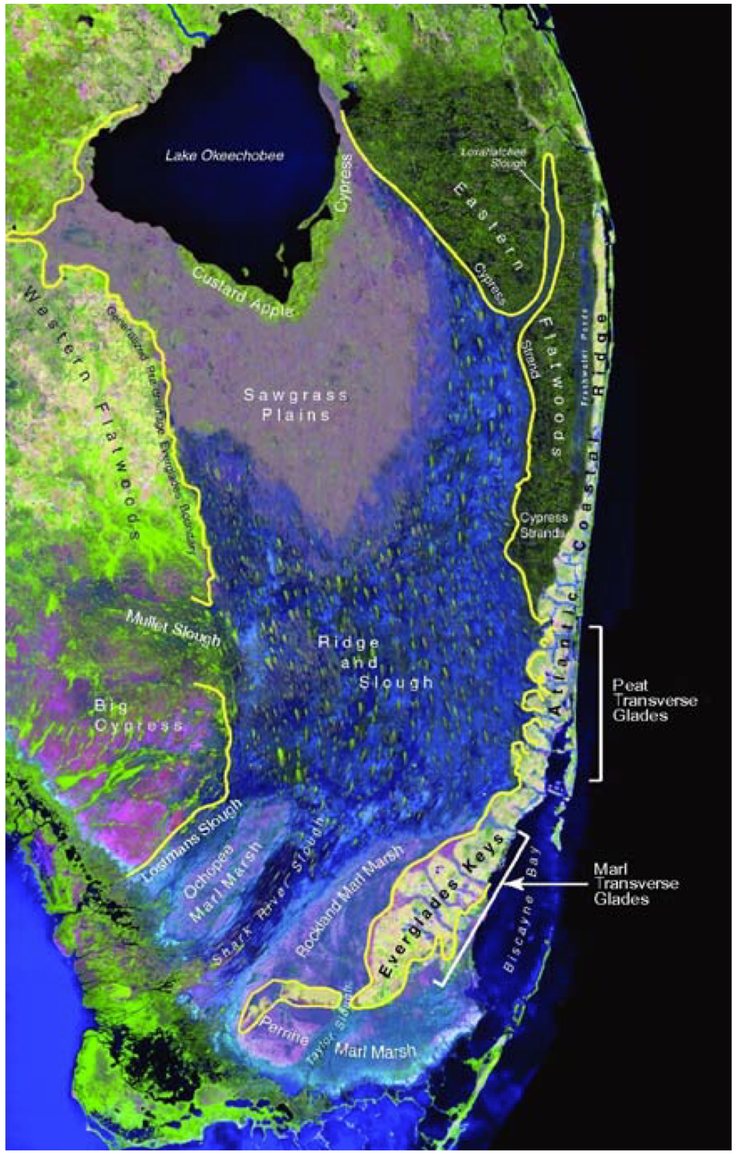


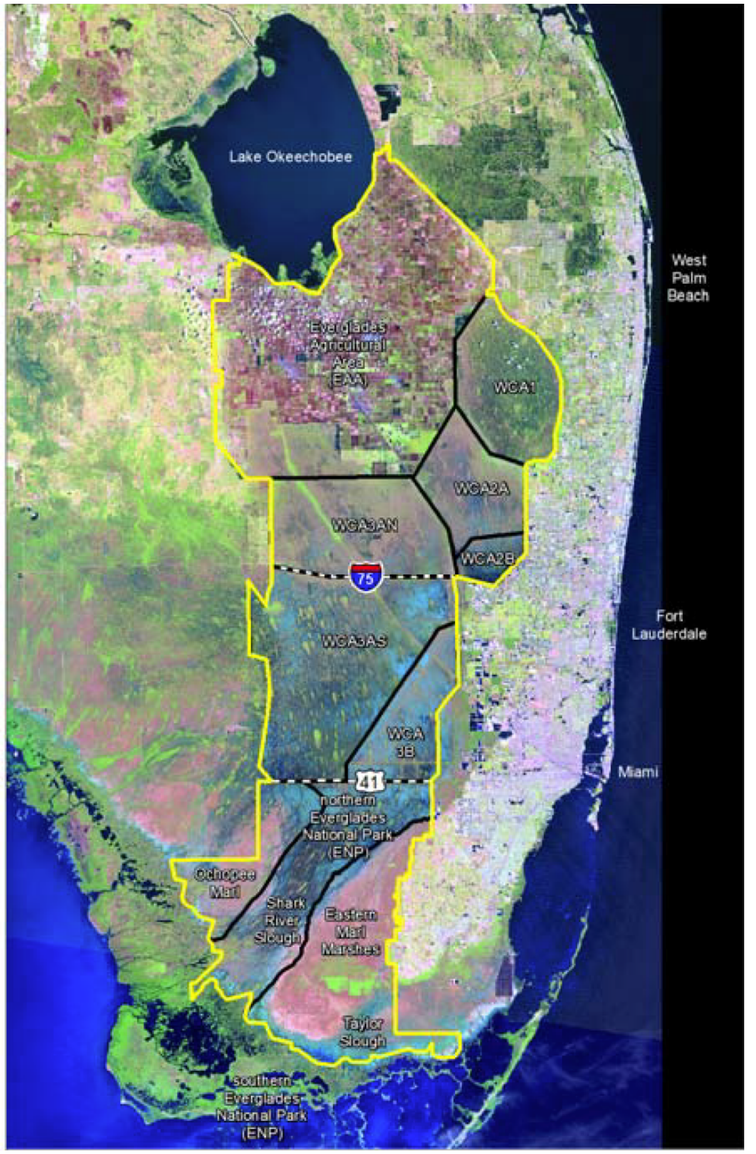

EVERGLADES DYING OF DROUGHT


ESTUARIES FLOODING
ALGAE BLOOM
RED TIDE

# DRAINAGE OF THE EVERGLADES

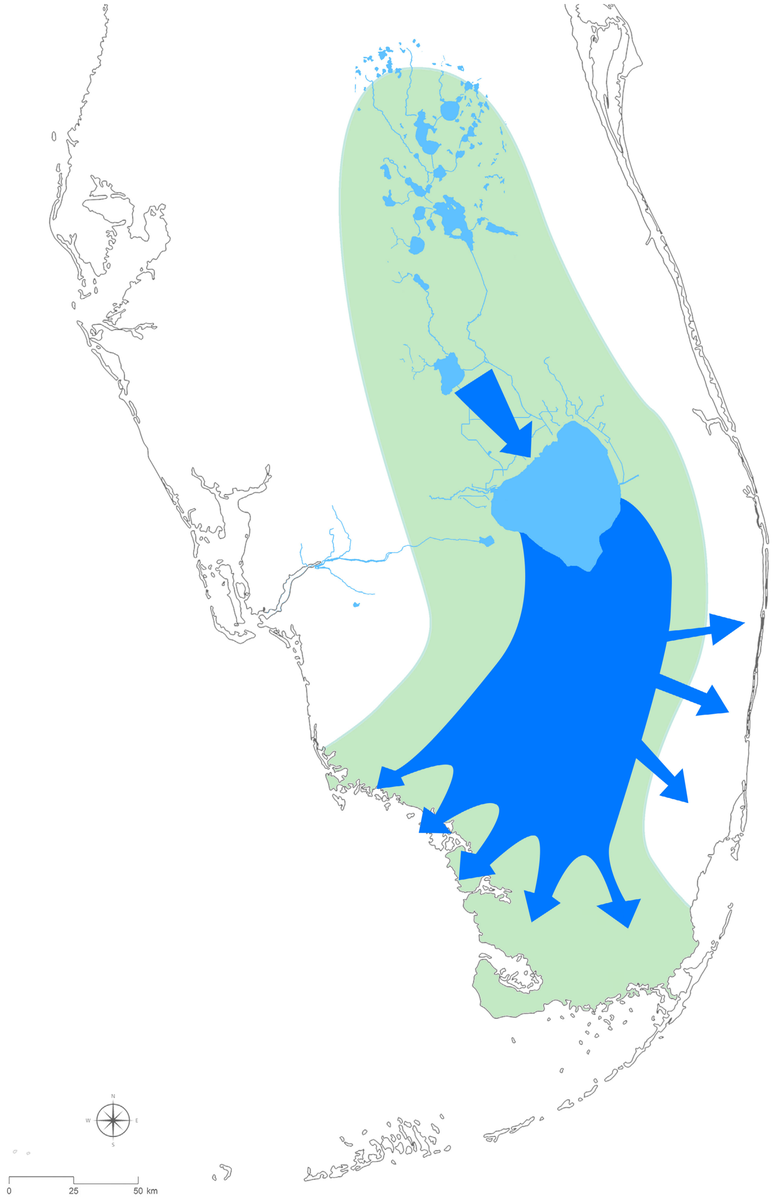
South Florida Water Management System



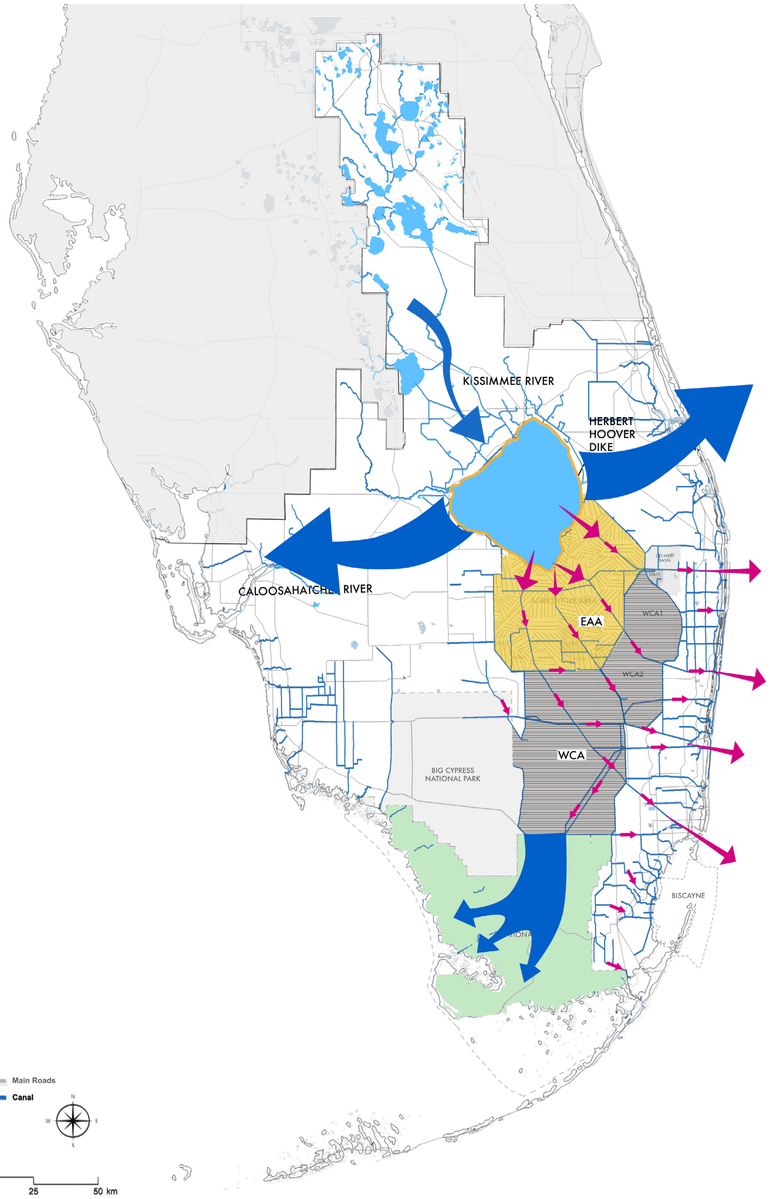




Simulated Satellite Maps of the Everglades before (1880) and after drainage (1994)
Source: McVoy et al. (2011)

# HISTORIC FLOW

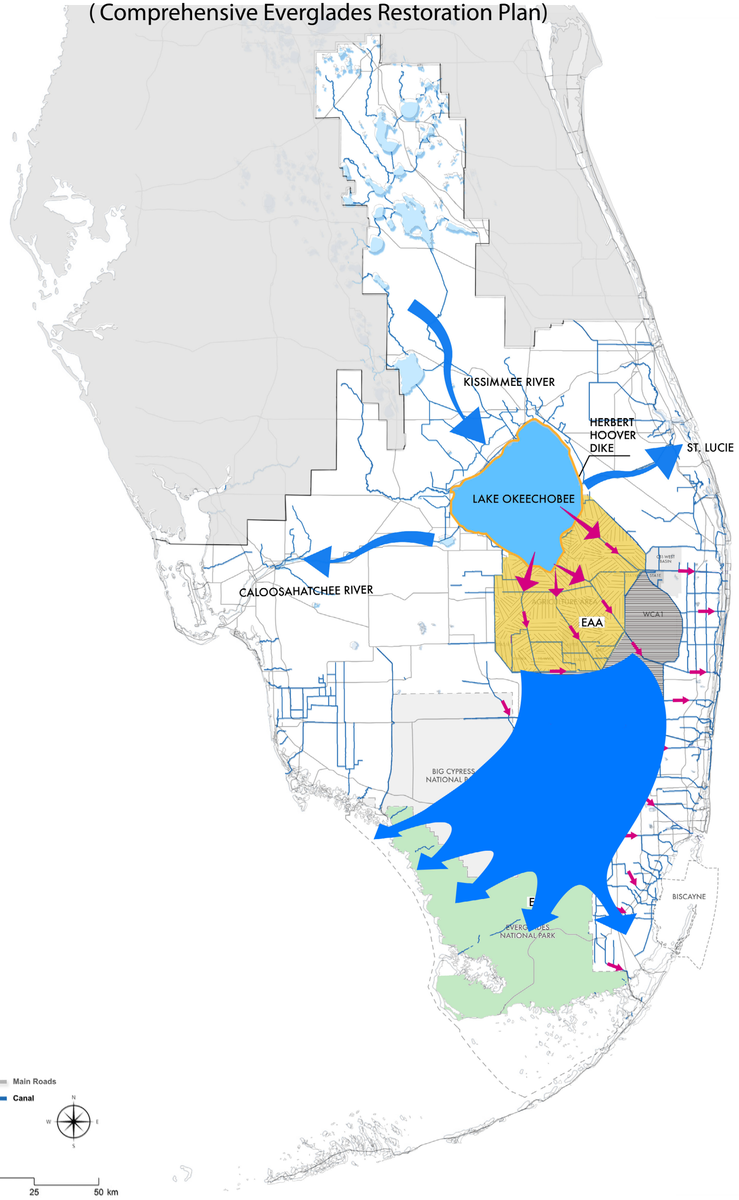



# CURRENT FLOW




# CERP FLOW

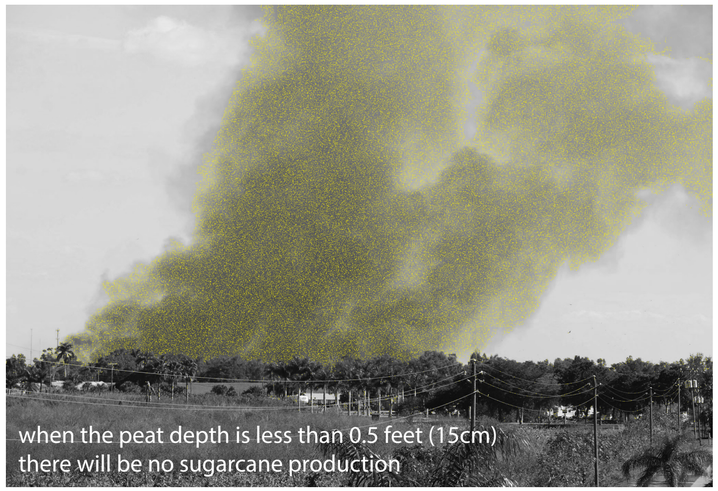
( Comprehensive Everglades Restoration Plan)



# Area of Interest: Everglades Agricultural Area

Internal Challenge:

- Steep decline in sugarcane production




- Land sinking **1 inch** (2.5cm) per year





**90%** of peat are gone in EAA

Research Question



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



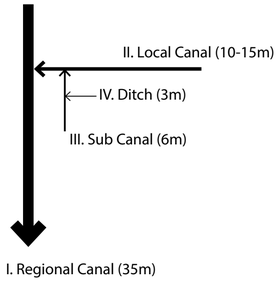
# II. UNDERSTANDING LANDSCAPE THROUGH SCALES

Hydrology Geology Ecology Agriculture Recreation

# 2.1 Hydrology

## Water Control in EAA: Anti natural water dynamics

Wet season: drainage excess water
Dry season: pump water out for irrigation

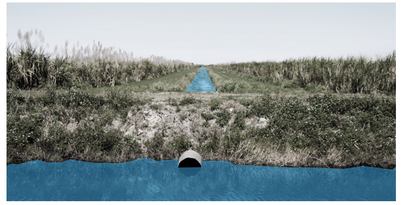



Hierarchy of Canals

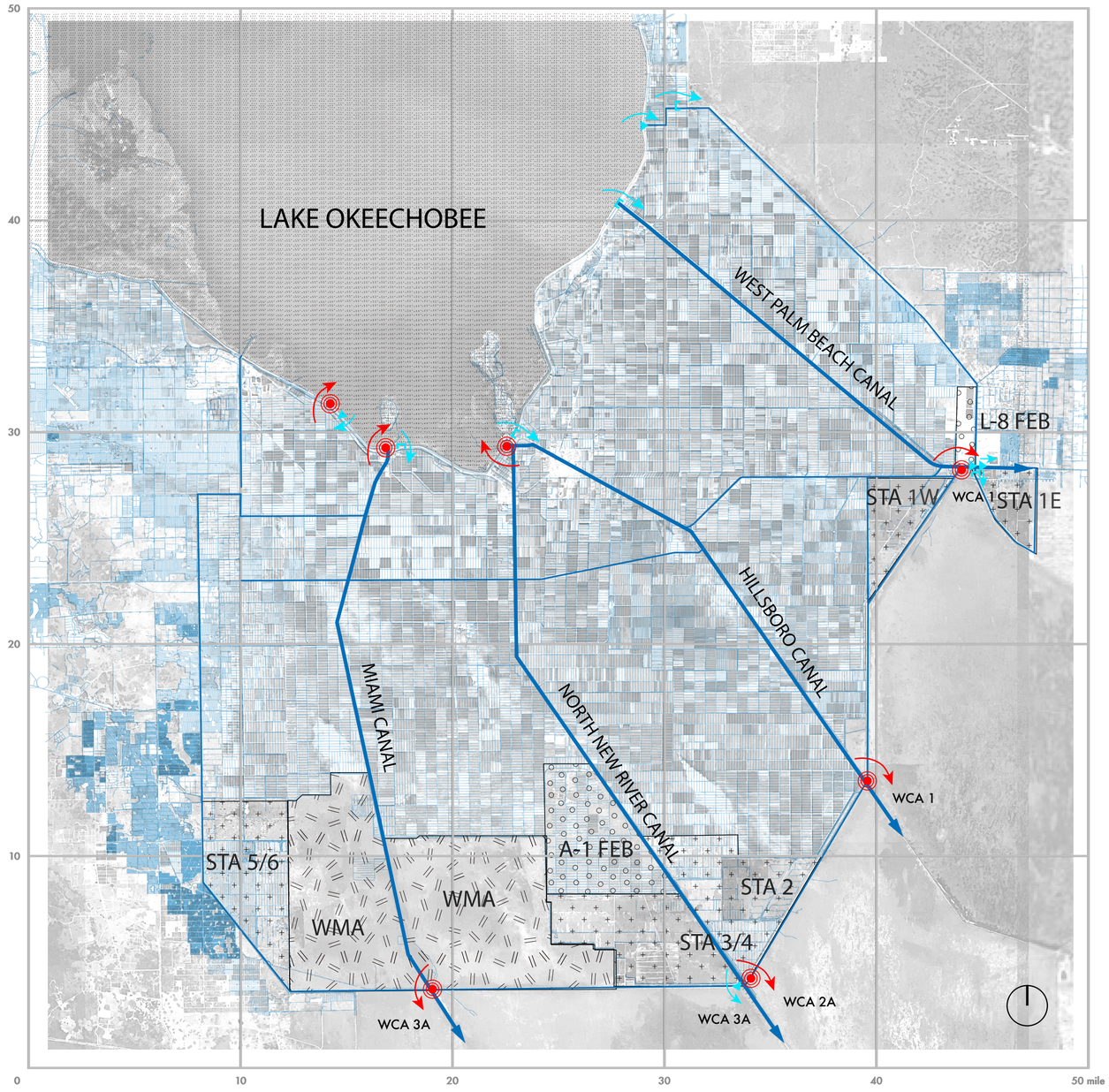
There is a hierarchy of canals system from 4 main district canals (like the boezem in the Netherlands), local canals, sub-canals to ditches.



Regional Canal



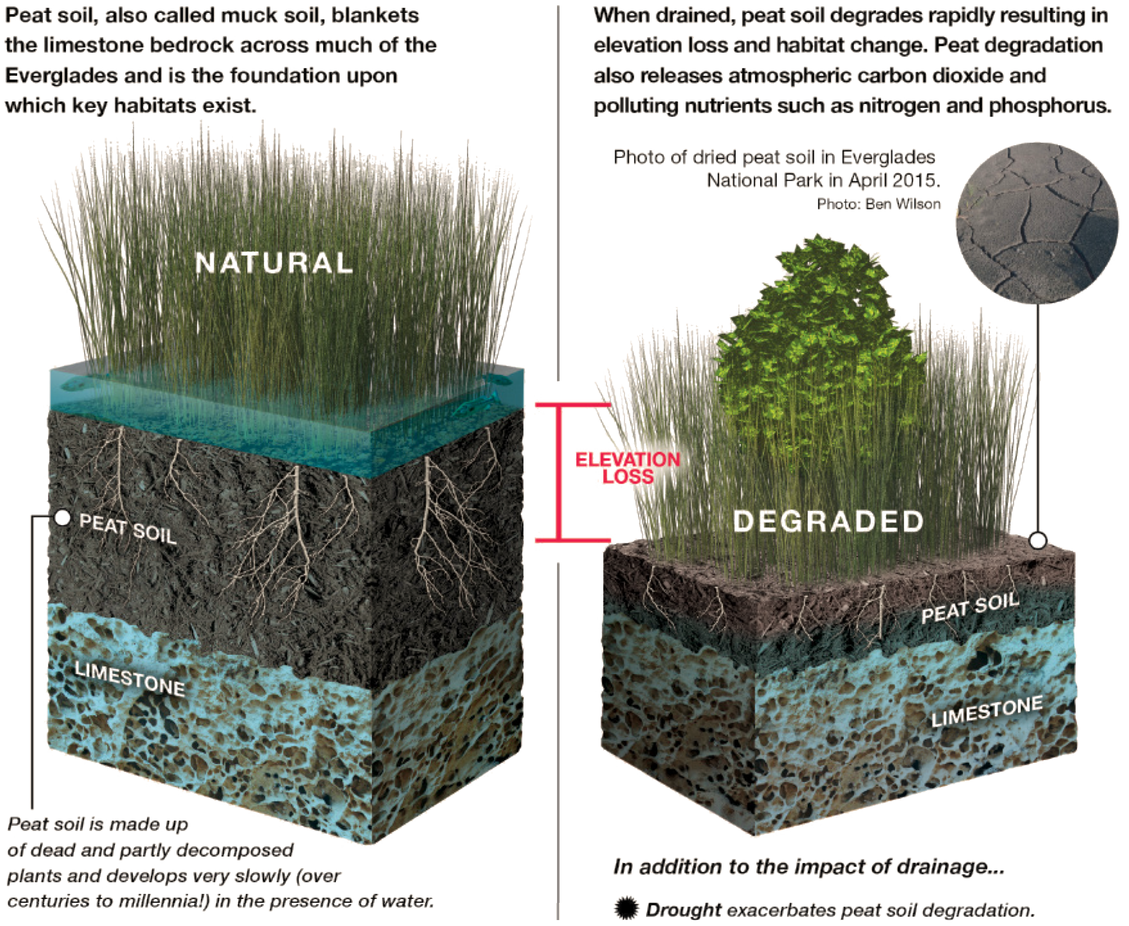
Local Canal & Ditch



**Formation & Degradation of Peat:**
**Water is the key driver**

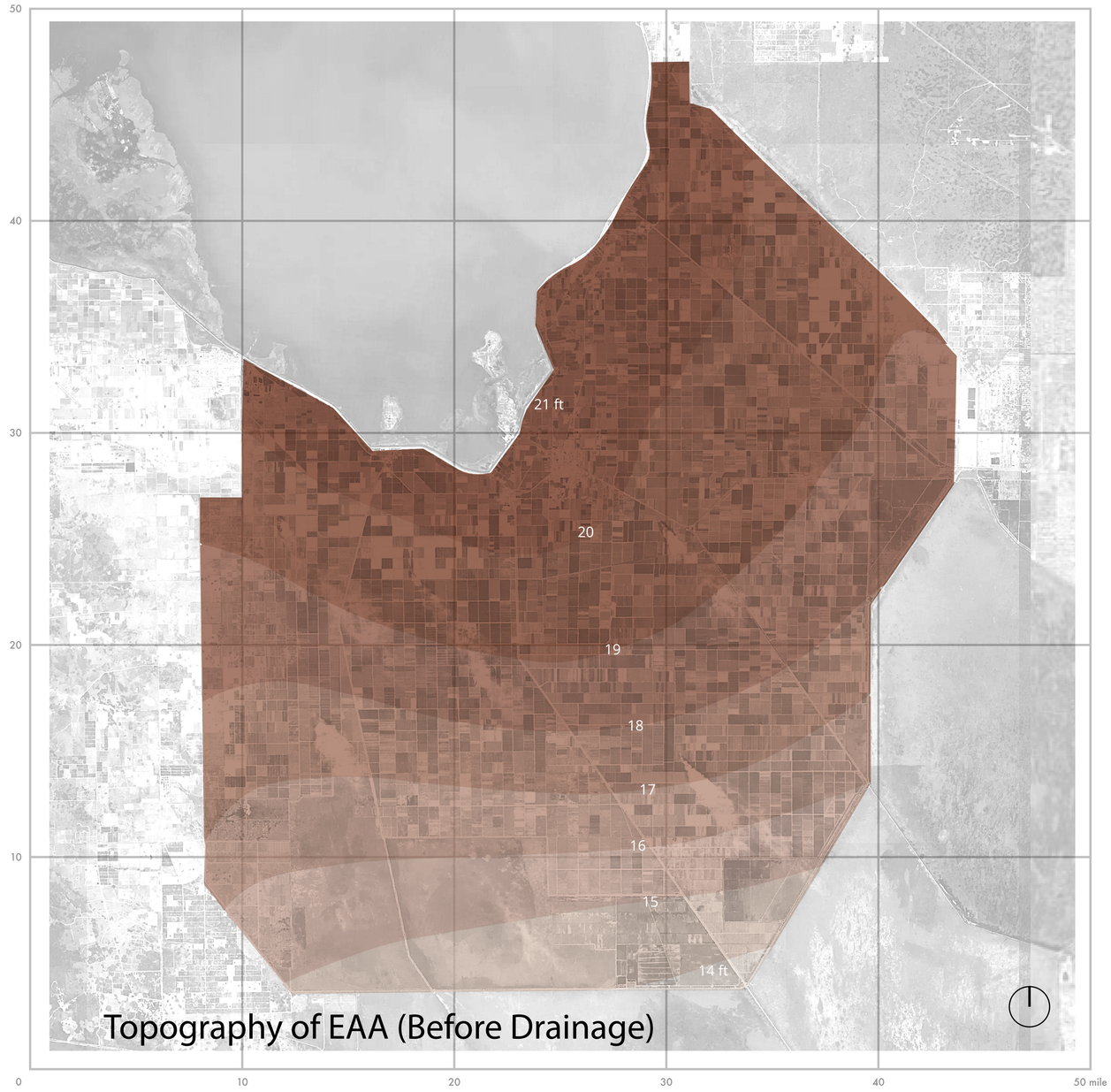
Conditions for peat growth

- Elevate water table
- Lower nutrient concentration in the water
- Stop burning the sugarcan field

