JAXSponge



A Multi-Faceted Innovations in Flood Management and Advancements in Blue and Green Infrastructure for Jacksonville's Future

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"A Multi-Faceted Innovations in Flood Management and Advancements in Blue and Green Infrastructure for Jacksonville's Future"

Master Thesis Report
MSc Architecture, Urbanism and the Built Environment
Landscape Architecture Track

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Acknowledgement

I'm deeply grateful to my first tutor, Steffen Nijhuis, for his thoughtful guidance despite the personal challenges I faced. His noble character and genuine concern for my well-being were evident as he actively supported me through the graduation process, coordinating with relevant departments. His tutoring was truly invaluable during this time. Additionally, Steffen's academic expertise and patient guidance were fundamental to the success of the program.

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I'm equally grateful to my study advisor, Ellen, for her friendly demeanor and insightful guidance. She always offered a listening ear and practical advice, helping me overcome psychological barriers and adopt healthy study habits.

Lastly, I want to express my appreciation for the TU Delft library, where I spent countless hours. The positive atmosphere and tranquil rooftop green space provided me with a conducive environment for studying and reflection, making it a cherished part of my academic journey.



Nietzsche once said, "When you look long into an abyss, the abyss looks into you." Likewise, when we look long into the ocean, the ocean looks into us

(Michele Orallo, Published on June19, 2018 Gloomy days in Florida, Jacksonville Beach, United States, accessed by author on May 6th, 2024,)



[Julius Hildebrandt, Florida, USA, Published on March 2, 2024, accessed by author on May 6th, 2024,]

Abstract

As a community of life on Earth, humanity's fate has always been tied to this blue planet. However, human activities continuously impact the Earth's ecology, hydrology, and geography. Since entering the industrial society, these impacts have accelerated in speed and intensity. Consequently, excessive emissions have led to rising sea levels and the exacerbation of the urban heat island effect, significantly affecting coastal cities.

Coastal cities are attractive as they offer a more moderate climate, diverse natural ecosystems, access to water for commerce ports and recreation, and an entryway to the hinterland through rivers that connect with oceans. However, as many coastal cities are in low-lying areas and prone to land subsidence, they are vulnerable to coastal flooding and will only become more vulnerable in the face of rising sea levels and more frequent storms. At the same time, rising sea levels and extreme climate changes lead to more frequent hurricanes, exacerbating the severity of urban flooding. The types of floods include areal flooding, riverine flooding, coastal flooding, and urban flooding. Floods can originate from the adjacent ocean, stormwater, or rivers.

Cities, therefore, need to adapt themselves to these changes. The answer lies within the cities themselves. This project will use Jacksonville, Florida, as a design case, addressing urban issues through the implementation of a blue-green infrastructure network. Blue-green infrastructure is a meticulous landscape strategy that can be applied to streets, houses, parks, and other areas. It slows down stormwater runoff and includes measures to protect land from flooding, provide high-quality green spaces, enhance ecological benefits, and improve urban resilience. Additionally, this project will discuss how blue-green infrastructure can strive to achieve spatial equity in American society, enhance community safety and cohesion, and address community segregation to a certain extent.

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Image © 2021 Jacksonville Beach, Florida, United States | Published on June 6, 2017 | Accessed by author on May 30, 2021

PART Ⅰ
Born of Water,
Entrapped Within Water

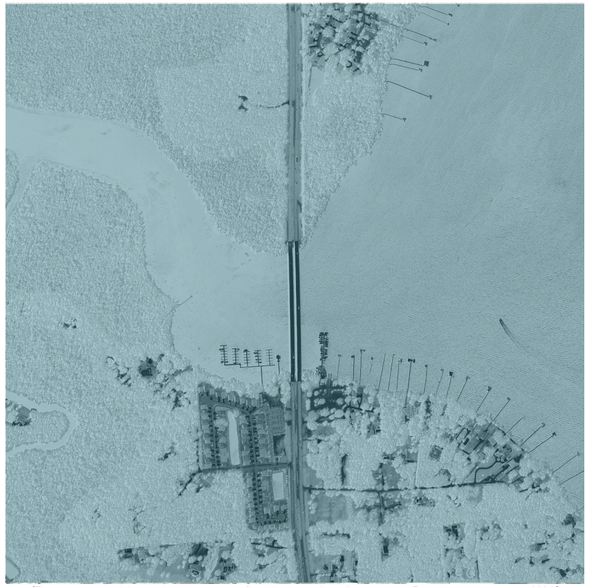
PART Ⅰ
BORN OF WATER, ENTRAPPED WITHIN WATER

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01 INTRODUCTION

In this chapter, the site location and the site context is introduced, and the initial fascination with the project is described. Additionally, issues concerning the St. Johns River and Jacksonville are elaborated upon.



[The topography of river residence and dam, Satellite image from Google earth, Edited by author on May, 2024,]

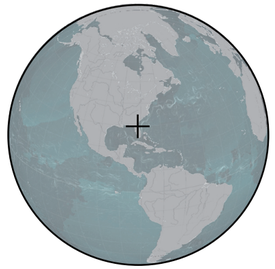
1.1 LOCATION

From the St. Johns River to the Atlantic: the City Rising

Focus on North America, Florida, a state in the southeastern United States which borders the Gulf of Mexico to the west and the Atlantic Ocean to the east. Located at the northeastern corner of the state is the intersection of the St. Johns River and the Atlantic Ocean. Here, a city with a unique landscape, developed waterways, and a history rooted in its port, Jacksonville, was born.

The lazy river, St. Johns River, Florida's longest, holds immense significance for both commercial enterprises and recreational pursuits. With a minimal elevation drop of less than 9 meters from its source to its mouth and a leisurely flow rate of 0.13 meters per second, the river's gentle currents foster extensive backwater areas.

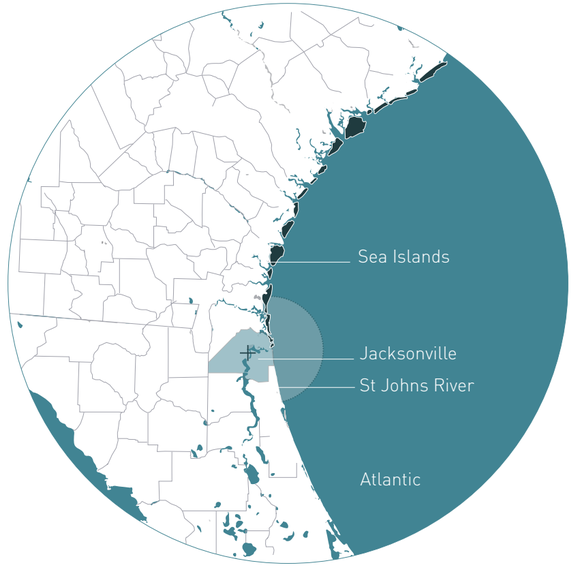
"From the St. Johns River to Atlantic : the City Rising". Jacksonville is the largest city located downstream of st johns river, where it meets the Atlantic ocean . Jacksonville has a coast on the Atlantic Ocean with the Jacksonville Beaches. At the same time, the city developed along both sides of the St. Johns River. The Trout River, a major tributary of the St. Johns River, is entirely within Jacksonville. Above all, Jacksonville boasts a unique topography with meandering streams, diverse ecosystems, and well-connected water routes, including the Intracoastal Waterway linking it to neighboring St. Augustine.
Unlike typical deltaic cities, Jacksonville's water features, from creeks to rivers to sea islands, are distributed in an organic, irregular pattern.







The Atlantic's Western Gemstones: Sea Islands



The Sea Islands comprise a series of over a hundred tidal and barrier islands along the Atlantic Ocean coast of the Southeastern United States. Stretching between the mouths of the Santee and St. Johns rivers across South Carolina, Georgia, and Florida, these islands form a distinctive coastal landscape.

Barrier islands, the primary component of the Sea Islands, are coastal landforms characterized by dune systems and sandy expanses. They arise parallel to the mainland coast through the accumulation of sand shaped by wave and tidal forces. Typically aligned in chains, these islands are dynamic entities, susceptible to alteration during storms and other natural events. Despite their ever-changing nature, they serve as buffers, absorbing energy from oceanic forces and safeguarding coastlines. Additionally, they foster protected water zones conducive to the proliferation of wetland habitats.



(Stephen Wood, Sunset on the St Johns River in Brevard County Florida, accessed by author on May 6th, 2024,)



(Lance Asper, Jacksonville BEACH Florida, Jacksonville, USA, Published on June 30, 2019, accessed by author on May 6th, 2024,)

1.2 SITE CONTEXT

Laziest yet Picturesque: the St. Johns River

When a river is labeled "lazy," it's often due to its slow flow speed. The St. Johns River, with its leisurely pace of 0.13 meters per second, embodies this characteristic. This leisurely flow imparts an sense of tranquility and grace as the river meanders from south to north through Florida, traversing 12 counties. Some placid lakes join it, while its winding, tentacle-like streams reach out to the land.

As Earth twirls in silent grace, forests thrive in nature's embrace. The river's tranquil, gentle pace, where fish generations find their space. Salty marshes, high and low, withstand tides' relentless flow. How can one describe the high ecological diversity here? The answer is all species thrive, evolve, and interact concurrently in this very place, shaping and reshaping the landscape.

When humans stand here, they become a part of all species. Twelve thousand years ago, ancient Indians arrived, settled, utilized, and transformed this land. By the late 19th century, Jacksonville emerged as a pivotal military and civilian deep-water port. Ships of every size departed and arrived, connecting Jacksonville to the world and bringing the world to its shores. Humans erected their homes and havens, casting lines into the waters of the St. Johns River, rowing, and navigating.

However, the St. Johns River does not always offer a gentle embrace. Its modest elevation drop results in prolonged backwater periods. It ebbs and flows with the tides, coursing through barrier islands and along coastal channels. Though it may slumber, when met with storm surges or hurricanes, the St. Johns River eagerly reaches out to claim the land, engulfing everything.

Facing the Boundless Waters: The Beaches

Standing here, facing the vast expanse of the Atlantic Ocean, humanity is compelled to confront the mysteries of the sea. All land ends here, as the ocean separates everything, yet it also connects all.

The Jacksonville Beaches, affectionately referred to as "The Beaches" by locals, comprise a collection of towns and communities nestled on an unnamed barrier island along Florida's First Coast. On these fragmented isles, human habitation coexists with the intricate patterns sculpted by meandering streams—marshlands. Marshlands, coastal forests, sand dunes, and saline waters intertwine, shaping and influencing one another in an eternal dance.

With toes sinking into soft sands, one can listen to the gentle melody of the sea breeze harmonizing with the cries of seagulls overhead. As the tide recedes, it brings forth waves and marine life. As the tide coming, the ocean's relentless rhythm weathers all it touches. While sand dunes may not always remain steadfast, the joy of humanity etched in memories endures eternally.

The ocean's power remains an enigma,It brings forth clouds heavy with moisture and spawns demons of the sea—hurricanes. The relentless pounding of the waves against the shore puts humanity in peril when floods arise.

[Bird's Eye View, "Jacksonville, Florida, 1893" ,Augustus Koch ,1893, Accessed on May 2024.]

1.3 FASCINATION

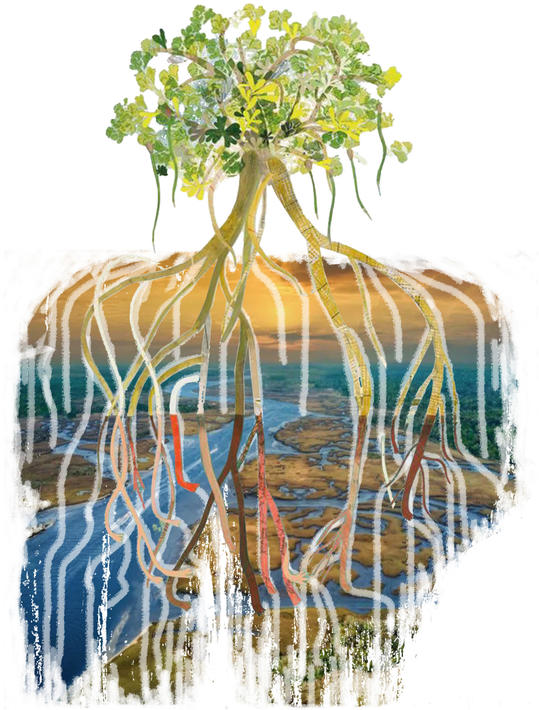
Transition and Ecological Richness: Estuarial Landscape

Estuaries belong to the world's most productive natural habitats. They constitute ecologically diverse ecosystems, are home to unique plant and animal communities and have a great intrinsic value. The most common definition applied to the term 'estuary' is a semi-enclosed body of water which has an open connection with the sea and in which sea water is measurably diluted with fresh water derived from land drainage (e.g. rivers) (Pritchard, 1967).

These transitional ecosystems experience the dual influences of marine forces such as tides, waves, and saline water influx, alongside riverine inputs of freshwater and sediment. Tidal dynamics predominantly shape estuarine environments, while freshwater inflow is a critical driver as well.

Estuarine ecosystems fulfill crucial ecological functions, serving as essential habitats for a myriad of species. They provide sustenance, refuge, and breeding grounds for various trophic levels, including migratory birds, marine mammals, and numerous fish and crustacean species. (Ecoshape,2024)

Among the notable estuaries, the St. Johns River Estuary in Jacksonville stands out as one of the largest and most biodiverse in the United States. Characterized by tide-dominated sediment transport, the St. Johns River flows northward through the city before meeting the Atlantic Ocean. Estuaries exhibit rich gradients of processes and environmental factors, including the interplay between river and marine dynamics, the mixing of fresh and saline water, and the interaction between river and marine sediments. These gradients contribute to the complexity and diversity of estuarine ecosystems, making them vital components of the global landscape.





(SEAN RAYFORD 1964, Flooding in downtown Jacksonville after Hurricane Irma topped a record set in 1964 during Hurricane Dora, Getty Images, accessed 4 March 2024)

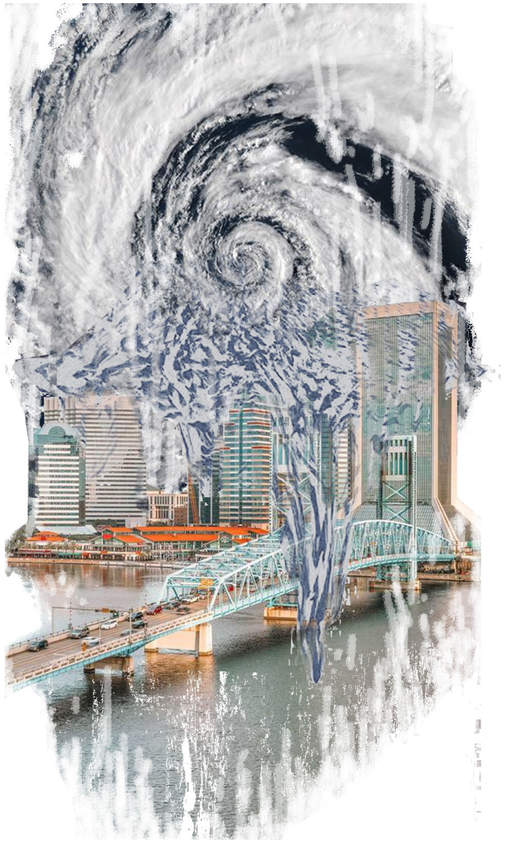
Assault and Super-Destructiveness: Hurricane Irma

In 2017, the Atlantic Ocean brewed an unprecedented, highly damaging natural conspiracy, Hurricane Irma. Irma was considered the most powerful hurricane on record in the open Atlantic region (Wikipedia, 2017). About 400 miles north of Hurricane Irma's first landfall in South Florida, the coastal city of Jacksonville was engulfed by water, with heavy rain and a record storm surge turning streets into churning rivers and wind-whipped waves crashing through windows (NBC NEWS, 2017).

Jacksonville quickly turned into a city submerged in water, with Riverside's Memorial Park inundated, giving rise to the legendary widely circulated photo. Cummer Gardens were completely submerged. The city plunged into darkness as the power system was destroyed. Some people's houses were washed away, while others awaited rescue in the water. The city seemed to be plunged into despair.

According to the Campa Bay Times, Hurricane Irma forced floodwaters under the door of Andralliski's tiny apartment. Andralliski, his girlfriend, and her mother fled for the nearest shelter, running from the water pooling in his living room carpet. They own little more than their phones and the clothes they were wearing. Their apartment is condemned. "Irma came and washed it all away — all of our birth certificates, pictures," he said. "It's like we don't even exist." (Campa bay times,2017)

In fact, the damage wrought by the tropical storm and urban flooding from the hurricane far exceeded just the high winds. Jacksonville took several months to recover from Hurricane Irma.

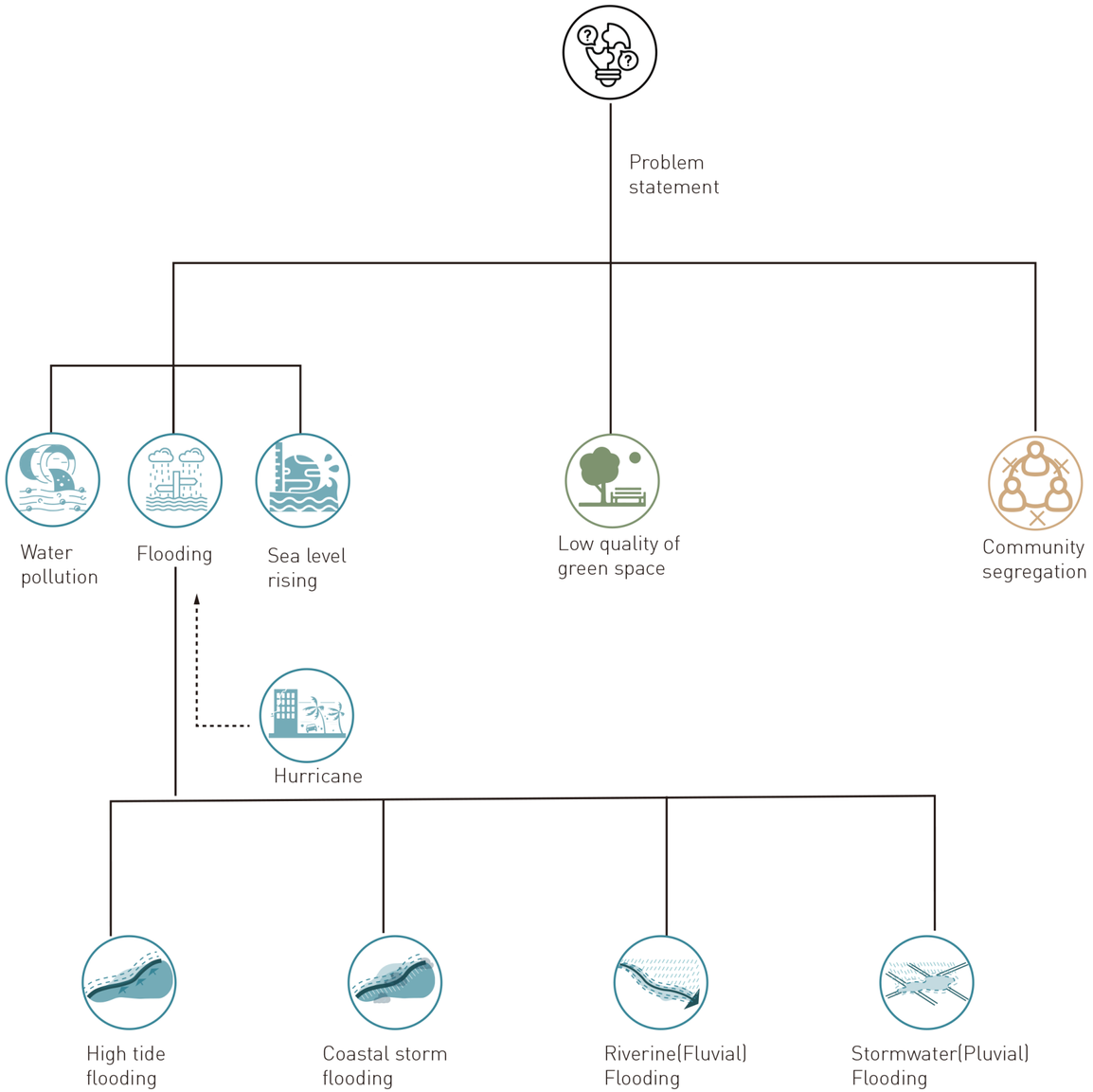


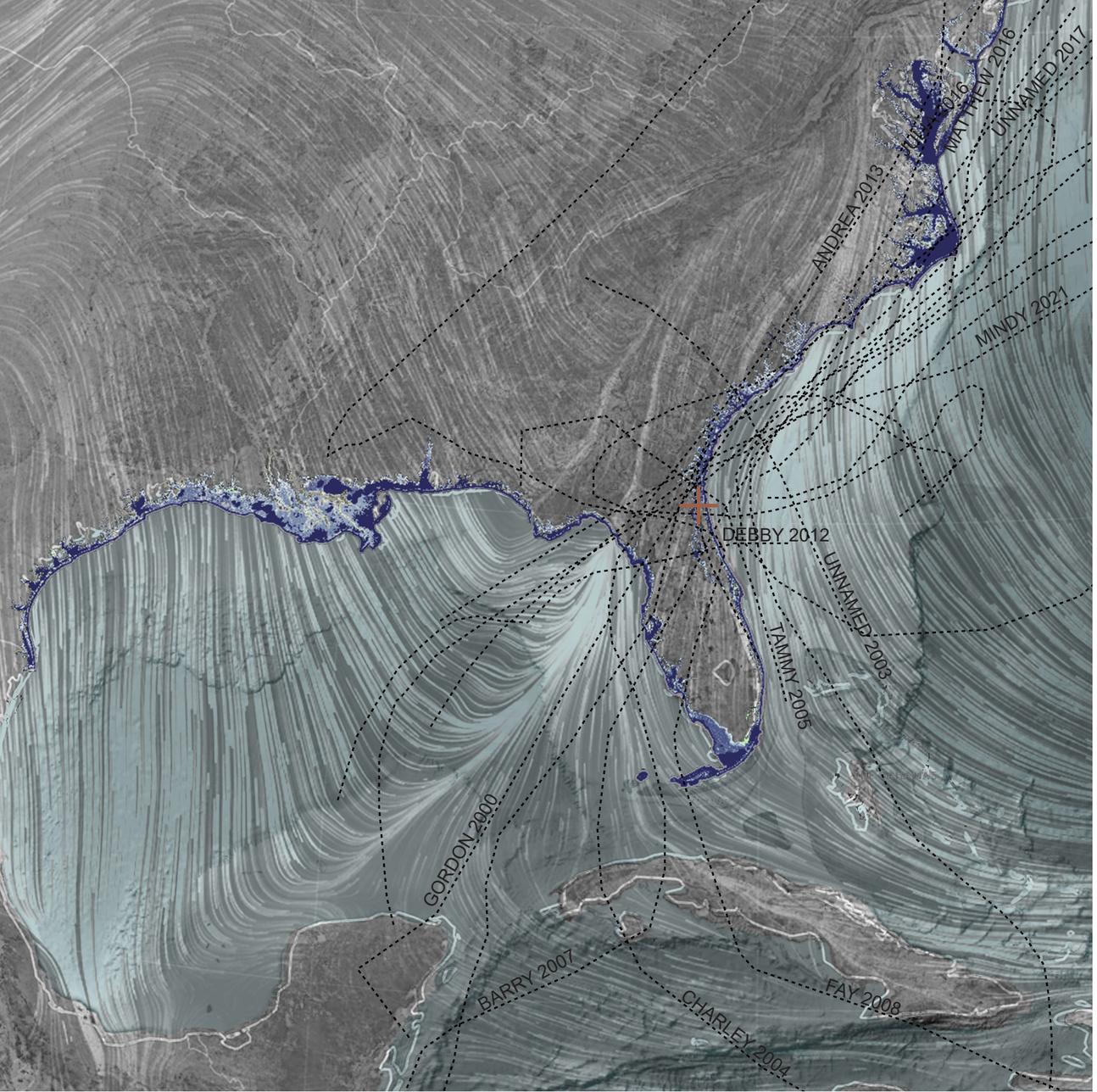
1.4 PROBLEM STATEMENT

Fragile city: Facing Multiple Threats

As a city closely tied to water, Jacksonville is born in water and simultaneously threatened by it. With current global warming and climate extremes, the frequency and severity of hurricanes here are increasing, leading to both flooding during rainy seasons and droughts during dry seasons. This results in more severe flooding in the city. Four types of flooding—high tide flooding, coastal storm flooding, river flooding, and stormwater flooding—are all becoming more severe compared to before. Due to many areas of the St. Johns River being stagnant water, agricultural, domestic, and industrial wastewater discharge exacerbates river pollution. When we stand in the city, we notice that the quality of green spaces is also low. Additionally, due to historical community segregation issues in the United States, the wealth gap here is particularly pronounced within communities.



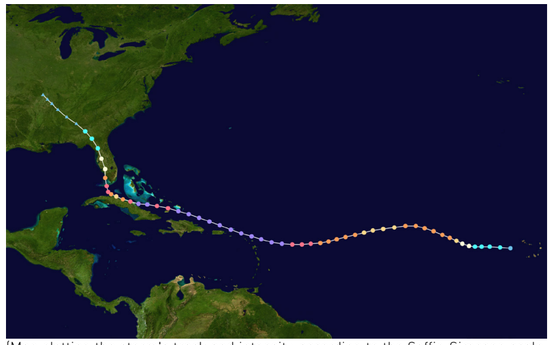




Hurricane-Stricken City

An Atlantic hurricane is a type of tropical cyclone that forms in the Atlantic Ocean primarily between June and November. The terms "hurricane", "typhoon", and "cyclone" can be used interchangeably to describe this weather phenomenon (Wikipedia, 2017). The increased rainfall, urban flooding, destruction of power systems, and damage to infrastructure caused by hurricanes prove their potency as extreme weather events. The left graph shows hurricane paths occurring in Florida after 2000 (black dashed lines), as well as the areas affected by sea level rise (blue areas).

The most representative hurricane is Hurricane Irma in 2017. Hurricane Irma was an extremely powerful Cape Verde hurricane that caused widespread destruction across its path in early September 2017 (Wikipedia, 2017). The right graph shows the path of Hurricane Irma. Although it did not directly hit Jacksonville, this city still suffered greatly from its impact.



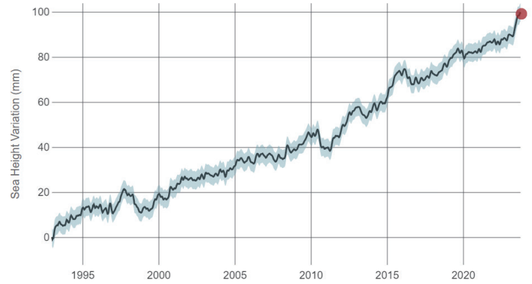
(Map plotting the storm's track and intensity, according to the Saffir–Simpson scale, from NASA. Tracking data is from the National Hurricane Center, accessed on May, 2024)

Sea Level Rising-Threaten City

The rise in sea levels has become a global issue, with coastal cities being the most vulnerable. Most coastal cities have flat terrain and low elevation, making them susceptible to being submerged by rising sea levels.The same situation occurs in Florida, a peninsula extending from the southeastern United States.

"By 2100, Florida is likely to experience at least 2 feet of rise (above 2020 levels) due to emissions to date," NOAA oceanographer William Sweet told Newsweek.As a city located at the mouth of the St. Johns River, Jacksonville is similarly not spared. Jacksonville's flat terrain, with an average elevation of 4.88 meters, and its unique geographical location place this port city in jeopardy as well.

The chart on the right shows sea level rise trends from 1995 to 2020. Sea levels have risen by 100mm in 25 years.



(Observed sea level since the start of the satellite altimeter record in 1993 (black line), NOAA Climate.gov graphic, adapted on May, 2024)

FLOODING



Jacksonville's iconic sculpture amid floods





People trapped in floods





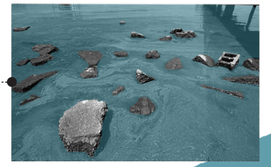




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Pollution always collects in the tributaries of rivers and streams



Factories can impact local water quality



Images of polluted water appear in downtown

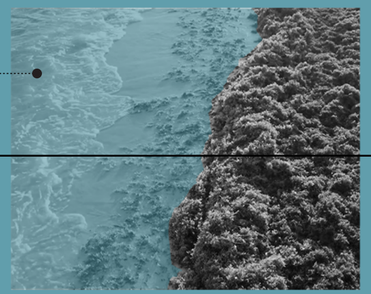


The stream near the residence seems to have become a smelly ditch



Plastic waste washed up on the beach





!!!

Born of Water,

Entrapped Within Water

POLLUTION

Flooding:

Jacksonville is situated on the Atlantic coast and the St. Johns River, making it particularly vulnerable to flooding from both the ocean and the river.
Low-lying areas and extensive waterways contribute to frequent flooding, especially during heavy rainfall and hurricane events.
Hurricanes and Storm Surge:

Hurricanes and tropical storms pose a significant risk, bringing storm surges and heavy rainfall that can lead to severe flooding.
Notable hurricanes, such as Hurricane Irma in 2017, have caused widespread flooding and damage.
Rainfall and Drainage Issues:

Intense rainfall can overwhelm the city's drainage systems, leading to urban flooding.
Aging infrastructure and insufficient stormwater management exacerbate the problem.
Sea Level Rise:

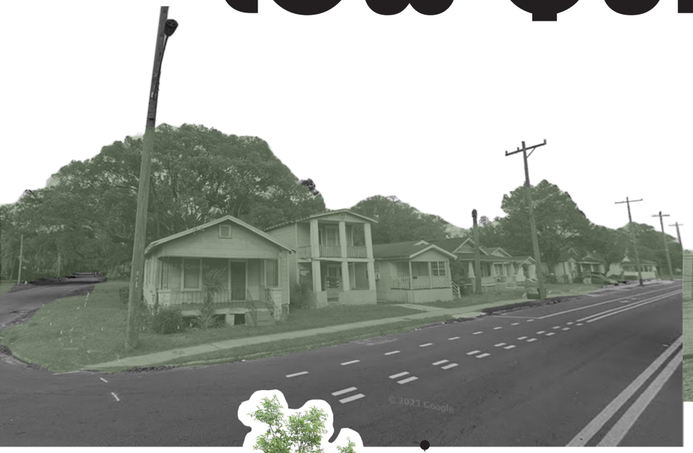
Rising sea levels due to climate change are increasing the frequency and severity of coastal and riverine flooding.
The city's coastal and riverfront properties are at heightened risk.

Water Pollution:

The St. Johns River, a major waterway in Jacksonville, faces significant pollution from agricultural runoff, industrial discharges, and untreated sewage.
Contaminants include nutrients like nitrogen and phosphorus, which lead to harmful algal blooms, affecting water quality and marine life.

Ocean pollution in Jacksonville stems from agricultural runoff, industrial discharges, and untreated sewage, leading to nutrient pollution, harmful algal blooms, and plastic contamination. These pollutants harm marine life, damage habitats, and pose health risks through contaminated seafood and polluted recreational waters.

LOW QUALITY GREEN SPACE



Crowded and poor neighborhoods

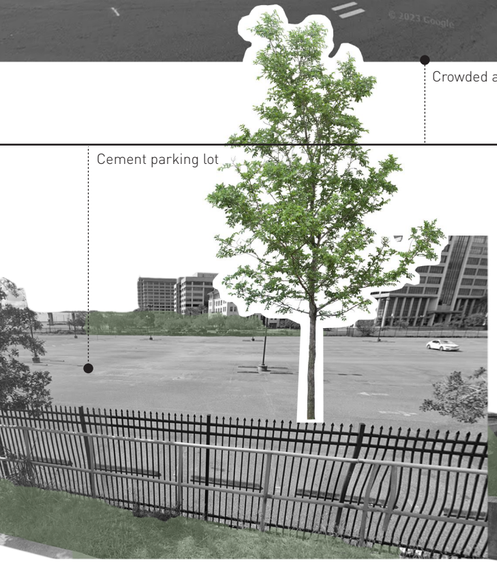


Port

Forgotten place

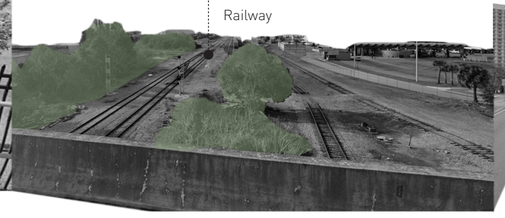


Downtown



Cement parking lot

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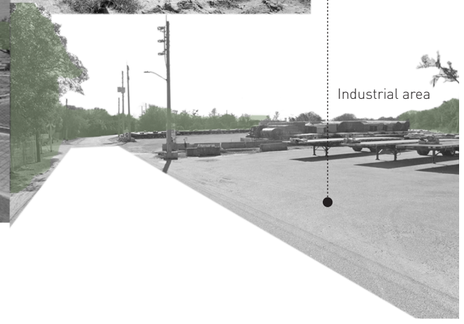
Railway



Unbuilt urban land



Unbeautiful river bank



Industrial area

Low Quality Green Space:

Limited Accessibility and Maintenance: Many green spaces in Jacksonville suffer from poor maintenance, leading to overgrown vegetation, litter, and damaged facilities. Accessibility issues are common, with some parks and green spaces lacking adequate paths, signage, and facilities for people with disabilities.

Urban Development Pressure: Rapid urban development and expansion have encroached on existing green spaces, reducing their size and quality.Development often prioritizes commercial and residential projects over the preservation and enhancement of green areas.

Inequitable Distribution: Green spaces are unevenly distributed across Jacksonville, with wealthier neighborhoods having better-maintained parks and recreational areas compared to underserved communities. Residents in lower-income areas often have limited access to quality green spaces, affecting their quality of life and overall well-being.

Environmental Degradation: Pollution and environmental degradation impact the quality of green spaces. Issues like water pollution, air pollution, and soil contamination diminish the usability and attractiveness of these areas.
Invasive species and loss of native vegetation further reduce the ecological health of green spaces.

Lack of Investment: Insufficient funding and investment in green space development and maintenance lead to deteriorating conditions. Budget constraints and competing priorities often result in delayed or inadequate upkeep of parks and recreational areas.

