



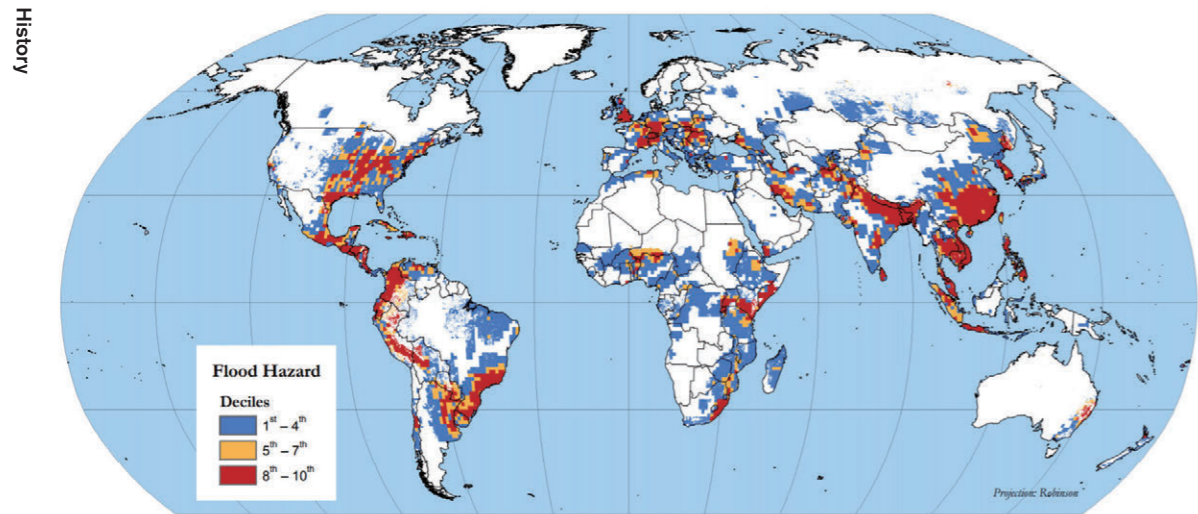
Non-parasitic Economy
Towards a symbiosis between coastal cities
and water

Jun Chen 4844130
01-07-2020

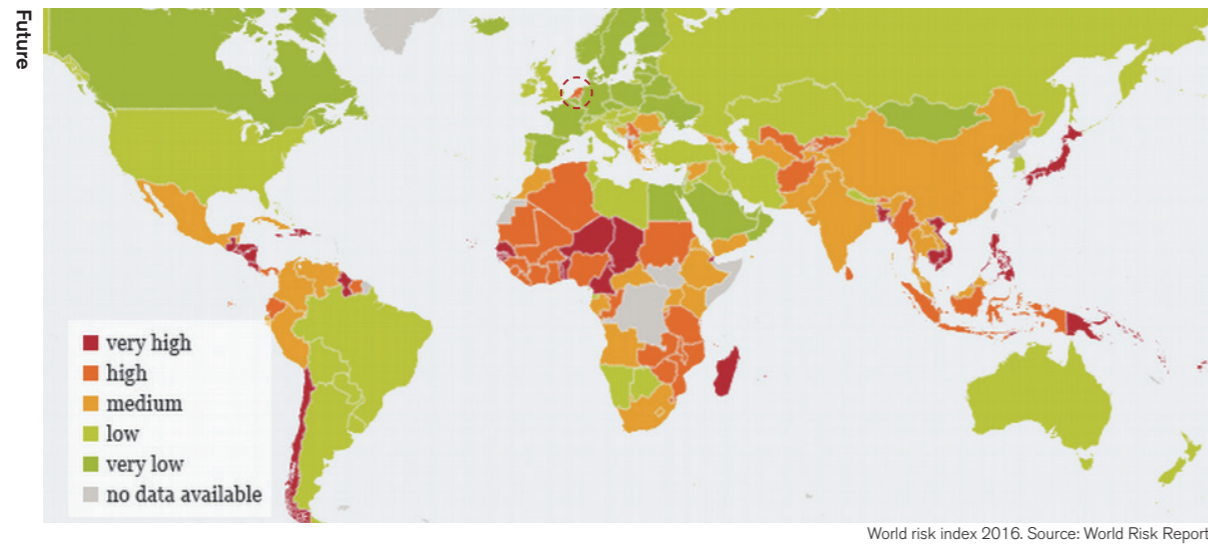
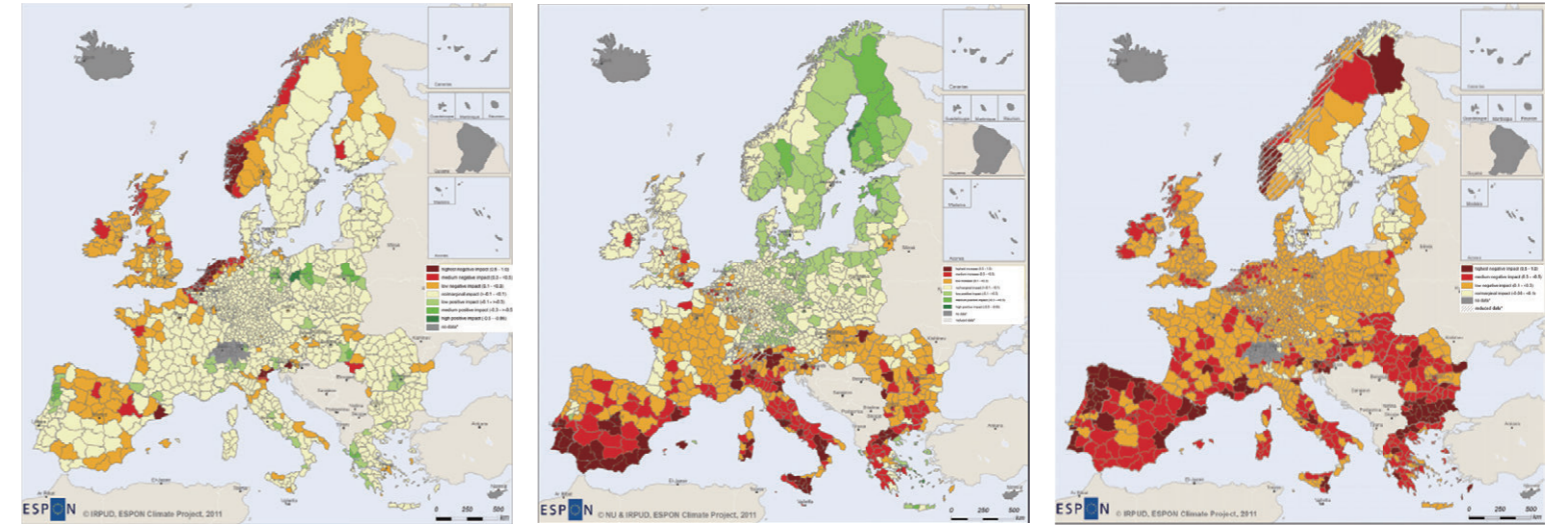
First Mentor: Dr. Diego Sepulveda Carmona
Second Mentor: Dr. ir. Luisa Maria Calabrese

INTRODUCTION

Global context: Climate change



Coastal urbanization



INTRODUCTION

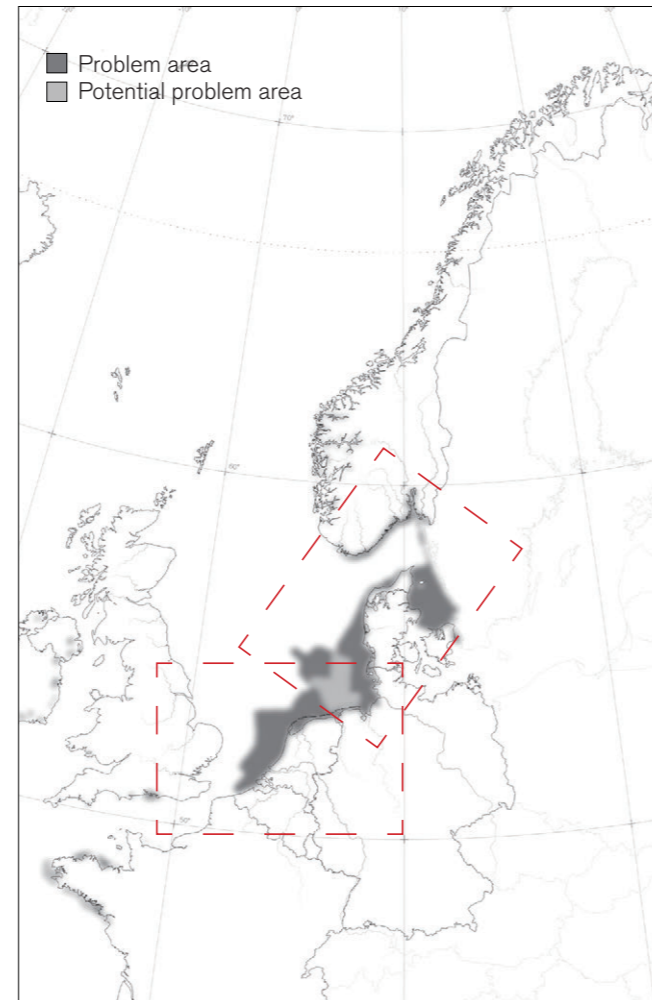
North Sea context

1. Population growth



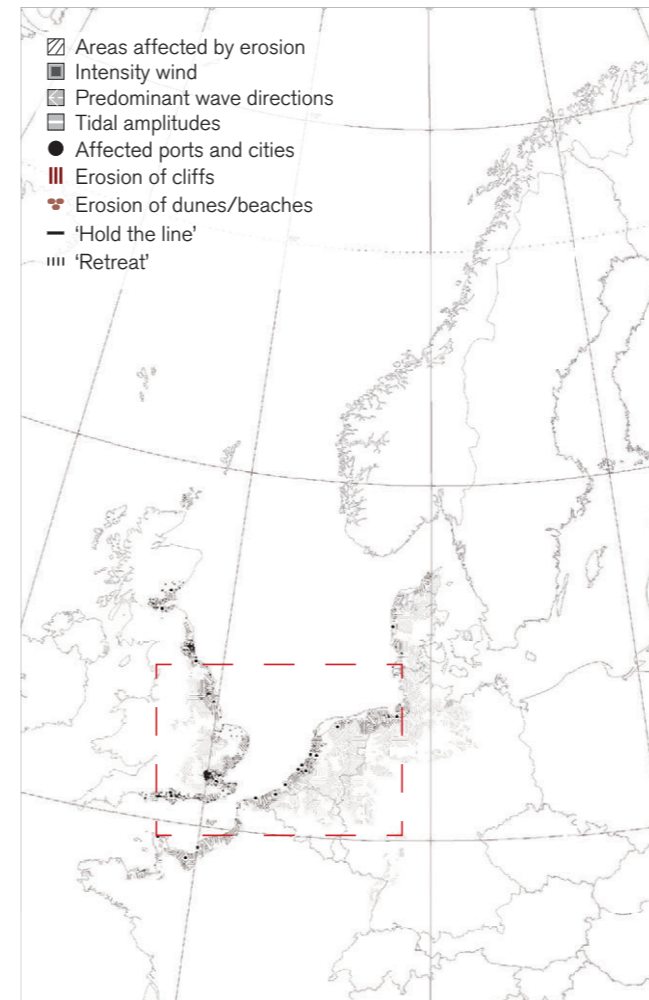
Population growth. Source: BBSR Bonn, Group work.

2. Contamination waterbody



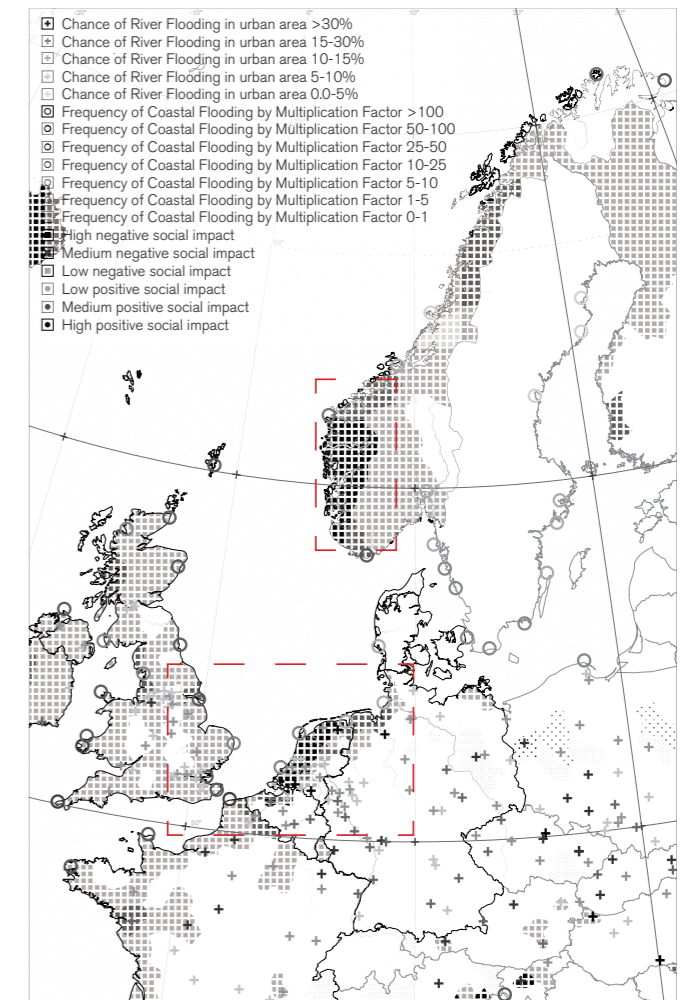
Contaminated waterbody. Source: Map created by author. Data from: OSPAR Intermediate Assessment 2017.

3. Soil erosion



Soil erosion. Source: European Environment Agency, Group work.

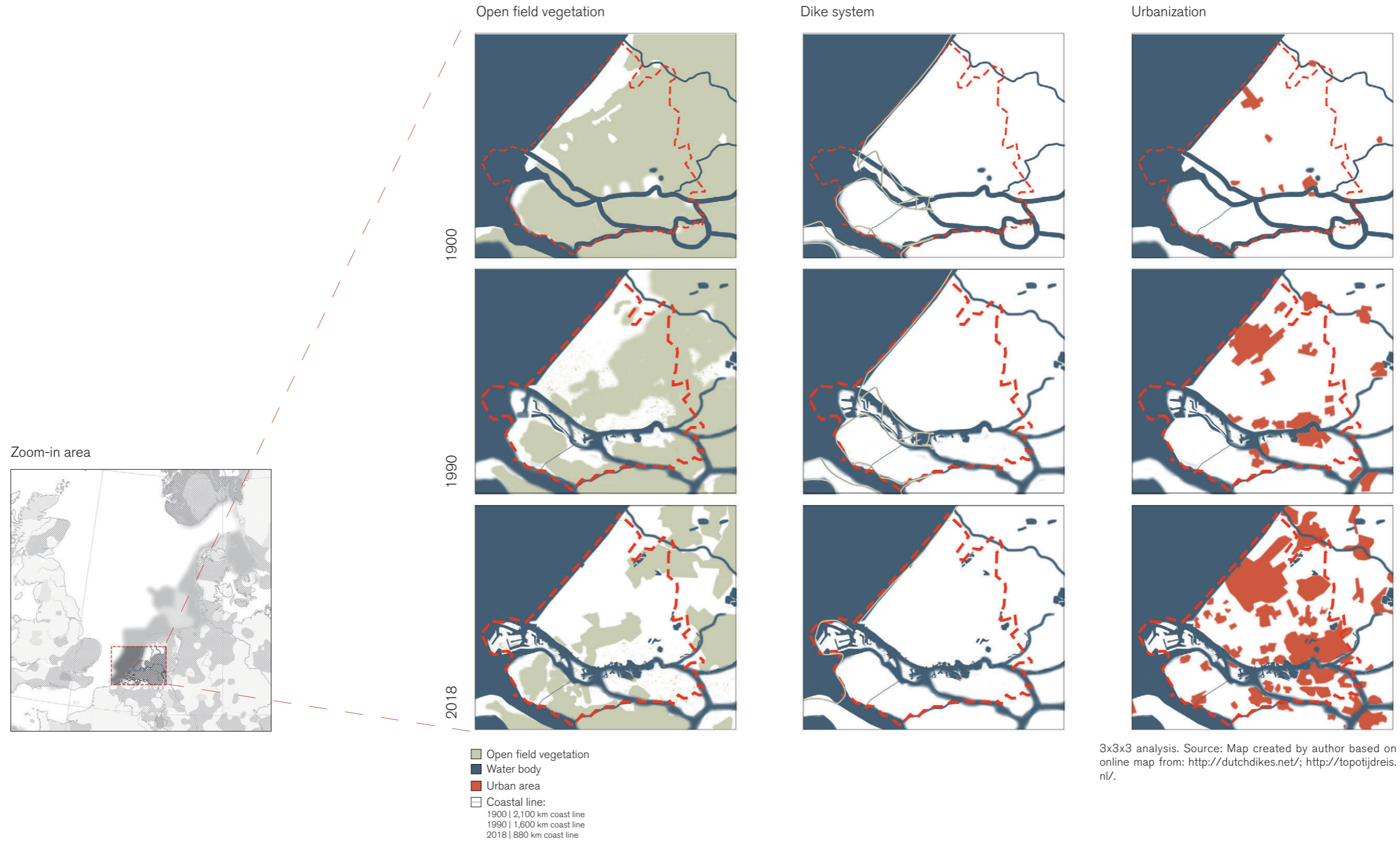
4. Risks



Flood risk. Source: European Environment Agency, Group work.

INTRODUCTION

The Metropoolregio Rotterdam Den Haag (MRDH) context



PROBLEM FIELD

PROBLEM FIELD

1. The drivers for economic output

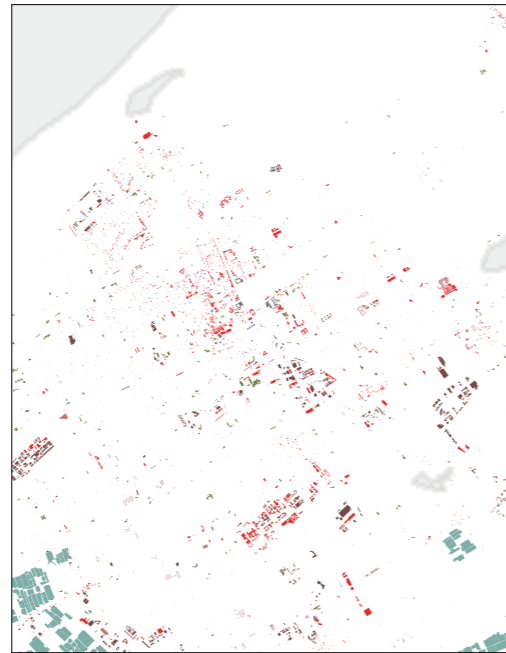
- Building type**
- Office
 - Industrial&creative
 - Recreation
 - Service
 - Greenhouse
 - Education
 - Commercial
 - Farm



Drivers for Westeland zoom in. Source: Map created by author. Data from: Geofabrik.



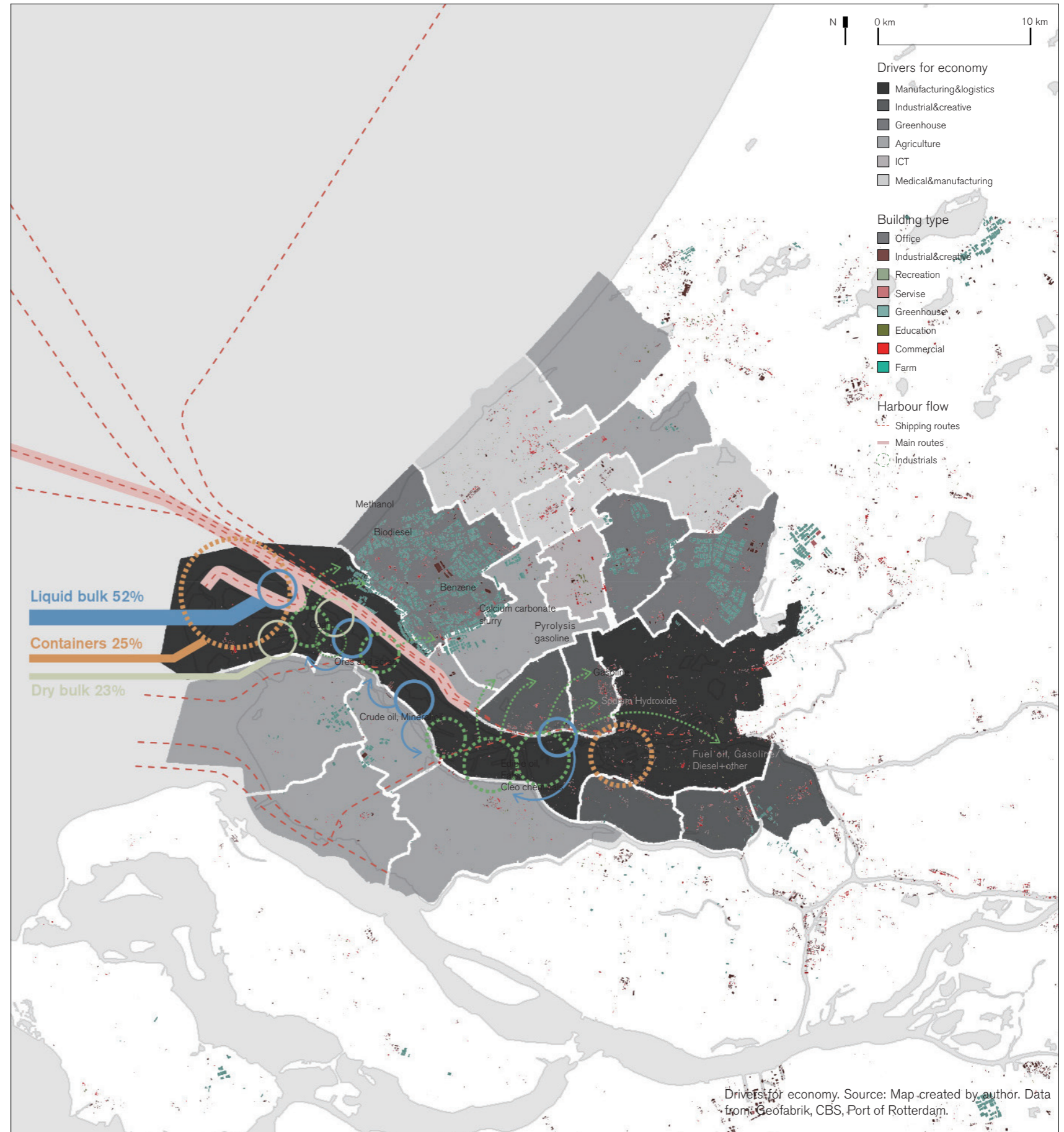
Drivers for The Hague zoom in. Source: Map created by author. Data from: Geofabrik.



Drivers for Rotterdam zoom in. Source: Map created by author. Data from: Geofabrik.



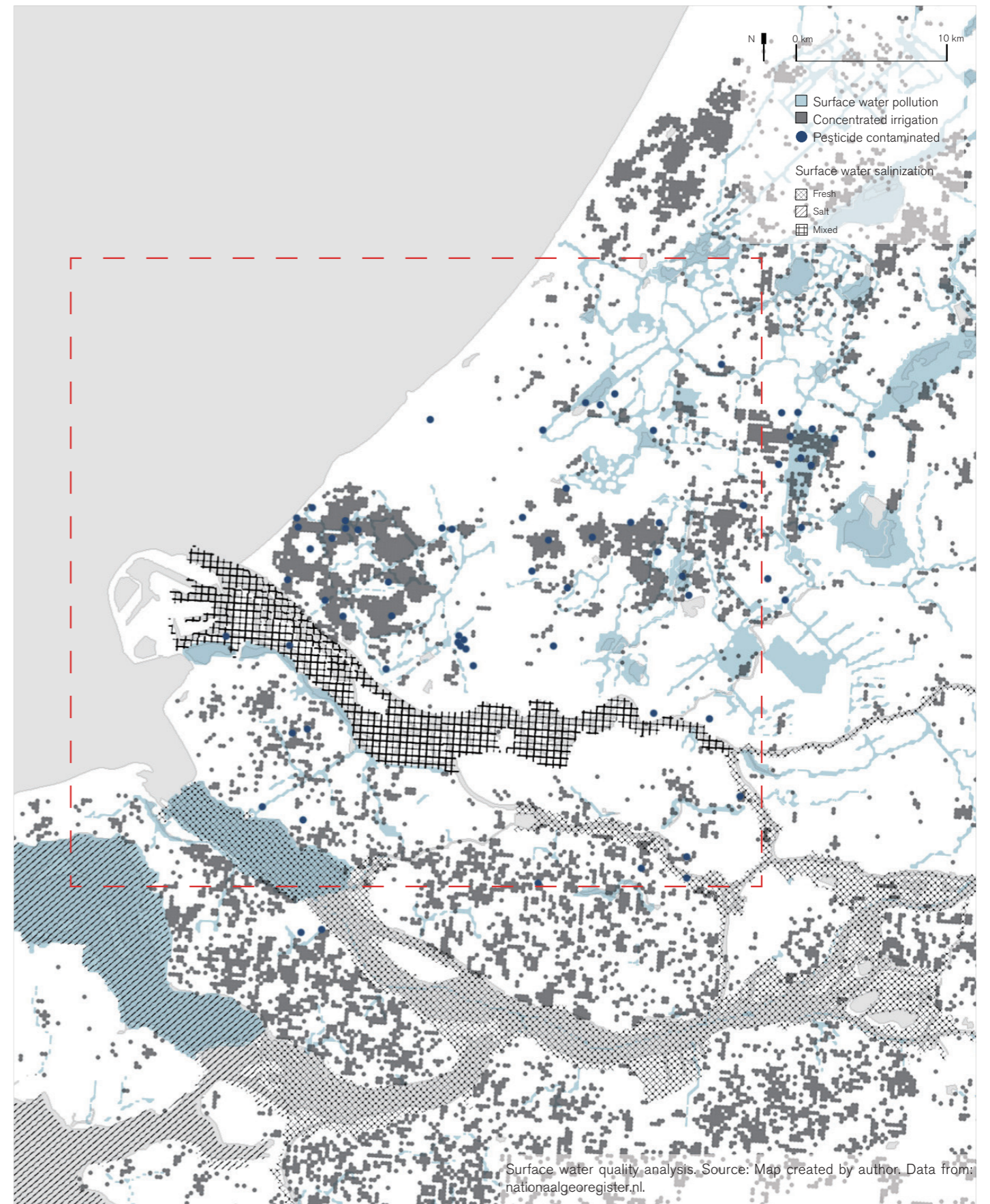
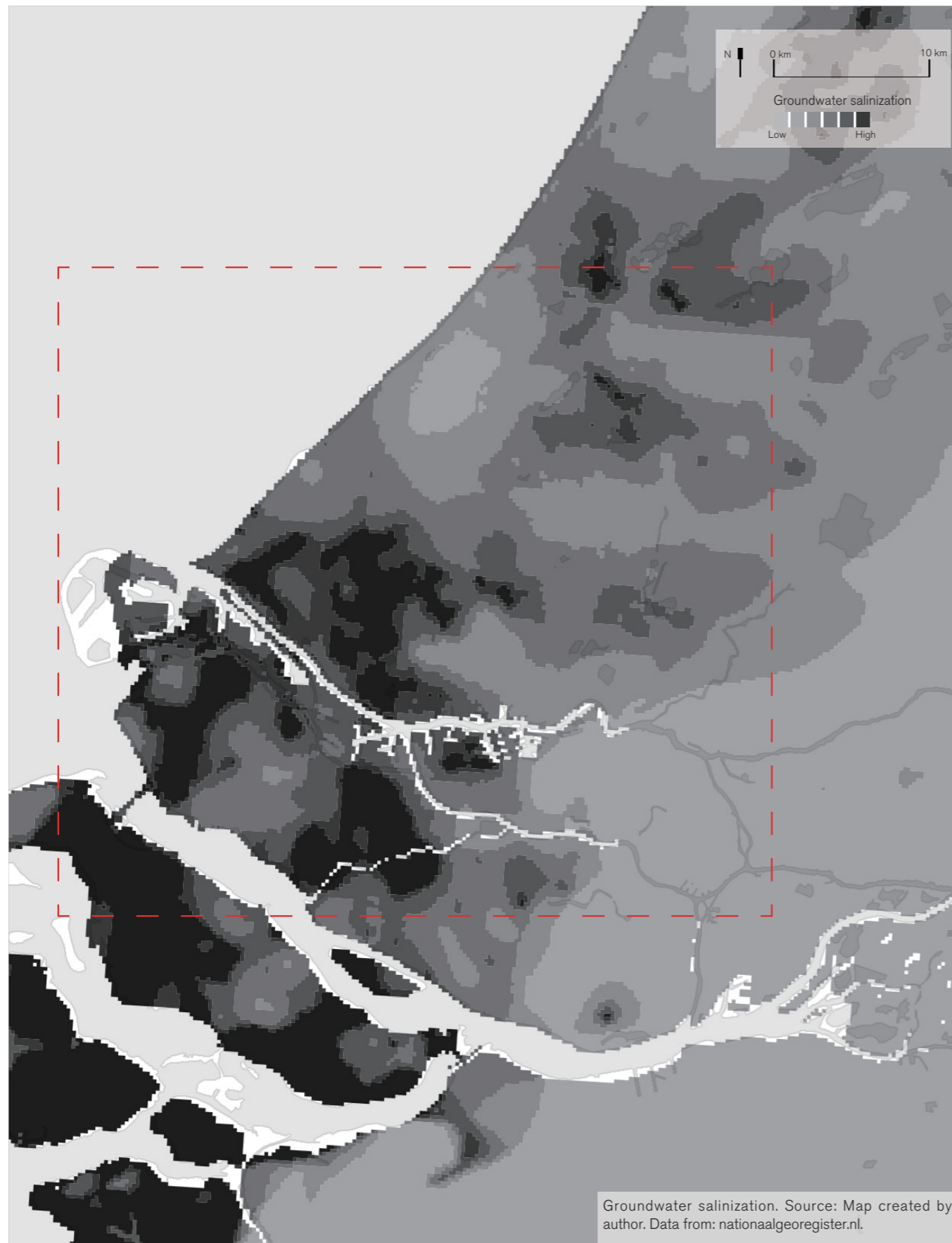
Drivers for Delft zoom in. Source: Map created by author. Data from: Geofabrik.



Drivers for economy. Source: Map created by author. Data from: Geofabrik, CBS, Port of Rotterdam.

PROBLEM FIELD

2. Water pollution threatening ecosystems



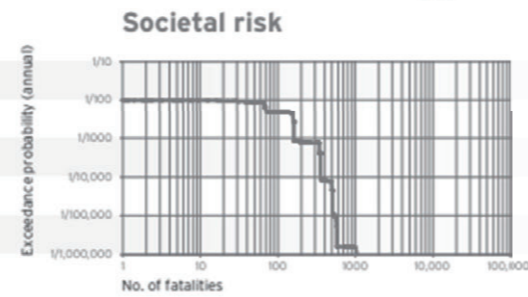
PROBLEM FIELD

3. SEA-LEVEL RISE AND CLIMATE CHANGE

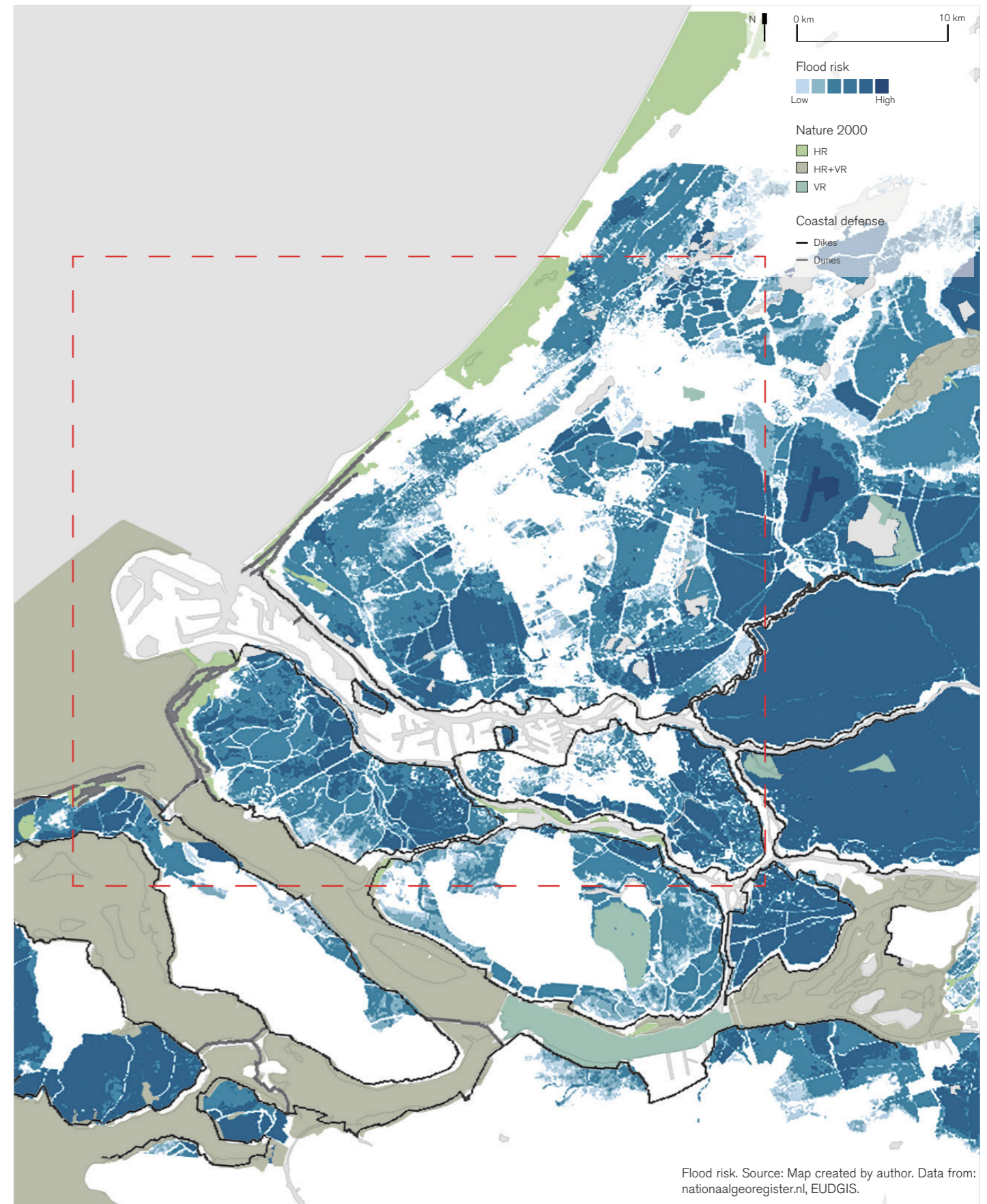
Key features	
Management authority/ies	Hollandse Delta water authority
Length of category-A defences	71.0 km
No. of hydraulic structures	22
Surface area	19,500 ha
Population	155,400



Flood risks	
Annual probability of flooding	1/100
Annual economic risk	€ 12.9 million
Ave. losses per flood event	€ 1.3 billion
Annual loss-of-life risk	1.2
Ave. no. of fatalities per flood event	120



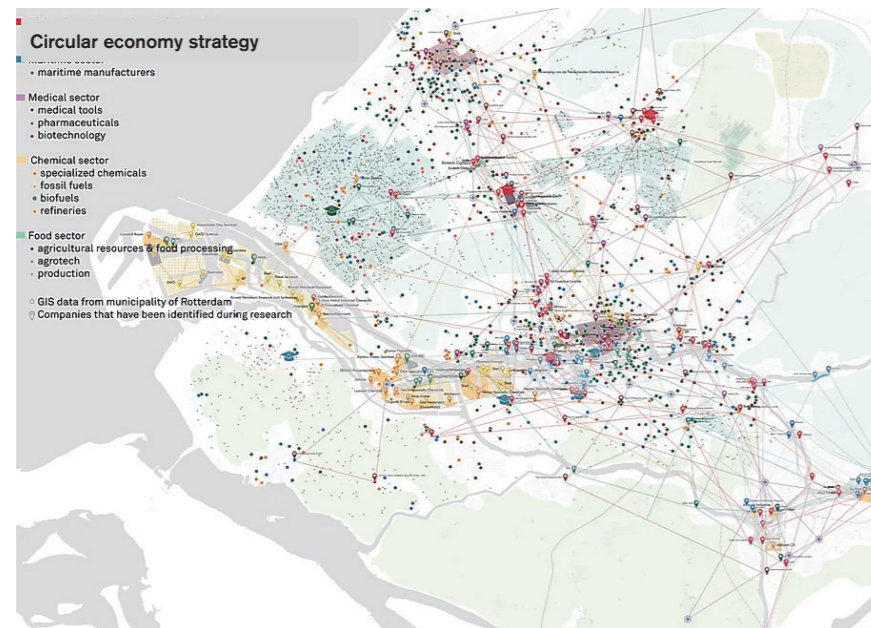
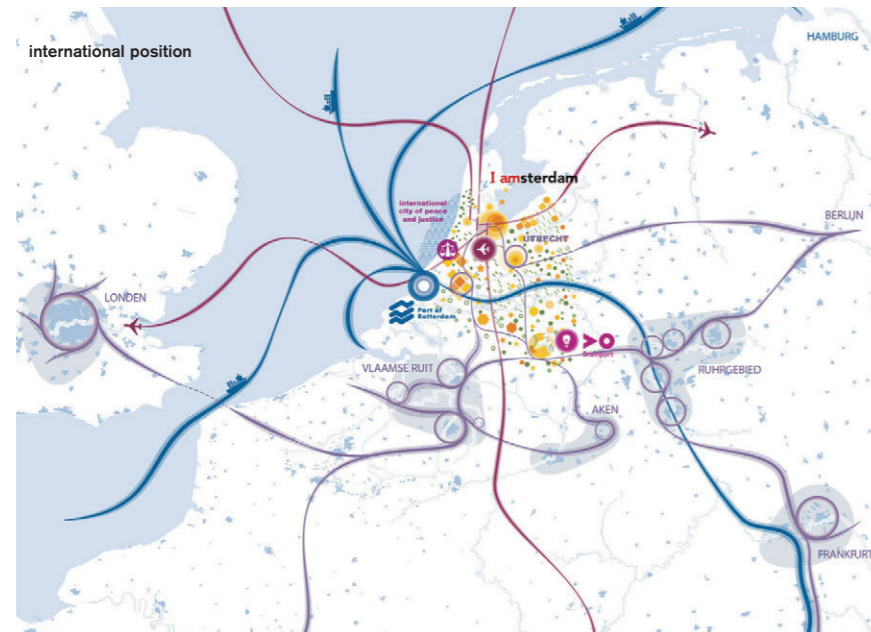
Risk assessment. Source: The National Flood Risk Analysis for the Netherlands (2017)



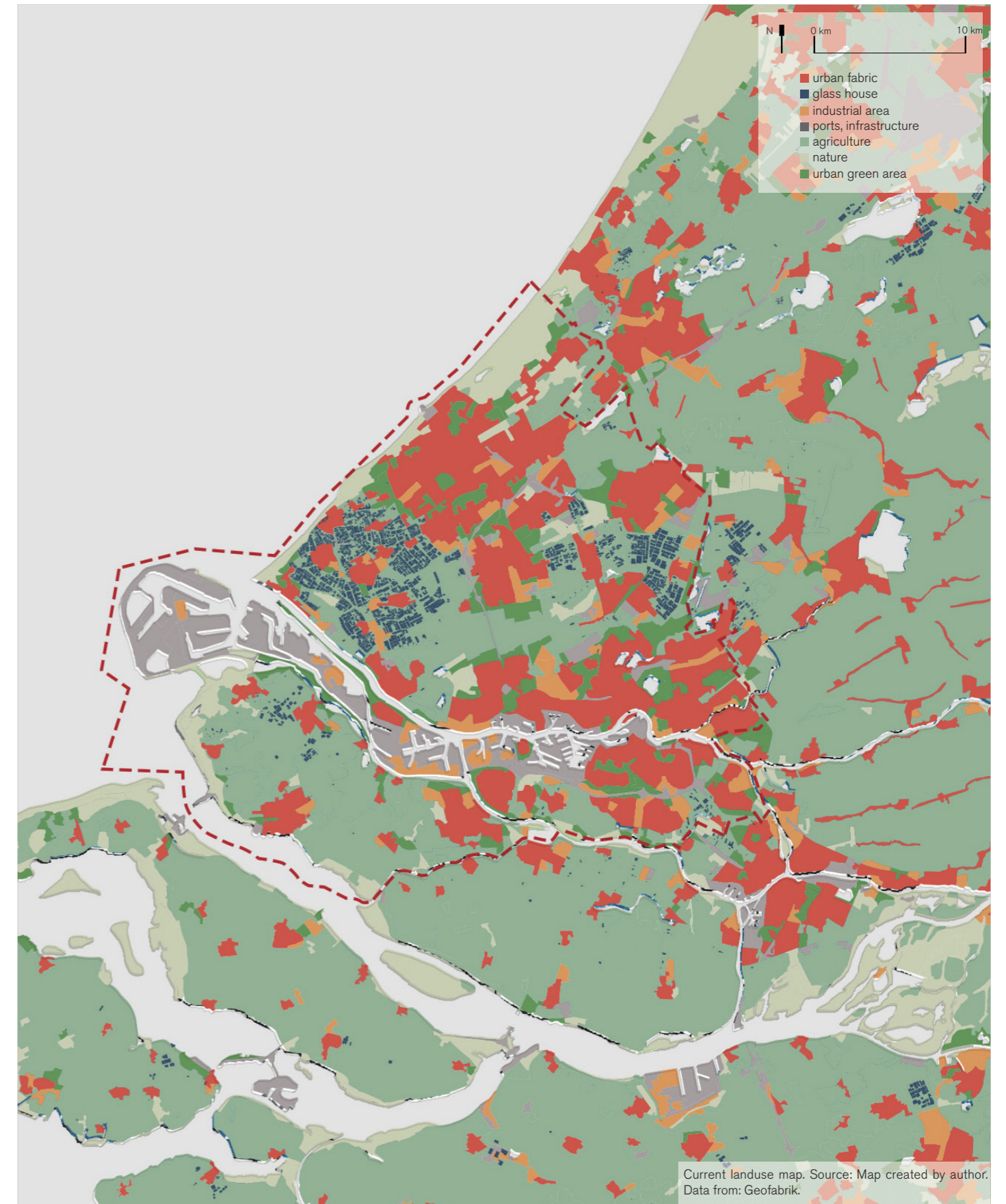
Flood risk. Source: Map created by author. Data from: nationaalgeoregister.nl, EUDGIS.

PROBLEM FIELD

4. The needs to revise production system and ecological impact



Existing strategies. Source: NEXT ECONOMY, NEXT CITY, marcobroekman.



PROBLEM FIELD

5. Bio-based solution and circular economy

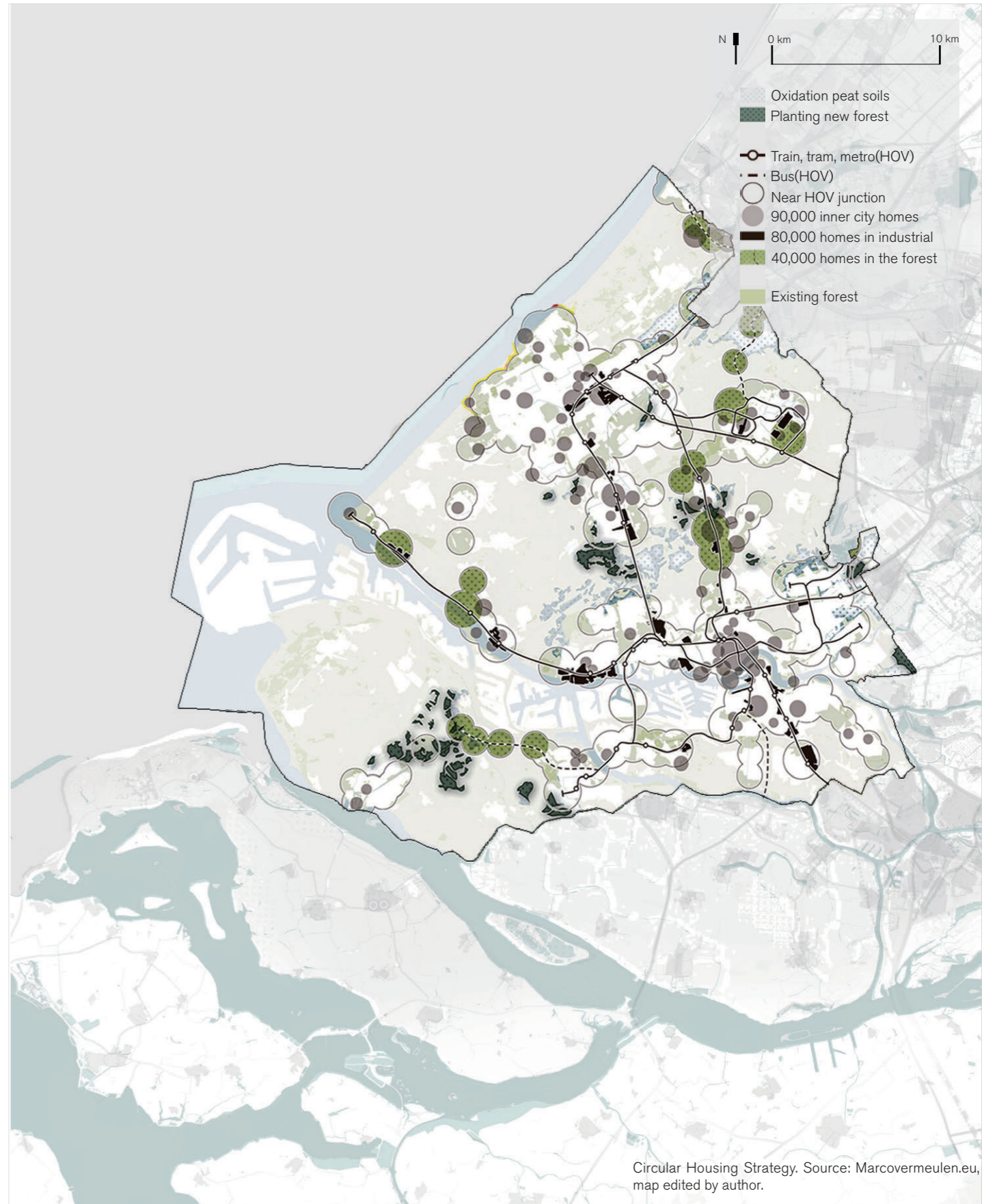
Seaweed farm fix the climate



Biogas Energy plant



Source: chinadialogue.net, picture edited by author.



PROBLEM STATEMENT

The **growing urban economy comes at the cost of natural capital, destroying ecosystem services** forming an unsustainable production cycle.

In the face of sea-level rise, high precipitation condition, the use of **bio-based solutions** is crucial, we need to **rethink the economic production patterns** and the relationship between cities and nature, so to **facilitate a sustainable economic system, also areas and conditions for urban expansion.**

RESEARCH QUESTION

What kind of shift in the economic production system could change the current waste flows between cities and nature to facilitate a sustainable and resilient economy in the Metropoolregio Rotterdam Den Haag (MRDH)?

HYPOTHESIS

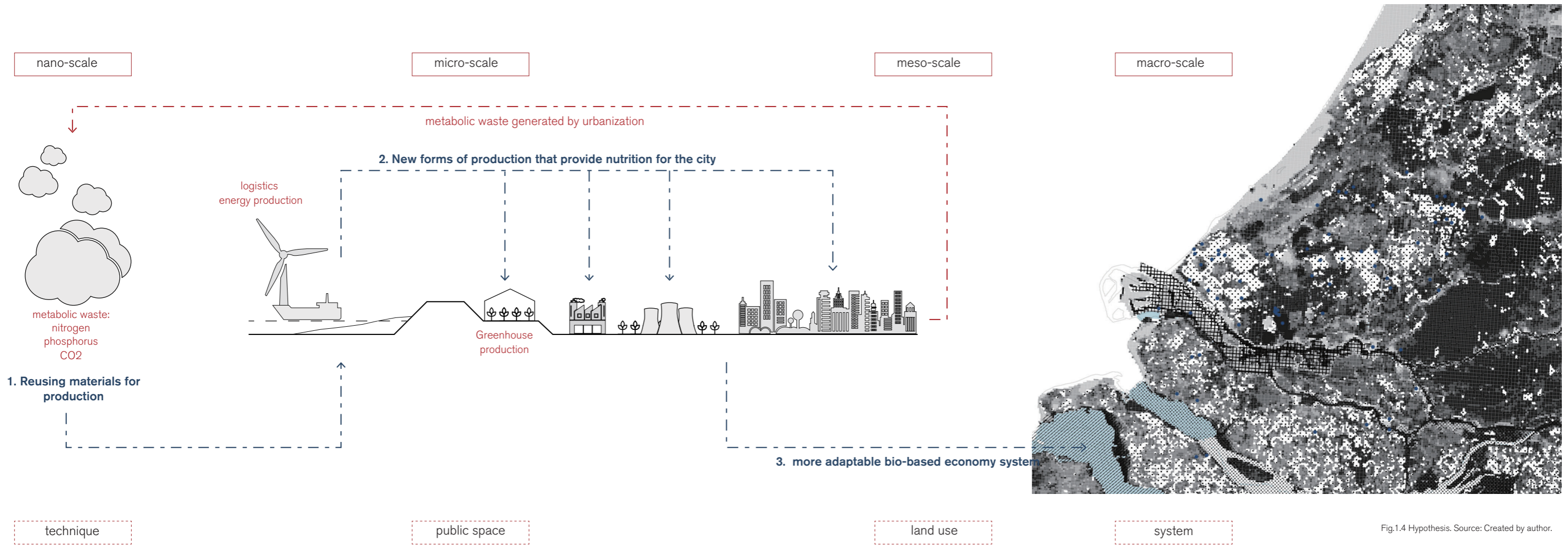
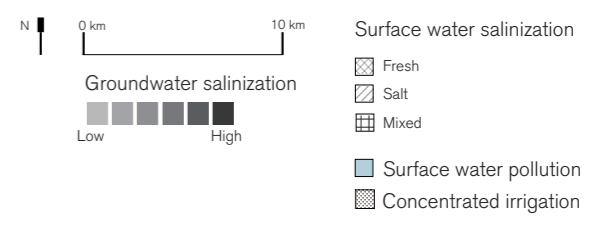
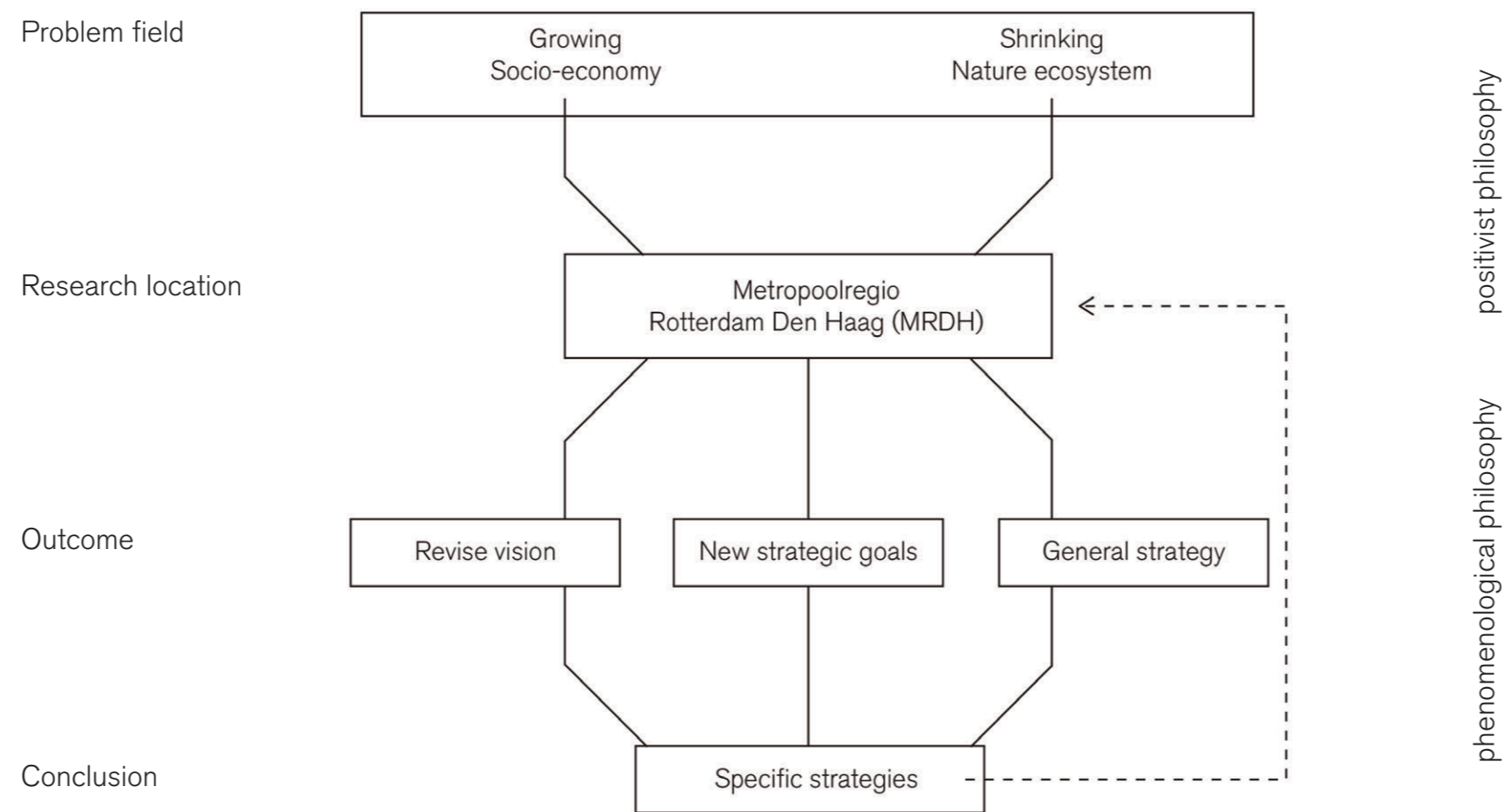


Fig.1.4 Hypothesis. Source: Created by author.