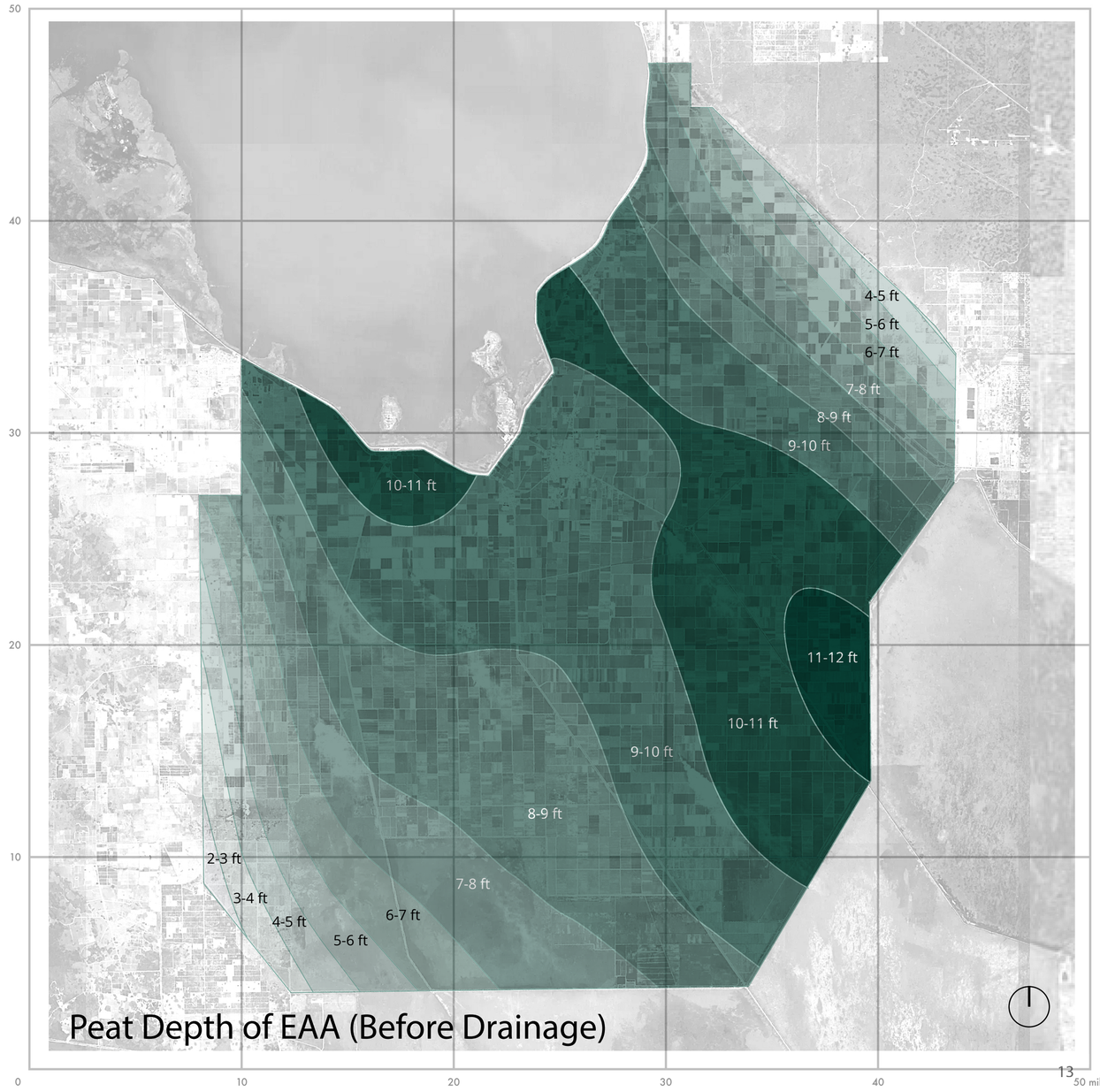



Peat Morphology (Davis et al., 2016)

# 2.2 Geology

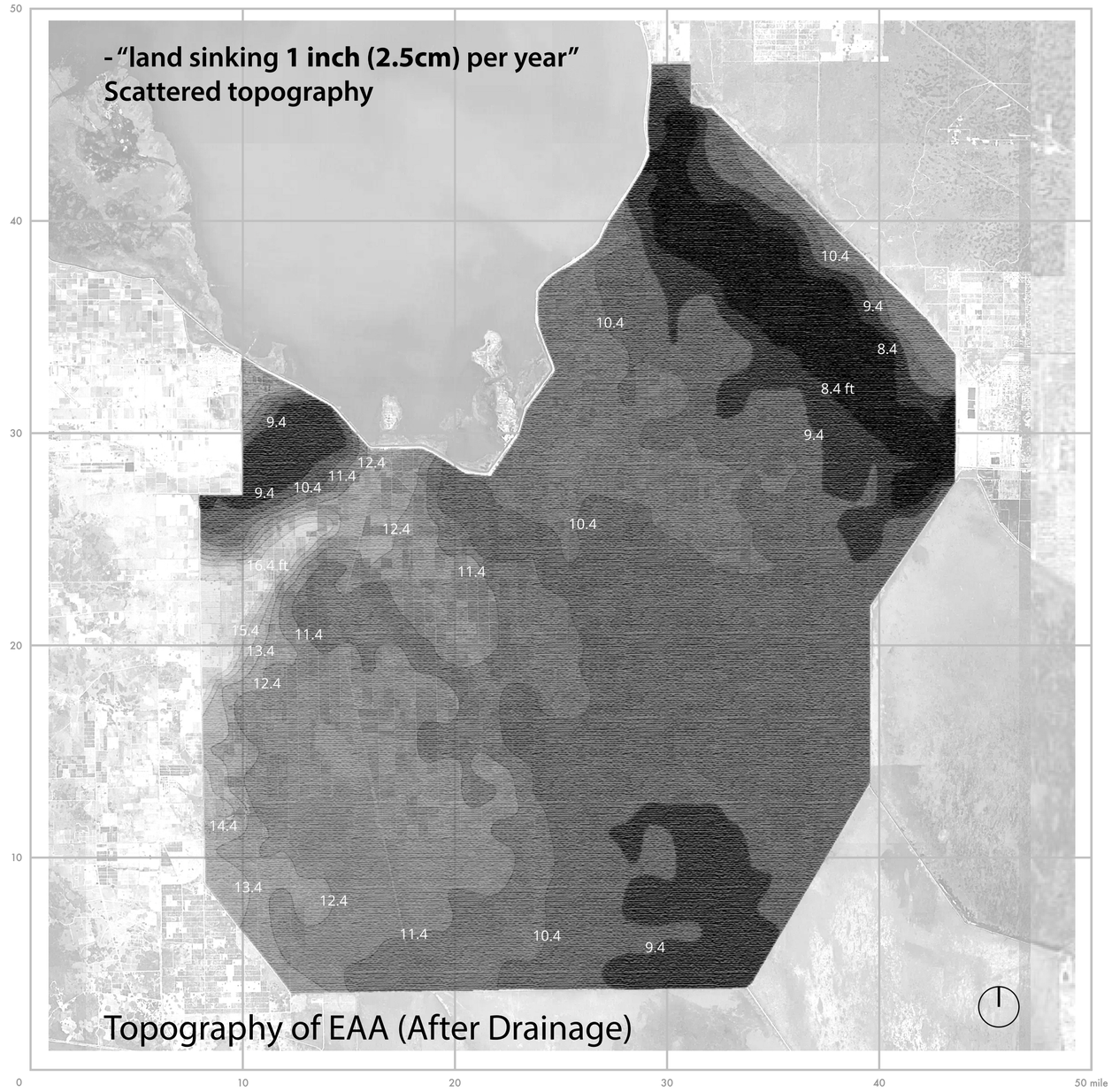



Topography of EAA (Before Drainage)

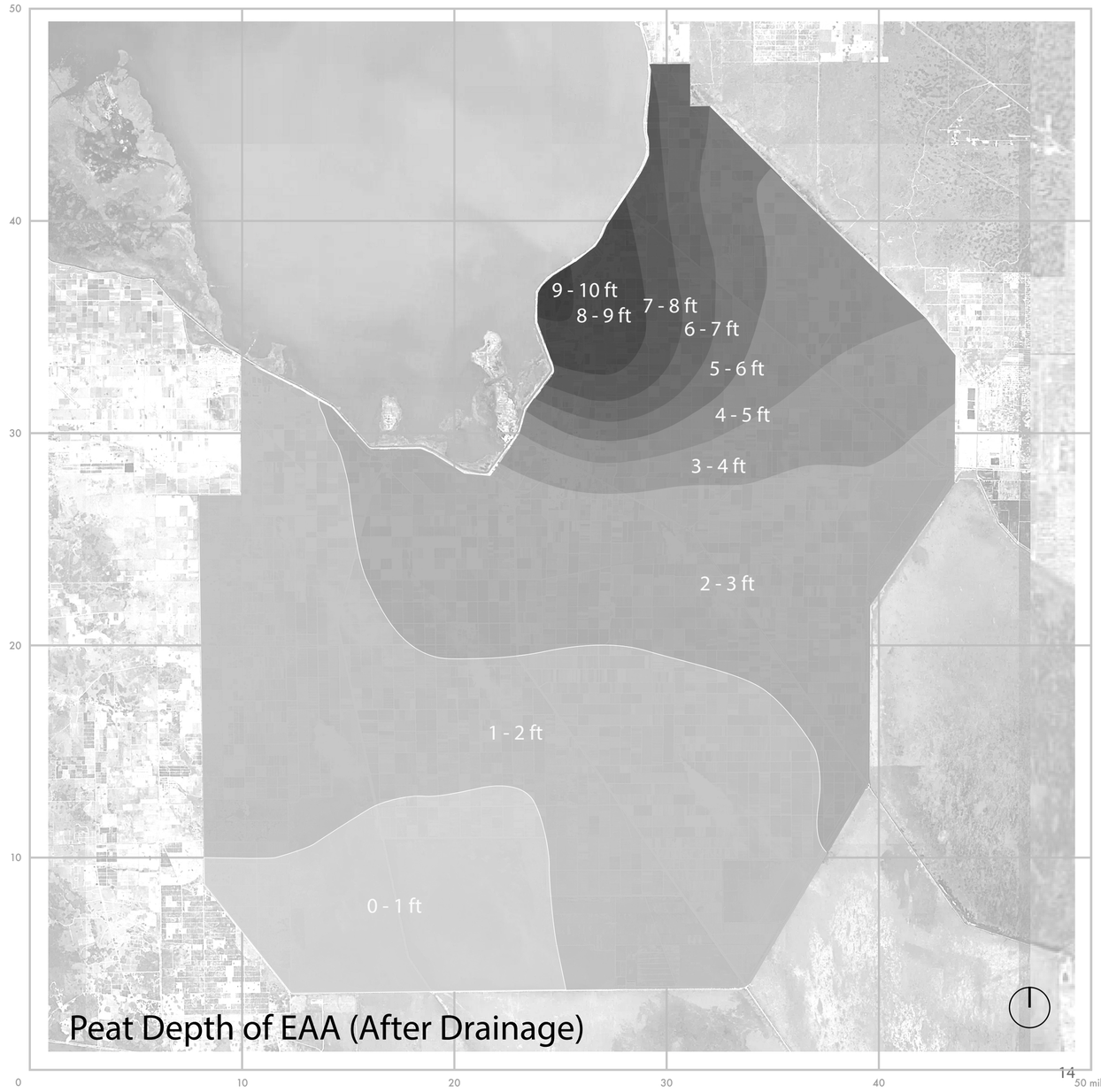



Peat Depth of EAA (Before Drainage)

# 2.2 Geology




Topography of EAA (After Drainage)



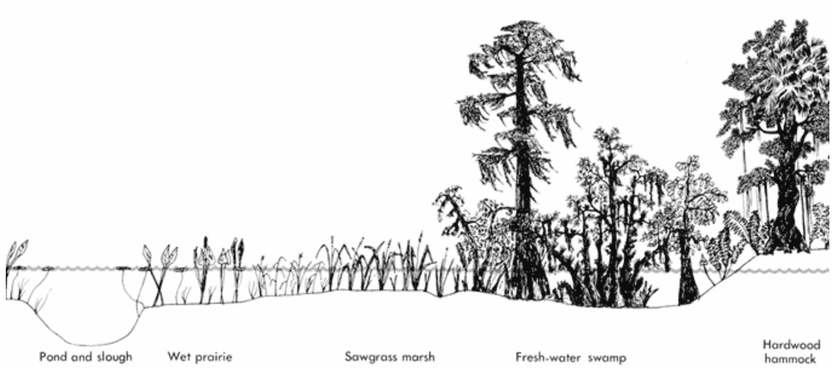

Peat Depth of EAA (After Drainage)

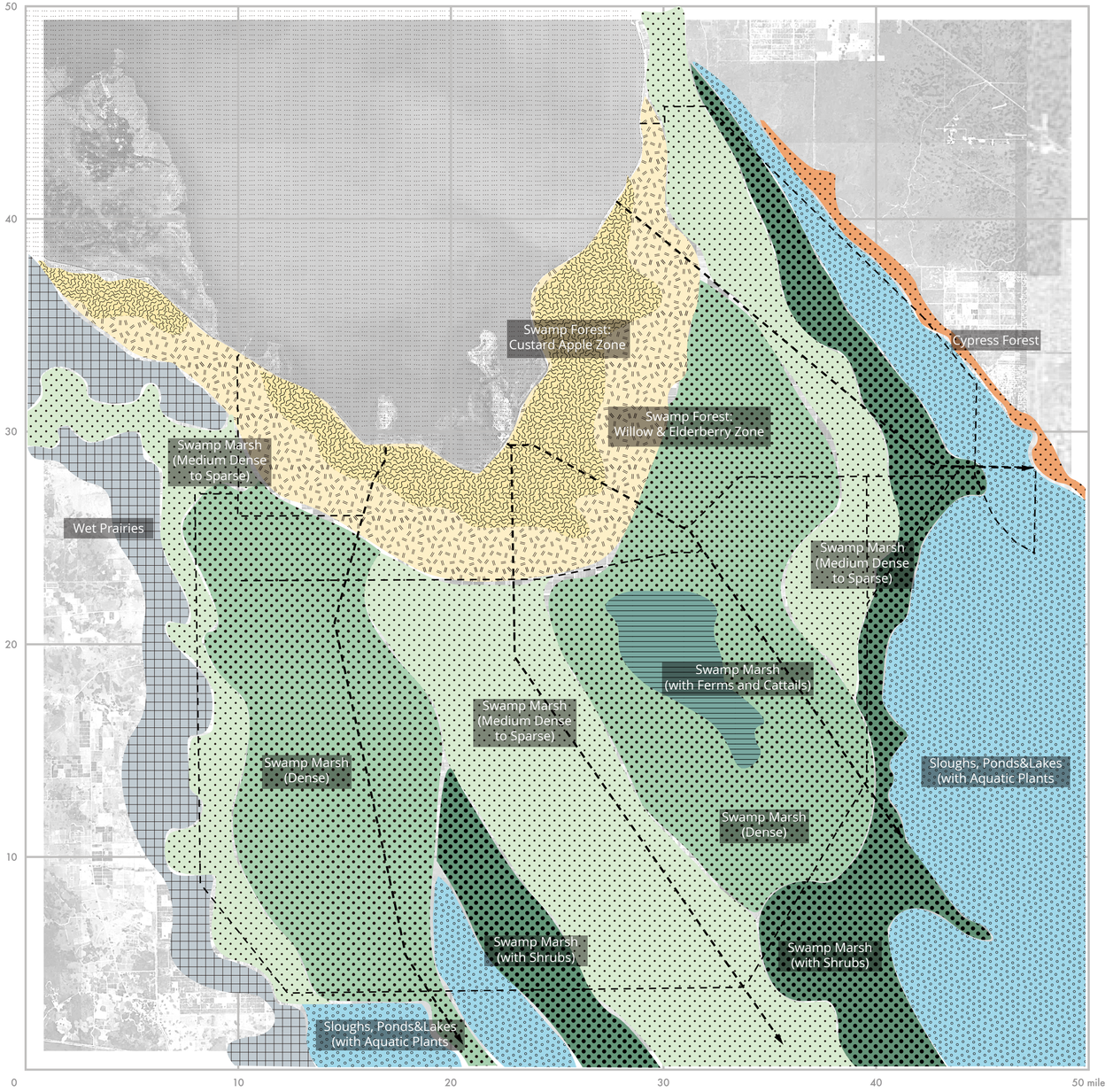
# 2.3 Ecology

**Centimeters Makes Huge Differences:**
**Landscape varying with subtle topographic changes**

*"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 (2015)



# 2.4 Agriculture

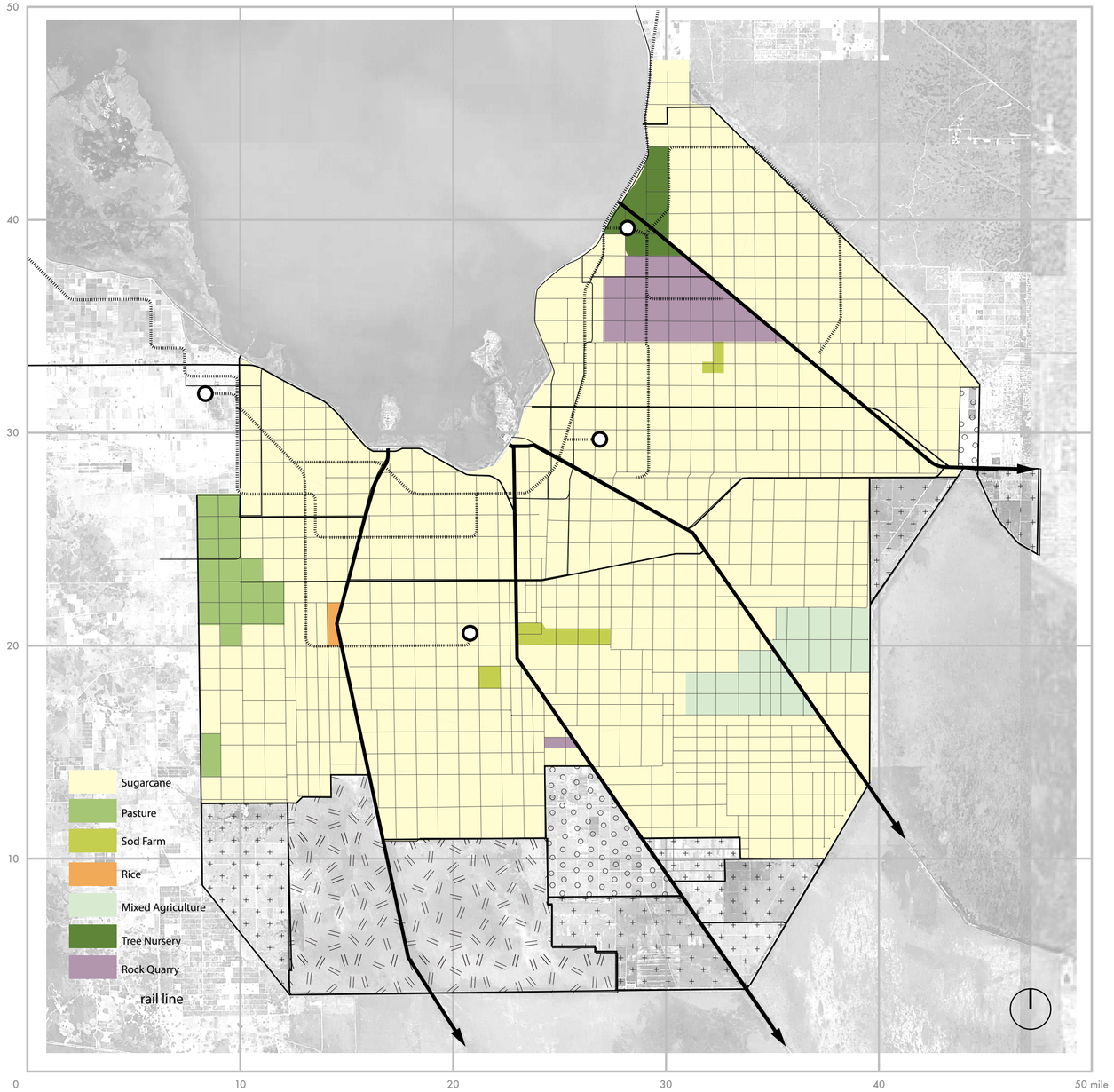
**From Sugarcane Empire to Rice Campaign: Future of Polyculture**

- In other areas of EAA, rice is grown in rotation with sugarcane.

- Rice has been recommened as a cost-effective means of controlling soil loss.

- Rice could be planned as the crop for EAA during the transition time to balance the economic value.



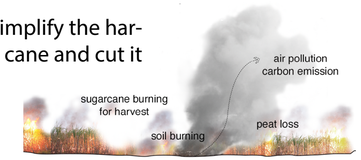



Crop Type in EAA

# 2.4 Agriculture

## Post Sugarcane Industry Heritage: potential of transformation

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



Sugarcane Infrastructures

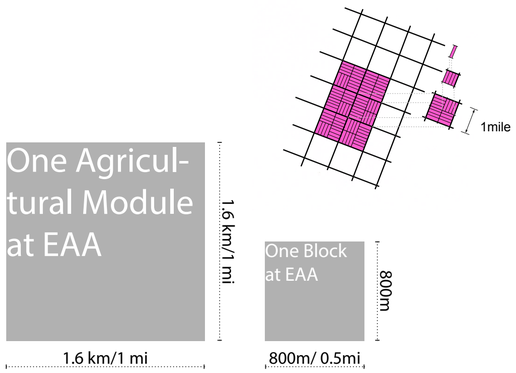



Rail line and sugarcane Mill in EAA

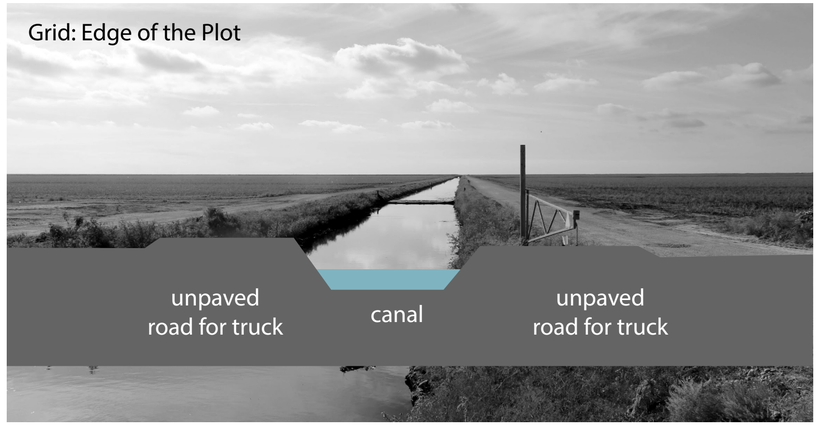
# 2.4 Agriculture

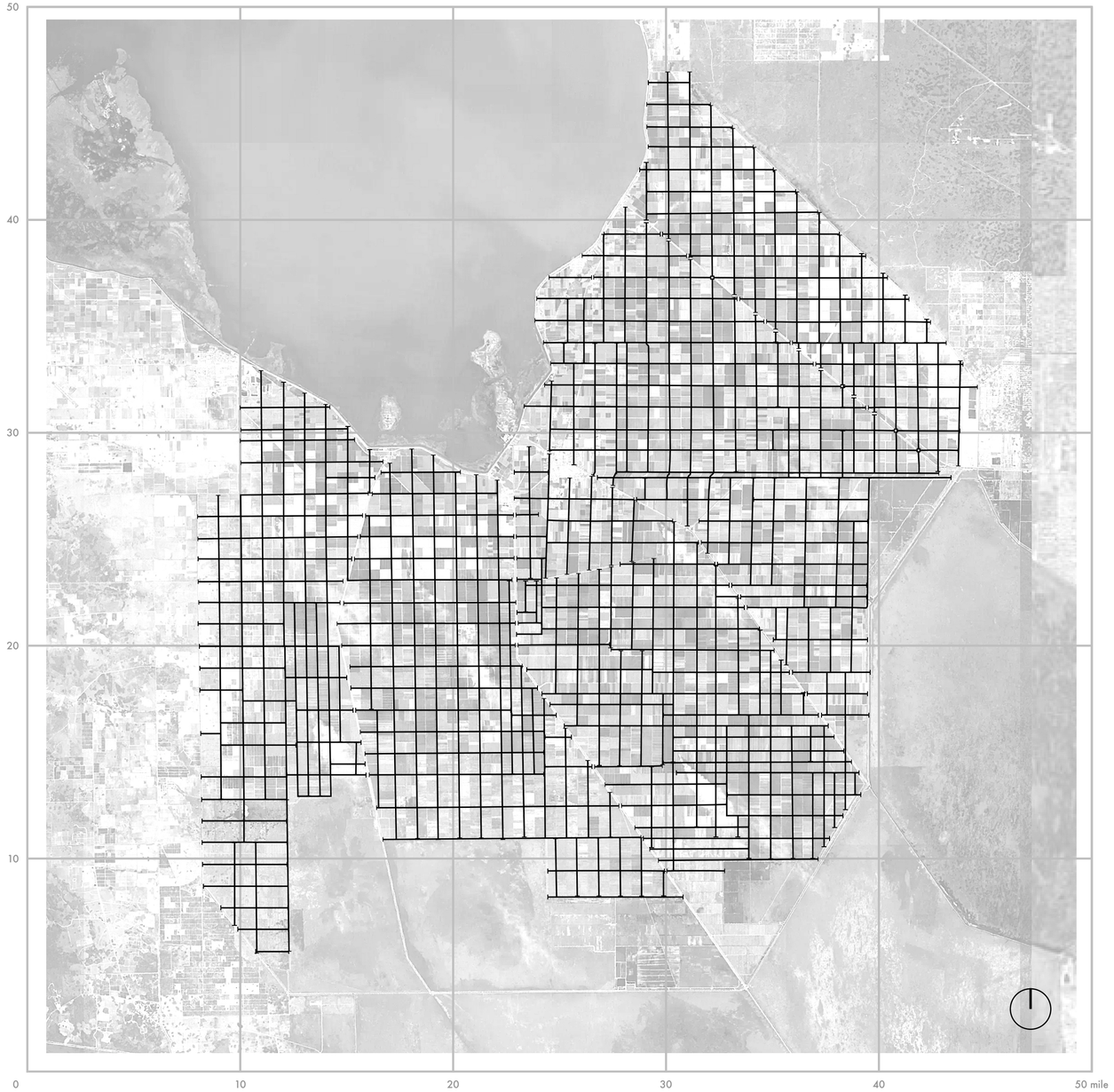
**Enormous Chessboard on Earth: EAA Grid pattern**






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




Grid pattern in EAA

# 2.5 Recreation

## Limited recreational space





## Potentials

Lake Okeechobee





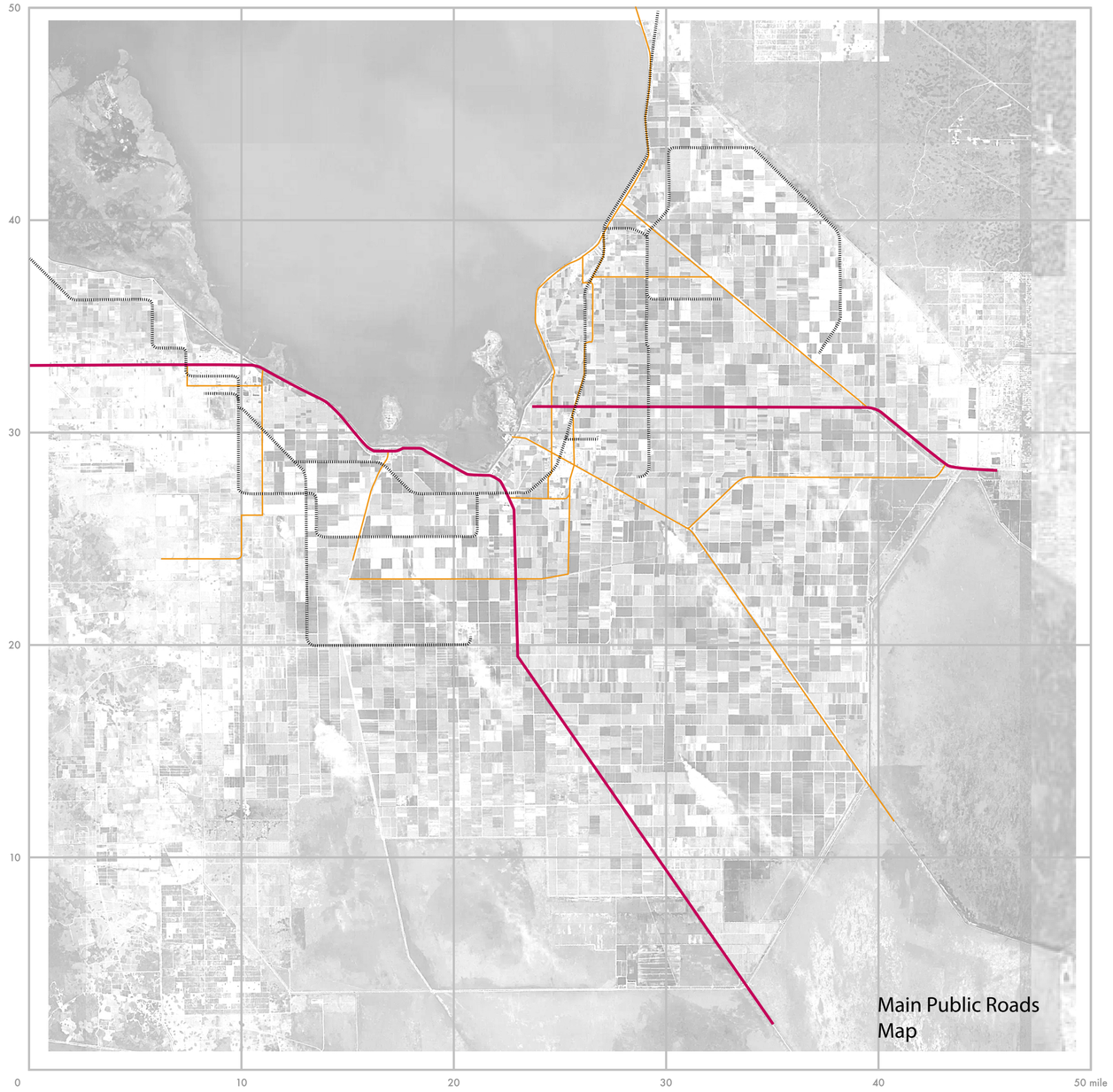

STA



Agritourism



Source: https://www.southfloridaagfoundation.org





# III. VISION OF EAA

# 3.1 Scenarios Development

A

Extreme Scanario
**Supremacy of Economic Benefits**

Economic development would be placed at the highest priority



Source: http://starquarries.com/

B

Extreme Scanario
**Managed Conservation**

Ecological value would be placed at the highest priority



Source: SFWMD

**+ Preservation of ecological value as the basis for a sustainable development**

**+ Economic value is required to be rebalanced**

**+ Improving spatial quality**

**+ Systematic plan that connecting different scales and a series of development processes**

0

**Setting Up Conditions for**
**A Sustainable Development**

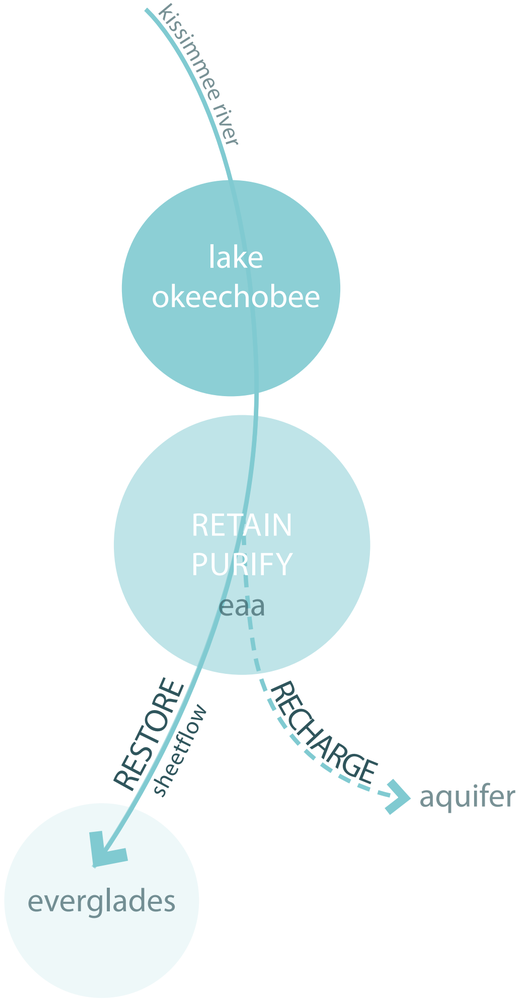
The priority of the design intervention is to preserve and restore the ecological value through the intervention in EAA.