Safety Concerns: Safety concerns, including crime and inadequate lighting, deter people from using some green spaces, particularly after dark.Poorly maintained areas can become hotspots for illicit activities, making them less inviting for families and community gatherings.

Community Involvement: There is often a lack of community involvement and engagement in the planning and upkeep of green spaces.

His Tory of Segregation

In the late 19th and early 20th centuries
Jim Crow Laws
Enforced Racial Segregation



SEGREGATION



Segregation in schools



?





What`s the segregation city future?

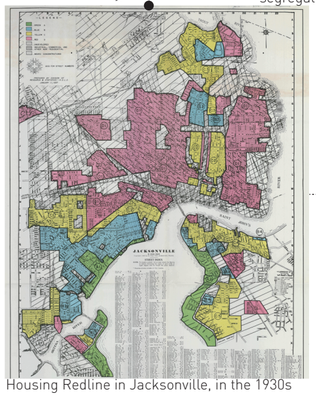


In the 17th century
History of racial segregation in America:
The Sinful Legacy of Slavery

Redlining and Housing Discrimination
In the 20th century,

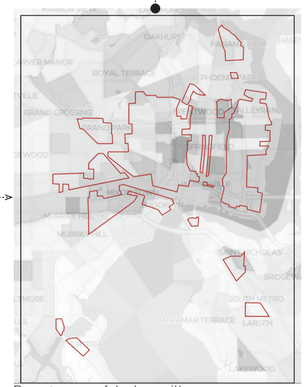
Block Busting maliciously evicted white residents and exacerbated community segregation

where is the future?



Housing Redline in Jacksonville, in the 1930s

Redlines are still in play mentally



Poverty map of Jacksonville now,
Poverty concentrated within the historical red line

Community Segregation: A Persistent scar on America's Past

History of racial segregation in America: The Sinful Legacy of Slavery

Facilities and services such as housing, healthcare, education, employment, and transportation have been systematically separated in the United States based on racial categorizations. Segregation was the legally or socially enforced separation of African Americans from whites, as well as the separation of other ethnic minorities from majority and mainstream communities. (C. Vann Woodward,1947)

In the 17th century, when the first African slaves were transported to the American continent on sinful ships, their fate was sealed. They became slaves to white people, deprived of human rights. This sin was written in the annals of history. Although slavery was later abolished, the situation did not improve. In the late 19th and early 20th centuries, the infamous Jim Crow Laws were enacted. They enforced racial segregation in public facilities, transportation, schools, and housing. These laws effectively created separate facilities for African Americans and whites, perpetuating racial inequality and reinforcing racial stereotypes.

History of housing segregation in America: Redlining and Housing Discrimination

In the 20th century, discriminatory housing practices such as redlining were prevalent. Redlining refers to systematically denying various services, including mortgage loans, to residents of specific geographic areas, often based on race. This resulted in white people typically living in white communities and people of color residing in racially segregated areas.

Modern-day community segregation: ZIP codes determine one's future

Due to various historical reasons, the current situation of community segregation has been shaped. In Jacksonville, this segregation still exists. In Jacksonville's poverty map, some communities have poverty rates of over 50%, and these communities are typically inhabited by people of color. "We must first accept some harsh truths about our city. Poverty impacts 135,000 residents in Jacksonville, 46,000 of whom are children. This means 14.5 percent of our neighbors live in poverty. According to the Centers for Disease Control, if you lived in the neighborhood of Ortega – which is 96 percent white – in 2017 your life expectancy was 13 years longer than if you lived in the neighborhood of Durkeeville, which is 99 percent black. Ortega and Durkeeville are approximately 8 miles apart.

Why does an Ortega resident enjoy 13 more years with their grandkids? What happens in those eight miles? Why does a ZIP Code determine life expectancy?" (Florida Times-Union, 2018)

New forms of wealth segregation: A desperate future

Racial inequality, housing inequality, community inequality, healthcare inequality, spatial inequality—how can we strive to change the unequal situation at the landscape level? How can we create new forms of equality? These are the responsibilities faced by every landscape designer in modern society.

"Why does a ZIP Code determine life expectancy?"



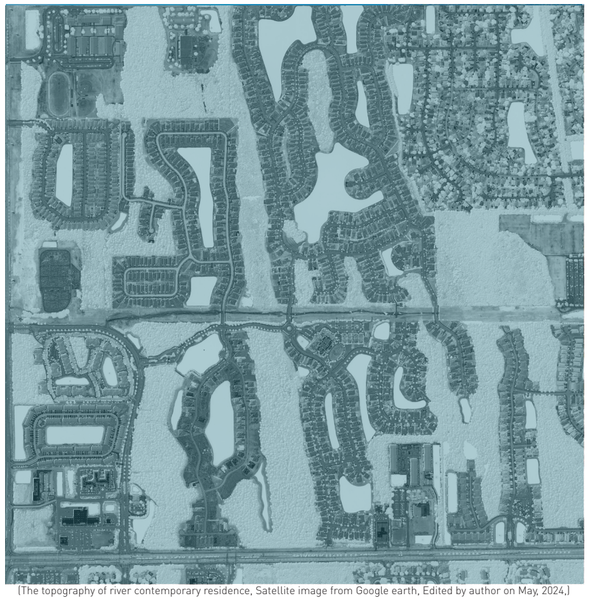






02 RESEARCH APPROACH

This chapter thoroughly introduces the research framework and presents the research question. It also introduces blue-green infrastructure as a baseline, along with other landscape approaches such as multi-scalar, layers approach, and design graphic methods. The Living Breakwaters Project and the Waterplan Antwerp Project are presented as reference case studies. Additionally, it discusses the global thinking of designers.



[The topography of river contemporary residence, Satellite image from Google earth, Edited by author on May, 2024.]

Research Framework

Problem Statement

Problem: 1
Community segregation
- Racial segregation
- Houseing segregation
- Poverty rate
- Spatical inequality

Problem: 2
Water crisis
- Hurricane
- Sea level rising
- Stormwater flooding
- Riverine flooding
- Storm surge flooding
- Tidal flooding
- Water pollution

Problem: 3
Green issues
- Low quality of green space
- Ecological vacancy

Fascination

Hurricane

Estuary landscape

Research Question

Main Research Question
How to improve and build the blue-green infrastructure based on the original green structure of Jacksonville to address urban vulnerability and improve urban resilience.

SRQ1
How does blue-green infrastructure address existing urban issues at different scales, including regional, city, area, community, and street scales, in terms of creating better blue-green structures, enhancing urban resilience, and transforming into sponge cities?

SRQ2
How can blue-green infrastructure creatively focus on social issues and the people living in urban areas? For example, how can it address community segregation, spatial inequality, and the ever-widening wealth gap?

SRQ3
How does the new blue-green infrastructure address water crises and green issues such as water pollution, flooding, low-quality green spaces, and the irrational structure of urban green spaces?

Understanding the Present

Regional scale
St Johns River Lowerbasin
- Waterscape
- Water structure
- Green
- Landuse

City scale
Jacksonviile
- Water
- Green
- Ecology
- Blue Green network
- Development type

Zoom in scale
Case study1
Historical walkable neighborhood
- Water
- Green
- Landuse
- Mobility

Community scale
- People

Housing scale

Method

Gis map-ping

Model

Section

Layer Approach

Challenge

Regional scale
- Flooding
- Water pollution

City scale
- Flooding
- Low quality of green
- Society Inequality

Zoom in scale
- Flooding
- Low quality of green
- Community segre-gation

Community scale
- community segre-gation

Blue Green Infrastructure

Literature review
- Reference book
- Reference case study

Blue green infrastructrue --SRQ1

Blue green infrastructrue --SRQ2

Blue green infrastructrue --SRQ3

Components of Blue green infrastructure
- Flooding
- Water pollution
- Low quality of green
- Community segregation

↓

Typological toolbox

Future

Vision of Regional scale

Vision of City scale
- Blue Green network

Vision of Zoom in 1
- Blue Green network
- Landcape

Vision of Community
- Blue Green network
- Urban agrihood
- Improvement in vacant

Conclusion&Reflection

Conclusion

Reflection
- Main Research Question
- Sub-Research Question1
- Sub-Research Question2
- Sub-Research Question3

2.2 RESEARCH QUESTION

Main Research Question

How to improve and build the blue-green infrastructure based on the original green structure of Jacksonville to address urban vulnerability and improve urban resilience.

Sub-Research Question1

How does blue-green infrastructure address existing urban issues at different scales, including regional, city, area, community, and street scales, in terms of creating better blue-green structures, enhancing urban resilience, and transforming into sponge cities?

Sub-Research Question 2

How can blue-green infrastructure creatively focus on social issues and the people living in urban areas? For example, how can it address community segregation, spatial inequality, and the ever-widening wealth gap?

Sub-Research Question 3

How does the new blue-green infrastructure address water crises and green issues such as water pollution, flooding, low-quality green spaces, and the irrational structure of urban green spaces?

2.3 METHODOLOGY

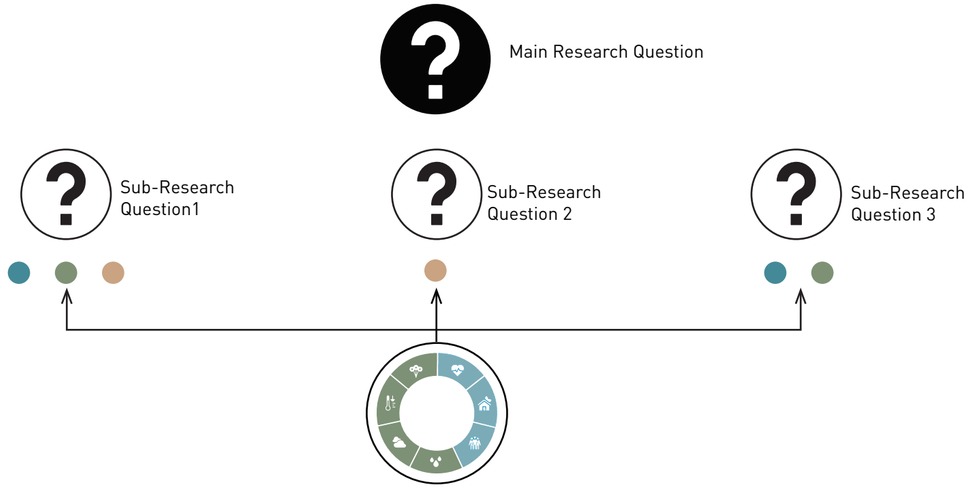
Blue Green Infrastructure As a baseline

In this project, the methods used to address practical water issues, green issues, and social issues are based on blue-green infrastructure. The network formed by blue-green infrastructure offers multifunctional benefits, which can effectively enhance urban resilience.

At multiple scales (Sub-question1): the microstructures formed by blue-green infrastructure are called blue-green grids. This makes multi-centered and decentralized urban development possible. The city's blue structure is no longer centered around rivers but becomes a multi-centered network where points form lines, and lines converge into scattered multi-centered structures connected to rivers. The benefits of numerous points can cumulatively have a significant impact, effectively alleviating rainwater pressure. The city's green structure is no longer a monotonous green ring or green labs but becomes green grids, maximizing ecological and social benefits.

Societal Impact (Sub-question2): The blue-green grids structure of blue-green infrastructure essentially decentralizes the urban layout. Decentralization effectively balances the city's overly congested central areas with large surrounding forests that are underutilized. The grids improve accessibility to green spaces for community residents. Necessary green components can attract residents, and reasonable design can enhance interaction and safety, increasing community cohesion. Urban agriculture to some extent can alleviate economic pressure in communities, offering multiple benefits.

Blue Crises and Low quality of green space (Sub-question3): Various water-sensitive components of blue-green infrastructure have been proven to relieve urban water pressure and flood pressure. Combining water-sensitive components appropriately can form a new water network, enhancing urban water resilience. The green components of blue-green infrastructure are small-scale inserts and improvements suitable for existing urban infrastructure. Enhancing numerous green points and lines creates a vision of "seeing green as soon as you step outside. At the same time, improve ecological value.



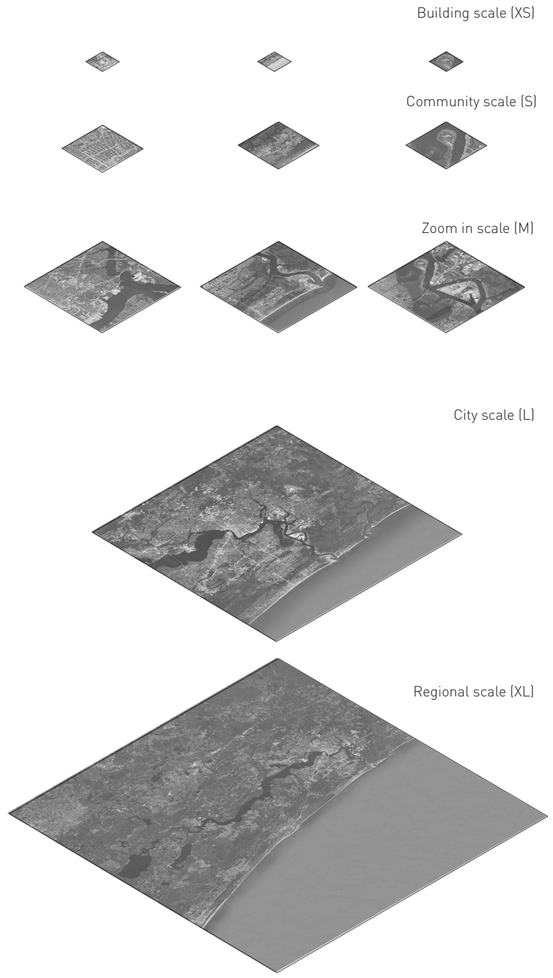
LANDSCAPE APPROACH: Multi-scalar

Successful landscape design requires an understanding of the relationships and interactions between different scales, from the regional landscape to the specific site.(Simonds, John Ormsbee, and Barry W. Starke, 2013)

Landscapes never exist in isolation from their surrounding environment. Water issues, for example, often involve larger-scale factors such as topography, water flow direction, sedimentation, and geological foundations.

In this project, the blue-green infrastructure network addresses comprehensive issues by applying appropriate strategies at multiple scales. It addresses issues at various spatial scales, from local to regional and even global scales. There are five scales in this project: regional scale (XL, St. Johns River Lower Basin), city scale (L, Jacksonville), zoom-in scale (M, Brentwood, coastal community), community scale (S, poor community), and building scale (XS, Urban Agrihood).

It recognizes that actions at one scale can impact other scales, necessitating coordination and coherence across different levels of governance and management.



Layers Approach

Unpacking the landscape in layers is a way of grasping the different systems and subsystems and their relationships (based on Nijhuis 2020).it is about discrete layers that infuence one another to a greater or lesser degree, and that infuence may also change over time. There are many types of layer-based analysis, such as the triplex model in which a distinction is drawn between the abiotic (relief, water, soil), biotic (fora and fauna) and anthropogenic (human activity) layers (Vrijlandt and Kerkstra 1976).(Steffen Nijhuis, 2022)

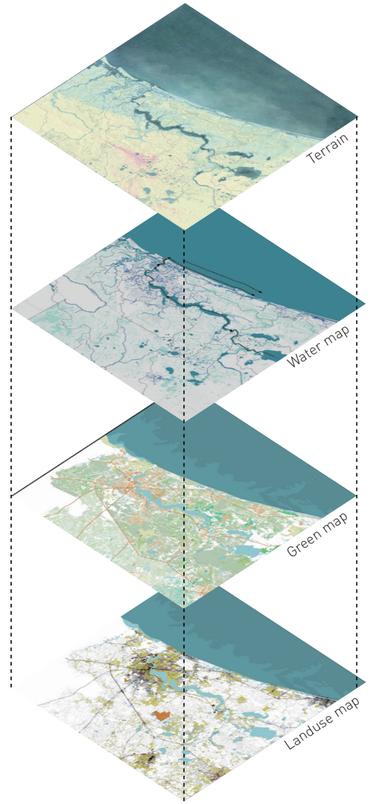
Key models include:
Triplex Model: Abiotic (relief, water, soil), biotic (flora and fauna), and anthropogenic (human activity) layers.
Substratum, Networks, and Urbanization Model: Lacks focus on social and cultural aspects. Alternative approaches highlight the interaction between the physical environment (hardware), human activity (software), and cultural ideas (orgware).

Layer-based analysis includes:

Natural Context: Geological features, climate, and ecosystems, characterized by slow natural changes.

Human Modifications: Activities like construction and water management, linked to social and economic history.

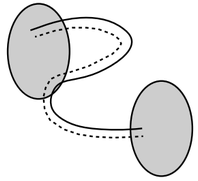
Culture and Politics: Cultural perceptions, technology, and political influences shaping landscape use.
Overall, the landscape is a complex, relational structure that requires multi-scale analysis to understand its dynamics.



Design Graphic Methods

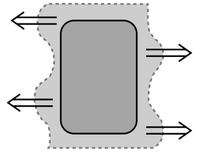
1. CONNECTION

Connection refers to intentionally linking various elements within a landscape to enhance functionality, aesthetics, and the overall experience. These links can be physical, visual, or conceptual. Physical connections include pathways, walkways, and bridges that aid movement. Visual connections frame views and tie the landscape to its surroundings. Conceptual connections involve symbolic elements or themes to create unity and harmony.



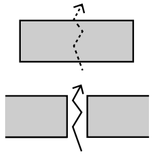
2.EXTENSION

In landscape architecture, "extension" refers to expanding the ecological benefits on the existing basis, breaking the original boundaries, and achieving the expansion of aesthetics and ecological benefits.



3.OPENING

upon the existing foundation, breaking inaccessible boundaries, and improving accessibility. After the quality of the existing urban green spaces is enhanced through design, they are more widely utilized by citizens. Human beings have always had a habit of taking shortcuts. Opening up pathways is a more convenient and effective way to improve accessibility and strengthen landscape connections.



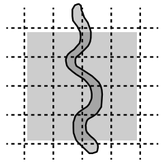
4.INSERTIOIN

Insertion means strategically adding new elements or features to enhance the existing landscape, such as pathways, seating, green roof, pocket park and artworks. This is the simplest and most fundamental way to improve landscape quality and achieve desired functionality.



5.EDGING

Edging refers to the demarcation or separation of different areas. This can involve the use of physical elements such as walls, fences, or plantings to delineate spaces and define their boundaries. At the same time, changes in edge can also bring expected benefits such as increased spatial diversity and richness, as well as enhancement in ecological benefits.



2.4 REFERENCE CASE STUDY

Living breakwaters by SCAPE/Landscape Architecture

The project is situated along the shoreline of Staten Island in New York, strategically positioned to confront the multifaceted challenges presented by climate change, hurricanes, and persistent threats stemming from urbanization, contamination, sediment depletion, and rising sea levels. These challenges mirror those encountered by numerous islands globally, sharing akin topographical

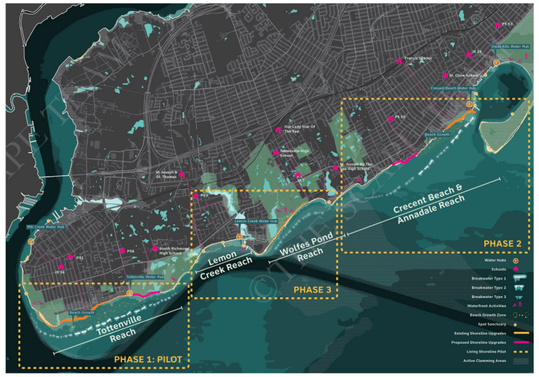
Reducing Rish With Breakwaters

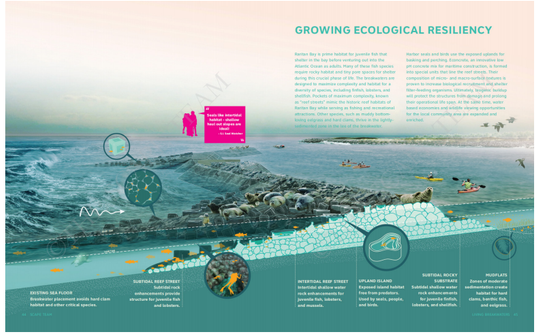
The SCAPE team has developed a science-driven methodology that pairs layered eco-infrastructural systems sited for risk-reduction with social and educational networks, rebuilding water-based infrastructures in tandem with surrounding communities.(SCAPE, 2021)

The project introduces an innovative strategy by constructing offshore breakwaters that serve as living infrastructure. These Living Breakwaters are strategically positioned along the South Shore of Staten Island to mitigate risks for coastal communities, bolster existing shoreline enhancements, and foster fresh perspectives on coastal edge management. They are strategically placed to promote sedimentation and facilitate beach regeneration in regions experiencing significant land loss and infrastructure vulnerability. In zones of heightened ecological or economic sensitivity, their footprint is either minimized or carefully realigned.

Rather than creating a wall between people and water, the project embraces the water.

Unlike traditional sea walls that aim to block seawater intrusion into cities, the project team employs a more ecologically friendly, multifunctional approach to enhance urban resilience and address the city's fragility, effectively mitigating potential risks. The project is divided into three phases.







(Leaving breakwaters , SCAPE/Landscape Architecture, 2021)

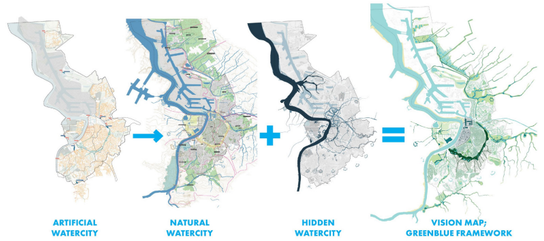
Waterplan Antwerp by DE URBANISTEN

The Waterplan for Antwerp offers a forward-thinking approach to addressing climate change impacts and creating a resilient and livable city. As climate change continues to manifest in extreme weather events globally, cities are increasingly vulnerable to floods, soil subsidence, water shortages, and heat stress. Recognizing these challenges, the Waterplan presents an ambitious vision to not only mitigate risks but also capitalize on opportunities for sustainable urban development.

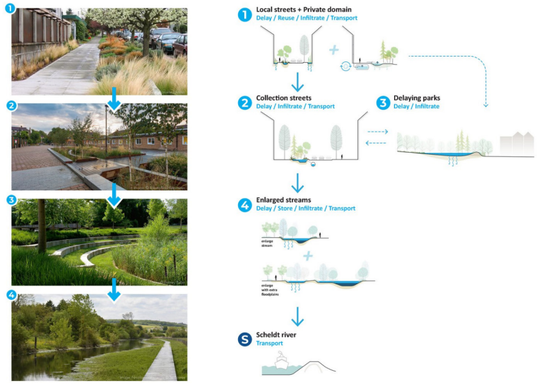
Central to the Waterplan is the concept of three distinct 'watercities': the artificial, hidden, and natural watercities. The plan aims to transition from reliance on artificial water infrastructure to harnessing the potential of natural water features while reviving historical water elements where feasible. By reimagining urban water management, Antwerp seeks to enhance its resilience to climate extremes and create more attractive and sustainable living environments for its inhabitants.

At the core of the Waterplan are five main water structures, each equipped with rainwater cascades and water-sensitive measures designed to achieve the plan's overarching goals. These structures not only serve as functional elements but also contribute to the city's aesthetic appeal and ecological health. By integrating water-sensitive design principles into urban planning, Antwerp aims to create a more harmonious relationship between its residents and the natural environment.

To validate the effectiveness of the Waterplan, three exemplary cases were thoroughly examined. These cases include proposals to optimize rainwater management within cascades, implement green infrastructure in the densely populated Stuivenberg area, and unlock the potential of historical water structures such as the Ruien. Through these case studies, Antwerp seeks to demonstrate the practicality and efficacy of its approach while laying the groundwork for broader implementation across the city.







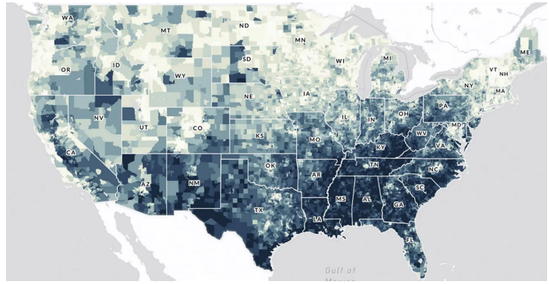
(Waterplan antwerpen, de urbanisten, 2018-2019)

2.5 SCOPE RELEVANCE

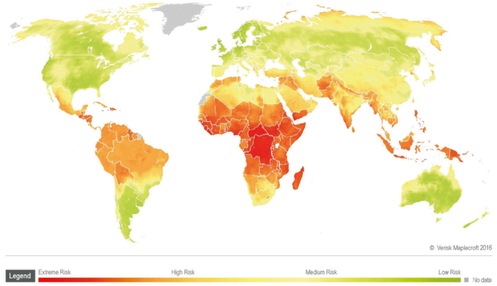
Think Global, Act Local.

Due to extreme global climate changes and rising sea levels, many coastal cities face common urban challenges such as flooding, pollution, and issues with green spaces. (Other problems include urban heat islands, city winds, and shifts in urban energy, though these will not be covered in this project.) Addressing these issues requires significant transformations. However, there are numerous untapped opportunities that can be discovered through a detailed approach to these urban challenges—solutions that can be very effective when applied thoughtfully.

Architects and urban planners have the important task of finding appealing ways to integrate these measures into our cities and taking on leadership roles in their implementation. Recently, blue-green planning has been gaining traction and popularity, indicating growing support for this approach. However, there remains a need for comprehensive overviews of the possibilities, along with critical and constructive evaluations of these measures, to ensure they can be effectively implemented and produce the desired outcomes.



(The U.S. Climate Vulnerability Index; Mapbox / OpenStreetMap, accessed 4 March 2024)



(The Global Climate Vulnerability Index; Mapbox / OpenStreetMap, accessed 4 March 2024)

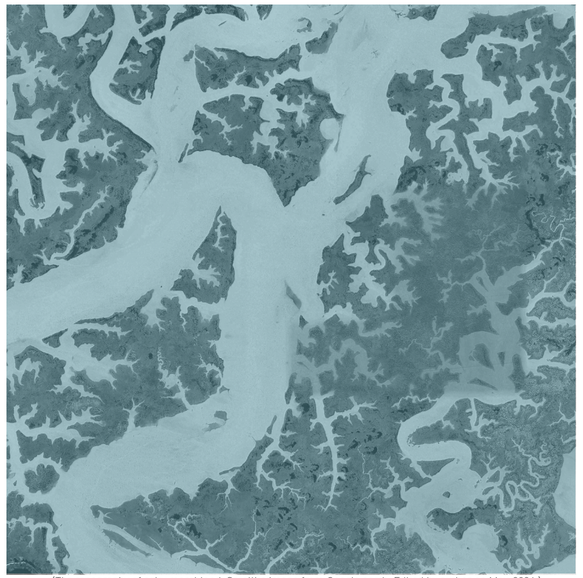
PART Ⅱ
TODAY OF THE RIVER AND THE RIVER CITY

Part Ⅱ
TODAY OF THE RIVER AND THE RIVER CITY
03 EXPLORE THE RIVER: ST JOHNS RIVER
3.1Existing Condition
3.2Challenge
3.3Potential

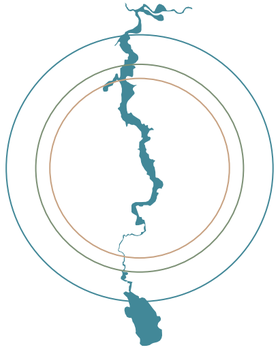
04 EXPLORE THE RIVER CITY :JACKSONVILLE
4.1Existing Condition
4.2Challenge

03EXPLORE THE RIVER: ST JOHNS RIVER

This chapter analyzes the St. Johns River, highlighting its beautiful waterscape and providing an analysis of water, green spaces, and land use. It also addresses the challenges faced, such as flooding and pollution. Fortunately, the St. Johns River has many streams, which serve as buffer zones between the river and the land.



[The topography of salty marshland, Satellite image from Google earth, Edited by author on May, 2024.]



Regional scale

St Johns river
Lowerbasin

Local scale

Jacksonville,FL

Zoom in

Historical Walkable Neighborhoods

3.1 EXISTING CONDITION

History of St johns river

Brackish River

Due to the small elevation difference of the river, tides cause seawater to flow into the mouth of the St. Johns River, affecting its water level up to the middle basin. Consequently, much of the river in Jacksonville contains seawater, forming an estuarine ecosystem. This ecosystem is unique, characterized by high biodiversity and ecological importance. Some fish migrate from the ocean to spawn in the freshwater tributaries upstream.

the earliest human habitat

Due to its favorable geographic conditions, this area has been inhabited by ancient humans. Human arrival on the Florida peninsula dates back to 12,000 years ago, with these ancient ancestors being the Native Americans. Over 9,000 years ago, villages began to form here. Around 2,500 years ago, people of the St. Johns culture inhabited the area. By the year 700 AD, the favorable climate enabled the St. Johns culture to cultivate corn. When European explorers arrived in northern Florida, they encountered the Timucua people, numbering around 14,000, who were the largest indigenous group in the region.

Rivers during the Colonial Period

European settlement in Florida began in 1513, but significant colonization didn't occur until 1562. The St. Johns River was the first area colonized, witnessing conflicts between the French and Spanish. Over time, indigenous populations declined, and American settlers, like Zephaniah Kingsley, established plantations along the river during Spanish control.

Rivers during the United States Confederation Period

Following Florida's incorporation into the United States in 1821, conflicts between settlers and Seminoles shaped towns along the St. Johns River. The era saw the naming of landmarks reflecting these clashes, while steamboat travel fostered commerce until the Civil War. Post-war development brought land booms and environmental challenges like invasive species and water pollution, prompting restoration efforts and debates over water usage and conservation.



(View of the St. Johns River ,William Morris Hunt, 1874, accessed on May 2024)



(A Florida Lagoon, St. Johns, George Henry Smillie, 1874, accessed on May 2024)



(St. Johns Cove,Laura Woodward, 1890, accessed on May 2024)

Water Scape

Timucuan Ecological and Historical Preserve

Coastal sand dune

Jacksonville Port

Beach

Downtown riverine Landscape

Urban Creek Landscape

Intracoastal Waterway

Nature Creek Landscape

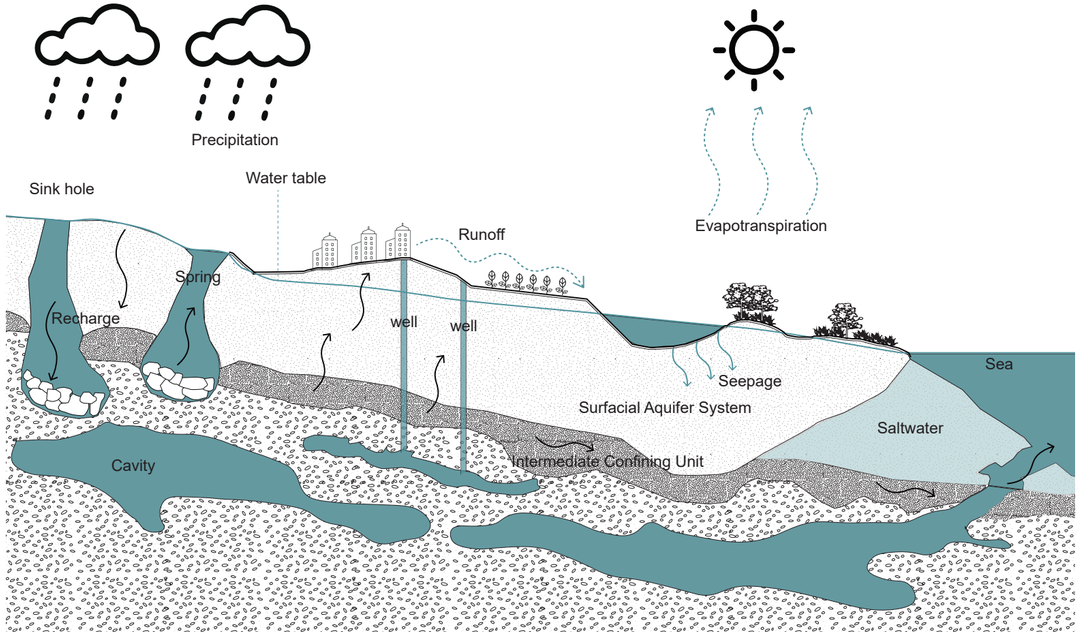
St Johns River

Lake George

The Hydrological Foundation

All of Florida's abundant freshwater is the result of precipitation, which returns to the atmosphere through a process called evapotranspiration. During rainfall, most of the water flows into lakes, streams, and rivers. However, a large amount of freshwater is stored underground in shallow aquifers. The surficial aquifer is mainly composed of clay, shells, and sand, located above the confining layer of denser materials. Drilling wells into the surficial aquifer provides better quality water for areas with higher mineral content in the deepest aquifers. Sometimes, the confining layer fractures, allowing water to seep through and replenish the underlying layers. The Floridan aquifer lies beneath the confining layer and is particularly accessible in northern Florida, serving as a freshwater source from north of St. Petersburg to the metropolitan areas of Jacksonville and Tallahassee.

Acidic rainwater can erode limestone and form caves. When the cover layer of these caves is particularly thin (less than 100 feet (30 m)), sinkholes form, most of which are located upstream. Springs are formed when limestone or sand/clay cover layers dissolve over the aquifer and water pressure pushes out. There are four first-magnitude springs that provide water to the St. Johns River.