METHODOLOGY

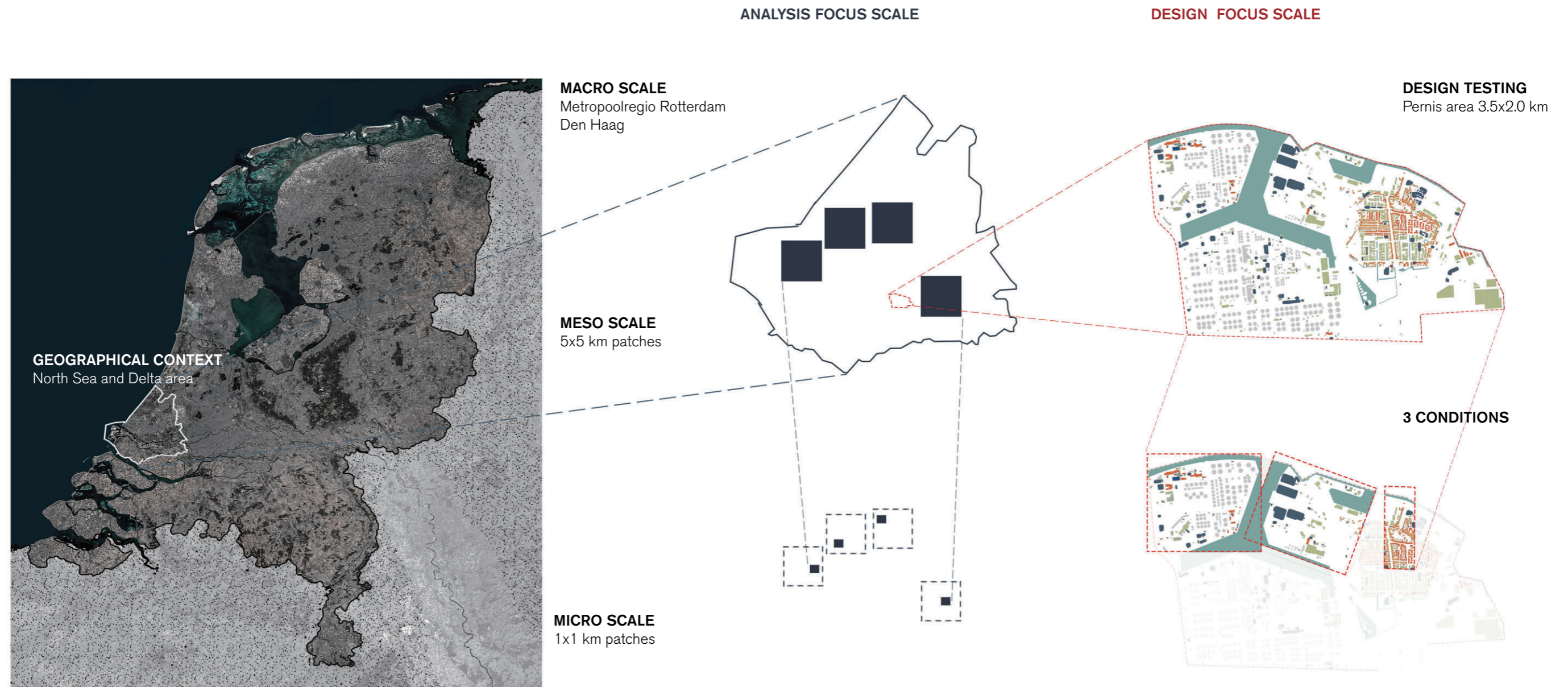
RESEARCH APPROACH



Research approach. Source: Created by author.

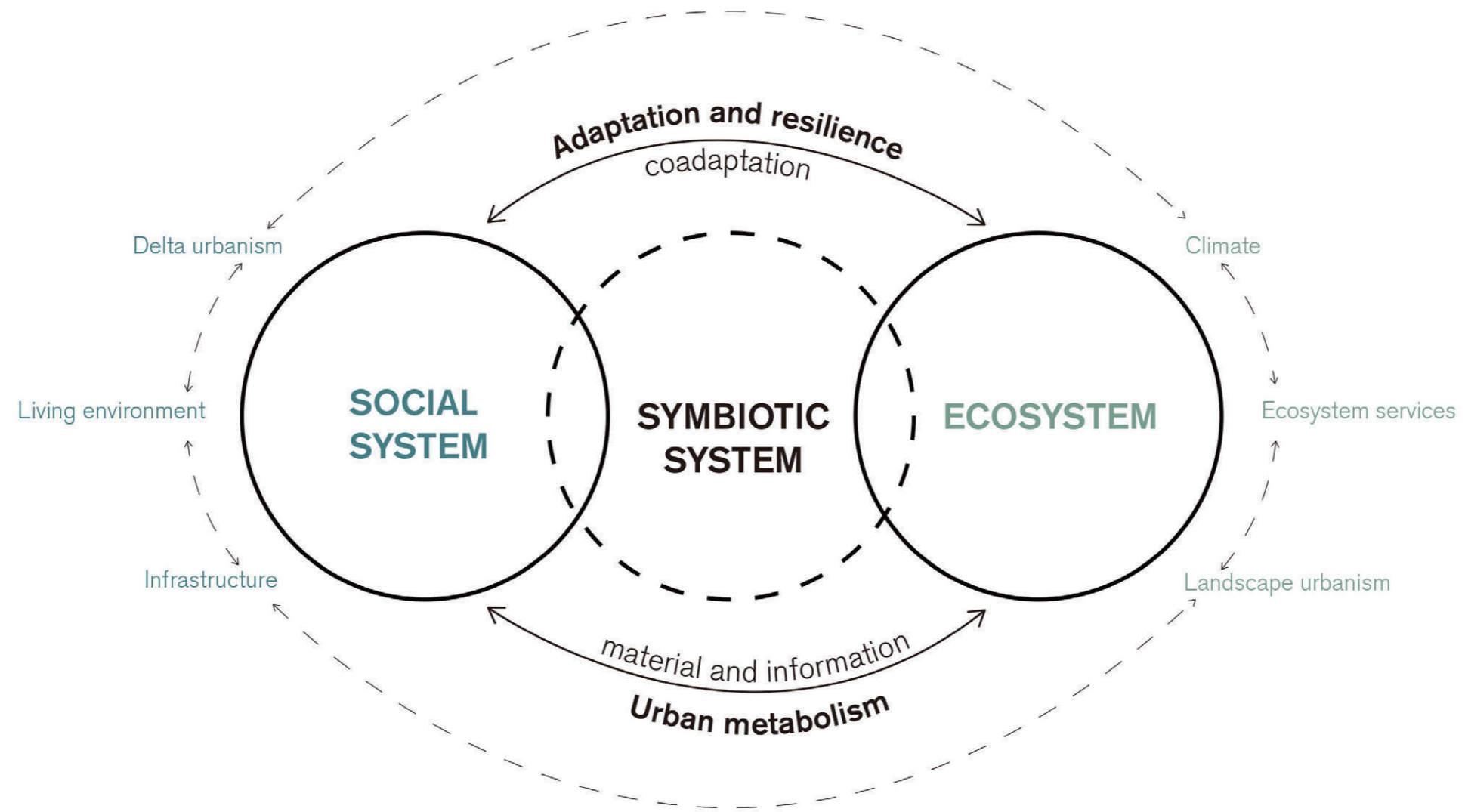
RESEARCH APPROACH

Spatial scale and systematic approach



Source: Map created by author. Satellite image from Googlemap.

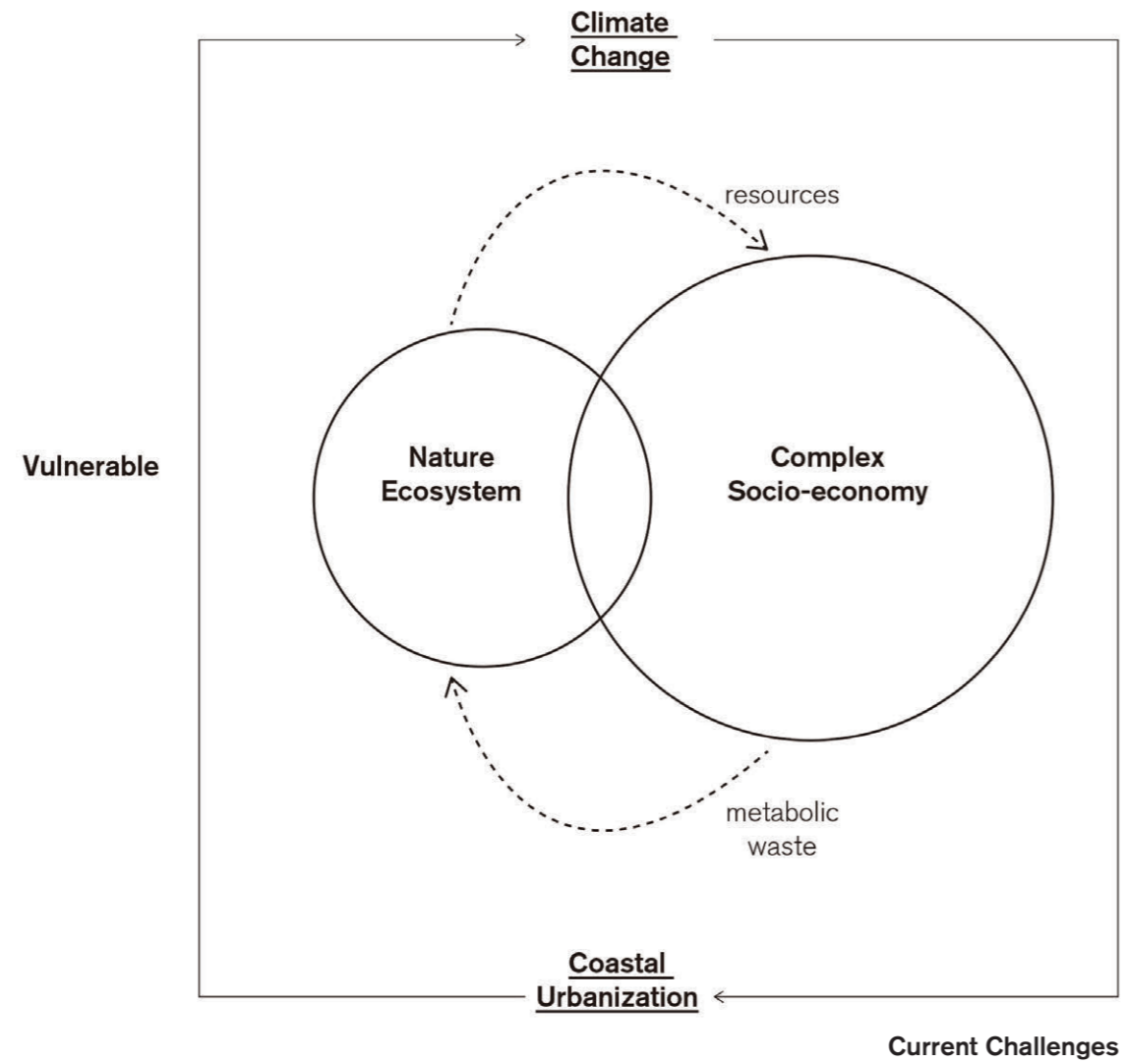
THEORETICAL FRAMEWORK



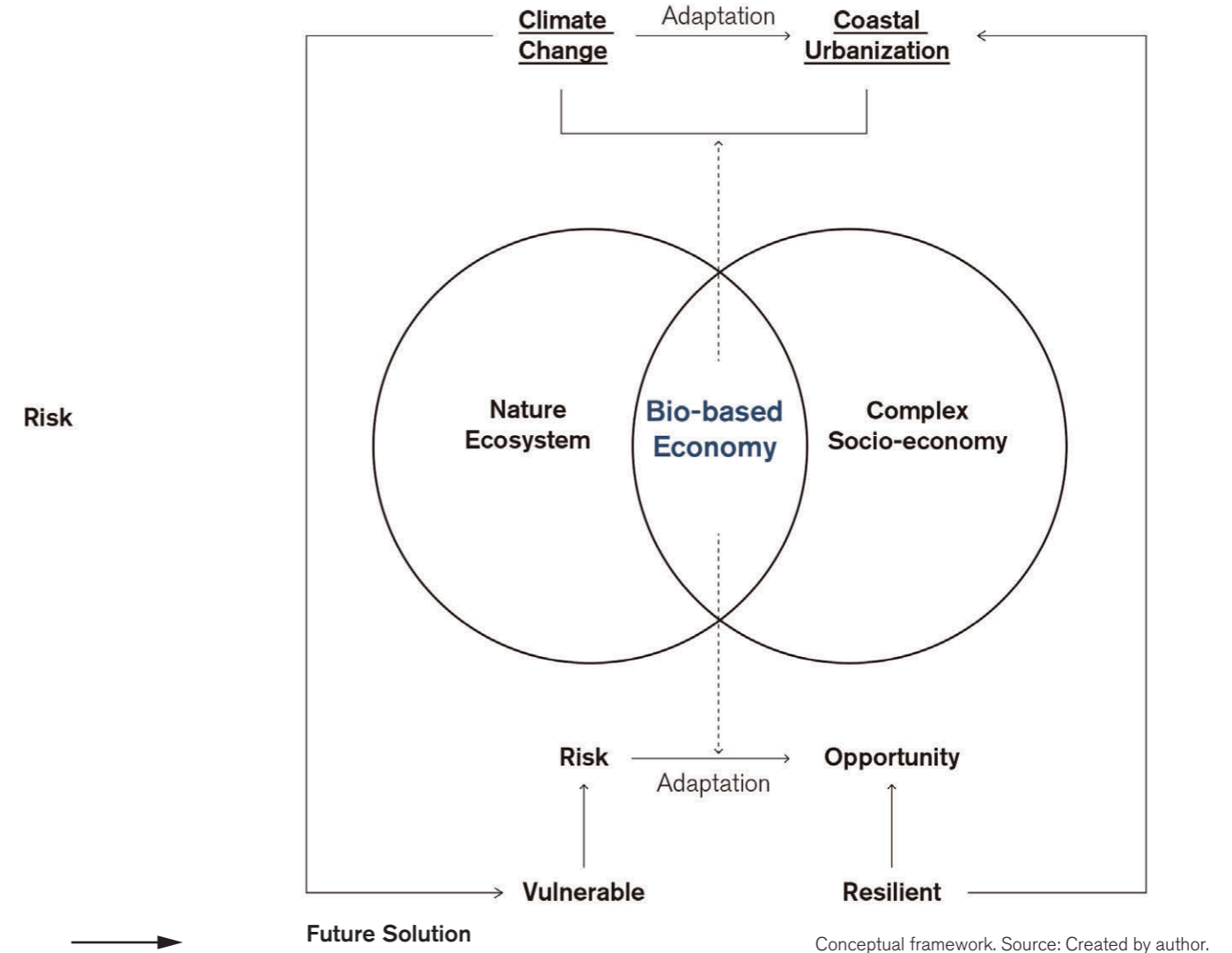
Theoretical framework. Source: Created by author.

CONCEPTUAL FRAMEWORK

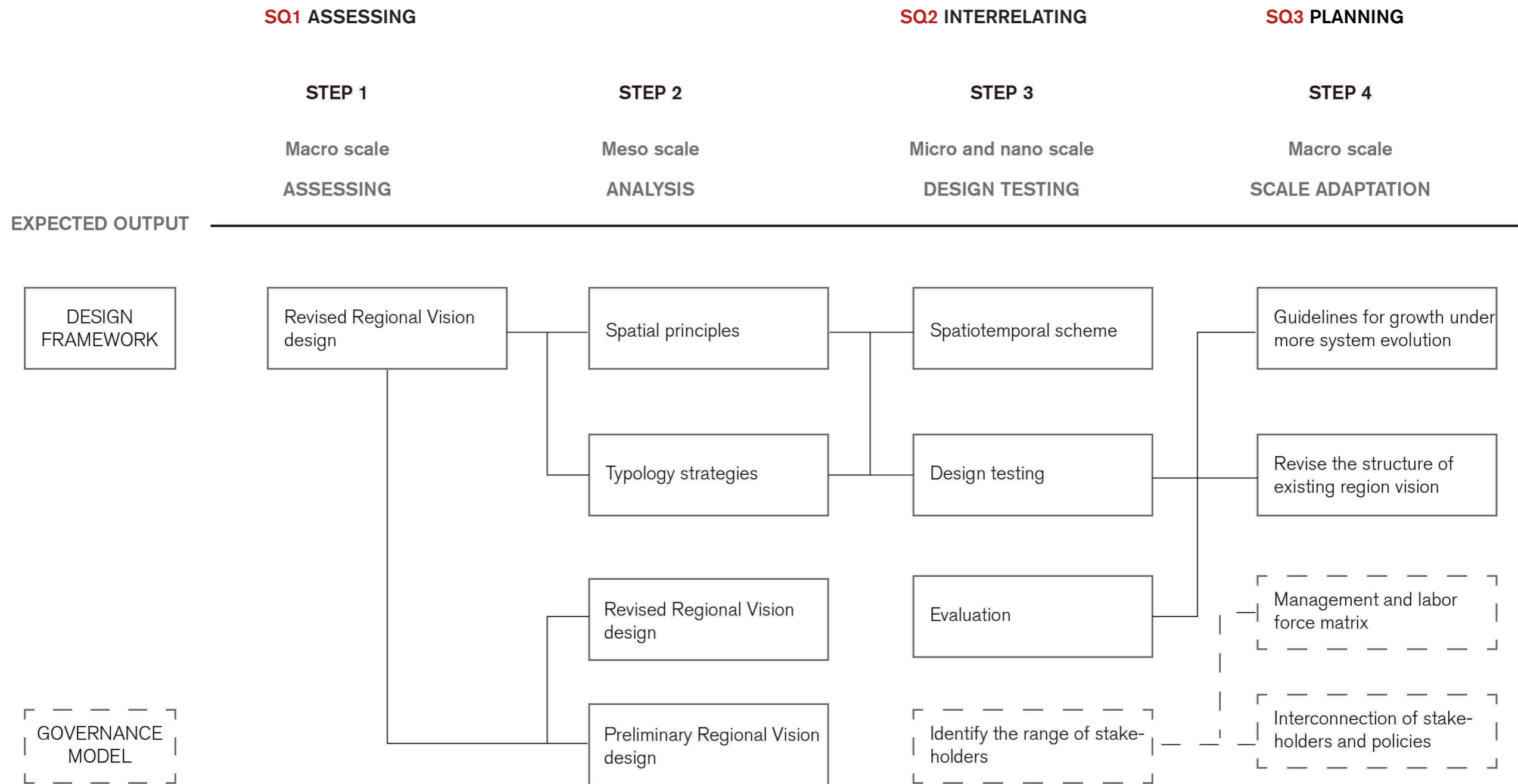
Unbalanced and unsustainable development



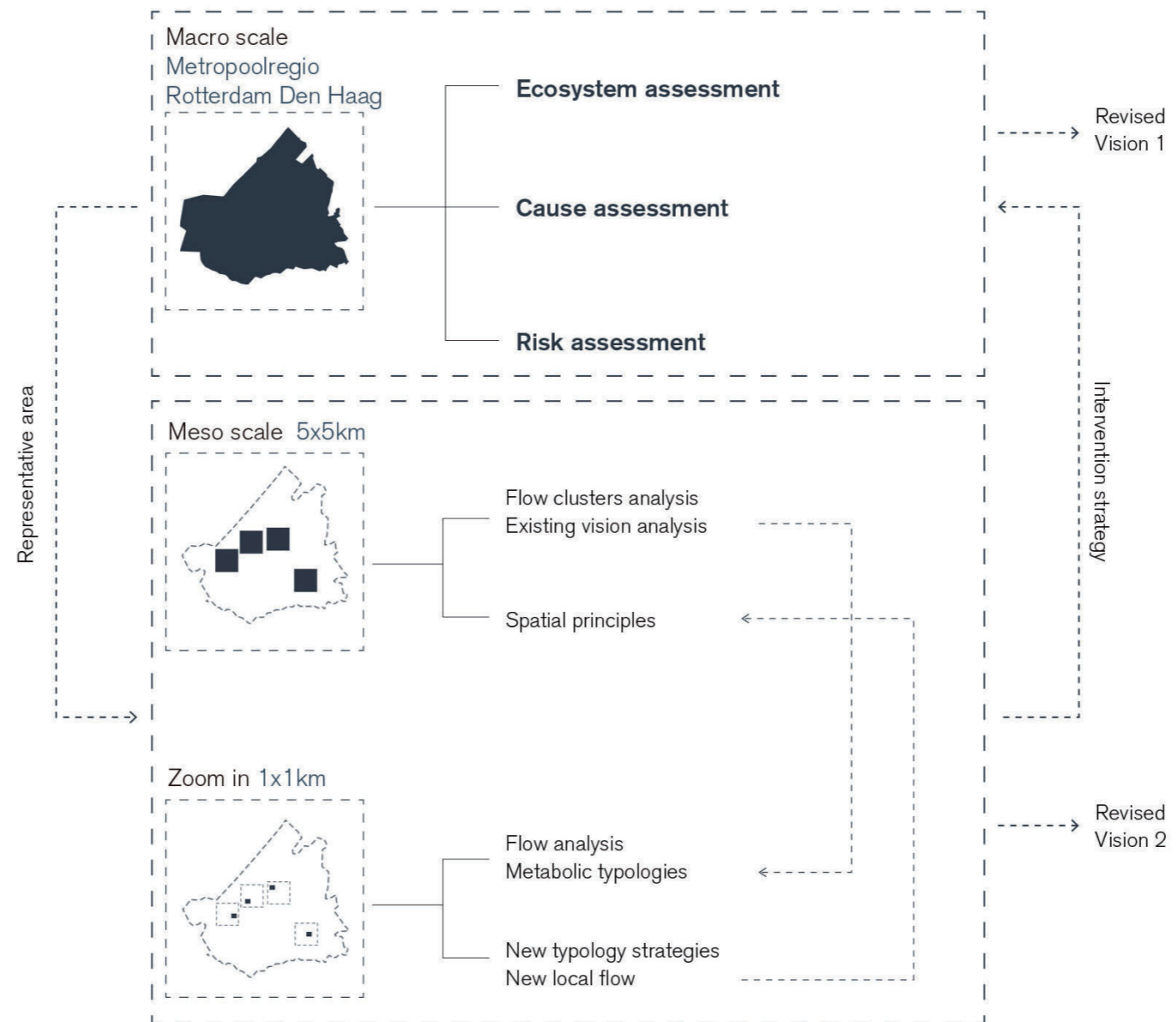
Balanced and sustainable development



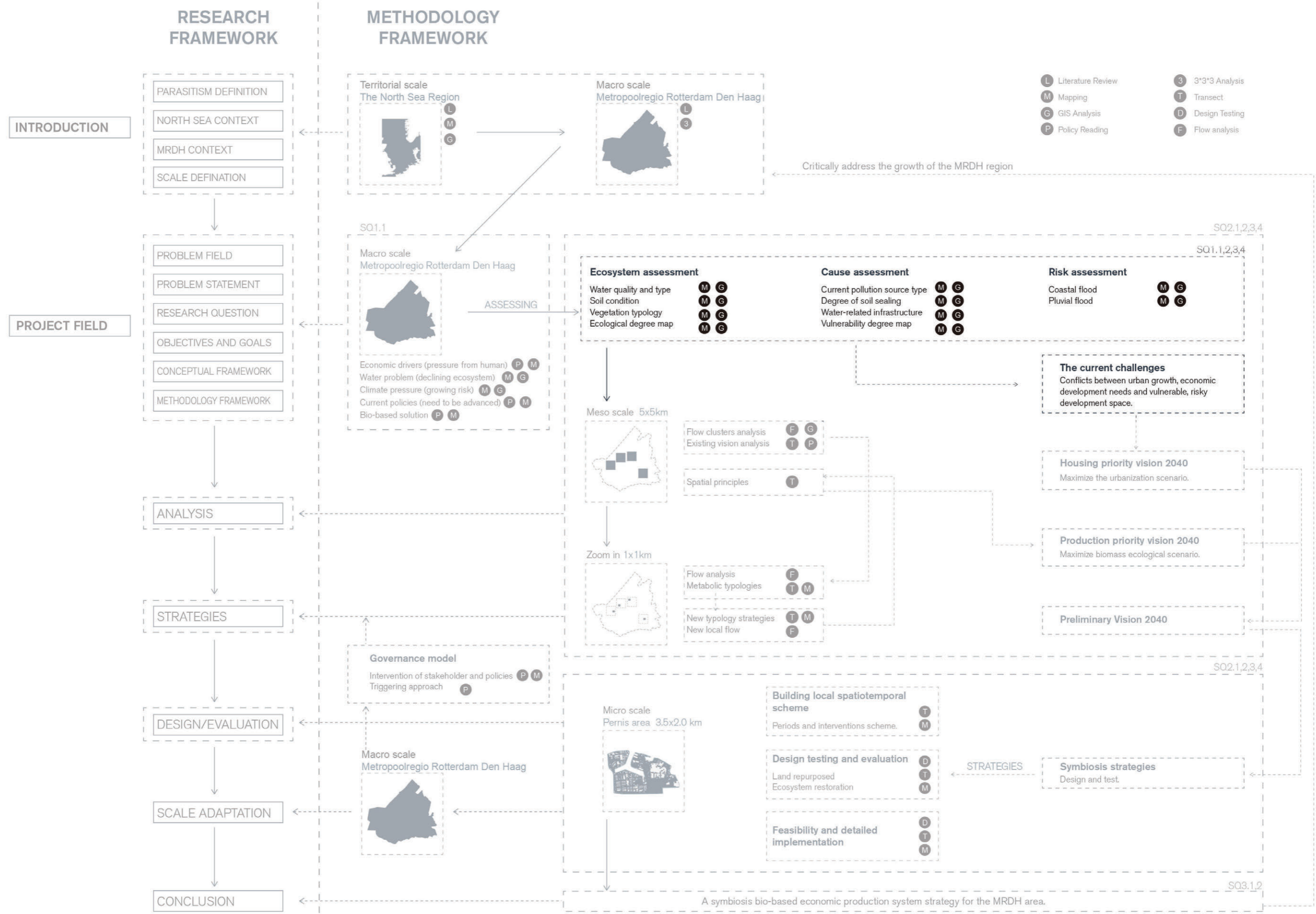
EVOLUTIONARY OUTPUT FRAMEWORK



ANALYSIS



MACRO SCALE ANALYSIS

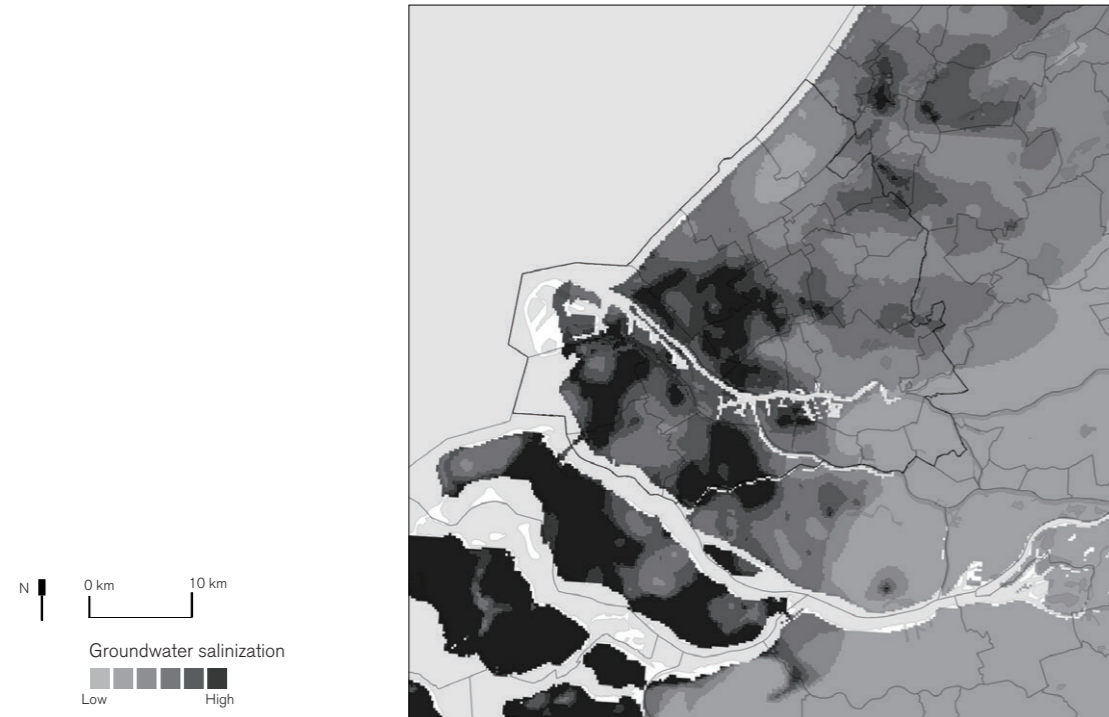


MACRO SCALE ANALYSIS

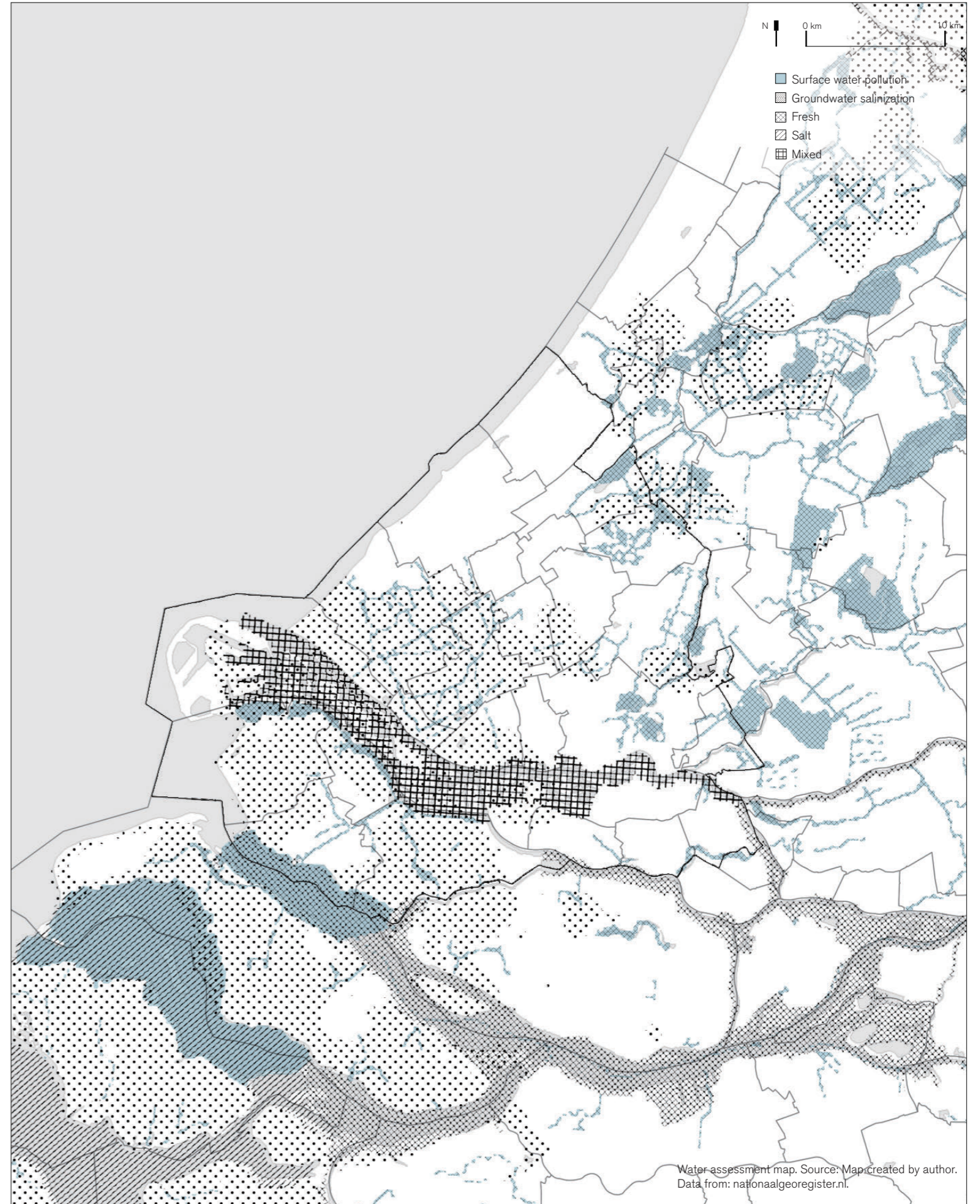
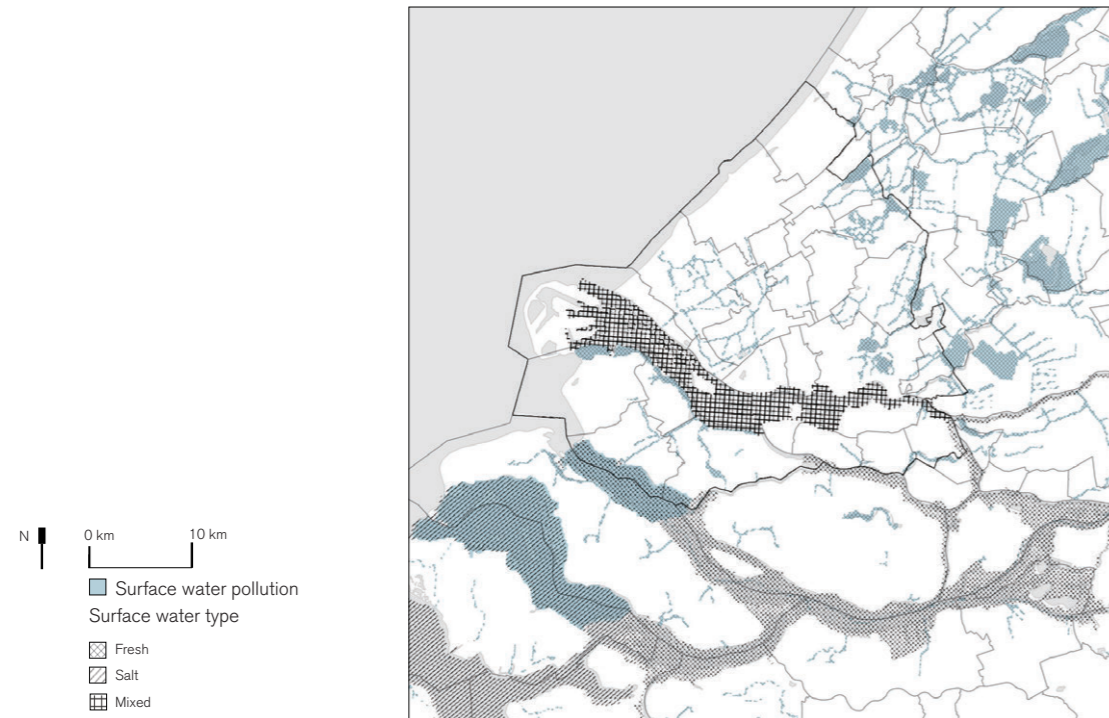
Ecosystem assessment

1. Water assessment

Groundwater salinization. Source: Map created by author. Data from: nationaalgeoregister.nl.



Surface water pollution and type. Source: Map created by author. Data from: nationaalgeoregister.nl.

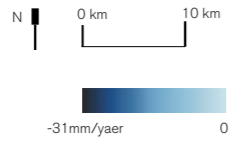


Water assessment map. Source: Map created by author. Data from: nationaalgeoregister.nl.

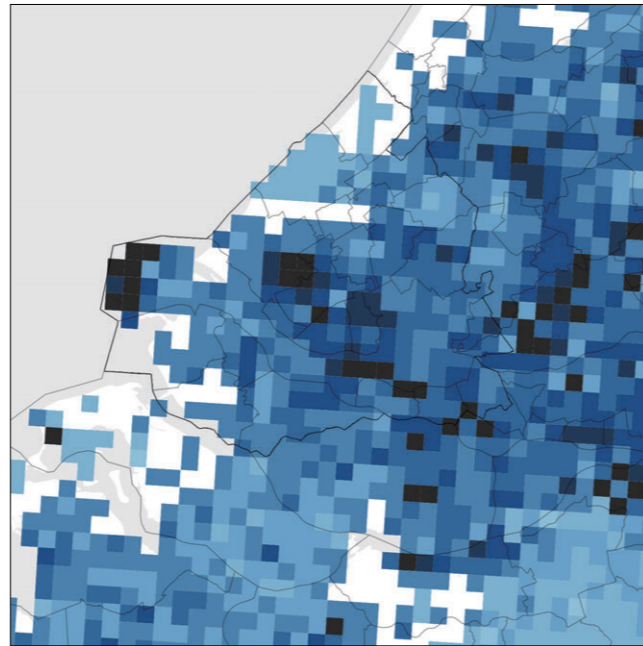
MACRO SCALE ANALYSIS

Ecosystem assessment

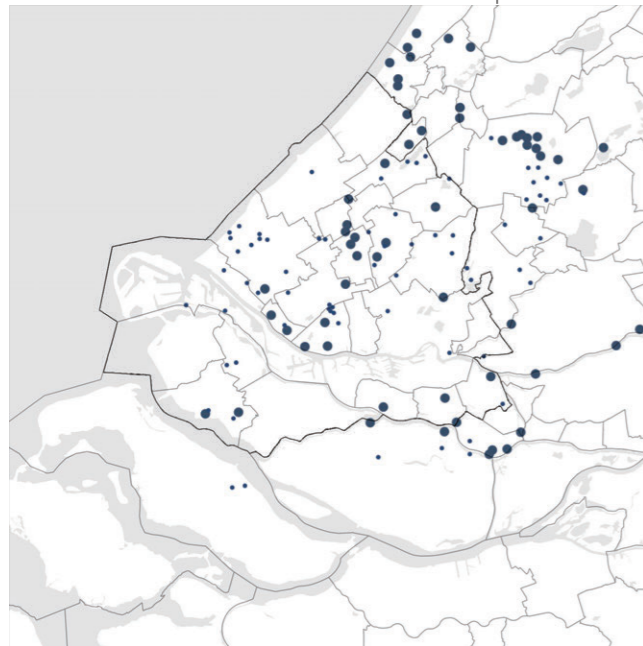
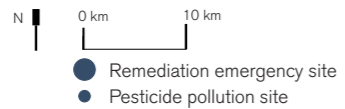
2. Soil assessment



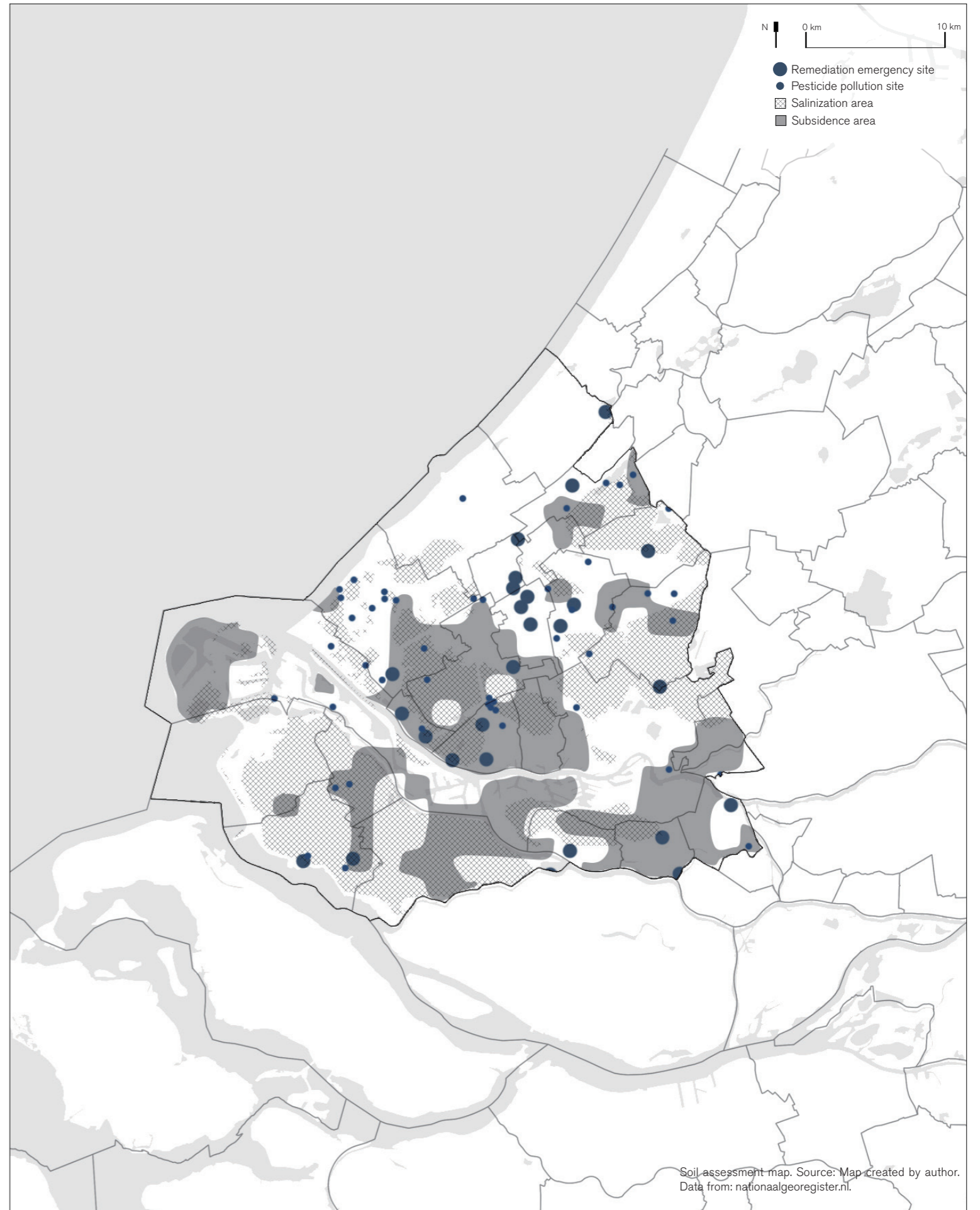
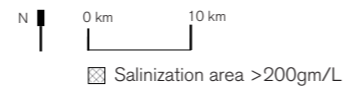
Soil subsidence. Source: Map created by author. Data from: nationaalgeoregister.nl.



Surface soil pollution. Source: Map created by author. Data from: nationaalgeoregister.nl.



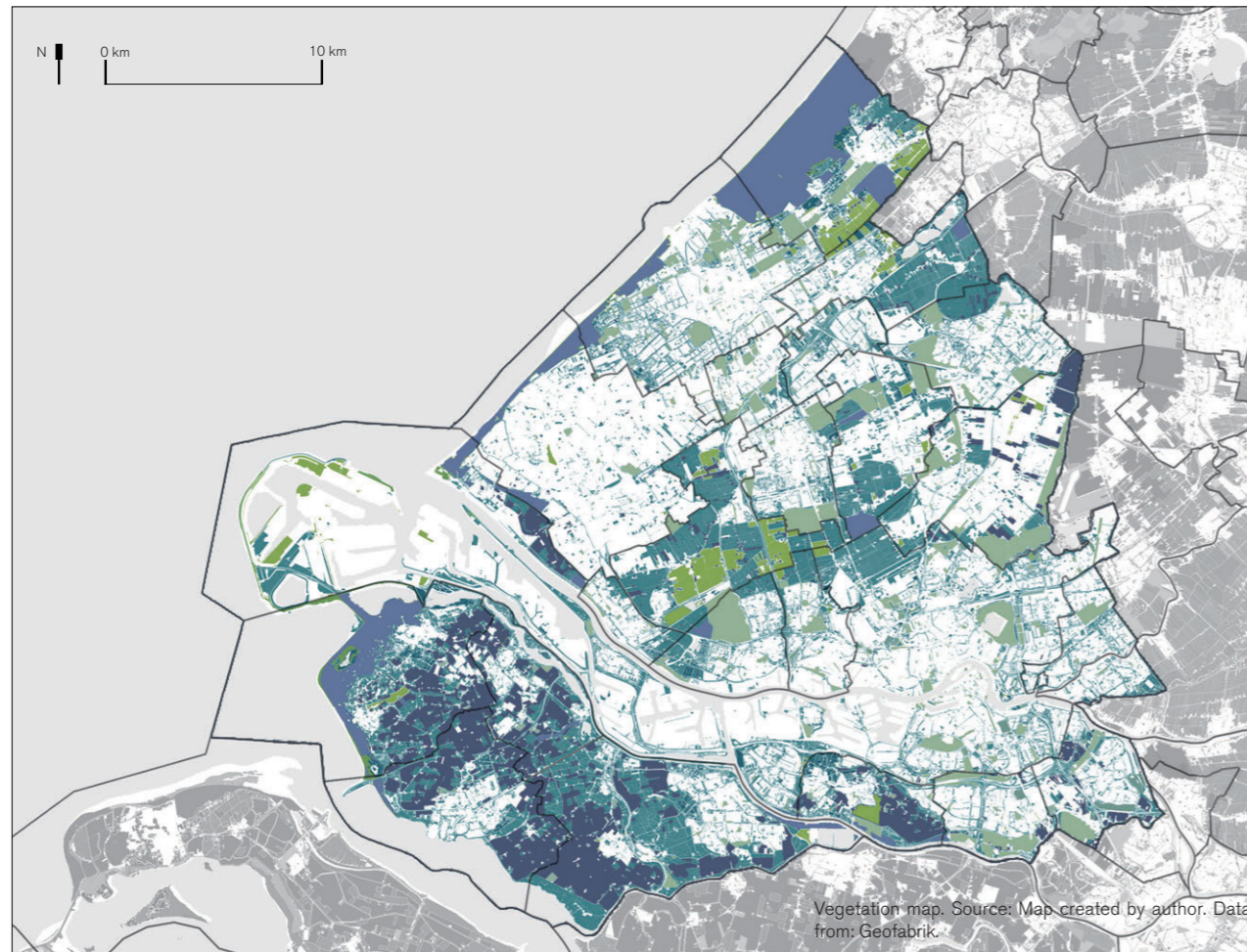
Groundsoil salinization. Source: Map created by author. Data from: nationaalgeoregister.nl.