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.

# 3.3 Vision of EAA: **Reverting to Nature** | Enhancing Experience | Sustaining Economics

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

EAA is transformed into a resilient water infrastructure, **allowing more room for natural process and fresh water retention.**



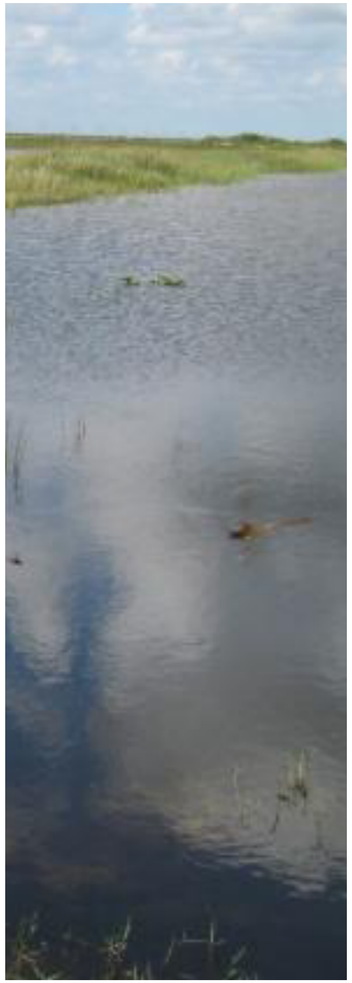



# 3.3 Vision of EAA: Reverting to Nature | **Enhancing Experience** | Sustaining Economics

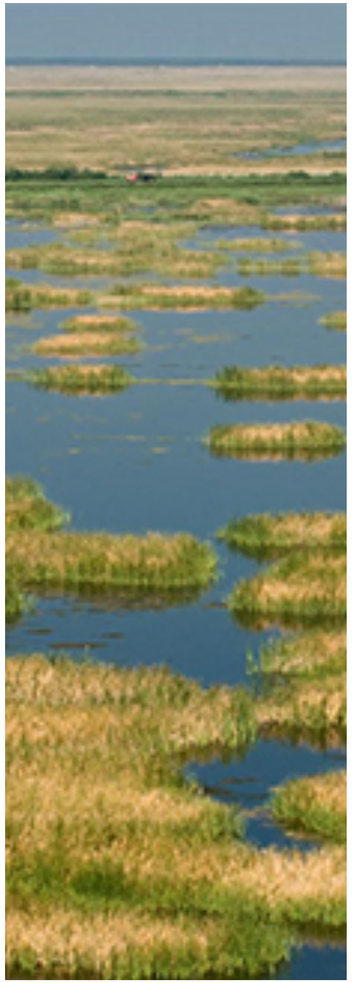
***EXPERIENCE PRINCIPLE*** | ***Vary Landscape, Enrich Experience, Connect People***

*"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. "*

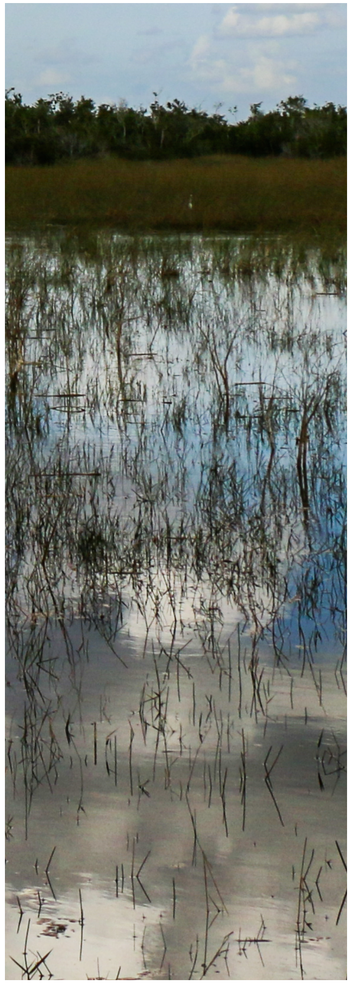
- Elizabeth K. Meyer



Pond



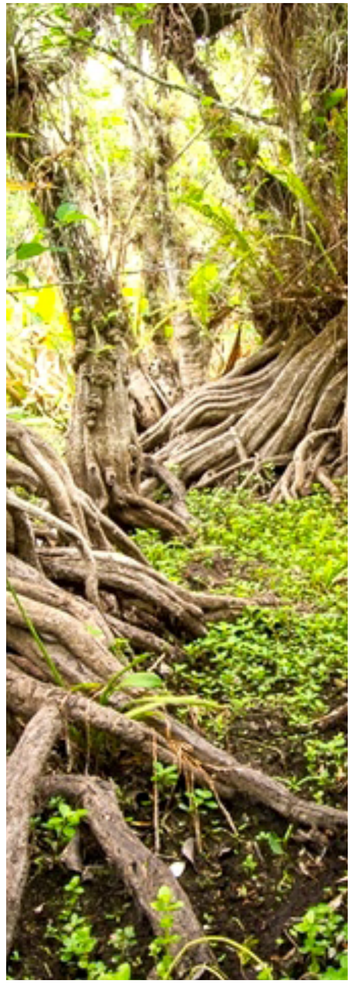
Marsh



Sawgrass prairie



Meadow



Swamp Forest



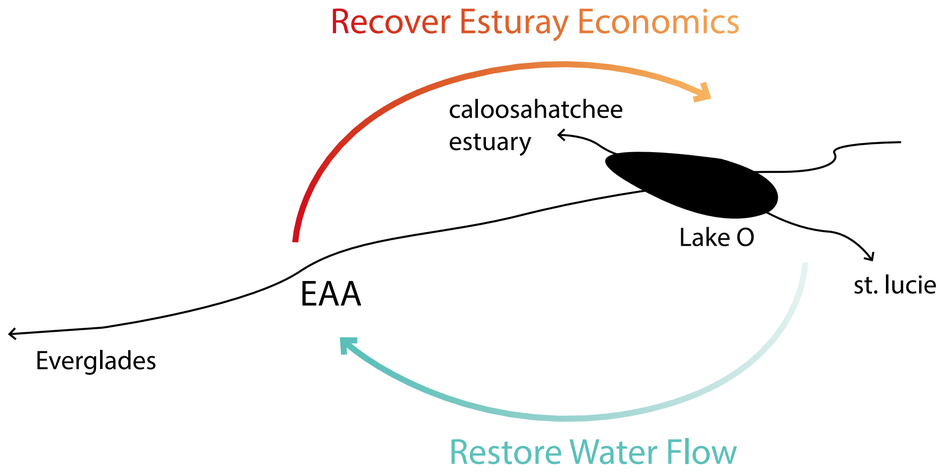
Rice Field

Diverse landscapes are created and provide a variety of spatial experiences

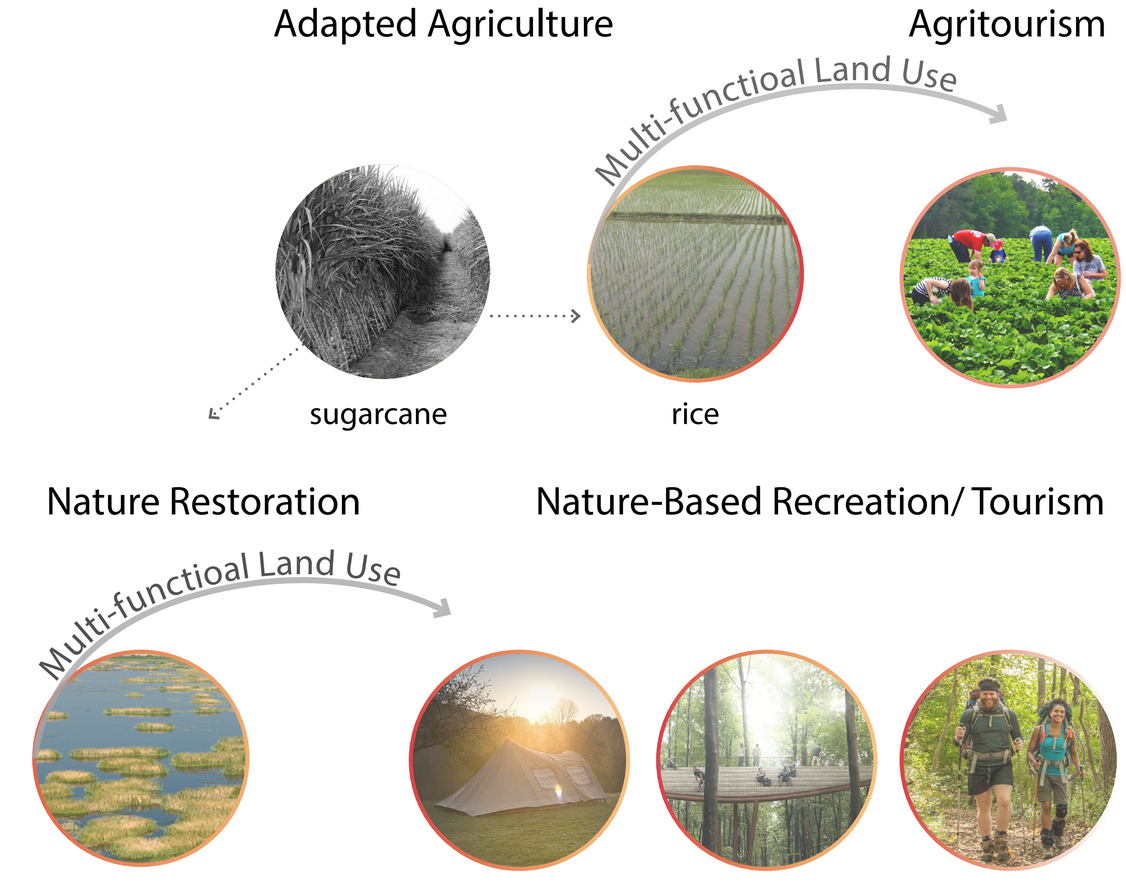
# 3.3 Vision of EAA: Reverting to Nature | Enhancing Experience | **Sustaining Economics**

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

**Region: SF**




**EAA**




Land Rotation

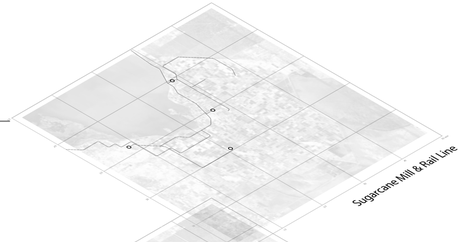
*"Land rotation is not nearly as crop rotation, but it involves the same principle: the land is allowed to rest after a period of demanding use (cultivation) by putting it to a use that is less demanding. "*

- Hart, 1977

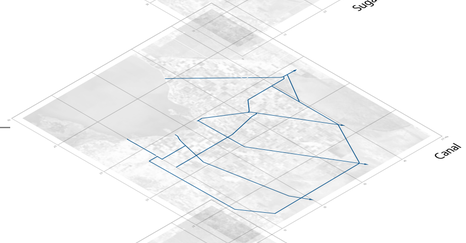
# 3.4 Priority of EAA Transformation Factors

## past

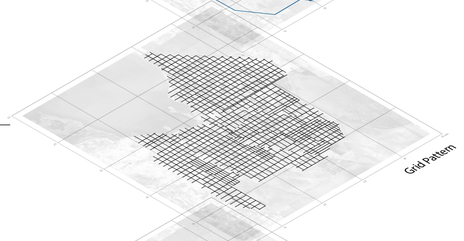
Dominant sugarcane industry



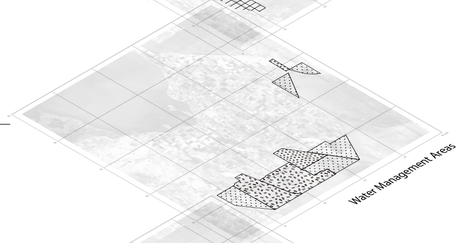

Canal as drainage infrastructure



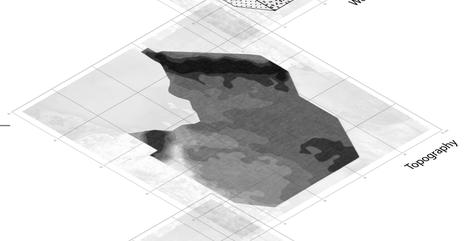

Grid shaping the land



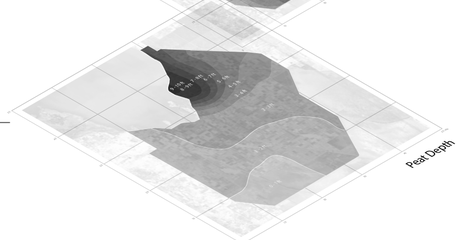

Constructed wetlands as mitigation solution




Ignored topography

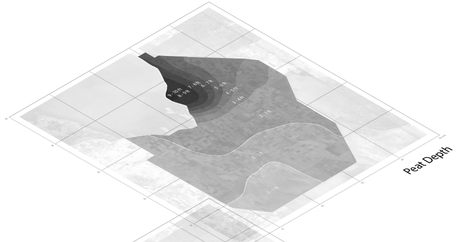



Decreasing peat depth

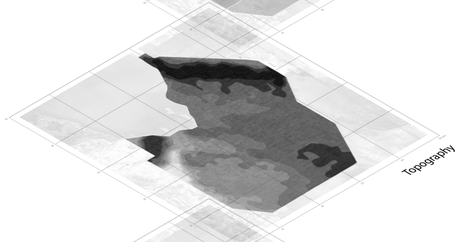



## future

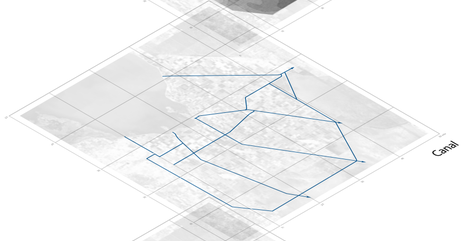
Preserving peat




Revealing subtle topography



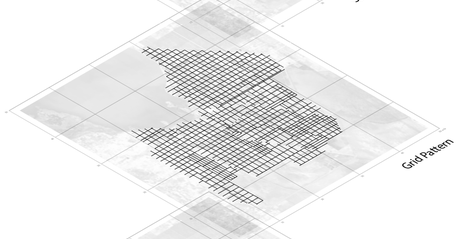

Tool to retain water



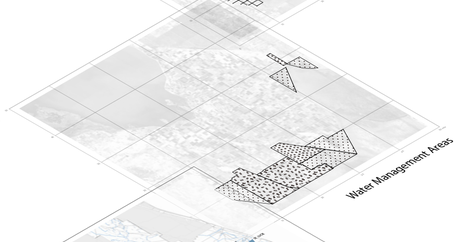

Post-industrial heritage



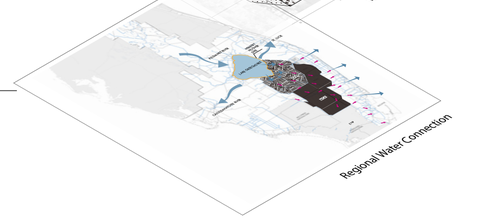

Grid being covered



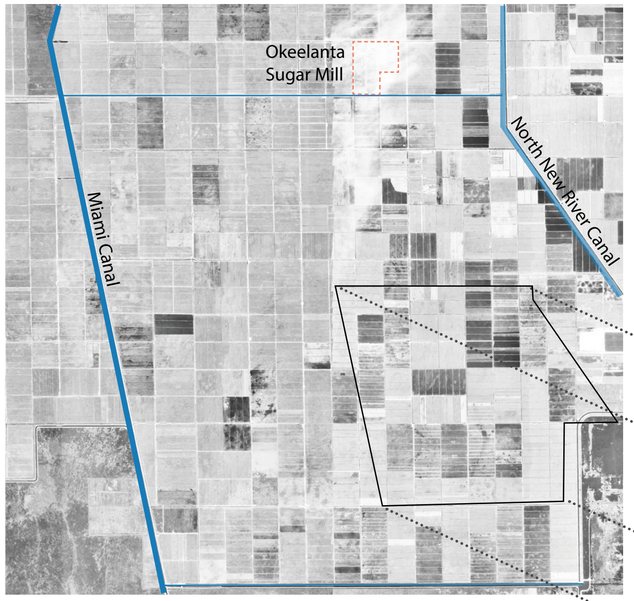

Connecting with existing constructed wetlands




Relinking with lake Okeechobee



# 3.5 Defining Pilot Area

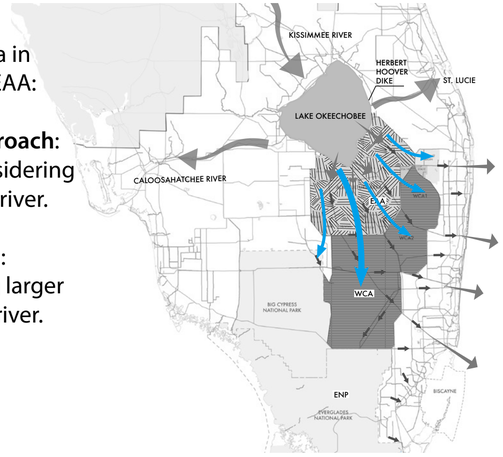


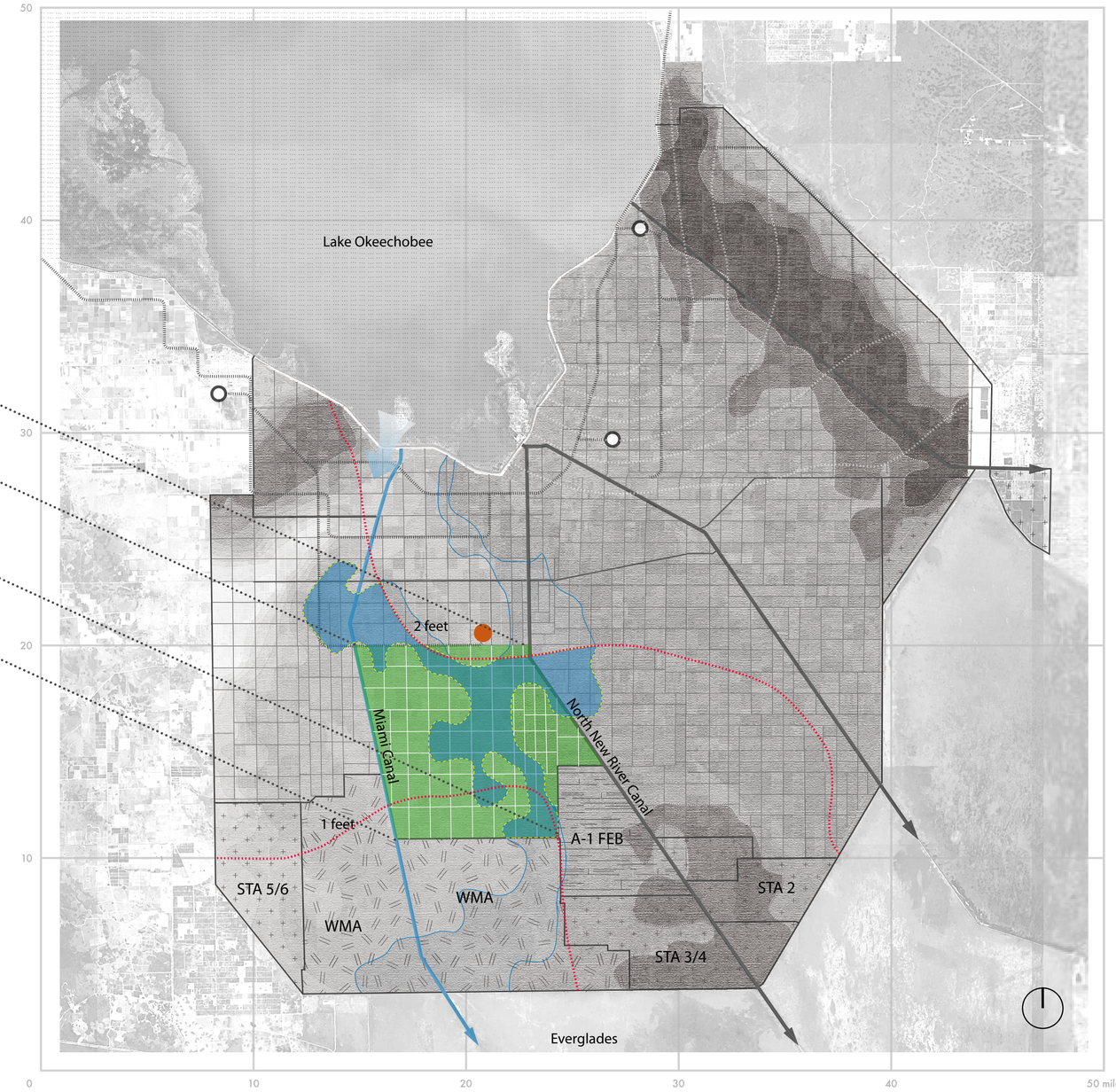

**Least Peat + Crucial Water Corridor + Low Topography**

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

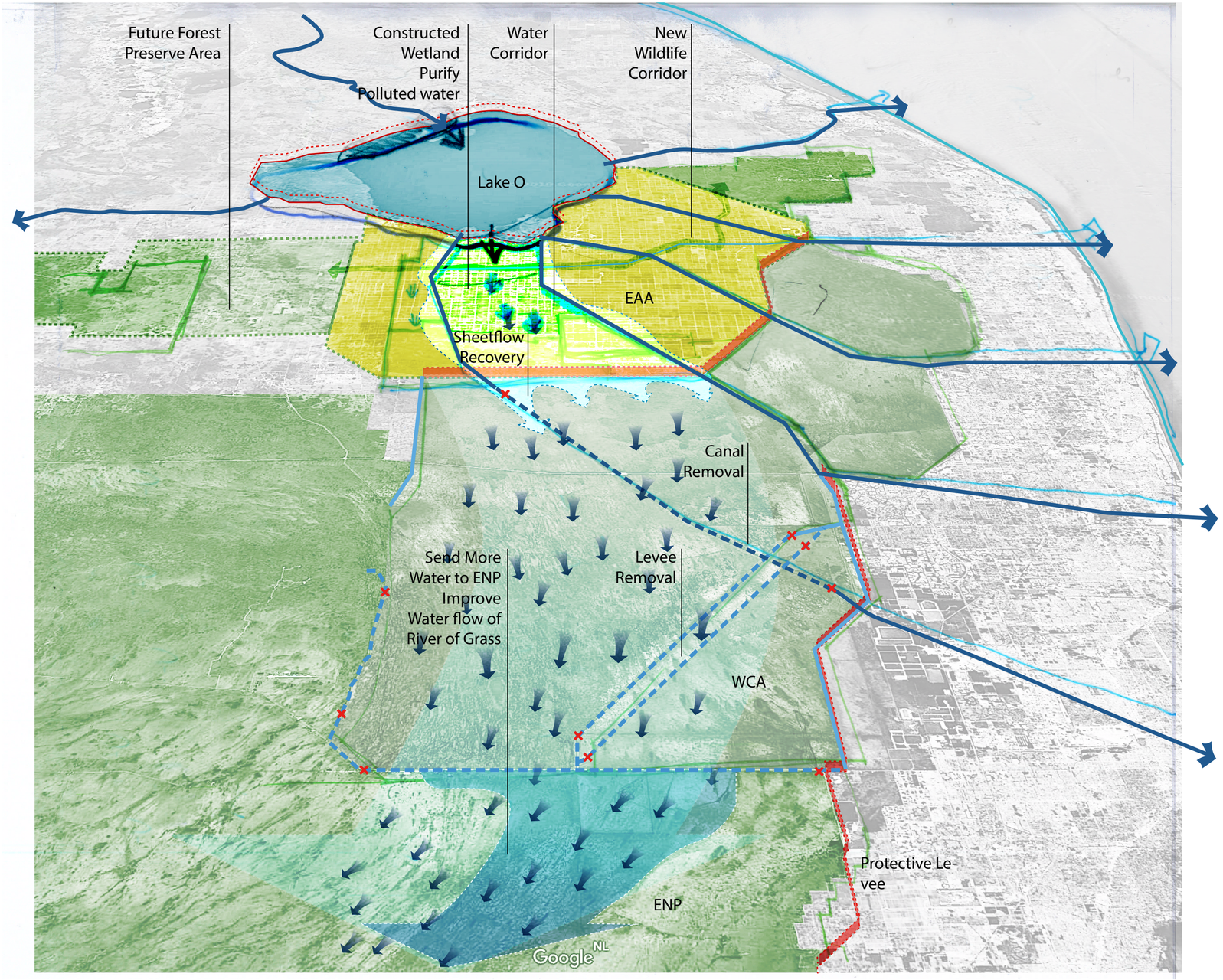
**Subsurface domains approach**: where developments considering peat depth are the main driver.