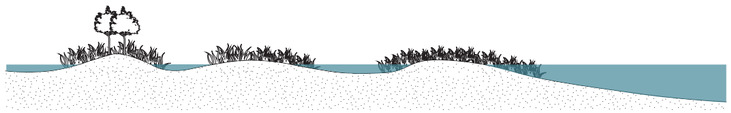


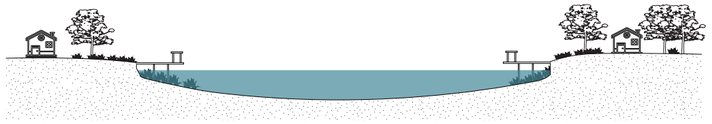
(Reference:US Geological Survey - United States Geological Survey Ground Water Cycle, 2006, edited by author on April, 2024)

Water Scape



Timucuan Ecological and Historical Preserve



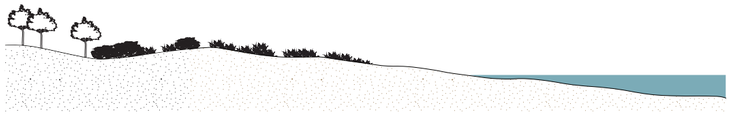


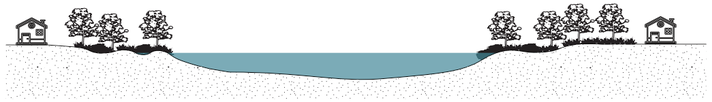


Urban Creek Landscape



Coastal sand dune



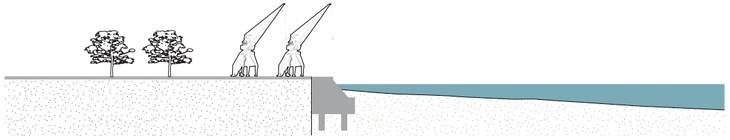




Intracoastal Waterway



Jacksonville Port



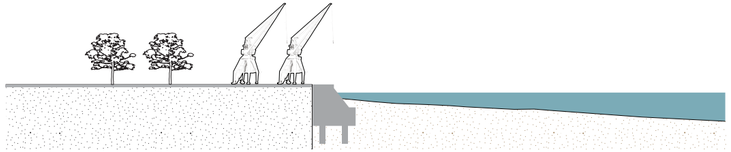


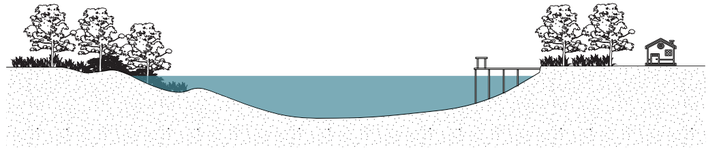


Nature Creek Landscape



Beach



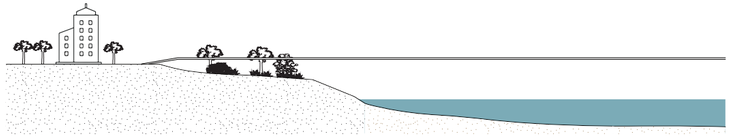


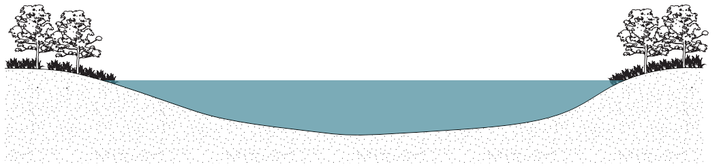


St Johns River



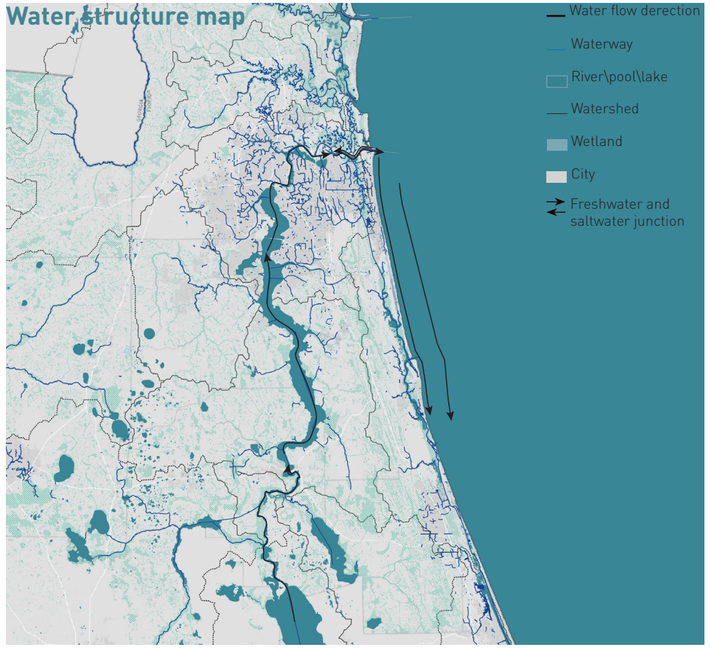
Downtown riverine Landscape







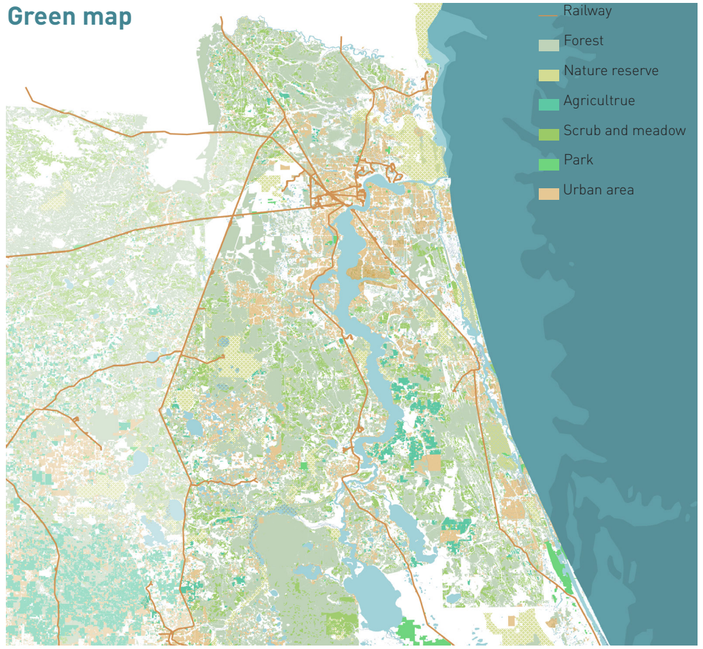
Lake George



A Brackish River and Interwoven Water Networks

The St. Johns River is becoming wider. After traveling 200 miles, the St. Johns River converges with surface water from 3,200 square miles of wetlands, farmland, forests, as well as urban and suburban areas. Downstream of the St. Johns River, numerous streams from forests and fields converge into the river, forming a network of rivers that intersect and gather in an irregular and organic manner. Marshland wetlands are typically distributed on both sides and at the headwaters of these streams.A significant portion of the water in the water system is stagnant.

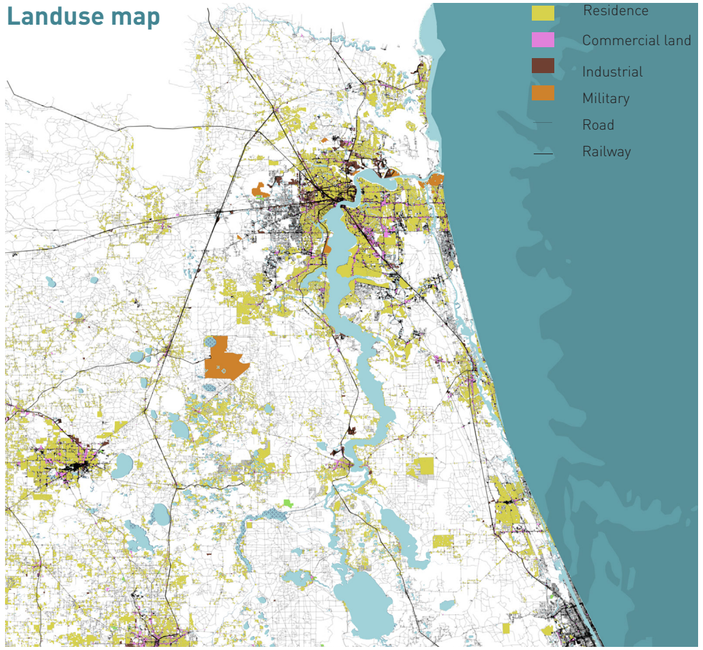
The river is a brackish river, with salinity increasing closer to the ocean. This is due to tidal action, where seawater flows into the river. Despite urbanization in the area, it does not affect the high ecological diversity and abundance of organisms in the brackish river. Some fish migrate from the ocean to spawn in the freshwater tributaries upstream.



Cities Enveloped by Forests

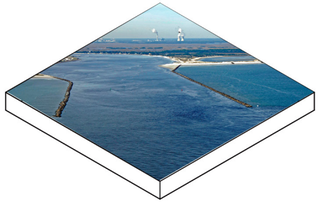
Forests surround cities and rivers, and it must be acknowledged that this area possesses abundant green resources. Apart from rivers, cities, and farmland, nearly all the land is covered with forests. Cities are surrounded by forests. Large expanses of salt marsh wetlands are distributed along the river, serving as natural reserves.

The estimated nitrogen removal of 187,765 metric tons per year by SJR wetlands is valued at over $400 million per year, and the estimated phosphorus removal of 2,390 metric tons per year is valued at over $500 million per year (Craft et al., 2015). Wetlands also serve as nursery grounds for many commercially and recreationally important fish, as well as refuge, nesting, and forage areas for migratory birds. They contribute to shoreline stabilization and provide critical habitat for a wide variety of aquatic and terrestrial wildlife (Groom et al., 2006; Mitsch and Gosselink, 2000).



Cities connected by Canals and Railways

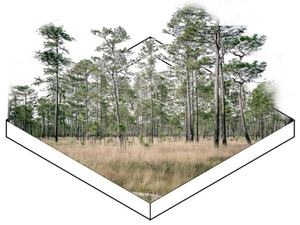
The successful construction of the railway system replaced the once dominant role of river navigation in history. The railways connected adjacent cities and military installations were established along them. Industrial areas occupy strategic riverbank locations downstream. Additionally, leveraging the sea island terrain, the gaps between sea islands and the mainland serve as the Intercoastal Waterway, playing a significant role in navigation and boasting high wetland biodiversity on both sides. Jacksonville is serviced by two Class I railways (CSX and Norfolk Southern Railway) as well as the regional railway Florida East Coast Railway, providing 40 trains per day.

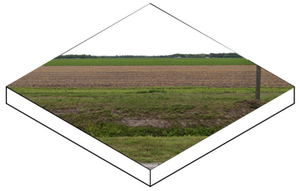


St johns river estuary: St Johns Point

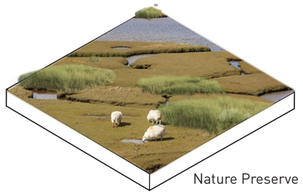


The intersection of salt water and freshwater: Blount Island









Nature Preserve



Scrub and meadow



Urban area



Residence



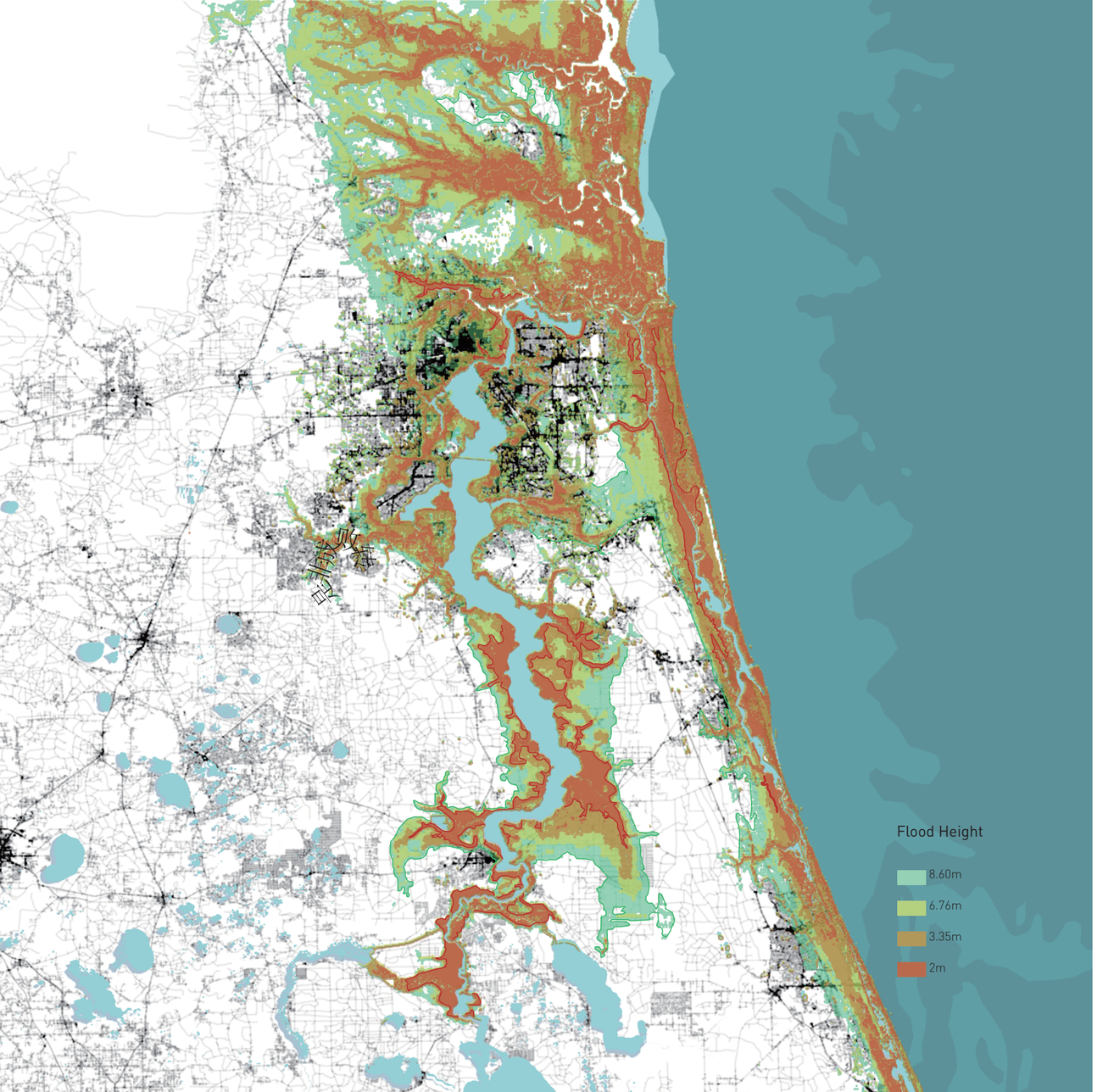
Commercial land



Industrial land

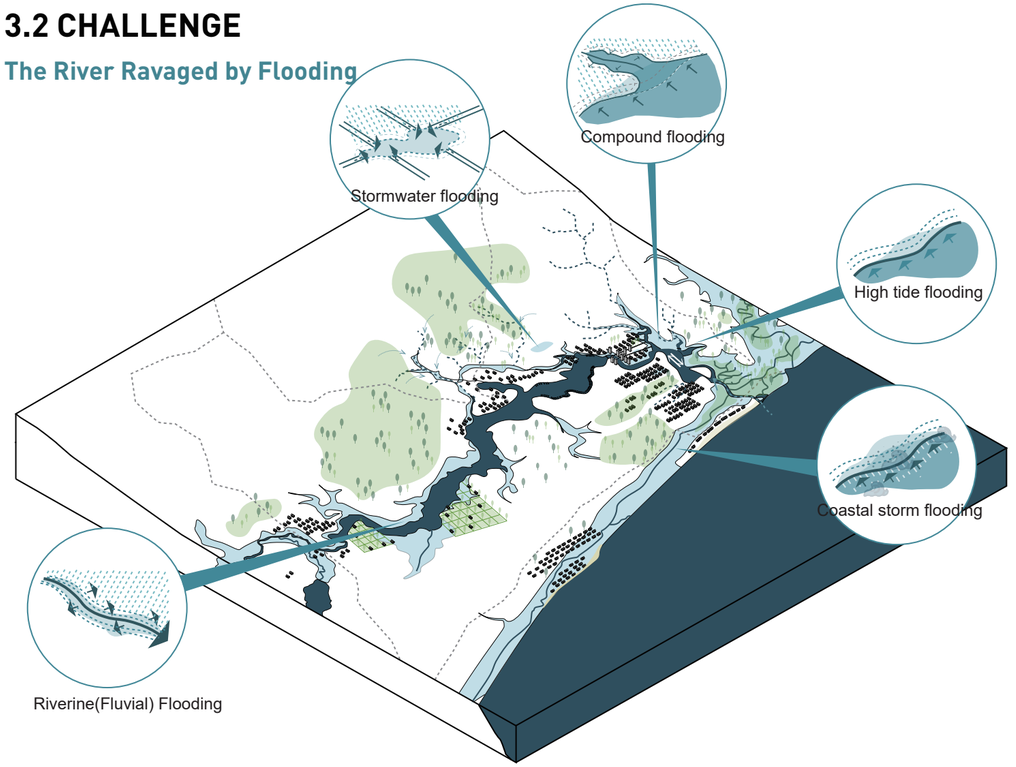


Military land



3.2 CHALLENGE

The River Ravaged by Flooding



Stormwater Flooding

Stormwater flooding, also known as pluvial flooding, is flooding due to rainwater piling up in areas with poor or undersized drainage. This often happens during heavy rainfall events when drains and pipes cannot keep up with the amount of falling rain. (Scape, 2023)

High Tide Flooding

High tide flooding involves flooding of low-lying coastal areas by high tides. This can occur during normal high tides or extreme high tide events. As sea levels rise, the time periods when tidal flooding occurs will increase in frequency and duration (Scape, 2023)

Rivering Flooding

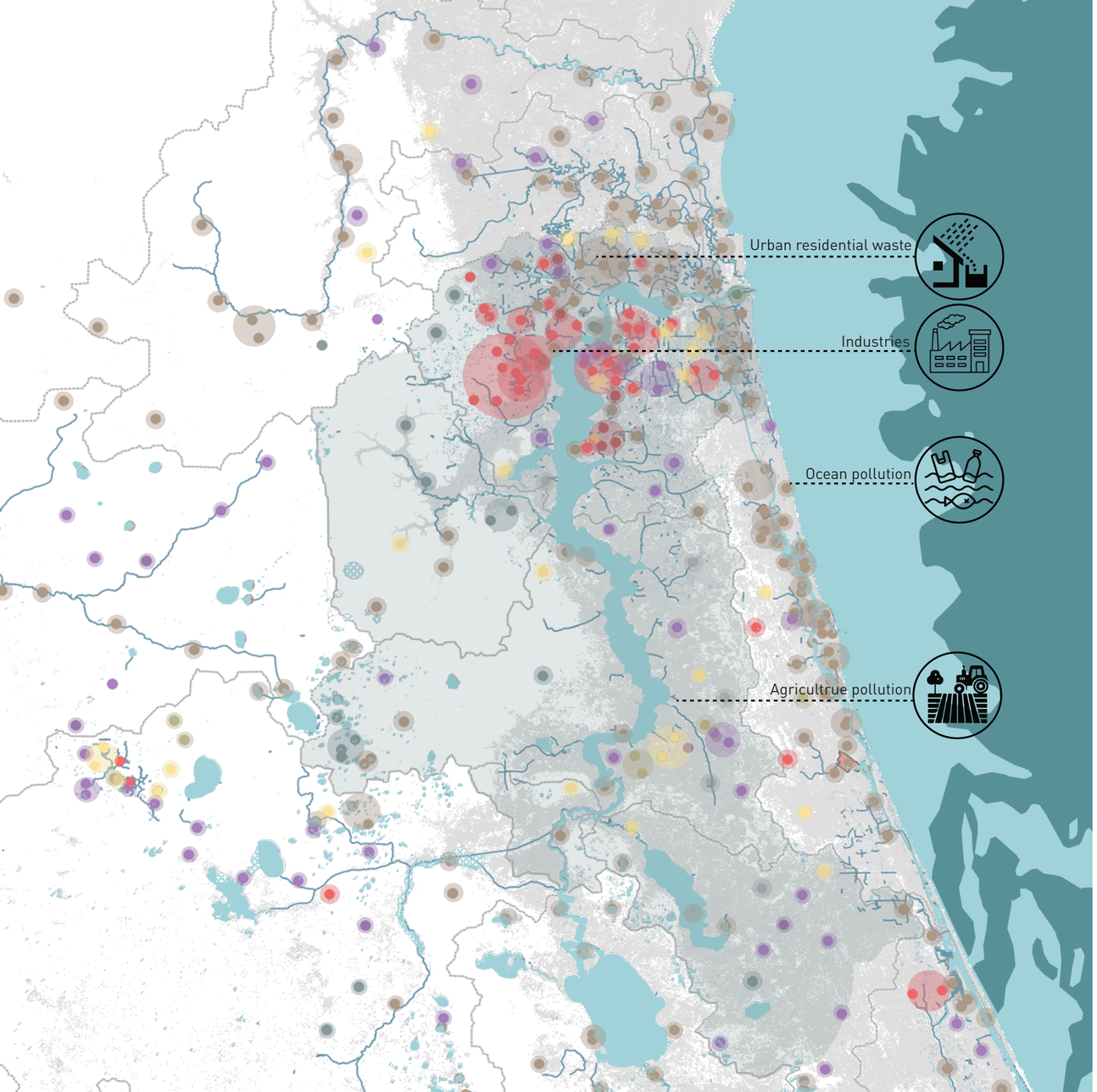
Riverine flooding, also known as fluvial flooding, is when water in rivers, creeks, or canals overtop their banks. This can happen due to locally heavy rainfall. It can also result from rainfall upstream, even when it has not rained where the flooding occurs.

Coastal Storm Flooding

Coastal storm flooding is flooding driven by coastal storms like hurricanes. It includes the effects of both storm surge and high waves. Higher sea levels due to climate change will raise the elevation of storm surge and waves and cause them to travel further inland than in the past, impacting more coastal assets. (Scape, 2023)

Compound Flooding

Compound flooding is when different types of flooding occur at the same time—for example, when heavy rain falls during a coastal storm, resulting in flooding from both coastal storm surge and waves as well as from riverine or stormwater flooding. Many places along the St. Johns River and its tributaries are vulnerable to compound flooding. However, the likelihood of this type of flooding is the most difficult to estimate for Jacksonville due to the complexity of predicting flooding from multiple sources of water occurring at the same time. (Scape, 2023)





(Pollution on the beach of tropical sea, JACKSONVILLE Magazine, accessed on April, 2024)



(A large algal bloom chokes off the oxygen to Goodby's Creek along the St. Johns River, one of the most polluted waterways in Florida. SARASOTA HERALD-TRIBUNE, accessed on May, 2024)

The Pollution of St Johns River Lower Basin

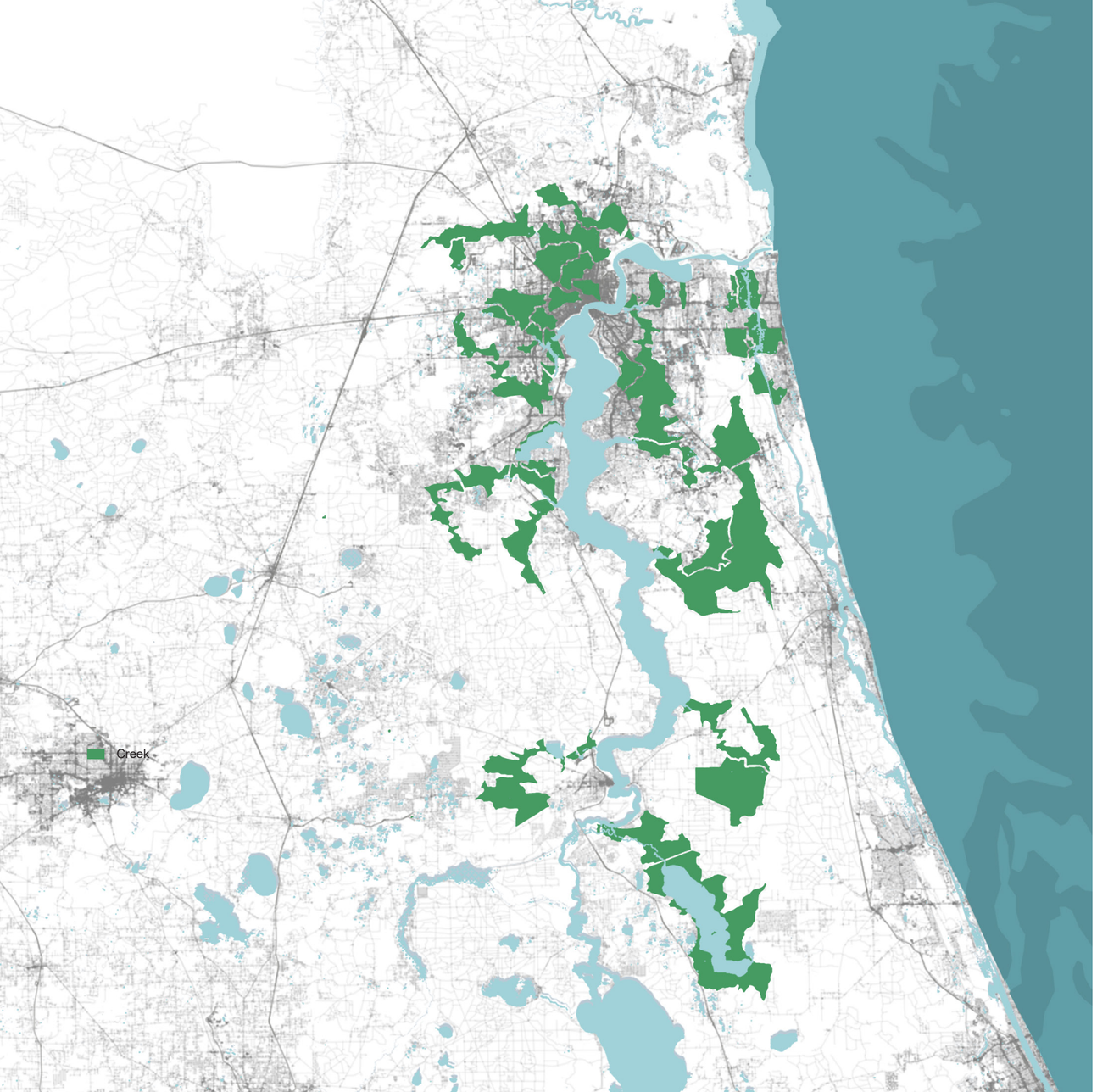
St johns river lower basin tributaries show concerning levels of fecal bacteria, with 60 exceeding water quality standards, and six experiencing over a 10% increase in the past seven years despite mitigation efforts.

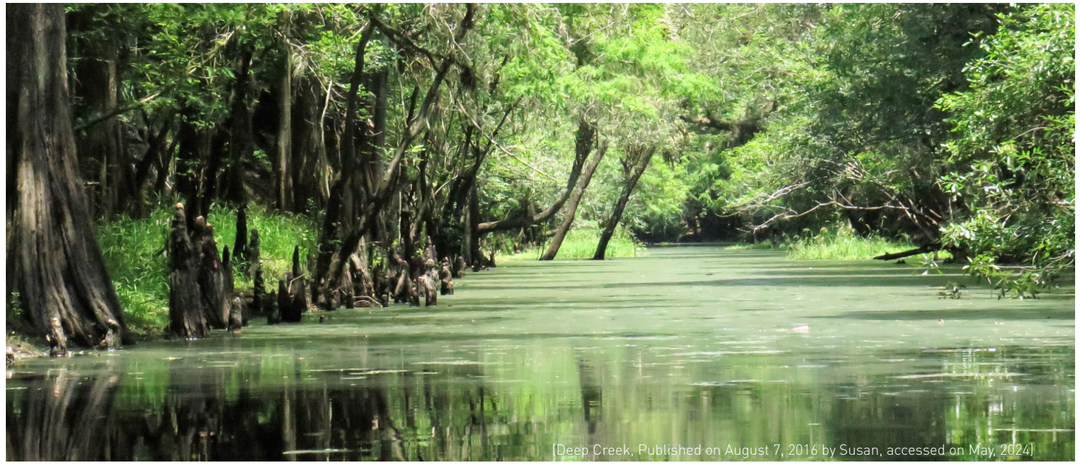
Harmful algal blooms sporadically emerge in the basin due to factors like nutrient inputs, habitat changes, and climate shifts.

Dissolved oxygen levels in the mainstem are adequate, while in tributaries, they vary by location, season, and time of day.

Total nitrogen levels in both mainstem and tributaries are satisfactory overall, but there's a potential slight increase in the freshwater mainstem over the past decade.

Total phosphorus levels in tributaries are concerning, while in the freshwater mainstem, they are stable, but there may be a rise in the marine section over the past decade. (LOWER SJR REPORT, 2023)





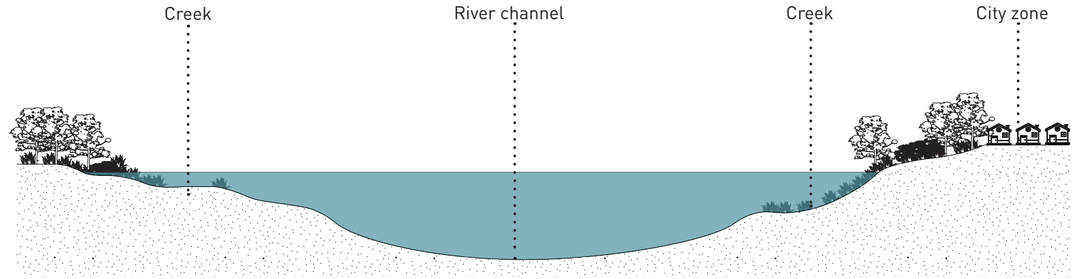
[Deep Creek, Published on August 7, 2016 by Susan, accessed on May, 2024]

3.3 POTENTIAL

Creek is Natural Buffer

The St. Johns River features abundant streams, typically located in positions of high ecological value, also serving as locations for wetlands. Tidal creeks constitute extensive and rich estuarine ecosystems, yet their ecological significance has been underestimated. These creeks exhibit distinct hydrological and watershed characteristics that can profoundly impact ecosystem functions and human utilization of these resources . Due to their typically higher surface area-to-volume ratios compared to larger river-dominated estuaries and their richness and extent, they hold significant collective importance in material transfer and other ecological processes. (Alan J. Lewitus, 2004)

The figure below shows why streams play an important role. Streams are always at the edge of rivers and are also the connection between land and rivers. They have a higher surface area to volume ratio, gentle slopes and shallow depths, so they are also natural flood control buffer zones.



04EXPLORE THE RIVER CIRY:JACKSONVILLE

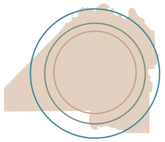
This chapter provides an analysis of Jacksonville, a city rich in water resources, describes its water, green spaces, land use, ecology, and types of residences. It also summarizes Jacksonville's blue-green network.



[The topography of Quarantine Island, Satellite image from Google earth, Edited by author on May, 2024.]

Regional scale

St Johns river
Lowerbasin



Local scale

Jacksonville,FL

Zoom in

Historical Walkable Neighborhoods



(Jacksonville, Florida, Lance Asper, Published on 2021, accessed on Ma, 2024)

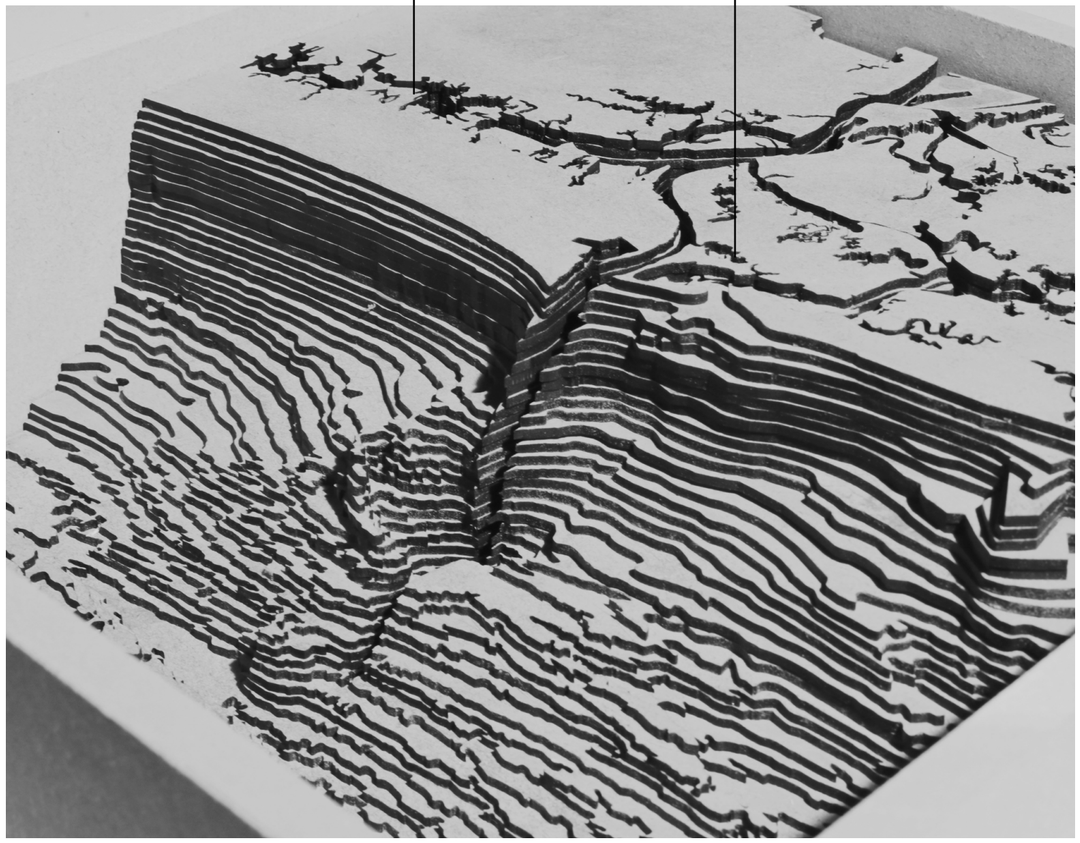


St johns river

Ocean

Intercoastal waterway

Marshland



Water Map

Wetland
Marshland
Water body
Road

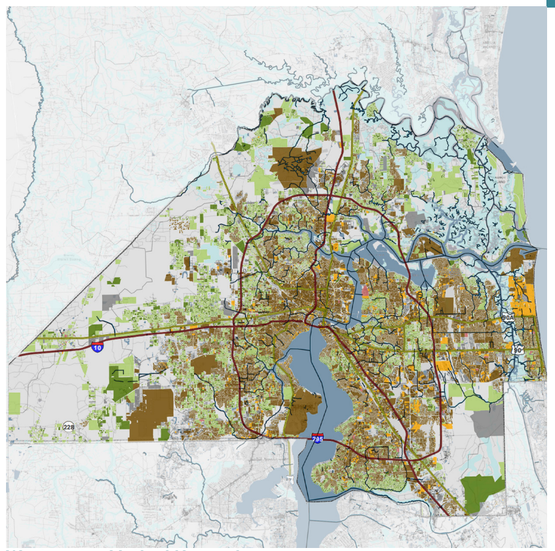
4.1 EXISTING CONDITION

The Water City: Jacksonville

Jacksonville's connection to water is integral to its history, present, and future. The city's geography is heavily influenced by its proximity to the Atlantic Coast, the Intracoastal Waterway, and the St. Johns River, which runs through its center. Additionally, Jacksonville boasts over 59 tributaries—streams, creeks, and smaller rivers that flow into the St. Johns River—within its city limits. Overall, Jacksonville features more than 1,500 miles of shoreline. This abundance of water supports the city's unique ecosystems. Over thousands of years, waves, winds, and sediment deposits have shaped the area, creating the St. Johns River, coastal plains, barrier islands, and dunes that define Jacksonville today.