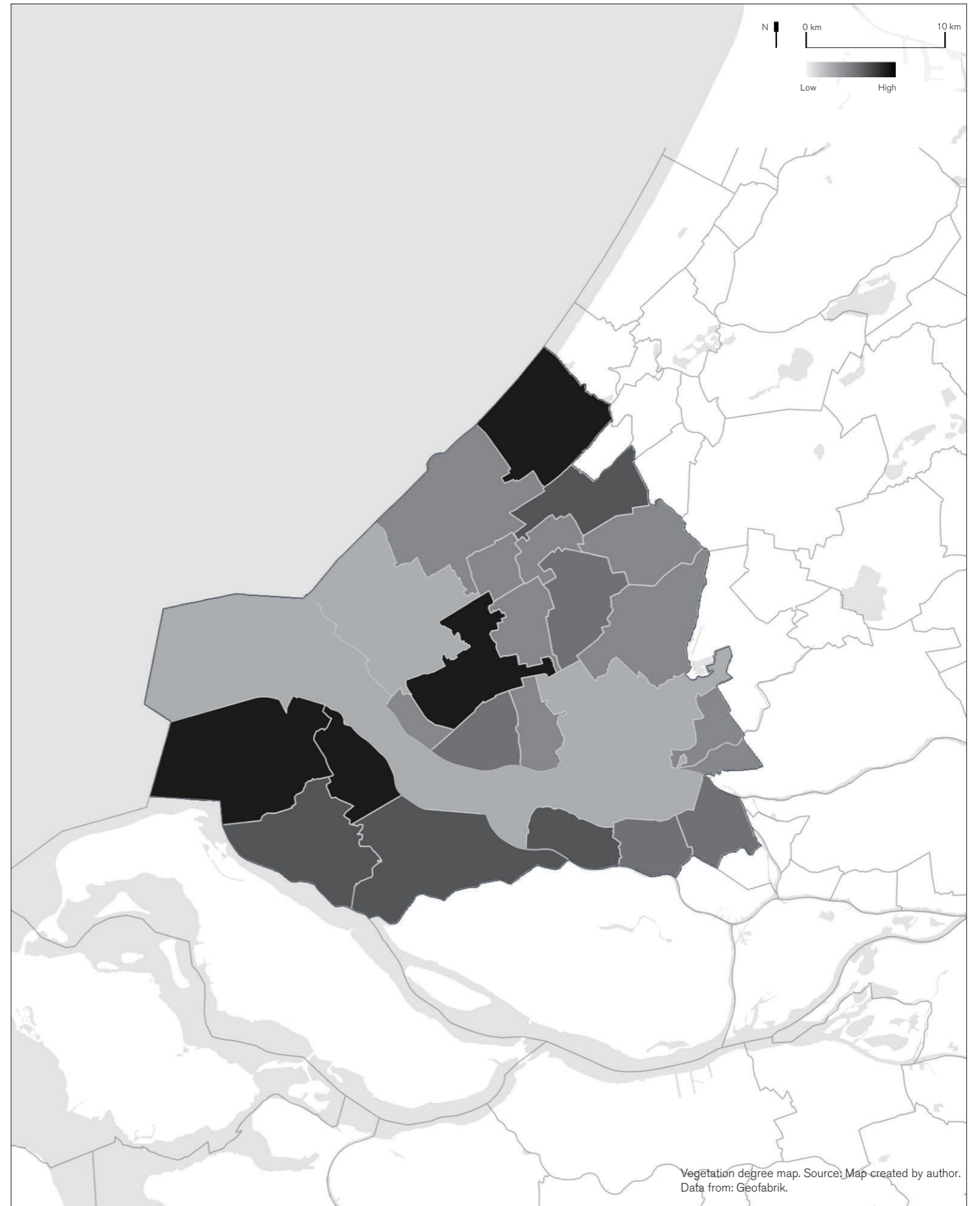
MACRO SCALE ANALYSIS

Ecosystem assessment

3. Vegetation degree



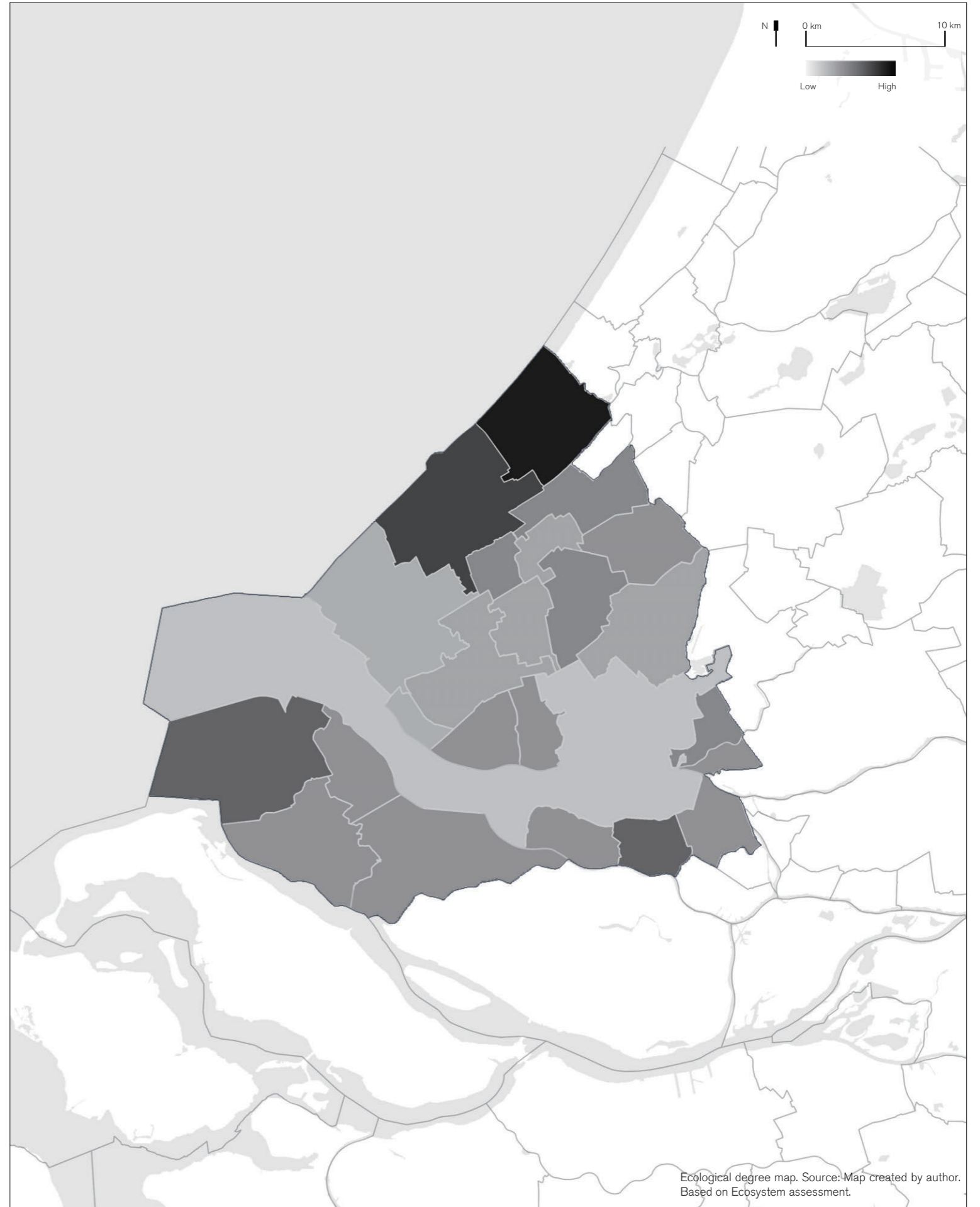
$$\text{Vegetation degree} = \frac{\text{Area}(\text{factor}1) \times \text{Weight}(1) + \dots + \text{Area}(\text{factor} n) \times \text{Weight}(n)}{\text{Area}(\text{city} 1)}$$



MACRO SCALE ANALYSIS

Ecosystem assessment conclusion: Ecological degree map

Synthesis of ecosystem assessment. Source: Map created by author based on ecosystem assessment.



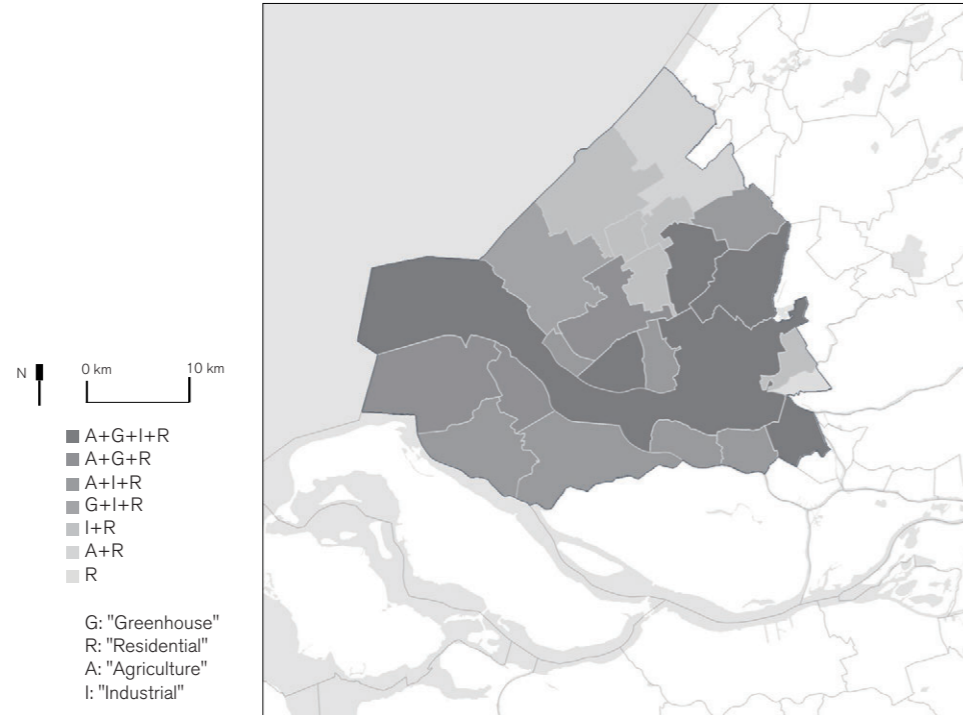
Ecological degree map. Source: Map created by author. Based on Ecosystem assessment.

MACRO SCALE ANALYSIS

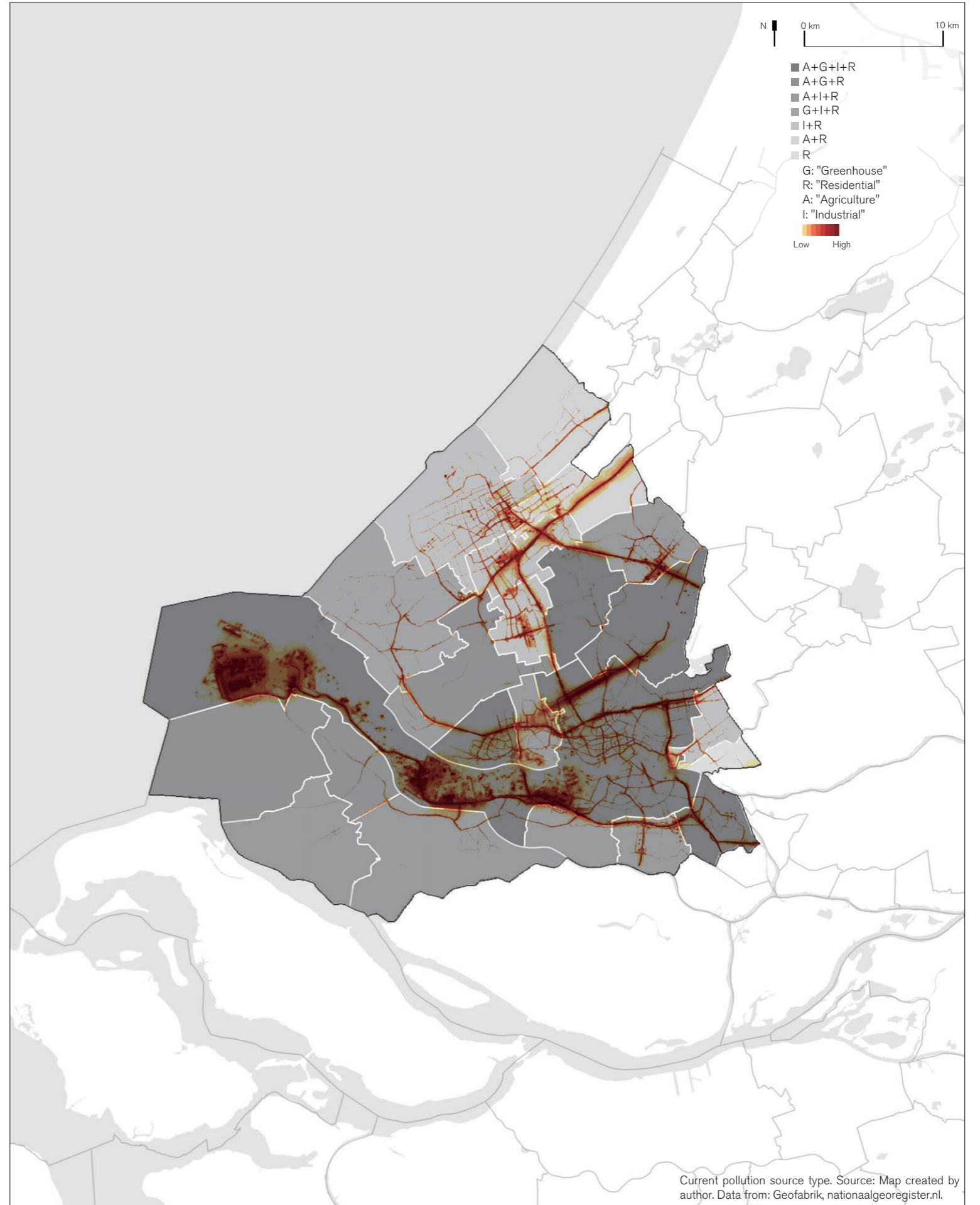
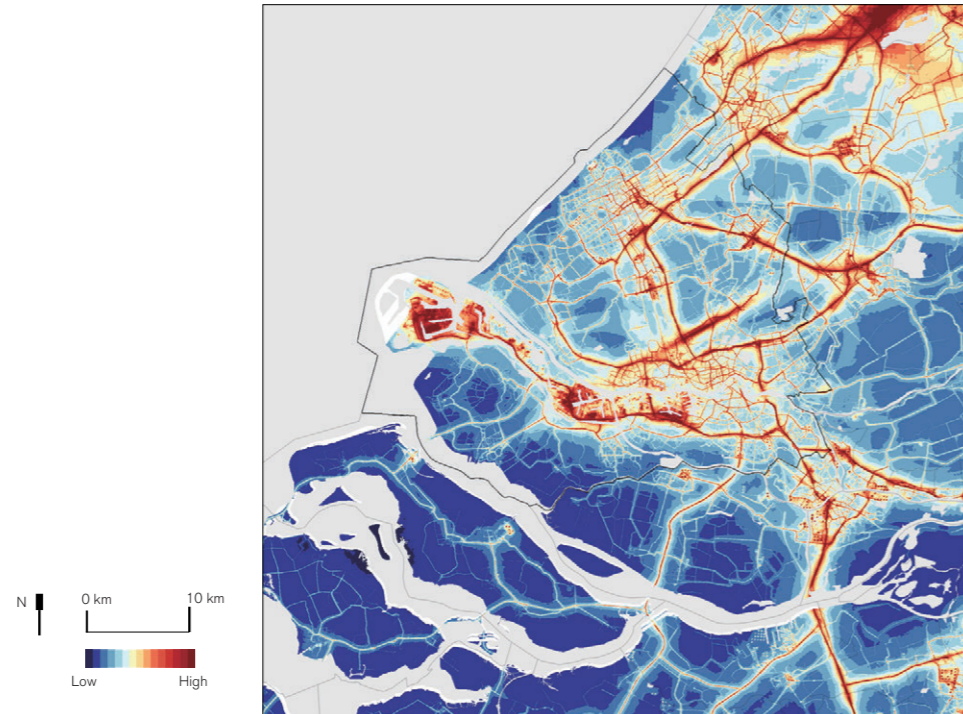
Cause assessment

1. Current pollution source type

Pollution from production. Source: Map created by author. Data from: nationaalgeoregister.nl.



Pollution from infrastructure. Source: Map created by author. Data from: nationaalgeoregister.nl.



Current pollution source type. Source: Map created by author. Data from: Geofabrik, nationaalgeoregister.nl.

MACRO SCALE ANALYSIS

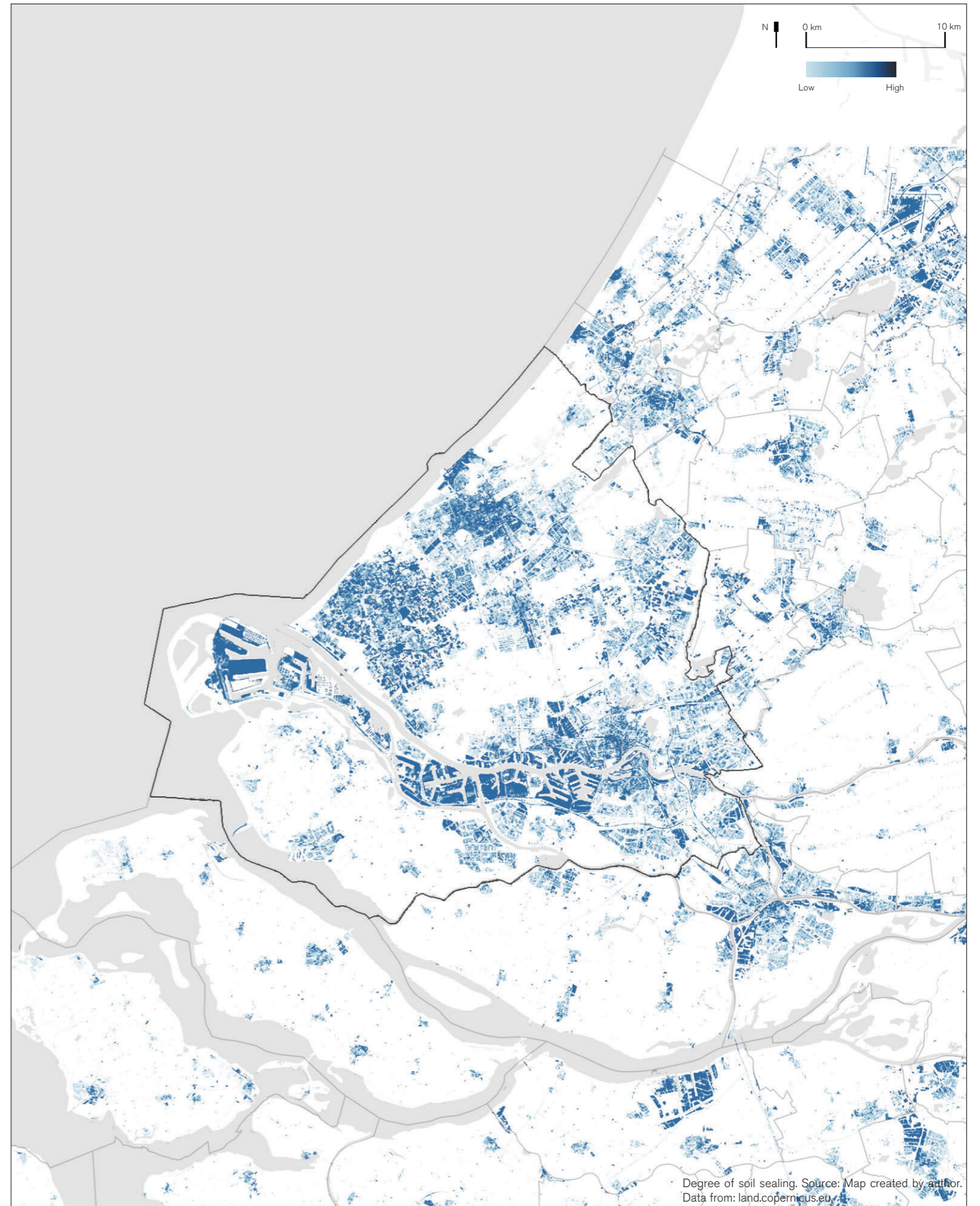
Cause assessment

2. Soil sealing

Westland. Source: Map edited by author, satellite image from Bing Map.



Port of rotterdam. Source: Map edited by author, satellite image from Bing Map.



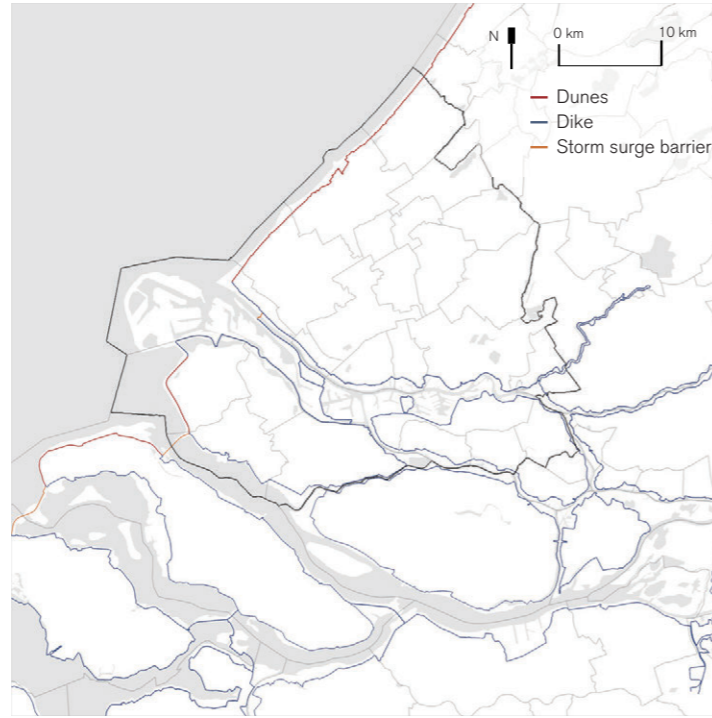
Degree of soil sealing. Source: Map created by author. Data from: land.copernicus.eu.

MACRO SCALE ANALYSIS

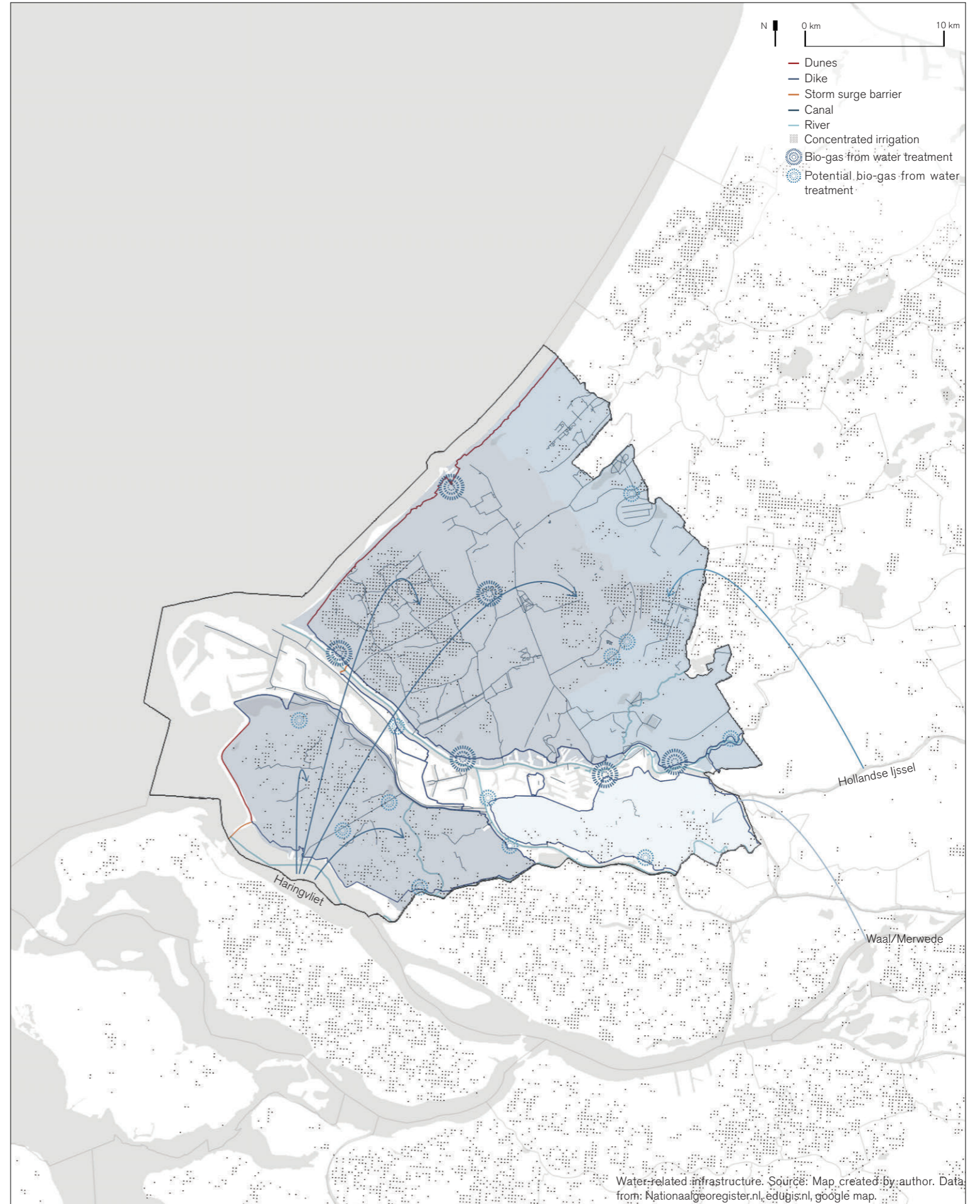
Cause assessment

3. Water-related infrastructure

Coastal defense system. Source: Map created by author. Data from: edugis.nl.



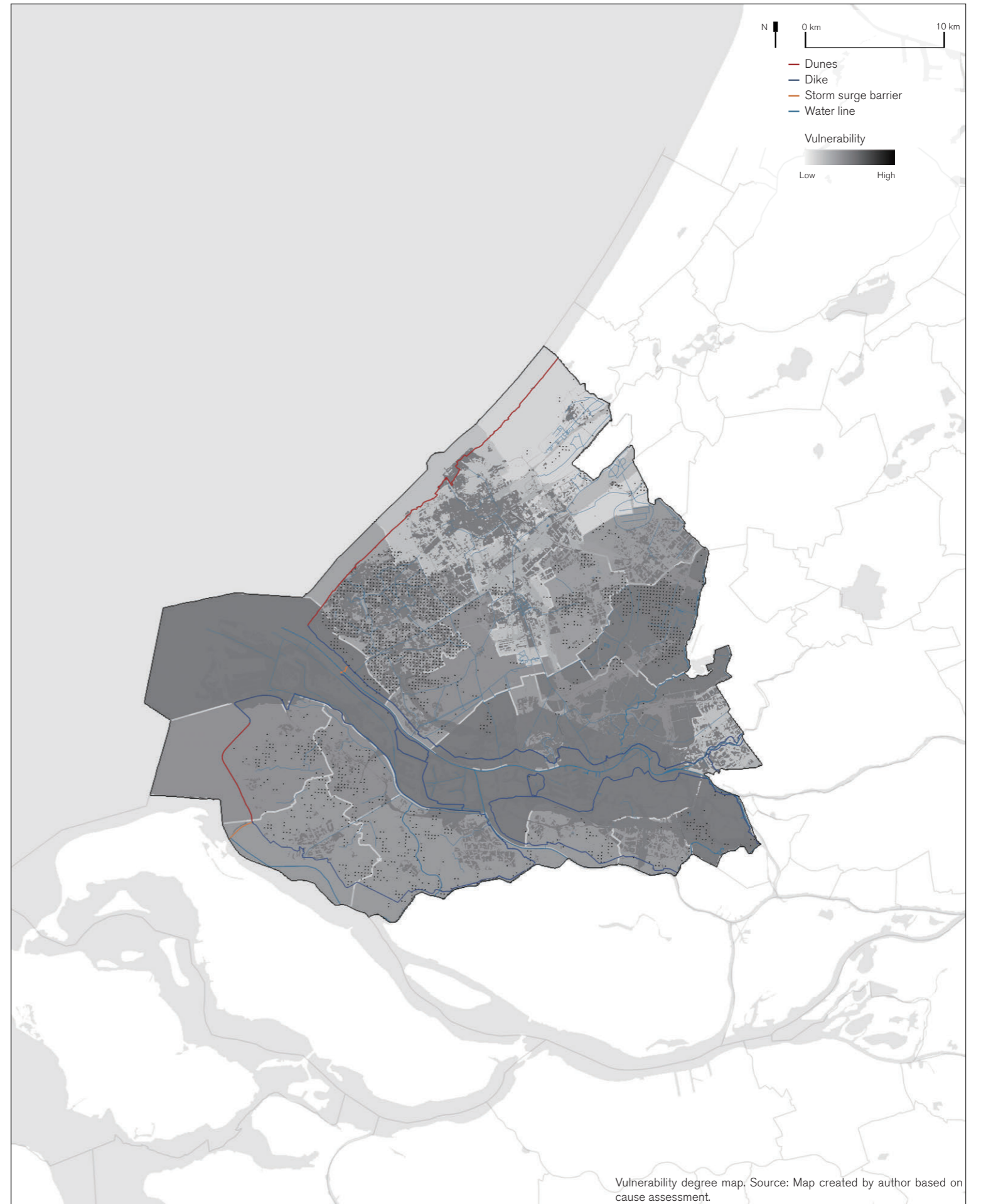
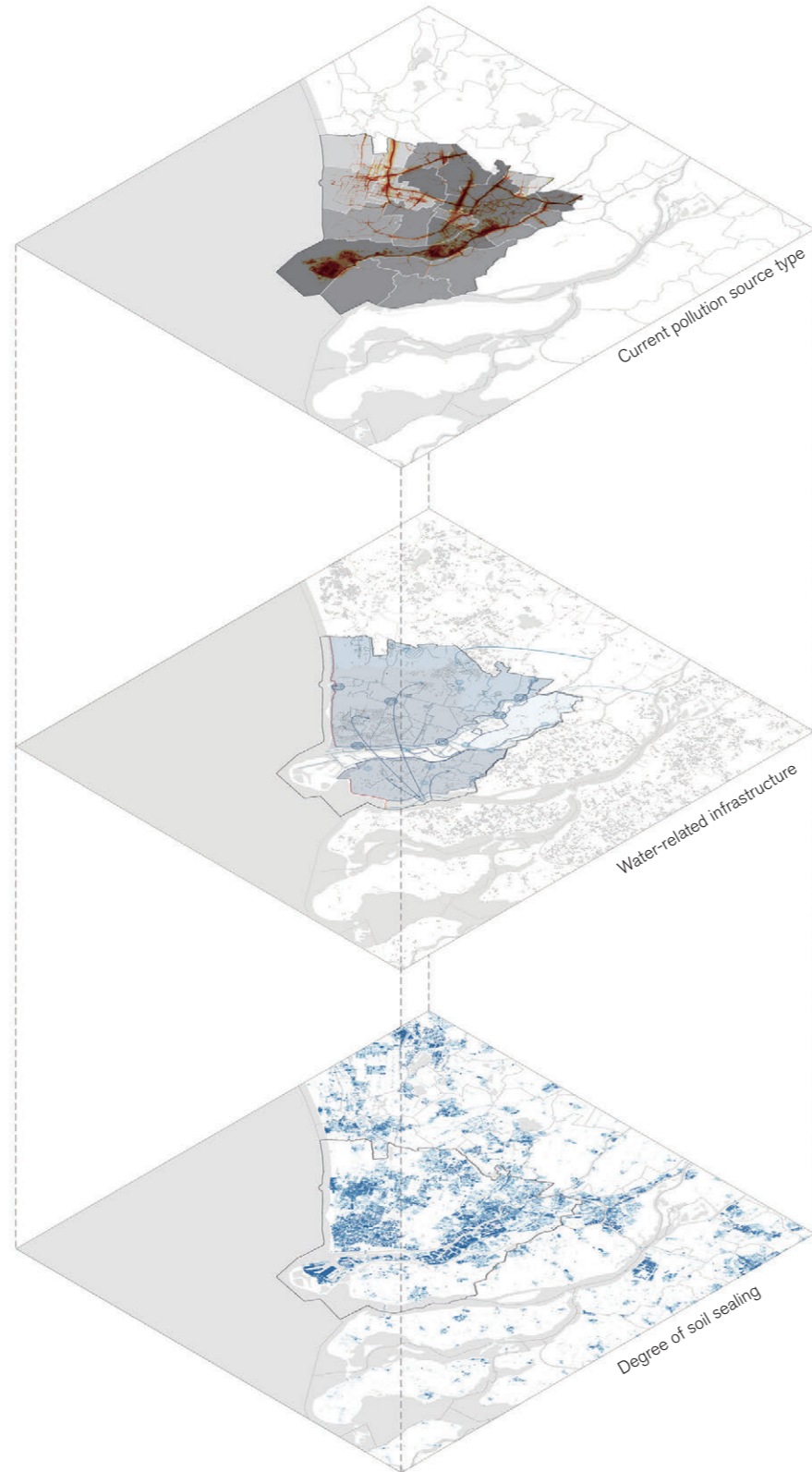
Water treatment company. Source: Map created by author. Data from: Google Map.



MACRO SCALE ANALYSIS

Cause assessment conclusion: Vulnerability degree map

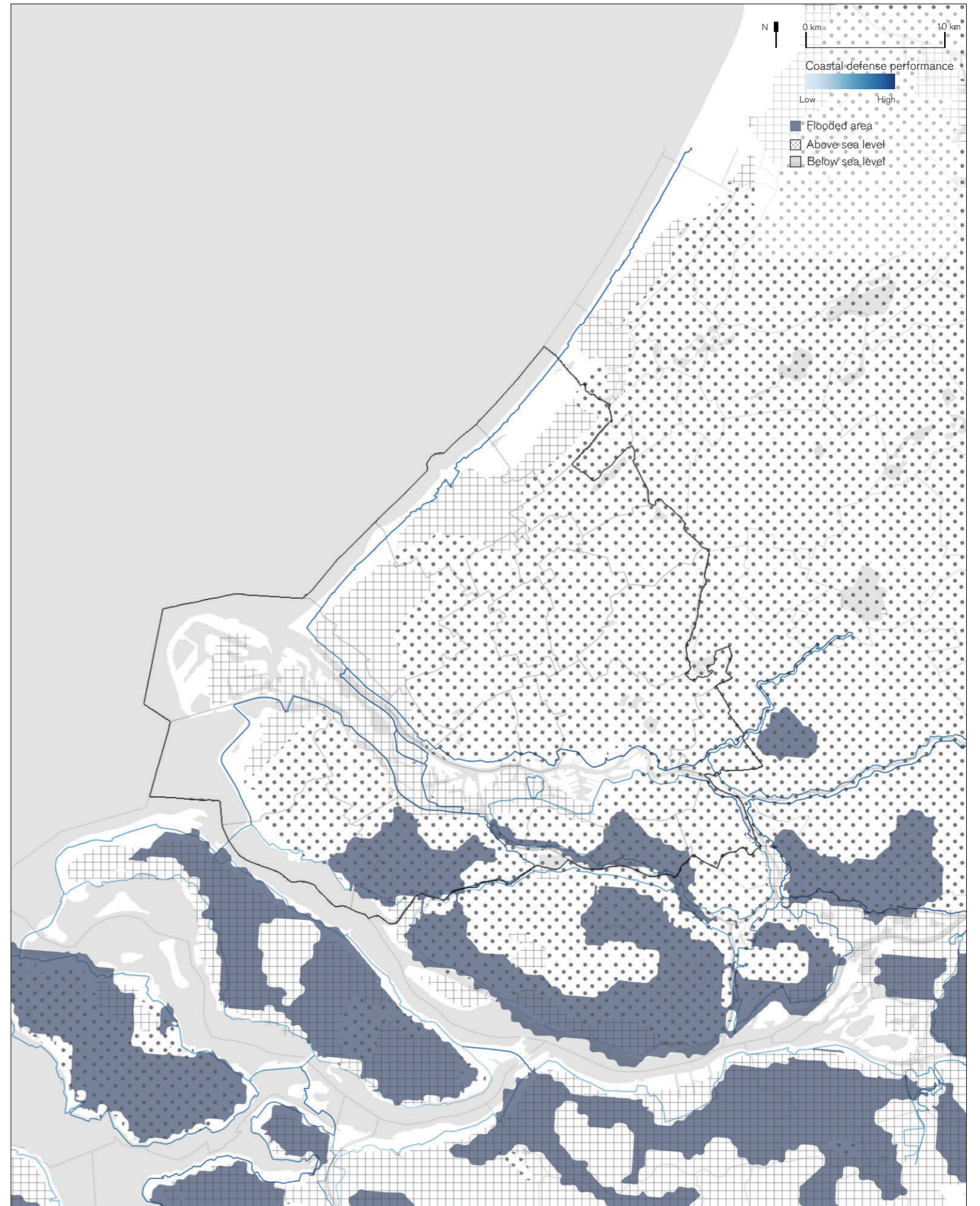
Synthesis of cause assessment. Source: Map created by author based on cause assessment.



Vulnerability degree map. Source: Map created by author based on cause assessment.

MACRO SCALE ANALYSIS

Risk assessment



Risk level of coastal flood areas. Source: Map created by author. Data from: Nationaalgeoregister.nl, PBL Netherlands Environmental Assessment Agency, Deltawerken.

MACRO SCALE ANALYSIS

Risk assessment



MACRO SCALE ANALYSIS

Current challenges conclusion

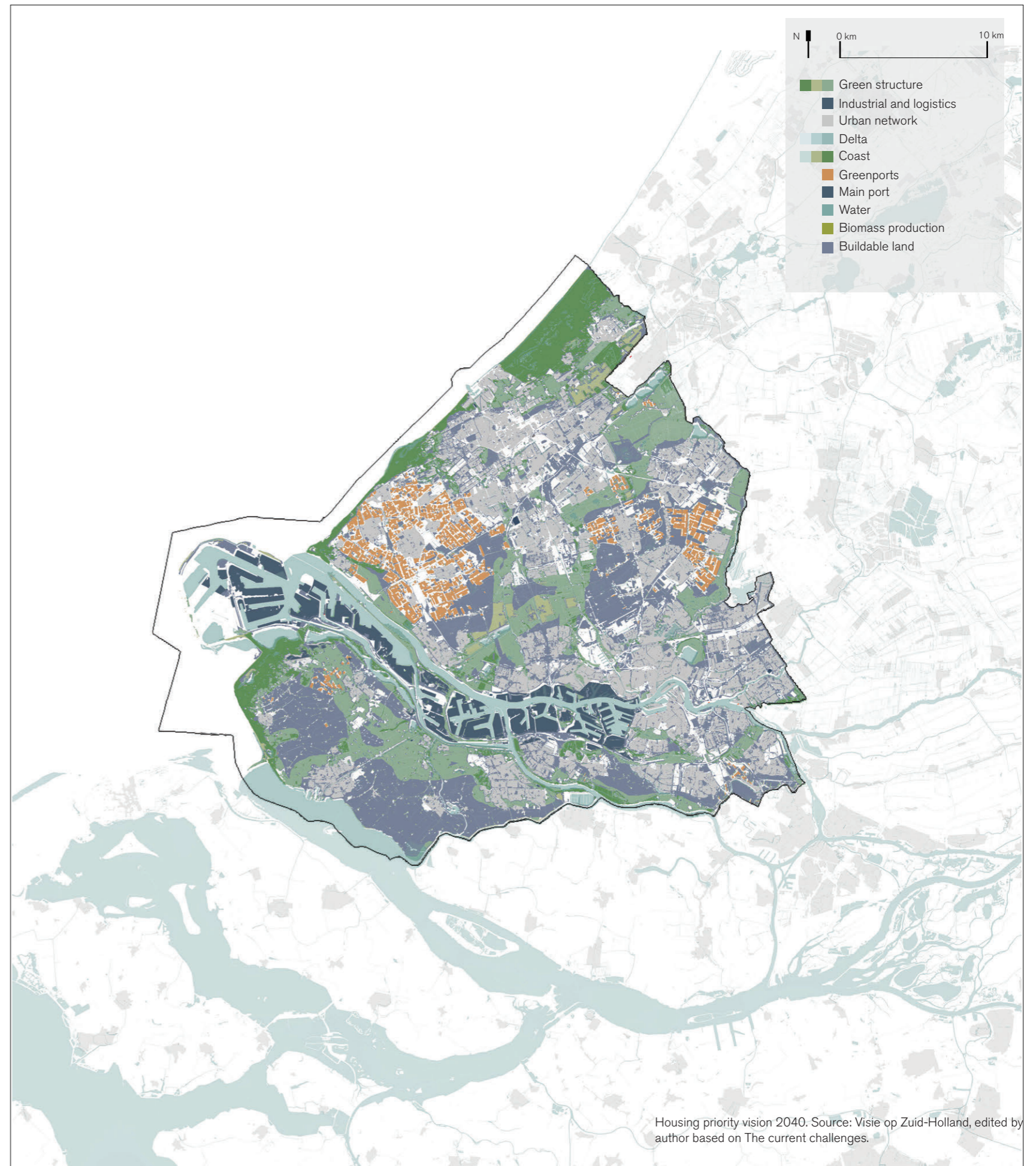
Synthesis of Macro scale assessment results.



Synthesis of current challenges.

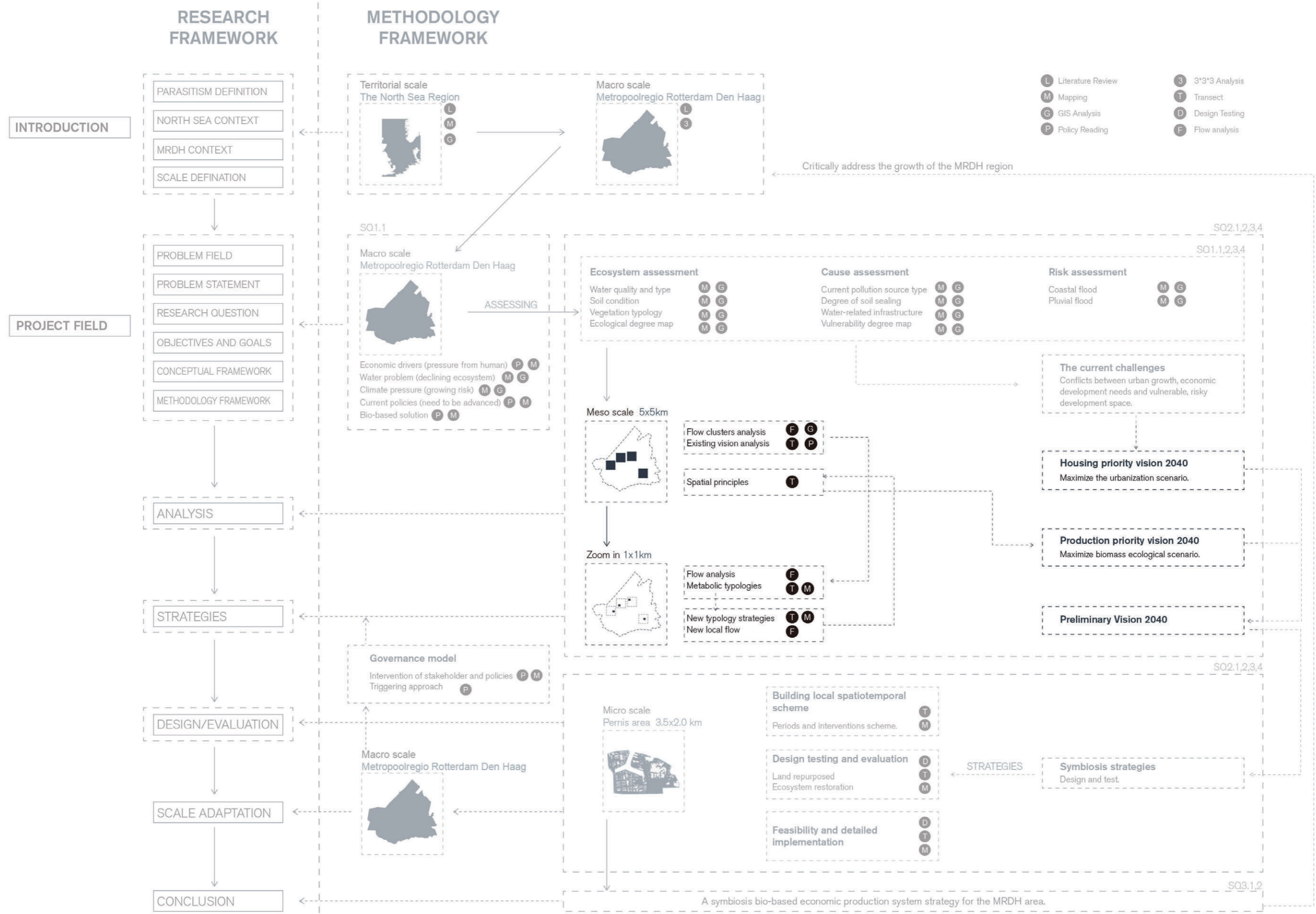
OUTPUT 1

Revised vision 1



Housing priority vision 2040. Source: Visie op Zuid-Holland, edited by author based on The current challenges.

MESO AND MICRO SCALE ANALYSIS



FLOW ANALYSIS

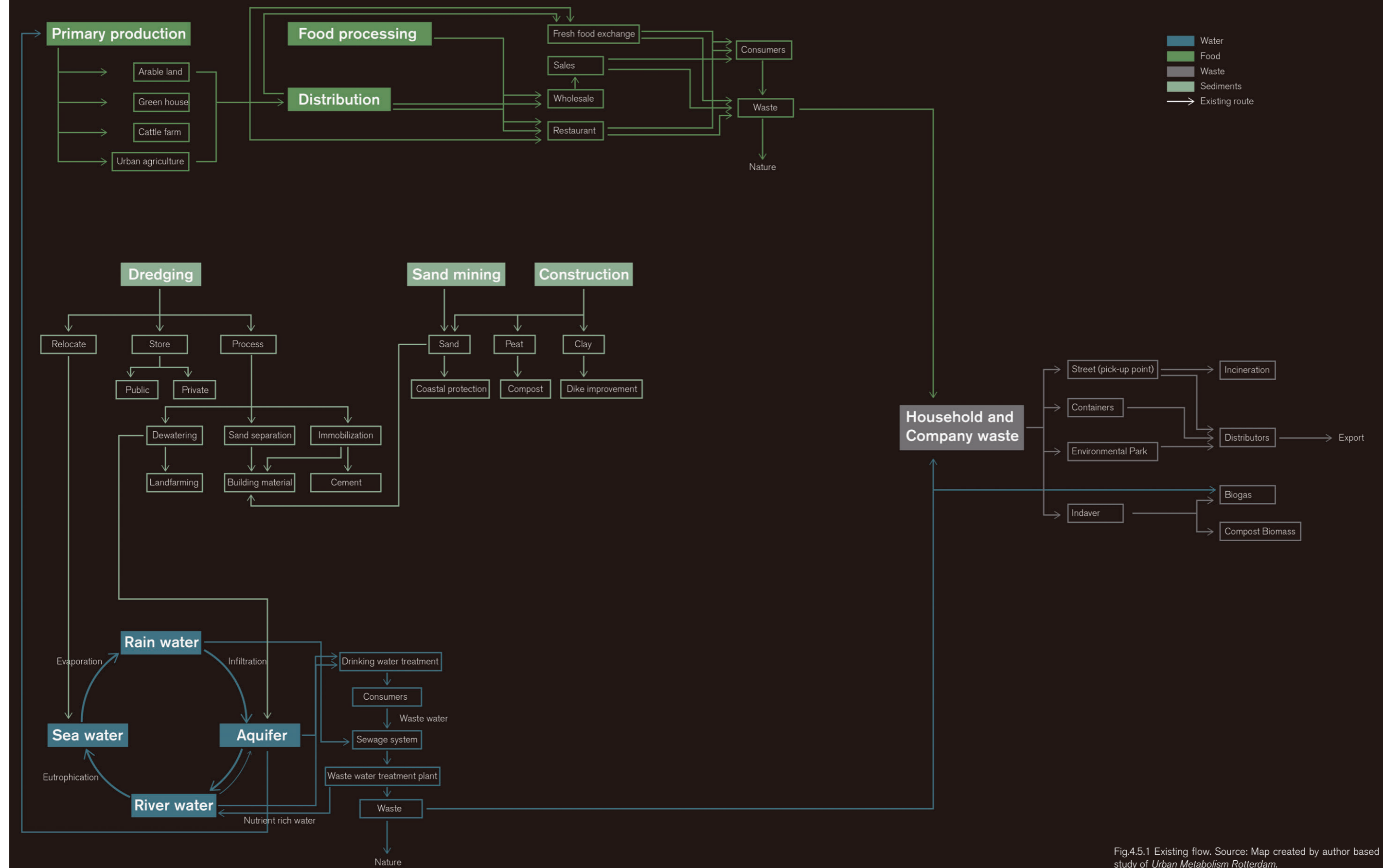
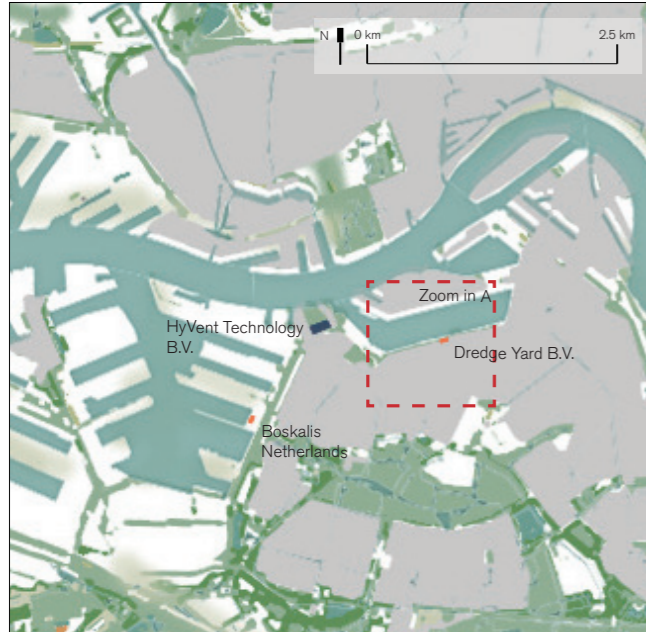


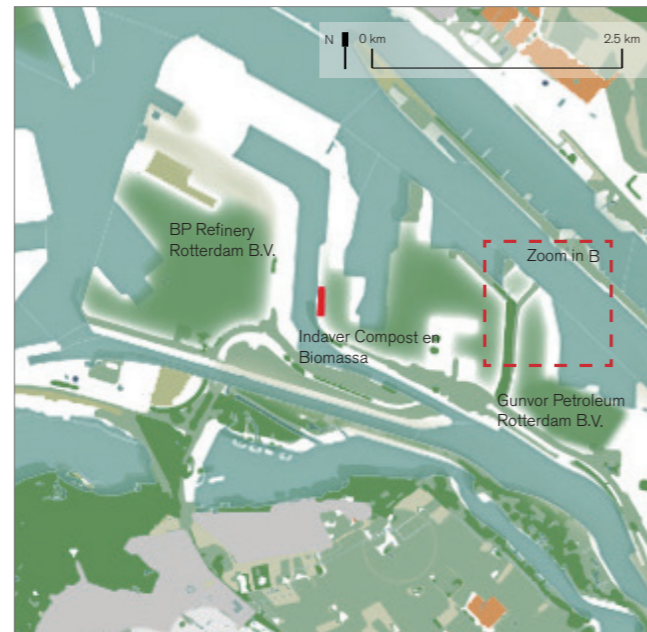
Fig.4.5.1 Existing flow. Source: Map created by author based on study of *Urban Metabolism Rotterdam*.

ZOOM IN MESO SCALE

5x5 km metabolic clusters



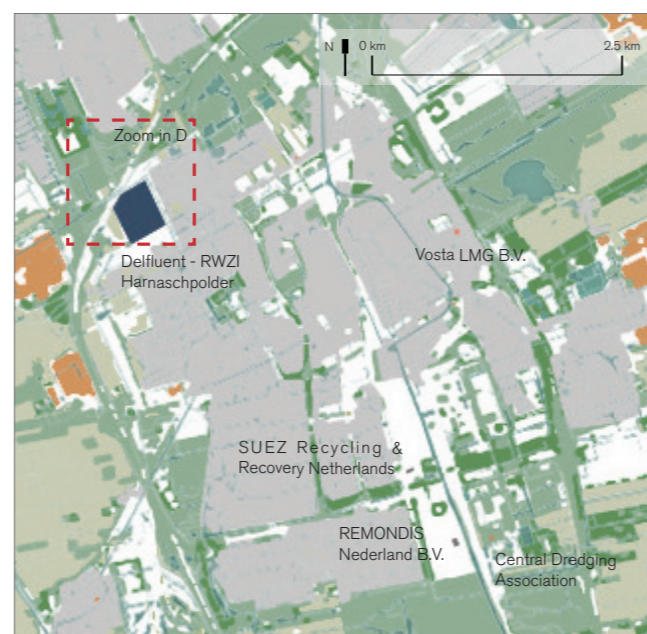
Zoom in 1. Source: Map created by author.