**Mainstreaming approach**: where changes benefiting larger ecosystem are the main driver.



# 3.6 State of Transition: Strategic Regional Plan

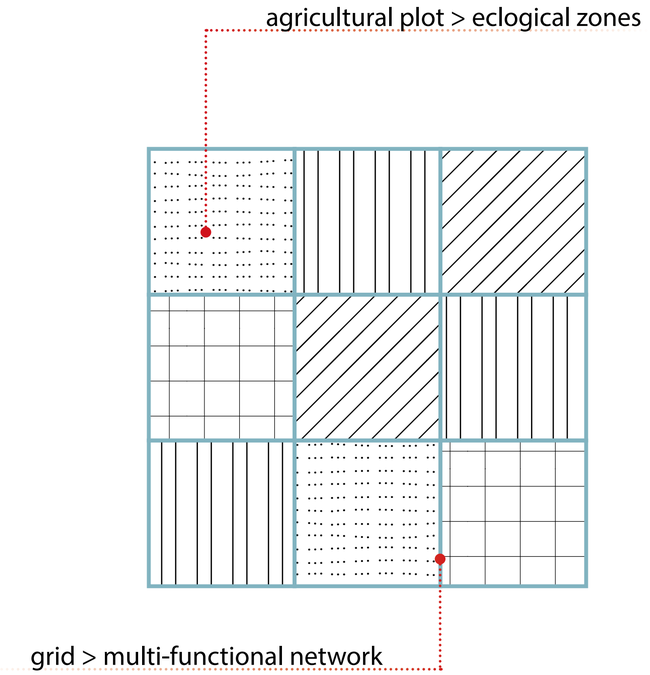




# IV. DESIGN FRAMEWORK

# 4. DESIGN FRAMEWORK

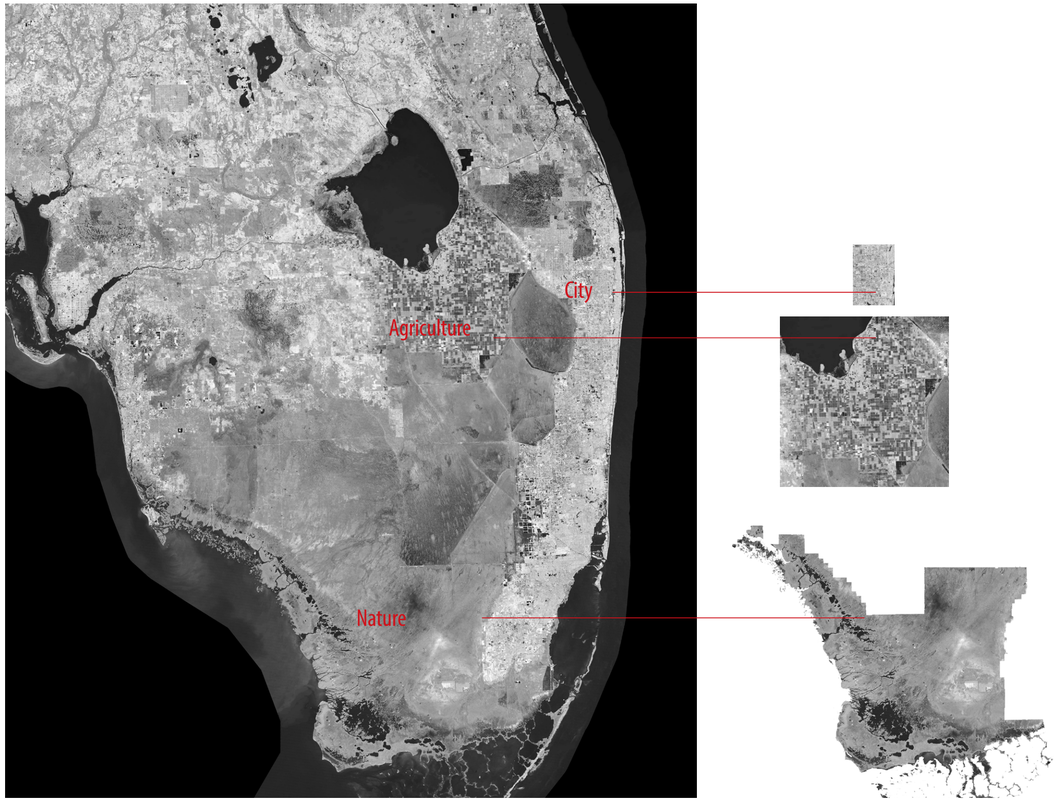
4.1 From Plot to Zones
4.2 From Edge to Network



# 4. DESIGN FRAMEWORK

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.

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.




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

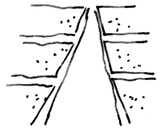


800 m



Medium - Medium



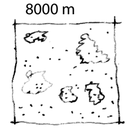


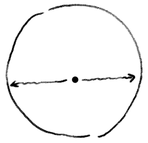
EAA, the green space is defined into grids

## Nature

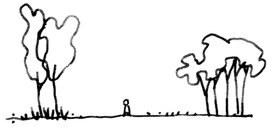


8000 m





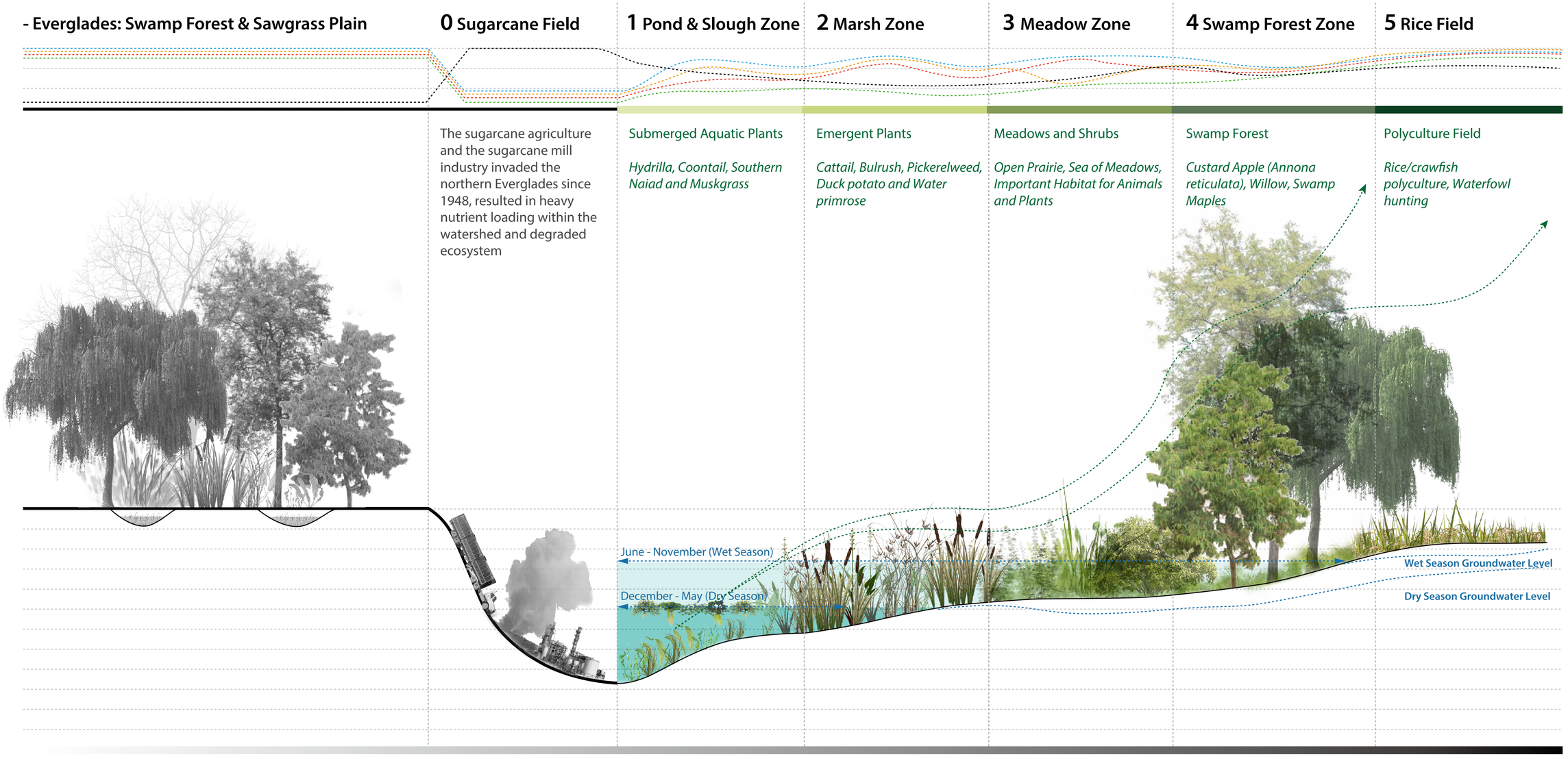
Small - Lagre



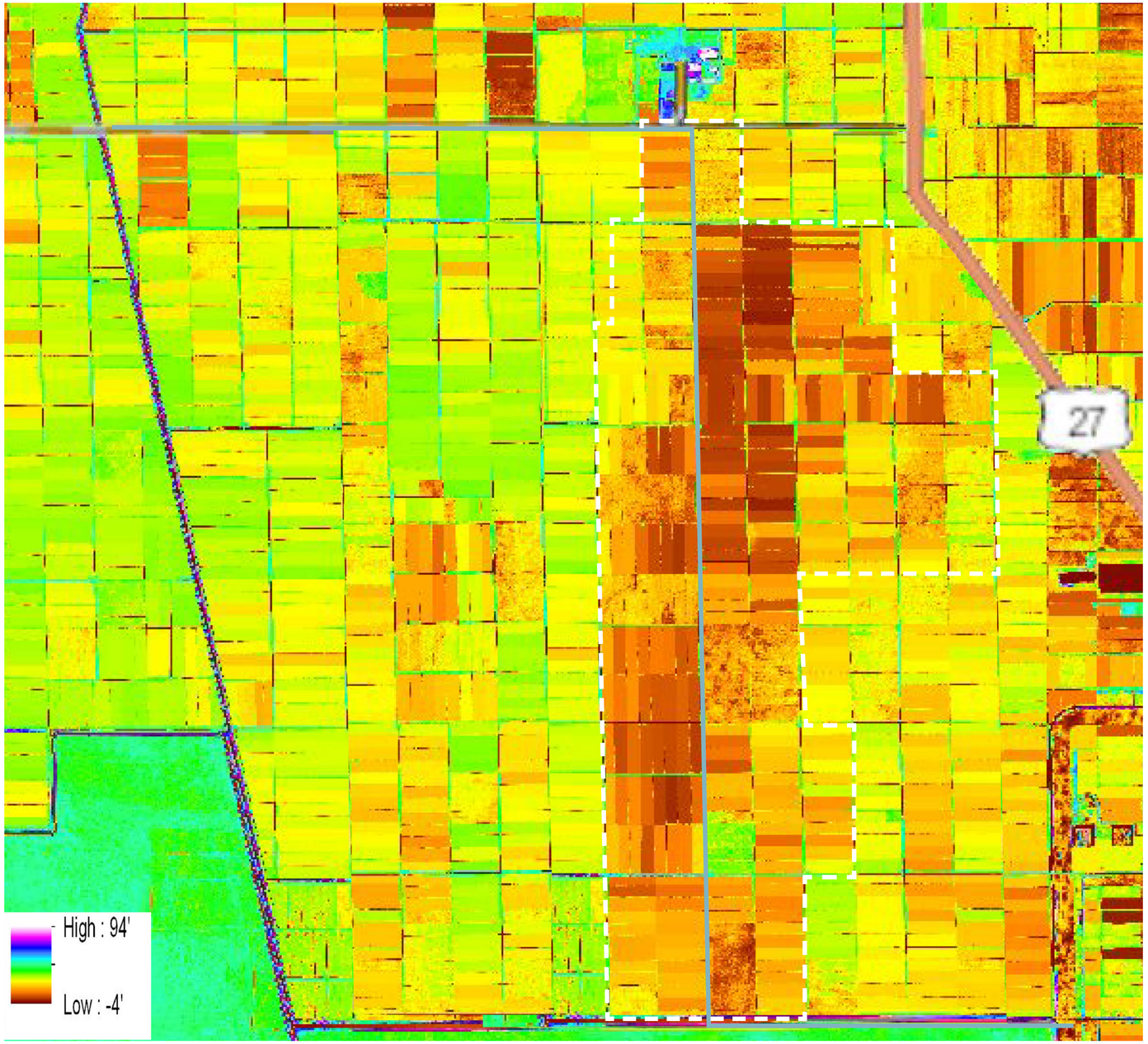


Everglades, the form is one of freedom, expressing undefined areas, which spread uncontained

# 4.1 DESIGN FRAMEWORK | FROM PLOT TO ZONES



# 4.1 FROM PLOT TO ZONES | Application

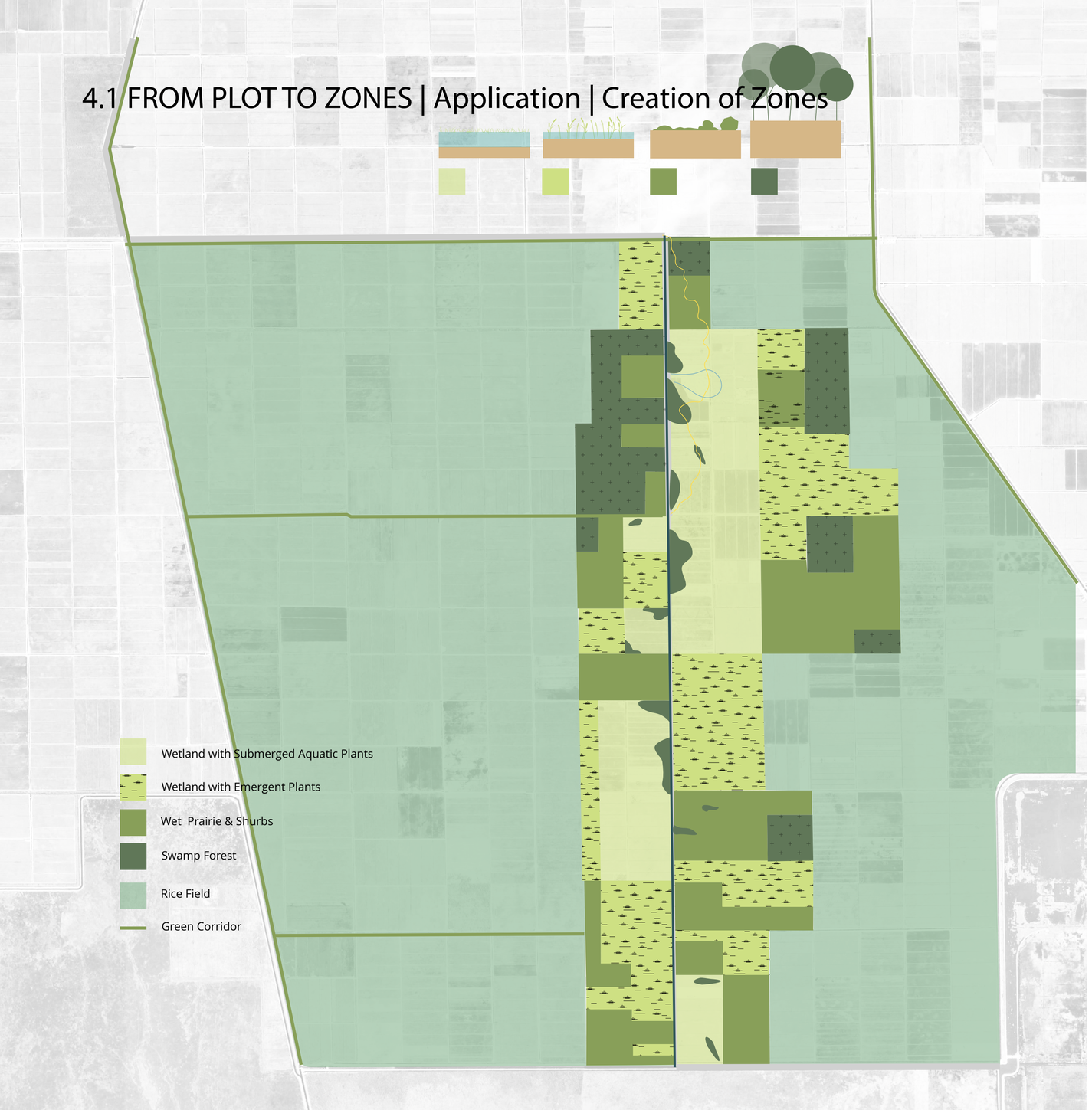


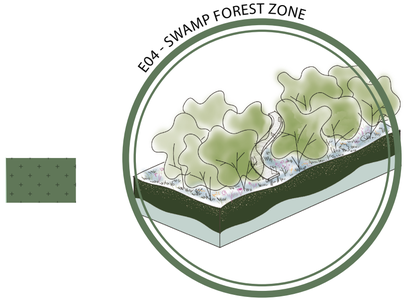

+ Store 60,000 acres (243km$^2$) water

+ Purify 40,000 acres (162 km$^2$) water

+ Reduce phosphorus concentrations to 10 ppb

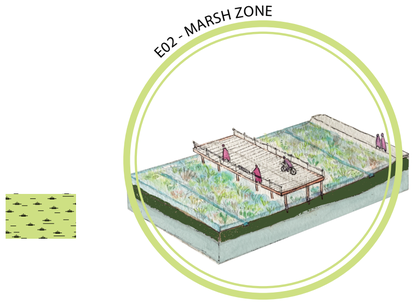
# 4.1 FROM PLOT TO ZONES | Application | Creation of Zones

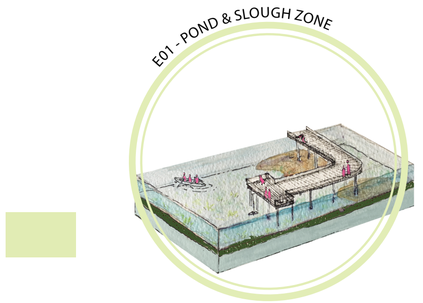




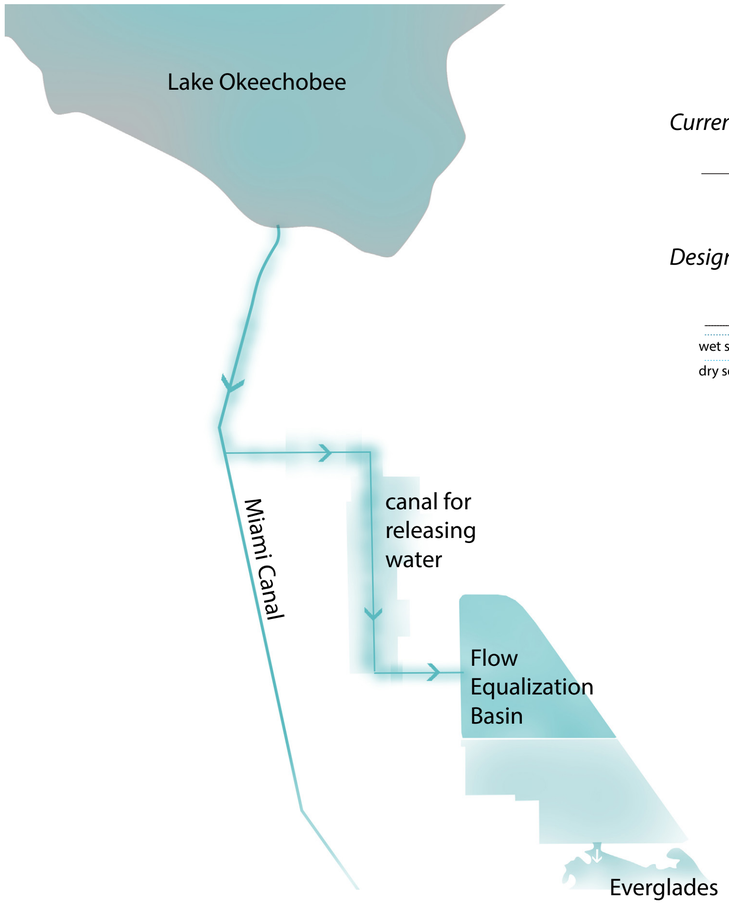







# 4.1 FROM PLOT TO ZONES | Application | Water Management




*Current Situation*




*Designed Situation*

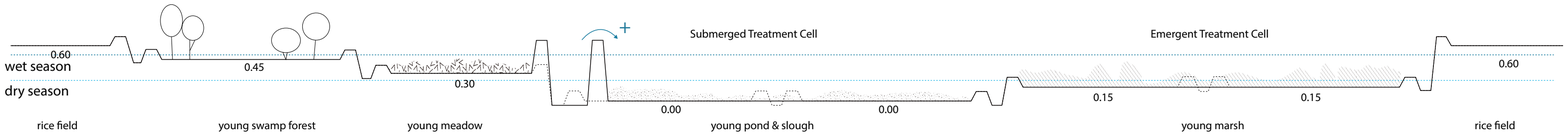
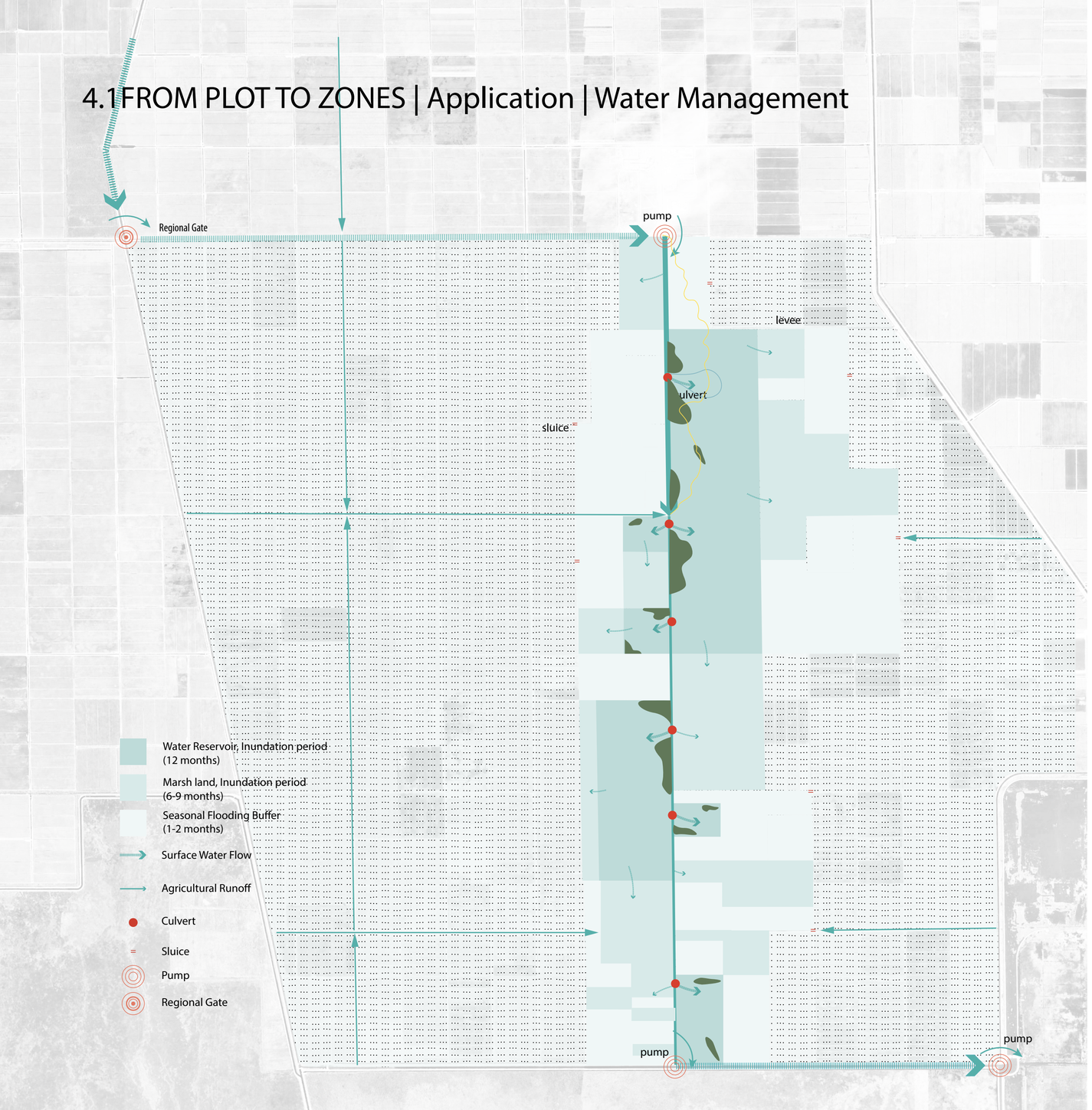



Figure 51. Section A-A

*Water Management Strategy*

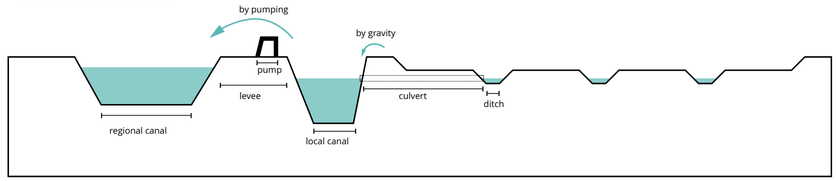
Water from lake Okeechobee flows into Miami Canal and being released into the restoration site, where it is retained and purified. At the end of the process, the water is pumped into the flow equalisation basin. After this, the water will move to the Everglades in the form of sheetflow. The canal will 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.

# 4.1 FROM PLOT TO ZONES | Application | Water Management

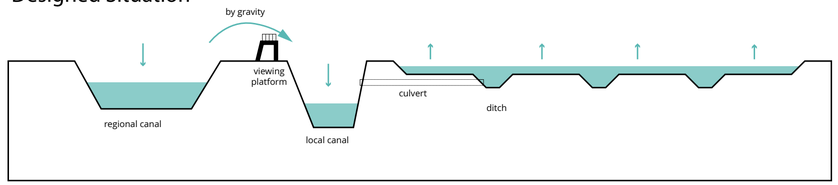



## New Water Management Strategy

### Current Situation

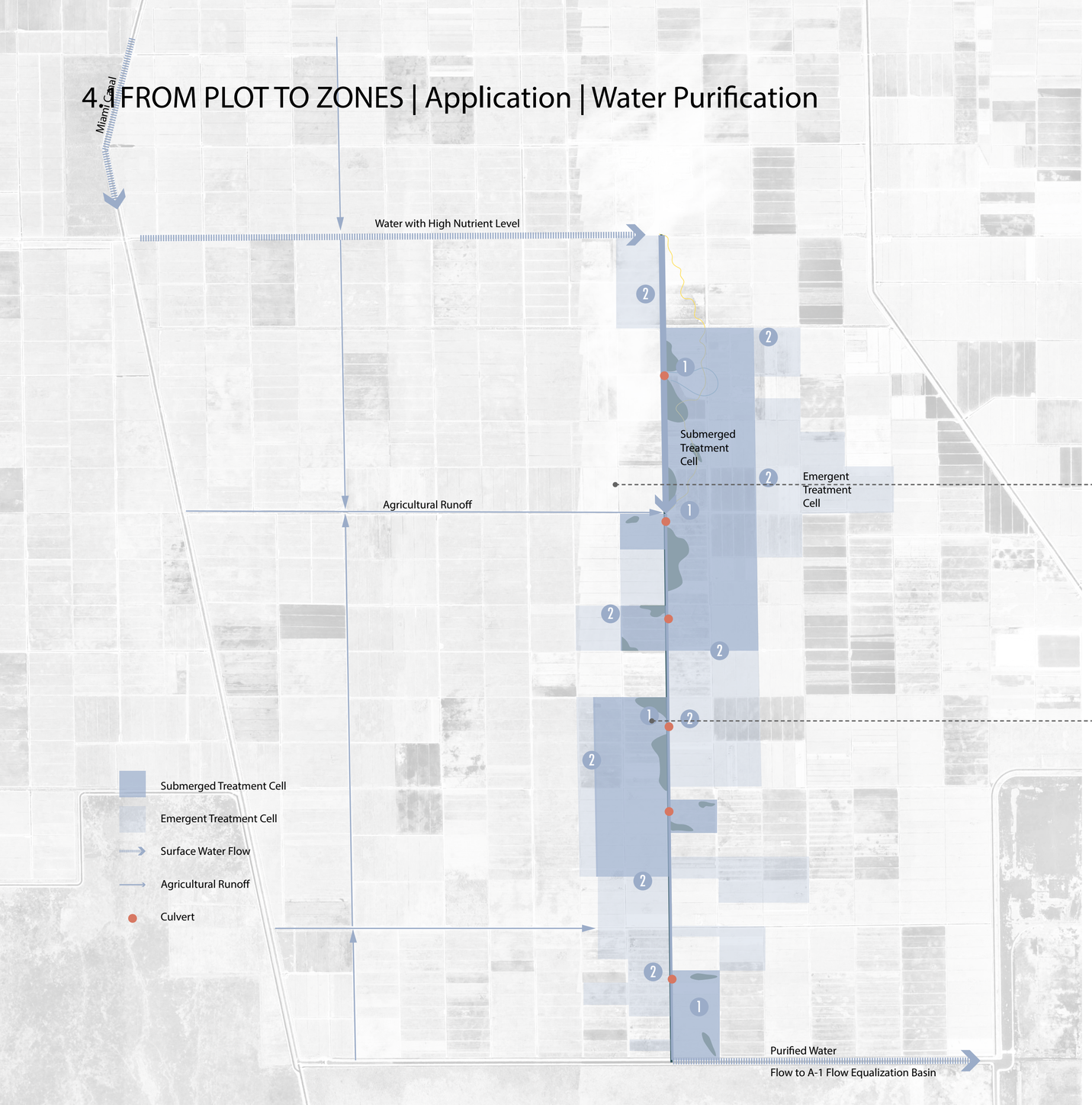



### Designed Situation




Elevating water level

# 4 FROM PLOT TO ZONES | Application | Water Purification




Submerged Treatment Cell



Emergent Treatment Cell



**Phytoremediation:**
use of plants to remove contamination from soils and surface water



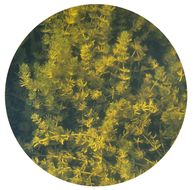
*Hydrilla*



*Southern Naiad*



*Coontail*



*Muskgrass*



*Cattail*



*Bulrush*



*Pickerelweed*



*Duck potato*



*Water primrose*

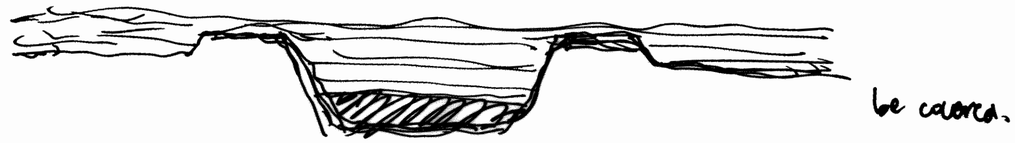
# 4.2 DESIGN FRAMEWORK | FROM EDGE TO NETWORK

Those infrastructures will be reshaped into various morphology according to different needs.