Since Jacksonville does not have a complete bozeman system like the Netherlands, Jacksonville's numerous rivers and streams have taken on an irregular organic form, distributed according to elevation differences. Ponds can be seen everywhere (many of which are located in contemporary suburb residences), forming Jacksonville's complex water system.

The figure on the right shows the wastewater treatment methods in Jacksonville, mainly Septic parcel and sewer parcel.
The wastewater method for septic and sewer parcels involves monitoring and managing their respective systems. Septic parcels use on-site septic tanks, requiring checks to prevent groundwater contamination. Sewer parcels are connected to centralized sewer systems, monitored for efficient operation and leak prevention. Proper management of both systems is essential for public health and environmental protection. A good understanding of the local wastewater treatment methods may be useful for improving the water cycle and reducing groundwater contamination in the future.

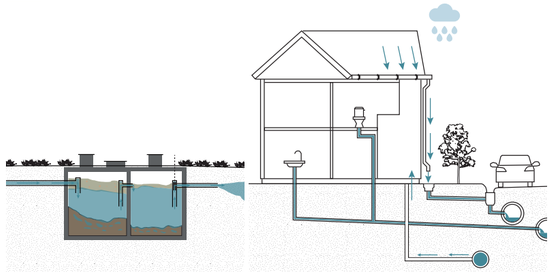


Wastewater Method Network

Septic parcels
- 14,356 Known(4.3%)
- 61.945 Likely(18.5%)

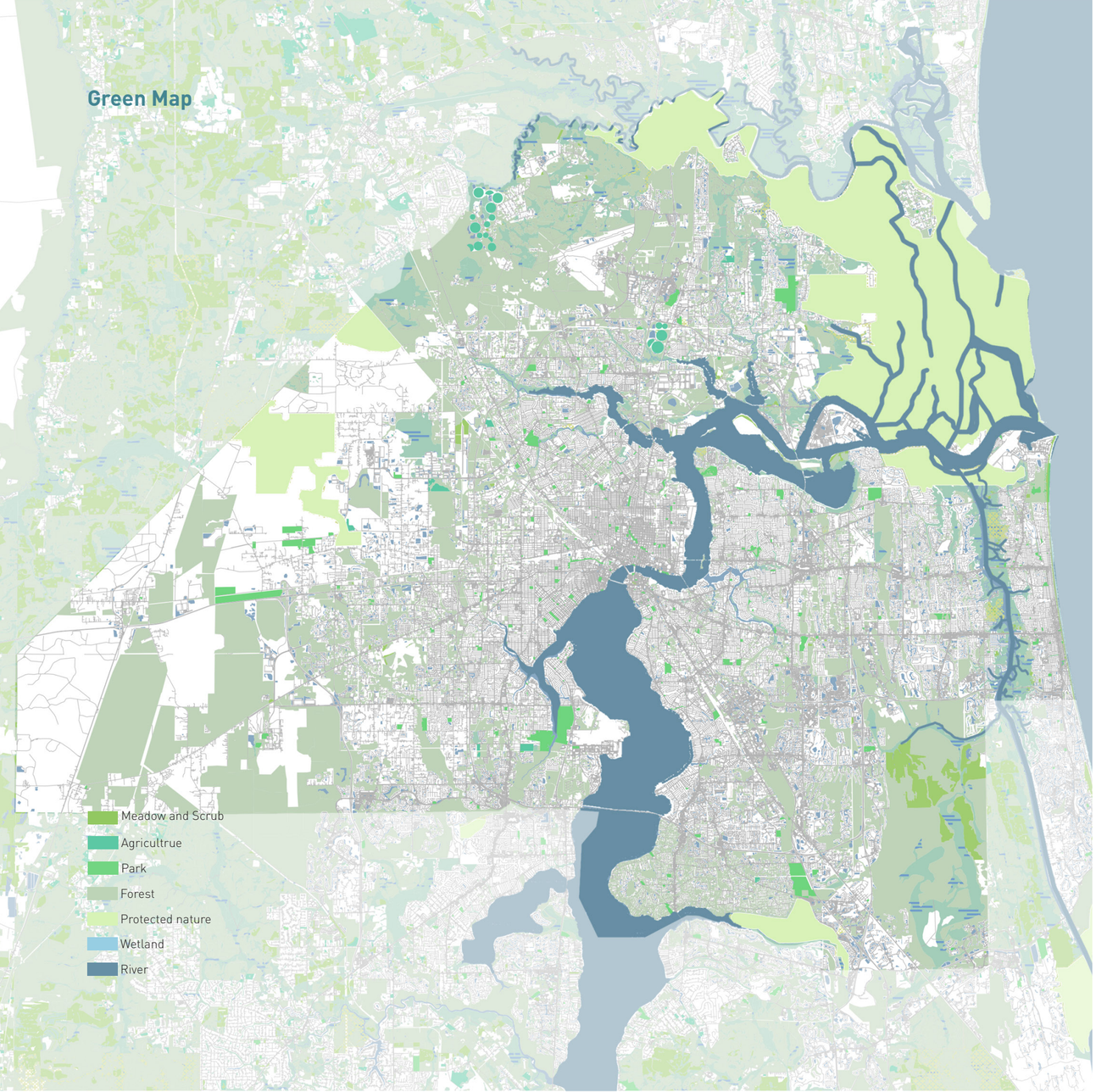
Sewer parcels
- 212,156 Known (63.3%)
- 27,585 Likely(8.2%)
- Unknown

Watershed
- Linear Surface Water Drainage Network



Septic parcel

Sewer parcel



A Green City

More than half of Jacksonville's land is undeveloped forests, wetlands, grasslands, farmland and other open spaces. Forests are mostly located inland at higher positions and surround the city in a ring. Forming a natural wedge-shaped green structure. It has rich wetland resources. Due to the intrusion of seawater and the transition from salt water to fresh water, salty marshland, brackish marshland and freshwater marshland are formed here. There are also a large number of wetlands near streams. Jacksonville also has the largest urban park system in the country. These diverse and valuable ecosystems provide many benefits to Jacksonville residents: supporting clean air and water, controlling erosion and flooding, reducing urban heat, recreation, food and timber production, and biodiversity.

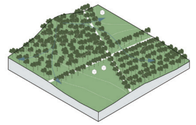
The right picture shows Jacksonville's Potential Habitat Richness map. It can be seen that the forest area around the city has a high ecological diversity, and the suburb area close to the city has low ecological diversity.

Blue Green Network



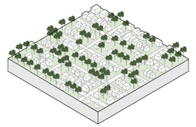


Contemporary Suburb



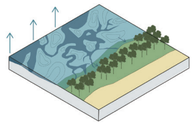
Eco-patch



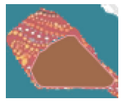


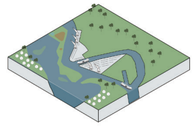
Historical walkable neighborhood and post-war suburb



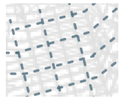


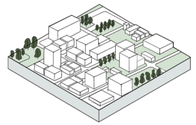
Estuary marshland





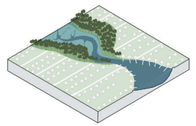
Quarantine Island





Downtown





Creek and Stream

Original Blue-Green Structure

Naturally based original blue-green structure
Natural systems provide prospects for a resilient city, providing opportunities for more characteristics and identifiability of the water city and can provide additional capacity.

Contemporary suburb: A new type of residential area established after World War II, with good privacy, private gardens connecting private and external landscapes, and creating a good ecological environment by using abundant small water bodies.

Eco-patch, generally refers to an area with large volume, many trees, and good ecological value. This area is distributed around Jacksonville, surrounding the city like a ring. It is generally an area with the highest biological channels and biodiversity and little human intervention.

Historical walkable neighborhood and post war suburb:
The obvious feature here is the grid arrangement, the single landscape, and the water system is generally underground pipes distributed along the streets.

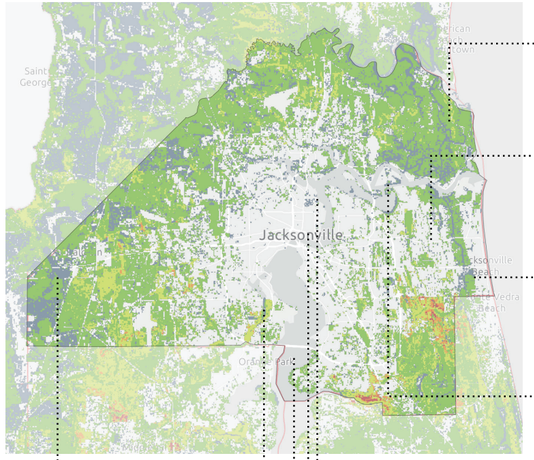
Estuary marshland: A unique ecological area formed by river sediment deposition and tidal erosion day after day. The water salinity here changes from low to high, and it is a habitat for many fish to return to spawn and birds. However, due to rising sea levels and continuous flooding by seawater, marshland is gradually disappearing or moving inland.

Quarantine island: This is the area where wastewater and waste soil are disposed of by river dredging projects. Although it is in an excellent location in the middle of the river, it seems to be an untouchable and forgotten area. The water here is in sharp contrast with the rivers outside, and the landscape needs to be restored.

Downtown area: As the downtown area of Jacksonville, there is a lack of greenery and almost no natural water bodies. The water system is a pipeline distributed along the streets.

Creek and Stream: It is a good buffer zone, a transition from land to river, and a natural floodplain, but it faces serious pollution problems.

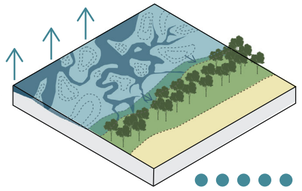
Ecology Analysis



Potential Habitat Richness Map

- 1 Species
- 2-4 Species
- 5-6 Species
- 7 Species
- 8-13 Species

(FGDL, UF GEOPLAN CENTER, Accessed on April, 2024)

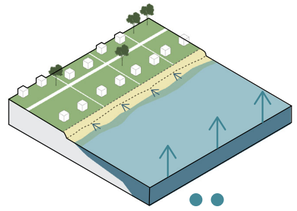




Orsilochides guttata | Pyrota lineata | Leptuca pugilator | Sialia sialis | Passerina caerulea | Egretta tricolor | Alligator mississippiensis



Polygala cymosa | Polygala lutea | Gordonia lasianthus

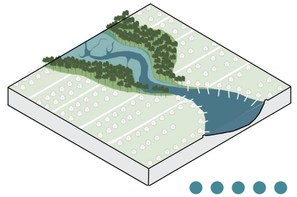




Quercus virginiana | Crinum asiaticum | Pseudogynoxys chenopodioides | Helianthus debilis



Strix varia | Anatidae | Hyla cinerea

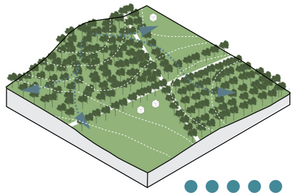




Juniperus virginiana | Pinus taeda | Aristolochia littoralis | Pleopeltis michauxiana | Passiflora incarnata



Minuca minax | Gasteracantha cancriformis | Lithobates catesbeianus | Tramea carolina

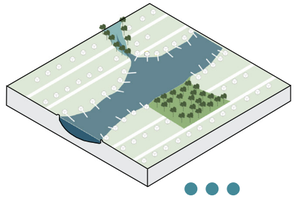




Calopogon tuberosus | Helenium pinnatifidum | Stenanthium densum | Coreopsis integrifolia | Carya illinoinensis



Papilio palamedes | Pantherophis guttatus | Dasypus novemcinctus

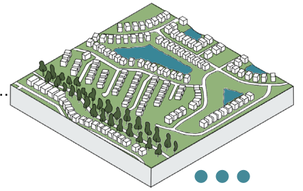


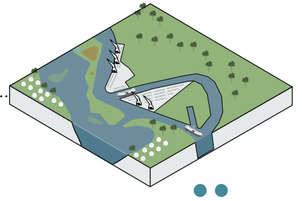


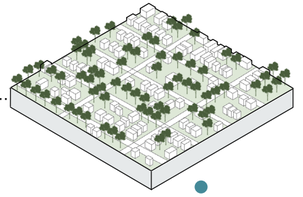
Largemouth Bass | Channel Catfish | Yellow Bullhead | Rainbow Trout

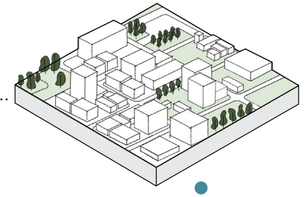


White Crappie | Bluegill | Green Sunfish | Walleye











Quercus virginiana | Treaty Oak | Lechea mucronata | Tillandsia bartramii | Koelreuteria elegans | Canna



Rhadinaea flavilata | Charadrius vociferus | Trachemys scripta



Rubus trivialis



Hypagyrtis esther | Phyllonotus pomum | Alligator mississippiensis | Ardea herodias | Calidris Pusilla | Agama picticauda



Viburnum | Quercus virginiana | Euphorbia cyathophora | Triadica sebifera | Richardia scabra | Callicarpa americana



Thamnophis sirtalis | Cairina moschata



Tradescantia | Hamelia patens



Geothlypis trichas | Nycticorax nycticorax | Mniotilta varia | Branta canadensis

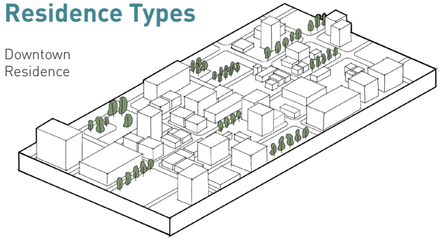
Landuse Map

Urbanscape
A prosperous city centered on the river

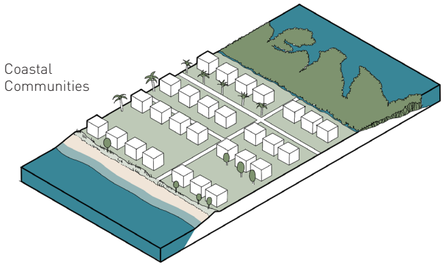
Residence
Commercial land
Industrial
Military
Road
Tailway

Residence Types

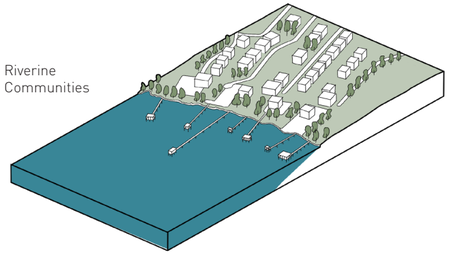
Downtown Residence



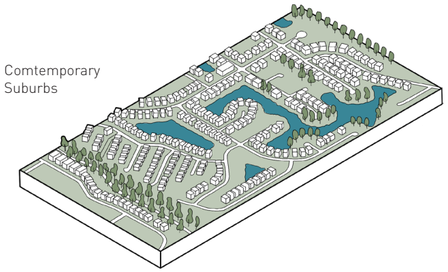
Coastal Communities



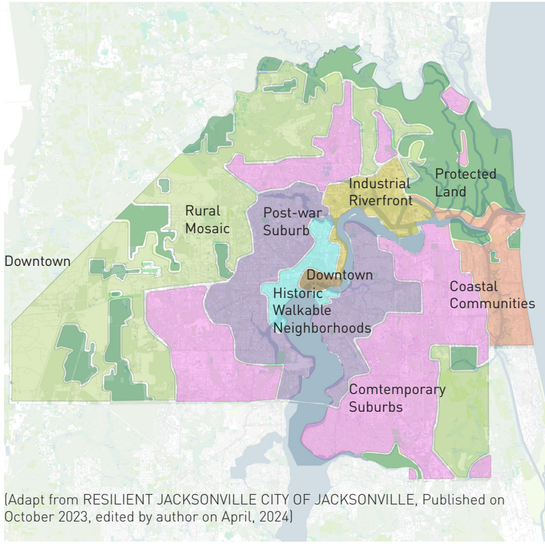
Riverine Communities



Comtemporary Suburbs



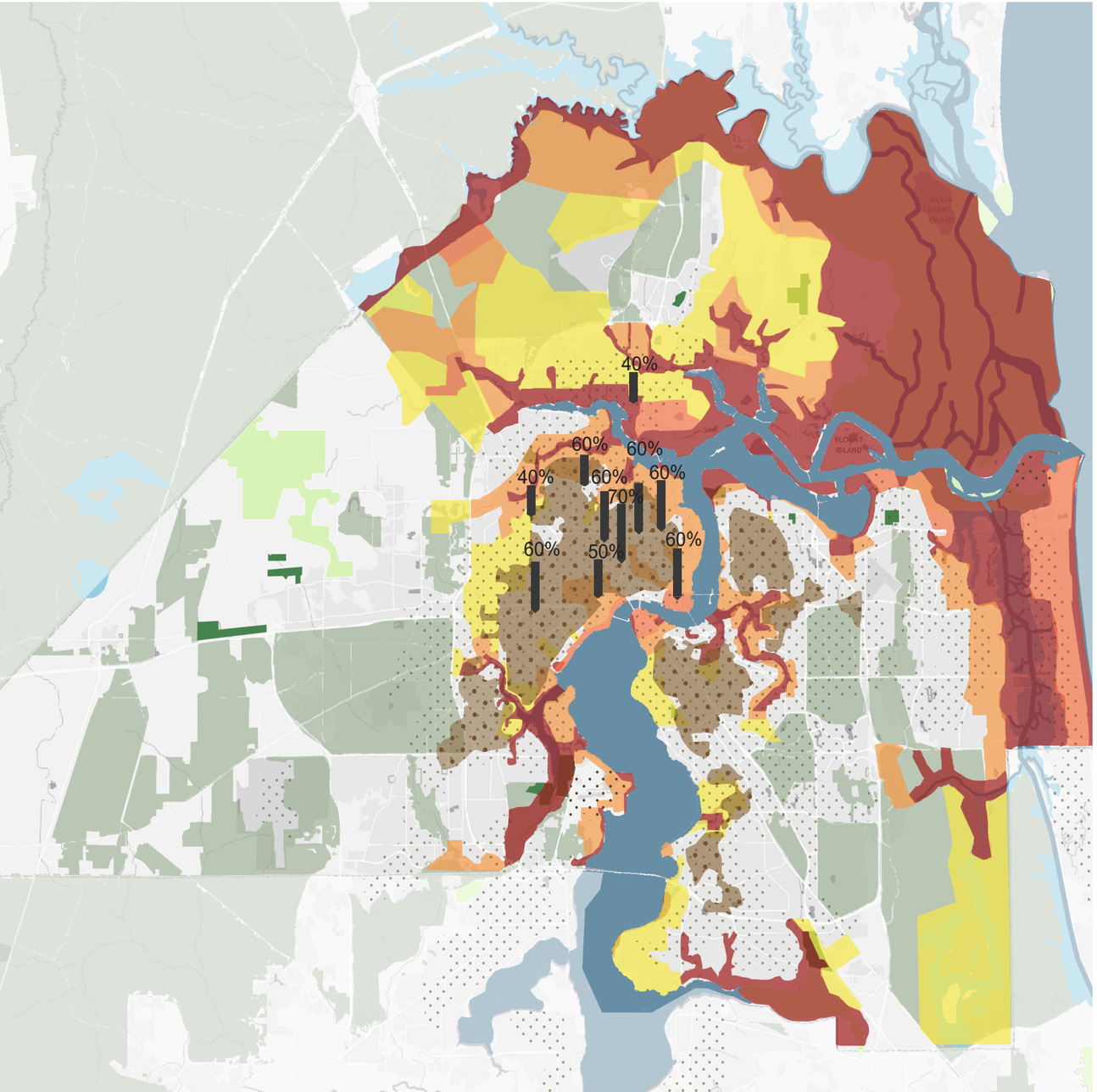
Development Types
Mapping the Types Across the City



(Adapt from RESILIENT JACKSONVILLE CITY OF JACKSONVILLE, Published on October 2023, edited by author on April, 2024)

Residential areas occupy most of the land and are large in area. Commercial areas are mainly distributed along roads. Industrial and military areas occupy some important positions on the edge of rivers. But even in residential areas, there are actually four typical residential area models. Coastal Communities: high landscape quality, distributed along the coast, but highly vulnerable to storm surge and tidal flooding. Downtown Residence: high building density and average landscape quality. Riverine Communities: have good views facing the river and have private docks, but are vulnerable to riverine flooding. Contemporary Suburbs, generally built after the war, have a good balance of privacy and landscape, and have abundant water bodies as part of private gardens.

The eight Development Types cover all of Duval County, each characterized by distinct patterns of development, infrastructure, and water relationships. These factors shape how different areas experience shocks and stressors, as well as the effectiveness and location of resilience actions. Rather than suggesting land use patterns, these types describe the current state of Jacksonville's built environment.



Potential storm tide

- 2m
- 3.35m
- 6.07m
- 6.76m
- 8.60m

Poverty rates

- Lowest landscape intergrity
- Low landscape intergrity

4.2 CHALLENGE

The Complex Problem is Concentrated in the City.

Low Landscape Quality

The United States has planned their residential areas in an extremely utilitarian and sophisticated way. These residential areas are distributed radially around the city center. The advantage of this distribution method is that it is fully private green. Every household can enjoy nature in their own garden. But the disadvantage of this distribution method is that it strengthens the isolation of the entire society, just like the word: atomized society. If it is transformed in a landscape way, it may be to increase the number of large parks, increase the siphon effect of parks, and conform to the natural social gathering needs of human beings.

(The point distribution represents areas with low landscape index and low landscape richness, which are generally concentrated in residential areas)

Floods threaten city

Whether it is excessive water from rain, excessive water from tides, or excessive sewage gathered in streams. The flooding crisis has caused harm to this city famous for water to a certain extent, especially extreme weather events such as hurricanes have caused greater harm. (The large red and yellow areas in the picture show the flood threat areas, distributed at the estuary and along the streams). The answer to the city's problems lies in the city. Improving the blue-green infrastructure to form a network will make the city itself like a huge sponge, quickly draining, storing, and protecting water.

Poverty is concentrated in the center

The rich and poor problems in the United States also exist in Jacksonville. As of recent data, the poverty rate in Jacksonville is approximately 15-16%, which is slightly higher than the national average of around 11-12%. This rate varies widely across different neighborhoods and demographics. The poverty rate map shows that poverty is mainly concentrated in urban areas, especially in historical walkable neighborhoods and post war suburbs. If the poverty isolation caused by breaking community isolation becomes an issue to be discussed in this project.

PART Ⅲ
The City as the Solution: Embracing Blue-Green Infrastructure and sponge city for Resilience

Part Ⅲ
[The City as the Solution : Embracing Blue-Green Infrastructure for Resilience]

05 OPPORTUNITIES
5.1WHY BLUE GREENINFRASTRUCTURE
5.2 LITERATURE REFERENCES
5.3 OVERVIEW OF BLUE GREEN COMPONENTS
5.4 COMBINATION AND LOCALIZED APPLICATION OF BLUE GREEN COMPONENTS
5.5 WATER FLOW INDICATION

05 OPPORTUNITIES

Based on the previously raised questions and the site analysis, where are the opportunities? This project proposes blue-green infrastructure as a solution to urban problems, providing relevant theoretical support as a foundation. It explains how blue-green infrastructure responds to the research question and problem statement. Additionally, it identifies relevant theoretical sections of blue-green infrastructure as design components and appropriately applies them to the site's topography, forming a toolbox.



(The topography of Agricultrue near the Picolata Produce Farm , Satellite image from Google earth, Edited by author on May, 2024,)

5.1 WHY BLUE GREEN INFRASTRUCTURE

Structural Strength: Integrating Blue-Green Infrastructure as Foundation

Blue-green infrastructure refers to a network that provides the "ingredients" for solving urban and climatic challenges by building with nature.(Hiltrud Pötz & Pierre Bleuze,2011)

Why Blue?

Water landscape infrastructures:The third field is the design of landscape infrastructures that focus on water management and riparian zones. Important issues here are coast and river management – including river modifications, seawalls and floodgates – as well as the use of beach nourishment, sand dune stabilisation, development of flood forests and coastal/ estuarine wetlands to create new multifunctional landscapes. It includes the planning and design of land reclamations, major flood control systems (dikes, levees, major pumping stations and floodgates), drainage systems (storm sewers, ditches), major irrigation systems (fresh water reservoirs, irrigation canals), and also sewage collection and disposal of wastewater beyond their utilitarian use. Other important operations are planning and design of multifunctional flood defence structures, river landscape modifications, aquatic landscape development, fresh water storage and supply landscape infrastructures, water fronts, waste water treatment plants, and adaptive water protection measures (STEFFEN NIJHUIS, DANIEL, 2015)

Why Green?

Green landscape infrastructures:The second field is the design of urban landscape infrastructures that maintain and develop natural ecosystem values and provide associated social, economic and aesthetic benefits to humans as a set of interconnected green space networks. Useful for planning and design is the concept of land mosaics consisting of green patches, corridors and matrices. Much of the foundation of this field draws on the planning principles of regional metropolitan park systems of the nineteenth century. Green space structures can act as organisational structures for sprawling metropolitan areas, providing space for nature development, leisure/recreation and cultural heritage. Food production and energy supply are becoming increasingly important as urban landscape infrastructures. Typical design operations include the planning and design of metropolitan park structures, development of agricultural urban landscapes, urban ecology and protection of heritage landscapes



Why Blue Green Infrastructure?

Historical importance and development of parks and public green grids.

Elisabeth Lichtenberger's work, "Überblick, die Function von Grünflächen," provides a summary of the social contexts behind the development of green areas in Western towns and cities. Throughout history, urban green spaces have served purposes related to representation, wellbeing, and urban hygiene. Renaissance terrace gardens and 18th-19th century landscaped gardens are examples of representational green spaces, typically sponsored by political elites, while green spaces in social housing are products of democratization. Public parks like New York's Central Park, found in Western and socialist societies, offer leisure and recreation.

Green areas require political support and planning tools, but despite these, they often remain marginalized compared to developed areas due to their limited financial returns. Recent decades have seen the rise of spontaneous vegetation in cities, influenced by environmental movements and planning processes. This spontaneous vegetation, such as in Duisburg's Landschaftspark, serves ecological purposes, like acting as bio-indicators.

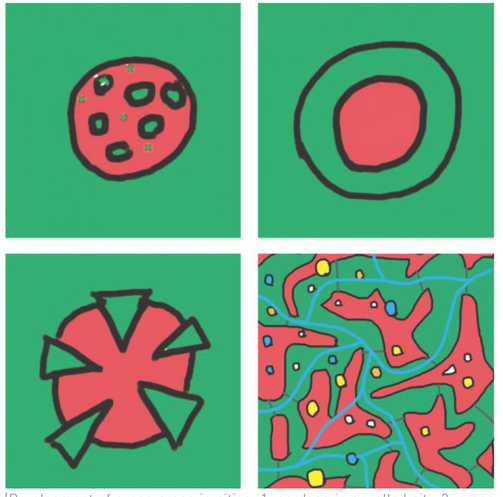
Urban ecology has become a focus in university towns in Germany and the Netherlands, producing significant research and data systems. However, despite these advances, urban planning still largely follows traditional principles focused on economic yield, and sustainable urban concepts have not yet been fully realized. Efforts like green roofs and low-traffic zones are often superficial.

More comprehensive pilot projects, such as Hammerby and EVA-Lanxmeer, show the potential for greater resident involvement and responsibility. The current era is marked by both increasing centralization and a push for greater local control. Urbanization continues to demand more space, leading to increased resource consumption and waste production.

Blue-green grids in urban planning can offer multifunctional green spaces for recreation, food production, nature development, water management, and urban cooling. However, increasing urban density threatens these spaces, necessitating efficient supply flows and a combination of central and decentralized structures.

Historically, urban expansion has consumed fertile agricultural land, separating food production from residential areas, a shift enabled by fossil fuels. In the Netherlands, the direct sale of agricultural products has only recently seen a resurgence through farmers' markets. The expansion of urban areas has reversed the traditional relationship between urban and rural landscapes, now making green zones crucial structuring elements in urban development.

Green spaces must provide structure to diverse urban developments, aid orientation, and offer identity, fulfilling the roles described in urban development theories and practices.



(Development of green areas in cities: 1. gardens in a walled city, 2. green ring, 3. green slabs, 4. greenblue grids - Source: atelier GROENBLAUW, accessed on May, 2024)

Brief retrospective on the function and structure of green urban areas.

Frank Lohrberg's dissertation "Stadtnahe Landwirtschaft" explores the relationship between green urban areas and agriculture. In response to 19th-century urbanization, green planning emerged, initially focusing on green spaces within districts and parks on city outskirts for recreation. Early 20th-century planning introduced connected green areas, like Vienna's green belt and Berlin's green radials, for urban ventilation and recreation, often incorporating meadows and fruit farms.

Visionary frontrunners

Visionaries like Arminius (Dohna Poninskas) in 1874 and urban planners such as Ebenezer Howard and Leberecht Migge in the early 20th century promoted green urban structures integrating agriculture and self-sufficiency. Howard's Garden City and Migge's Kolonialparken linked cities with productive green areas for food production and waste recycling.Despite these early models, post-World War II urban development largely neglected urban agriculture due to reliance on petroleum-based agriculture. In contemporary urban settings like the Randstad, urban agriculture exists, but disconnects between producers and consumers persist, and cycles of waste processing and production are minimal. Private gardens, though under-researched, play a significant role in biodiversity, heat mitigation, and water management. Encouraging green private gardens can increase citizen involvement and awareness of urban greenery's importance, as demonstrated by projects like EVA-Lanxmeer

The importance of green-blue grids in towns and cities

Many cities worldwide are increasing nature and water presence to enhance urban environments. Projects like London's 'Green Grids' highlight this trend, integrating green-blue grids that serve multiple functions: water storage, cooling, biomass production, biodiversity, food production, recreation, and providing safe routes for cyclists and pedestrians. These grids offer numerous benefits:

Climate Adaptation: Green surfaces absorb precipitation, reducing drainage needs.

Heat Alleviation: Vegetation and water bodies cool urban areas.

Improved Biodiversity: Cities provide habitats for diverse flora and fauna.

Food Production: Urban agriculture is growing in popularity.

Improved Air Quality: Vegetation absorbs pollutants.

Energy Production: Biomass and wastewater can generate energy.

Resource Recovery: Wastewater can provide valuable materials.

Quality of Life: Green spaces improve health, reduce stress, and boost property values.

Recreation and Mobility: Green-blue grids enhance recreational opportunities and encourage cycling and walking.

Community Participation: Involving residents in green space development fosters engagement and can reduce costs.

Overall, these initiatives make cities more sustainable, livable, and attractive for residents and businesses.(Hiltrud Pötz& Pierre Blueze, 2012)

Benifits Data of Green Infrastructure and Blue Infrastructure



1.Properties landscaped with trees sell quicker and are worth 5% to 15% more than homes without trees.
2.Trees properly places around buildings as windbreaks can save up to 25% on winter heating costs.
3. A single mature tree can absorb carbon at a rate of 21.6kg per year.



4.People are willing to pay 9% to 12% more for goods and services in a shopping area with large, well-cared for trees.
5.Increased canopy cover helps mitigate air pollution, with street trees reducing particulate matter connection by 15%-20%.
6.For every 10% increase in urban area canopy, carbon is reduced by 3-7%.



1.Evapotranspiration- trees 'breathe' water- a mature tree can use up to 200 litres per day, cleaning&cooling the air
2.Caculated correctly, stormwater exceedance flow is clean enough to go into watercourses, as the ArborFlow has dealt with first flush pollutants.
3.Potential attenuation space within specialist soil can store 22%-35% water by soil volume without effecting tree health.



4.For every 5% of tree canopy cover, stormwater runoff is reduced by 2%
5.ArborFlow SuDS can filter as much as 95% of pollutants, such as microplastics, hydrocarbons, metals etc from stormwater runoff.
6. Healthy urban trees are capable of holding huge amounts of water - up to 70% of the first hour of a rain event - on its canopy and branch structrue.

(Reference:GreenBlueUrban)

Sponge city

A sponge city is an urban development concept designed to manage and mitigate urban water issues, particularly stormwater runoff and flooding, by enhancing the city's ability to absorb, store, and reuse rainwater. The concept aims to address the environmental challenges associated with rapid urbanization, such as increased surface runoff, reduced groundwater recharge, and water pollution. Here are some key features and principles of sponge cities:

Permeable Surfaces: Use of permeable materials in pavements, roads, and sidewalks to allow water to infiltrate into the ground rather than running off into storm drains.

Green Infrastructure:Implementation of green roofs, rain gardens, green walls, and urban green spaces to increase the city's capacity to absorb and filter rainwater.

Retention and Detention Systems: Creation of ponds, wetlands, and swales to temporarily hold stormwater and slowly release it into the ground or drainage systems.

Rainwater Harvesting: Systems to collect and store rainwater for non-potable uses such as irrigation, reducing the demand on municipal water supplies.