Zoom in 2. Source: Map created by author.



Zoom in 3. Source: Map created by author.



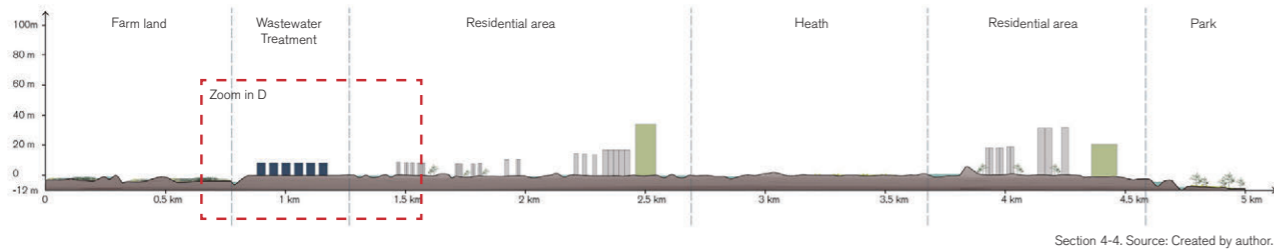
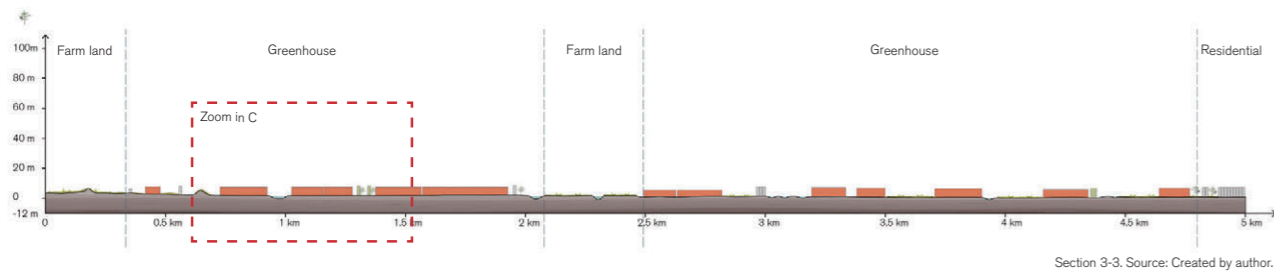
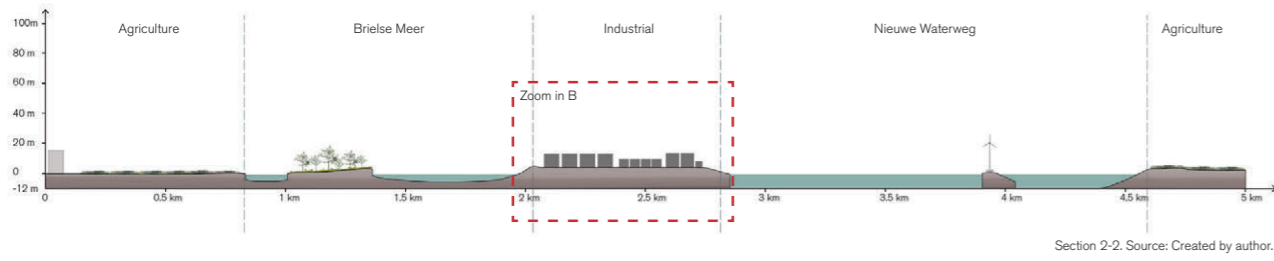
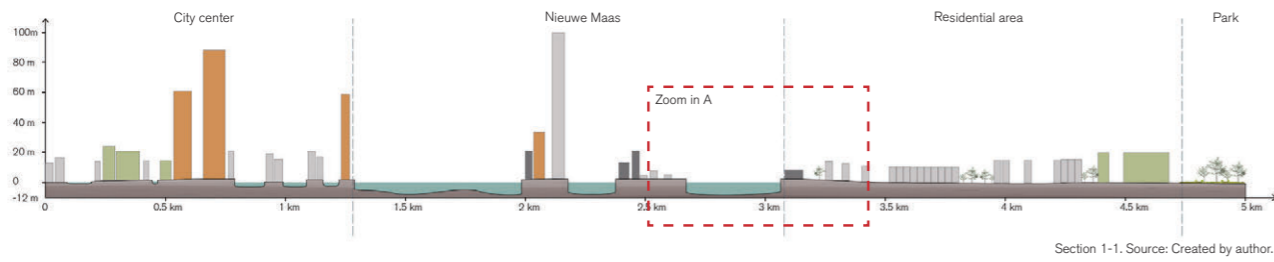
Zoom in 4. Source: Map created by author.



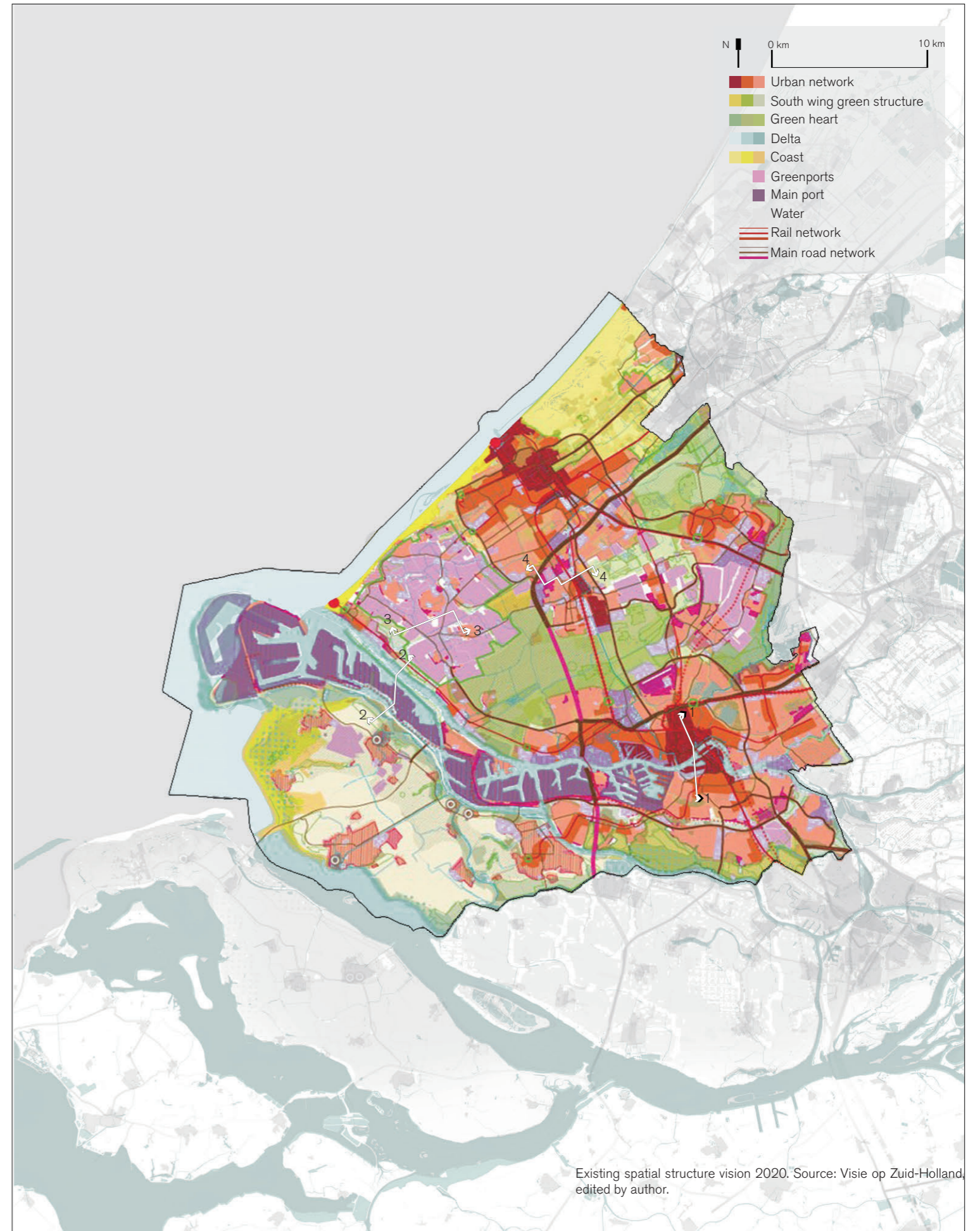
Existing urban-nature metabolic structure. Source: Map created by author based on the flow analysis.

SPATIAL QUALITY

Existing Vision analysis

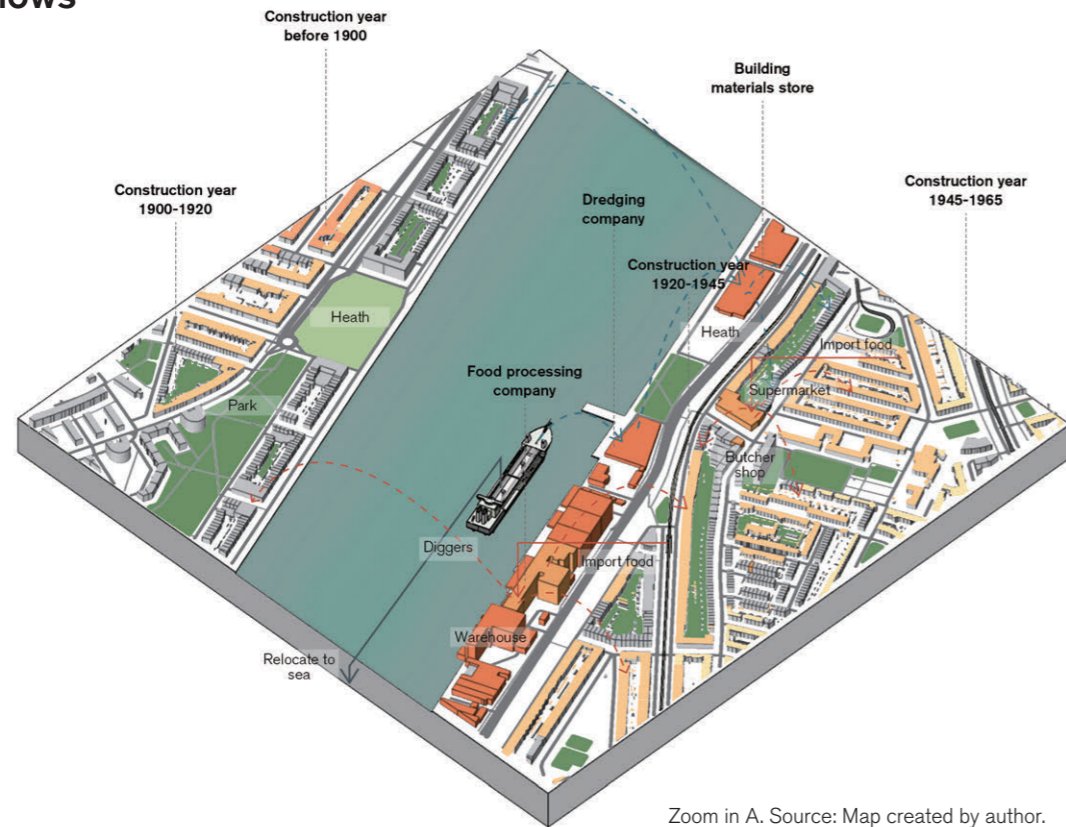


- Residential
- Industrial
- Greenhouse
- Wastewater treatment
- Commercial
- Business
- Water



ZOOM IN MICRO SCALE

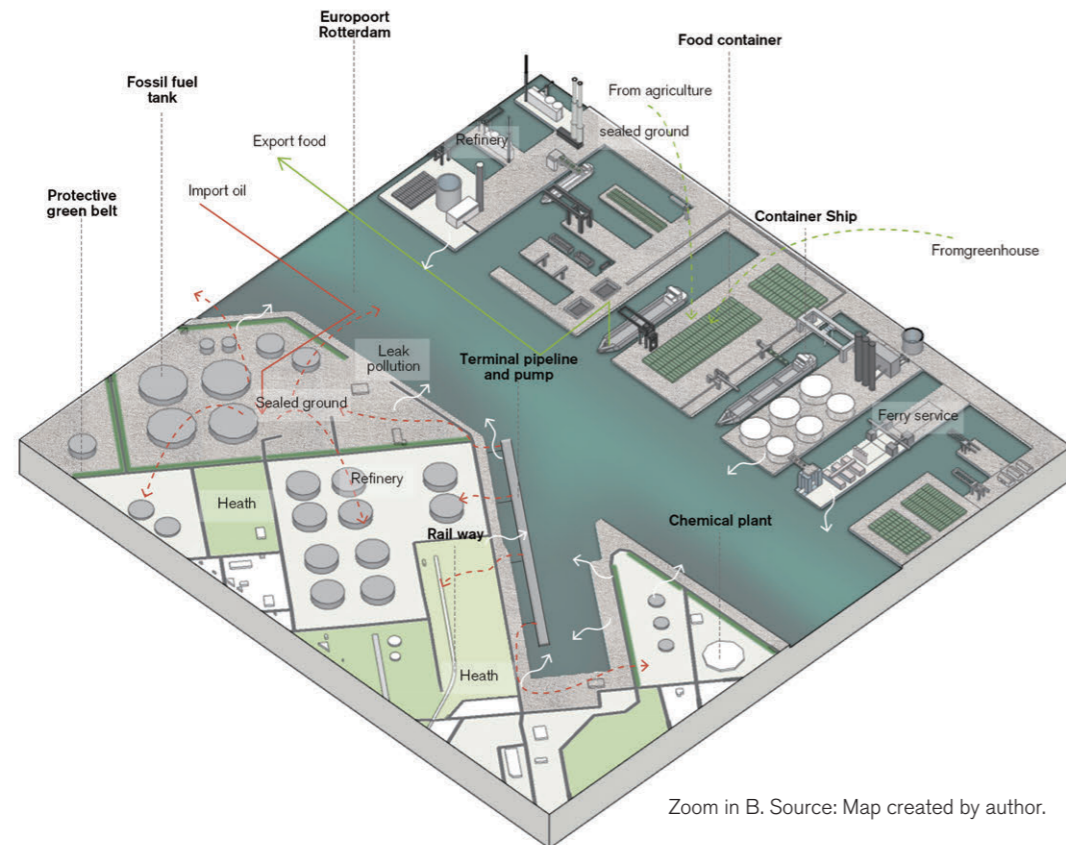
1x1 km flows



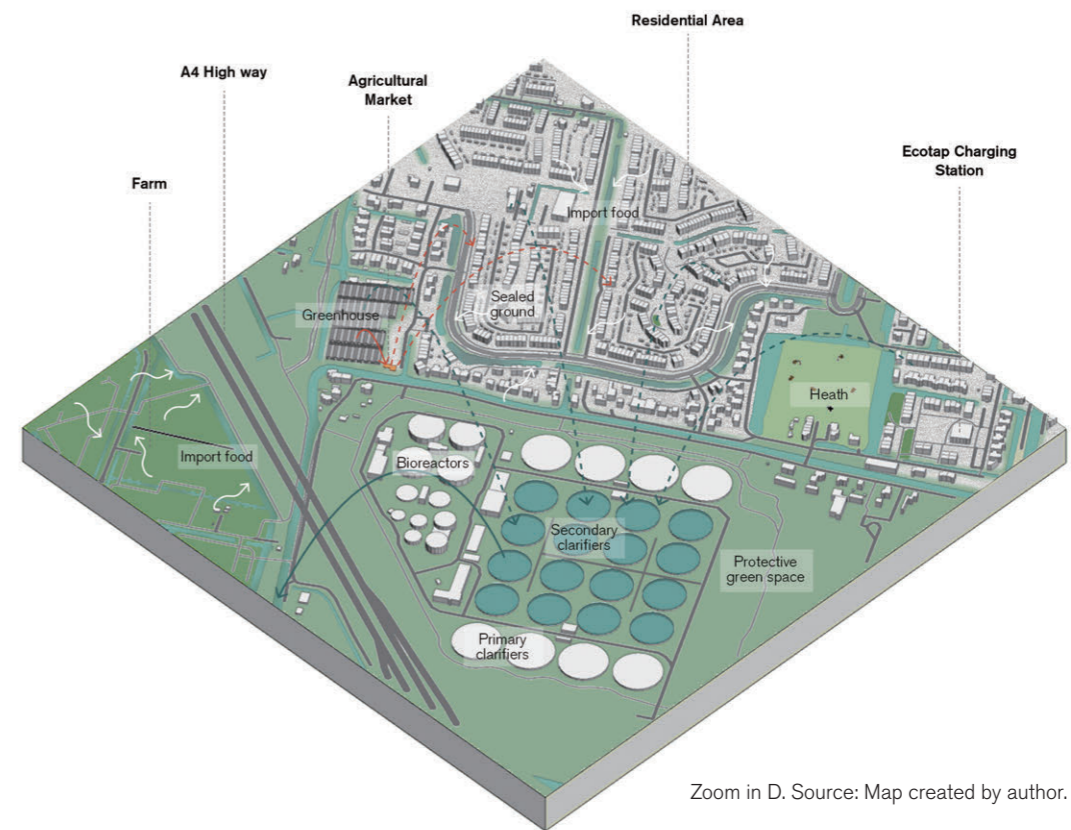
Zoom in A. Source: Map created by author.



Zoom in C. Source: Map created by author.



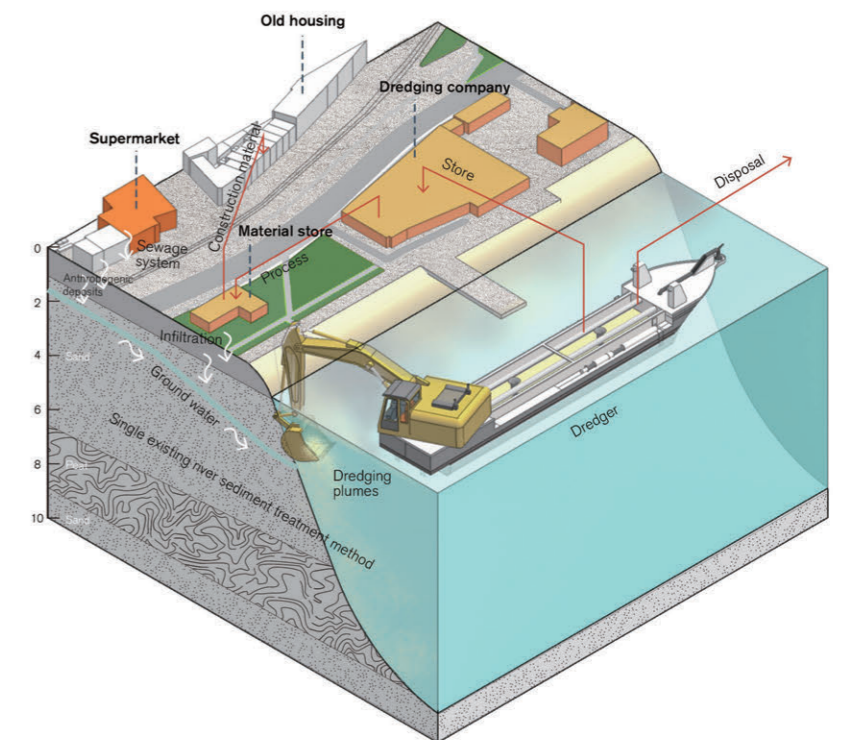
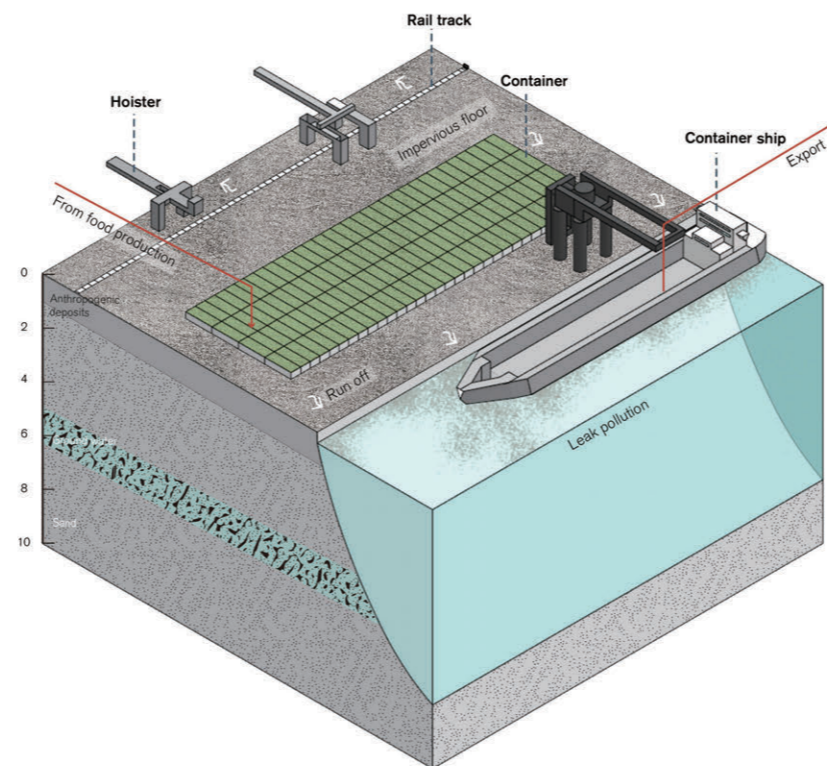
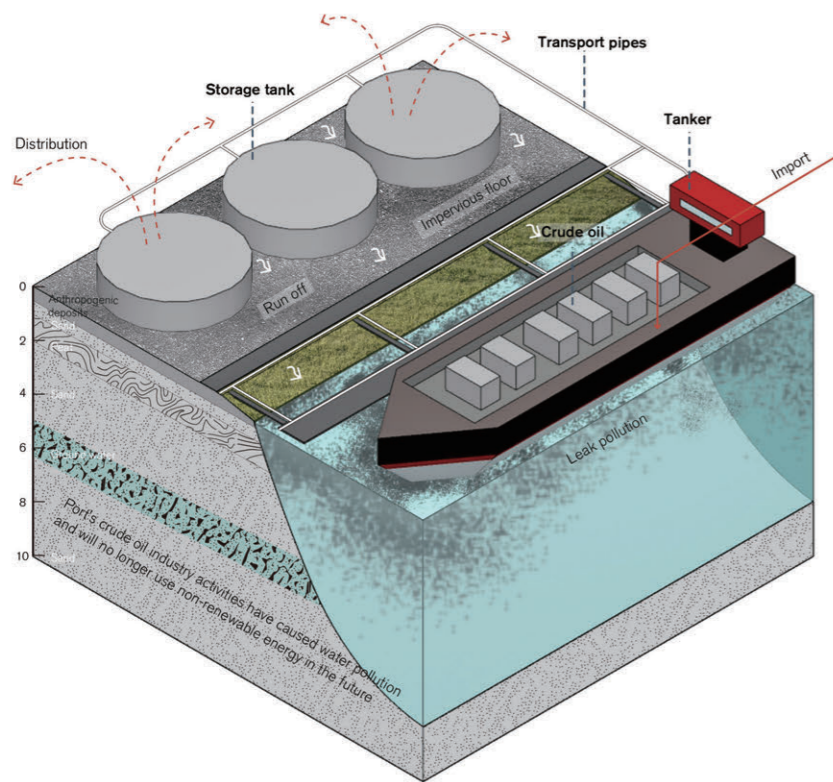
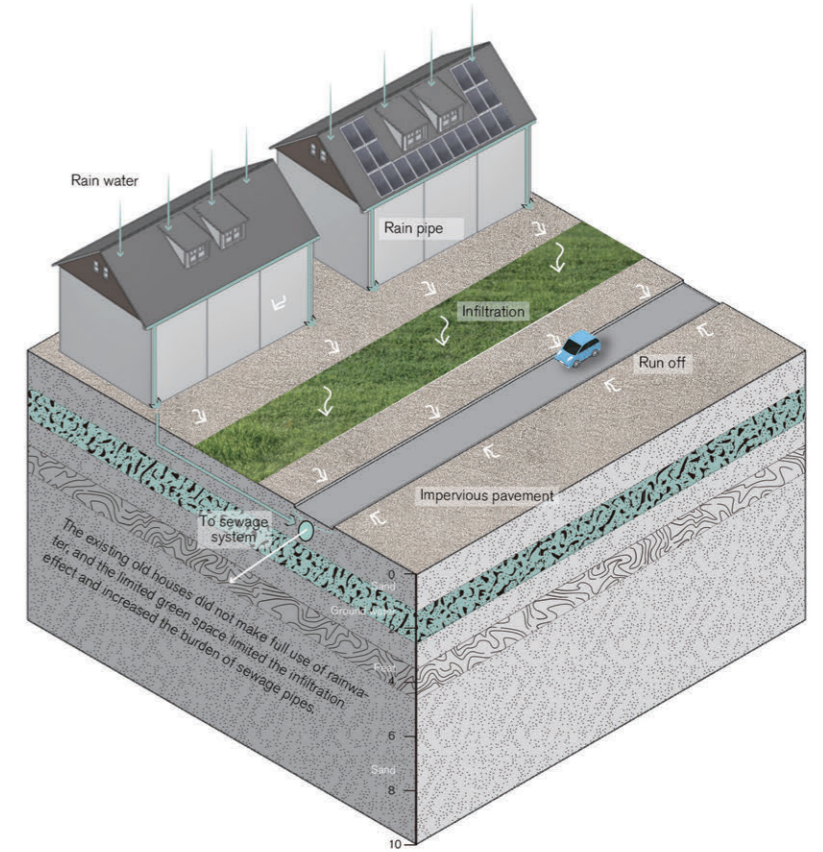
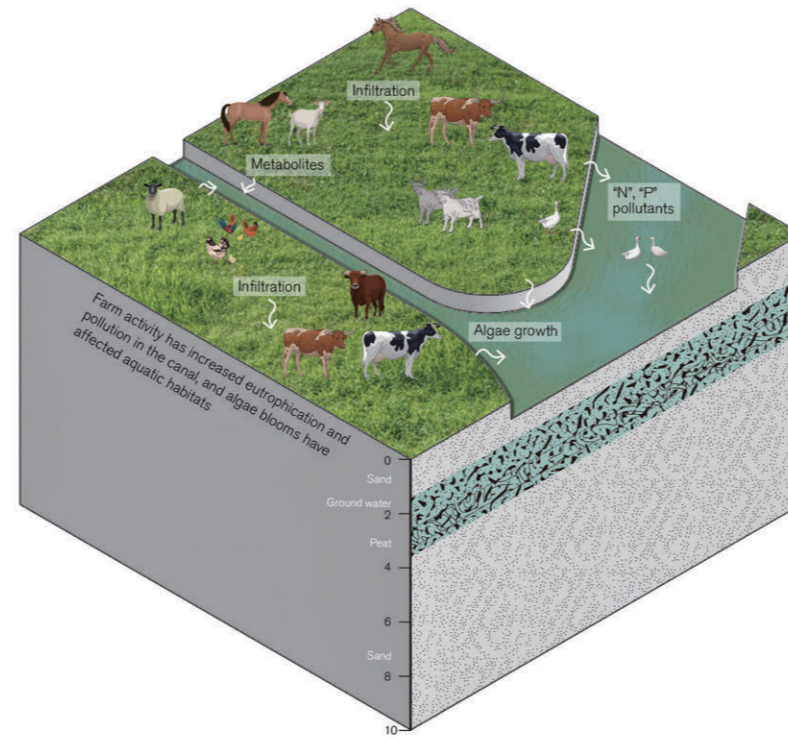
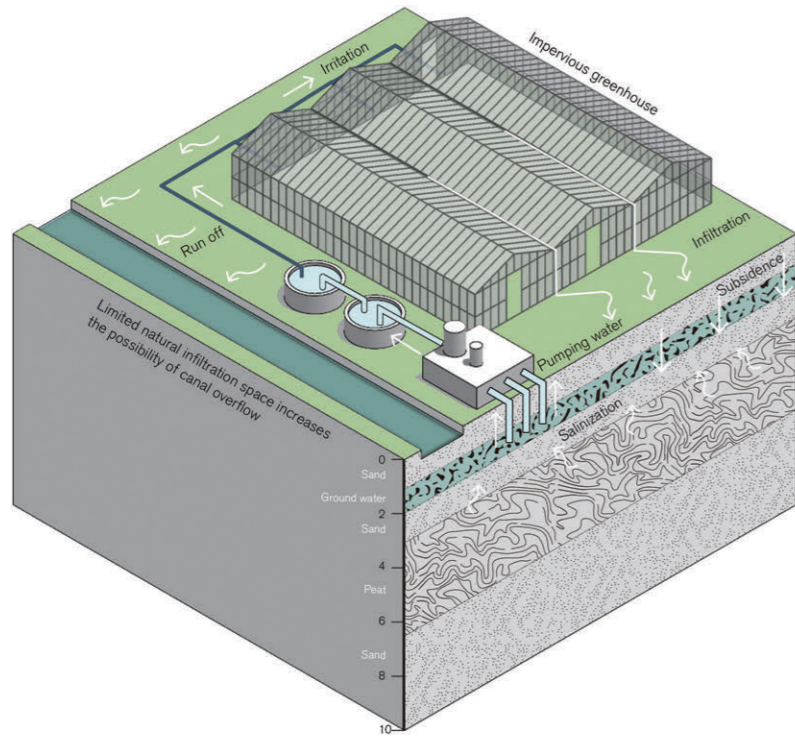
Zoom in B. Source: Map created by author.



Zoom in D. Source: Map created by author.

MICRO SCALE ANALYSIS

Existing metabolic typologies



Introduction

Problem field

Methodology

Analysis

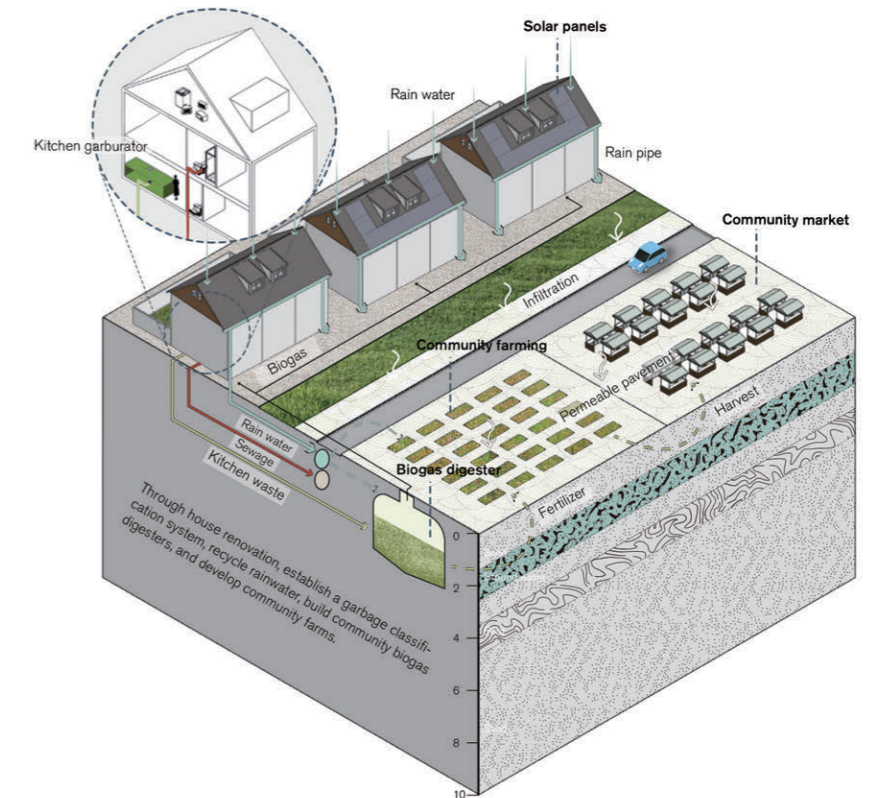
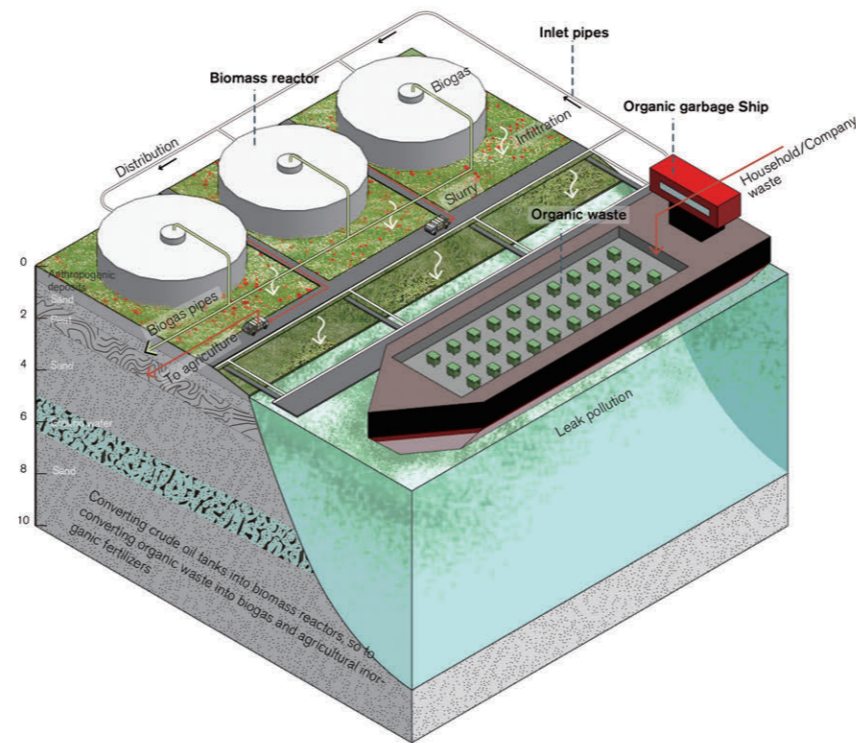
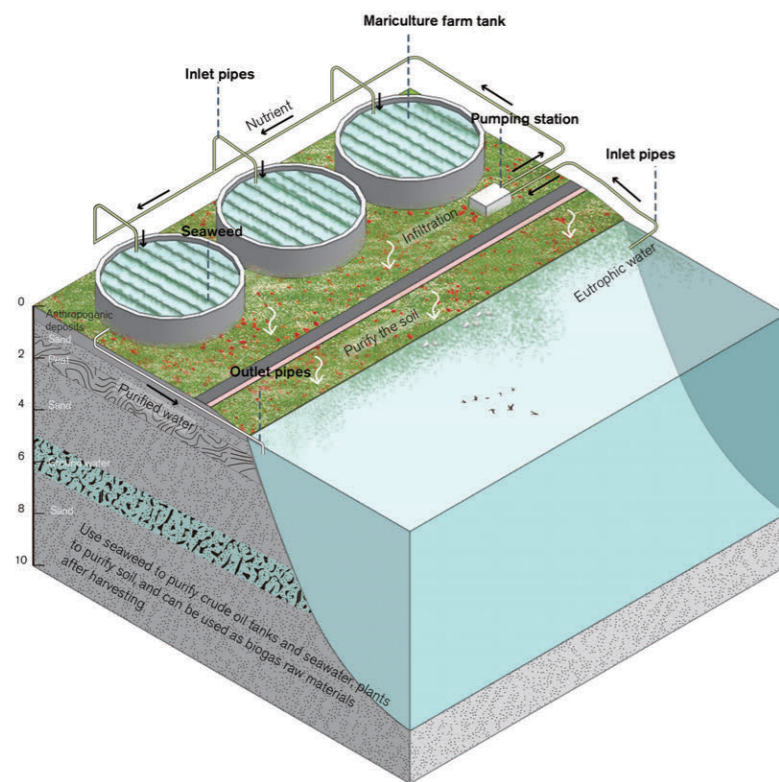
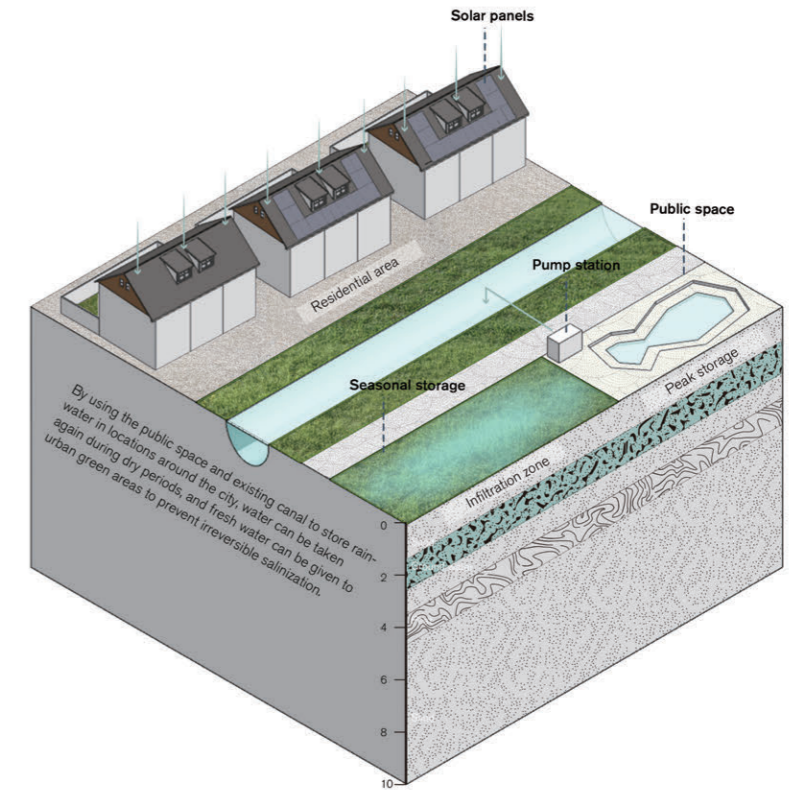
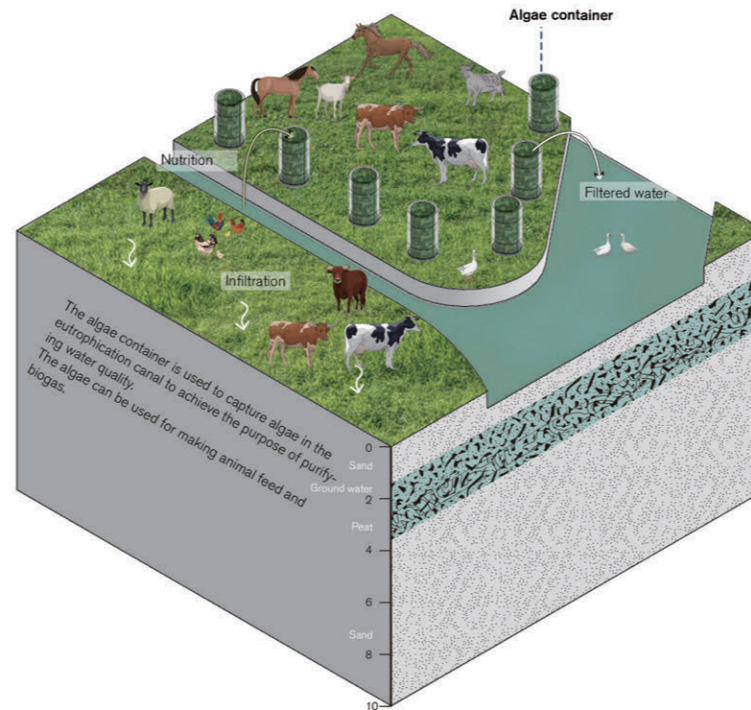
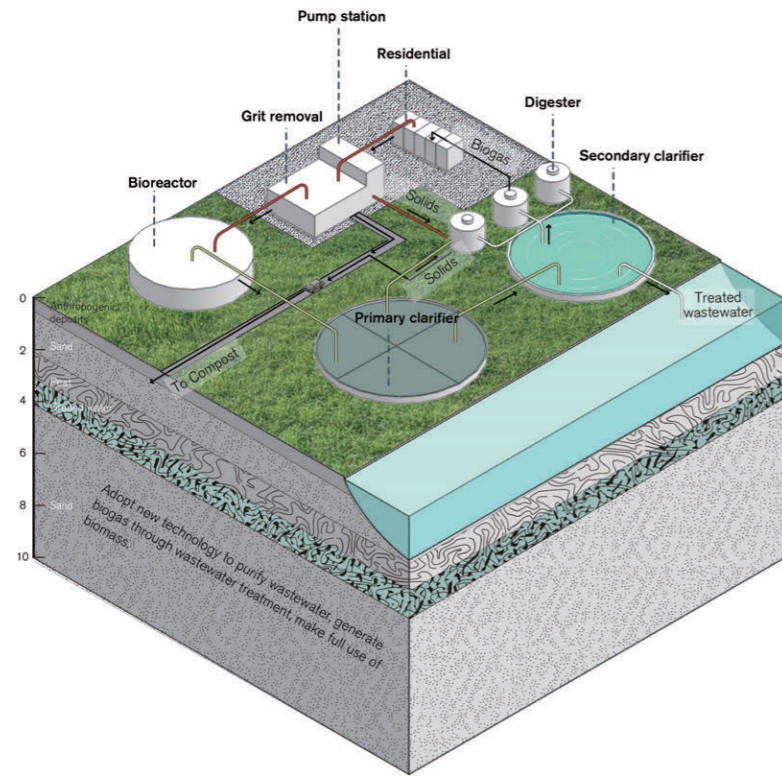
Strategies and Design

Conclusion

STRATEGIES AND DESIGN
Output 2 and Output3

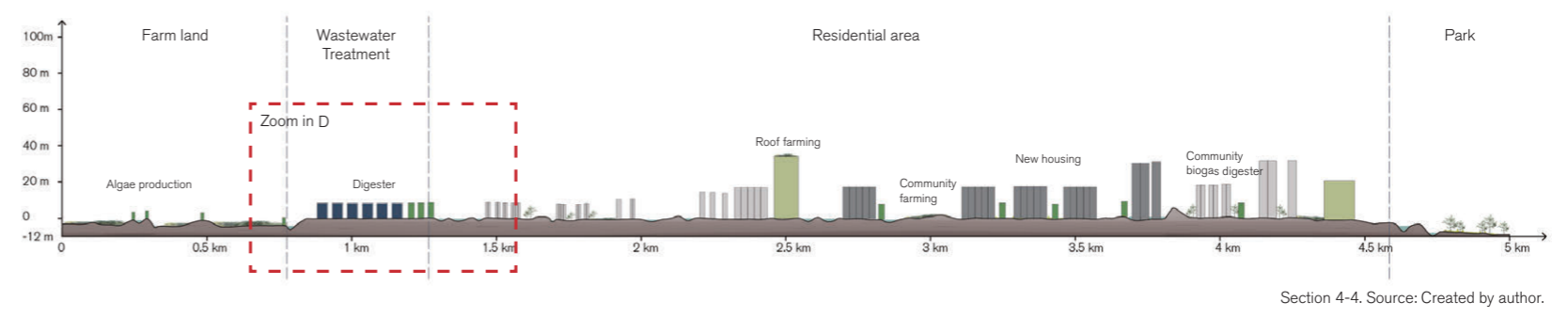
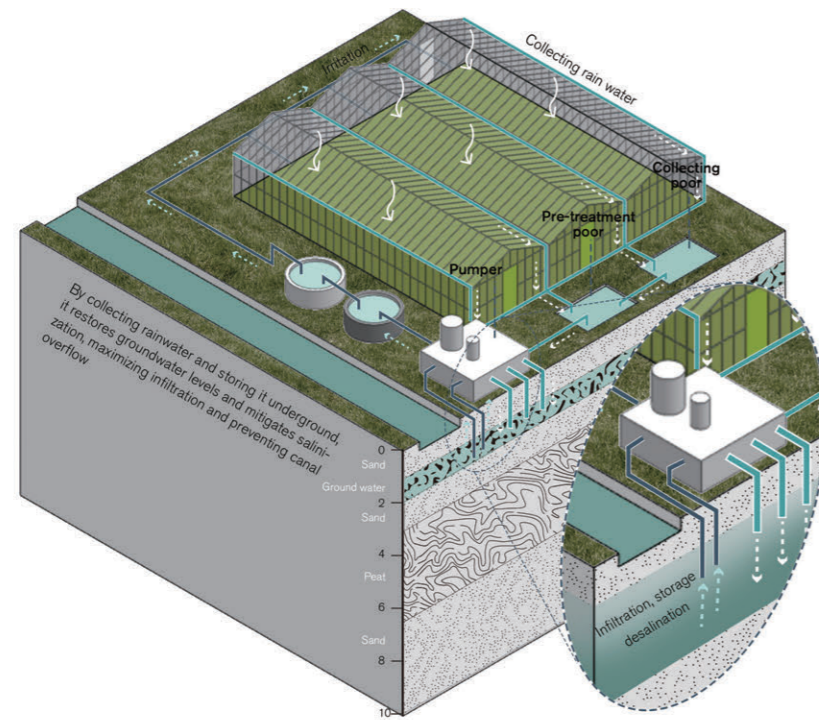
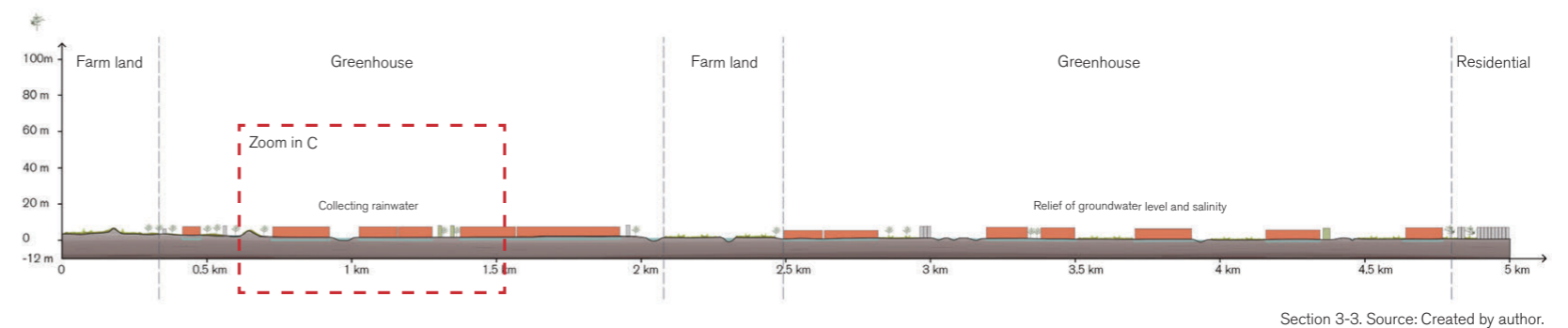
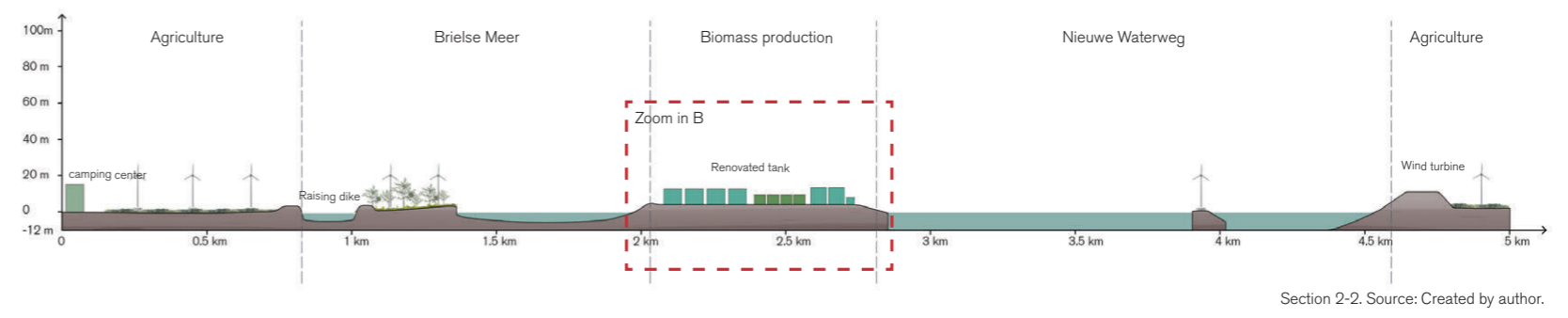
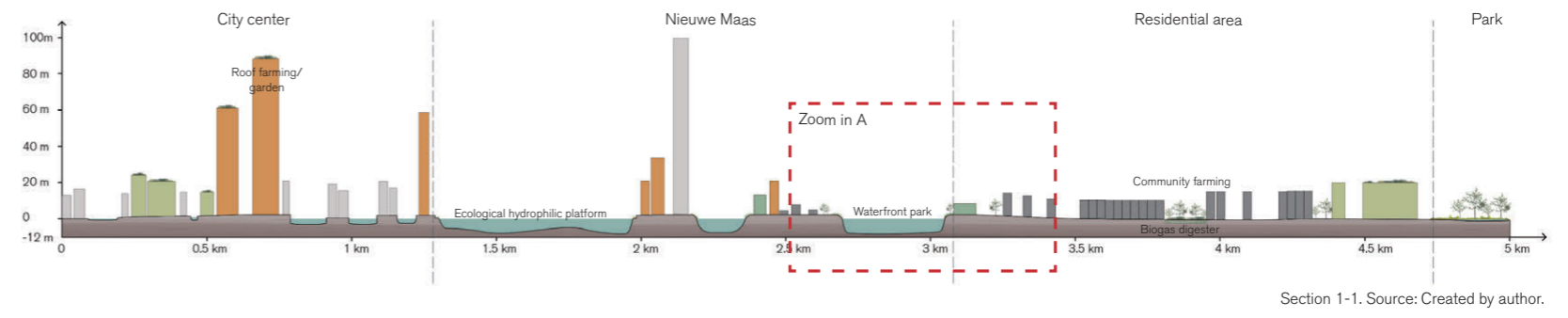
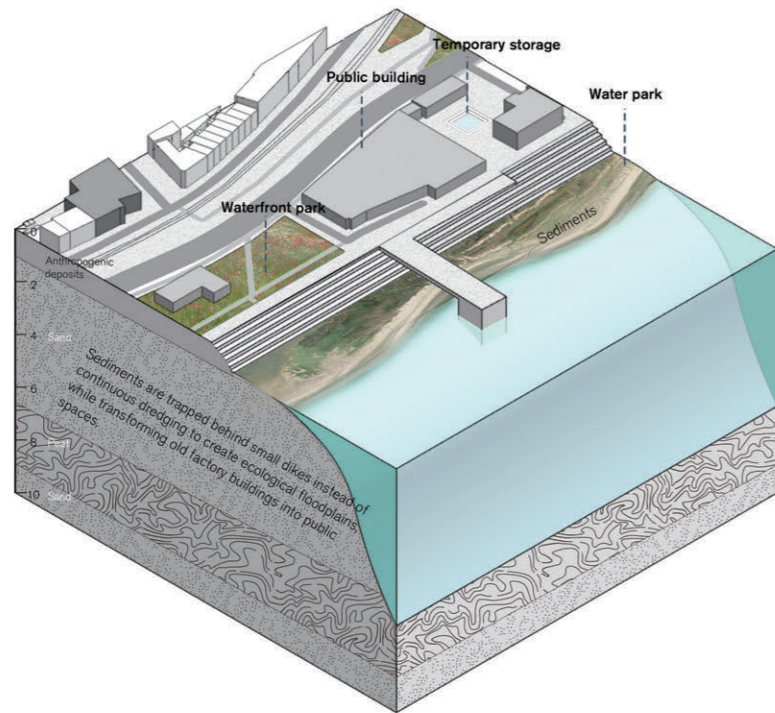
OUTPUT 2