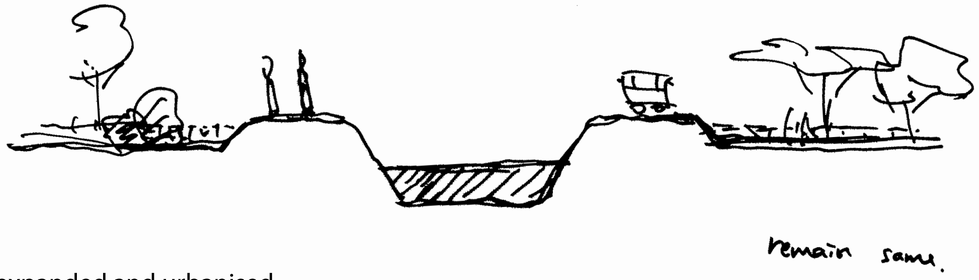
-Edge being covered by vegetation



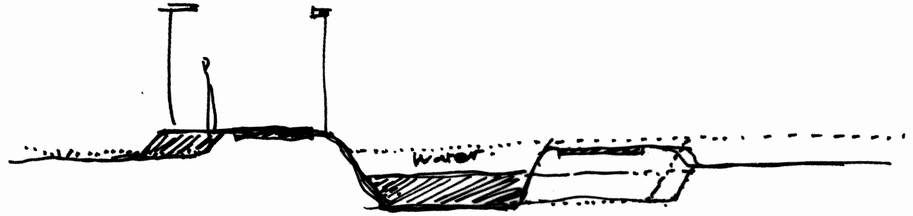
- Edge under water integrating into the zone




- Edge as sightseeing path




- Edge being expanded and urbanised

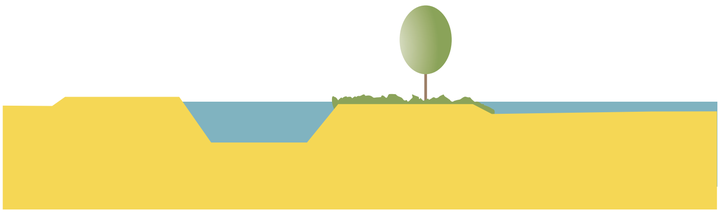


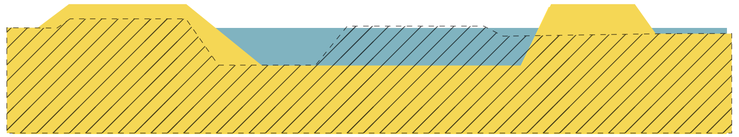

Current Situation



New Situation



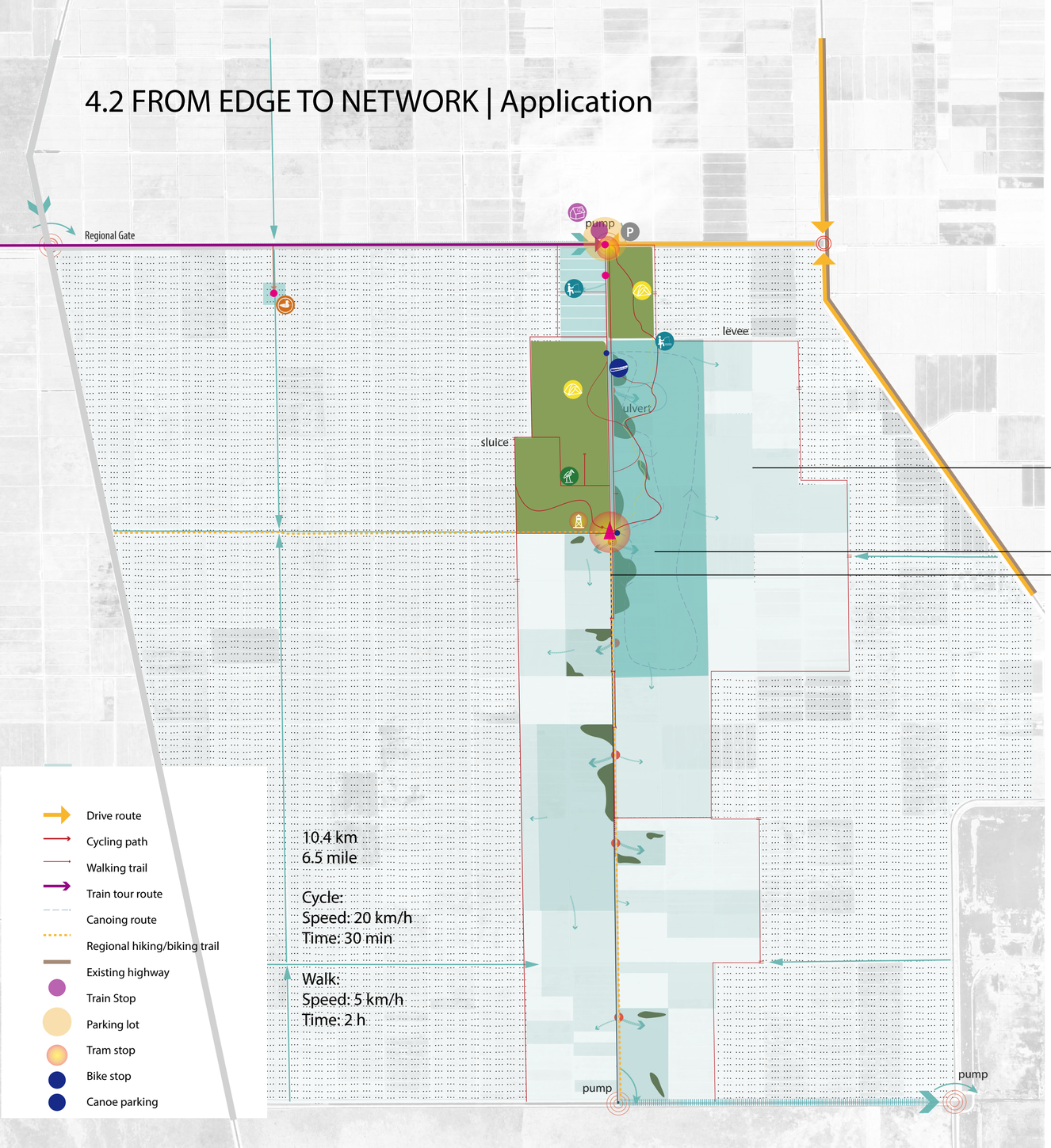


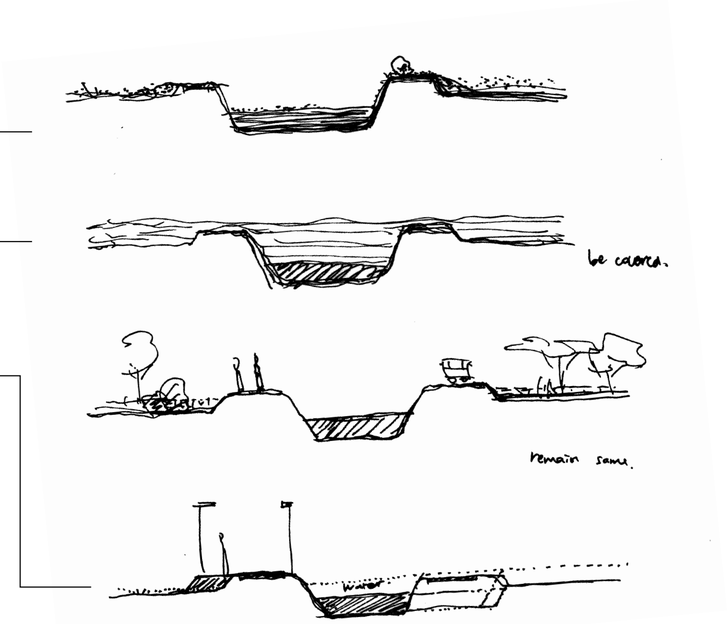


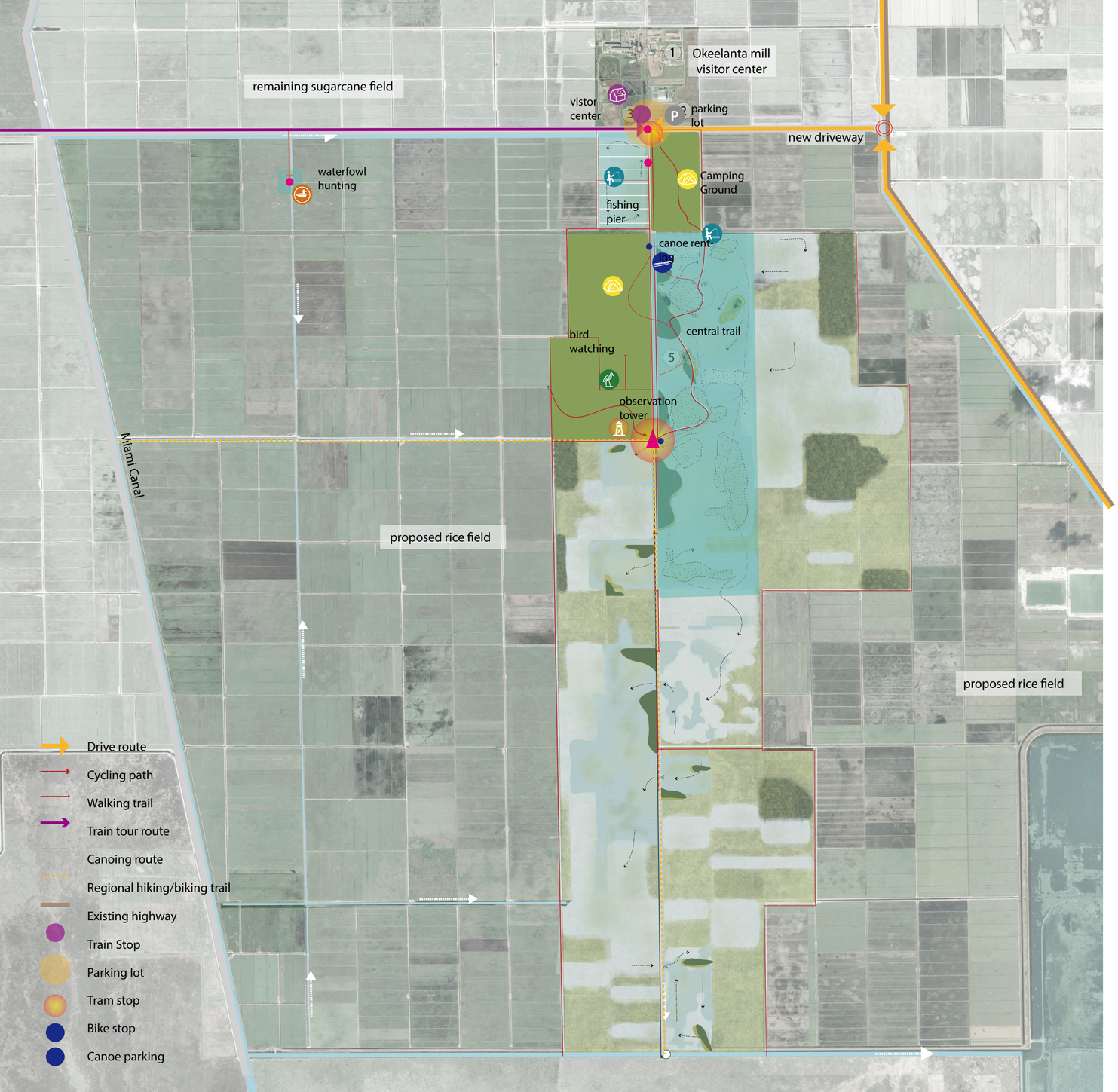
# 4.2 FROM EDGE TO NETWORK | Application

**Network of route: rail line/parkway/ cycling route/ hiking route**

**Network of ecological corridors: purification corridor**

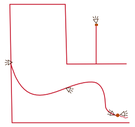


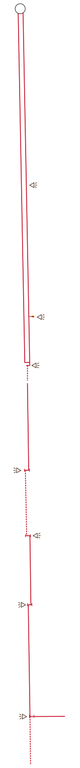



## Recreational Network

Swamp Forest Trail



Canal Trail



Tree Island Trail



visitor center: post-industry sugarcane mill

dense activities

sparse

Gradually into the wild

## New Program Strategy



Fishing



Camping



Canoeing



Hunting



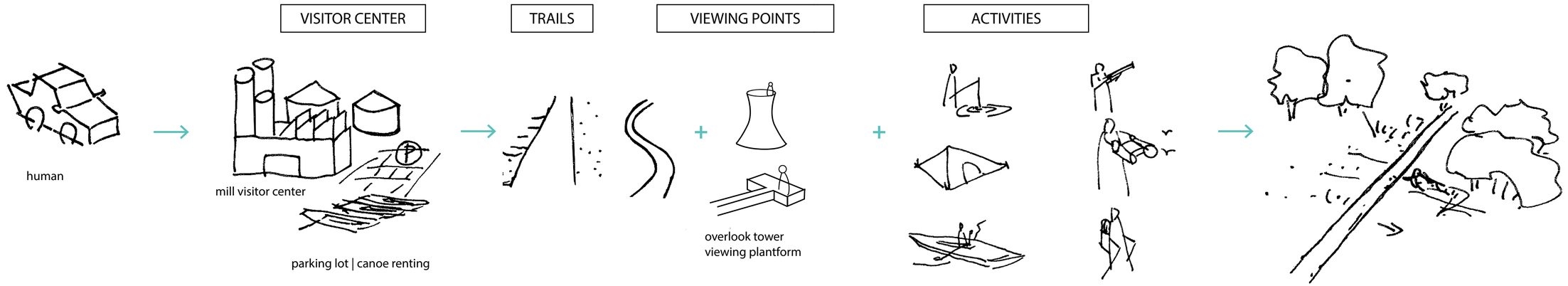
Bird Watching



Hiking

# 4.2 FROM EDGE TO NETWORK | Application | Experience

**Sequence of Experience**




City

Everglades Restoration Area (ERA)

Starting Point

Densified Experience

Into the Wild

cityscape

post industry landscape

agriculture landscape

various restored-nature landscape

wild/less managed landscape







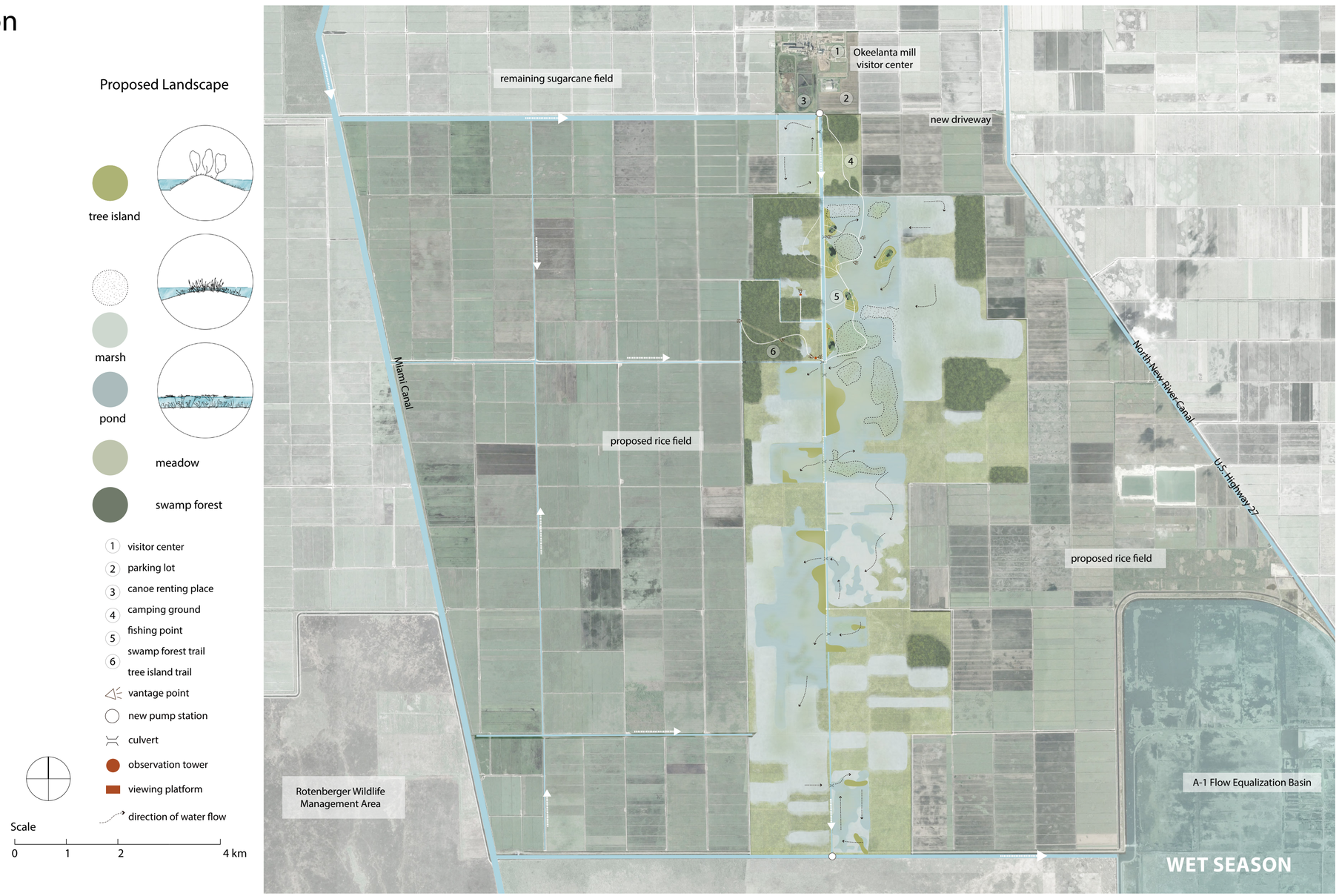


The sequence of experience in the restoration area represents the spatial gradient in South Florida.

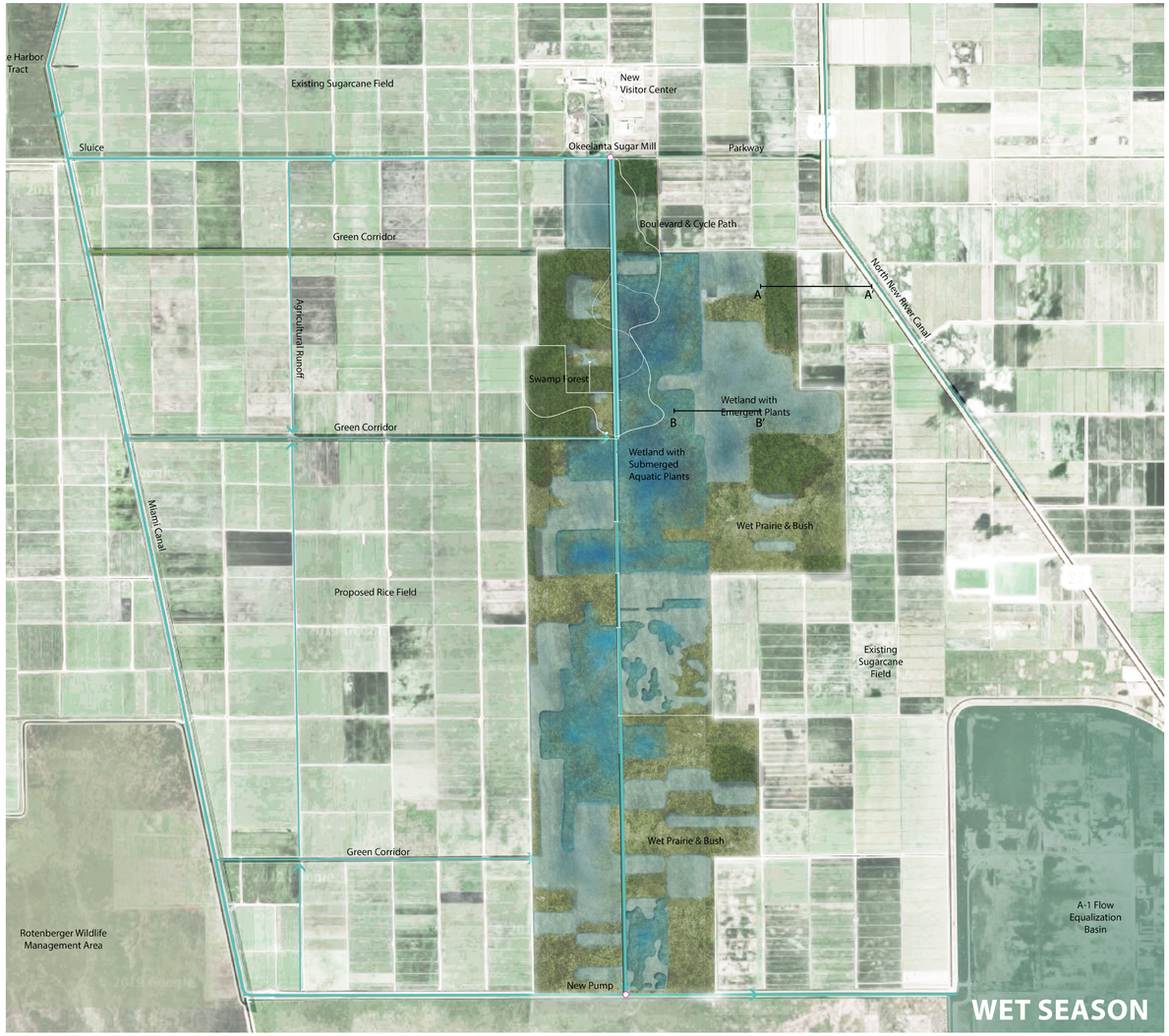
# 4. DESIGN FRAMEWORK | Application

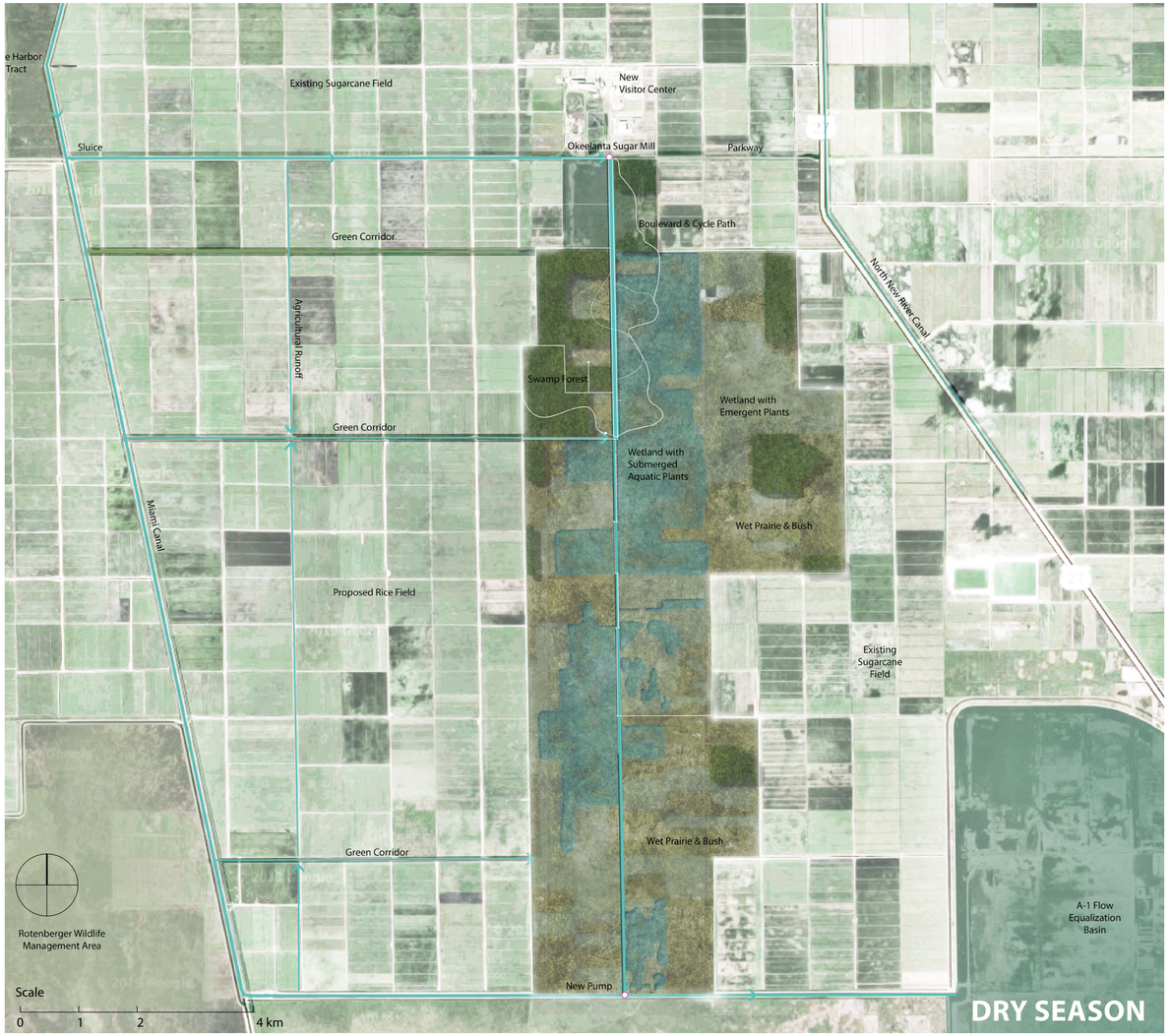
By applying the design framework in the pilot area, the design plan was created. It combines the different layers that were discussed before, such as the creation of the zones, the recreational network and the generated landscapes.