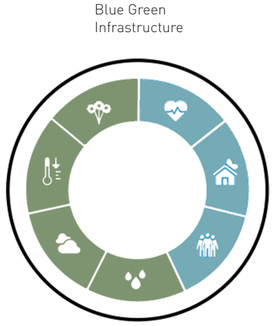
Revitalization of Natural Water Bodies: Restoration of rivers, lakes, and wetlands within urban areas to enhance their natural ability to manage floodwaters and improve biodiversity.
Principles of Sponge Cities

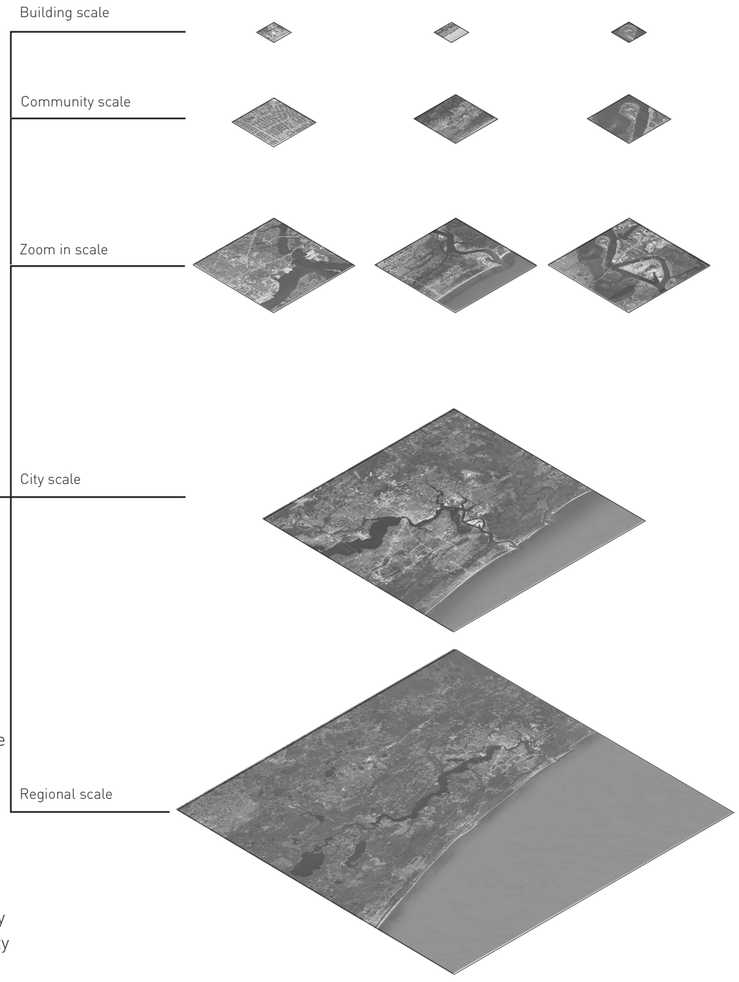
Sustainable Water Management: Emphasize the natural water cycle by promoting infiltration, natural purification, and storage of rainwater.

Integrated Urban Planning:Incorporate water management strategies into urban planning and development processes to create resilient and adaptable urban environments.

Integrating Blue-Green Infrastructure as Multi Scales Solution

Sub-Research Question1 : How blue-green infrastructure addresses existing urban issues at different scales, such as regional scale, city scale, area scale, community scale, and street scale, creating better blue-green structures, enhancing urban resilience, and transforming into sponge cities.

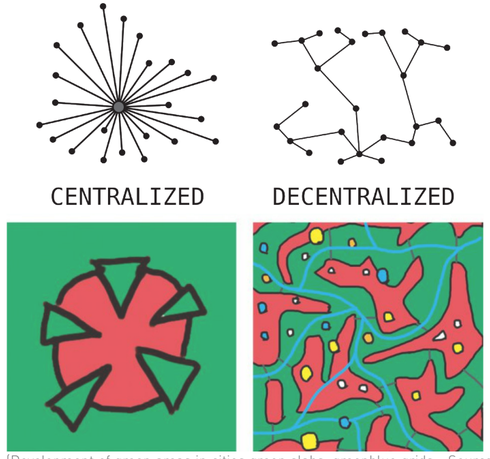




In this project, I discuss how blue-green infrastructure forms networks at different scales to address both environmental and social issues. The project is divided into five scales:
Regional Scale(XL Scale)Focuses on the lower basin of the St. Johns River
City Scale(L Scale)Jacksonville
Zoom-In Scale(M Scale)Zoom in1 area and zoom in 2 area
Community Scale(S Scale):Poor community
Building Scale(XS Scale): vacant community spaces

Addressing Community Segregation with Blue-Green Infrastructure through Centralized and Decentralized Approaches

Sub-Research Question 2: Generally, blue-green infrastructure has paid relatively less attention to social issues. How can we creatively focus on social issues and the people living here? For example, community segregation, spatial inequality, and the ever-widening wealth gap.



(Development of green areas in cities:green slabs, greenblue grids - Source: atelier GROENBLAUW, accessed on May, 2024)

The decentralized approach involves developing smaller, distributed green spaces like pocket parks, community gardens, and green roofs in various neighborhoods, ensuring equitable access to green areas and improving the quality of life across communities. Localized blue-green infrastructure solutions, such as rain gardens and permeable pavements, enhance resilience at the neighborhood level, making all communities more attractive and livable. Transforming streetscapes with green infrastructure creates visually appealing and functional public spaces that encourage movement and interaction within and between neighborhoods, thereby reducing physical and social barriers.

Addressing Comprehensive Water and Green Issues with Blue-Green Infrastructure

Sub-Research Question 3: How the new blue-green infrastructure addresses water crises and green issues such as water pollution, flooding, low-quality green spaces, and the irrational structure of urban green spaces.

New blue-green infrastructure (BGI) effectively tackles water crises and green issues through integrated solutions.

Water Pollution: BGI uses natural filtration systems like wetlands, rain gardens, and bioswales to clean stormwater runoff by absorbing and breaking down pollutants. Additionally, vegetated buffer zones along waterways capture contaminants from urban runoff, preventing them from entering larger water bodies.

Flooding: To manage stormwater, BGI incorporates permeable surfaces, green roofs, and retention basins that capture and slow down water, reducing urban flooding risk. Floodplain restoration and floodable parks also help absorb excess water during heavy rain events, protecting urban areas.

Low-Quality Green Spaces: BGI enhances underutilized or degraded green spaces by planting diverse vegetation, creating recreational areas, and integrating water management features. Urban greening initiatives like community gardens, green roofs, and street trees improve the quality and accessibility of green spaces, boosting biodiversity and providing social and health benefits.

5.2 LITERATURE REFERENCES

Groenblauwe Netwerken voor duurzame en Dynamische steden by Hiltrud Pötz and Pierre Bleuzé

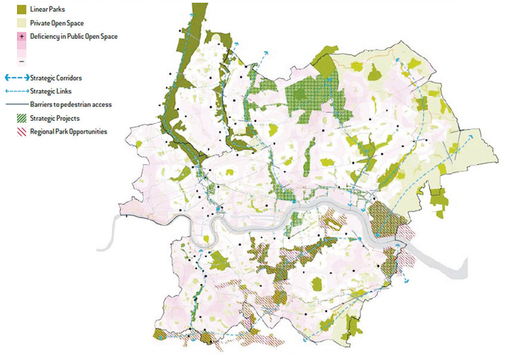
"Groenblauwe netwerken voor duurzame en dynamische steden" (Urban Green-Blue Grids for Sustainable and Dynamic Cities) by Hiltrud Pötz and Pierre Bleuzé is a comprehensive guide designed for anyone involved in urban planning and design, including professionals and private individuals. This 600-page book serves as a toolbox, inspiration source, and reference manual, focusing on the integration of green (vegetation) and blue (water) elements in urban environments to enhance sustainability and resilience.

The book addresses the challenges of urbanization and climate change by advocating for green-blue networks in cities, which help mitigate climate impacts and resource shortages. It covers a wide range of topics, including water management, heat reduction, biodiversity, urban agriculture, and energy production from biomass. The book also highlights the social and economic benefits of these networks, such as improved air quality, recreational opportunities, and increased property values.

Through numerous international case studies, such as the London Green Grid and projects in Singapore and the Netherlands, the book demonstrates the practical implementation of these principles. It is a visionary, practical, and inspiring resource for developers, urban designers, water engineers, and anyone interested in sustainable urban living.

The tool books and theoretical research in the book are of great guiding significance for this project.





How To Study Public Life by Jan Gehl & Svarre

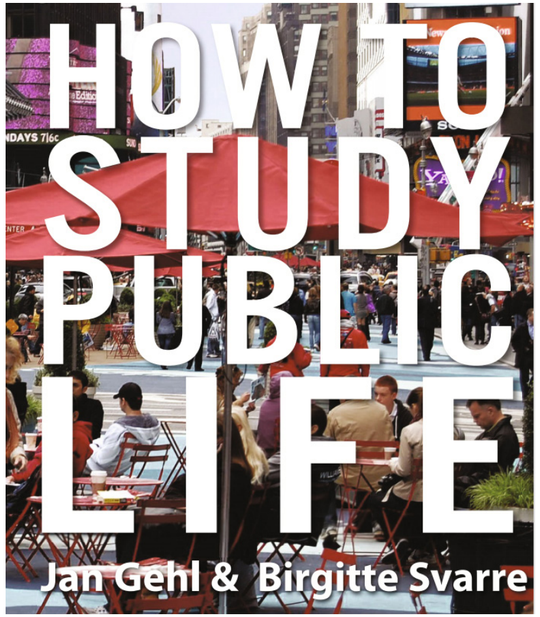
"How to Study Public Life" by Jan Gehl and Birgitte Svarre provides practical tools for urban planners, architects, and city officials to observe and enhance public spaces. The book highlights the importance of human-centric design in creating livable cities. It outlines methodologies such as counting, mapping, tracing, and tracking to gather data on how people use public spaces. Behavioral insights are also explored, focusing on stationary activities, optional activities, and social interactions to understand the attractiveness and functionality of urban areas.

The authors apply these insights using Gehl's twelve quality criteria for public spaces, emphasizing protection, comfort, and delight. Case studies from various cities demonstrate successful implementations of these principles. The book concludes with practical applications, including design interventions, influencing urban policies, and community engagement. It advocates for ongoing research and the use of empirical data to create vibrant, sustainable urban environments.

Jan Gehl's twelve quality criteria

These criteria are divided into three main categories: Protection, Comfort, and Delight.

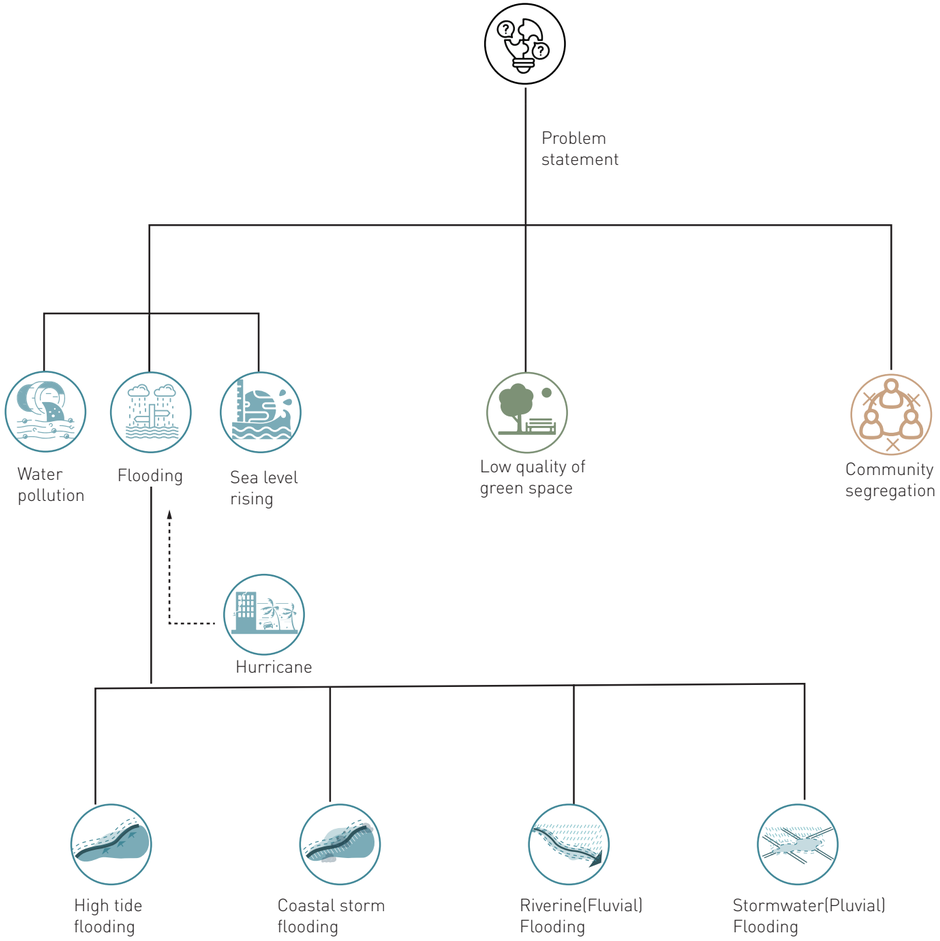
1.Protection against Traffic Accidents
2. Protection against Crime and Violence:
3. Protection against Unpleasant Sensory Experiences
4. Opportunities to Walk
5. Opportunities to Stand and Stay
6. Opportunities to Sit
7. Opportunities to See
8. Opportunities to Talk and Listen
9. Opportunities for Play and Exercise



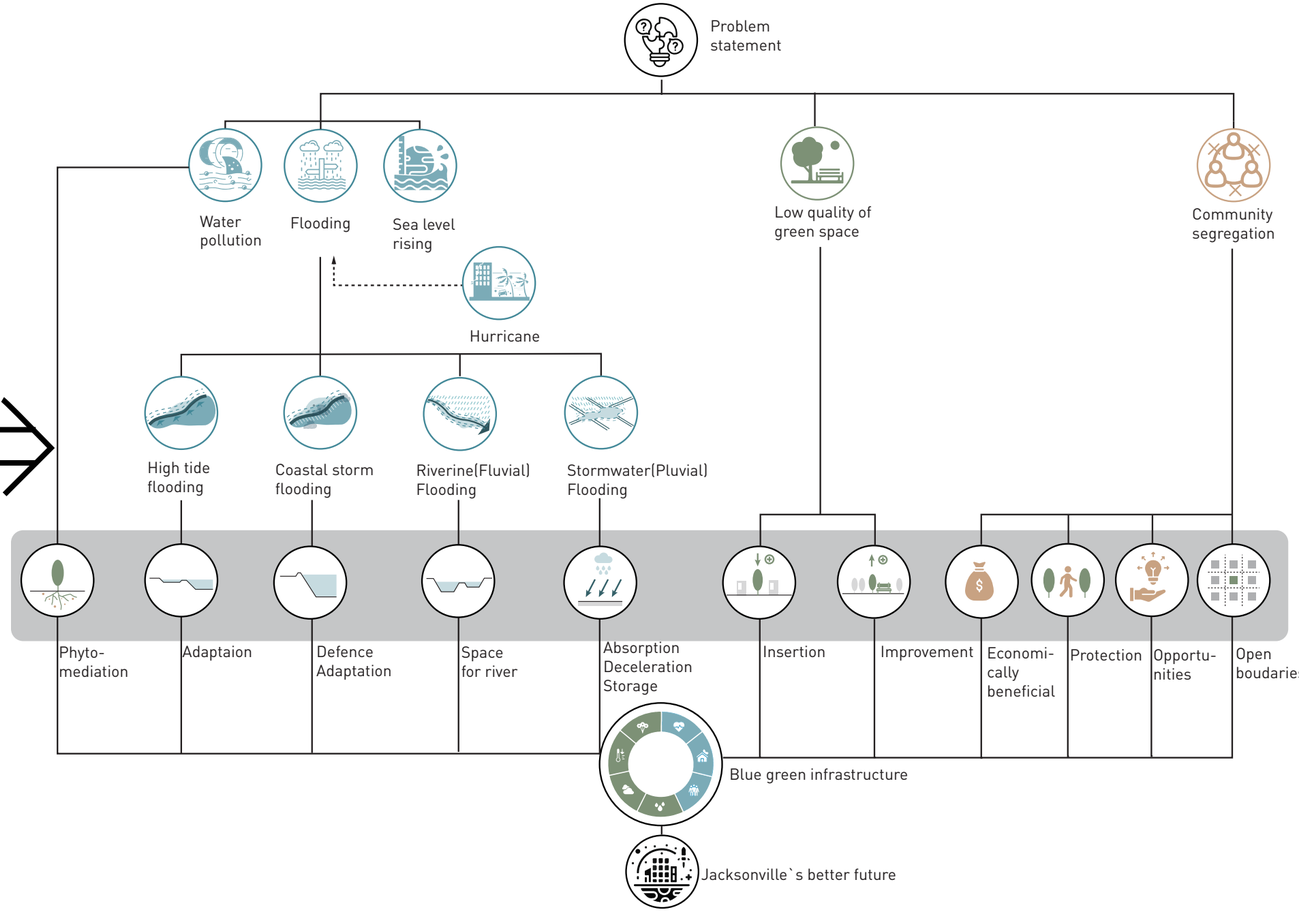
Protection	Against **traffic and accidents**	Against **harm** by others	Against **unpleasant sensory experiences**
Comfort	Options for **mobility**	Options to **stand and linger**	Options for **sitting**
	Options for **seeing**	Options for **talking and listening**	Options for **play**, exercise and activities
Enjoyment	Human **scale**	Positive aspects of **climate**	**Aesthetic qualities** and positive sensory experiences

5.3 OVERVIEW OF BLUE GREEN COMPONENTS

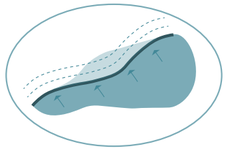
Problem statement



Blue Green Infrastructure as Sollution



Overview of Blue-Green Components



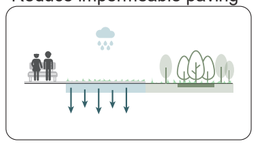
Stormwater(Pluvial) Flooding

Stormwater management first aims to maximize infiltration at the source to replenish groundwater. The second step is to slow down surface runoff to prevent flooding. Finally, increase the capacity for collecting rainwater.

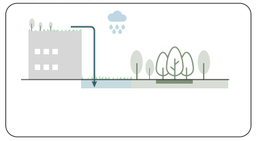
Absorption of rain water



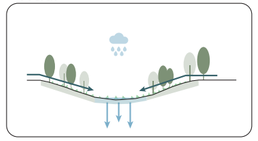
Reduce impermeable paving



Green Roof



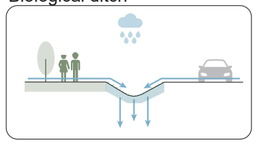
Wadi



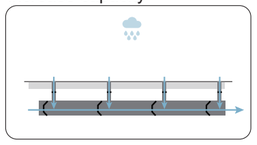
Deceleration of Runoff



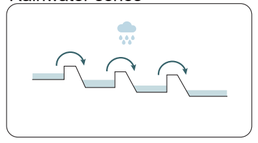
Biological ditch



Pipeline water storage to increase capacity



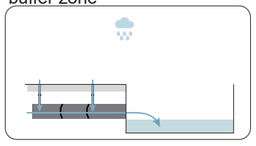
Rainwater series



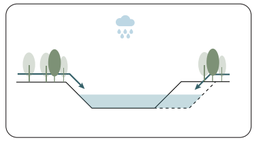
Storage of storm water



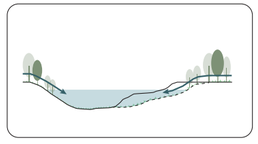
Underground stormwater buffer zone

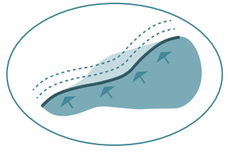


Add surface water storage



Widen river





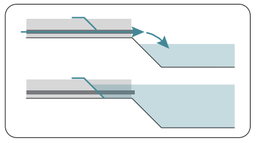
High tide flooding

Blue-green infrastructure (BGI) helps mitigate high tide flooding through:Coastal Wetlands and Mangroves: Absorb wave energy and trap sediments to protect shorelines.Living Shorelines: Use natural materials to stabilize coasts and reduce erosion.

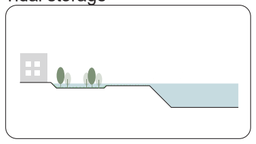
Adaptaion



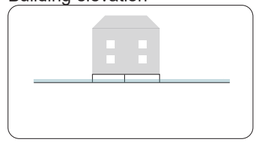
Tidal valve

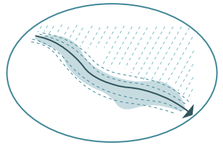


Tidal storage



Building elevation





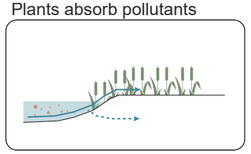
Riverine(Fluvial) Flooding

Blue-green infrastructure (BGI) helps manage riverine flooding by:Floodplain Restoration: Restores natural floodplains to absorb excess water. Riparian Buffers: Vegetated areas along rivers that slow runoff and filter pollutants. Wetlands: Absorb floodwaters and release them slowly, reducing peak flow. And the private Pier next to the river becomes a floating pier and float agriculture, such as rice, is planted.

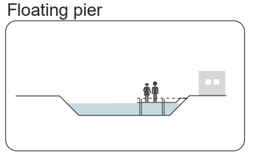
Adaptive sollution



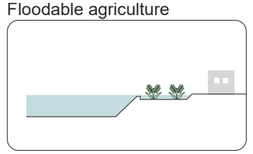
Plants absorb pollutants



Floating pier



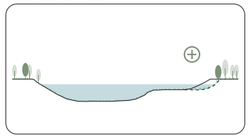
Floodable agriculture



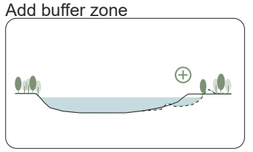
More space for river



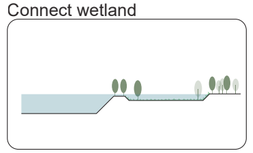
Widen creek

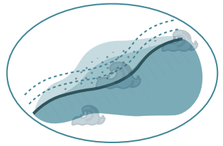


Add buffer zone



Connect wetland





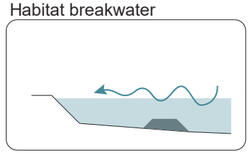
Coastal storm flooding

Blue-green infrastructure (BGI) mitigates storm surge impacts by: Coastal Wetlands and Mangroves: Absorbing wave energy, reducing surge height and velocity. Living Shorelines: Using natural materials to stabilize coasts and buffer against storm surges. Urban Green Spaces: Parks and green areas that absorb excess water from surges. Relocating Coastal Residents: Moving residents from vulnerable coastal areas to higher ground to reduce risk.

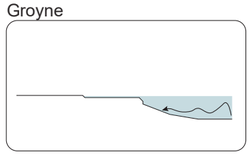
Defence



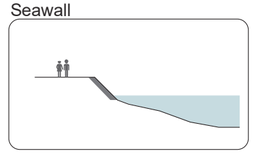
Habitat breakwater



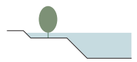
Groyne



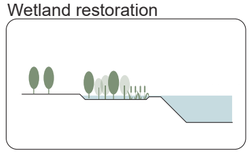
Seawall



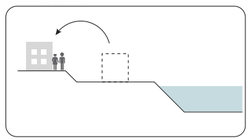
Adaptation



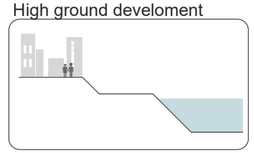
Wetland restoration



Relocation



High ground develoment





Water pollution

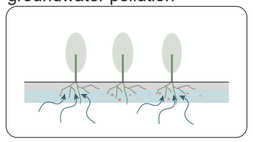
Blue-green infrastructure utilizes natural features such as wetlands and green spaces to sustainably manage water in urban areas. It includes methods like planting deep-rooted trees and using floating wetlands to absorb pollutants, as well as employing plants for phytostabilization.

Phytomediation

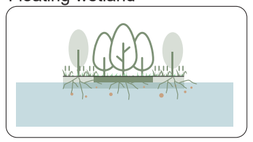
Absorption



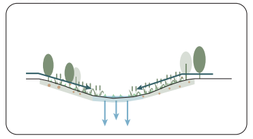
Deep-rooted trees absorb groundwater pollution



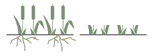
Floating wetland



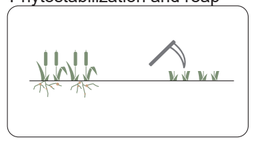
Wadi



Phytostabilization



Phytostabilization and reap





Green infrastructure

Blue-green infrastructure improves urban quality by cleaning the air, reducing heat, managing water, supporting wildlife, and enhancing well-being through green spaces. It achieves this by integrating greenery, vertical greening, improving green quality, enhancing park quality, creating green alleys, and implementing low impact development.

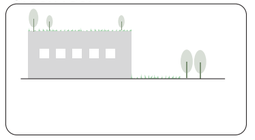
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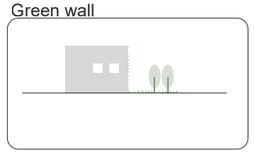
Improvement



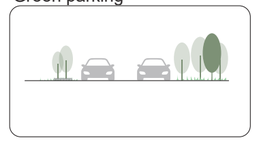
Green roof



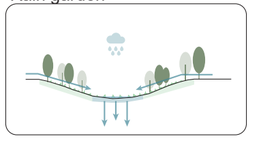
Green wall



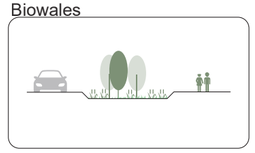
Green parking



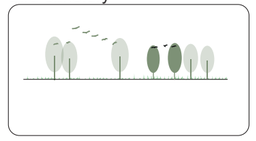
Rain garden



Biowales



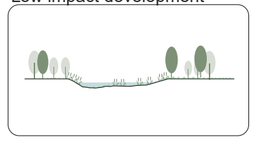
Bird sanctury



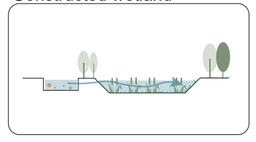
Park



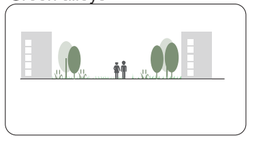
Low impact development



Constructed wetland



Green alleys

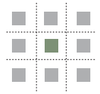




Community segregation

Blue-green infrastructure breaks community segregation by eliminating boundaries, improving community accessibility, and maximizing the use of community spaces. It also contributes to the economy by reducing wealth disparity. Green spaces in communities prioritize residents' protection and provide opportunities for walking, standing, sitting, and communicating.

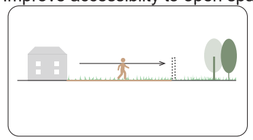
Open boundaries



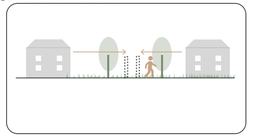
Increase public green space



Improve accessiblity to open space



Remove fences



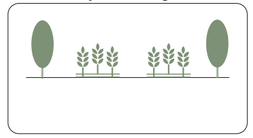
Economically beneficial



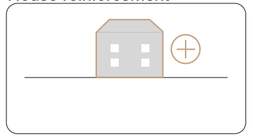
Community market



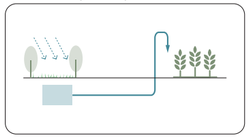
Community urban agrihood



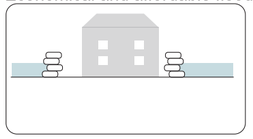
House reinforcement



Water recycle system



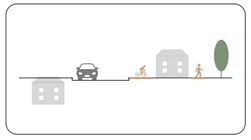
Economical and affordable flood control



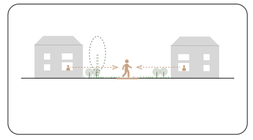
Protection



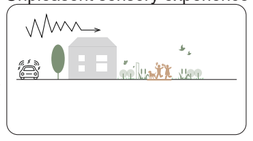
Protection against
Traffic Accidents



Protection against
Crime violence



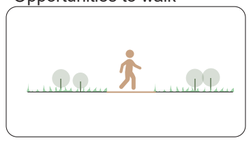
Protection against
Unpleasent sensory experience



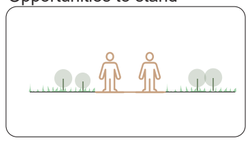
Opportunities



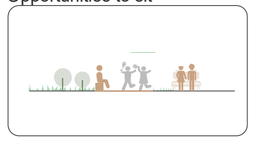
Opportunities to walk



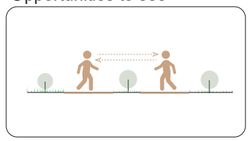
Opportunities to stand



Opportunities to sit



Opportunities to see



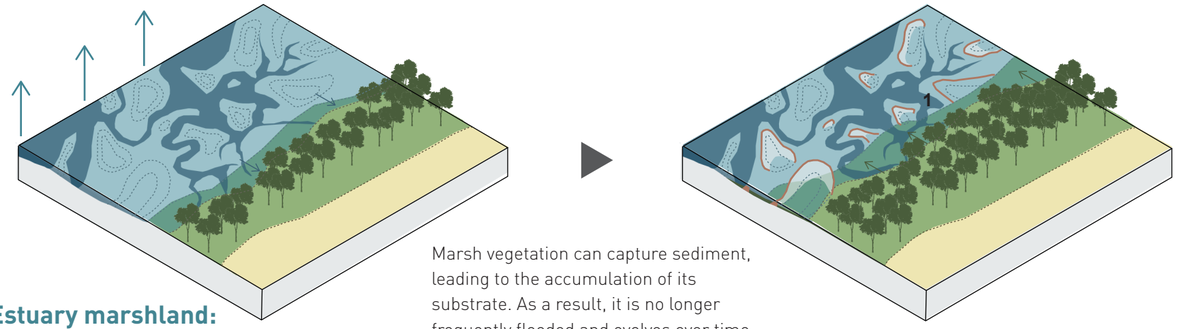
Opportunities to talk and listen



Opportunities for Play and Exercise



5.4 COMBINATION AND LOCALIZED APPLICATION OF BLUE GREEN COMPONENTS



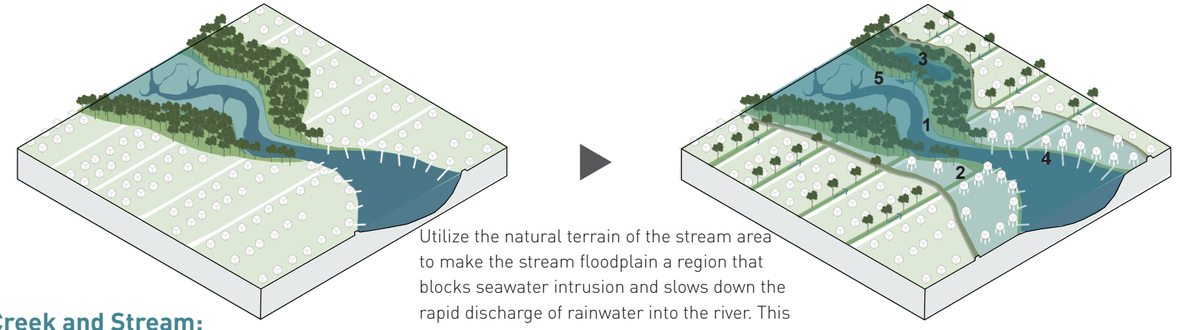
Estuary marshland: Marshland Protection and Natural Sediment Collection.

Marsh vegetation can capture sediment, leading to the accumulation of its substrate. As a result, it is no longer frequently flooded and evolves over time. Work with sedimentation to develop local habitats and enlarge the coastal buffer zone seaward.



Coastal Community: Protect the Coastline and Communities.

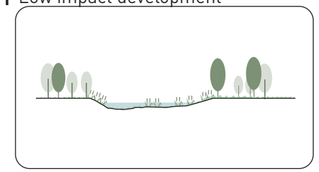
Relocate the residential areas of repeatedly endangered coastal communities (part of the Sea Islands in the United States) to safe areas, allowing the coastline to return to nature.



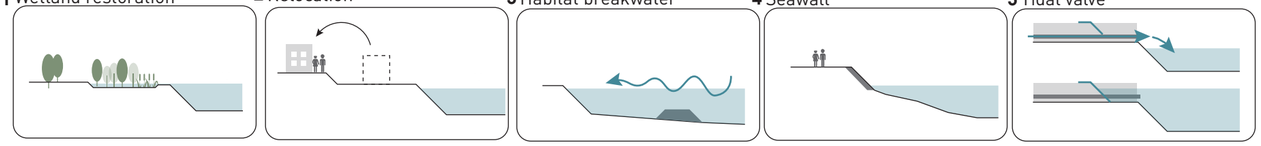
Creek and Stream: Being Creek Floodplain.

Utilize the natural terrain of the stream area to make the stream floodplain a region that blocks seawater intrusion and slows down the rapid discharge of rainwater into the river. This area will serve as a buffer zone where nature extends into the city.