Metabolic typology strategies



OUTPUT 2

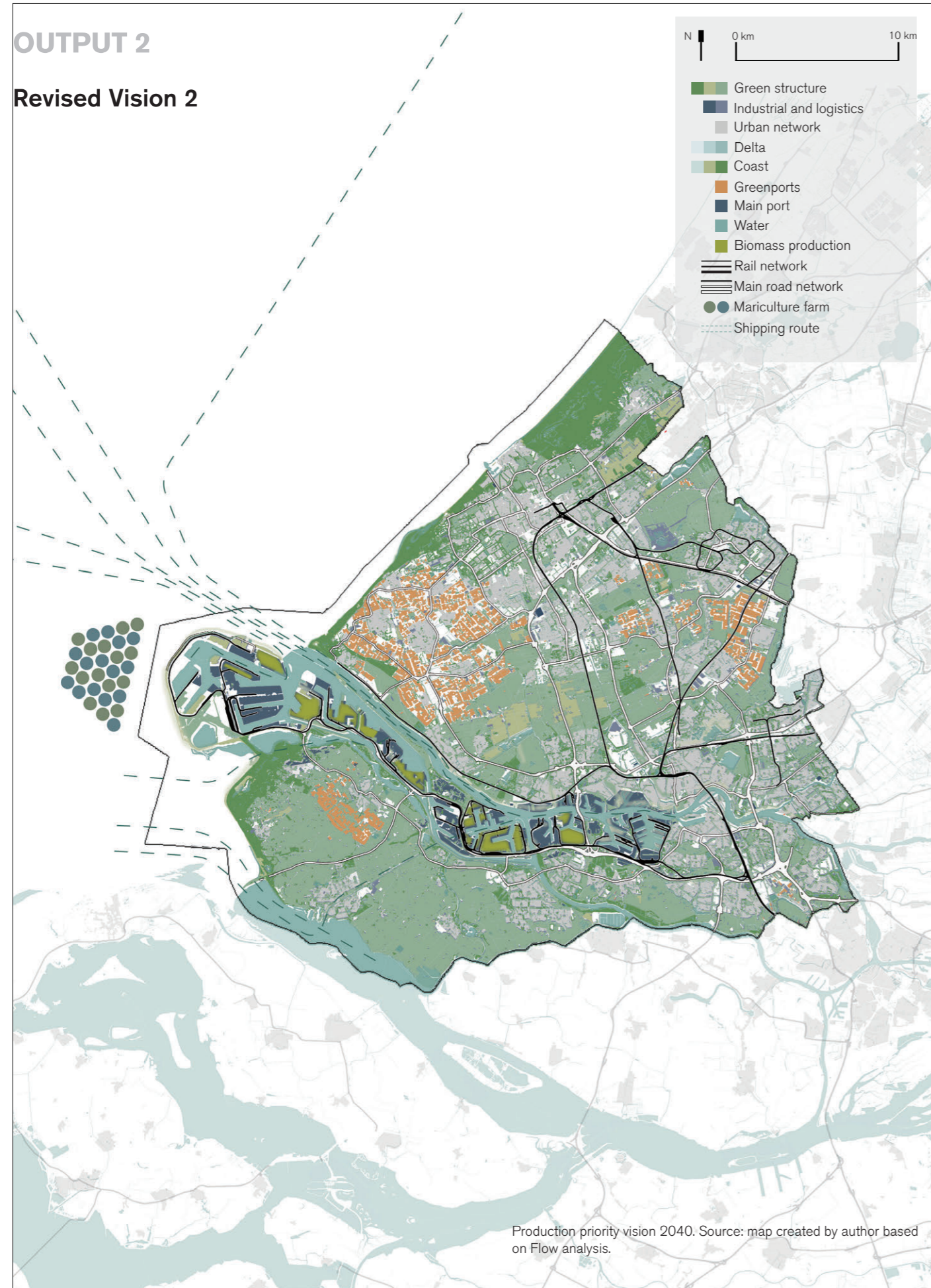
Spatial principles



	Open Space		Constructions		Water Related Facility		
	Spatial Form and Configurations		Circulatory Elements		Storage /Retention	Infiltration	Mixed
Urban area 	City core area Waterfront area 	O1 	C1 Rooftop agricultural collection to purify rainwater Residents use rainwater Excess discharge into rainwater pipes	S2 Increase secondary dike, use the agriculture plain as water storage place	I2 Increase primary dike, more space can be provide for natural infiltration	M1 Waterscape: filtering cycle Square as temporary storage Infiltration evaporation Rainwater goes into rainwater system Separate waterscape and rainwater system	
Rural area 		O2 	C2 Building private biogas digesters to reuse agricultural waste	S3 	I4 	M5 	
Green port 		O3 	C3 	S4 	I5 	M5 	
Suburban/Park 		O4 	C4 	S5 	I5 	M5 	
Industrial harbour 		O5 	C5 	S5 	I5 	M5 	

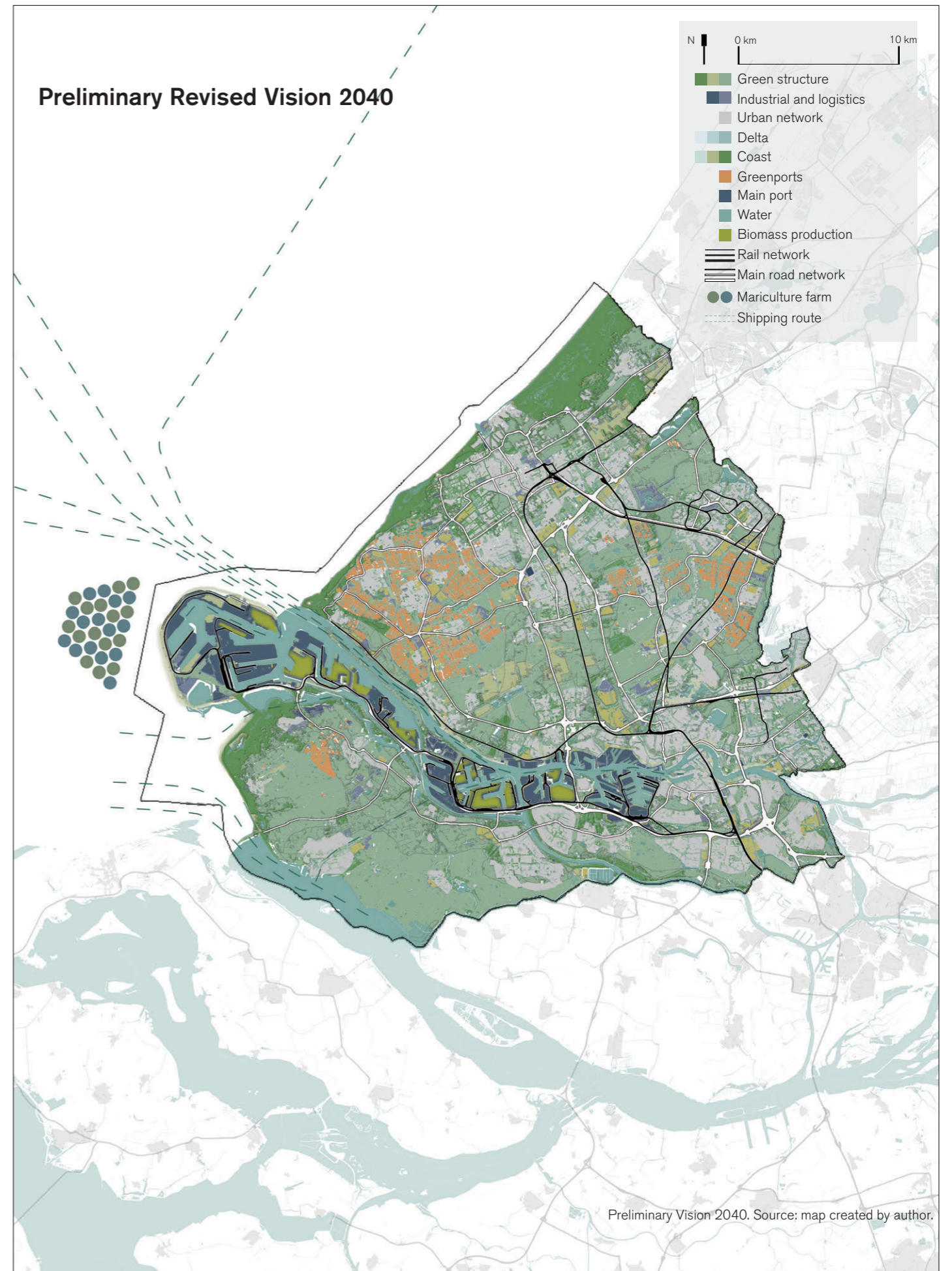
OUTPUT 2

Revised Vision 2



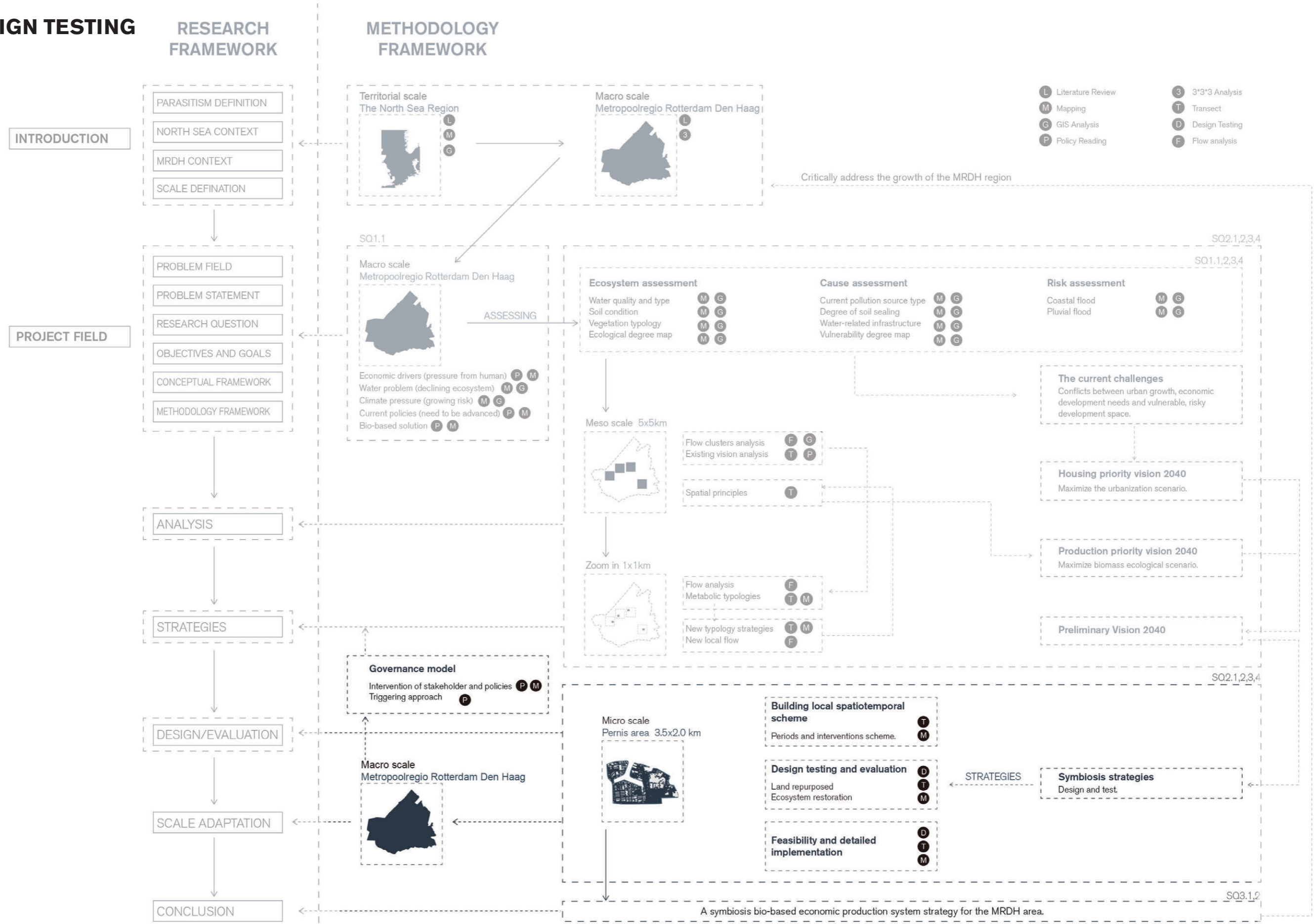
Production priority vision 2040. Source: map created by author based on Flow analysis.

Preliminary Revised Vision 2040



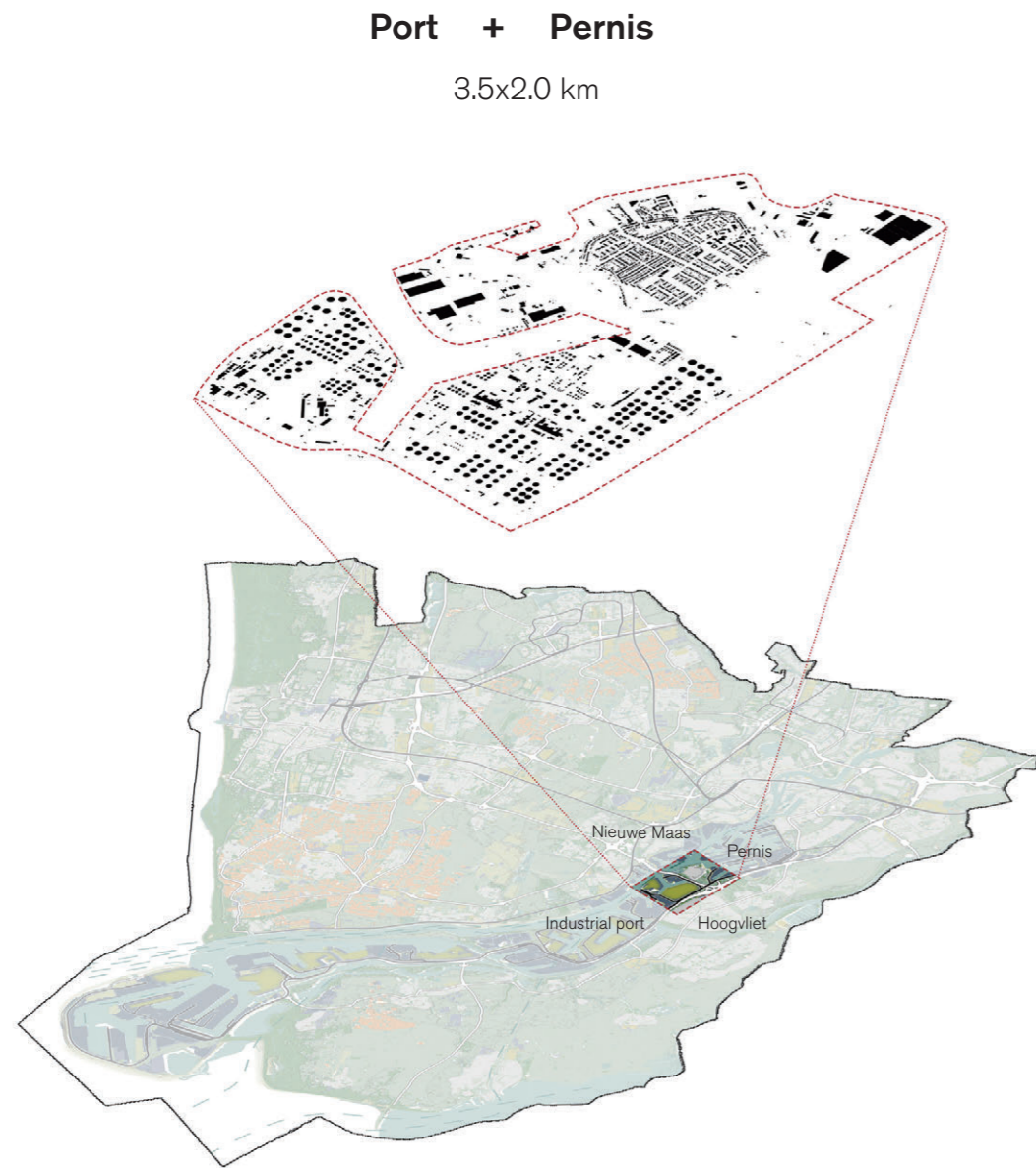
Preliminary Vision 2040. Source: map created by author.

OUTPUT 3
DESIGN TESTING



OUTPUT 3

Design testing area

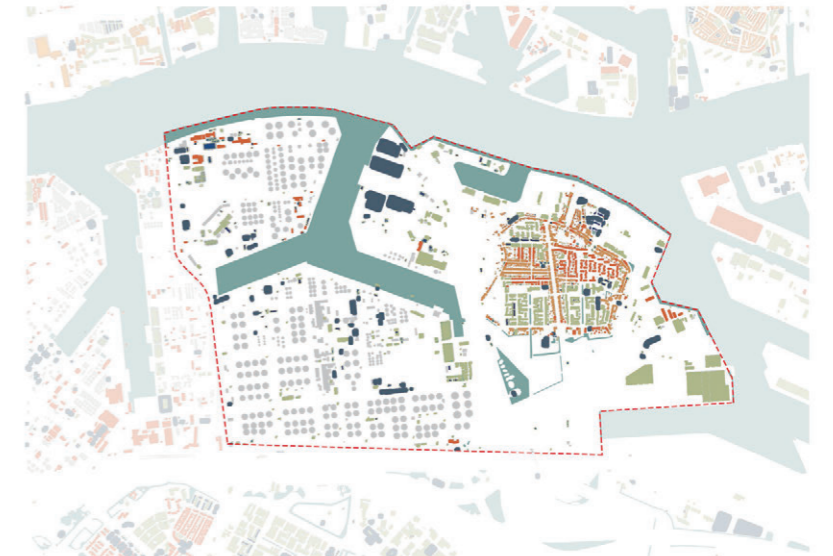


Context information



N 0 km 1 km Land use. Source: map created by author.

■ Park	■ Forest	■ Park	■ Industrial
■ Grass	■ Cemetery	■ Grass	■ Logistics
■ Urban area	■ Infrastructure	■ Water	



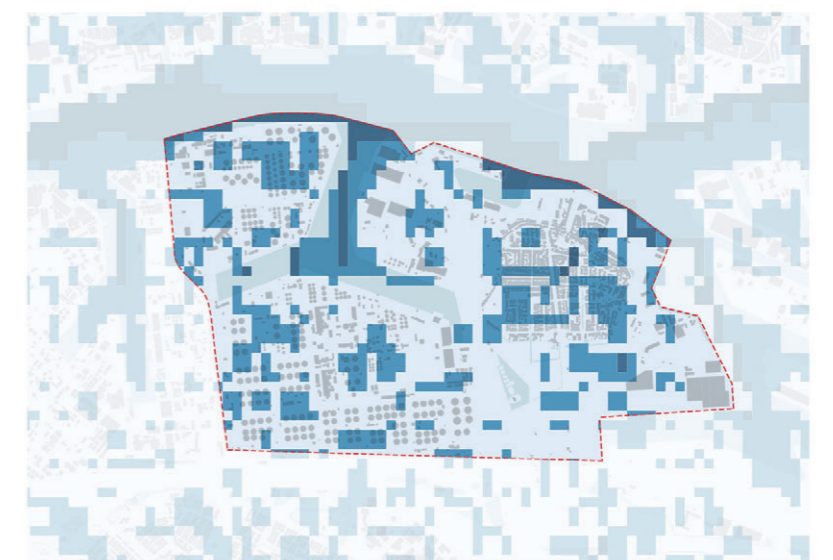
N 0 km 1 km Building year. Source: map created by author.

■ Before 1990	■ 1990-1960	■ 1960-2005	■ After 2005
■ Industrial	■ Water		



N 0 km 1 km Infrastructure. Source: map created by author.

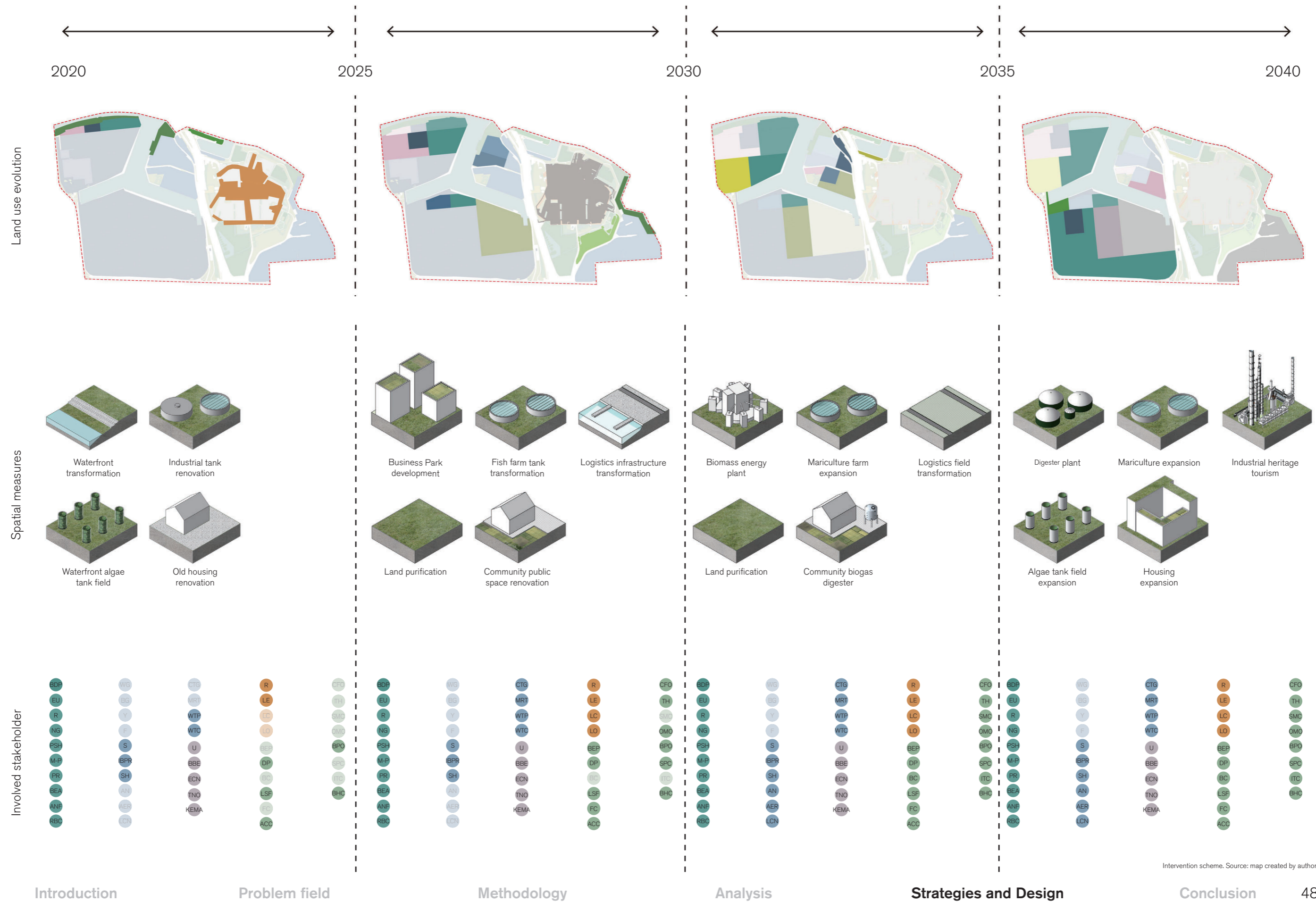
— Rail	— Motor way	— Residential road	— Bikeway
--------	-------------	--------------------	-----------



N 0 km 1 km Pluvial flood area. Source: map created by author.

■ Low risk	■ Medium risk	■ High risk
------------	---------------	-------------

Periods and Intervention scheme



Intervention scheme. Source: map created by author.

Condition 1

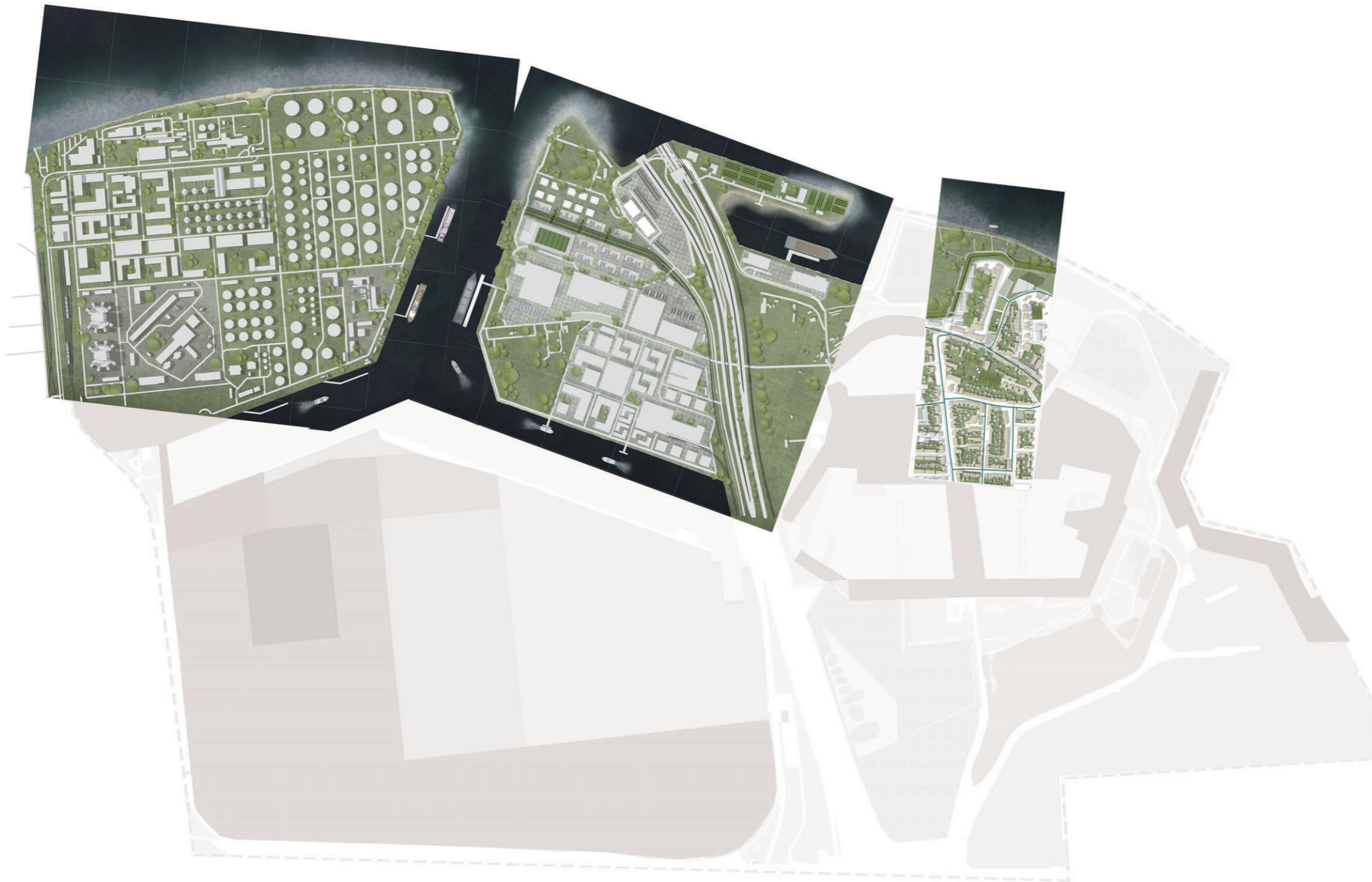
Industrial port transformation

Condition 2

Improvement of logistics ports

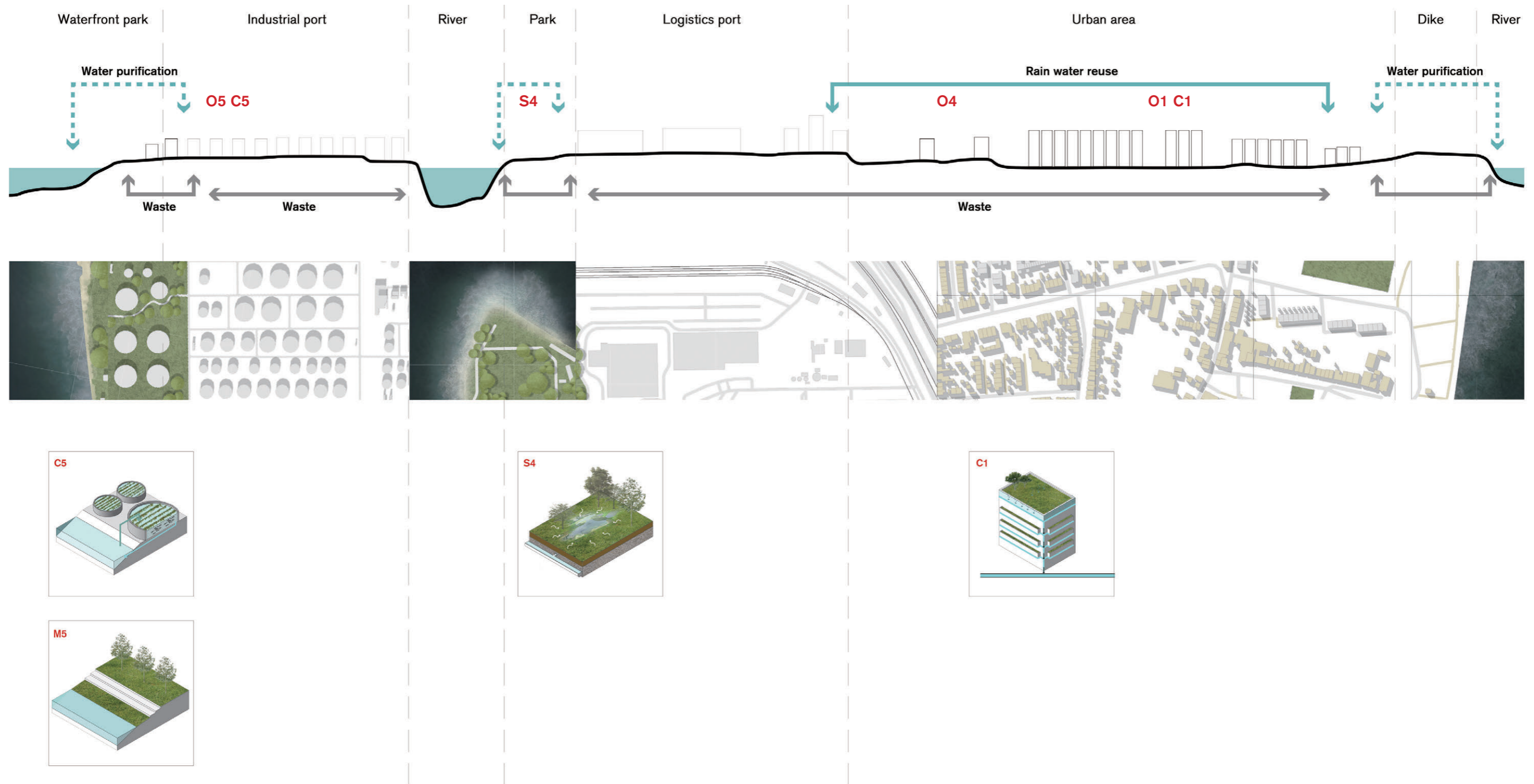
Condition 3

Urban regeneration



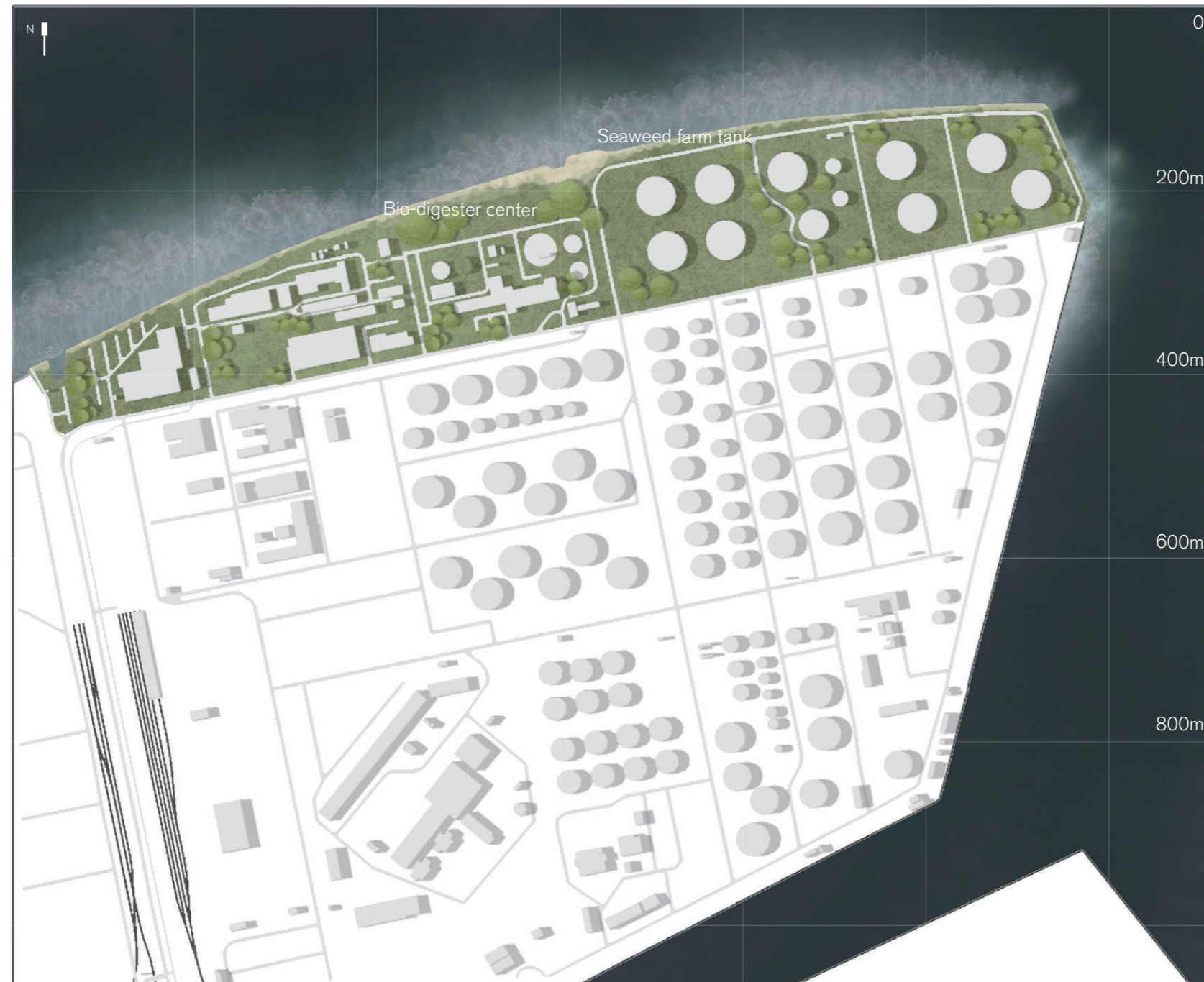
2020 - 2025

Overall input of intervention



Source: map created by author.

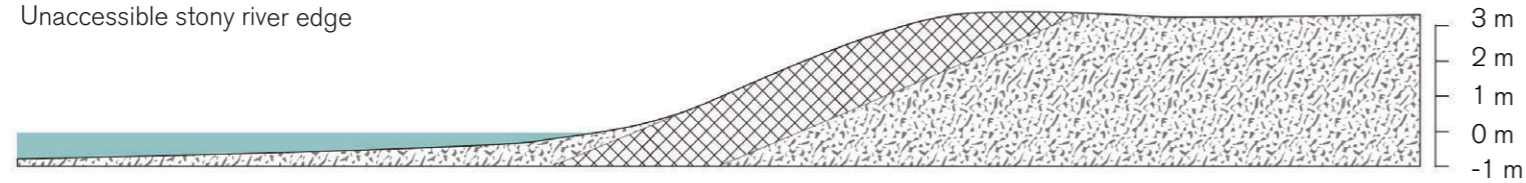
2020 - 2025
Condition 1



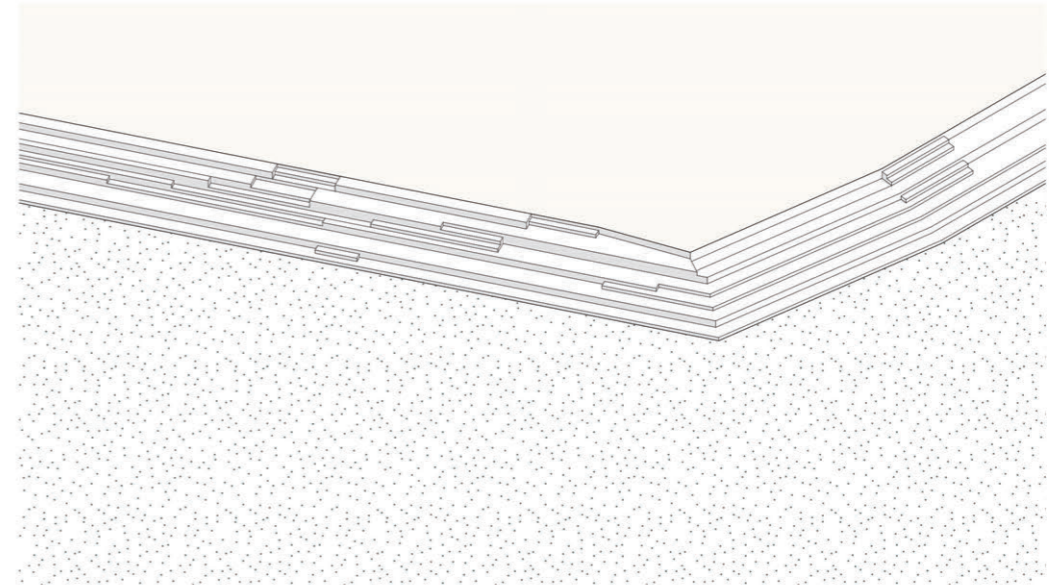
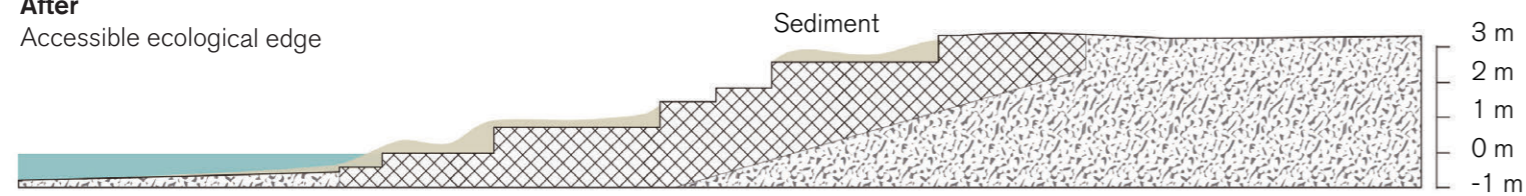
Source: map created by author.

Landscape changing

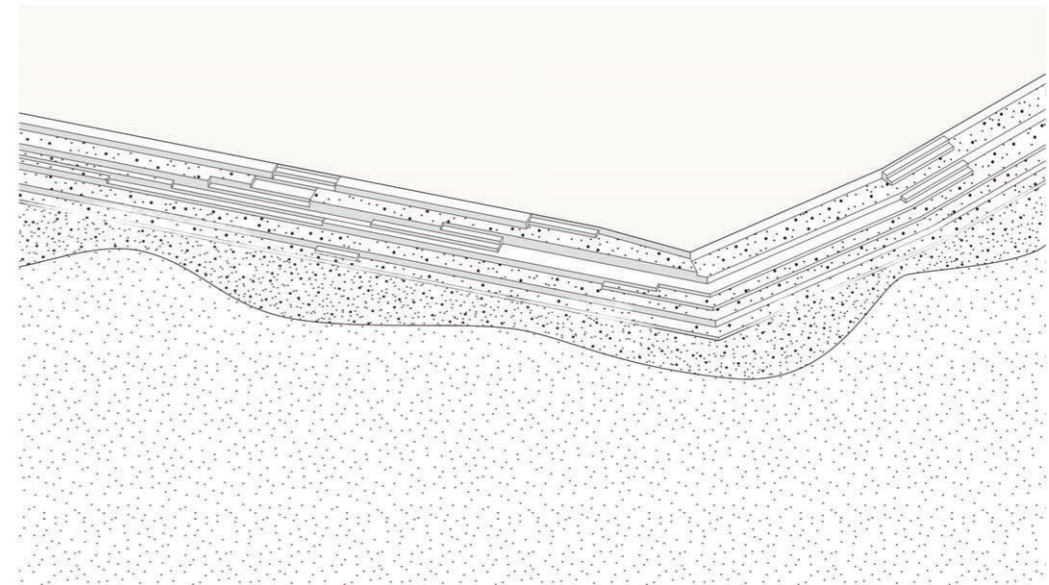
Before
Unaccessible stony river edge



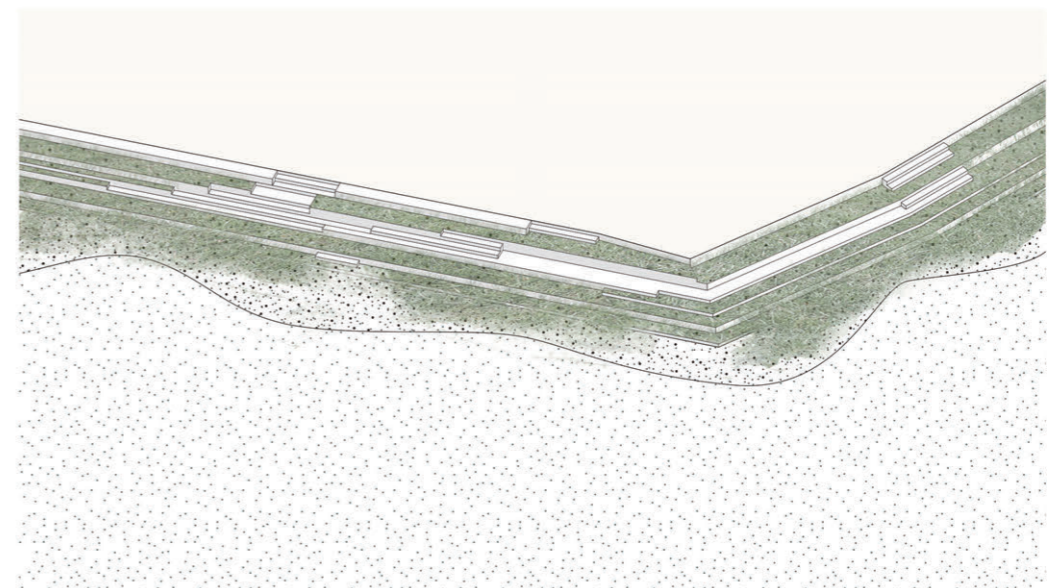
After
Accessible ecological edge



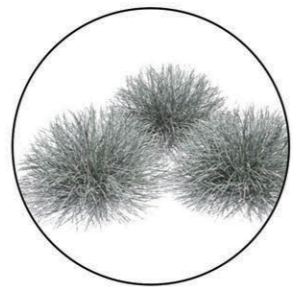
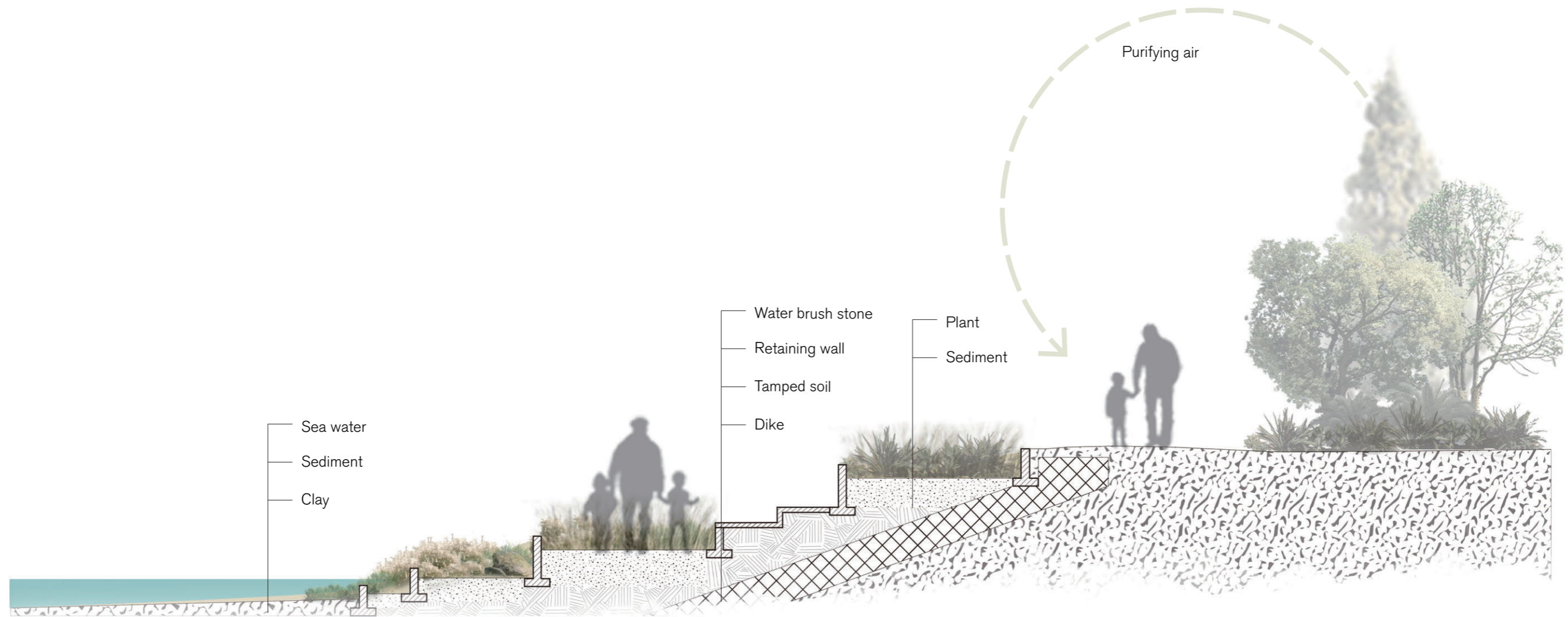
Step 1
Hydrophilic step



Step 2
Sediment retention



Step 3
Plant growth



Festuca



Triglochin



Spartina



Field maple



Phragmites



Salicornia



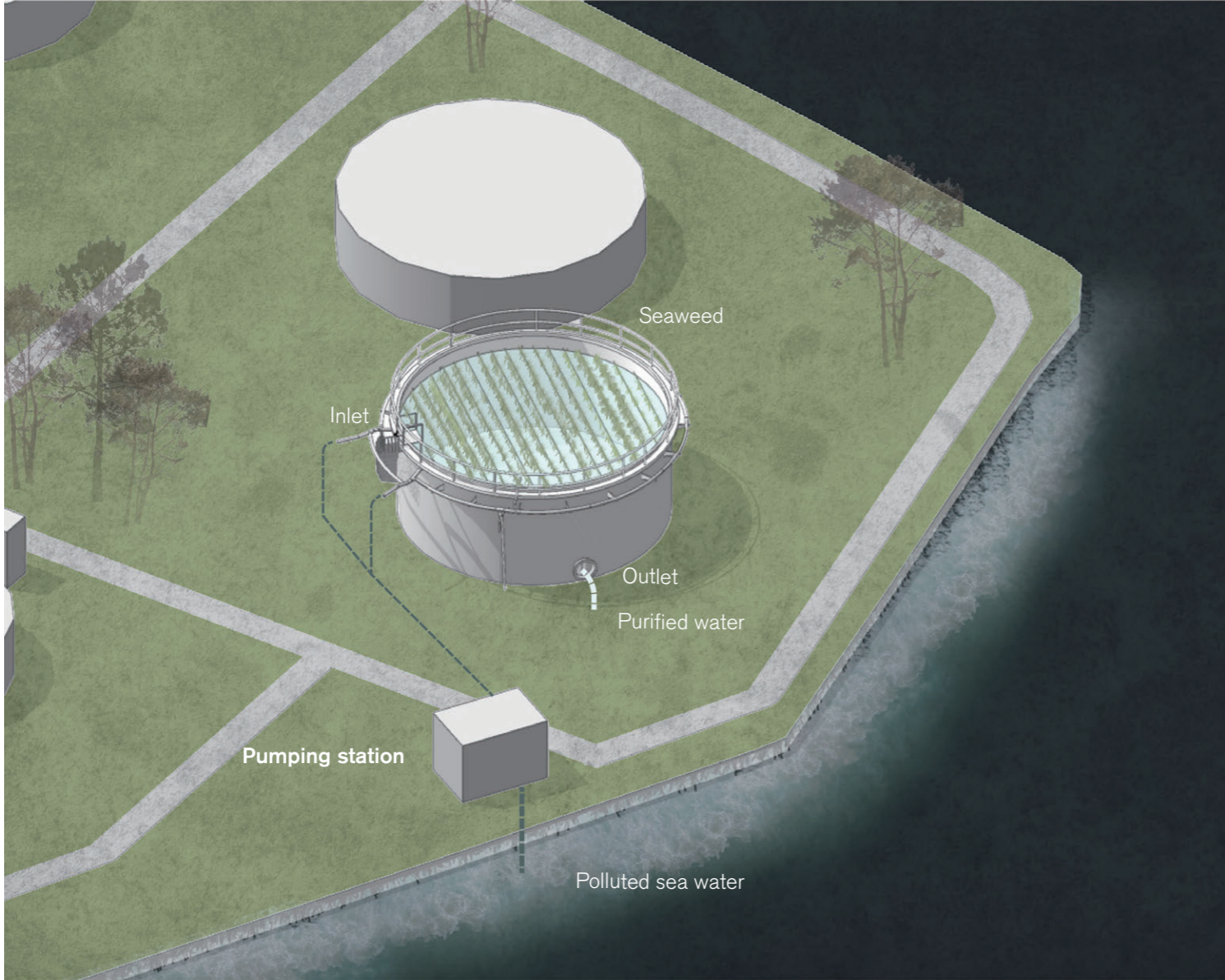
Ligustrum lucidum



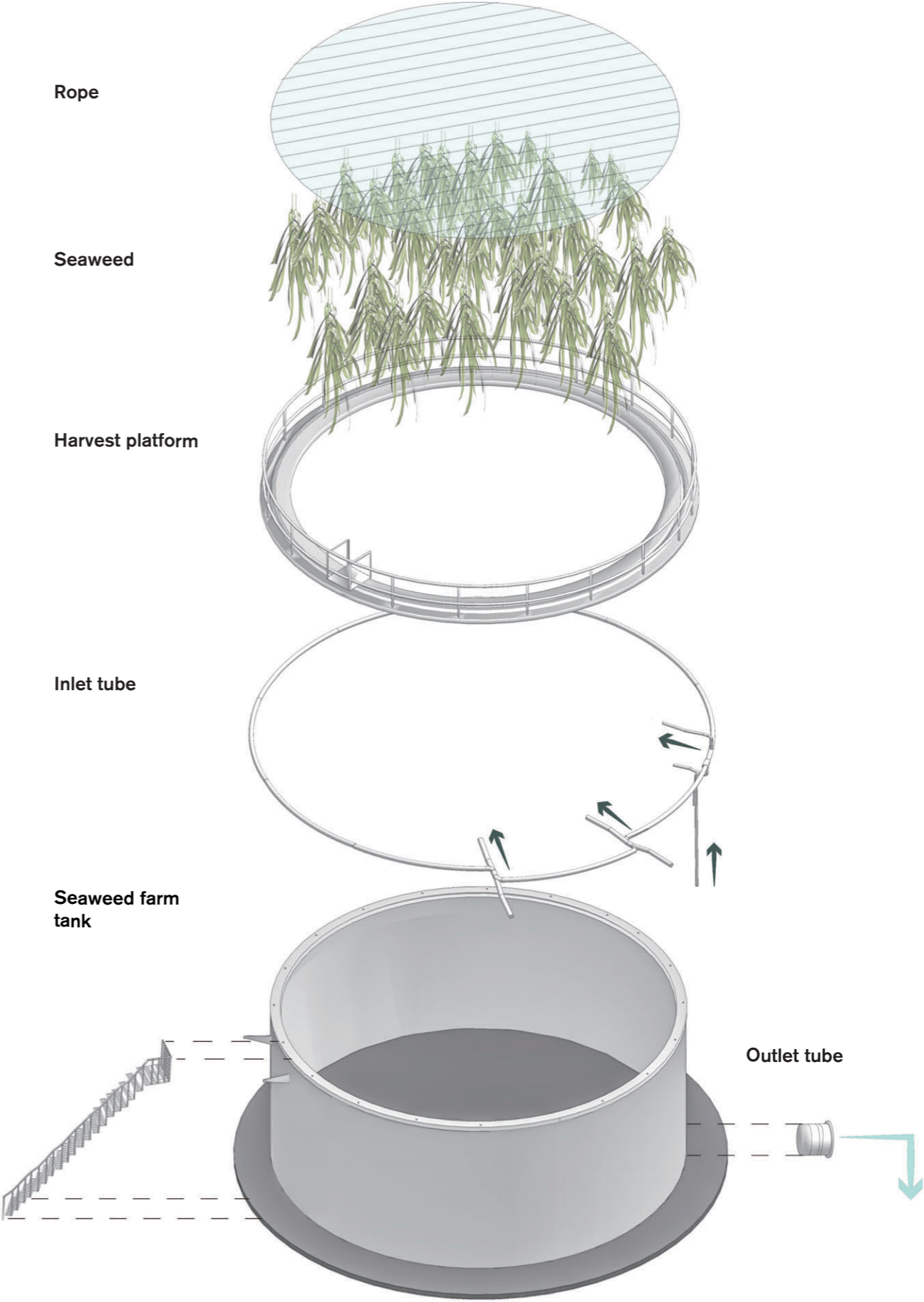
White Spruce

Source: diagram created by author.