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



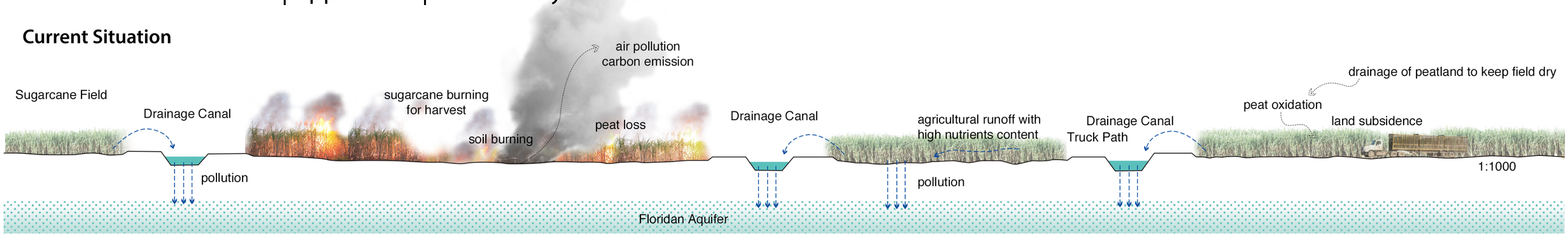
# 4. DESIGN FRAMEWORK | Application | Seasonal Dynamics



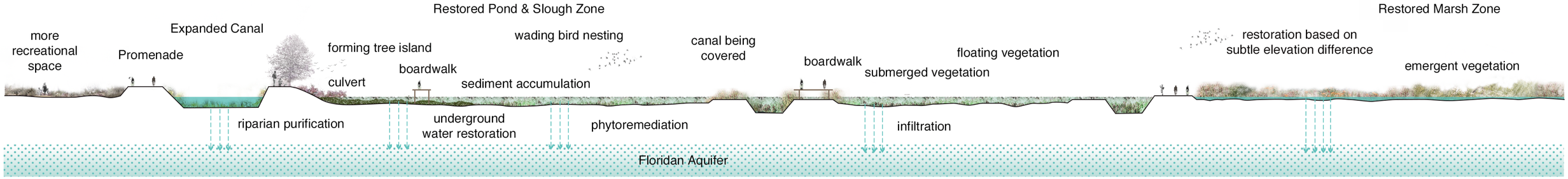



# 4. DESIGN FRAMEWORK | Application | Seasonal Dynamics

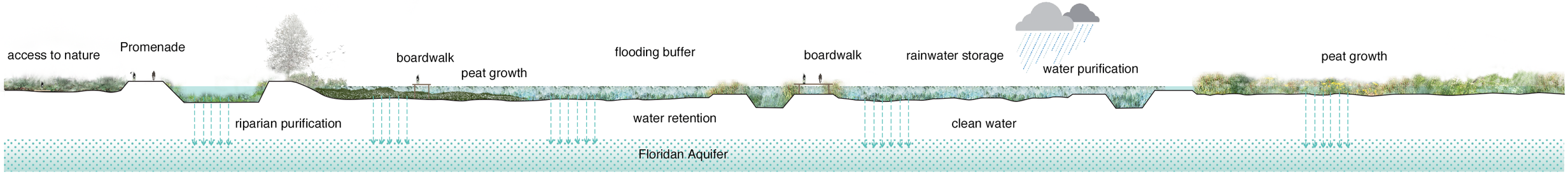
## Current Situation




## Designed Situation

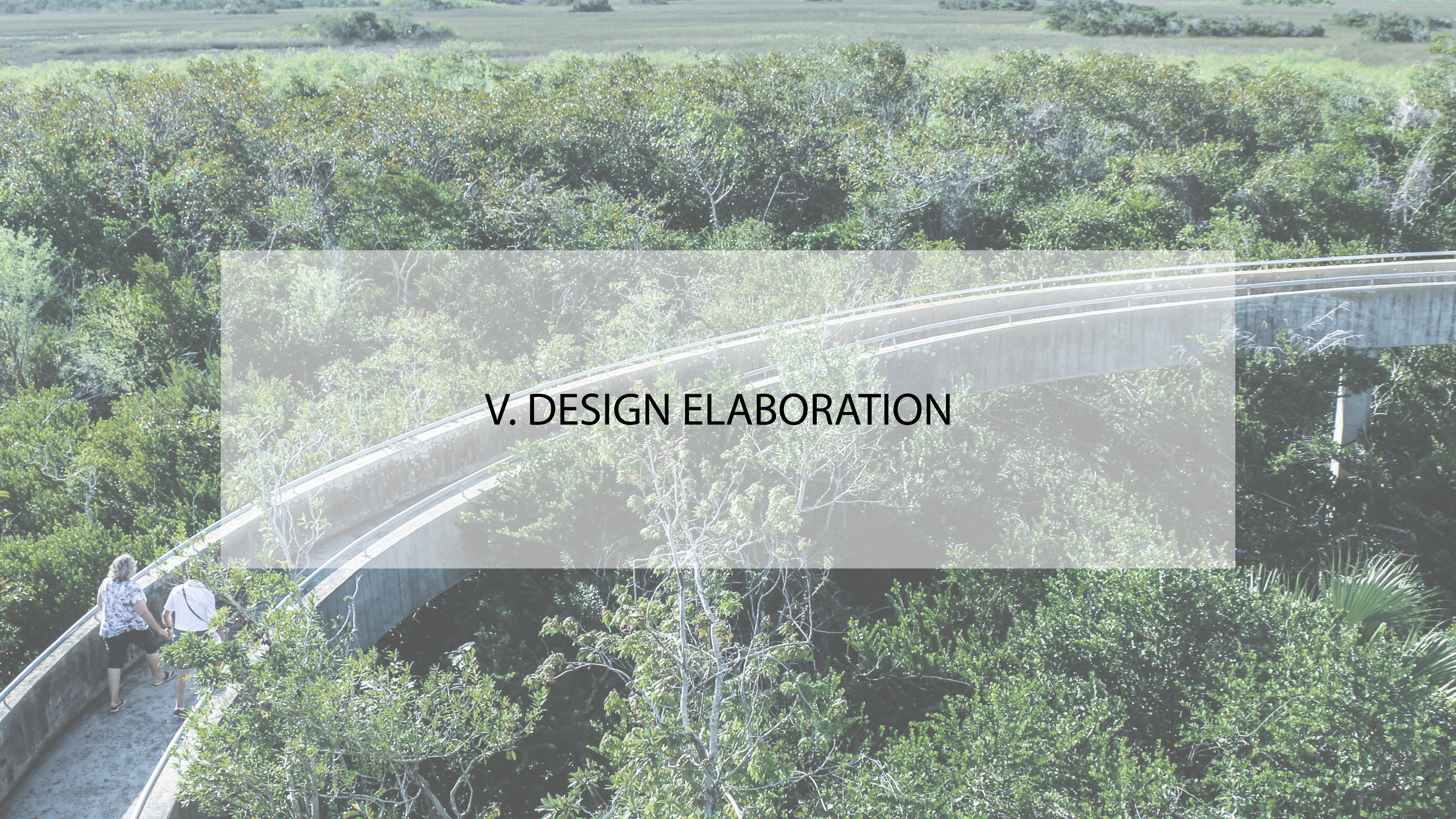



Dry Season



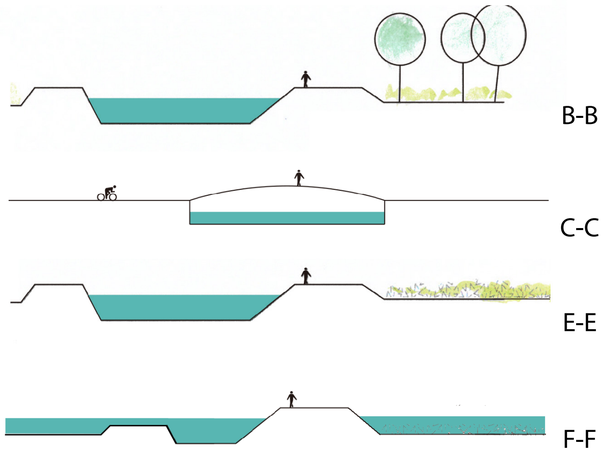

Wet Season

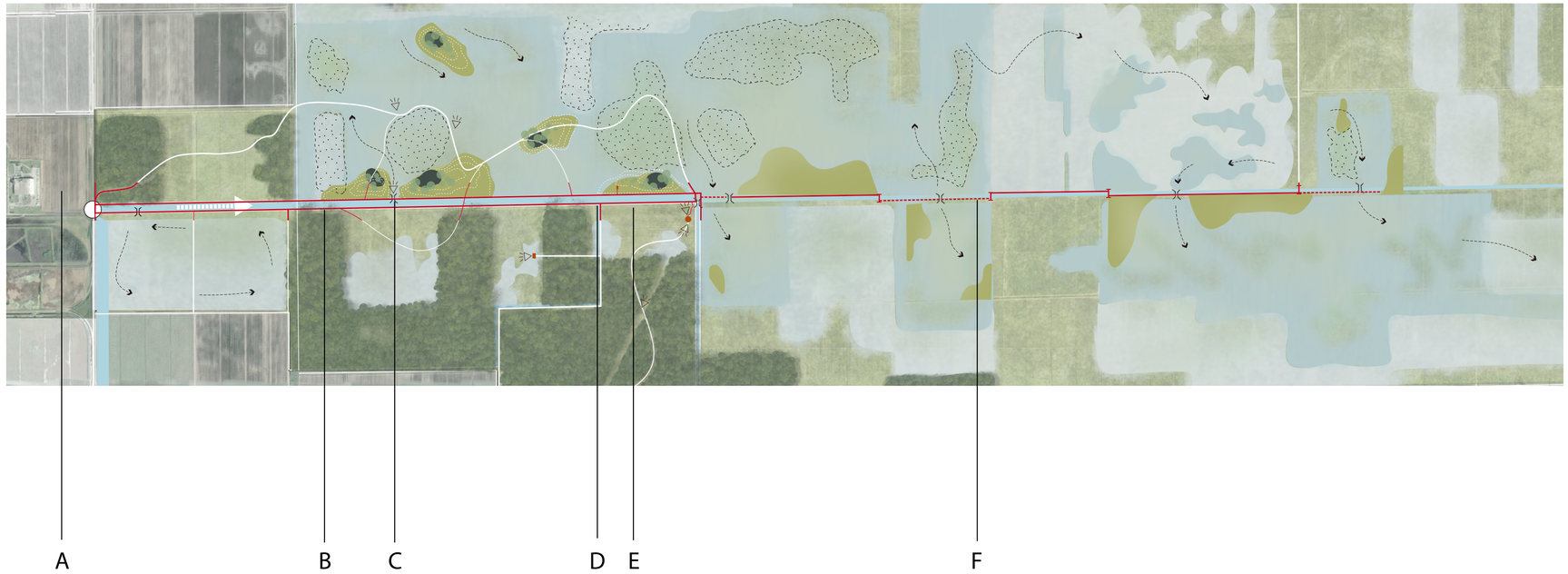
0 10 20 30m



# V. DESIGN ELABORATION

# 5.1 DESIGN ELABORATION | Canal Trail







A



B

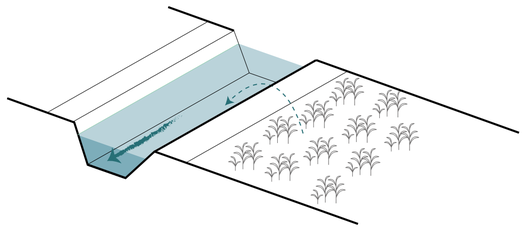


D

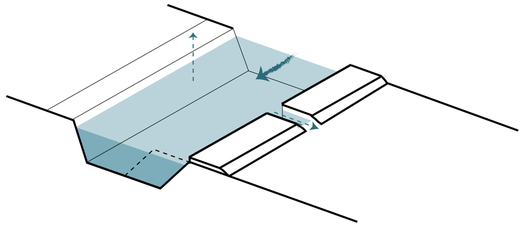


F

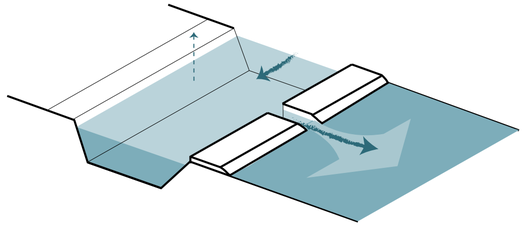
# Strategic Interventions



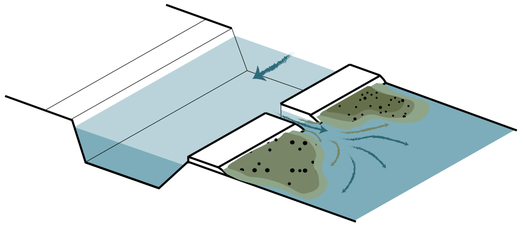
***CURRENT***: Drainage Canal



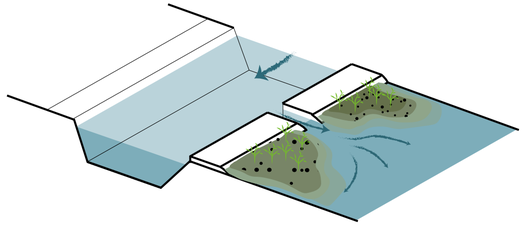
***STEP 1***: Expand Canal, Elevate Water Level



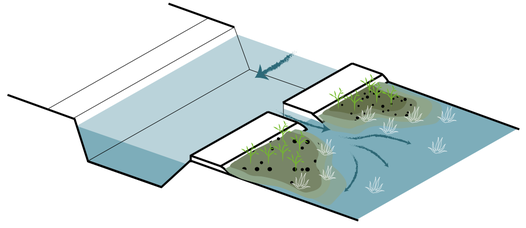
***STEP 2***: Restore Water Flow



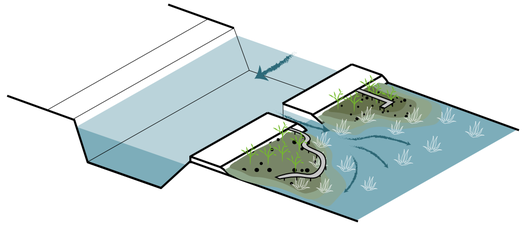
***STEP3***: Bring New Sediment



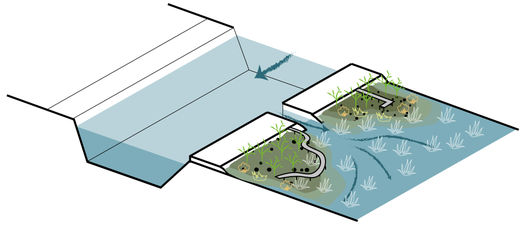
***STEP 4***: Form Tree Island



***STEP 5***: Purification Plants Introduced, Nutrient Closed By Plant

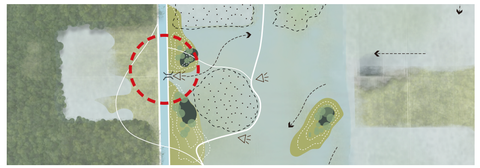


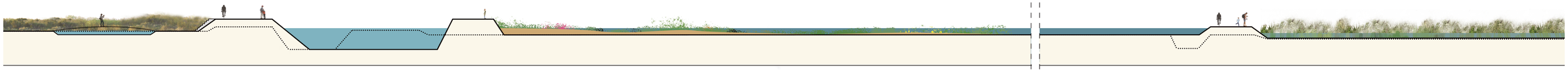
***STEP 6***: Upgrade Accessibility And Create Recreational Space



***STEP 7***: Guide Ecological Succession

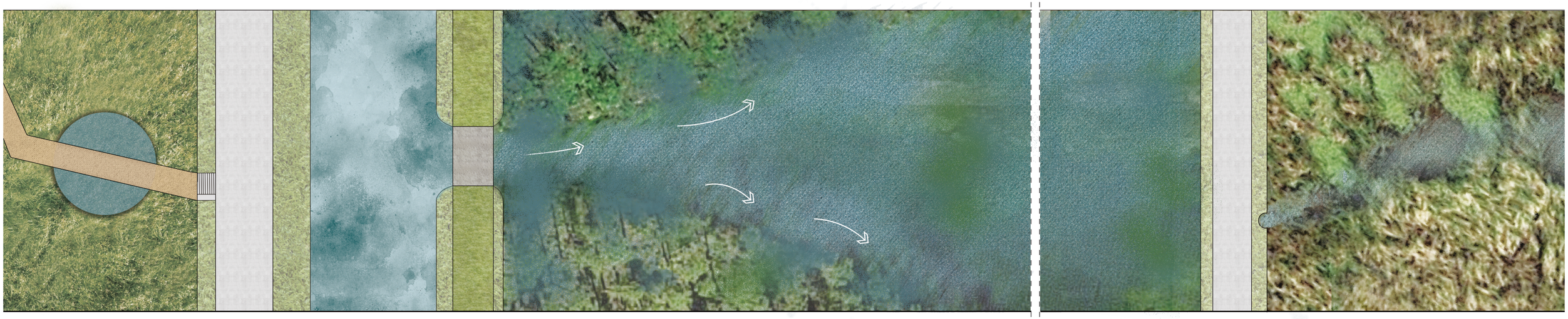
# Proposed Situation





A-A' SECTION

Meadow | Path | Canal | Path | Pond and Slough | Path | Marsh



A-A' PLAN

0 5 10 15m

**Eye-level Spatial Implication**

- Integrating spatial conditions of ecosystems into the landscape architectonic design



**Material Use**

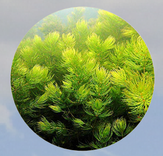
Purification flora + Permeable structures + Recycled building materials

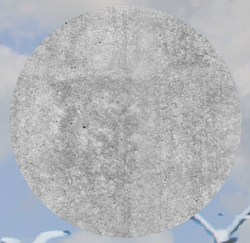

Cattail

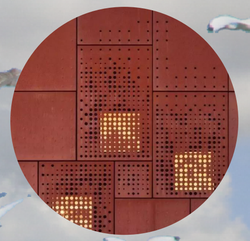

Bulrush


Hydrilla


Southern Naiad


Coontail


concrete


Corten Steel

invite people to witness the change

culvert

purification plants

sedimentation

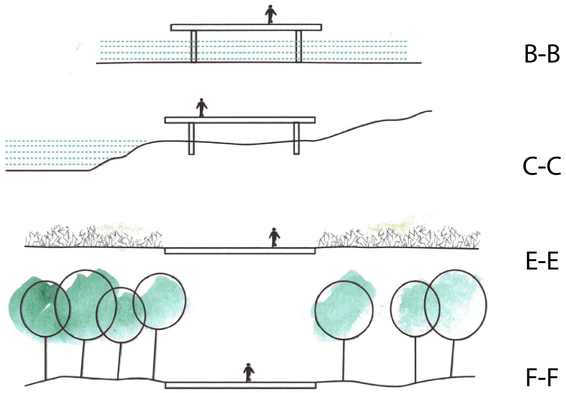
constructed tree island

# 5.2 DESIGN ELABORATION | Tree Island Trail






A






C

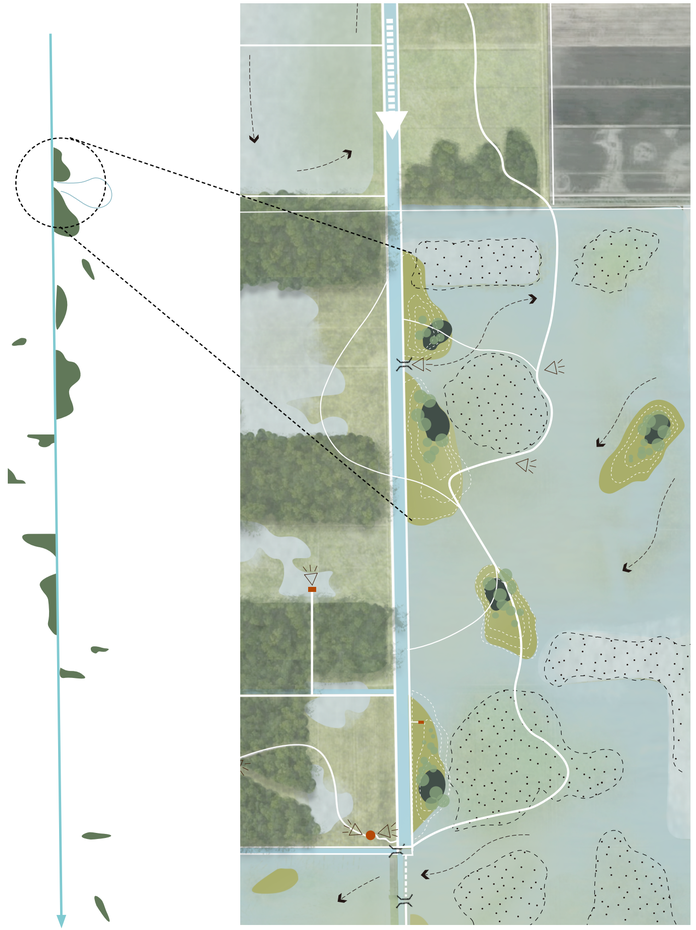


D



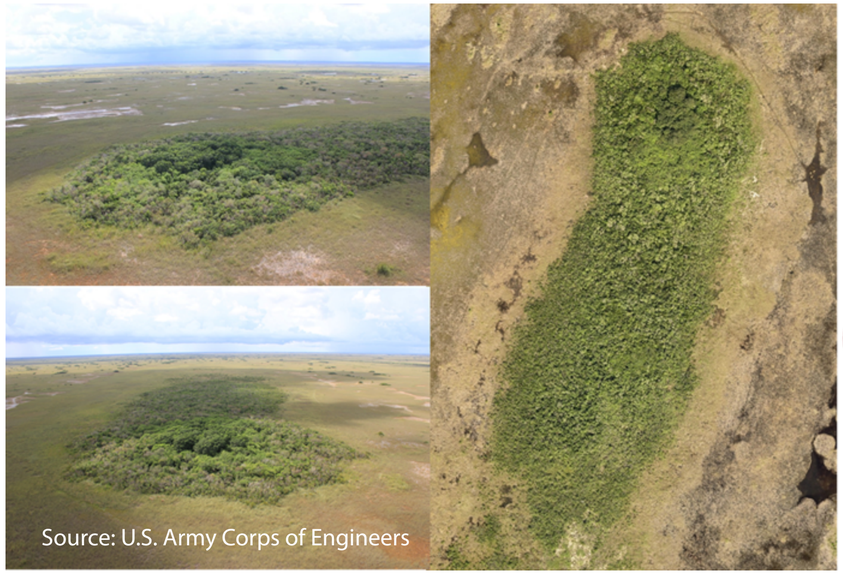
E

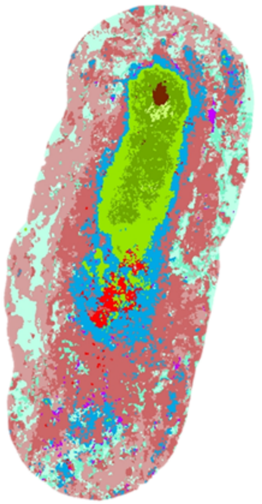
# Restore Tree Island: Bring disappeared important feature of the landscape back



***Map of 6 Tree Island***



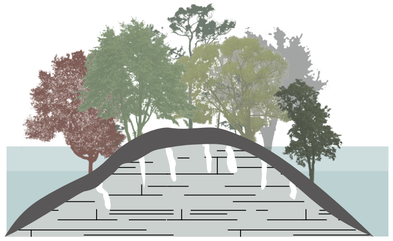



# Restore Tree Island: Material Use

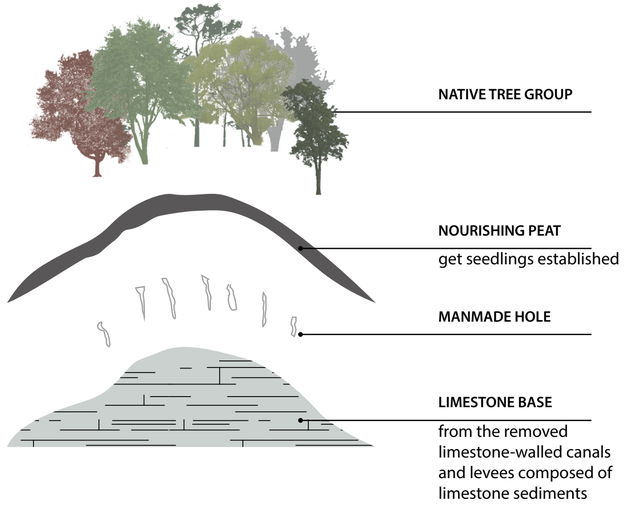


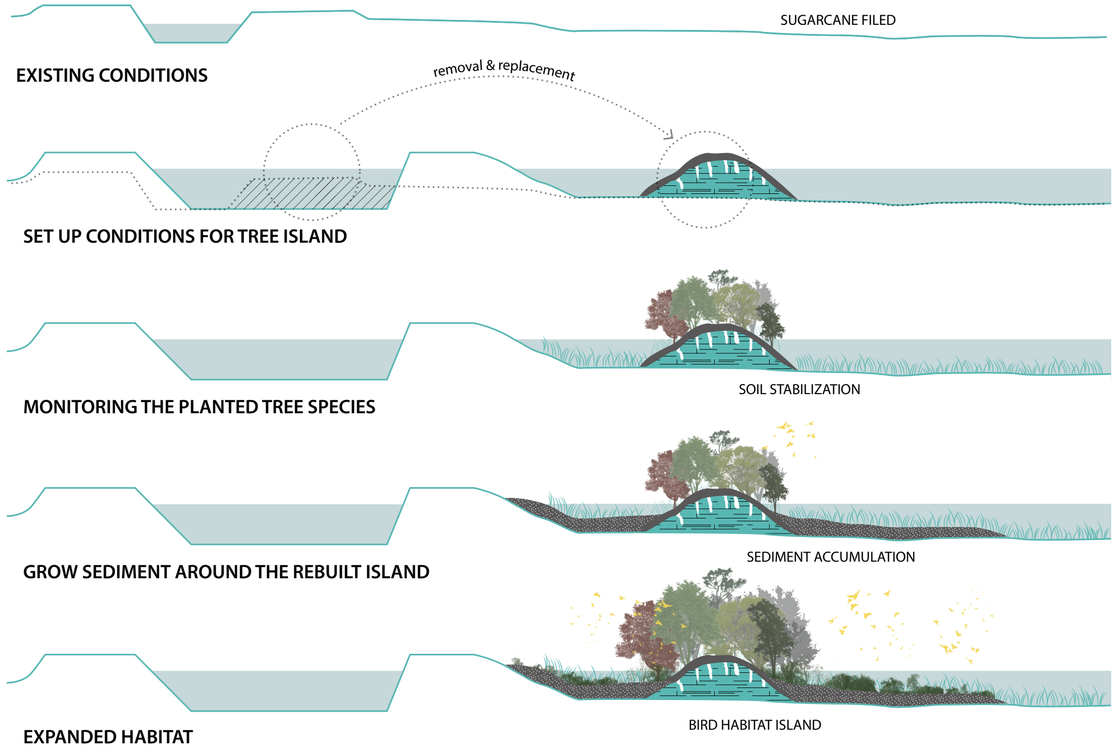

***Species of Tree Island***

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



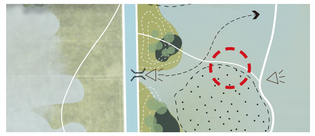
***Components of Tree Island***

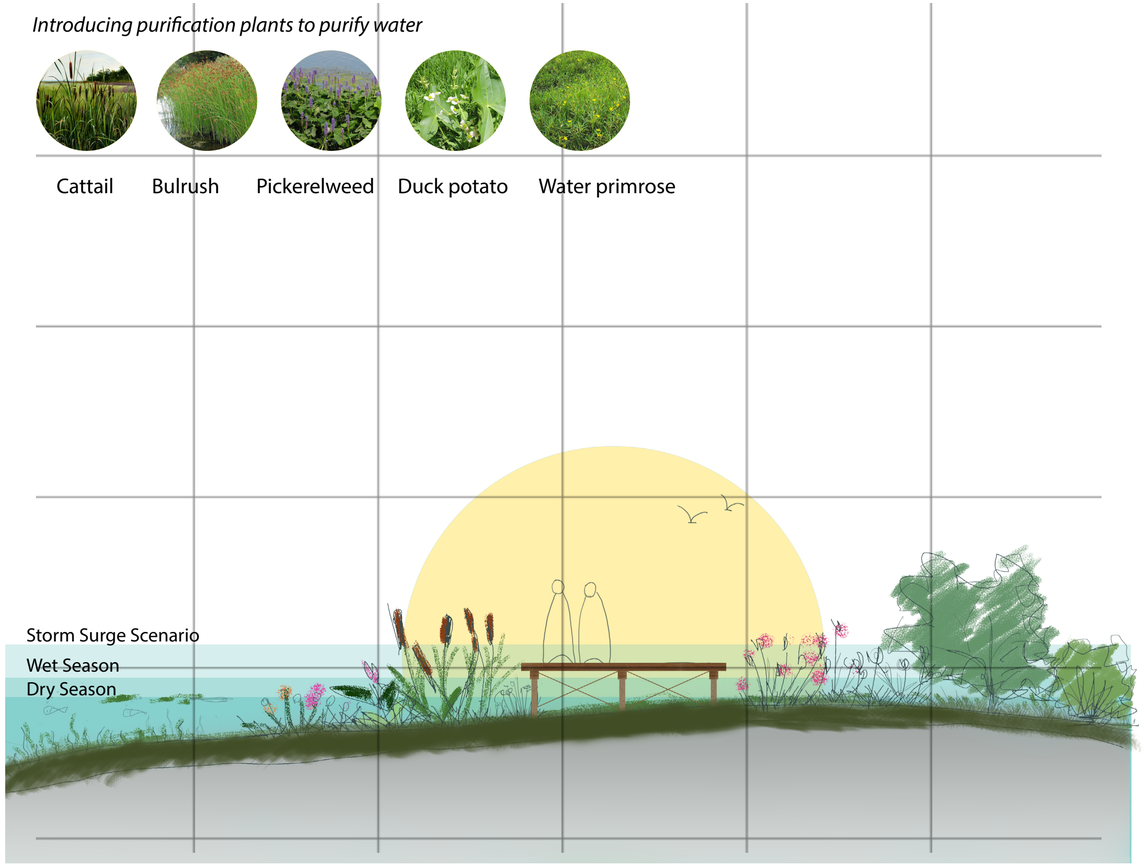


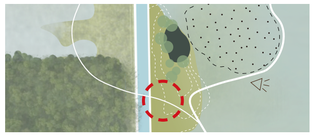
# Increase Accessibility & Awareness

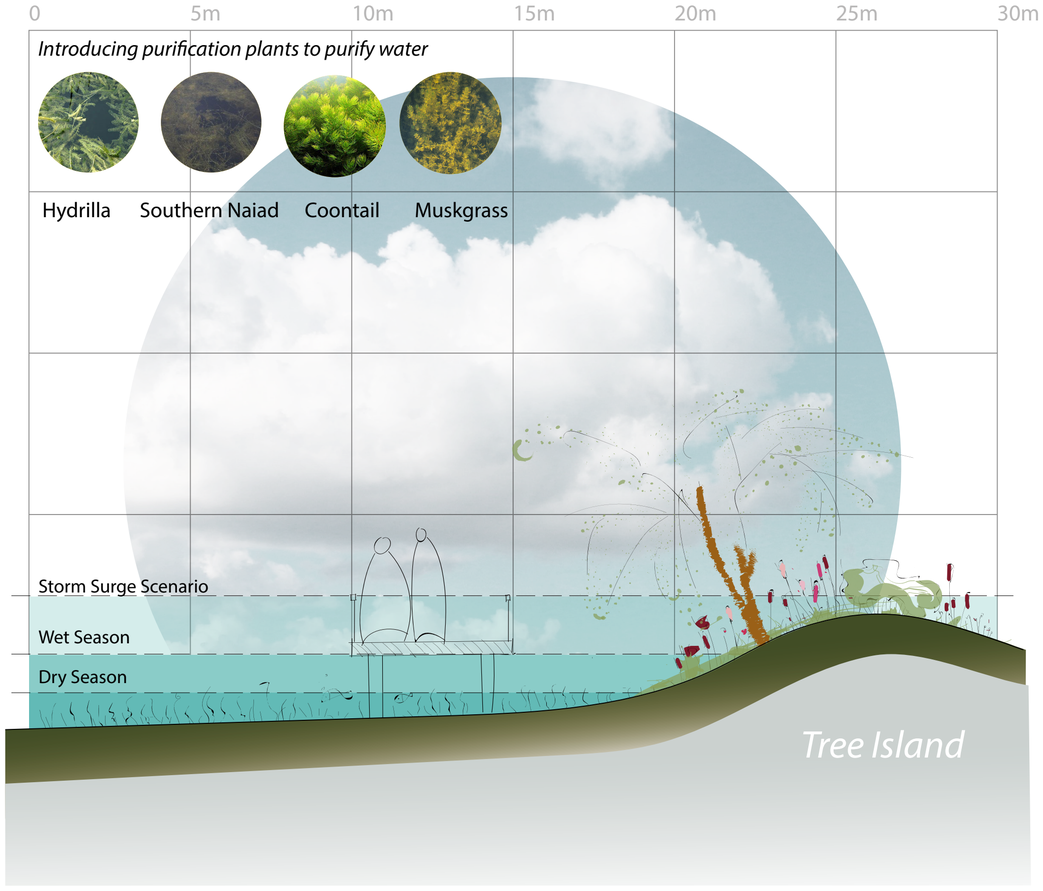
Build up new connections with water and create space to witness natural processes, and experience seasonal water dynamics