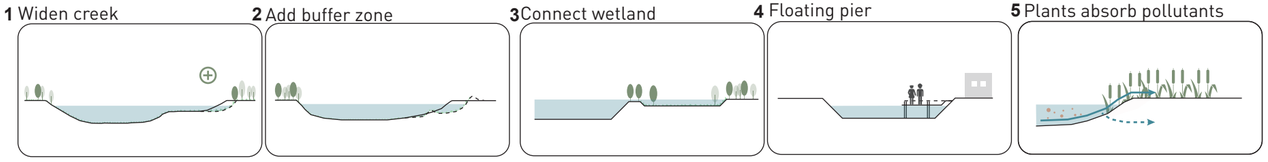
1 Low impact development

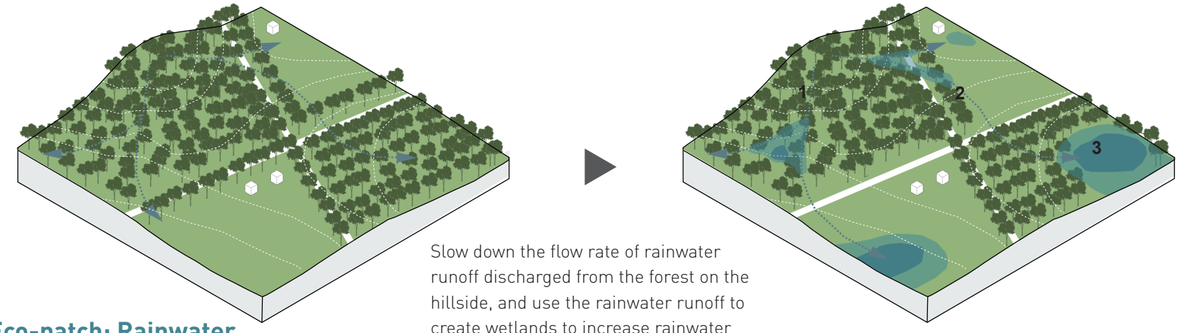


1 Wetland restoration **2** Relocation **3** Habitat breakwater **4** Seawall **5** Tidal valve



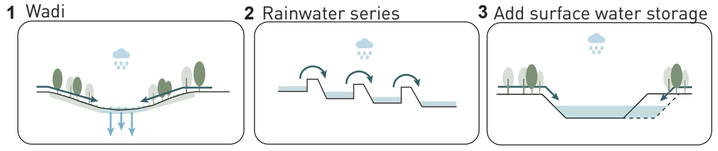
1 Widen creek **2** Add buffer zone **3** Connect wetland **4** Floating pier **5** Plants absorb pollutants

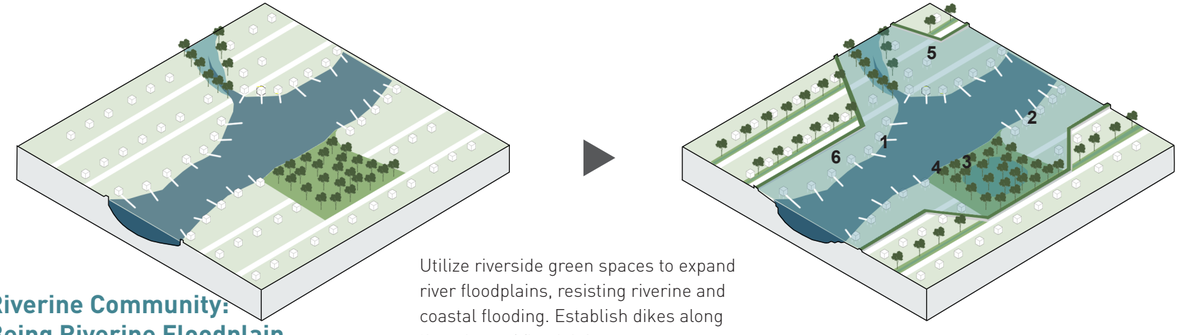




Eco-patch: Rainwater Mitigation and Collection in Forest Areas

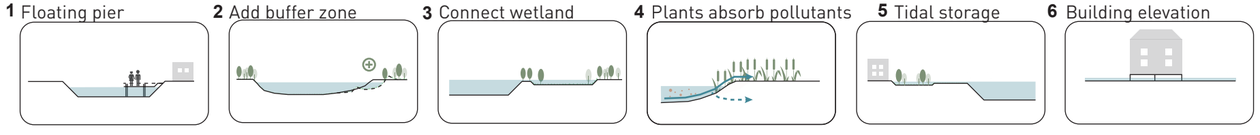
Slow down the flow rate of rainwater runoff discharged from the forest on the hillside, and use the rainwater runoff to create wetlands to increase rainwater storage capacity.

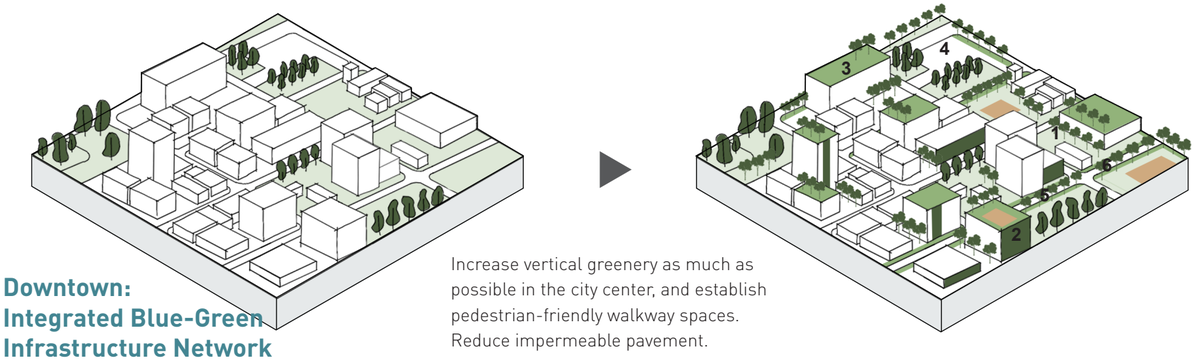




Riverine Community: Being Riverine Floodplain

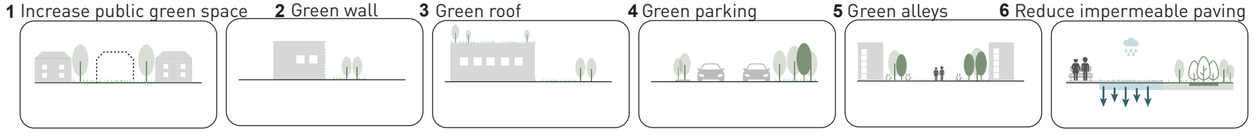
Utilize riverside green spaces to expand river floodplains, resisting riverine and coastal flooding. Establish dikes along the edges of floodplains.

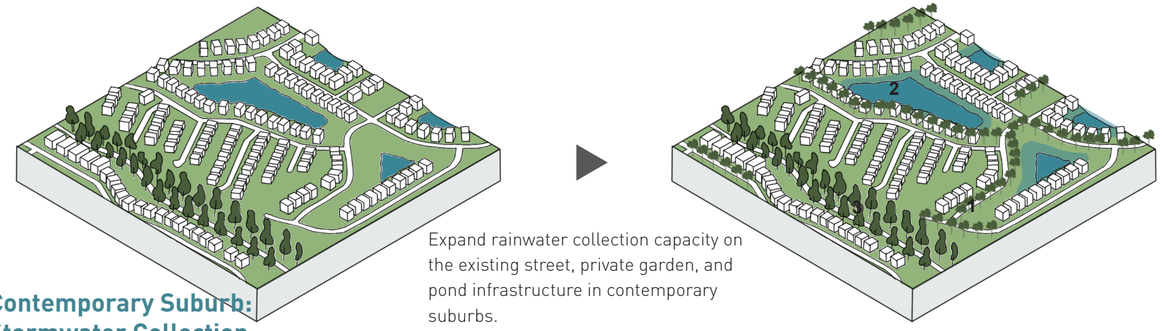




Downtown: Integrated Blue-Green Infrastructure Network

Increase vertical greenery as much as possible in the city center, and establish pedestrian-friendly walkway spaces. Reduce impermeable pavement.

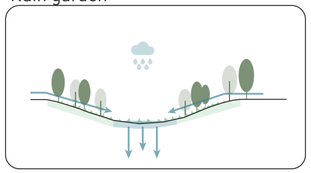




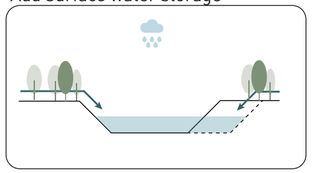
Contemporary Suburb: Stormwater Collection

Expand rainwater collection capacity on the existing street, private garden, and pond infrastructure in contemporary suburbs.

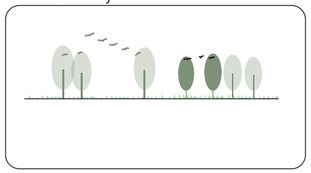
1 Rain garden

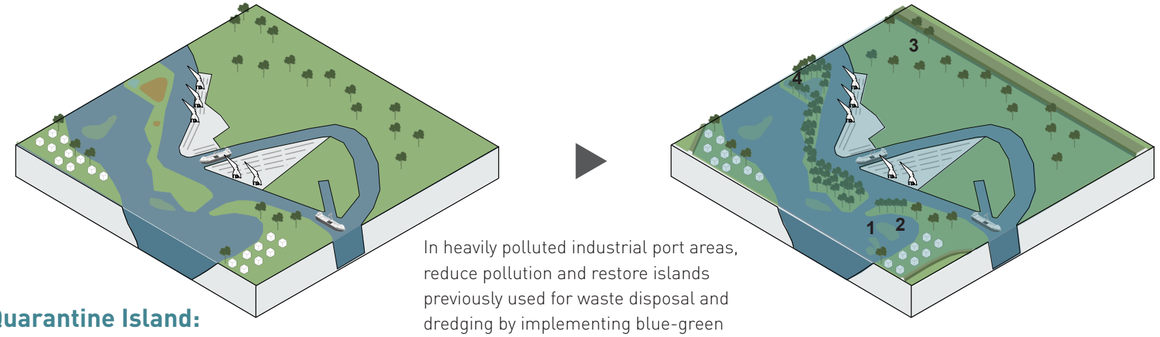


2 Add surface water storage



3 Bird sanctury

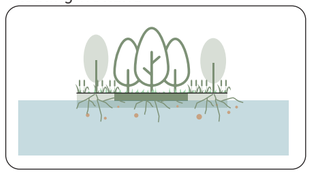




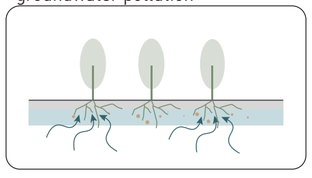
Quarantine Island: Restoration of Port and Dredging Areas to Nature

In heavily polluted industrial port areas, reduce pollution and restore islands previously used for waste disposal and dredging by implementing blue-green infrastructure.

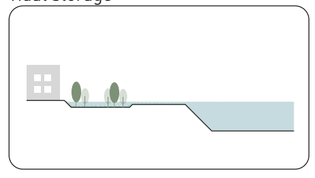
1 Floating wetland



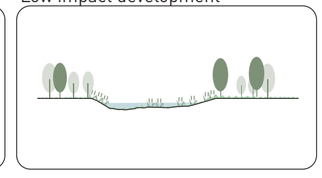
2 Deep-rooted trees absorb groundwater pollution



3 Tidal storage



4 Low impact development

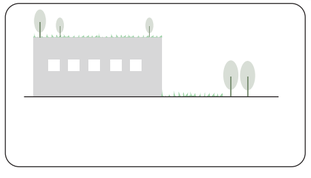




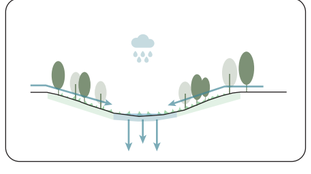
Historical walkable neighborhood and post-war suburb: Centralized and Integrated Green and Pocket park

In traditional grid neighborhoods, incorporating blue-green infrastructure along with spaces for human activity and rain gardens can achieve water recycling.

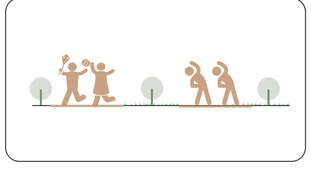
1 Green roof



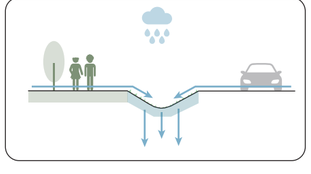
2 Rain garden



3 Opportunities for Play and Exercise



4 Biological ditch



5.5 WATER FLOW INDICATION

Stormwater Flow: Inland to Outland

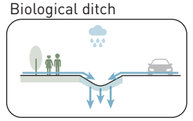


Stormwater Origins: Slowing Flow from the Community Source

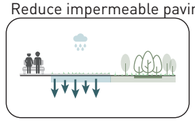


Stormwater Origins: Slowing Flow from the Donwtown Source

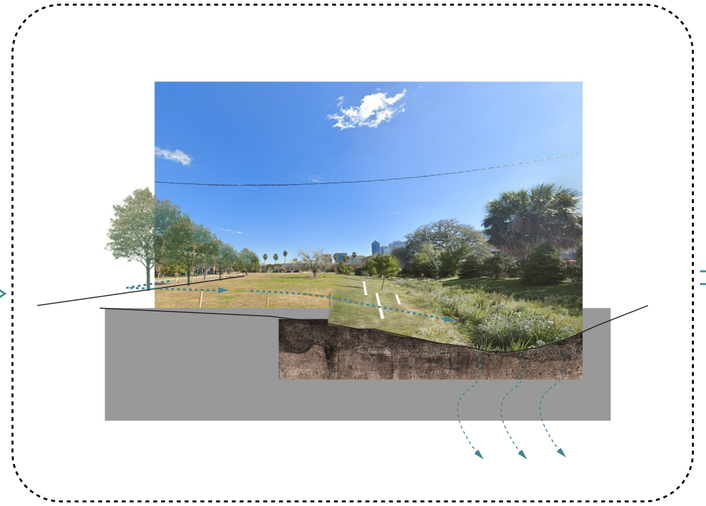
Biological ditch



Reduce impermeable paving



When there is a high volume of rainfall in a short period, the rainwater quickly flows from rooftops and accumulates on the streets. However, streets are usually paved with materials that have poor permeability. Therefore, it is very important to slow down the flow of rainwater. Generally, this is achieved by constructing green roofs, which allow rainwater to fall slowly, improving the permeability of the pavement, increasing the capacity of the city's drainage pipes, and using ecological swales to slowly drain surface water.



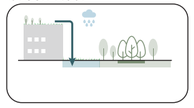
Stormwater Midst: Harvesting Rainwater in Open Spaces

Wadi

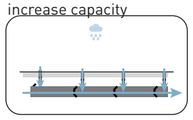


Building rainwater collection gardens in public green spaces not only meets the practical needs of stormwater management but also provides recreational areas for people, enhancing the interaction between people and water.

Green Roof



Pipeline water storage to increase capacity



Rainwater series

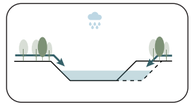


Rainwater series :Rainwater Harvesting Systems and Rainwater Management Practices (BMPs) These systems capture, filter, store, and utilize rainwater for various purposes.
Best Management Practices (BMPs) designed to manage rainwater sustainably. These practices aim to reduce runoff, improve water quality, and enhance groundwater recharge.



Final Stage of Stormwater: Decelerating in the Creek

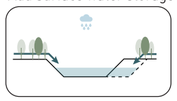
Add surface water storage



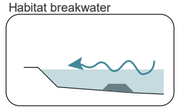
Stream areas are generally the final step for rainwater entering rivers. Establishing rainwater slowing and collection zones here, adding surface water storage, and improving accessibility can create areas for people to visit, play, and interact. This can showcase different landscapes during the rainy and dry seasons.

Tidal water coming from sea

Add surface water storage



Habitat breakwater





High tides can lead to coastal flooding, Preparation includes monitoring tide forecasts, securing waterfront property, and following local flood advisories,buiding breakwater.

Storm surge coming

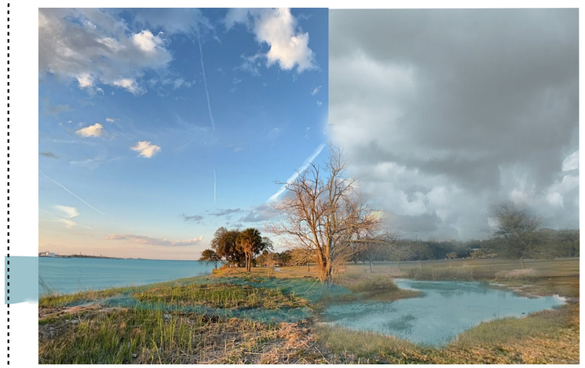


A storm surge is a rise in sea level caused by a storm, typically a hurricane or cyclone. It can lead to severe coastal flooding, causing damage to property and posing risks to lives. Preparation involves evacuating vulnerable areas, securing property, and following local emergency guidelines.

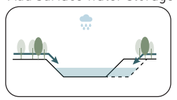
Floodplain along the creek



Floodplain along the river



Add surface water storage

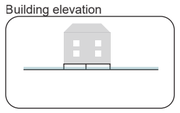


Tidal Seawater or riverwater Flow: Outland to Inland

High tides can lead to coastal flooding, Preparation includes monitoring tide forecasts, securing waterfront property, and following local flood advisories,buiding breakwater.

Final Dike protection land and water storage house

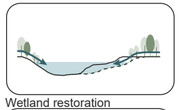
Building elevation



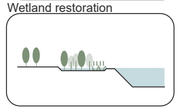


Final dike protection involves building structures like dikes (embankments) to shield land and water storage houses from flooding. These measures aim to prevent water from overflowing and causing damage, ensuring safety for both property and stored resources.

Widen river



Wetland restoration



A floodplain along a river is a flat area that can flood during heavy rains or snowmelt. It helps manage excess water, supports diverse ecosystems, and prevents downstream flooding. Preserving these areas reduces flood risk and protects habitats.

PART Ⅳ

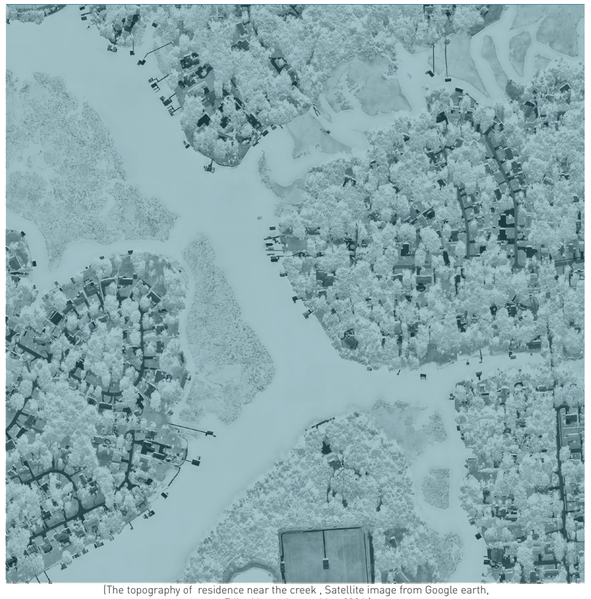
A Promising Future: Vision Through Blue-Green Infrastructure

Part Ⅳ
[A Promising Future:
Vision Through Blue-Green Infrastructure]

06 TOMORROW
6.1Regional vision
6.2 City vision

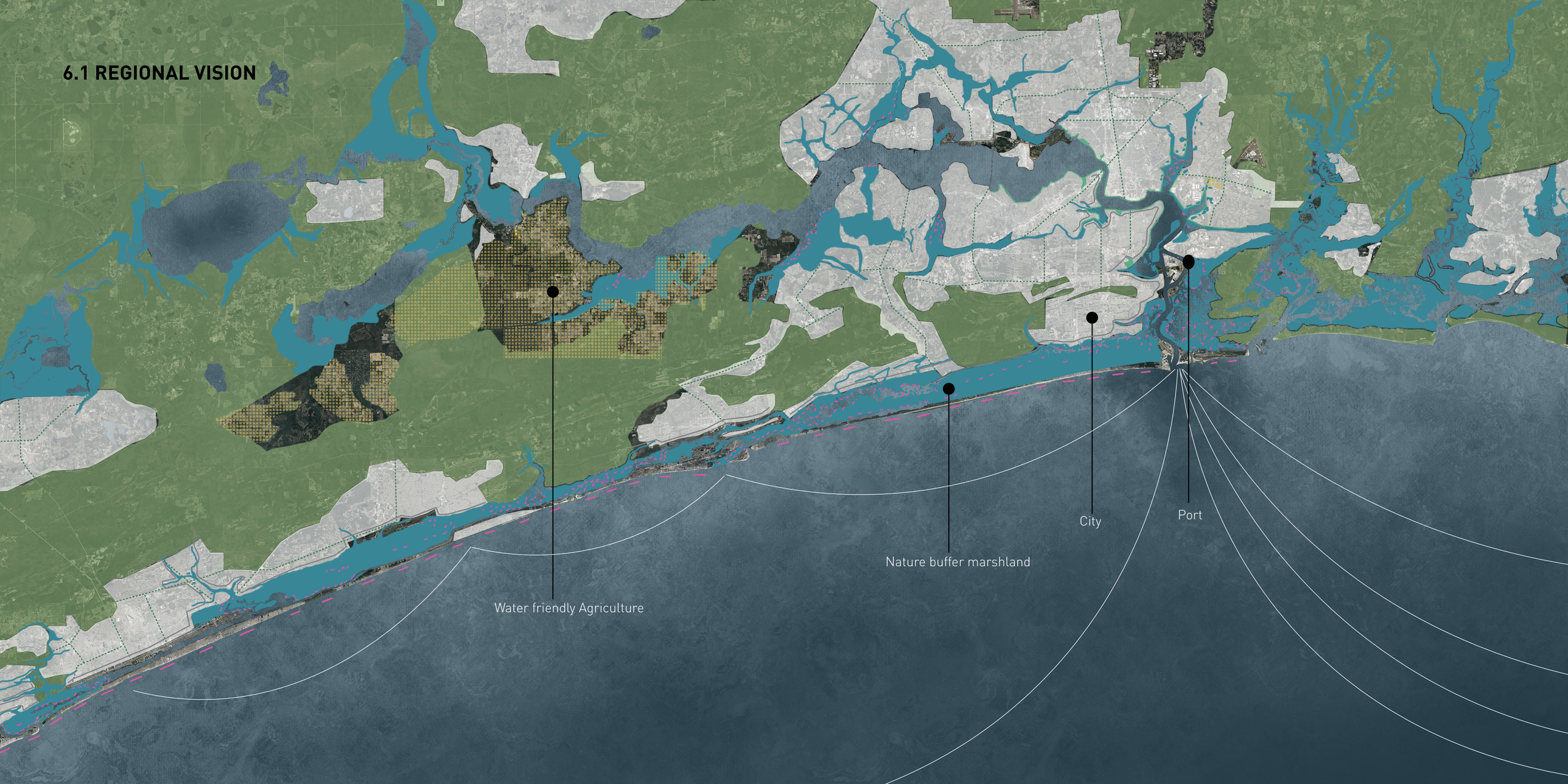
06 TOMMORROW

The previously mentioned topography toolbox is applied at the regional scale and city scale, forming a new vision. It also illustrates the water cycle in the city section.



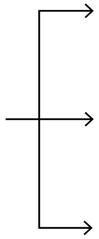
(The topography of residence near the creek , Satellite image from Google earth,
Edited by author on May, 2024,)

6.1 REGIONAL VISION



Transformation from the original blue-green structure to the new blue-green infrastructure network in lower basin of St Johns river







Contemporary Suburb:
Stormwater Collection

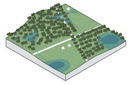


Historical walkable neighborhood and post-war suburb: Centralized and Integrated Green



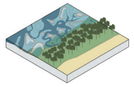
Downtown:
Integrated Blue-Green Infrastructure Network and Pocket park





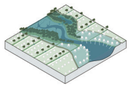
Eco-patch: Rainwater Mitigation and Collection in Forest Areas



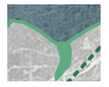


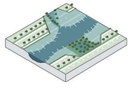
Estuary marshland:
Marshland Protection and Natural Sediment Collection.





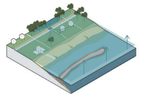
Creek and Stream:
Being Creek Floodplain.





Riverine Community:
Being Riverine Floodplain





Coastal Community:
Protect the Coastline and Communities.



Water friendly agriculture

Natural Dike

Green corridor

Regional vision

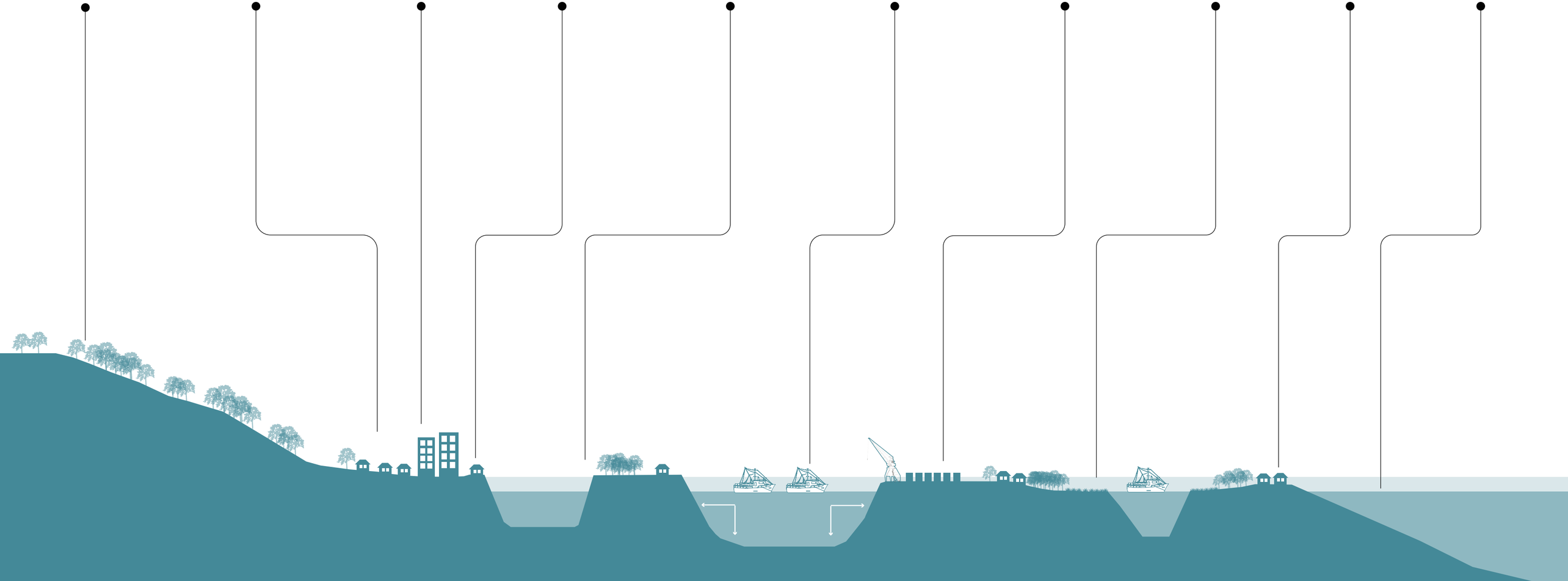
The region appears complex in terms of terrain and land use. Therefore, a typological toolbox is needed to determine the appropriate strategies to connect all areas. For urban areas, which are mostly residential, it is essential to implement stormwater collection and incorporate greenery, including vertical greening.

In forest areas, focus on rainwater mitigation and collection. In estuary marshland areas, prioritize marshland protection and natural sediment collection. For creek and stream areas, construct creek floodplains. In riverine community areas, establish riverine floodplains. In agricultural areas along the river, cultivate rice to create floodable agriculture.

Throughout the region, establish natural dikes to protect the land and create green corridors to connect ecological patches.

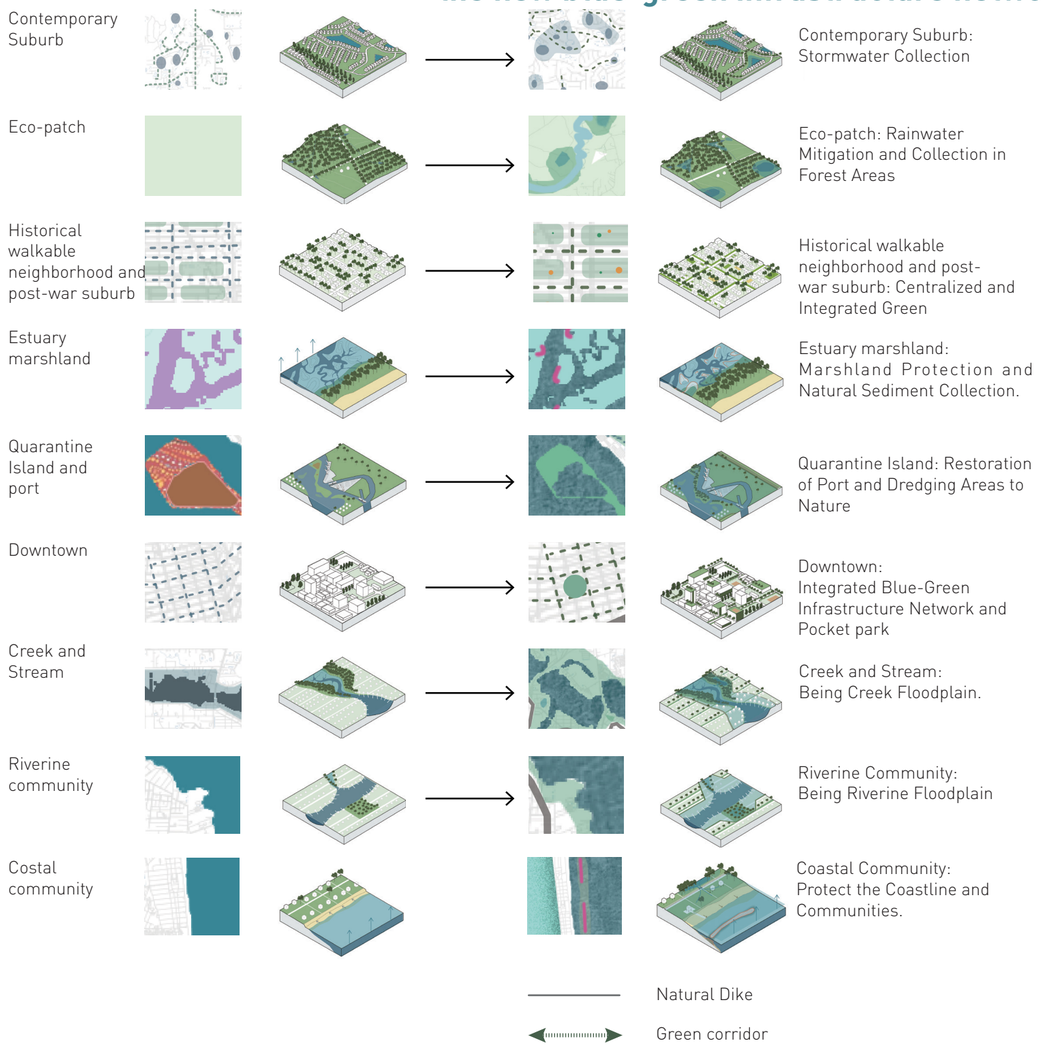
City scale: The Diverse Terrain of Jacksonville

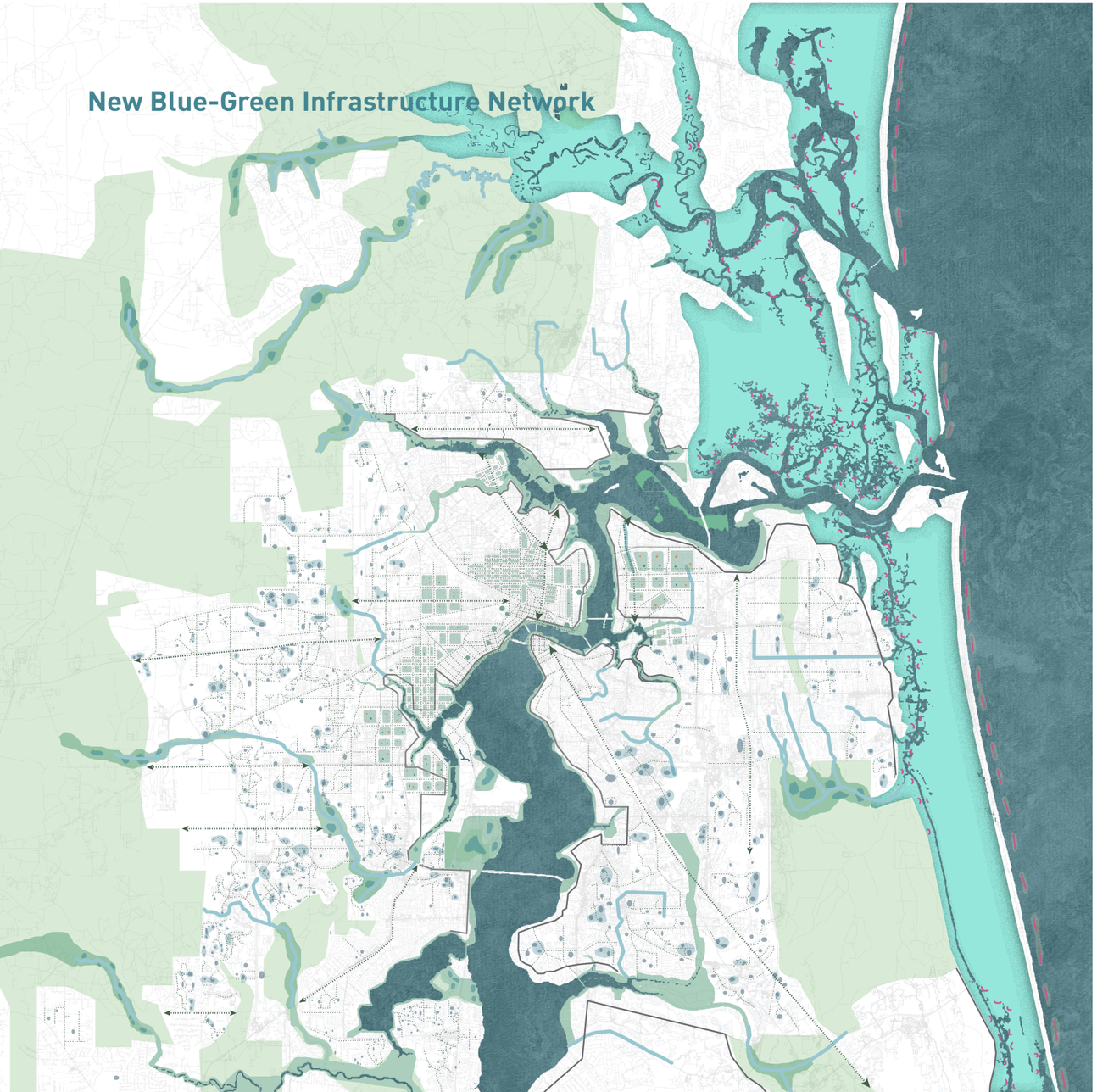




Original Blue Green Structure of Jacksonville

Transformation from the original blue-green structure to the new blue-green infrastructure network