Seaweed farm tank techniques

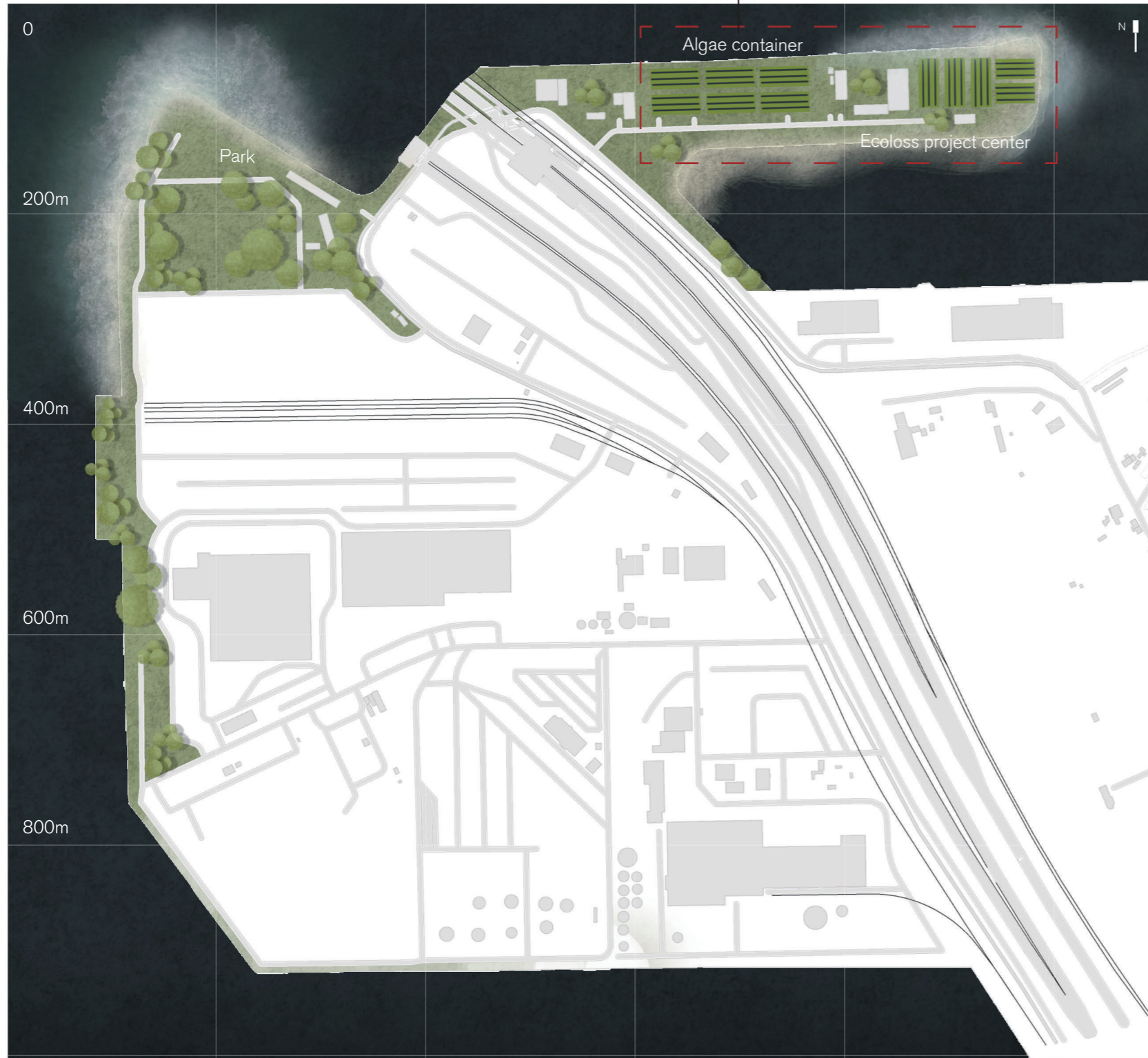


Source: map created by author.



2020 - 2025

Condition 2



Steel wire mesh

Glass jar

Steel wire frame

Steel wire mesh

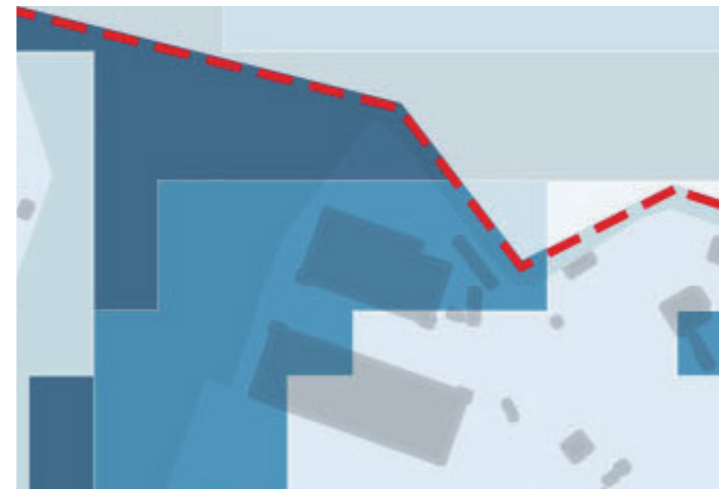
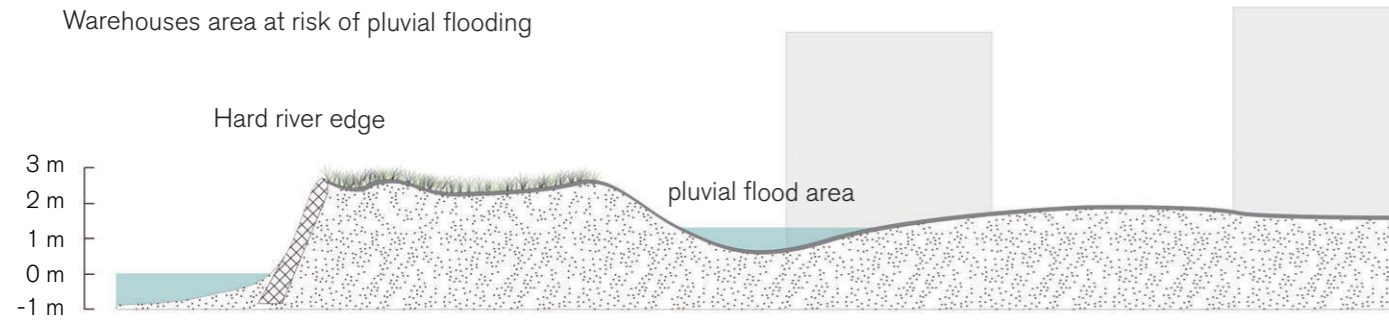
Outlet tube



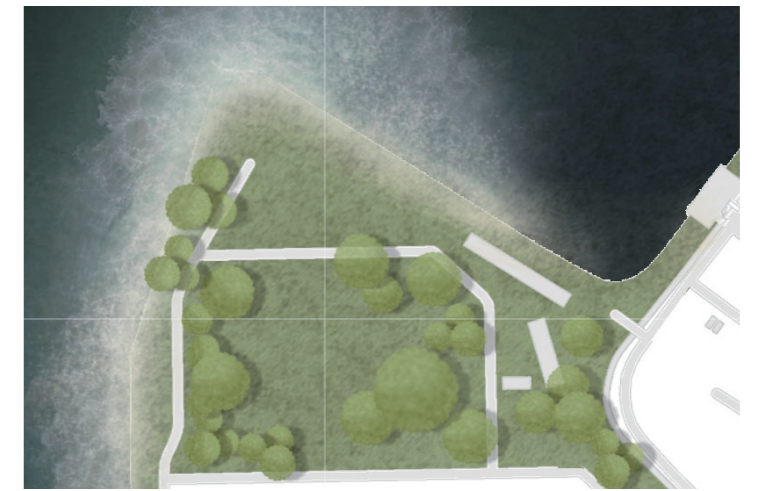
Source: map created by author.

Waterfront Park

Before
Warehouses area at risk of pluvial flooding

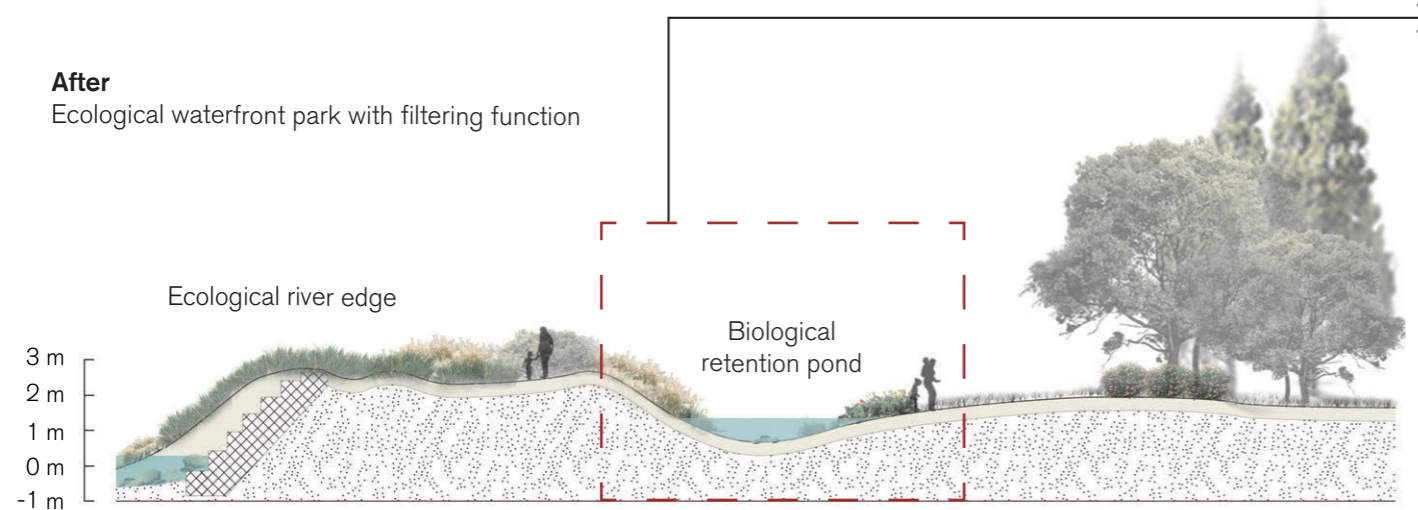


Pluvial flood area



Waterfront park

After
Ecological waterfront park with filtering function



Source: map created by author.

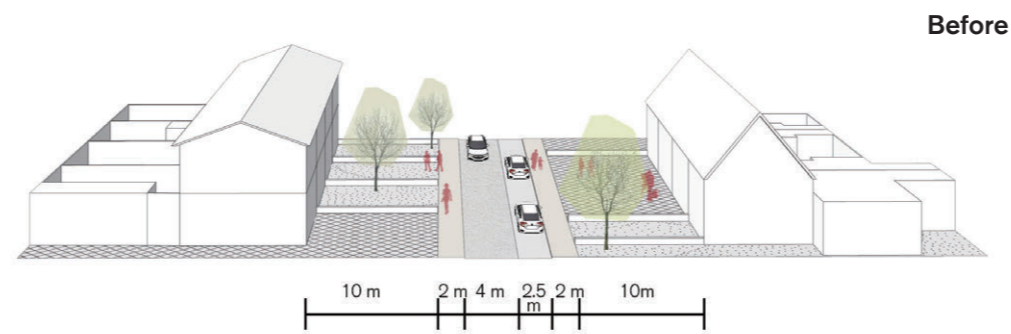
2020 - 2025

Condition 3

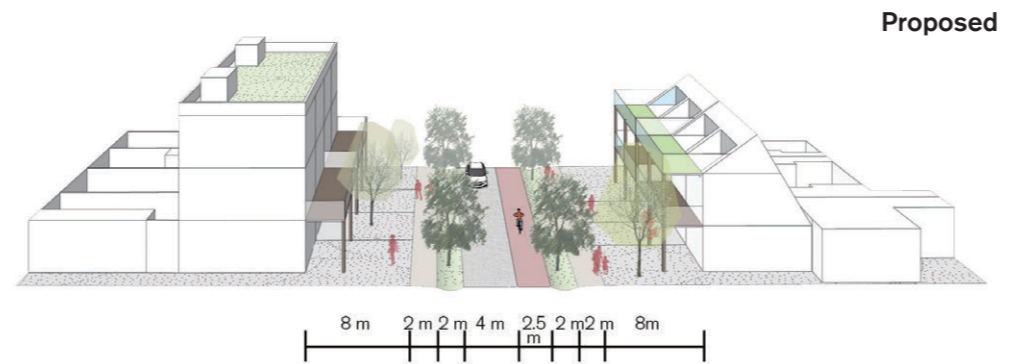


Old housing renovation

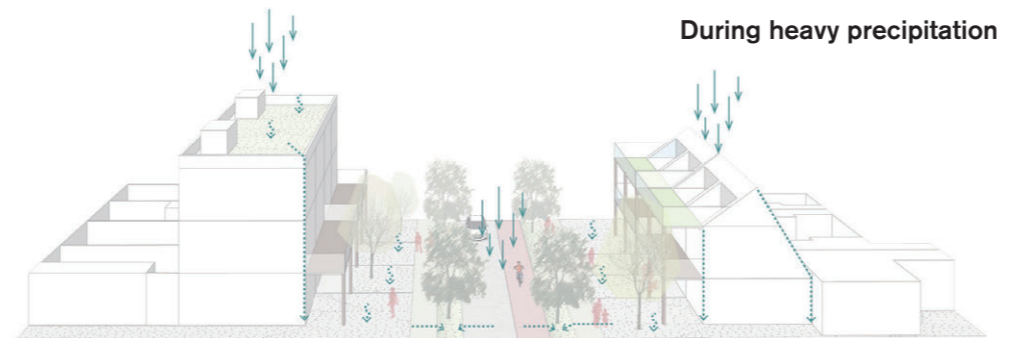
Main road A-A'



Before

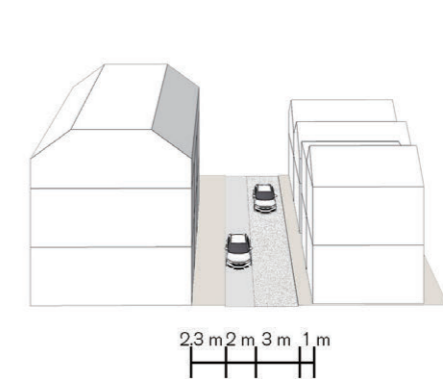


Proposed

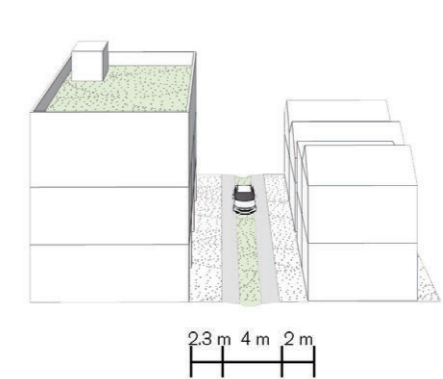


During heavy precipitation

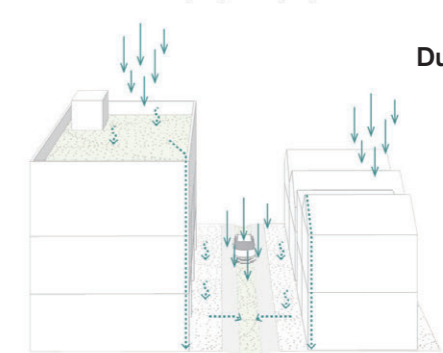
Main road B-B'



Before



Proposed

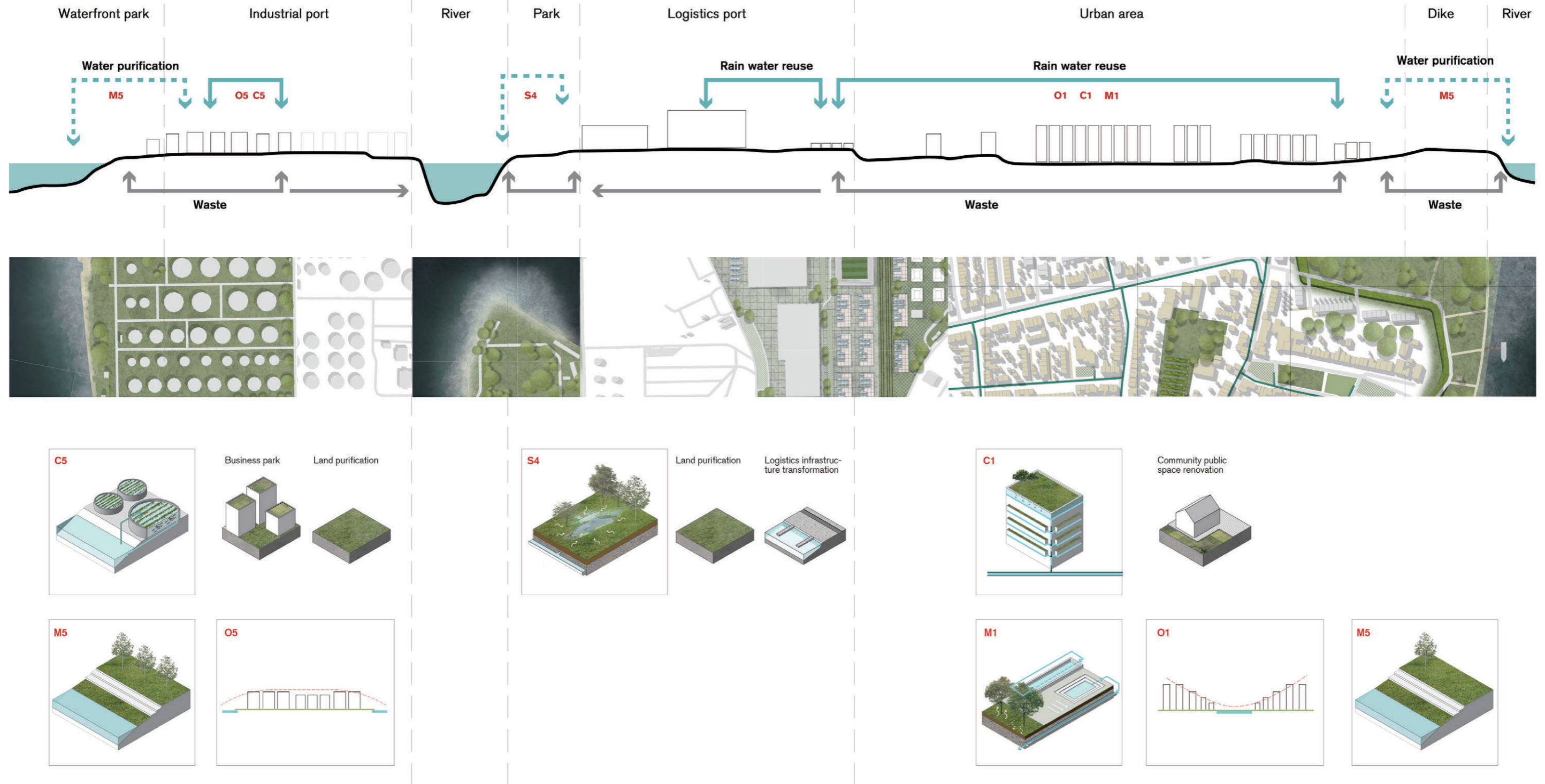


During heavy precipitation

Source: map created by author.

2025 - 2030

Overall input of intervention



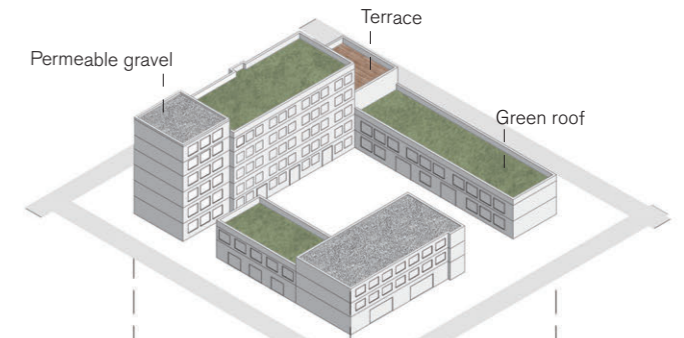
Source: map created by author.

2025 - 2030

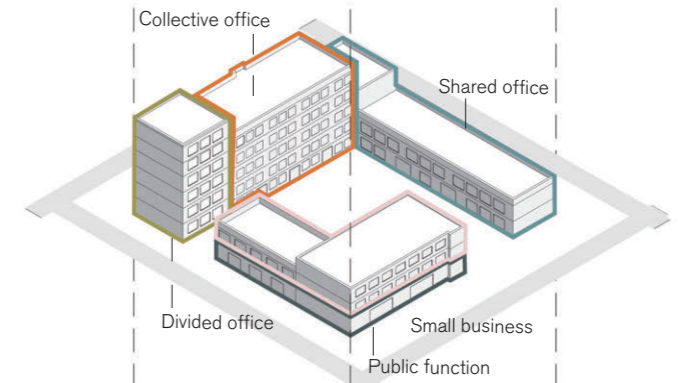
Condition 1



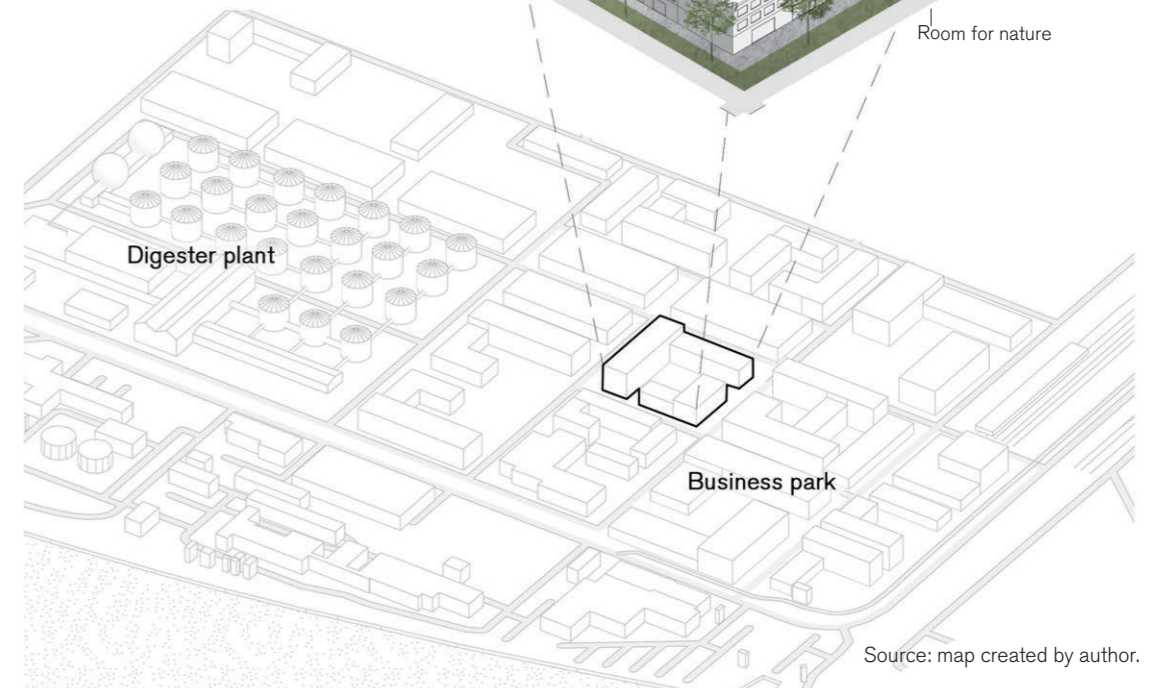
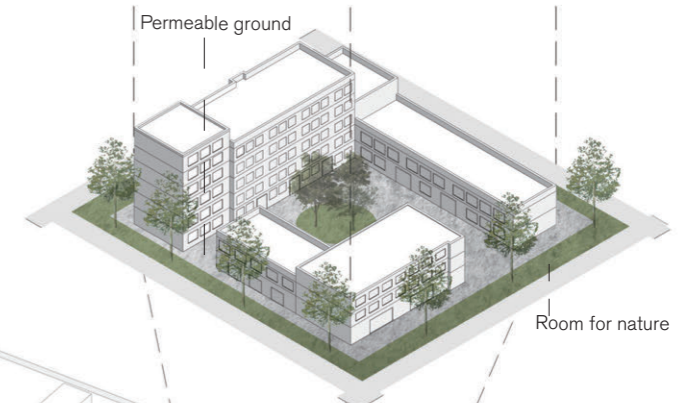
Use the fifth facade of the building



Diversified office



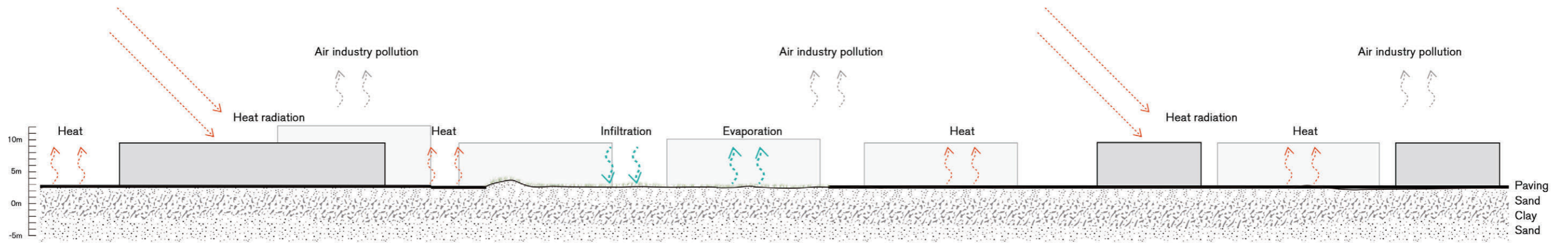
Room for water



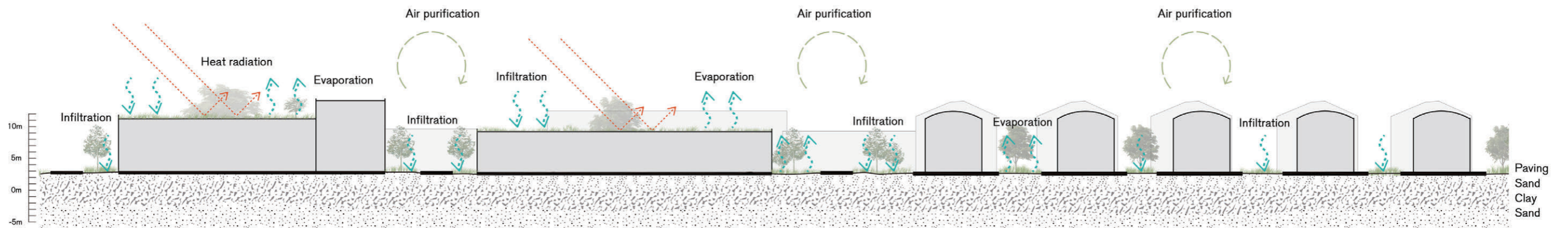
Source: map created by author.

Microclimate change

Before



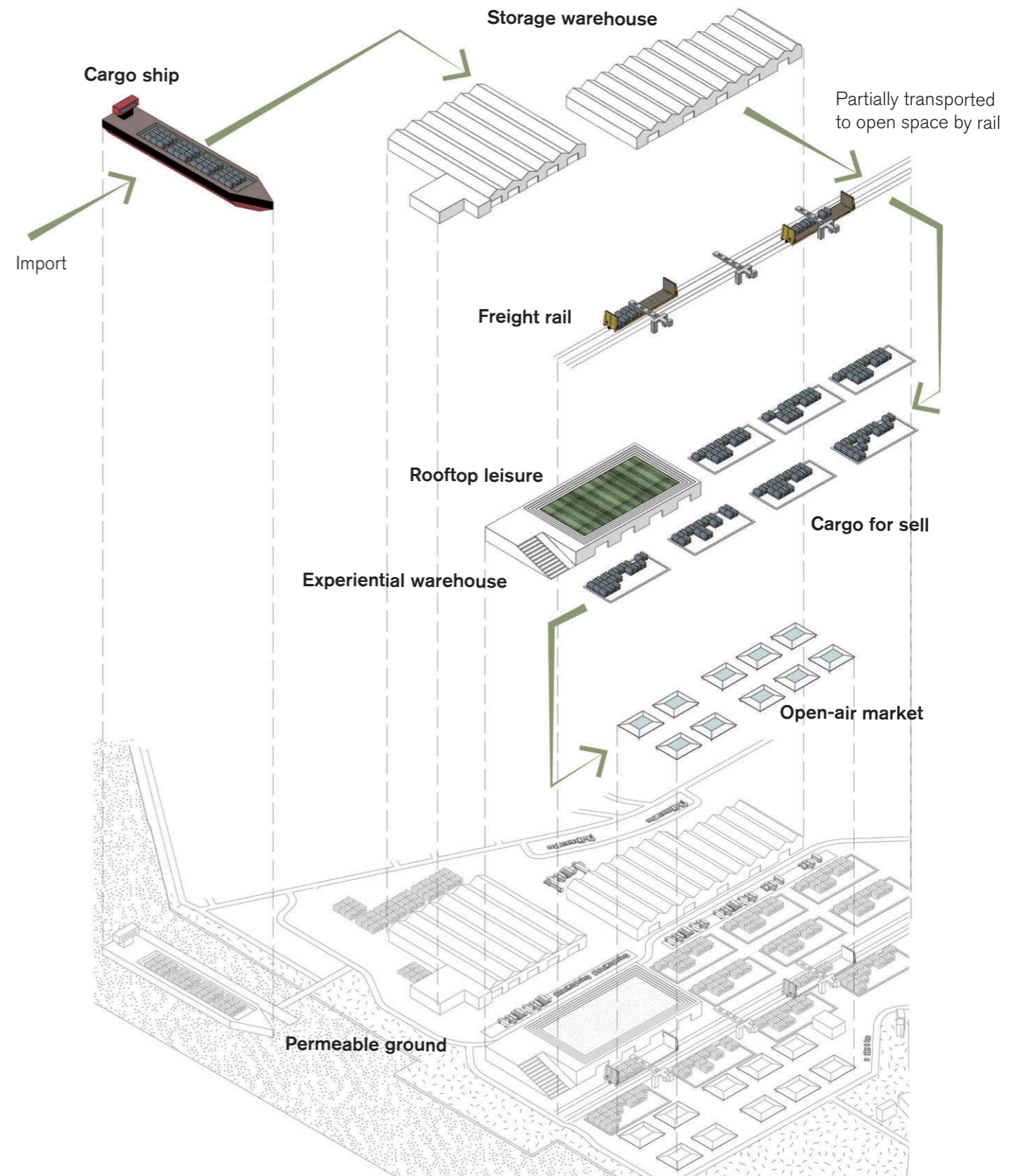
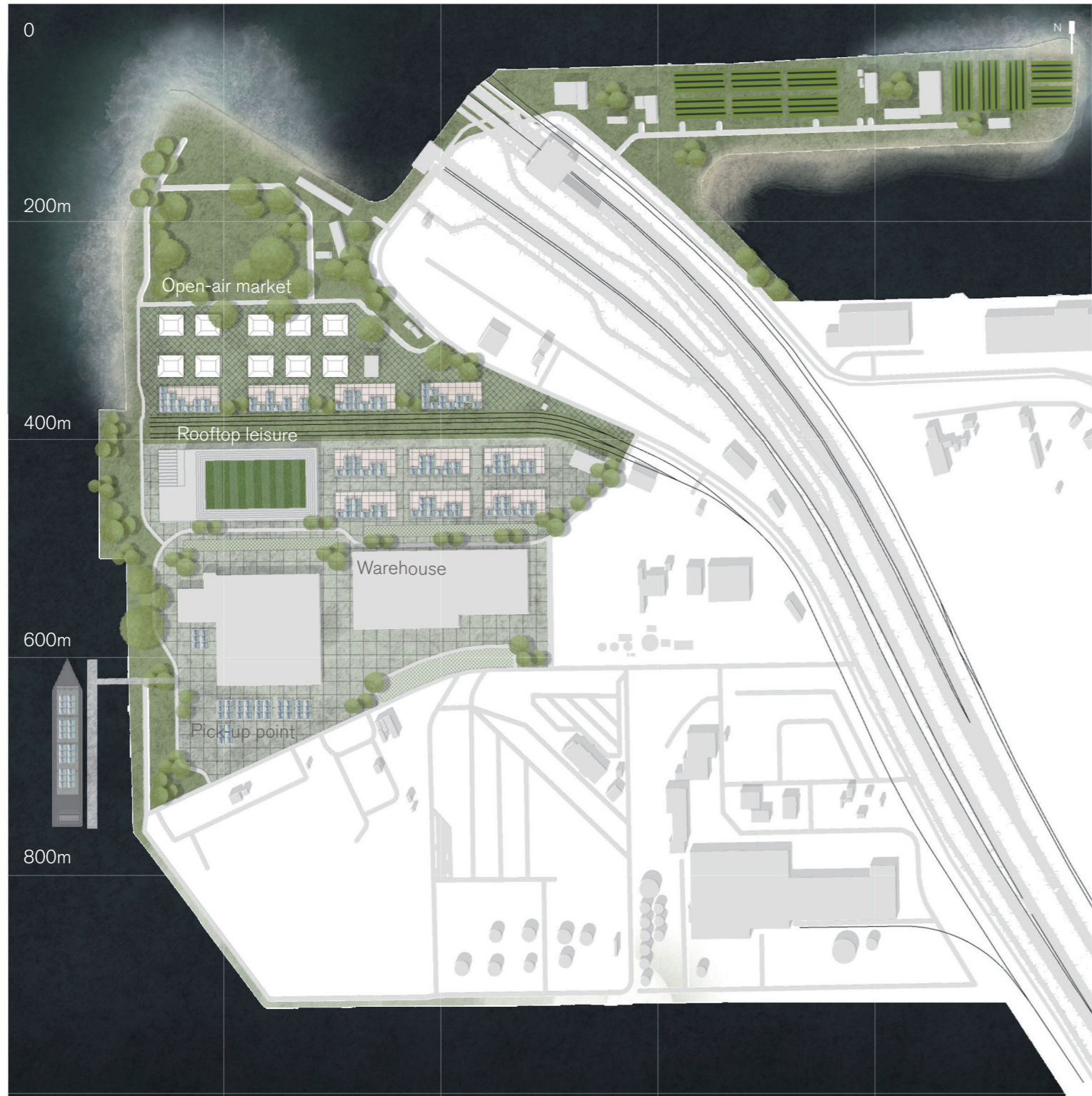
After **O5 C4**



Source: map created by author.

2025 - 2030

Condition 2



Source: map created by author.

2025 - 2030

Condition 3

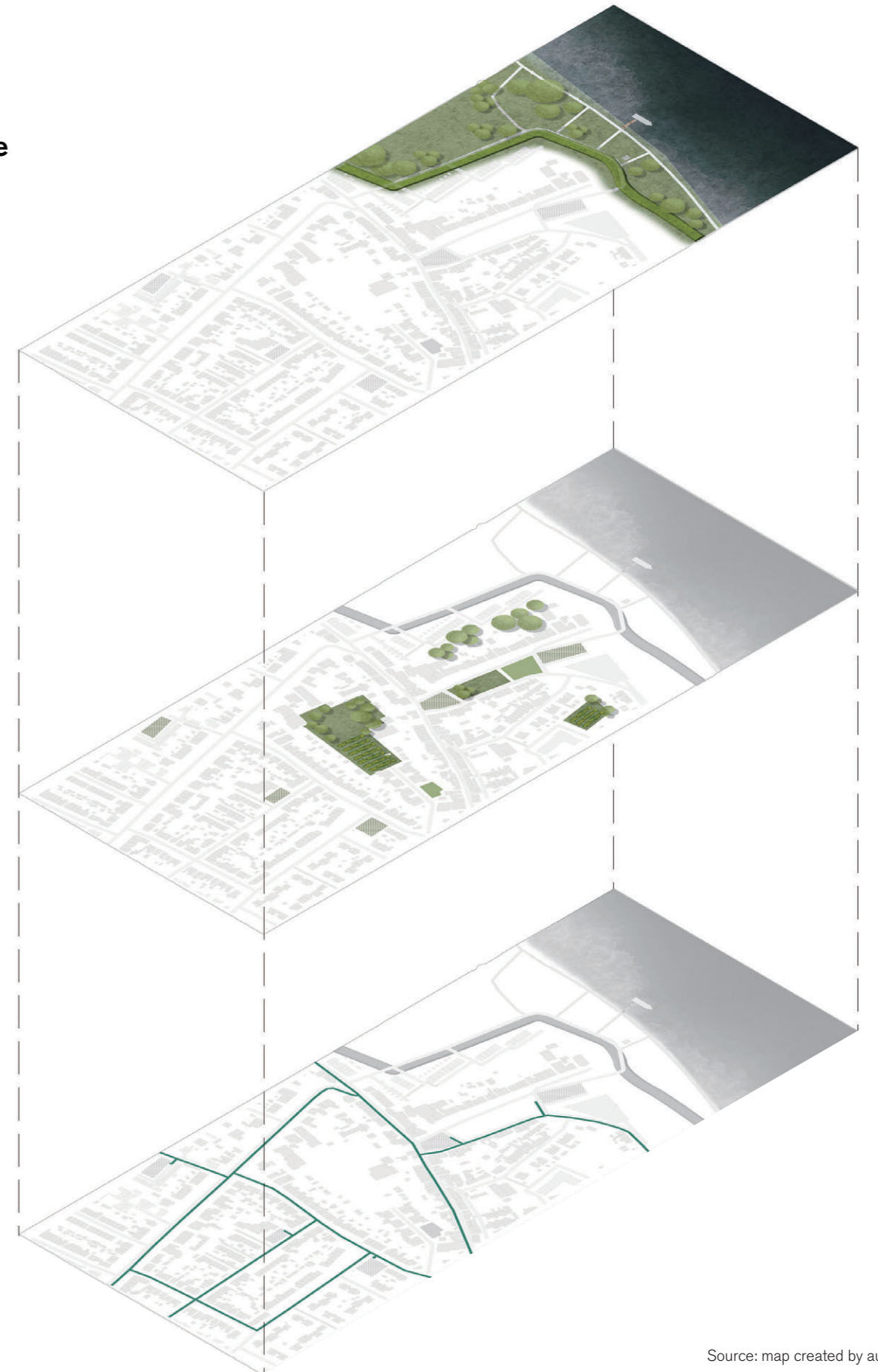


Multilayer buffering zone

Outside the dike
Sufficient natural space for water, tidal and transportation

Inside the dike
Multiple temporary storage spaces, mitigating the risk of flooding

Buffer network
Using sunken vegetation as buffer line, accelerating the discharge and infiltration of surface water, also connecting to a temporary storage space



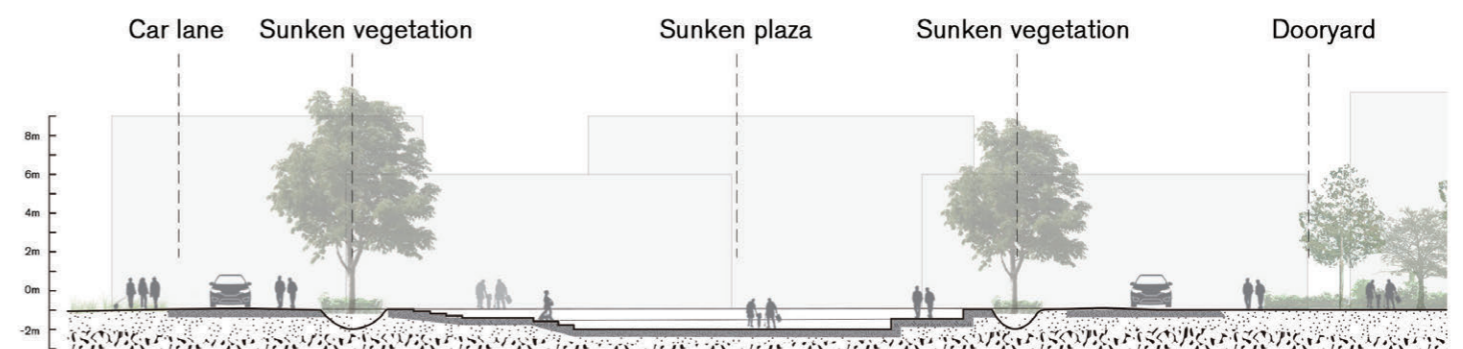
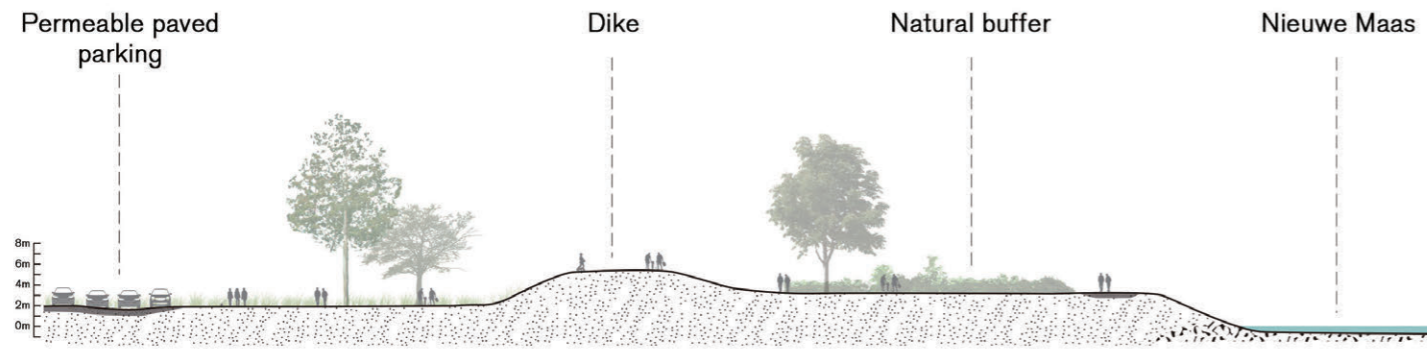
Source: map created by author.