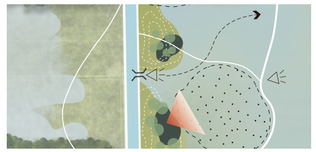

***Proposed Trail in the Marsh Zone***






***Proposed Trail in the Pond & Slough Zone***

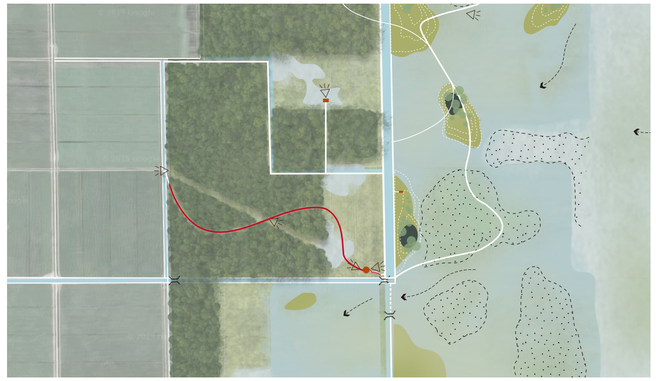
# Eye-level Spatial Implication

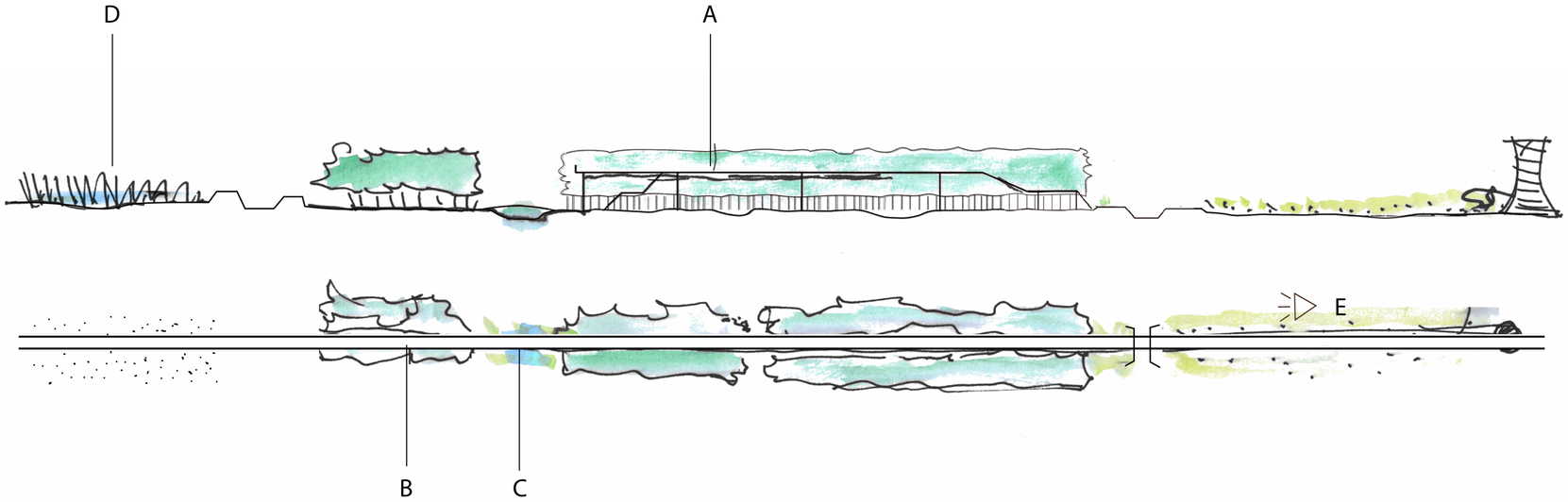


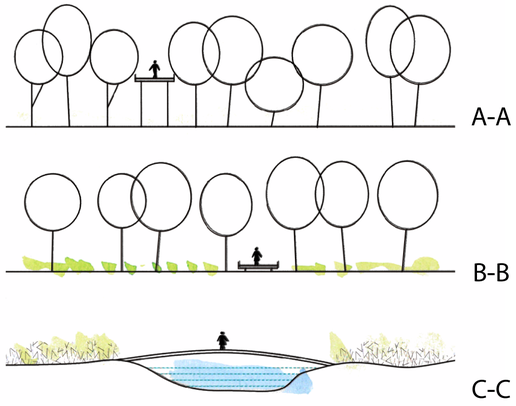
Location



# 5.3 DESIGN ELABORATION | Swamp Forest & Meadow Trail








A



B



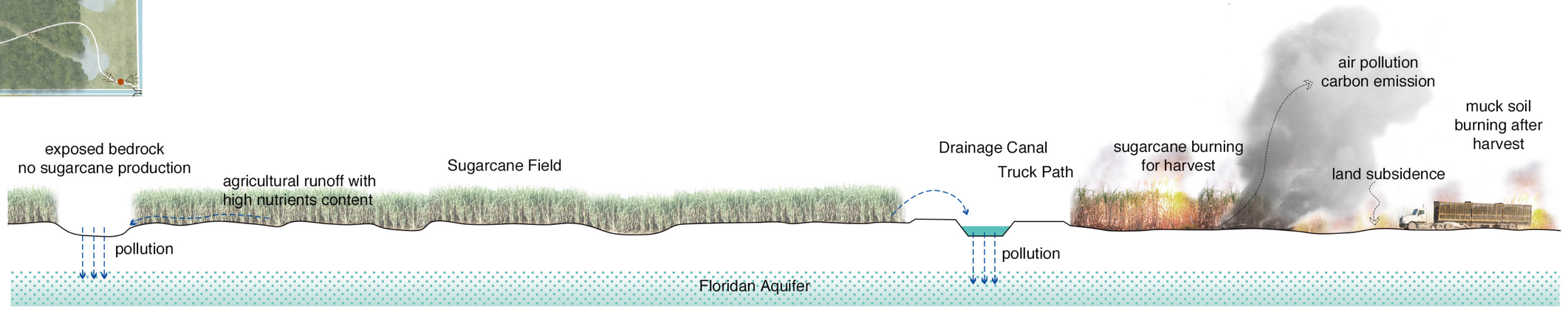
D



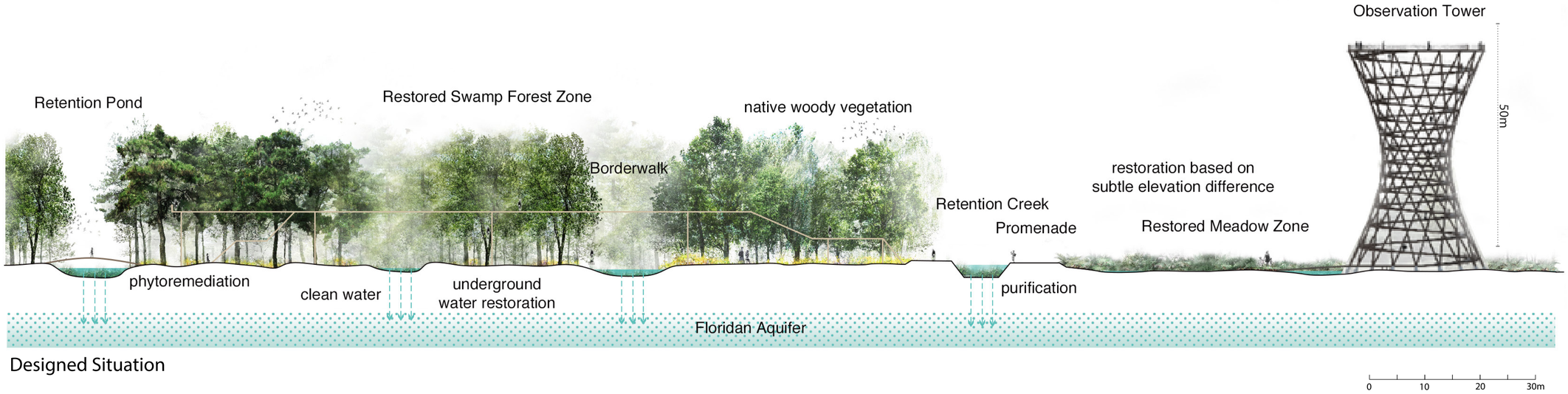
E

# Transformation Dynamics






Current Situation




Designed Situation



Cycling trail to the observation tower

Location





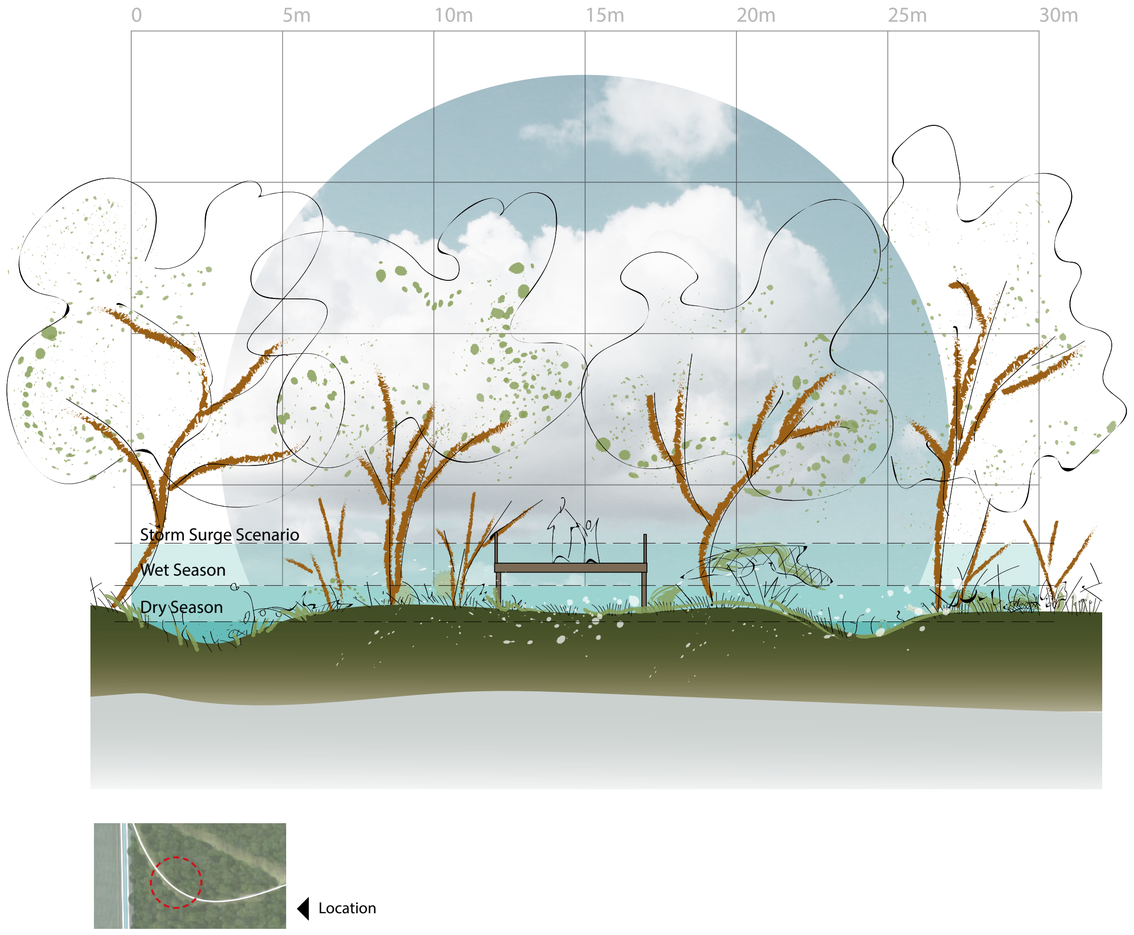
Overlook from the tower

Location



# Increase Accessibility & Awareness

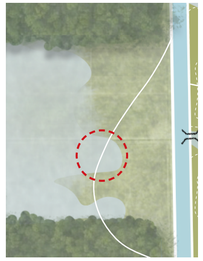
**Hiking trail in the swamp forest**




**Eye-level Spatial Implication**



# Landscape as Process




1

Current situation



2

Flood Sugarcane Field




3

Seed wet field




4

Introduce new programs

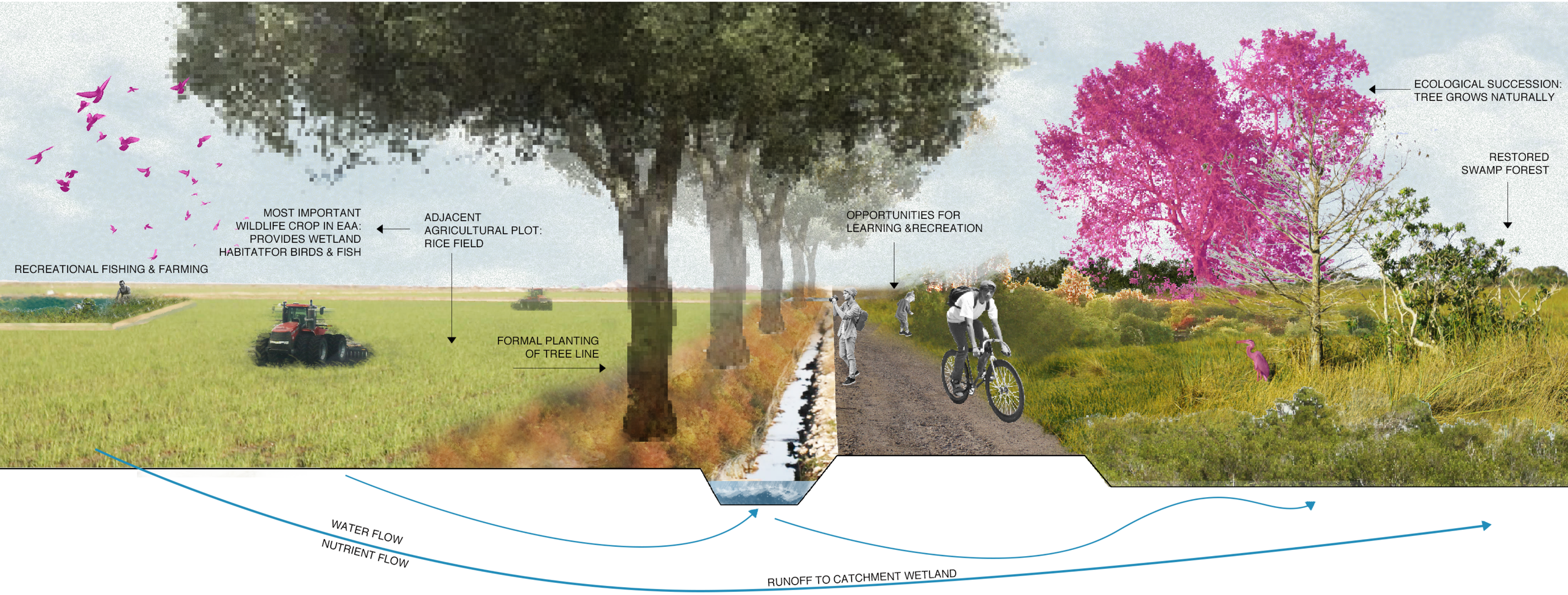


# 5.4 DESIGN ELABORATION | Walk Along the Border

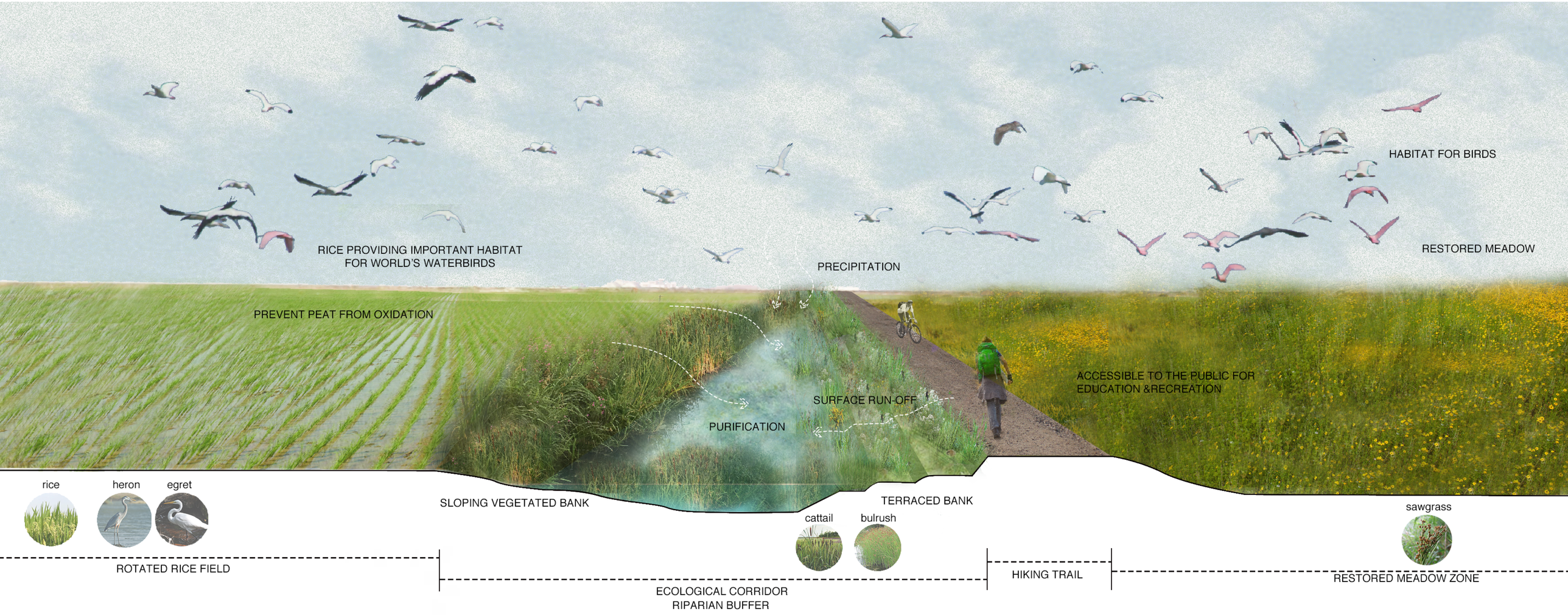
Current Situation: Spatial Homogenization



# Designed Situation - Swamp Forest & Rice Field



# Designed Situation - Meadow & Rice Field



# Designed Situation - Marsh & Rice Field: Levee as Viewing Promenade

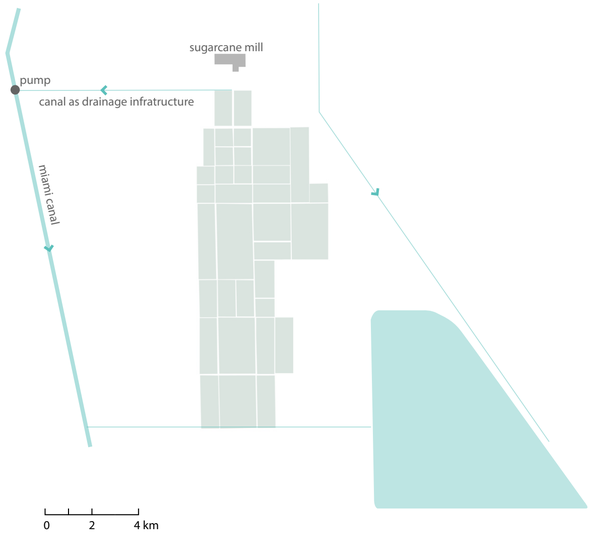


# VI. PHASING & DEVELOPMENT

# DEVELOPMENT STRATEGY | Ecological Conservation & Holistic Interaction

**1**

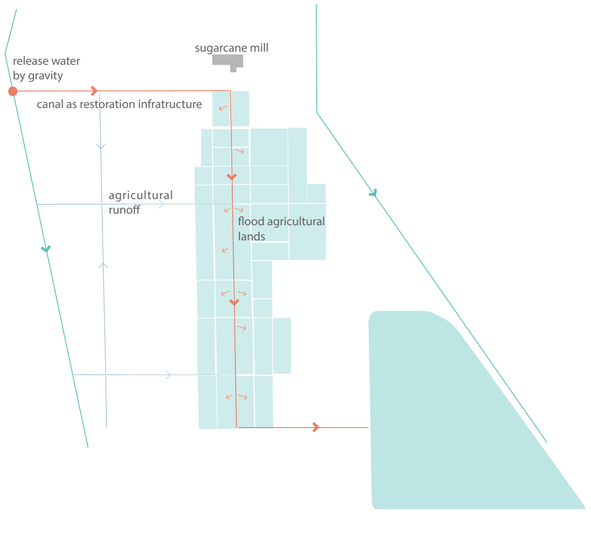
Existing Conditions




2019

**2**

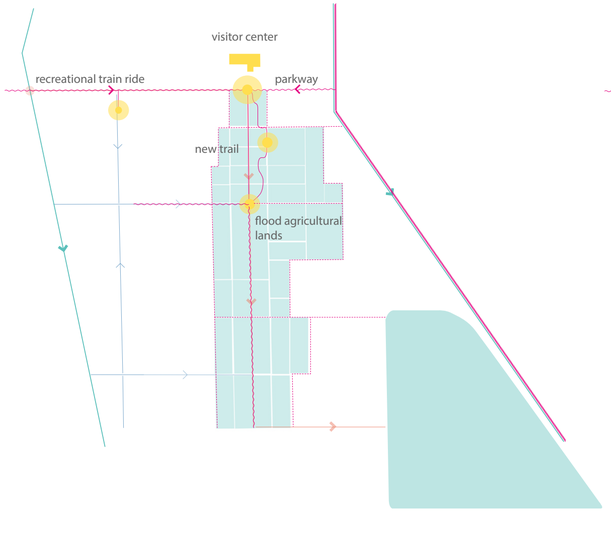
Retain & Purify Water
Tranform Agricultural Land into Wetland
Adjust Adjacent Sugarcane Field into Rice Field




Starting, 2020

**3**

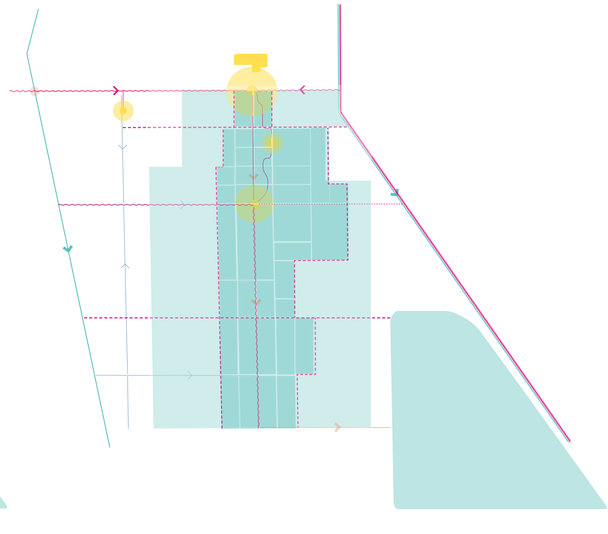
Grow 4 Main Habitats Based on Gradients
Introduce New Programs
Connect with the Public




5 years, 2025

**4**

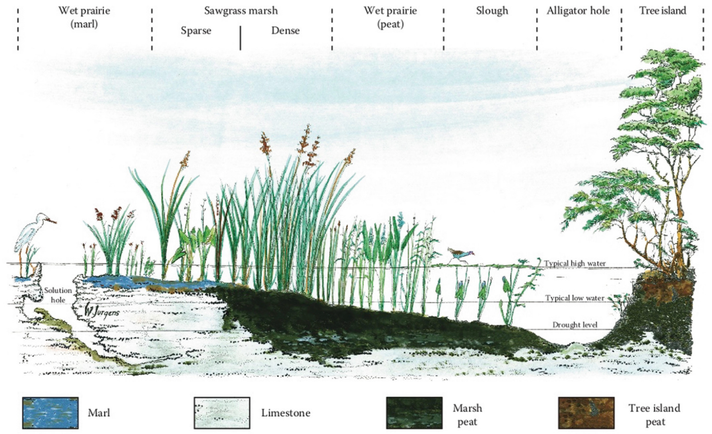
Evolve, Interact & Expand



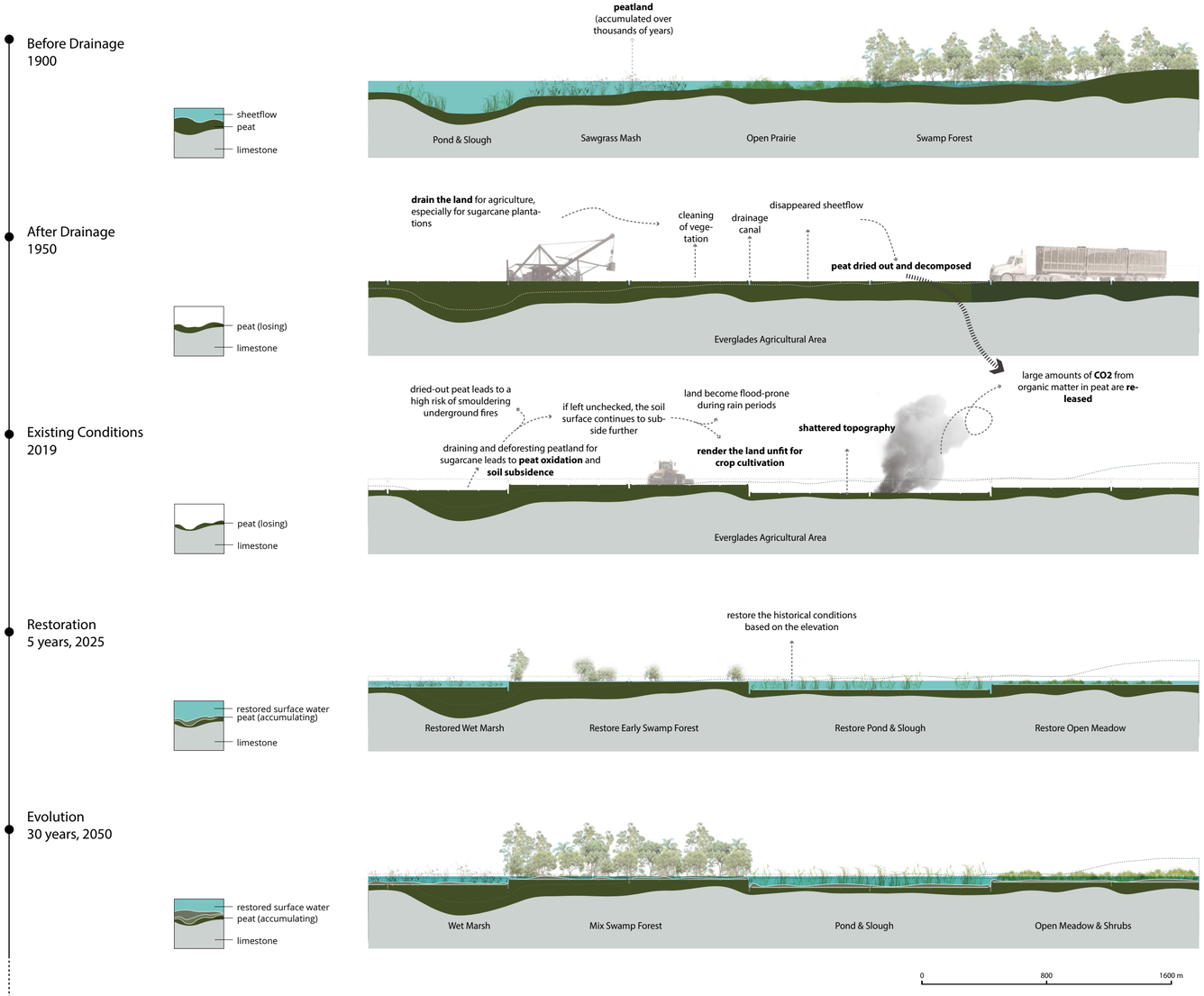
30 years, 2050

# 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.

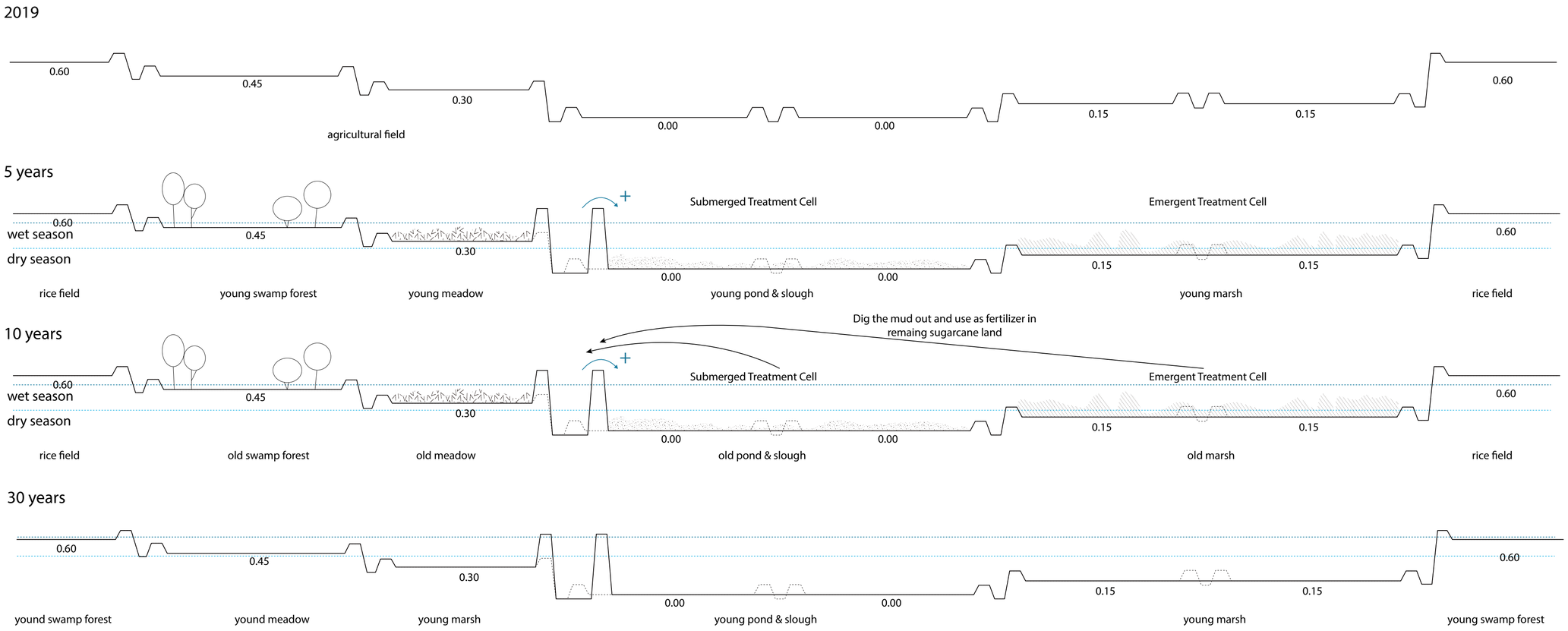



Cross section of typical Everglades plant communities, water levels, and underlying soils and bedrock (https://link.springer.com/chapter/10.1007/978-3-030-20070-1_1)