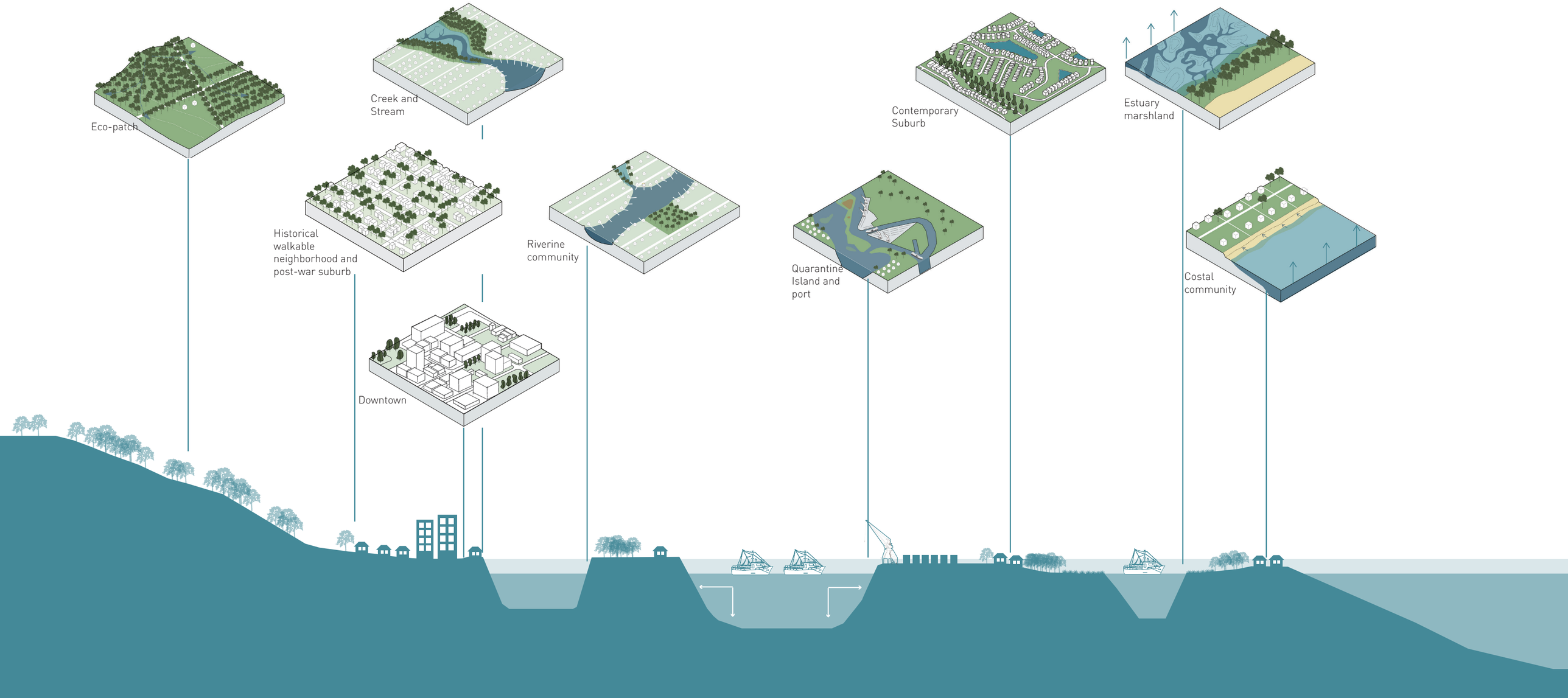


6.3 CITY VISION

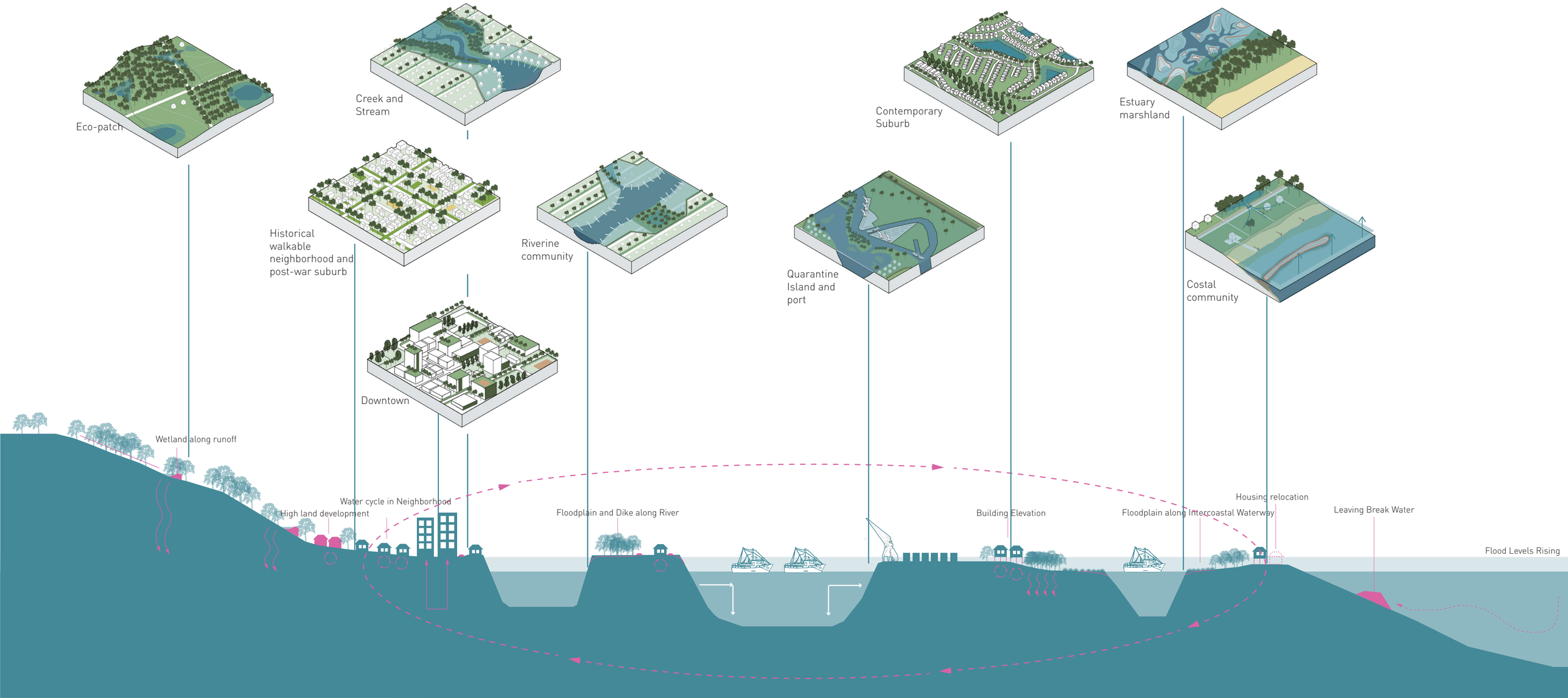
The city's new blue-green infrastructure network is built upon the existing blue-green structures. In the extensive river mouth marshlands, marshland and sediment protection are implemented to create a natural buffer zone for the city. Wetland extensions along streams and waterways help slow down rainwater flow. The urban area also features a distinctive network.

In historical walkable neighborhoods, community green spaces are established on the original foundations. In contemporary neighborhoods, rainwater storage areas are increased. In forest areas, rainwater buffering and infiltration are prioritized. In coastal neighborhoods, coastal protection and relocation efforts are made. Additionally, soft riverbanks are established to serve as green buffer edges, and a dike system is constructed to ensure the city's safety.

Before Intervention



After Intervention



PART Ⅴ

Area-Specific Adaptive Design based on Blue-Green Infrastructure

Part Ⅴ
Area-Specific Adaptive Design based on Blue-Green Infrastructure

07 ADAPTIVE DESIGN 1
Typical Areas of Jacksonville: Addressing Community Segregation with Blue-Green Infrastructure
7.1Existing condition
7.2 Challenge
7.3 New plan of Zoom in 1
7.4 New plan of community
7.5 Detailed desgin

08 ADAPTIVE DESIGN2
7.1Existing condition
7.2Challenge
7.3New plan of coastal communithy

07 ADAPTIVE DESIGN

Typical Areas of Jacksonville: Addressing Community Segregation with Blue-Green Infrastructure

At the zoom-in scale, a typical walkable historical area combines three typical topography toolboxes: creek, historical walkable neighborhood, and riverine residence. An analysis is conducted, and based on the new vision at the city scale, a zoom-in vision is formed. Detailed design is then carried out at the community scale.



(The topography of Irrigation Agriculture, Satellite image from Google earth, Edited by author on May, 2024.)

Regional scale

St Johns river
Lowerbasin

Local scale

Jacksonville,FL



Zoom in

Historical Walkable Neighborhoods

Sub-Research Question 2

How can blue-green infrastructure creatively focus on social issues and the people living in urban areas? For example, how can it address community segregation, spatial inequality, and the ever-widening wealth gap?

Sub-Research Question 3

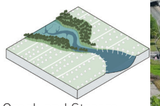
How does the new blue-green infrastructure address water crises and green issues such as water pollution, flooding, low-quality green spaces, and the irrational structure of urban green spaces?



7.1 EXISTING CONDITION

This area is located on the north side of the downtown region and is the turning point of the river. Here, a stream joins the river, but the prime riverbank area is occupied by industrial zones and private residences. The stream here seems stagnant, inaccessible, neglected, and obstructed.

The houses here are mostly in a historical, walkable neighborhood arranged in a grid pattern. The excessive grid layout results in a lack of large green spaces, leaving residents without access to big public parks, which leads to a loss of community cohesion.



Creek and Stream



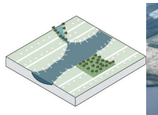
(Moncrief Creek, accessed on May 2024)



Historical walkable neighborhood and post-war suburb



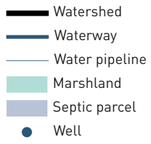
(Brentwood, accessed on May 2024)

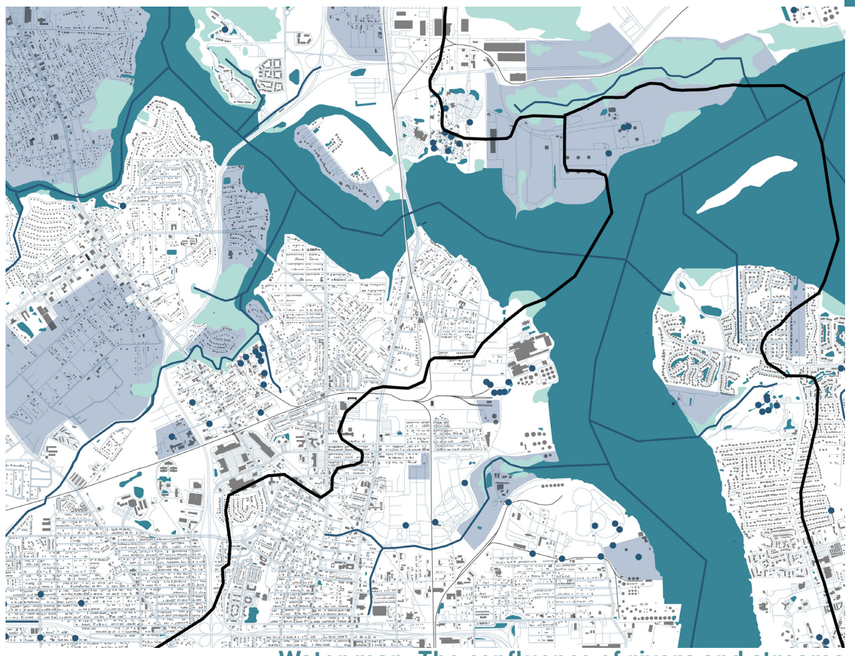


Riverine community



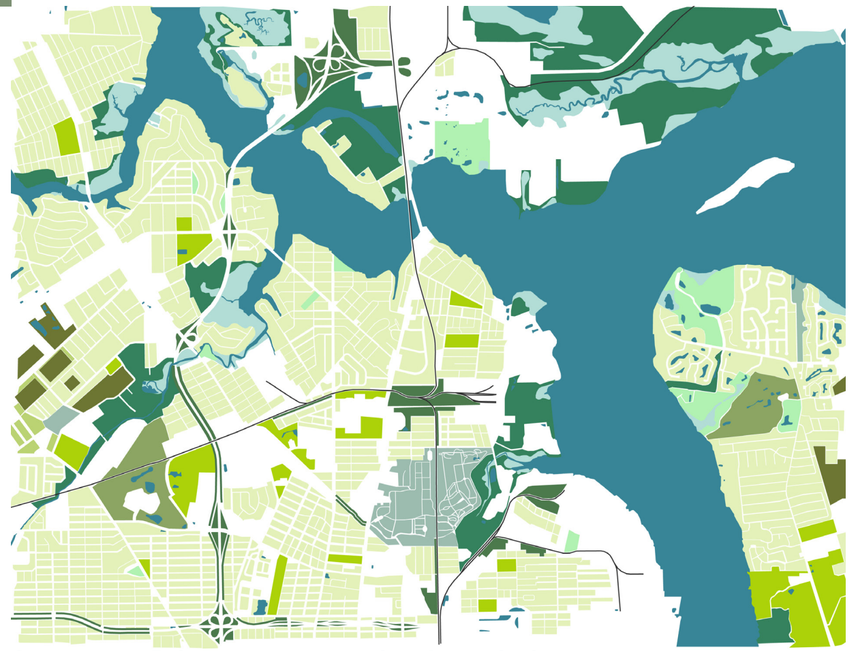
(Panama Park, accessed on May 2024)



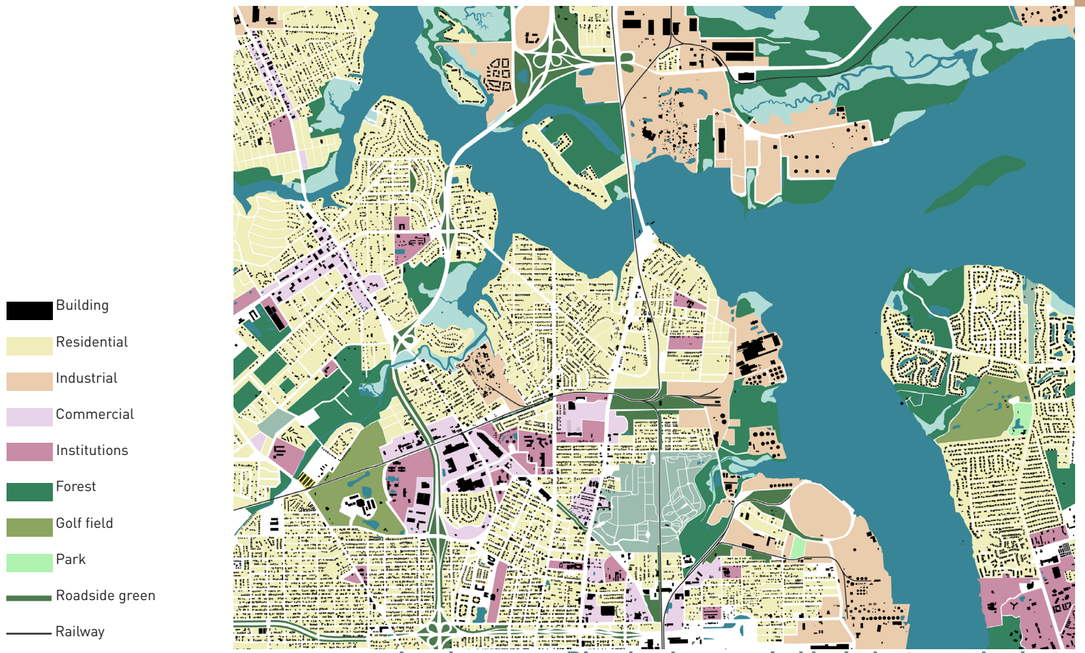


Water map: The confluence of rivers and streams

The black lines represent bodies of water, while the blue lines indicate the direction of stormwater runoff. This runoff flows from the higher areas of the residential neighborhood, following the elevation gradient into the stream and eventually merging into the St. Johns River. The diagram shows that marshland is always distributed alongside the stream, serving as a natural buffer zone. Water wells are distributed within the residential area, providing daily water usage. Some areas use septic parcels for sewage treatment, while most areas rely on traditional pipeline transport, which puts significant pressure on the pipelines during heavy rain. Although this area is relatively inland, the river here is influenced by sea tides, with water level differences of about 0.7 meters.



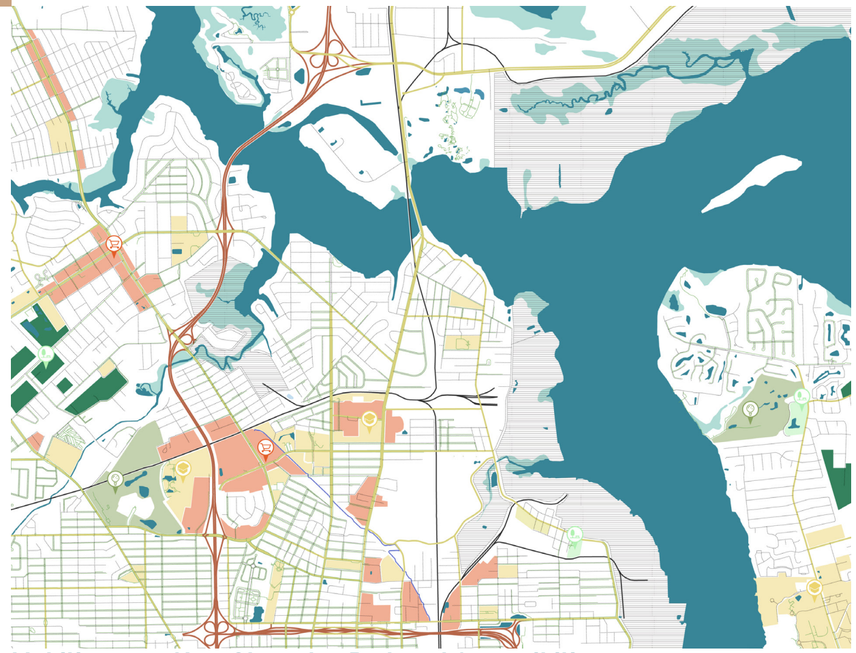
Green map: Private green occupies the majority.



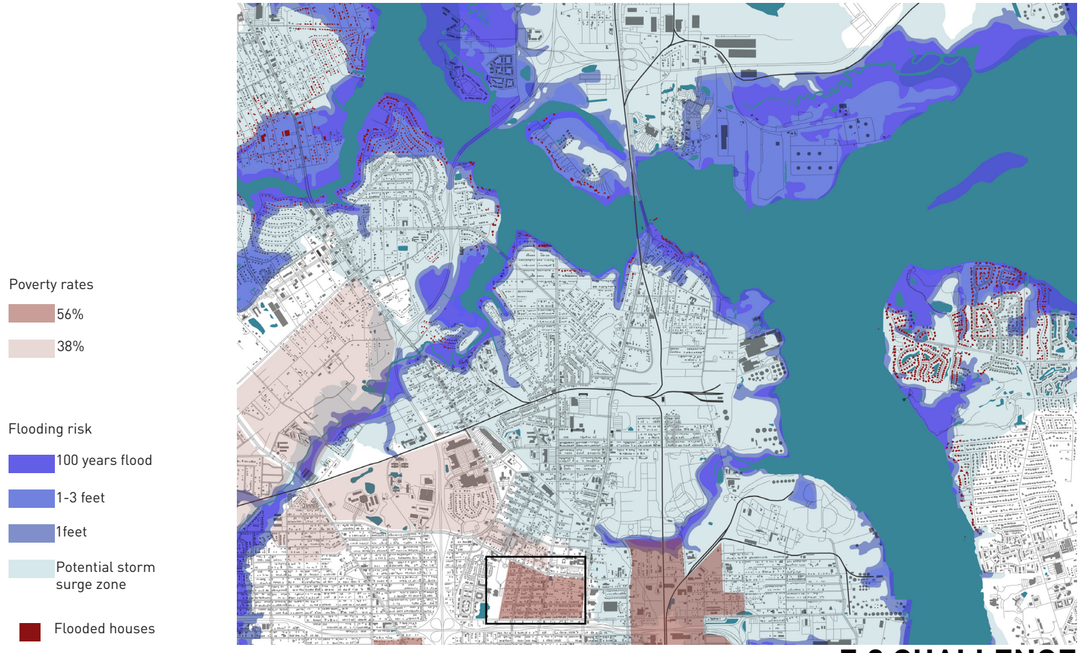
Landuse map: Riverbanks occupied by industry and private

It can be seen that most of this area consists of private green spaces, meaning that most of the land is actually occupied by residential green spaces, such as yards. The situation on the east side of the river is somewhat better than on the west side, with some large parks and golf courses. The creeks extending into the land are accompanied by corresponding forests, but this kind of greenery is usually not accessible, as residents always enclose it with tree walls for isolation. Meanwhile, on the far west side, there are some forests around the residential areas, but they are usually very dense. All public parks are very small, embedded in the gaps between roads and residential areas, and they do not achieve the siphon effect of large parks.

It can be seen that most of the area consists of residential zones, with industrial areas located along the northern and western banks of the river. Institutions and commercial zones are always distributed along major roads. Green forests extend inland along the creeks, but these forests seem to be just ornamental elements of the city rather than usable green spaces. Along the main roads, there are some protective green spaces on both sides, separating residential areas from the roads. However, the industrial areas occupy important positions along the riverbanks, creating a barrier that hinders people's access to the riverfront.



Mobility map: New Obstacles Reduced Accessibility



7.2 CHALLENGE

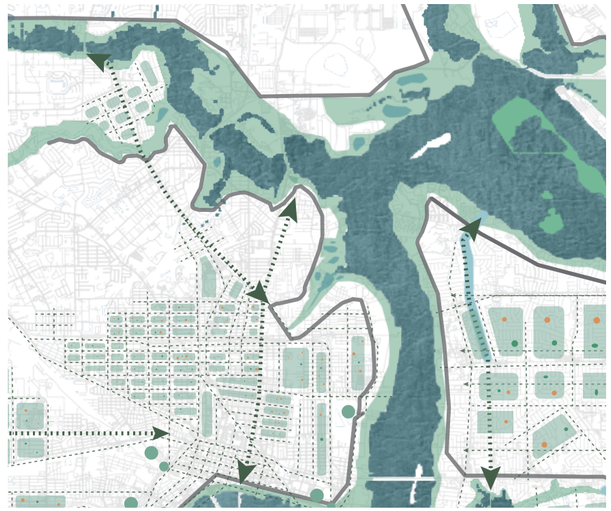
Challenge map: The interweaving of floods and poverty

It can be seen that the primary roads connect the north and south banks of the river, while secondary roads are spread throughout the area. Many schools, institutions, and shops are located here. Residential roads are found in the residential areas, which is mainly related to the fact that cars are the primary mode of transportation in American cities. Industrial and river areas are indeed inaccessible, becoming obstacles that reduce accessibility.

The riverbanks are always affected by flooding, especially extending inland through creeks. During extreme weather events, when storm surges occur, the land often becomes inundated, making it necessary to protect the inland areas with dikes. Additionally, many coastal residential areas are affected by flooding. These residents can be relocated to higher ground or have their houses elevated. It is evident that high-poverty neighborhoods are located on the southern side. The next section will discuss the redevelopment of typical impoverished neighborhoods.

NEW PLAN OF ZOOM IN 1

7.3 NEW PLAN OF ZOOM IN 1



1 Residence as pototential flood plain

2 Natural dike

3 Creek as new park

4 Creek as new park

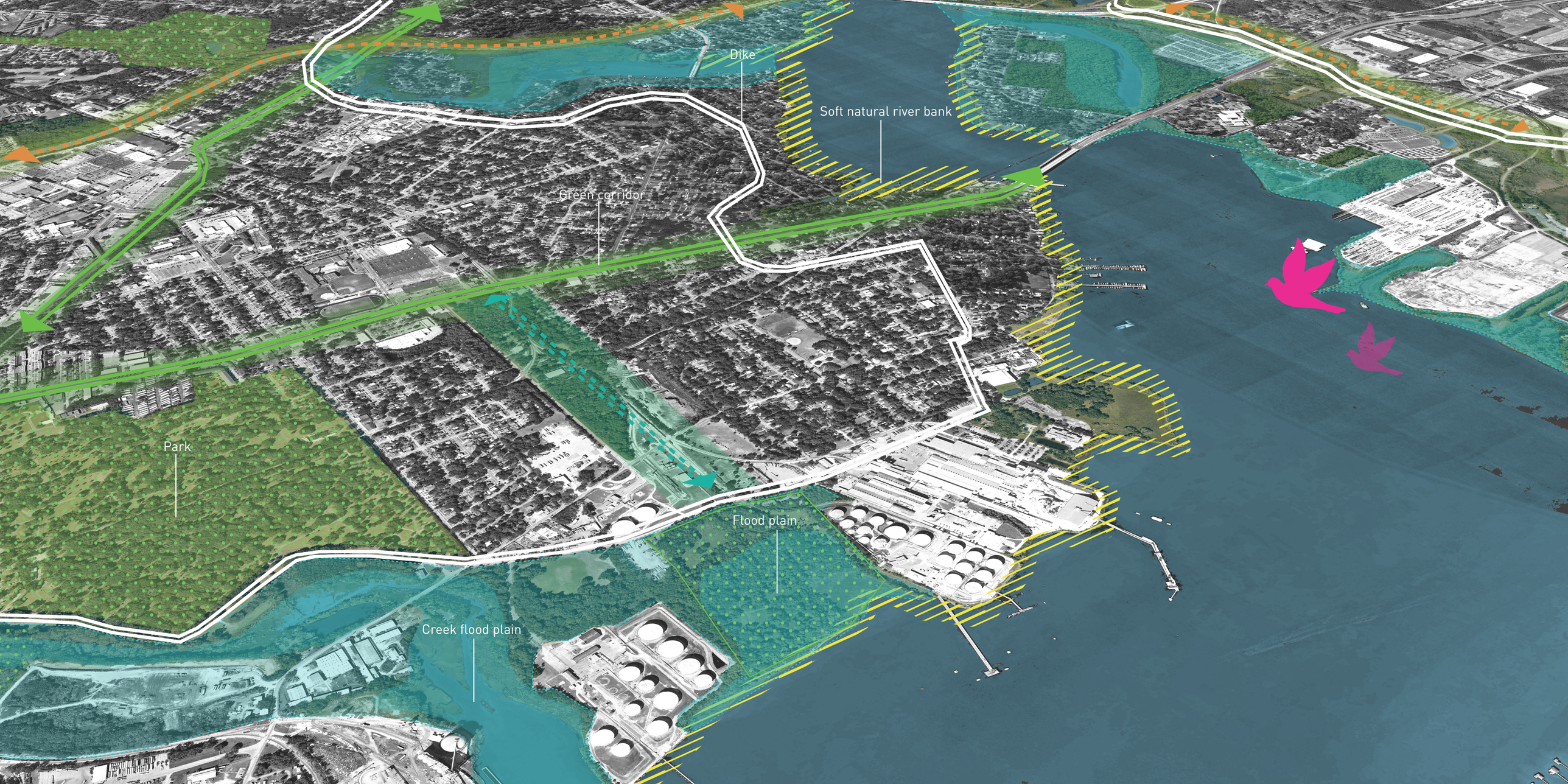
5 Semi-closure forest

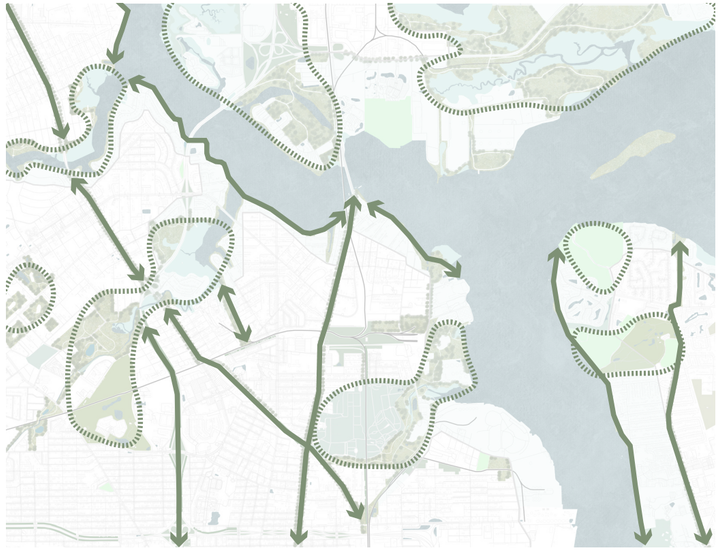
6 Creek as new park

7 Green corridor

8 Green corridor

9 Soft river bank


Dike
Soft natural river bank
Green corridor
Park
Flood plain
Creek flood plain



Ecology

The ecological corridors and soft riverbanks connect large public green spaces and ecological patches, forming a green network that spans the entire area. Coupled with the private green within the community, the new design constitutes a reasonable green structure,

Eco-patch

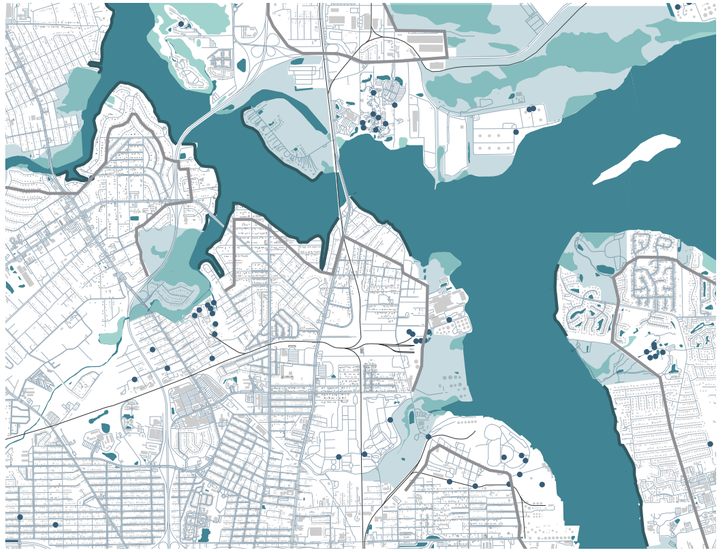
Eco corridor



Habitat

Along rivers and streams, fish enter the green floodplain, which becomes their natural habitat for spawning. The new design turns the green space along the stream into an ecological habitat with high green value.

Fish habitat



Water adaptive

Transform the many previously hard embankments into natural embankments to serve as buffer zones. Additionally, utilize the existing marshlands and riverbank green spaces to create a new floodplain, which can increase water capacity during floods and the rainy season. The dike protects residential areas on the land.

Dike

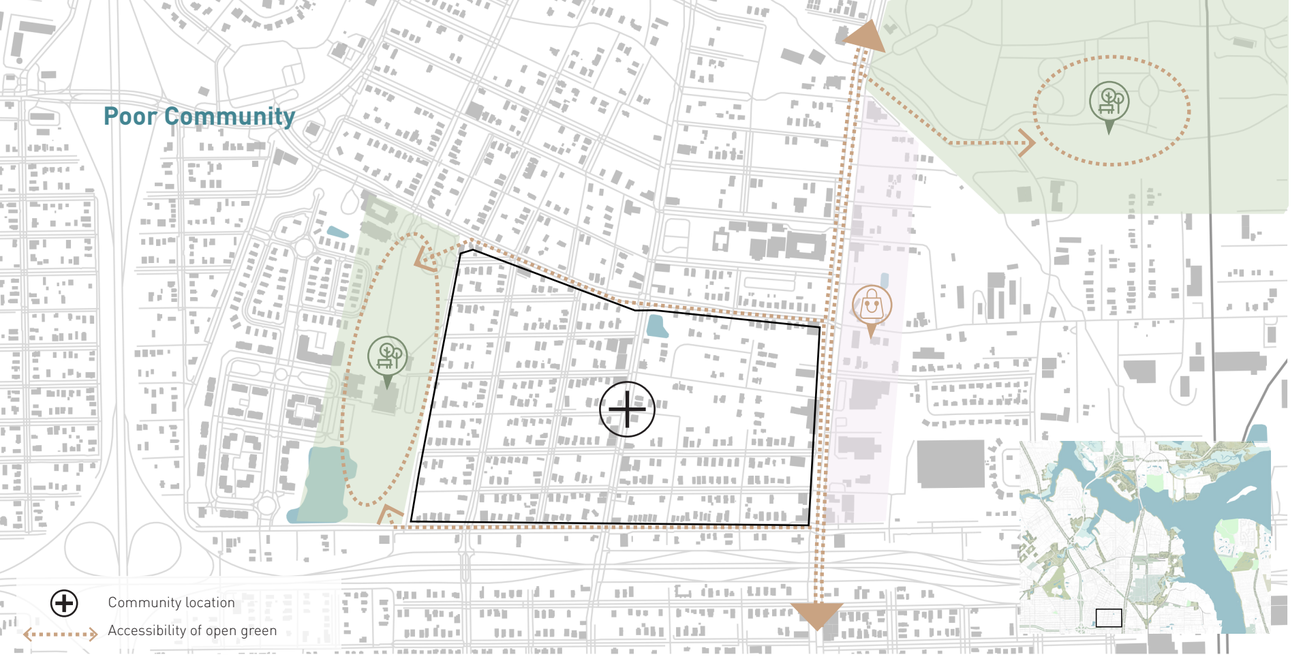
Soft river bank

Water pipeline

Wetland

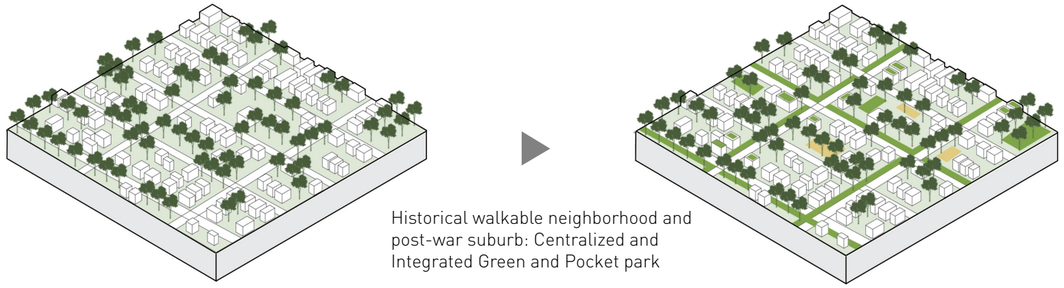
Floodplain

Well





Boundary to open green | Boudary between private green | Green that needs maintenance | Public Health | Boundary to pool

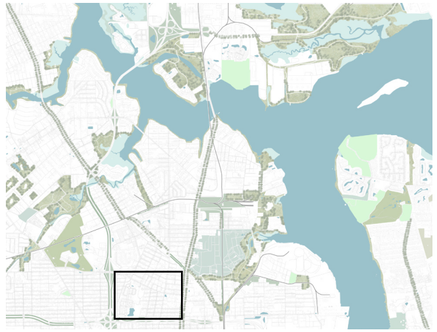


Historical walkable neighborhood and post-war suburb: Centralized and Integrated Green and Pocket park

Existing condition

When we focus on this community, we find that it faces numerous problems, with a poverty rate reaching 56%. Fences always separate the community from green spaces, blocking residents' access. The only small pond in the community is also fenced off. Additionally, there are many barriers within the community; houses are completely enclosed by fences. Walking through this community is not a pleasant experience. Fences are everywhere, and neighbors do not seem to communicate with each other. Residents' private cars are parked haphazardly on the streets, turning roads into parking lots. Since American residents primarily use cars for transportation, walking and cycling are inconvenient. The trees are in poor condition, lacking maintenance, and weeds are overgrown. Residents' household garbage is piled in corners, affecting public sanitation. It seems that the residents here rarely communicate with their neighbors, making it a lifeless community.