Water management performance

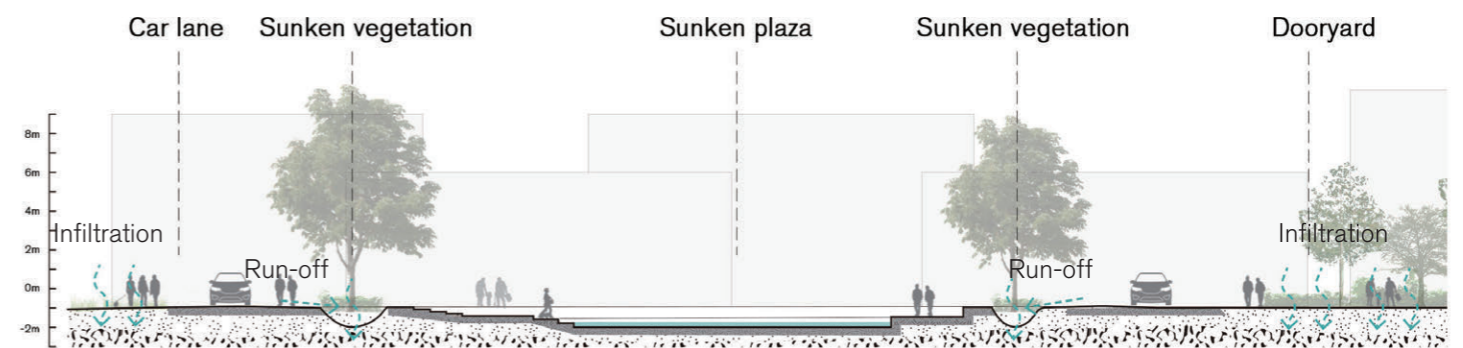
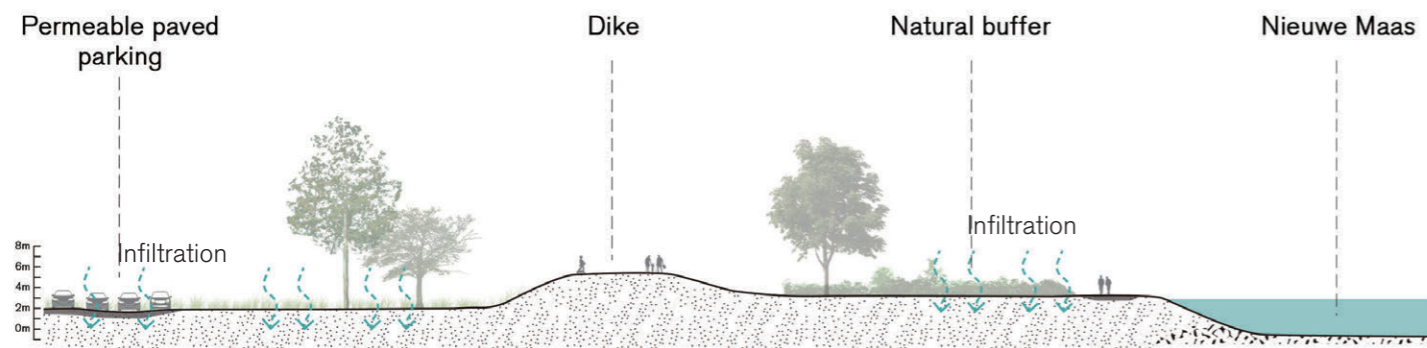
Section A - A'

Normal time

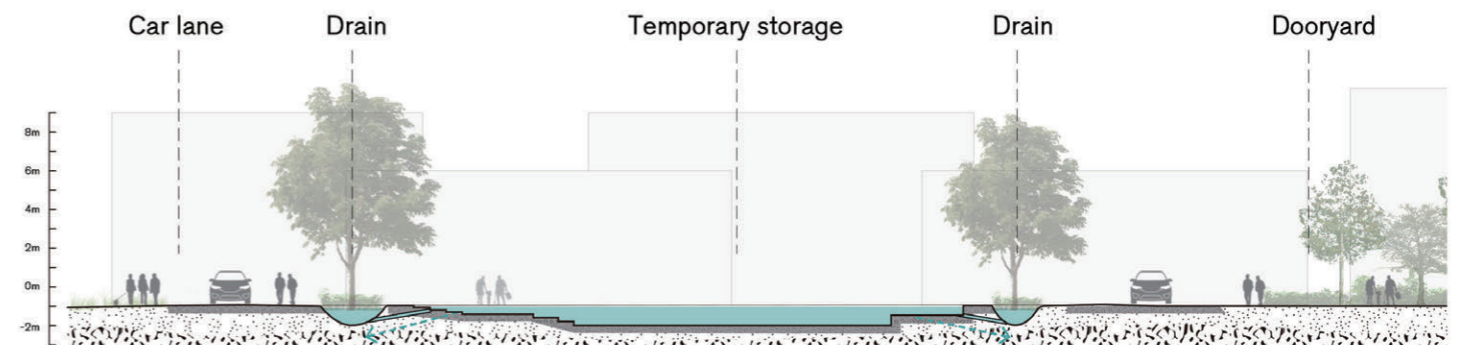
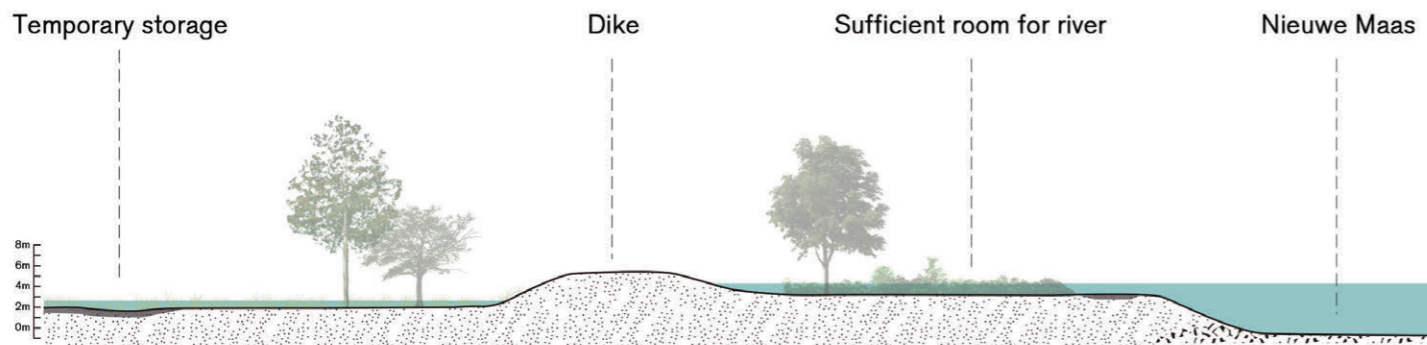
Section B - B'



Wet season

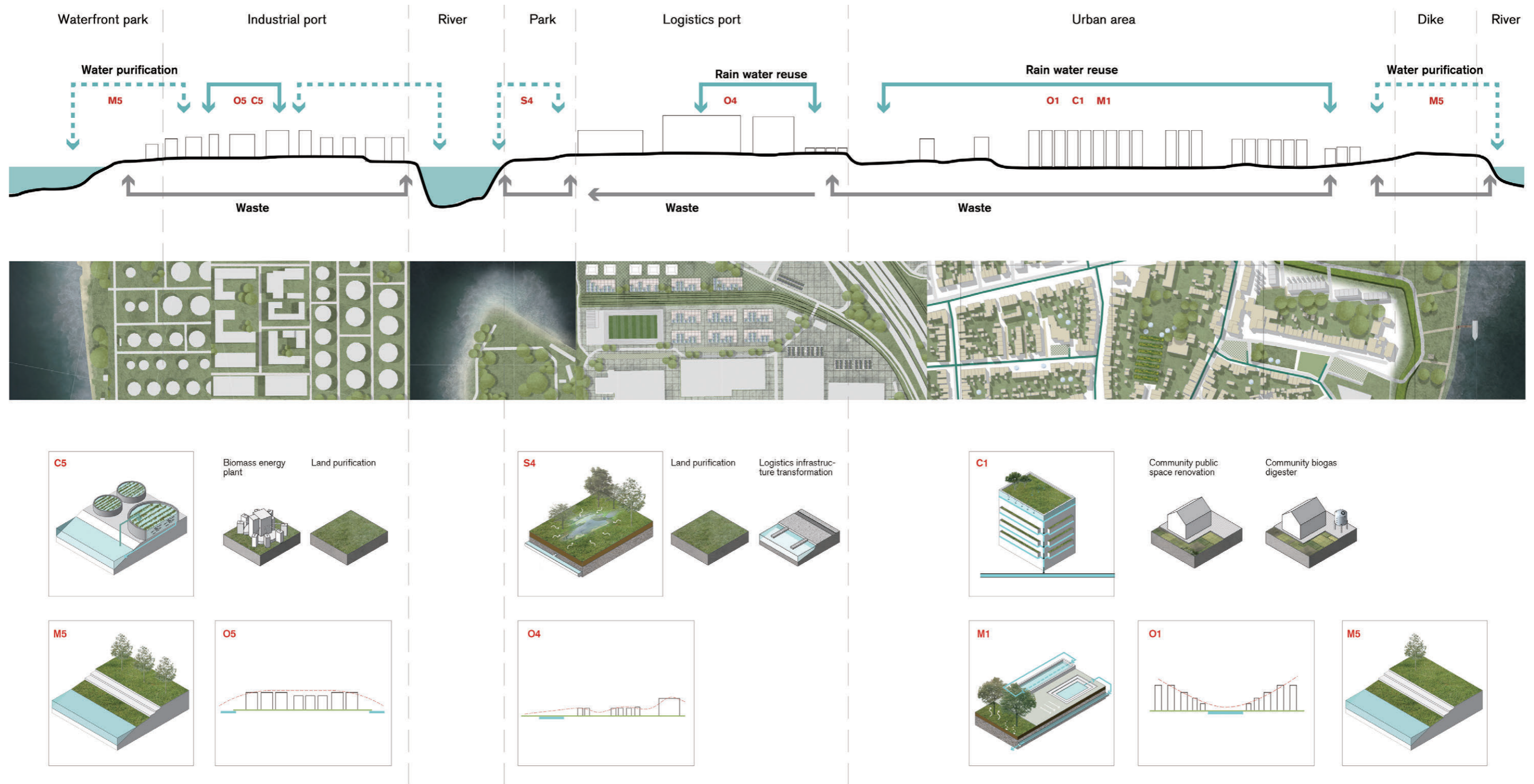


Storm events



2030 - 2035

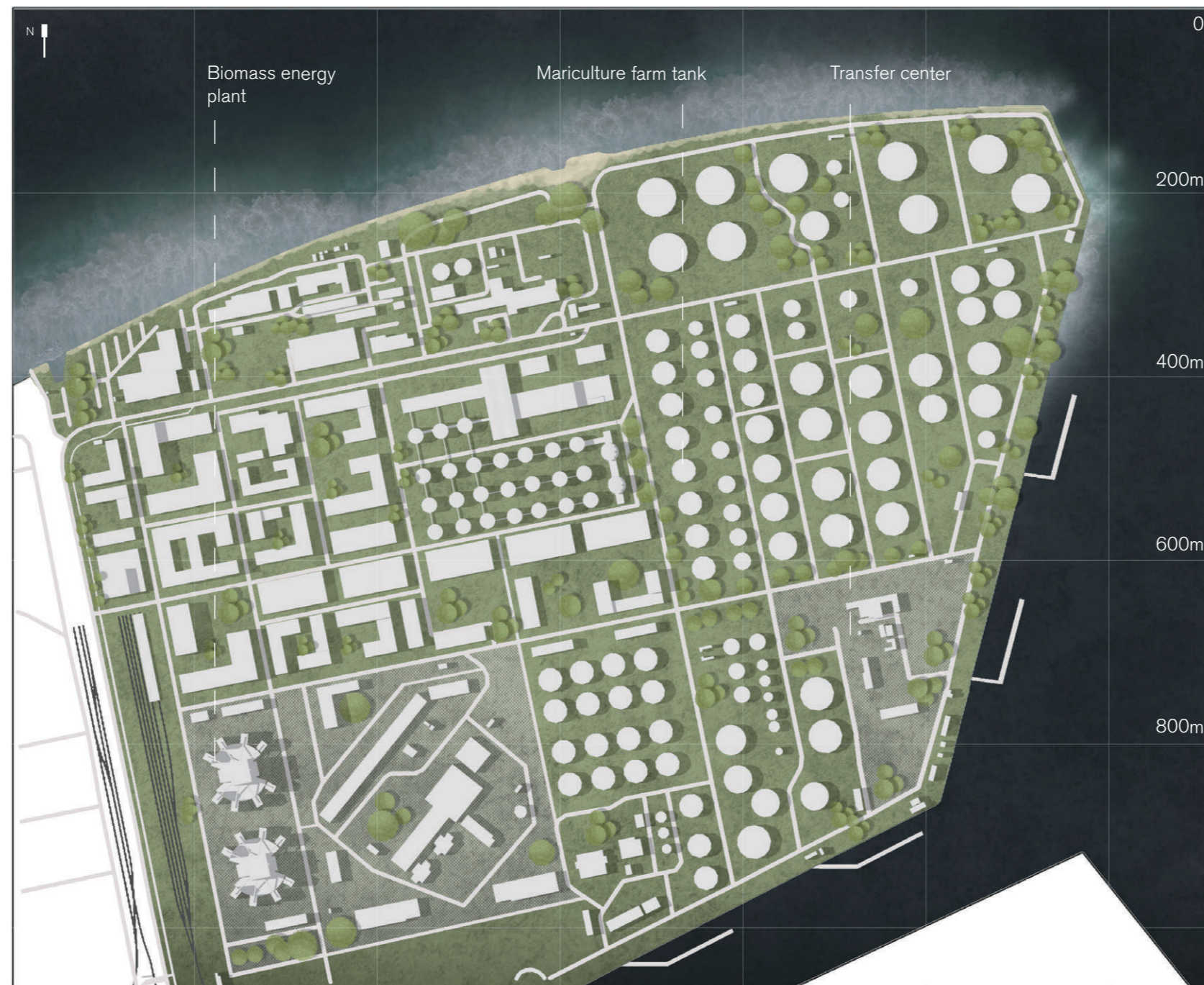
Overall input of intervention



Source: map created by author.

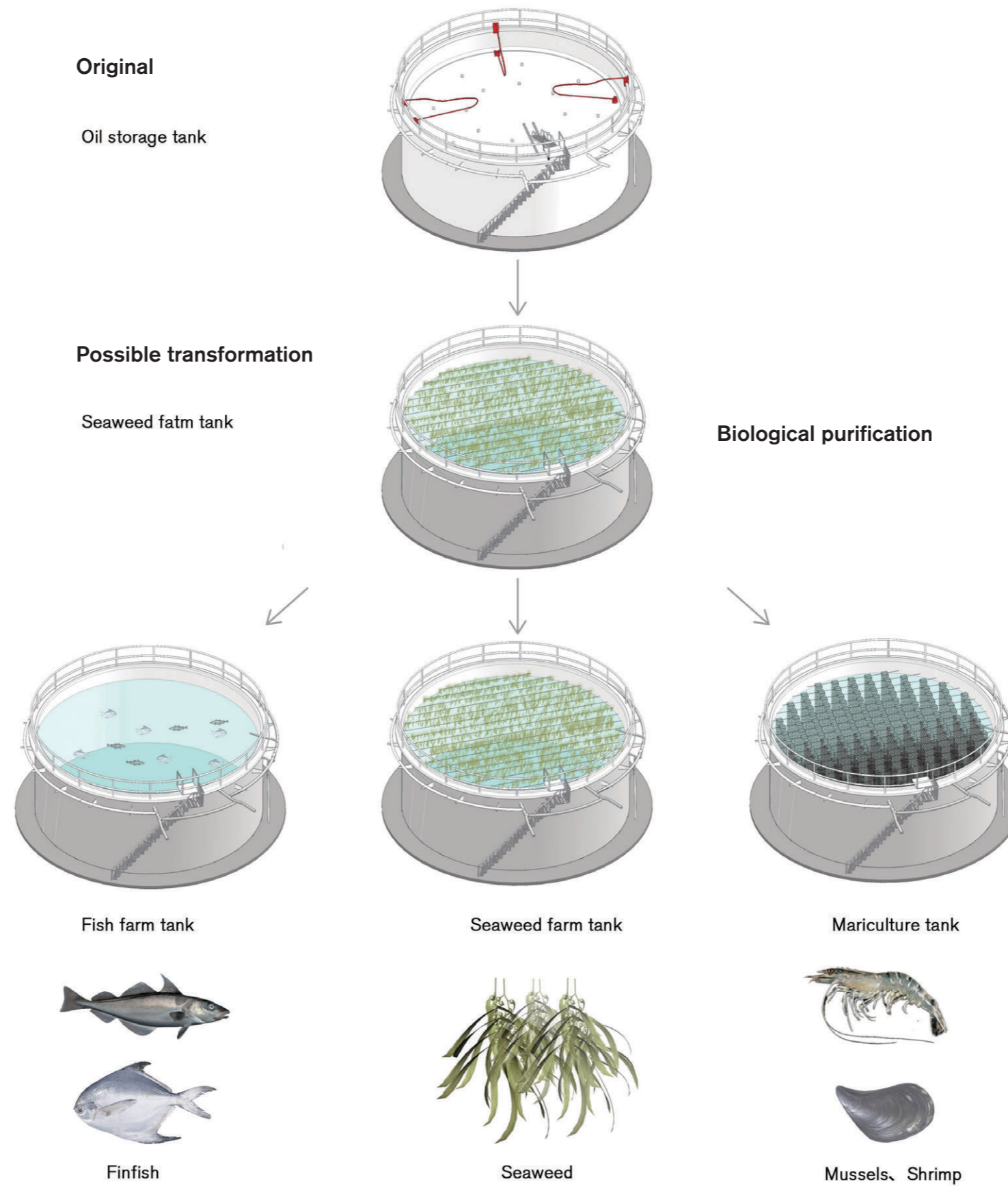
2030 - 2035

Condition 1



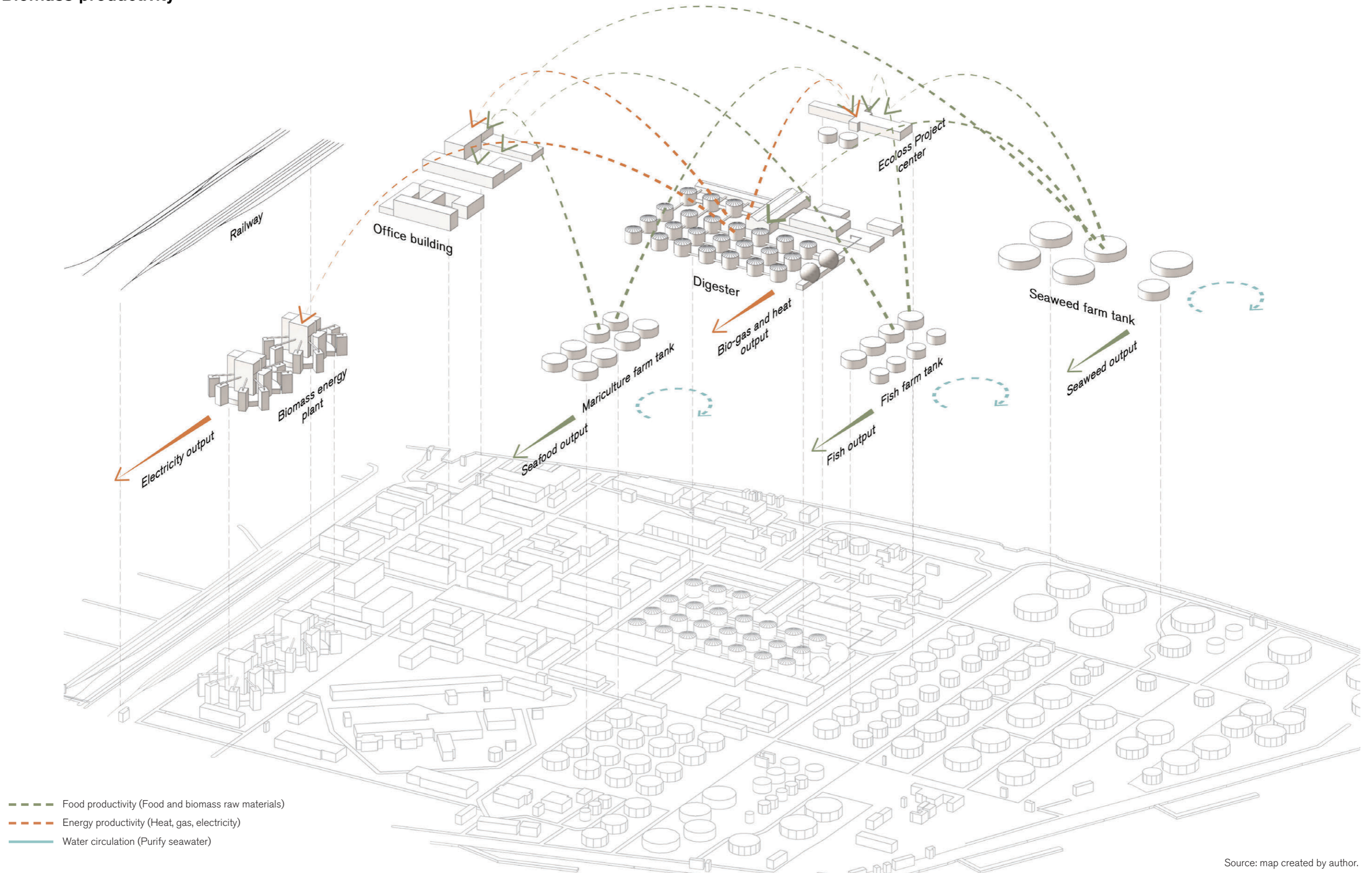
Source: map created by author.

Oil storage tank transformation



Source: map created by author.

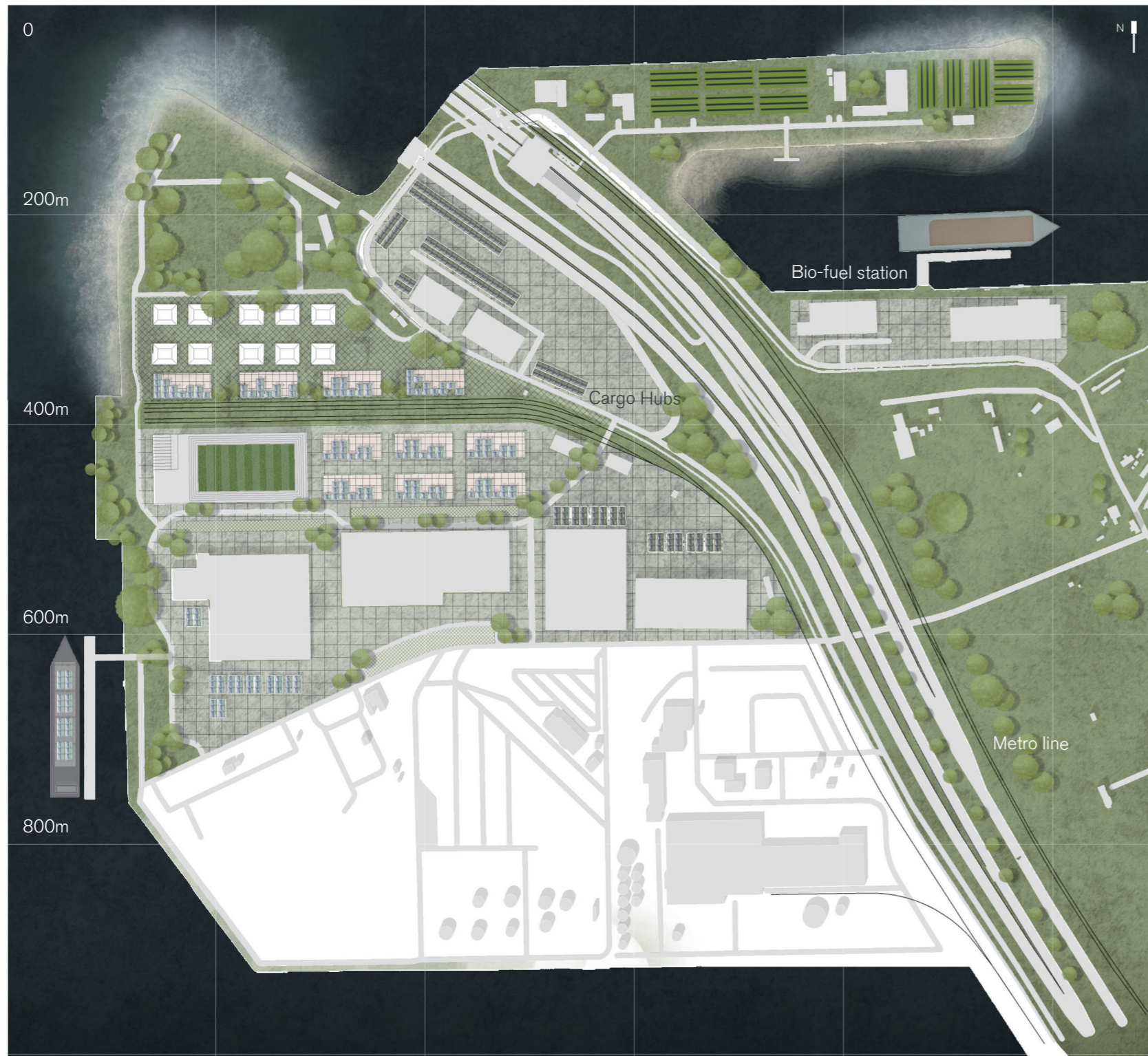
Biomass productivity



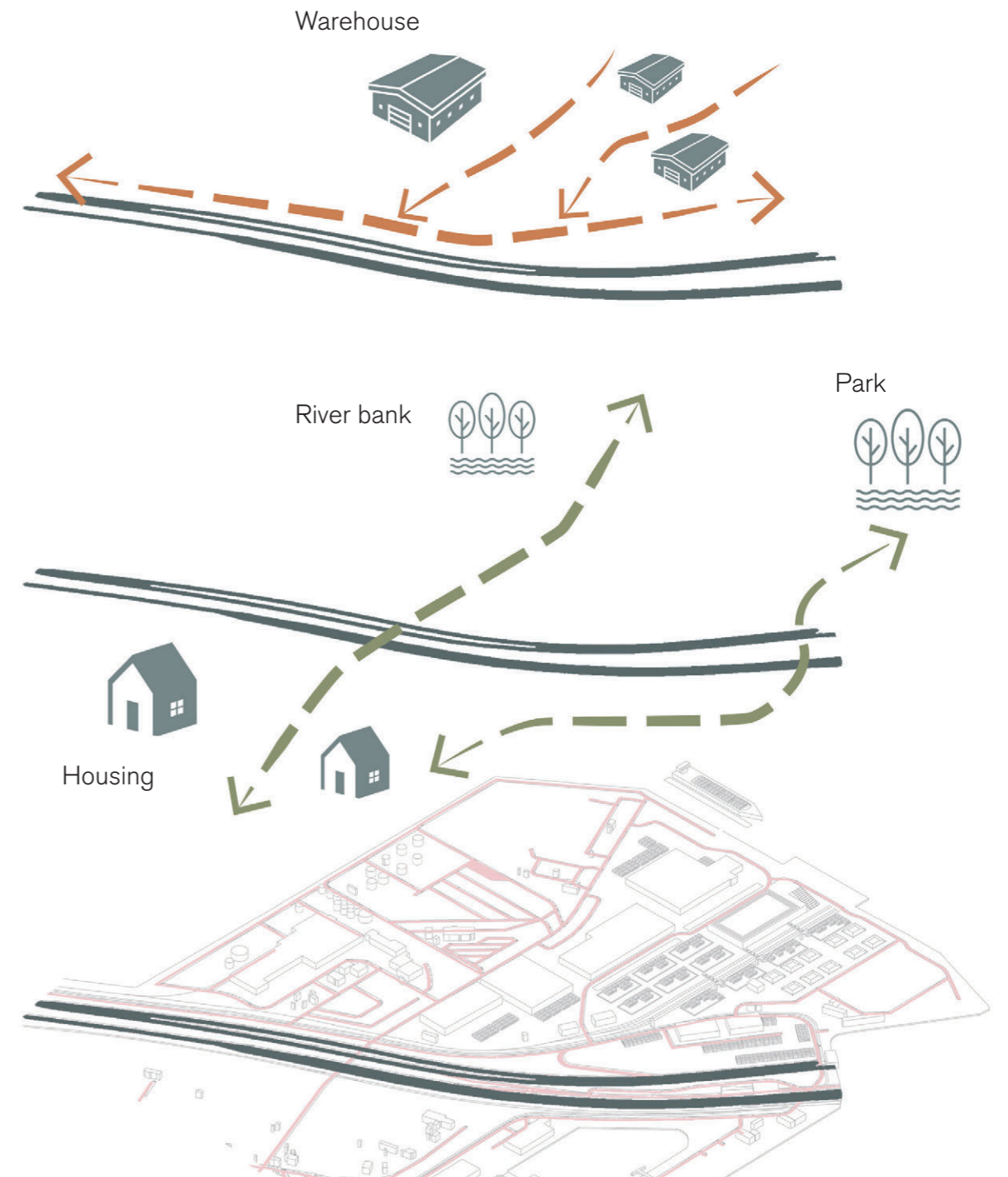
Source: map created by author.

2030 - 2035

Condition 2



New accessibility for people and cargo



Source: map created by author.

2030 - 2035

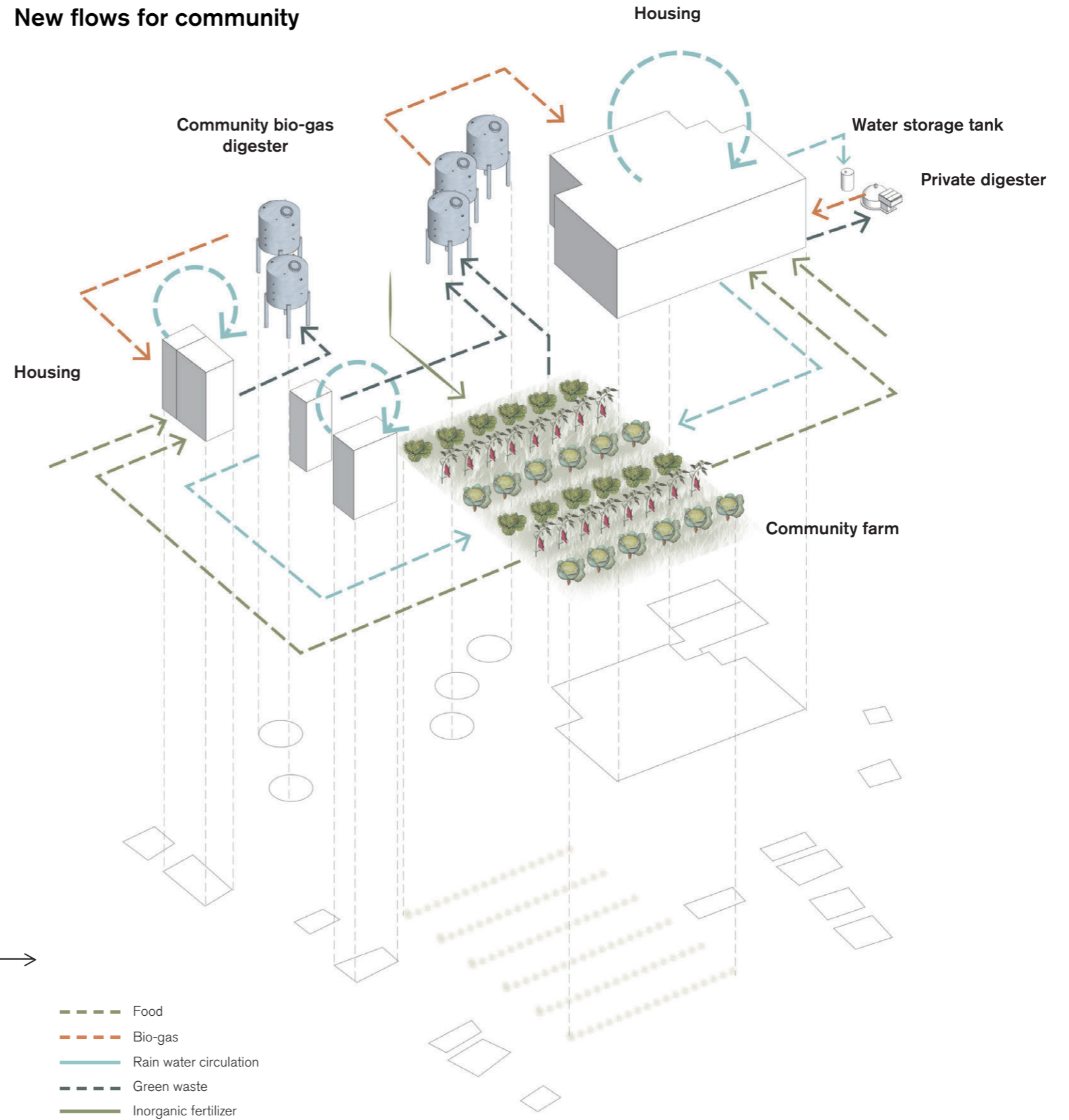
Condition 3



Introduction

Problem field

New flows for community



Methodology

Analysis

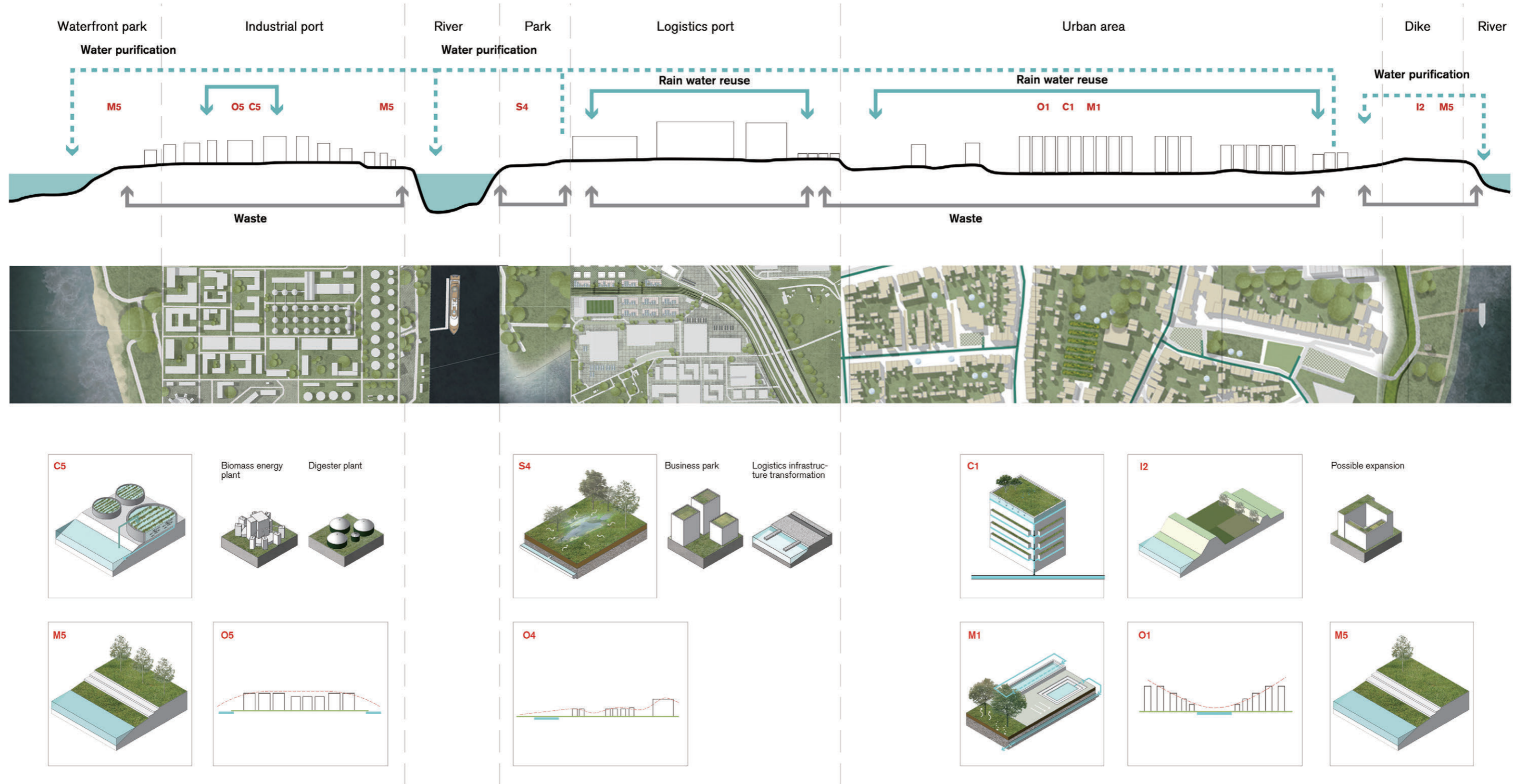
Strategies and Design

Conclusion

Source: map created by author.

2035 - 2040

Overall input of intervention



Source: map created by author.

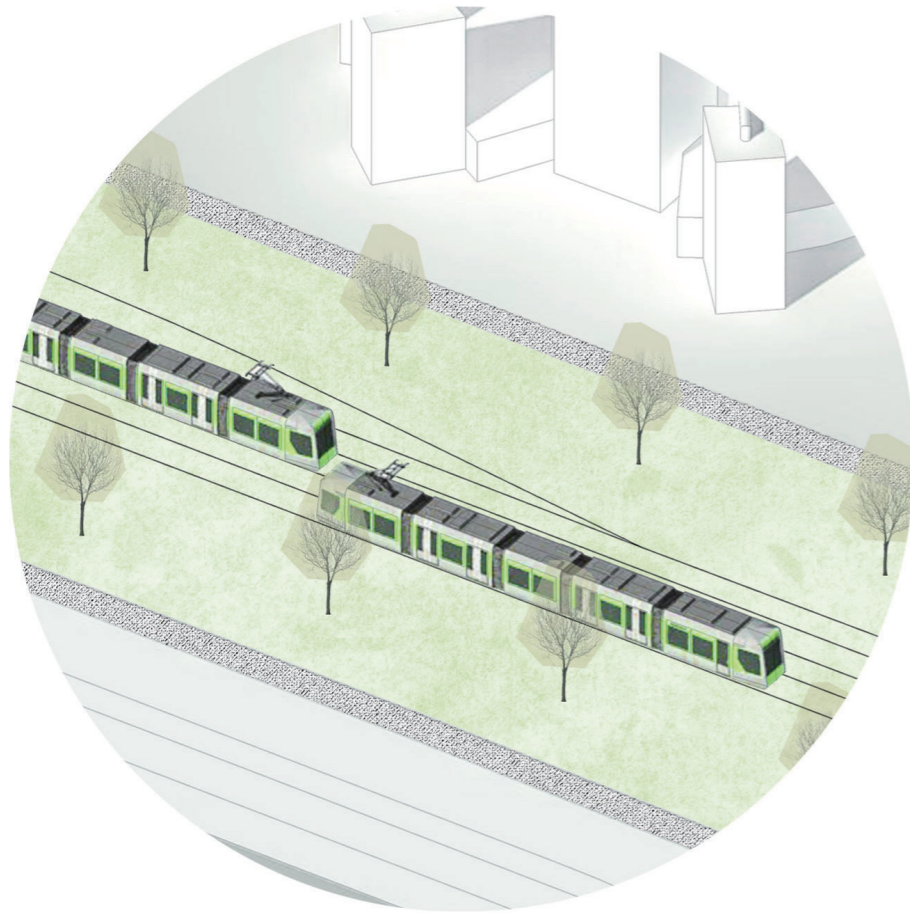
2035 - 2040

Condition 1



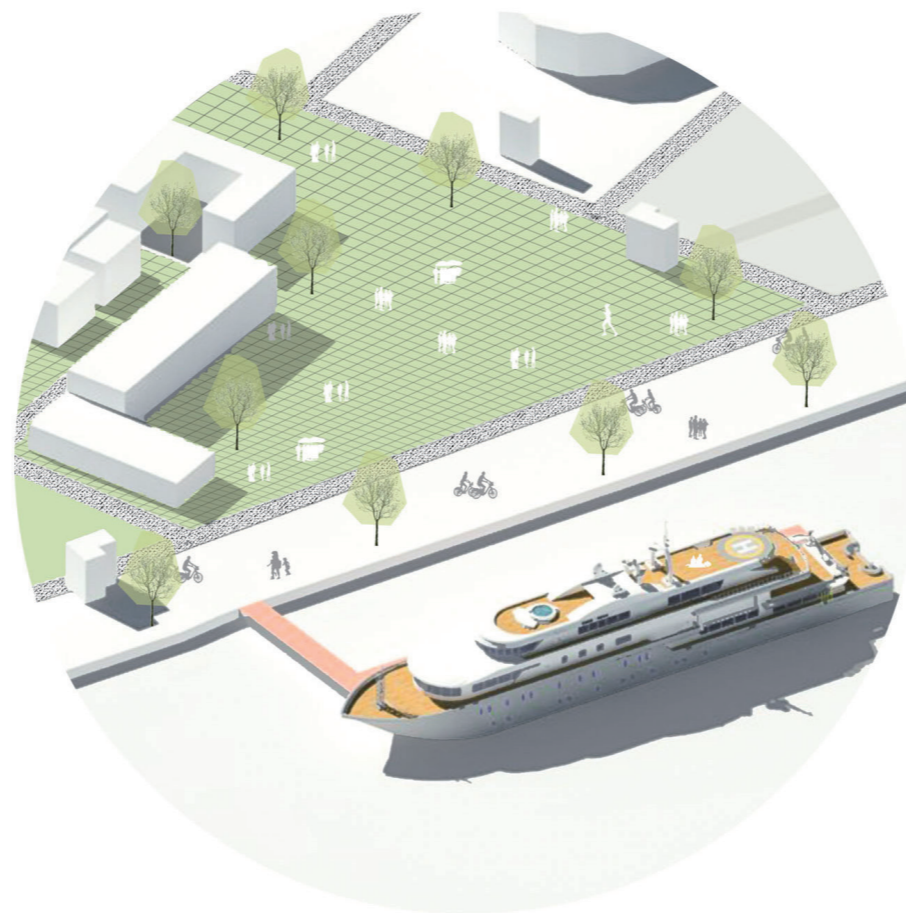
Source: map created by author.

Increase accessibility



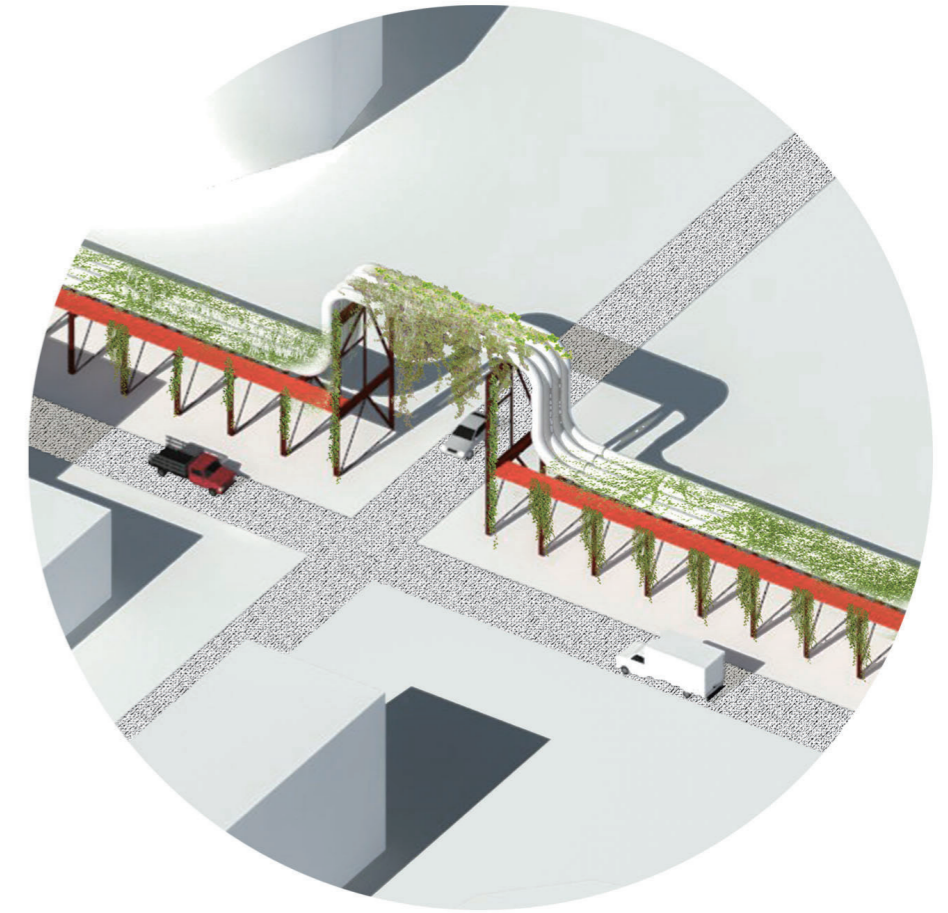
A. Tram line

After the transformation of the industrial zone, the rails that were originally used for cargo transportation can be transformed into tram tracks for public transportation



B. Ferry Terminal

The connectivity of the banks of the Nieuwe Maas River mainly depends on highways, and ferry terminals increase the connectivity between the two banks, and people can also reach here in more ways



C. New gate

The oil pipeline in the industrial zone originally used as a barrier to separate the entire area. By partially rebuilding the pipeline at the intersection to form a new gate, also the pipeline can be retained for transportation of bio-gas or bio-fue

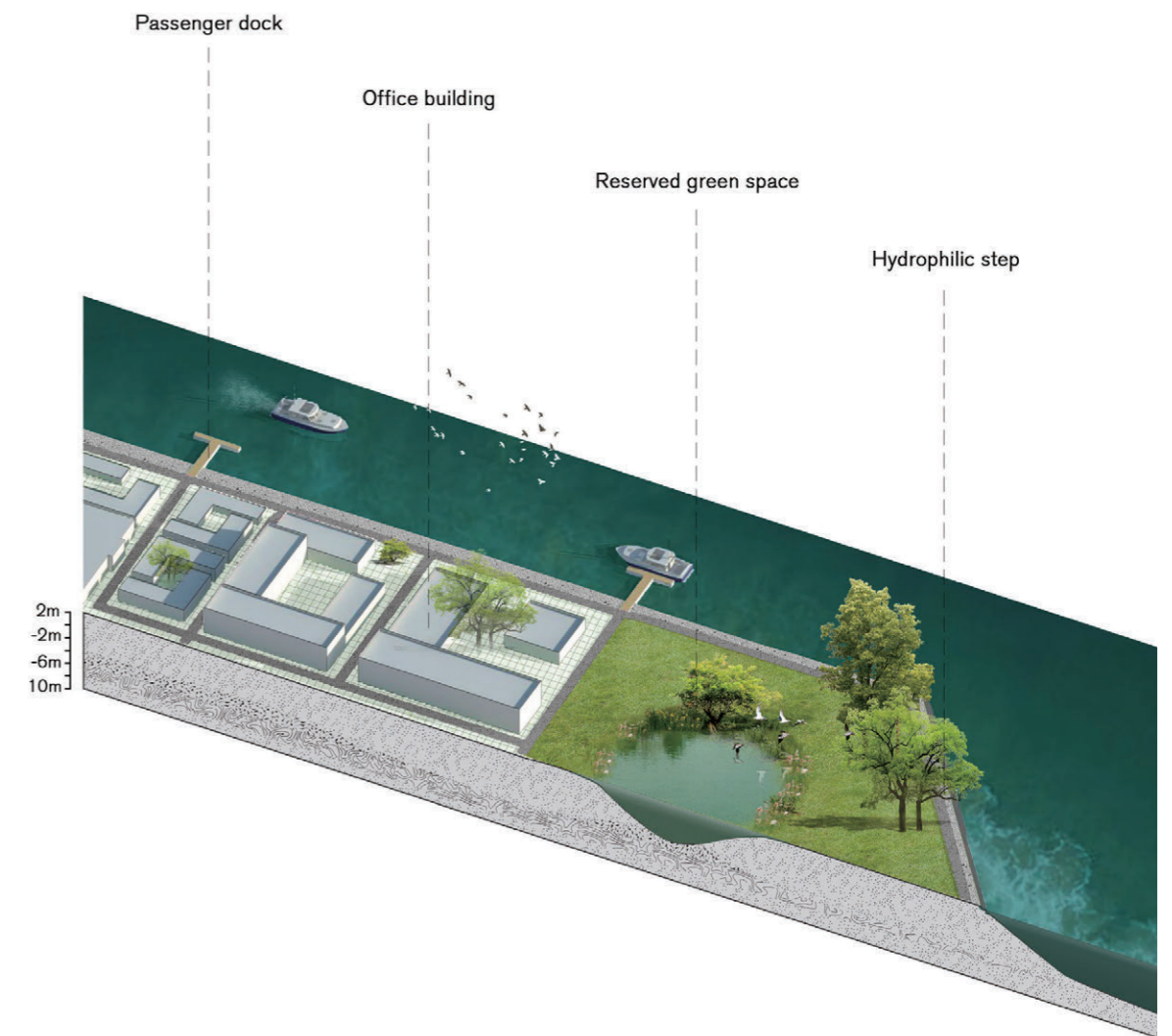
Source: map created by author.

2035 - 2040

Condition 2



Increase accessibility and functionality



Source: map created by author.

2035 - 2040

Condition 3

Possible future expansion - Low density



Source: map created by author.

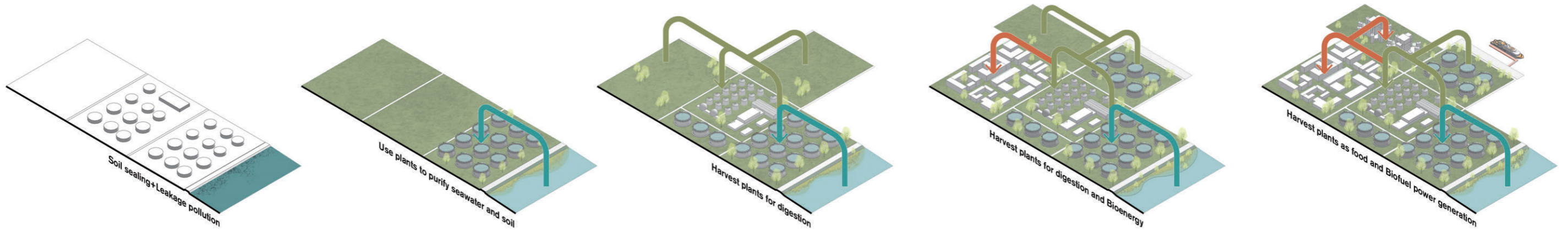
Possible future expansion - High density



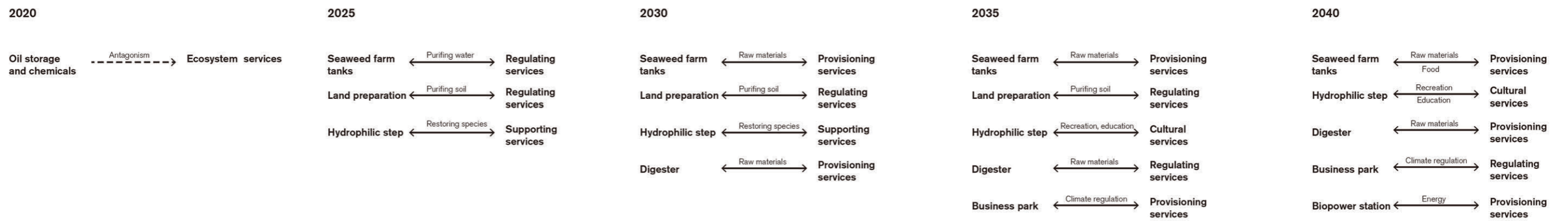
Source: map created by author.