# 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.



# 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***

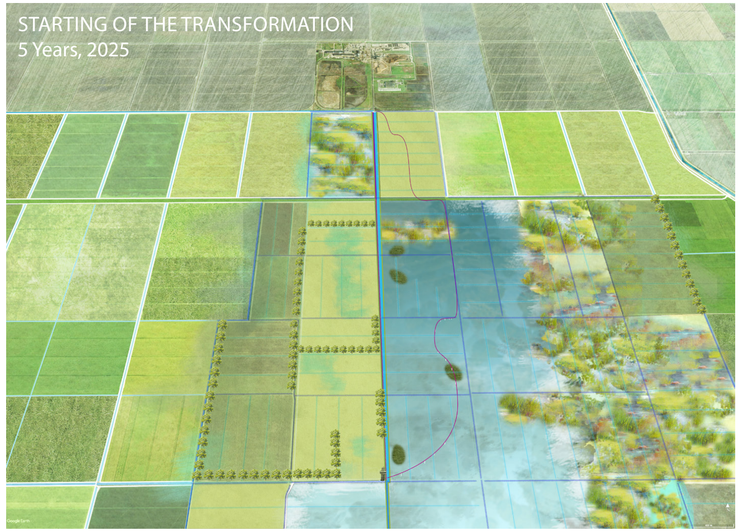
- Form Transformation
- Sustainable Agricultural Practices
- New Economic Agroforestry
- Incentives for transformation

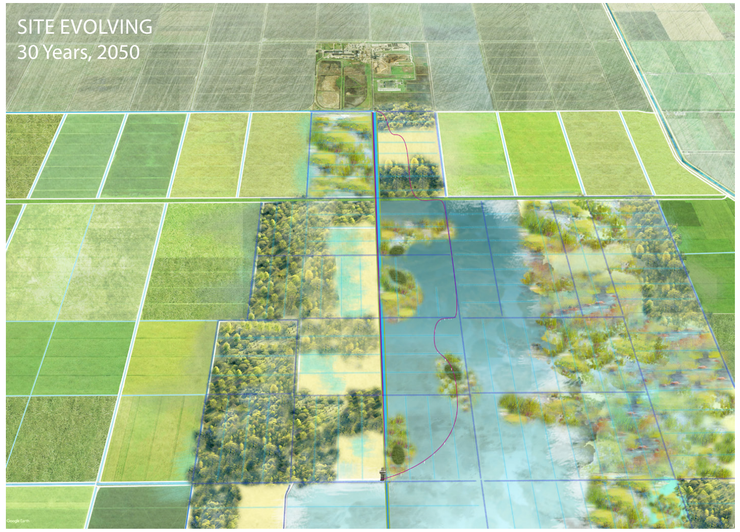
***Education & Recreation & Tourism Programming***

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

***Habitat Monitoring & Research***



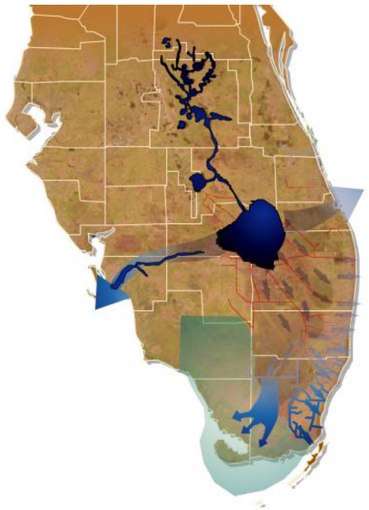



# Impact of transforming EAA on CERP

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)

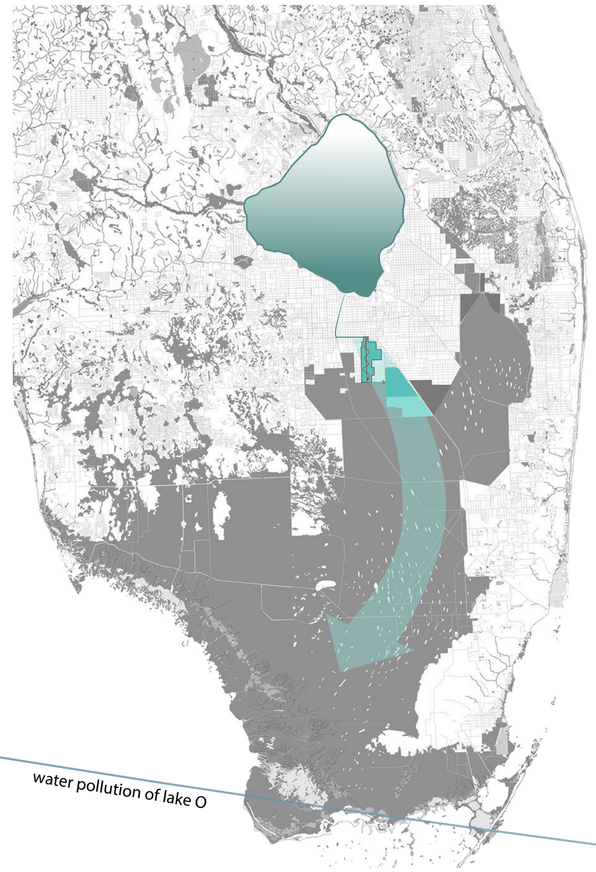


Proposed Flow
(2nd Stage)

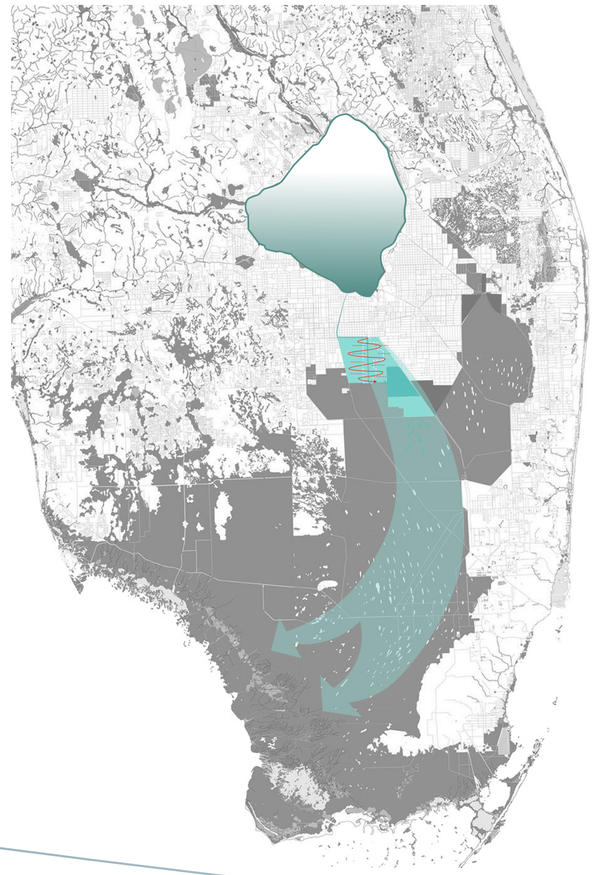
# Future Strategic Transformation Plan

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.

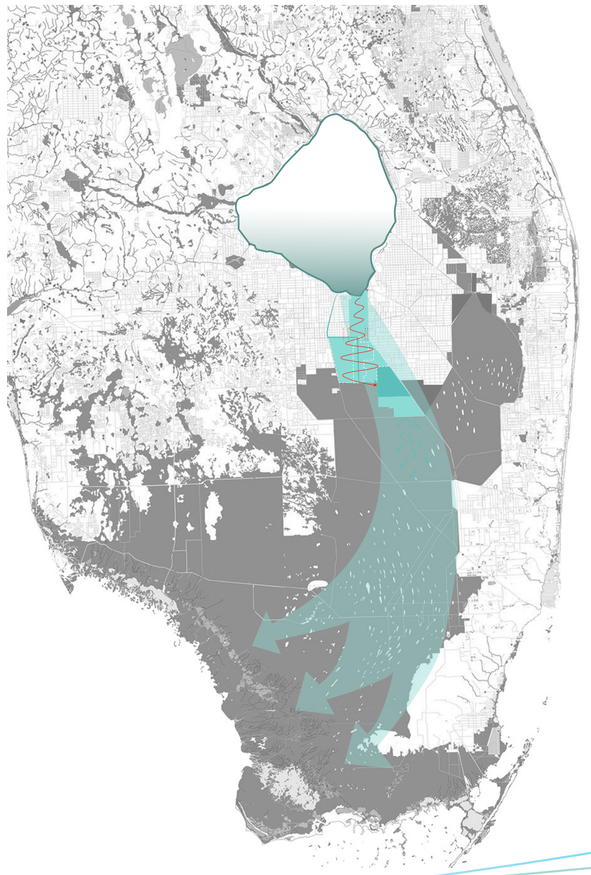
**1+** Restore the First Healthy Peatland in EAA



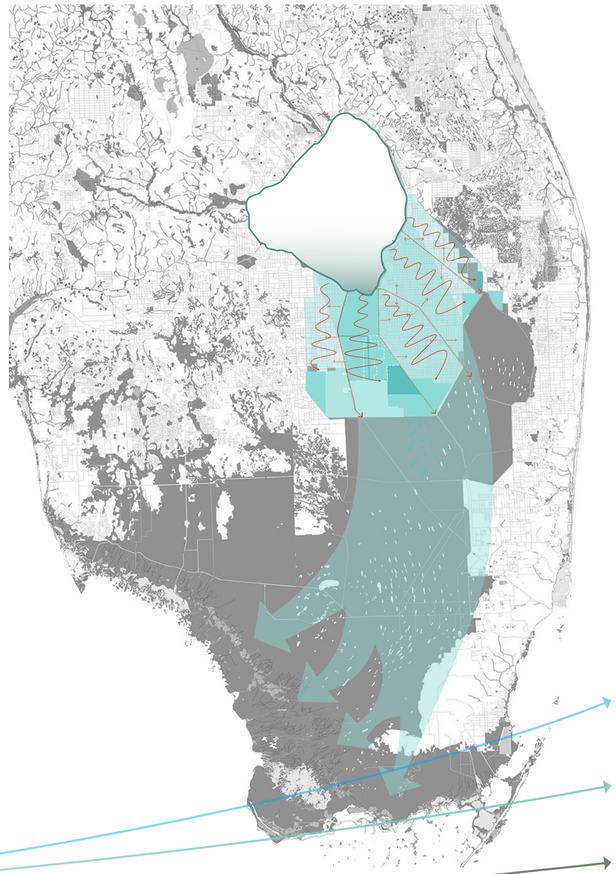
**2+** Site Evolve & Expand

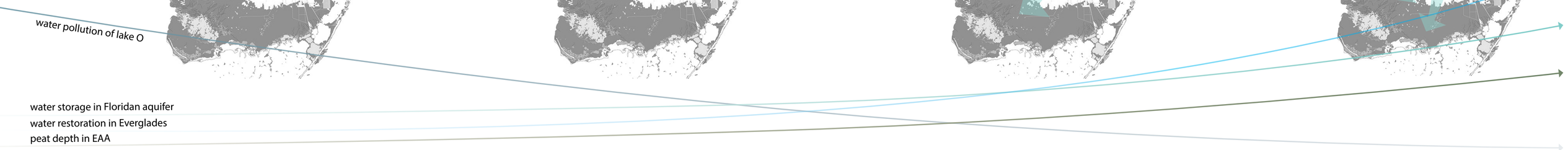


**3+** Connect Crucial Water Corridor



**4+** Stimulate Other Interventions in the Whole Region





# VII. CONCLUSION

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

- Charles Darwin

# FROM 20TH CENTURY TO 21TH CENTURY

Changing Mission through time:

The social and cultural change impacted
the mission of Everglades lands



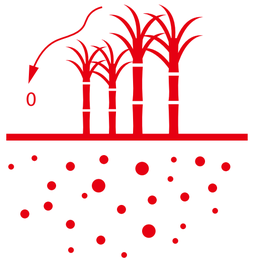
need for
economic growth



low population
density



low recreational needs




peat drops to nearly zero
sugarcane production drops



fast urbanisation



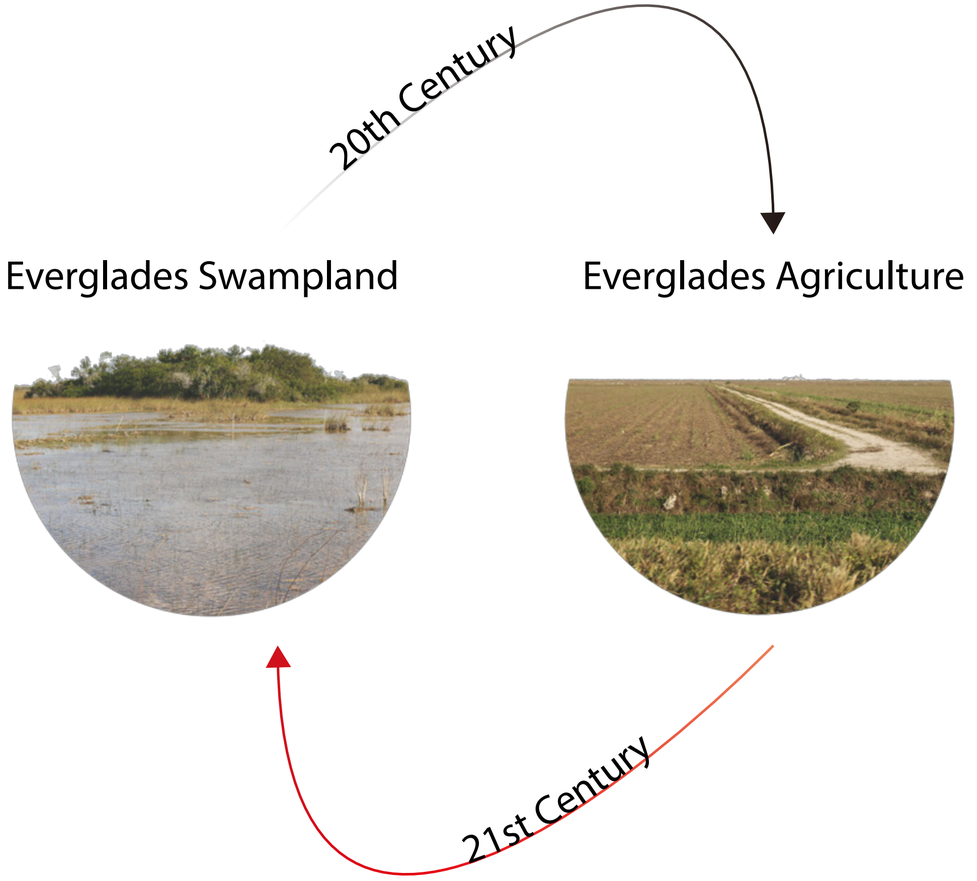
rising needs for recreation



water crisis

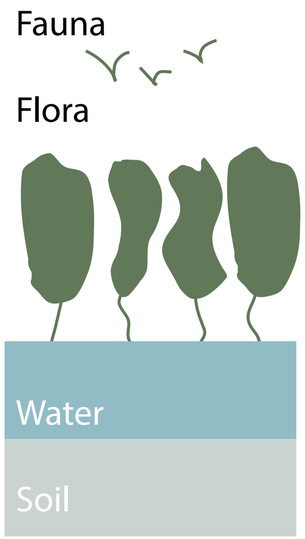


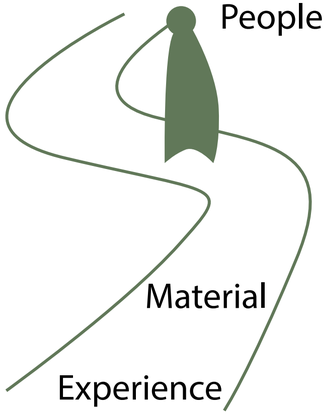
increasing population



# AN INTEGRATED APPROACH FOR TRANSFORMING EAA

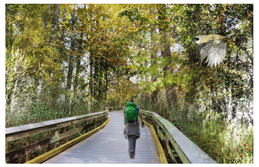
## Through ecological, functional and spatial aspects




## Improvement of the spatial quality



Create New Identity of EAA: From EAA To EAA

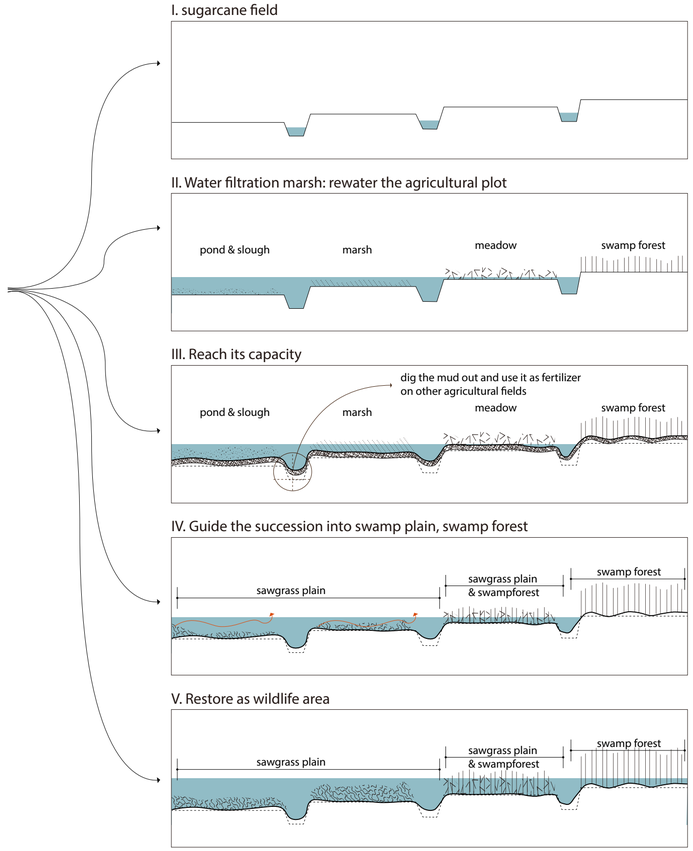
Toolkit

I.

- Everglades Swampland
- Everglades Agriculture
- Water Filtration Marshes (gradual bridge) (backbone)
- Wildlife Area

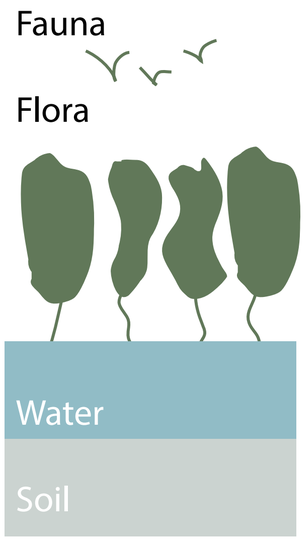
II.

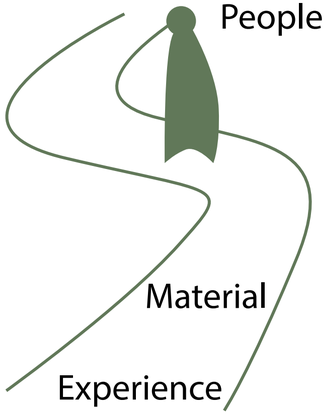
- Everglades Swampland
- Sugarcane Agriculture
- Rice Agriculture
- Water Filtration Marshes (gradual bridge) (backbone)
- Wildlife Area



# AN INTEGRATED APPROACH FOR TRANSFORMING EAA

## Through ecological, functional and spatial aspects




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.

Improvement of the spatial quality



Create New Identity of EAA: From EAA To EAA

## >> Towards a Sustainable Landscape

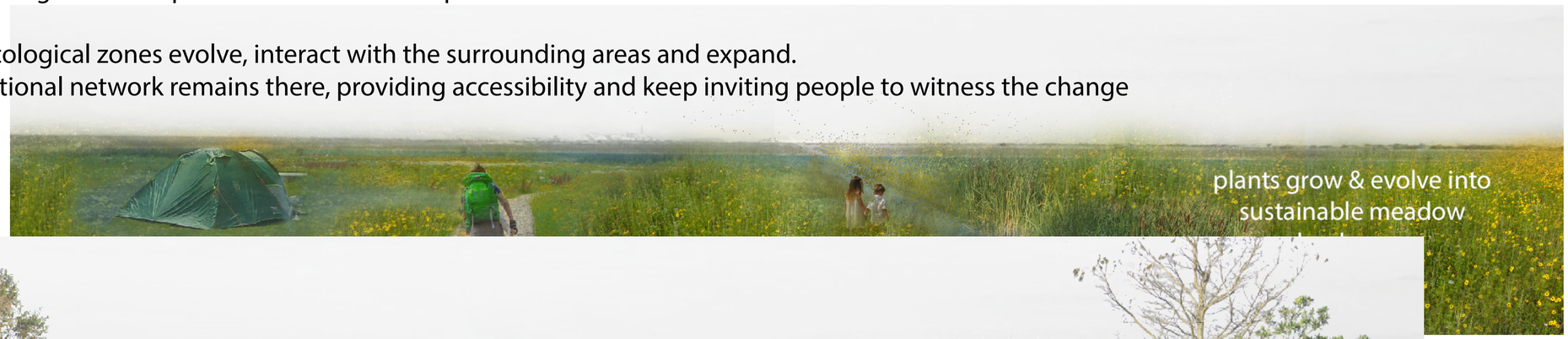
The landscape in this case is regarded as a process rather than as a product.



## >> Towards a Sustainable Landscape

The landscape in this case is regarded as a process rather than as a product.

As the time changes, the ecological zones evolve, interact with the surrounding areas and expand.
While the generated recreational network remains there, providing accessibility and keep inviting people to witness the change

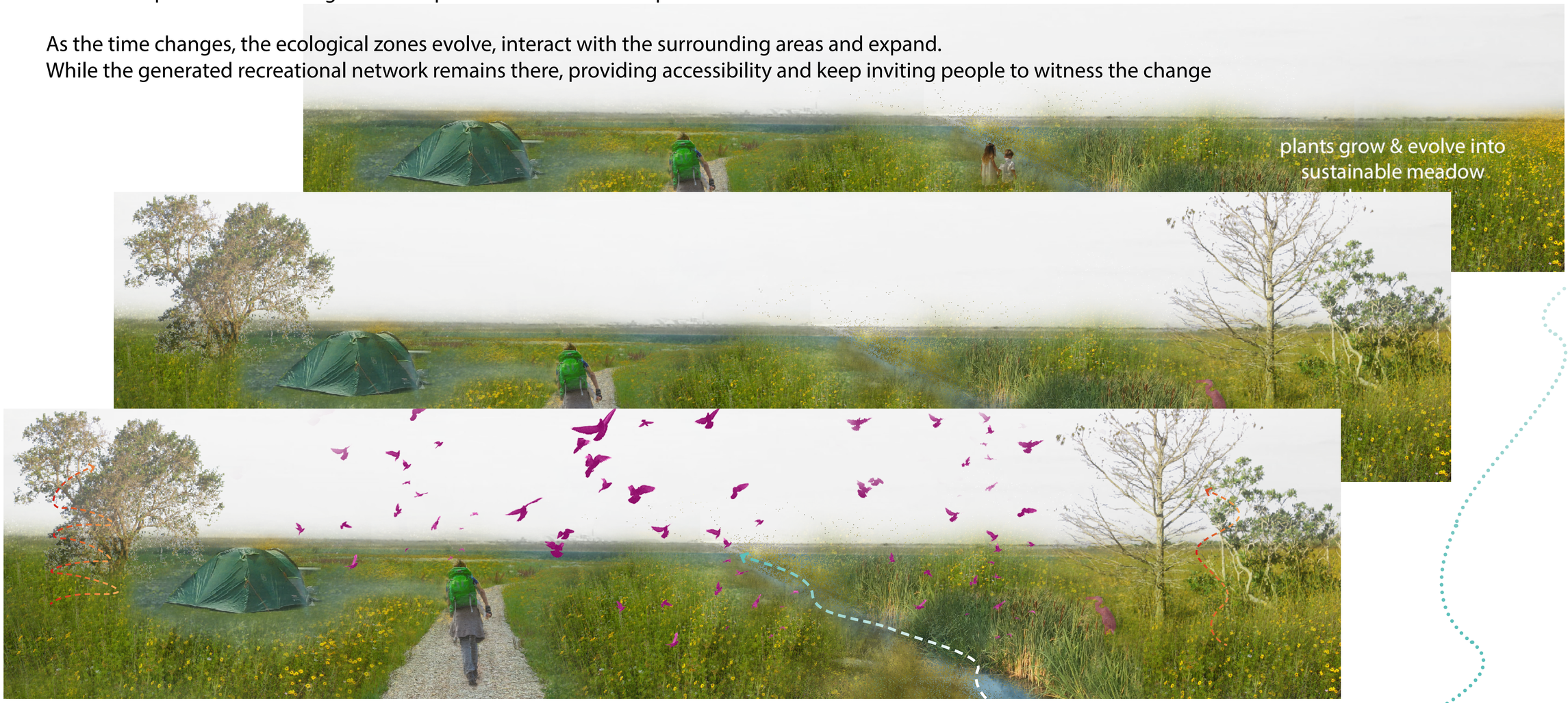





## >> Towards a Sustainable Landscape

The landscape in this case is regarded as a process rather than as a product.

As the time changes, the ecological zones evolve, interact with the surrounding areas and expand.
While the generated recreational network remains there, providing accessibility and keep inviting people to witness the change




water being purified,  trees growing, wading birds returning to nest




Source: Dr. Jack Share


Thank You
Delft University of Technology
Master Thesis
Danyan Liu
28 Oct 2019