7.4 NEW PLAN OF COMMUNITY

1 Community market

2 Community urban agrihood

3 Biological ditch

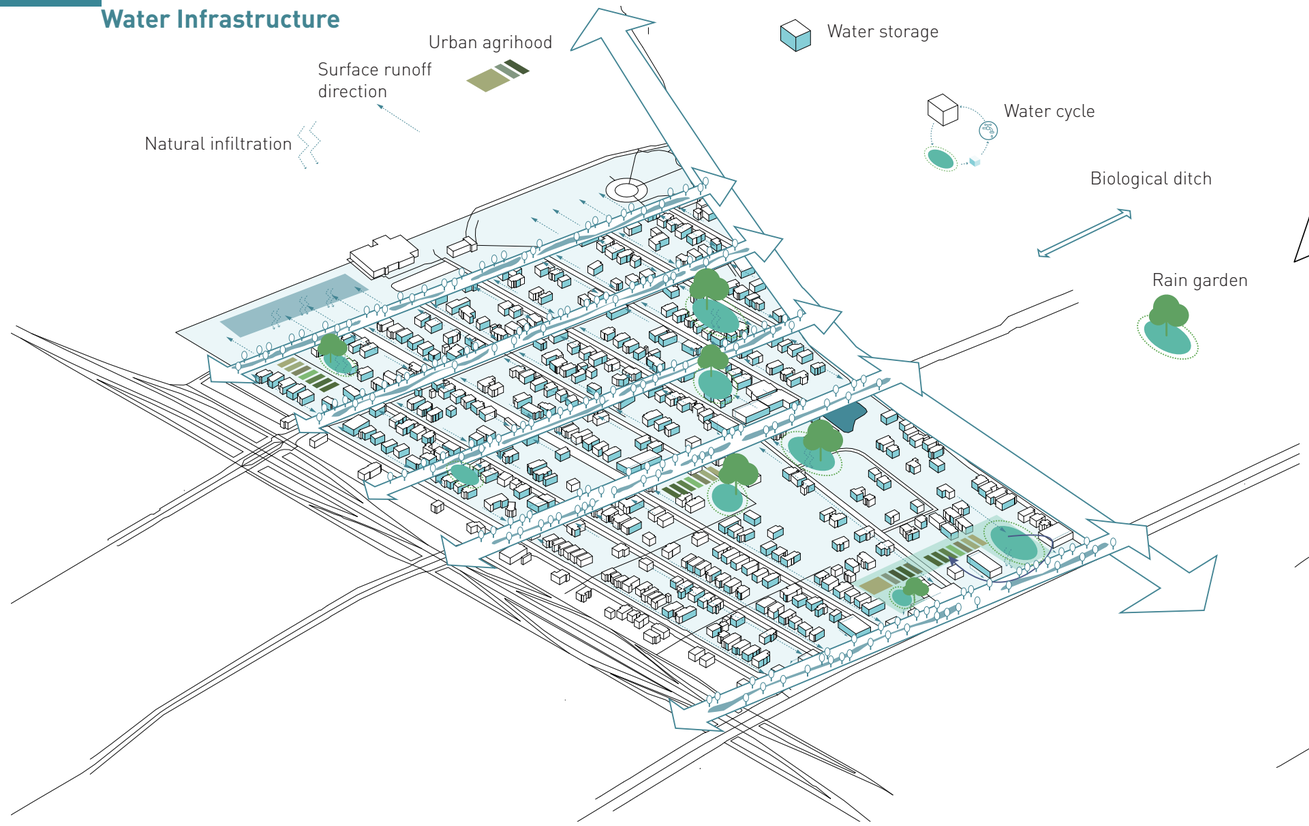
4 Children playground

5 Biological ditch

6 Green roof

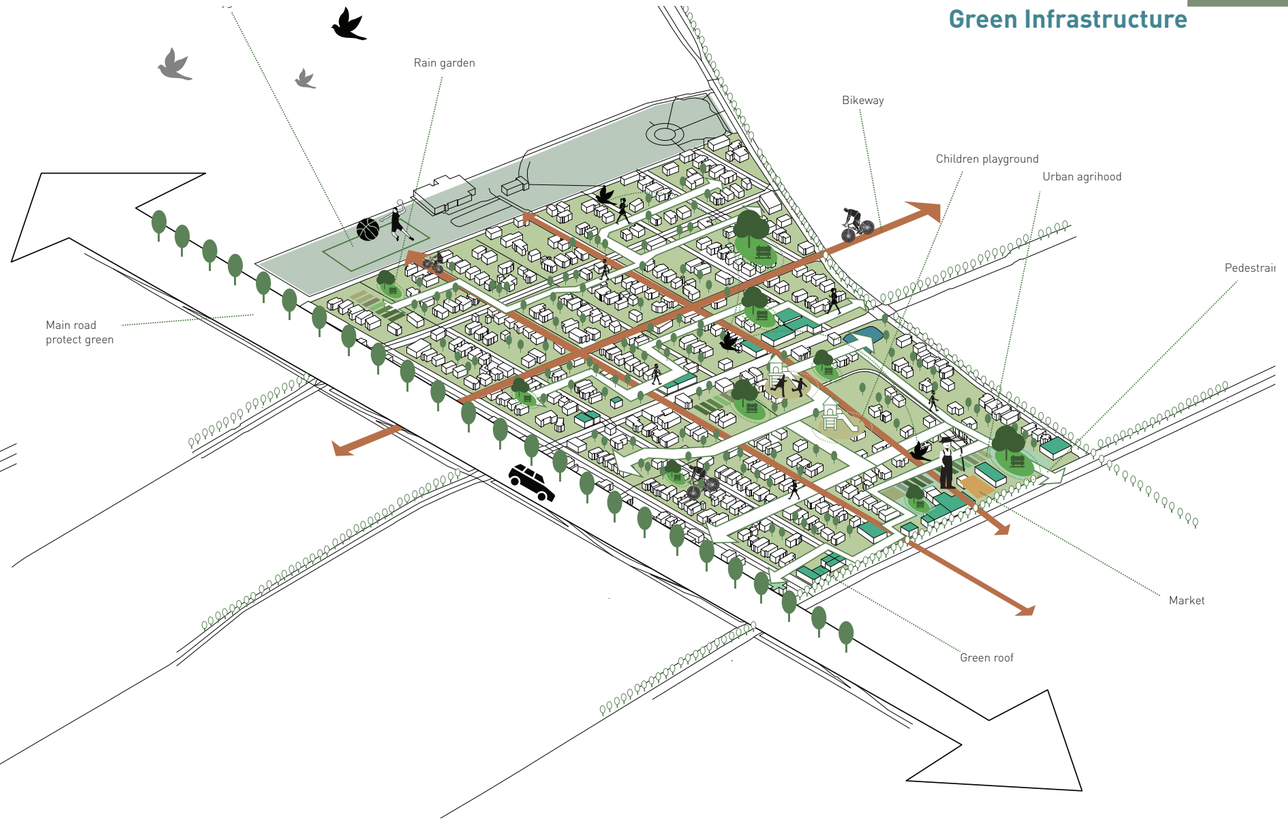
For the community design, the first step is to eliminate the boundaries within the community by removing fences. Then, connect the existing unused green spaces with pedestrian paths, allowing residents to move freely throughout the community. Functional areas, such as children's playgrounds, will be placed in the unused green spaces to provide a safe place for children to play. Neglected green areas along the roadsides will be redesigned as biological ditches to manage stormwater issues. Green roofs will be added to flat rooftops to slow down rainwater runoff. An urban agrihood will be established on the east side of the community, where residents can grow vegetables, interact, and share their harvests. Additionally, a market nearby will allow residents to buy affordable food, reducing their daily living expenses.

Water Infrastructure



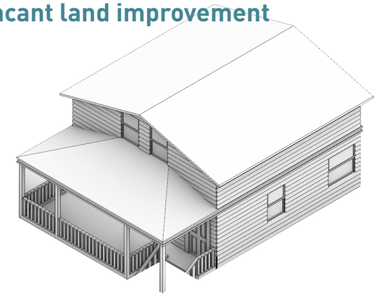
The path of rainwater begins with the green roof, which slows down the rainwater's descent. From there, the water enters private green spaces or flows through biological ditches to reach rainwater gardens or larger green areas, allowing for natural infiltration and replenishment of groundwater. Enhancing the water storage capacity of houses can facilitate self-circulation within residents' homes.

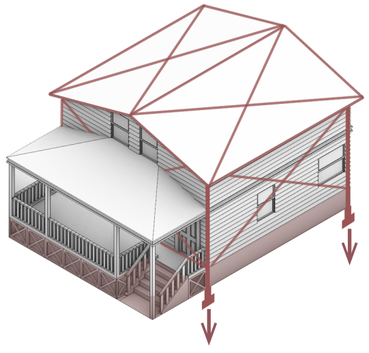
Green Infrastructure



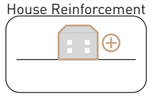
Residents can choose to ride bicycles along the newly designed bike paths. They can also freely traverse the community, walking to their neighbors' front doors or backyards, which are like the community's own secret gardens. Rain gardens become green gathering spots where residents can talk, linger, and enjoy nature. The playground is a safe place for children to play freely since it is within the community. On the east side of the community, an urban agrihood allows residents to lease plots to plant and harvest their own vegetables, and they can also share food with each other here.

Vacant land improvement

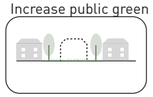


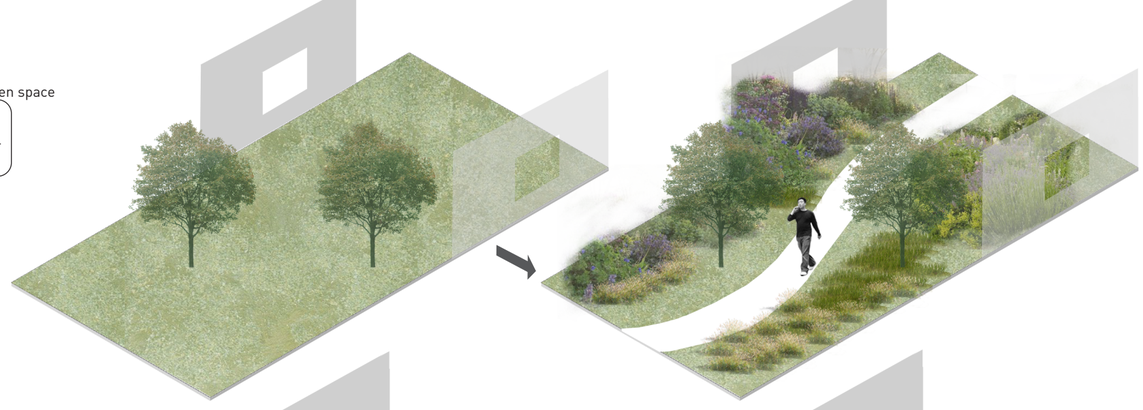


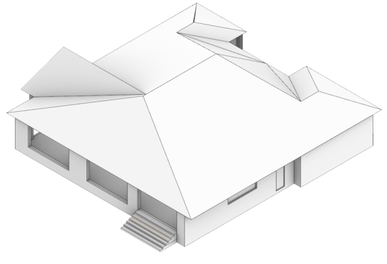
House Reinforcement

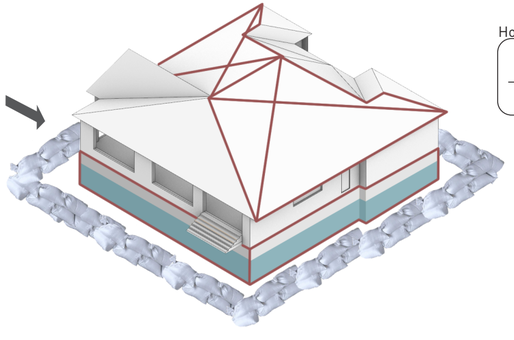


Increase public green space







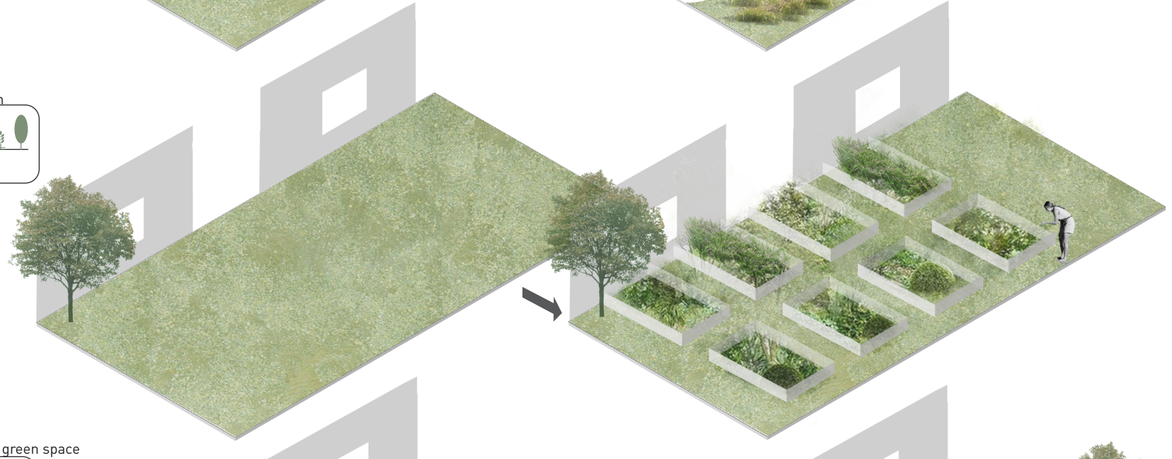


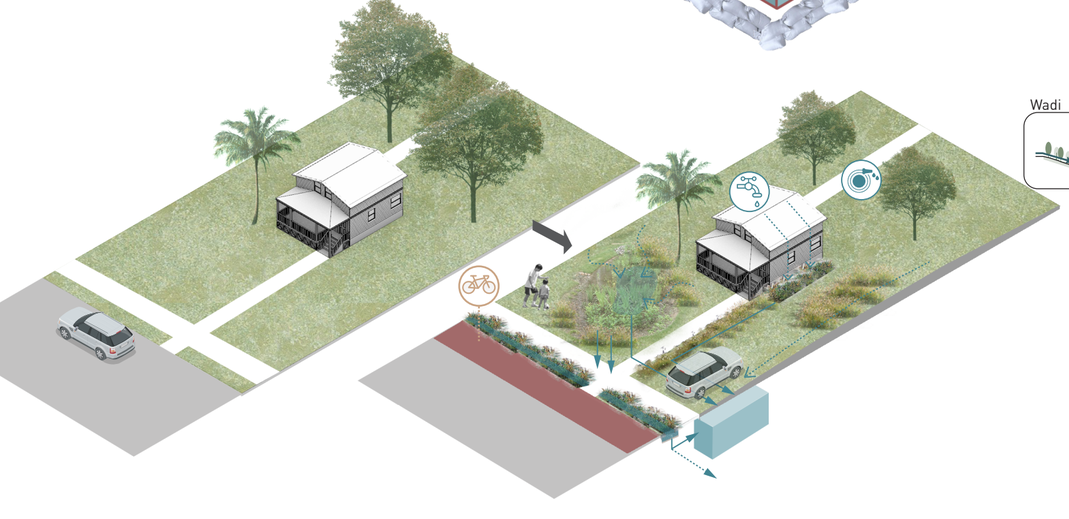
House Reinforcement



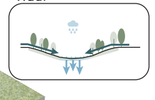
Community farm





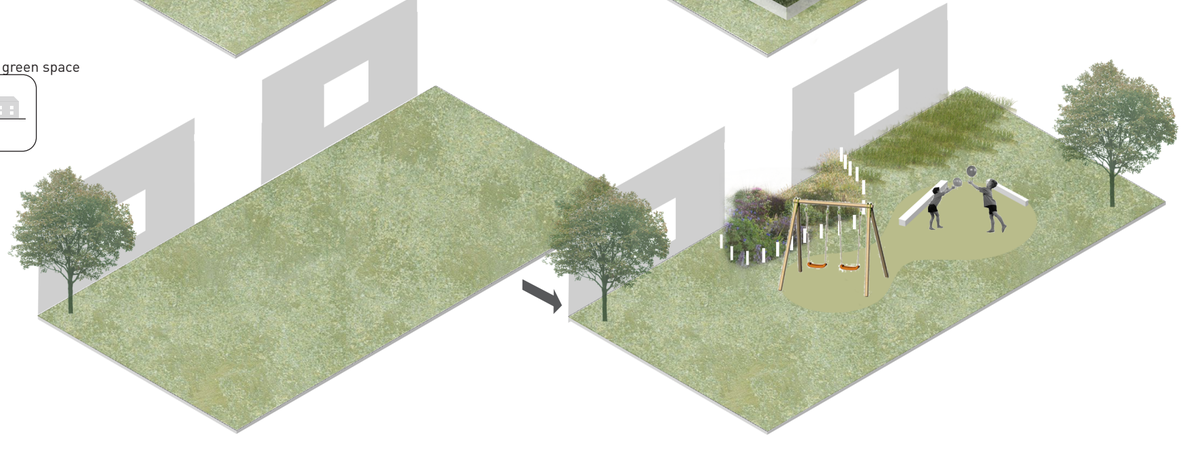


Wadi



Increase public green space





7.5 Detailed Design



1 Community market

2 Community urban agrihood

3 Rain garden

4 Green roof

5 Biological ditch

6 Community kitchen

7 Water storage under the parking lot and purification



Water cycle in urban agrihood

Housing water cycle

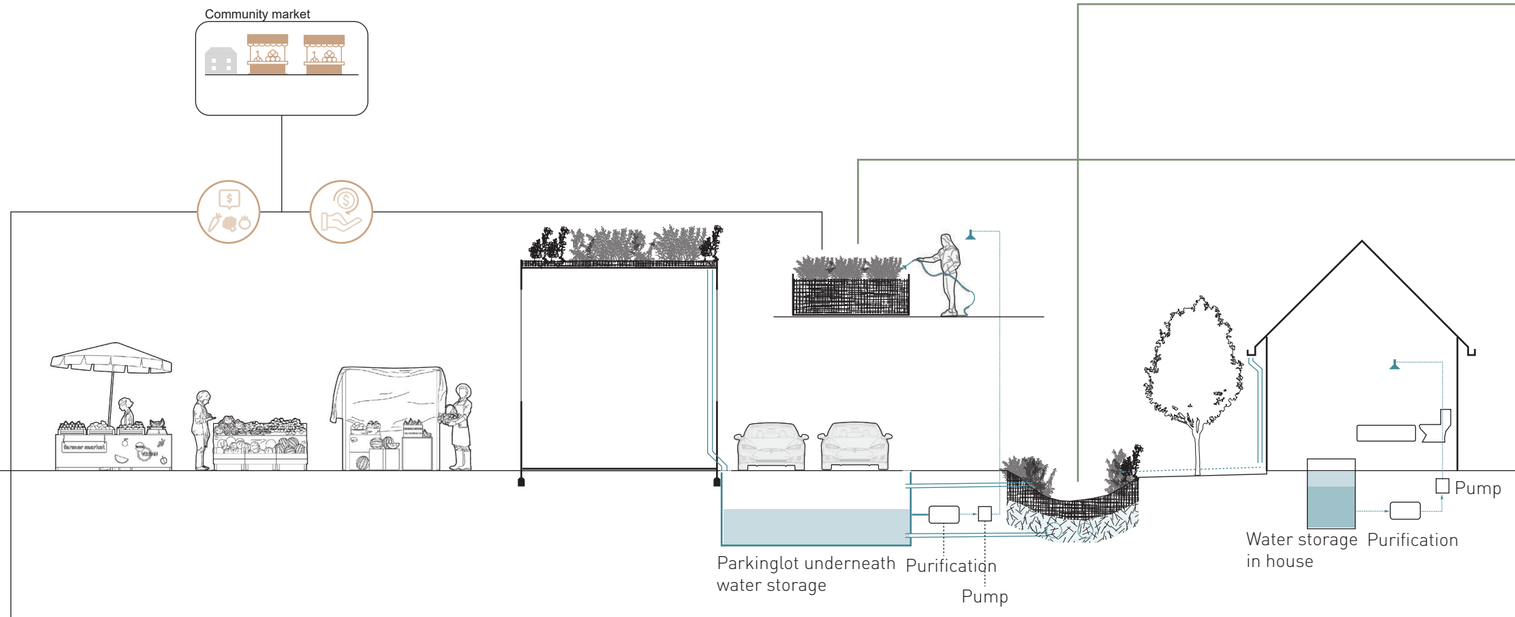
Water storage

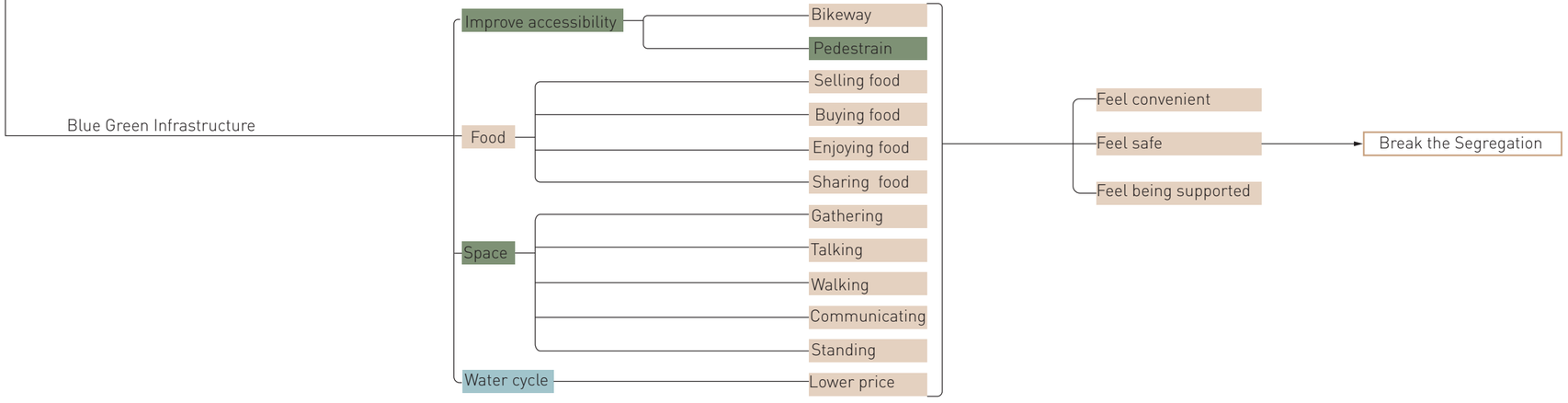
Water purification

Runoff

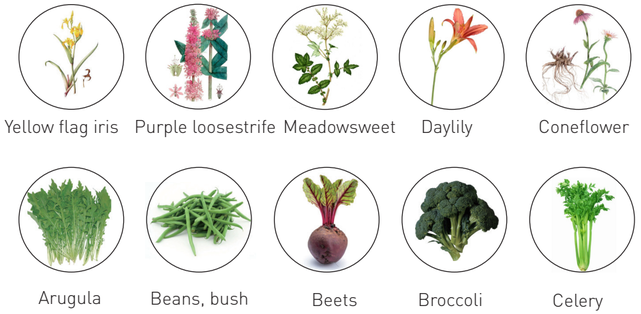
Runoff in biological ditch

Technical Section and water cycle





Plants and vegetables





PART VI

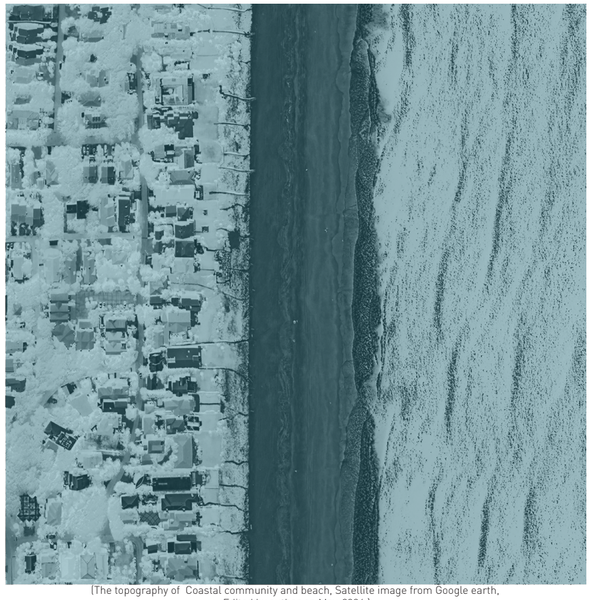
Conclusion and Reflection

PART VI
Conclusion and Reflection

8 Conclusion and Reflection
8.1Conclusion
8.2Reflection
8.3Bibliography

08 Conclusion

I summarized the entire project and asked myself whether I had answered the research question posed earlier. I reflected on the problems encountered throughout the project and the insights gained during the process.



[The topography of Coastal community and beach, Satellite image from Google earth,
Edited by author on May, 2024,]

8.1 CONCLUSION

Main question： How to improve and build the blue-green infrastructure based on the original green structure of Jacksonville to address urban vulnerability and improve urban resilienc?

In this project, I explore how blue-green infrastructure (BGI) can create a resilient urban network to address urban vulnerabilities and improve overall resilience. BGI combines water management and vegetation, offering multifunctional benefits.

Flood Mitigation
Implementation: Utilize wetlands, parks, and permeable surfaces to absorb excess water and reduce flood risks.
Application: Jacksonville can enhance its existing green spaces by integrating more permeable materials in urban planning and expanding wetland areas to act as natural flood barriers.

Stormwater Management
Implementation: Develop rain gardens, bioswales, and green roofs to capture and filter stormwater, easing the pressure on drainage systems.
Application: Discussing four types of flooding, the project applies blue-green principles using a typo logical toolbox for effective implementation. Incorporate these solutions in Jacksonville's urban planning to manage stormwater more efficiently.

Erosion Control
Implementation: Utilize coastal vegetation and dunes to stabilize soil and reduce erosion from waves and storms.
Application: In Jacksonville's coastal community areas where sand dune collapse is significant, implement breakwaters and protect marshlands to serve as ecological flooding buffer zones.

Water Quality Improvement
Implementation: Use natural filtration by wetlands and green spaces to remove pollutants from runoff.
Application: Focus particularly on creek and river areas in Jacksonville. Although industrial zone designs were not extensively developed due to time constraints, integrating BGI in these areas can address pollution problems effectively.

Biodiversity
Implementation: Create habitats for wildlife to enhance urban biodiversity and ecological resilience.
Application: Embed multiple blue-green nodes and lines within the city to form blue-green grids, boosting ecological benefits across Jacksonville.

Climate Adaptation
Implementation: Use vegetation and water bodies to regulate temperatures and sequester carbon, helping mitigate climate change.
Application: Strengthen Jacksonville's natural buffer zones and protect marshlands to defend against future sea-level rise.

Social and Economic Benefits
Implementation: Develop recreational spaces, boost property values, and strengthen community resilience.
Application: Detailed in the project's first zoom-in design, BGI enhances community resilience by applying Jan Gehl's twelve criteria to improve safety, cohesion, and reduce poverty and segregation in Jacksonville.

Disaster Risk Reduction
Implementation: Utilize green spaces as emergency buffers and integrate them into disaster planning.
Application: During extreme weather events, Jacksonville's green spaces provide safe areas and essential infrastructure for emergency situations.

In general, this project outlines how BGI can be developed based on Jacksonville's existing green structure to address urban vulnerabilities and enhance resilience. By incorporating these strategies, Jacksonville can improve flood management, stormwater control, erosion prevention, water quality, biodiversity, climate adaptation, social cohesion, and disaster risk reduction.

Research Question 1:How does blue-green infrastructure address existing urban issues at different scales, including regional, city, area, community, and street scales, in terms of creating better blue-green structures, enhancing urban resilience, and transforming into sponge cities?

In this project, I discuss how blue-green infrastructure forms networks at different scales to address corresponding blue-green and social issues. The project is divided into five scales:

Regional Scale: XL Scale
Focuses on the lower basin of the St. Johns River. By applying typological tools to various terrains, it aims to maximize flood control and create a robust blue-green network, thereby enhancing regional resilience.

City Scale: L Scale
Examines the city scale to understand how to construct an effective blue-green infrastructure network that improves urban resilience and addresses city-level issues.

Zoom-In Scale: M Scale
Selects the representative Brentwood area, which faces multiple integrated issues such as flooding, poverty, and low-quality green spaces. This scale serves as an extension of the city-scale new blue-green infrastructure network.

Community Scale: S Scale
At the community scale, a typical impoverished community in Brentwood is chosen to discuss how blue-green infrastructure can enhance community safety, strengthen positive communication among residents, and provide economic benefits to some extent.

Building Scale: XS Scale
Provides detailed discussion on utilizing vacant community spaces, transforming them into public spaces such as rain gardens and rainwater collection and reuse systems.

Research question 2: How can blue-green infrastructure creatively focus on social issues and the people living in urban areas? For example, how can it address community segregation, spatial inequality, and the ever-widening wealth gap?

Due to its history of racial segregation, the United States has long faced serious issues of separation. From racial segregation to residential segregation, the mindset of human separation has always been a painful wound on this land. (Refer to the history of community segregation; illustrations show that poverty remains concentrated within the redlined areas delineated a hundred years ago.) This mindset is deeply ingrained in American society. As landscape architects, how can we break this closed loop of thinkingmind?

Although we must admit that our capabilities are limited, and our profession has seemingly always served the higher echelons, lacking a revolutionary spirit, when we focus on the lower strata, how can we change their daily living environment and reignite their hope from the smallest details, breaking the cycle of their difficult and impoverished lives? When they no longer distinguish between "us" and "them" with walls, but step out of their homes to talk with their neighbors (social interaction is a basic human need), they gain psychological support from their neighbors. If the design of boundaries makes them feel safe, this sense of security enables them to fully engage in their work and even to nurture the next generation. This is what I hope to see.

When people start growing nessaritis, such as food, in community farms, it seems that all perceptions return to the most basic human needs. Eating food they have grown themselves, or buying more convenient and cheaper food at the market, or even selling their own produce, undoubtedly has a positive impact on their lives. At the same time, a blue-green network structure for water circulation makes water usage cheaper and reduces water waste. Removing walls and increasing the accessibility of communities to public spaces makes it easier for them to access green space, thereby making the use of space more equitable.

Research question 3: How does the new blue-green infrastructure address water crises and green issues such as water pollution, flooding, low-quality green spaces, and the irrational structure of urban green spaces?

Blue green infrastructure provides answers at both the regional and city scales by forming networks that better prevent water-related issues, such as flooding, and by creating more natural spaces, like green corridors, to enhance ecological benefits.

In the first zoom-in area, a new blue-green infrastructure framework has been established through a typological toolbox. Given the primary concern of riverine flooding here, strategies include using dikes to protect the land and residential areas. Additionally, increasing water storage along the riverbanks to create floodplains provides a place for excess water during flooding events. Micro-scale rainwater control structures within the community further enhance rainwater management.

Following the typological toolbox approach, formerly segregated green spaces are interconnected to form a green network. Through micro-scale interventions within the community, the quality of green spaces is improved, and accessibility for residents to these spaces is enhanced. These efforts collectively aim to enhance ecological benefits in the community.

8.2 REFLECTION

The Limitations of Designers' Abilities

Addressing the issue of community segregation, I designed the space using Jan Gehl's twelve criteria and attempted to create safer and more open community spaces where residents can play, converse, walk, exercise, and grow food, while also improving accessibility. However, I cannot avoid the question: can designers truly solve these problems fundamentally? This reminds me of a famous Chinese TV show, Dream Home Makeover, where a renowned interior designer redesigned the layout of a small hutong house for a family of six, creating a new indoor environment. Surprisingly, a month later, the newly designed house reverted to chaos, with clothes and garbage strewn about. What caused this result? It might be the deeply ingrained behavioral and thought patterns of the people. In this design, I often wonder if everything will truly achieve the expected effect as I anticipate. I am unsure. But the good thing is, at least we are doing something to help, to improve, and to try to break the impasse.

Systematic Thinking in Design and Application of Theory

In this project, systematic thinking and the application of design theory have been very helpful. From the initial problem statement, to finding theoretical support, to practical implementation, I used the typological toolbox as a theoretical foundation and a conduit for converting theory into practical design. This allowed me to apply blue-green infrastructure to the actual site effectively, handling details on a smaller scale to achieve design objectives and ultimately answer the research question posed at the beginning. Throughout the process, I developed a methodology for refining my designs, genuinely solving problems, and making them persuasive and feasible.

Feasibility of Results

This has been a long-standing question since my undergraduate studies in landscape architecture: how to truly implement design intentions, achieve design objectives, and realize the expected design effects. (I have seen beautiful water-themed parks designed by renowned studios that, when visited, offered no enjoyment; all the water features had turned into stagnant, foul-smelling water, which was very disappointing.) As I reach this important milestone in my sixth year of studying landscape architecture, this question resurfaces in my mind. I hope my designs are thoroughly researched and practically feasible. I also foresee numerous considerations during implementation, such as collaboration with the government, financial support, cooperation with residents, and negotiations with property owners. Although these are not issues I need to consider as a student, it is good to think comprehensively.

Scope Relevance

In the context of global warming and increasingly extreme weather affecting people worldwide, with sea levels still rising, all cities, especially those with large populations, face growing urban issues such as the urban heat island effect, energy shortages, excessive rainfall, and ecological problems. Where is the answer? The answer lies within the cities themselves. I hope that constructing more efficient and rational blue-green infrastructure networks will become the solution to these problems, achievable through clever design. I hope it becomes an effective method not only for this city but also applicable to other cities, enhancing urban resilience and creating sponge cities.

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