BIOPHYSICAL SYSTEM ADAPTATION IN EACH CONDITION OVERVIEW

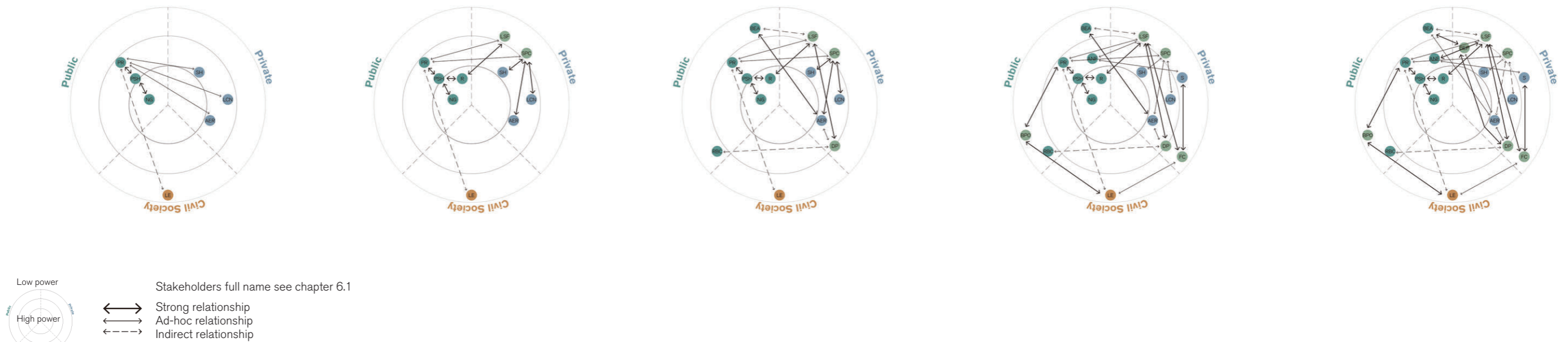
Condition 1



Synergy of bio-physical space and ecosystem services



Key stakeholder engagement



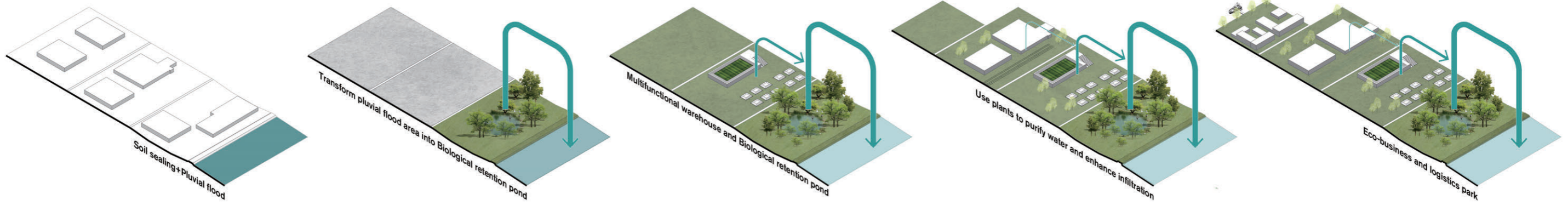
Low power
High power

Stakeholders full name see chapter 6.1

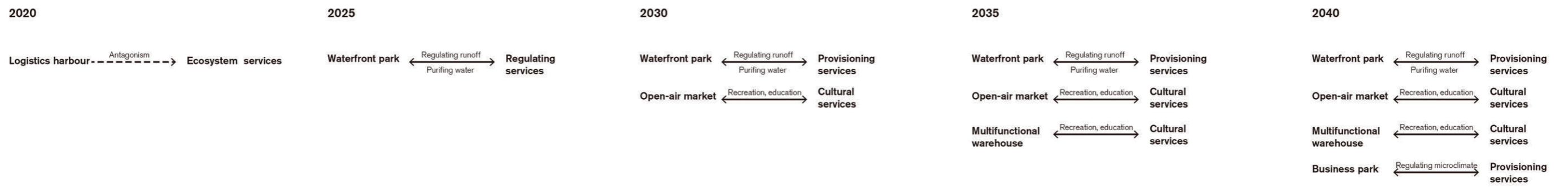
Strong relationship
Ad-hoc relationship
Indirect relationship

BIOPHYSICAL SYSTEM ADAPTATION IN EACH CONDITION OVERVIEW

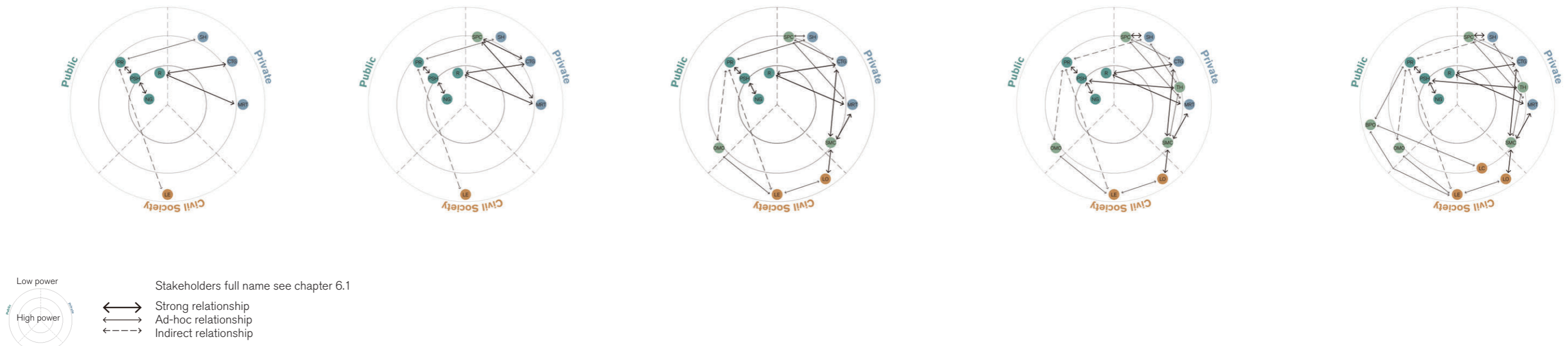
Condition 2



Synergy of bio-physical space and ecosystem services



Key stakeholder engagement



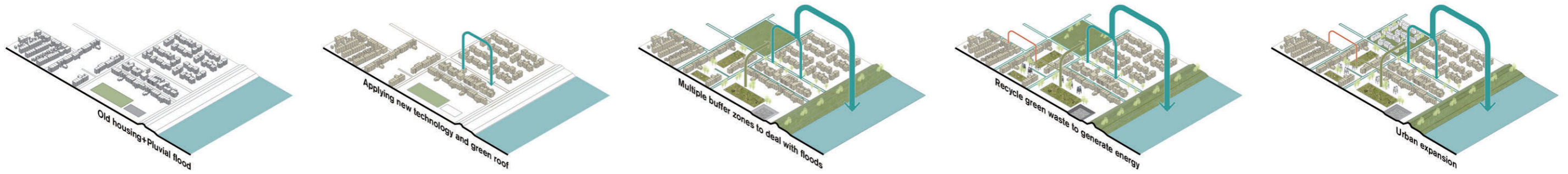
Low power
High power

Stakeholders full name see chapter 6.1

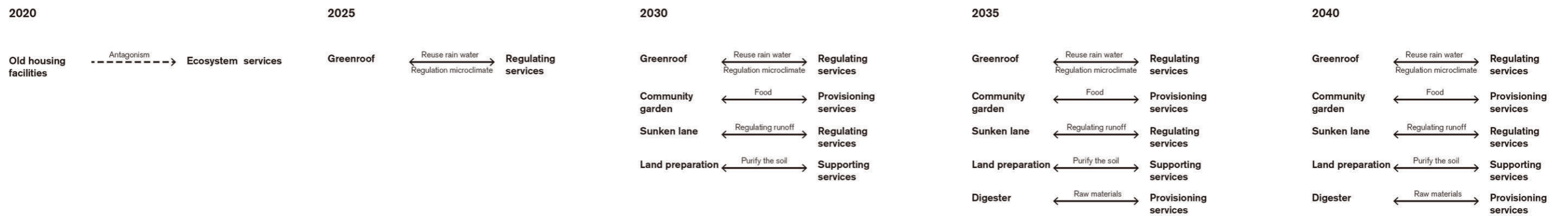
Strong relationship
Ad-hoc relationship
Indirect relationship

BIOPHYSICAL SYSTEM ADAPTATION IN EACH CONDITION OVERVIEW

Condition 3



Synergy of bio-physical space and ecosystem services



Key stakeholder engagement

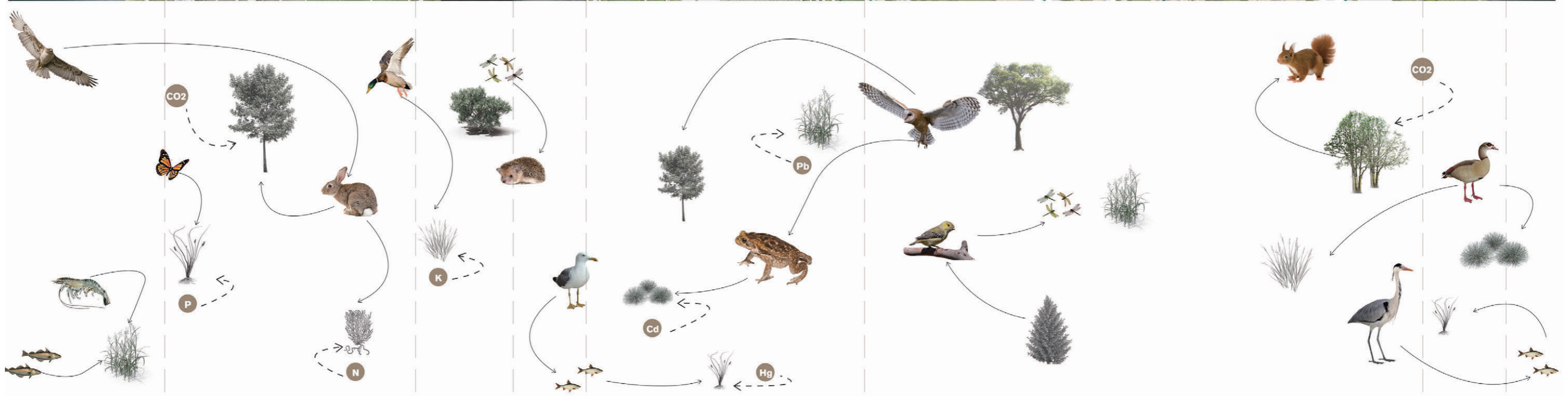
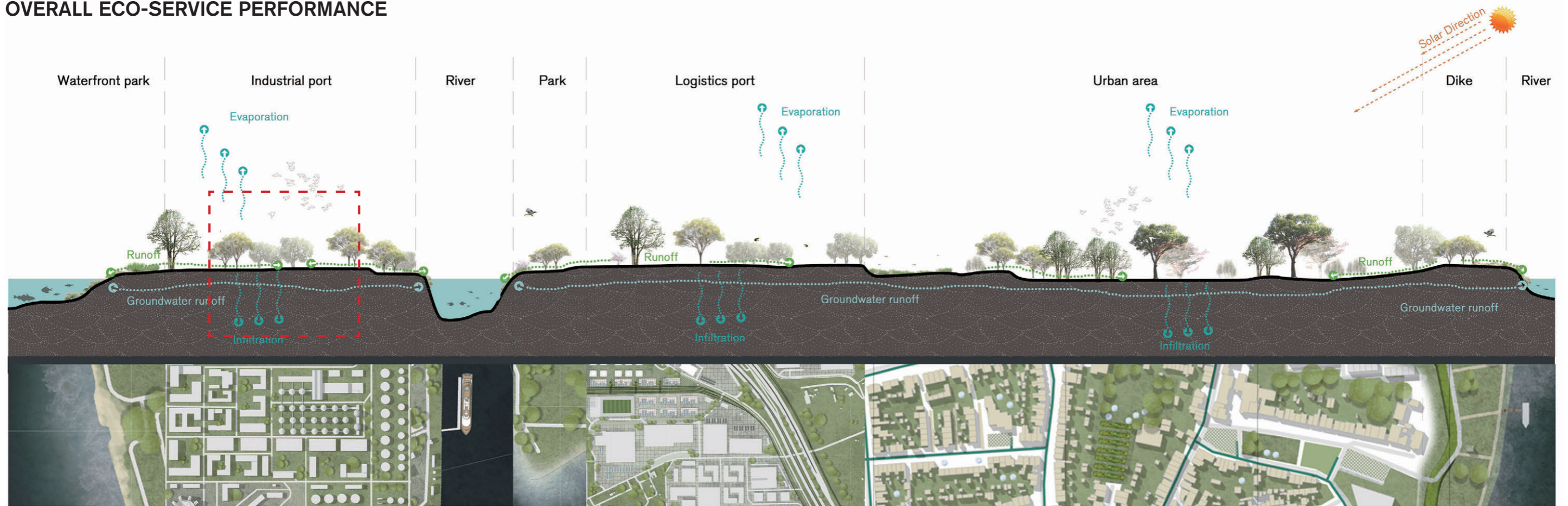


Low power
High power

Stakeholders full name see chapter 6.1

Strong relationship (solid double arrow)
Ad-hoc relationship (dashed double arrow)
Indirect relationship (dotted double arrow)

OVERALL ECO-SERVICE PERFORMANCE

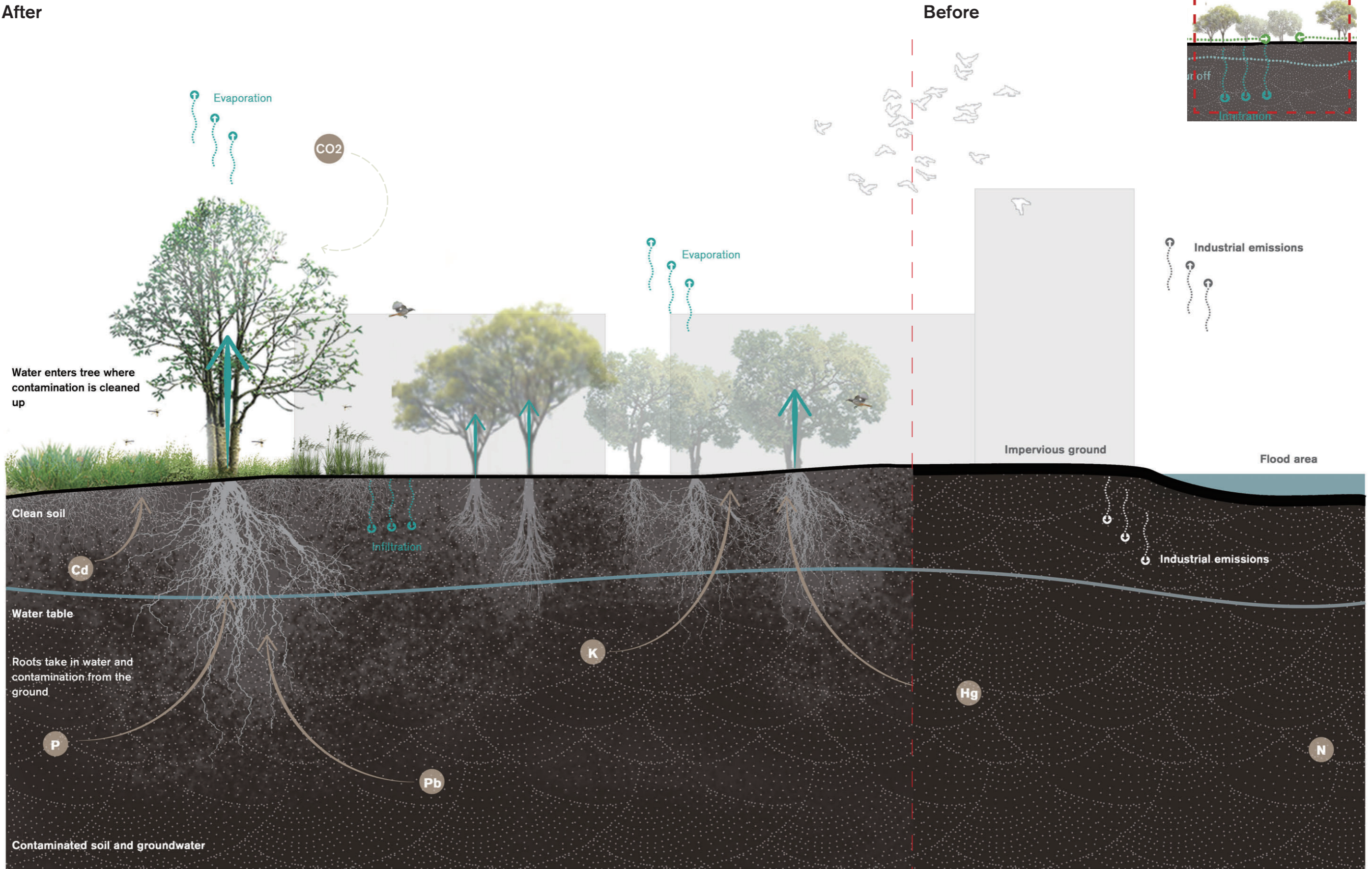


Source: map created by author.

FLOW CHANGE - NATURAL SCALE

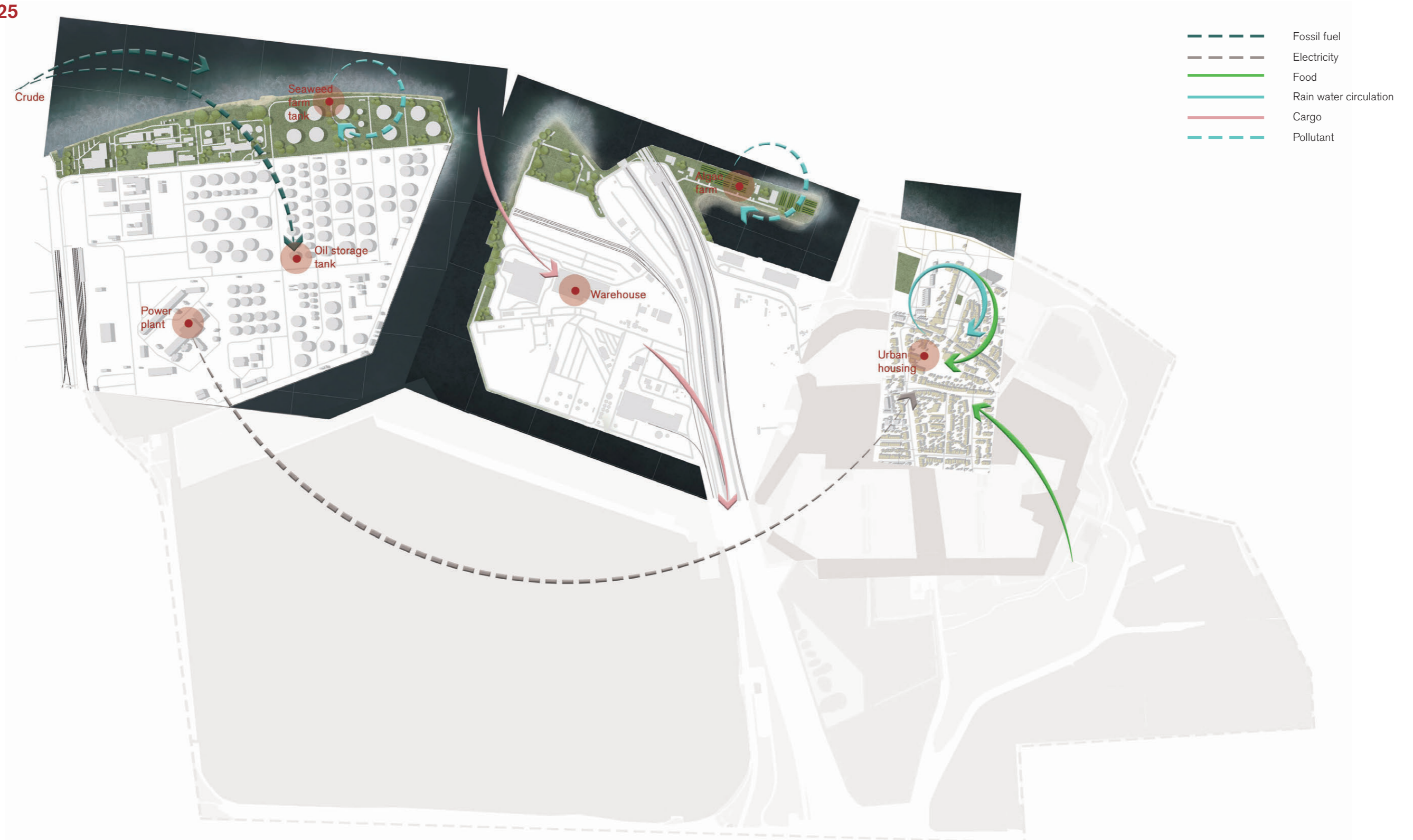
After

Before



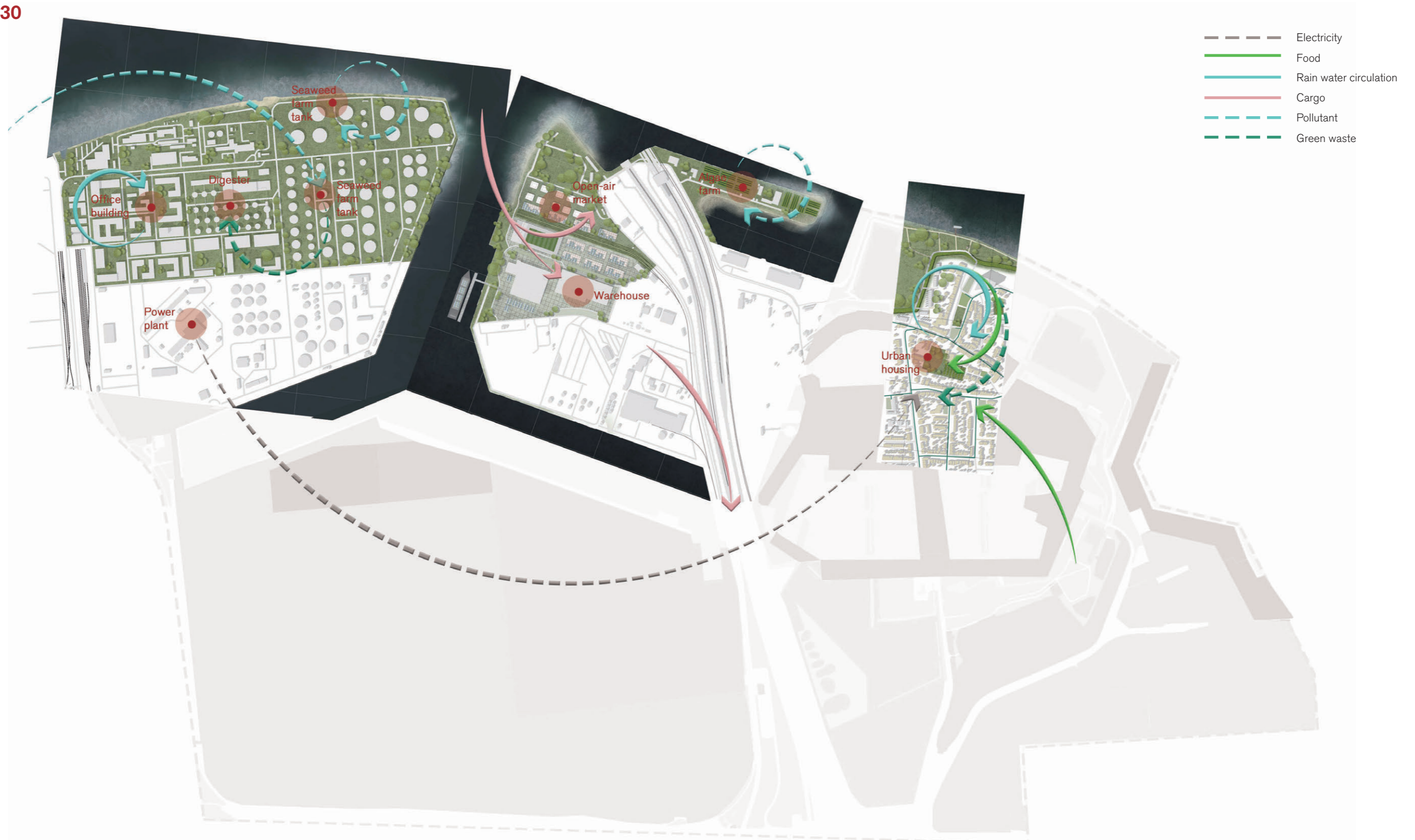
FLOW CHANGE - MESO SCALE

2020-2025



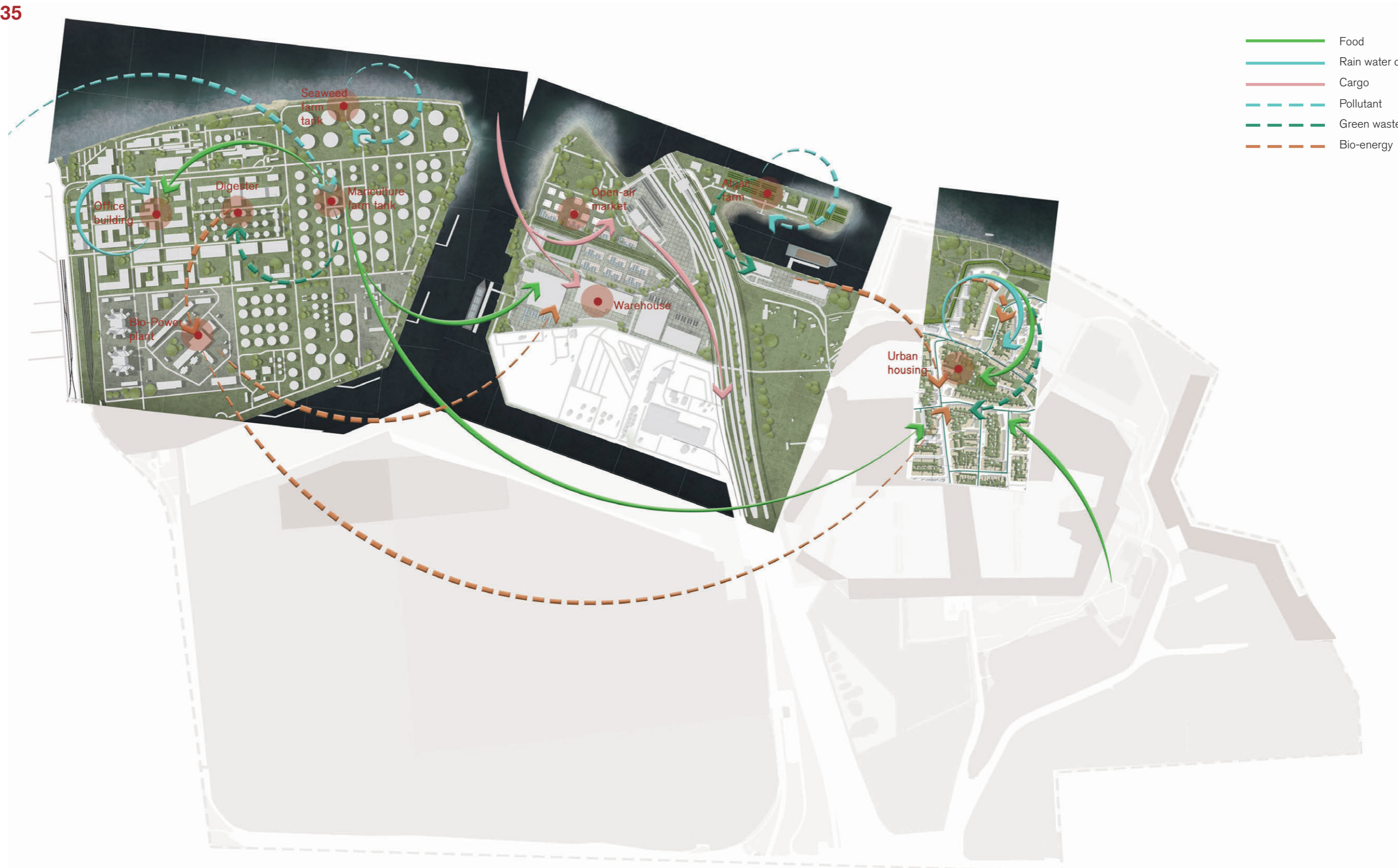
Source: map created by author.

2025-2030



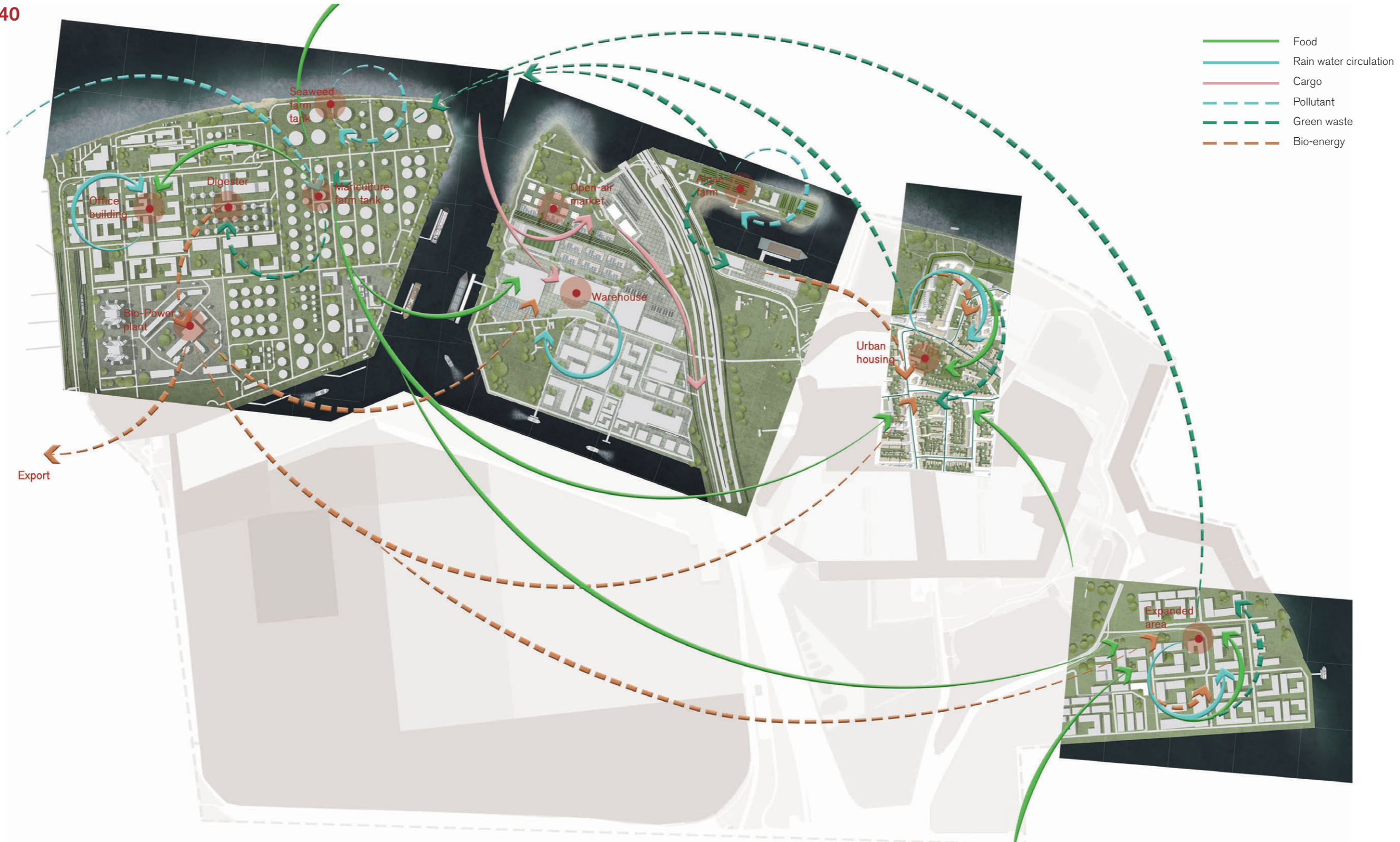
Source: map created by author.

2030-2035



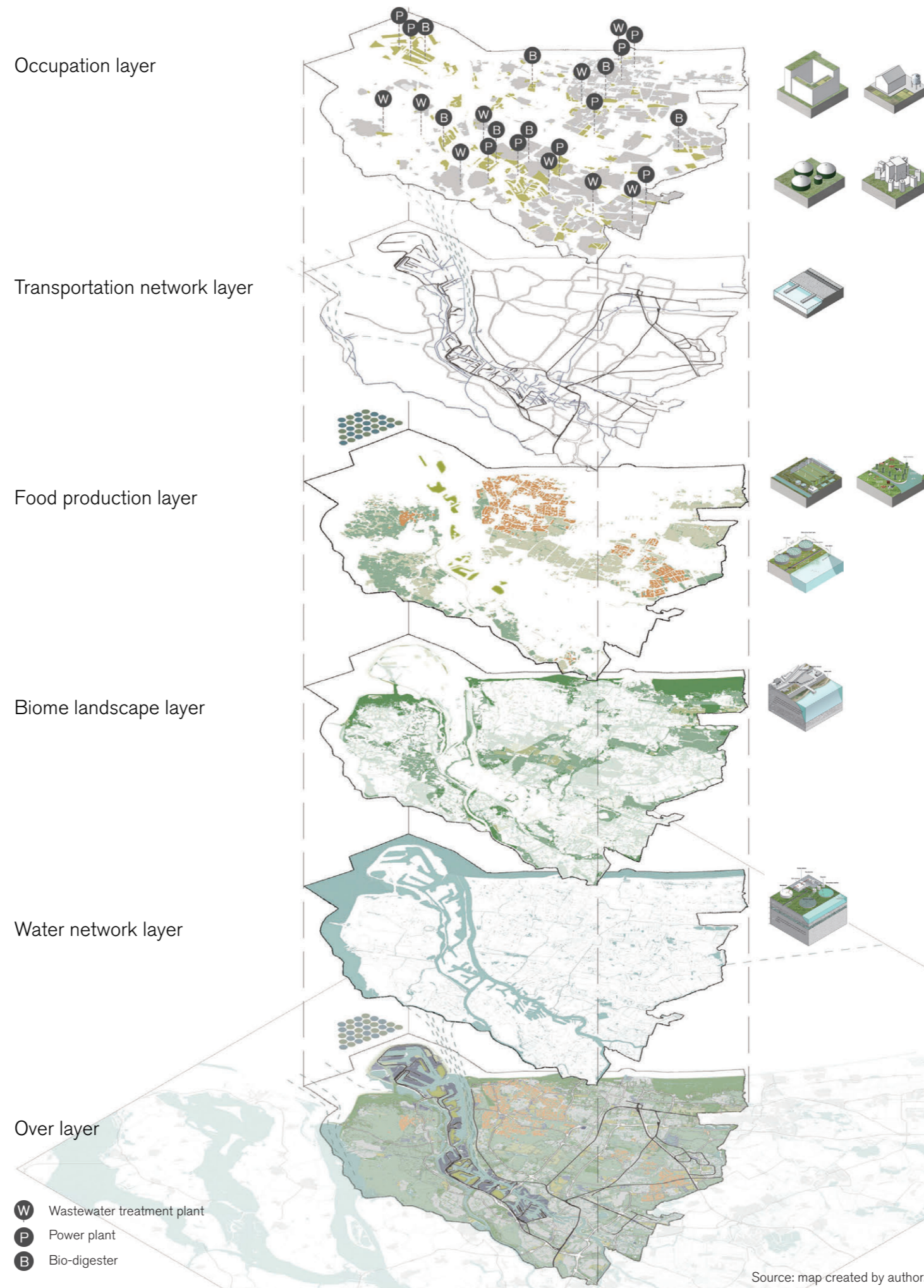
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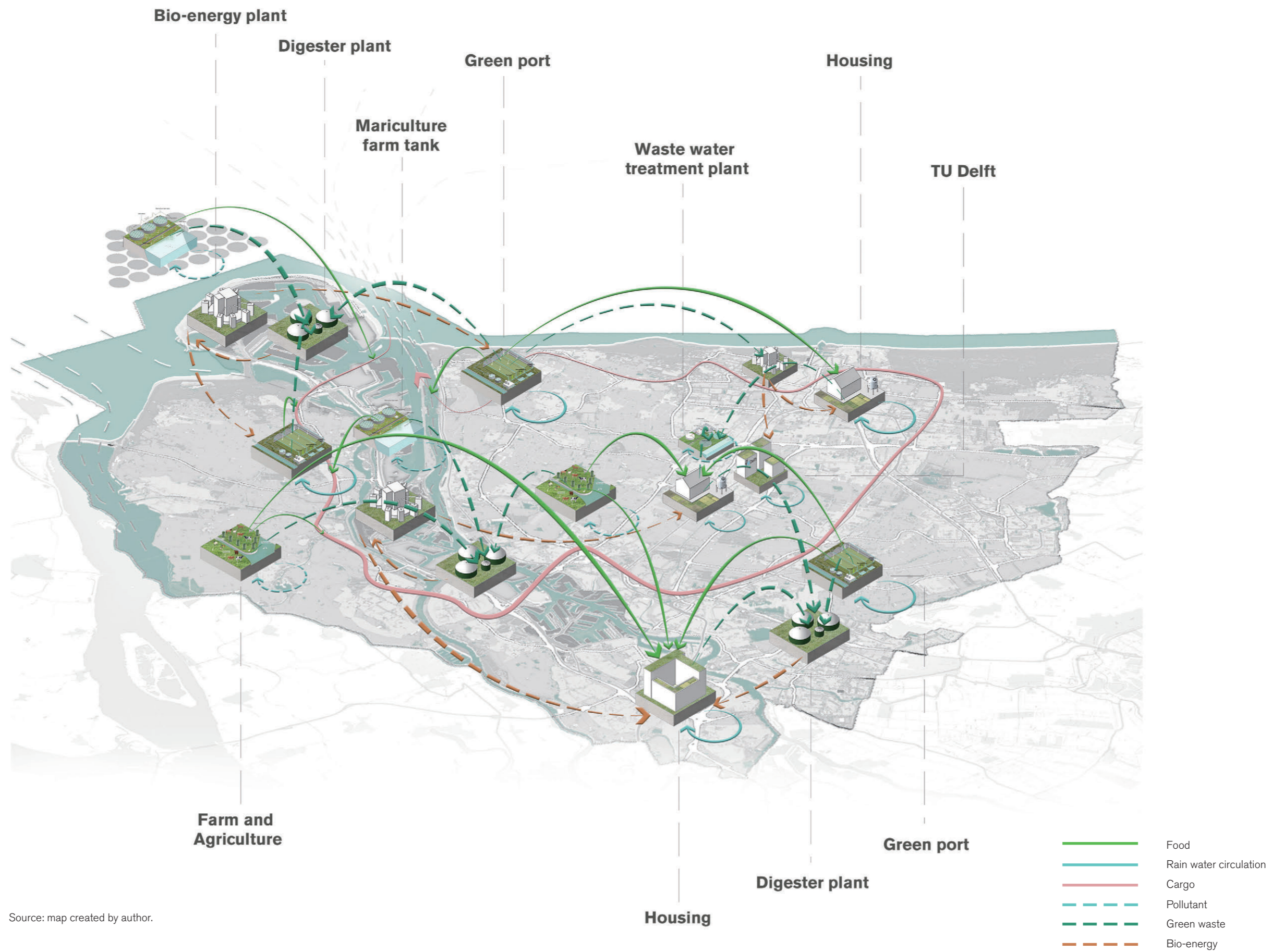
2035-2040



Source: map created by author.

Zoom out (2035-2040)





Source: map created by author.

EVALUATION

Ecosystem services through time

Provided Ecosystem Services

1. Recreation

- 1.1 Tourism
- 1.2 Water sports
- 1.3 Fishing
- 1.4 Accessibility of water

2. Educational environment

- 2.1 Awareness of climate change
- 2.2 Awareness of bio-based economy
- 2.3 Characteristic landscape: improving identity of MRDH as coastal region

3. Natural values and biodiversity

- 3.1 Water purification
- 3.2 Create refugia for migratory and resident species
- 3.3 Species recovery

4. Water safety

- 4.1 Use sediment to reduce current and waves
- 4.2 Reduce groundwater salinity
- 4.3 Create bio-based dikes and reduce maintenance costs
- 4.4 Reduce water acidification

5. Food productivity

- 5.1 Crop production
- 5.2 Seaweed production
- 5.3 Fish production
- 5.4 Algae production

6. Contribute to circular economy

- 6.1 Reuse of sediment
- 6.2 Reuse of rain water
- 6.3 Reuse of green residual material

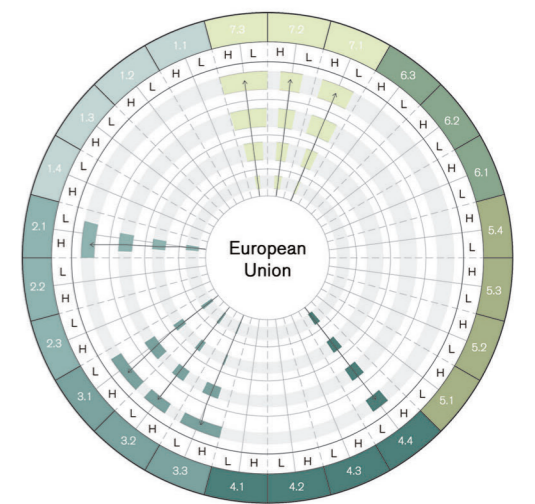
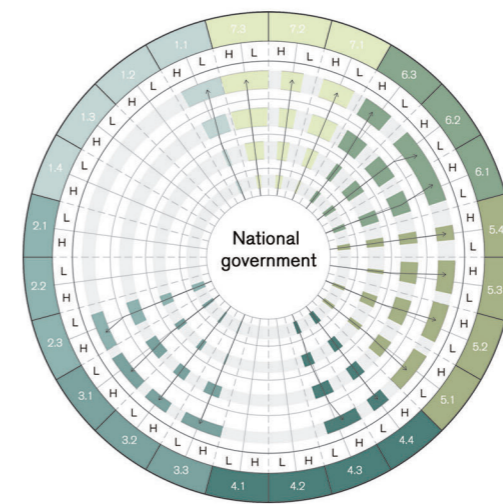
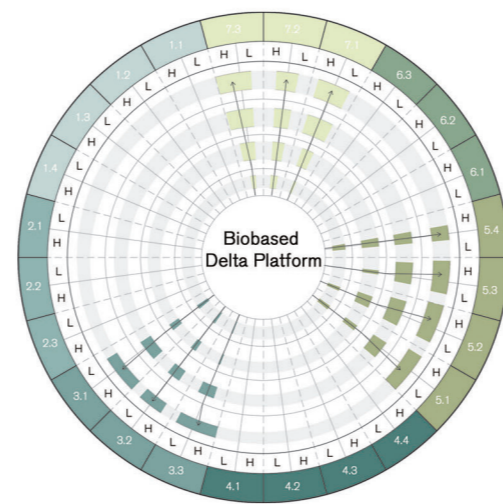
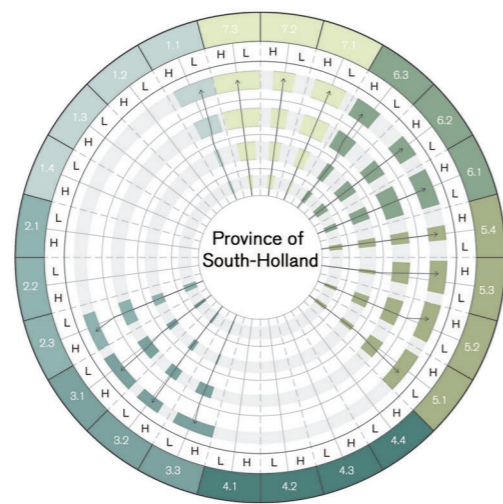
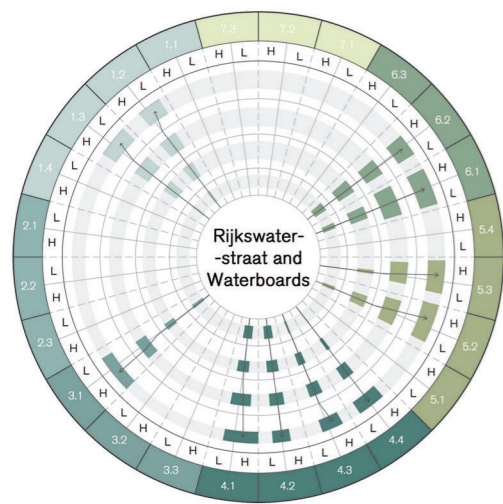
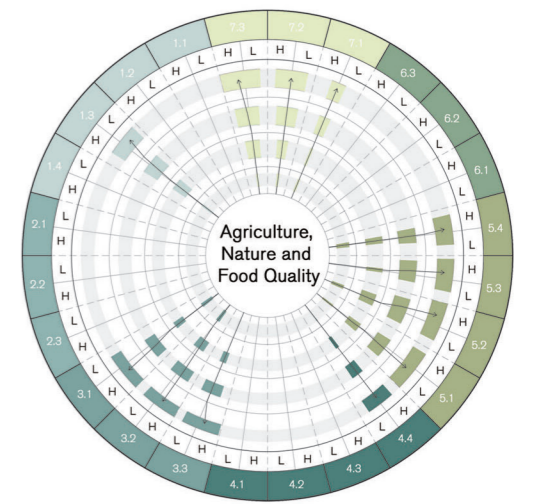
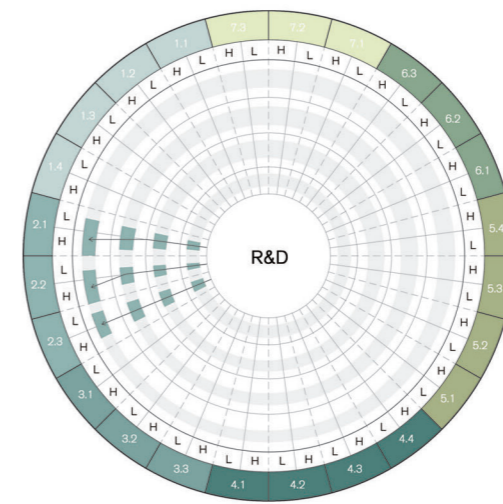
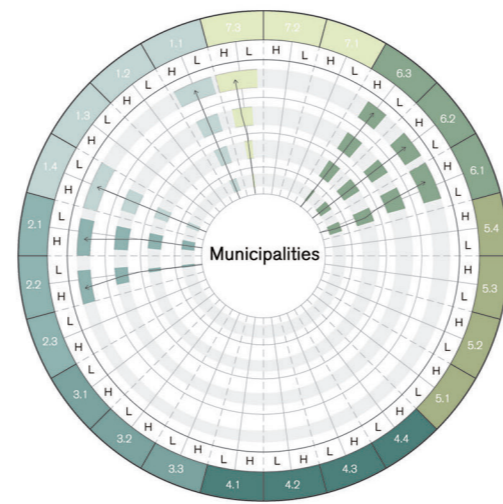
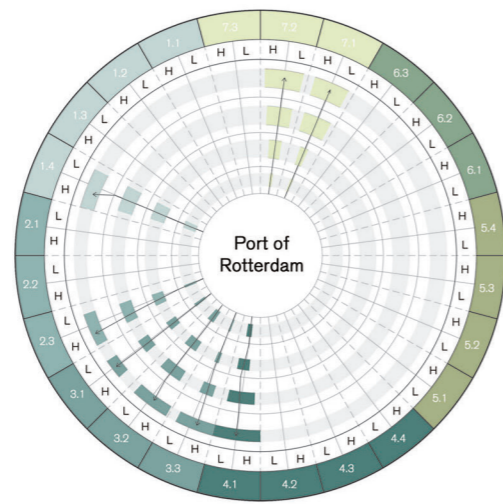
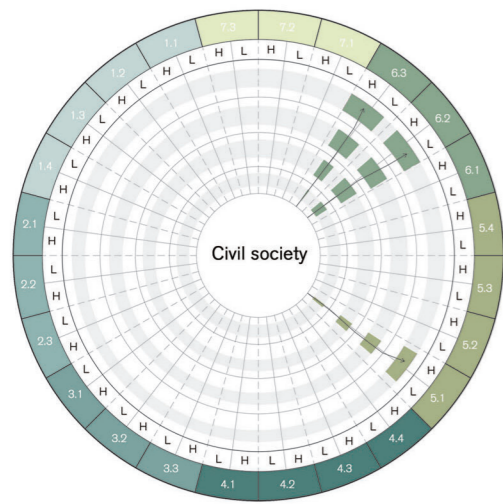
7. Contribute to climate regulation

- 7.1 Temperature regulation
- 7.2 Air purification
- 7.3 Carbon sequestration



Source: map created by author.

Interest of major stakeholders

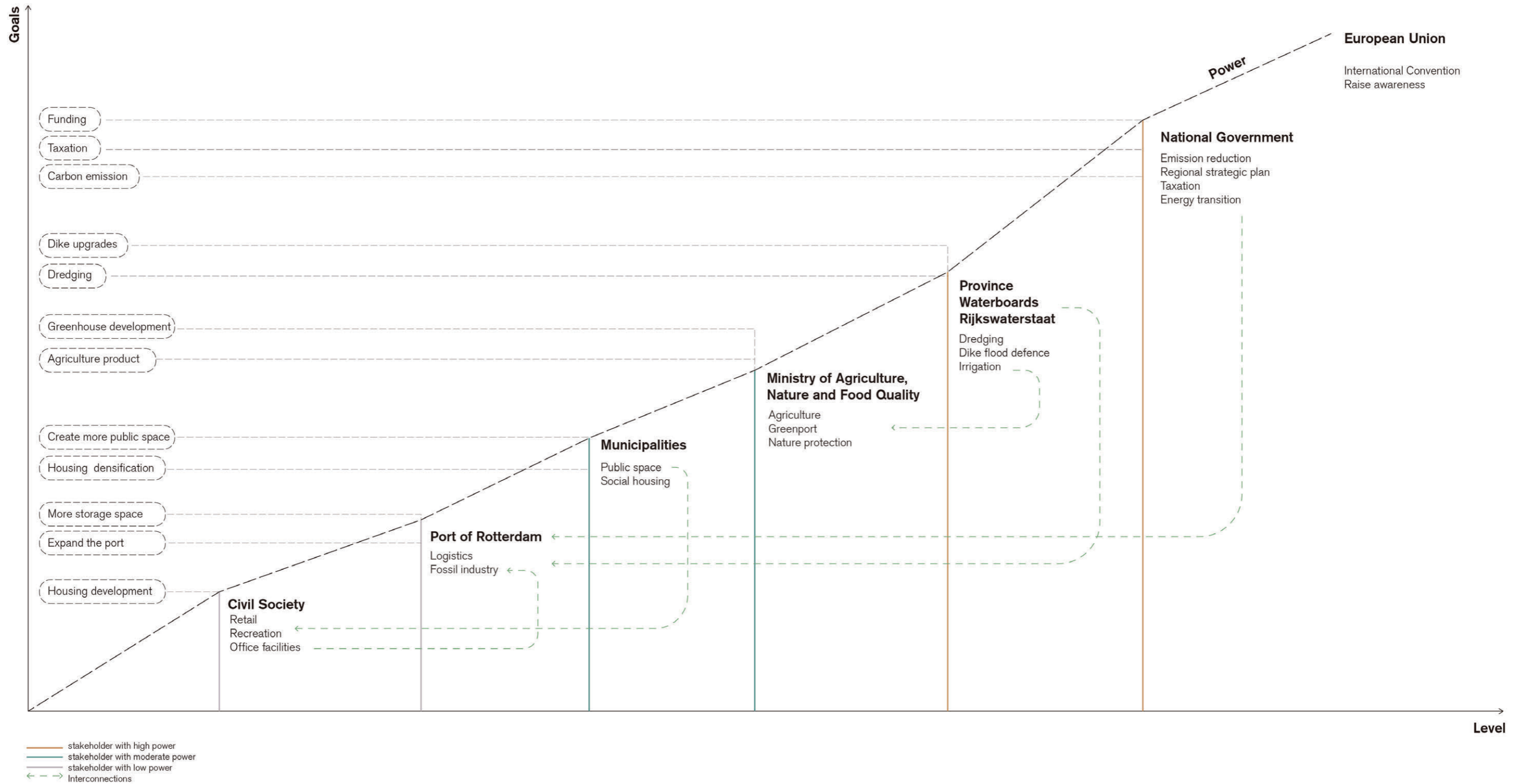


Source: map created by author.

OUTPUT 4

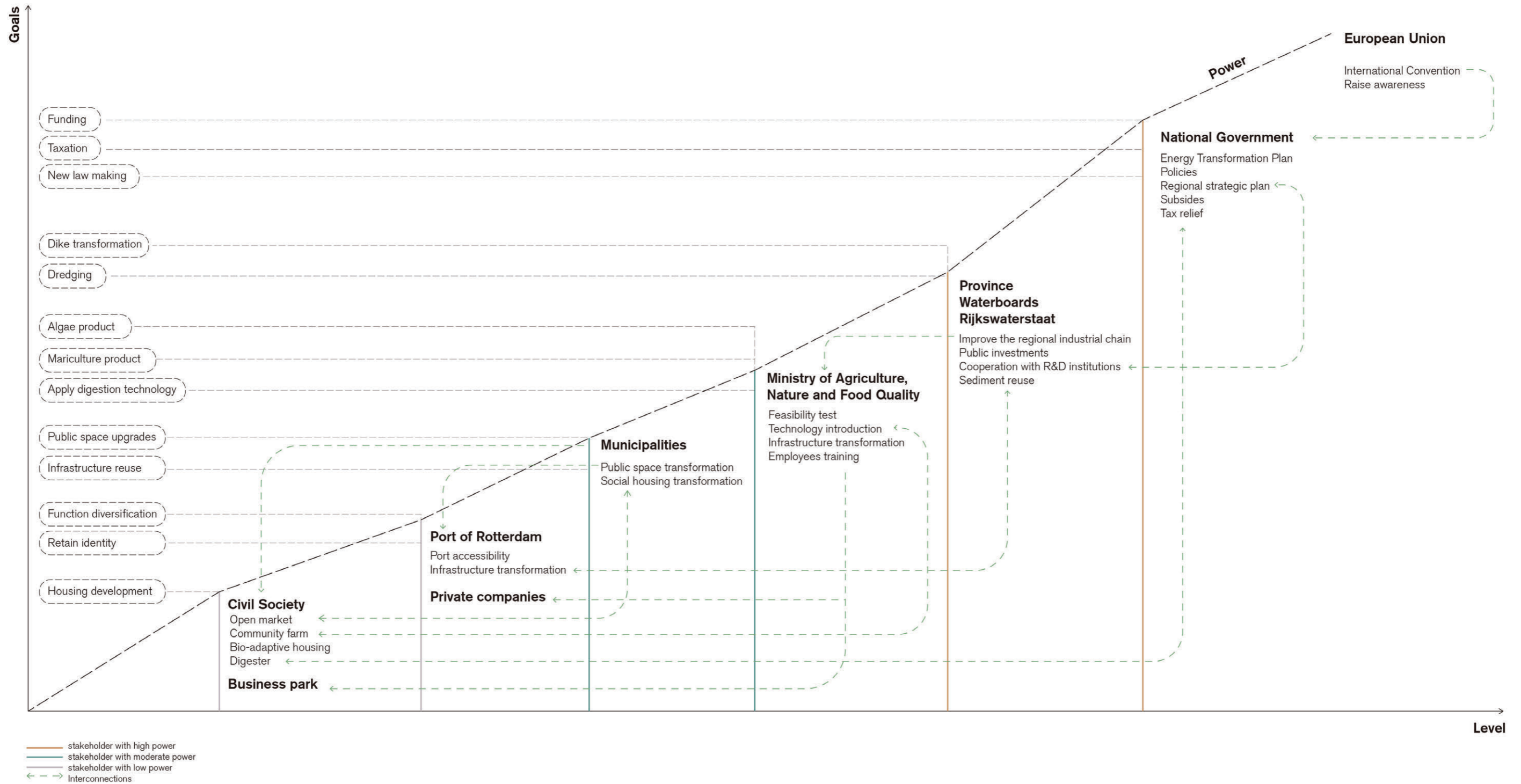
GOVERNANCE

Existing goals and interconnection



Source: map created by author.

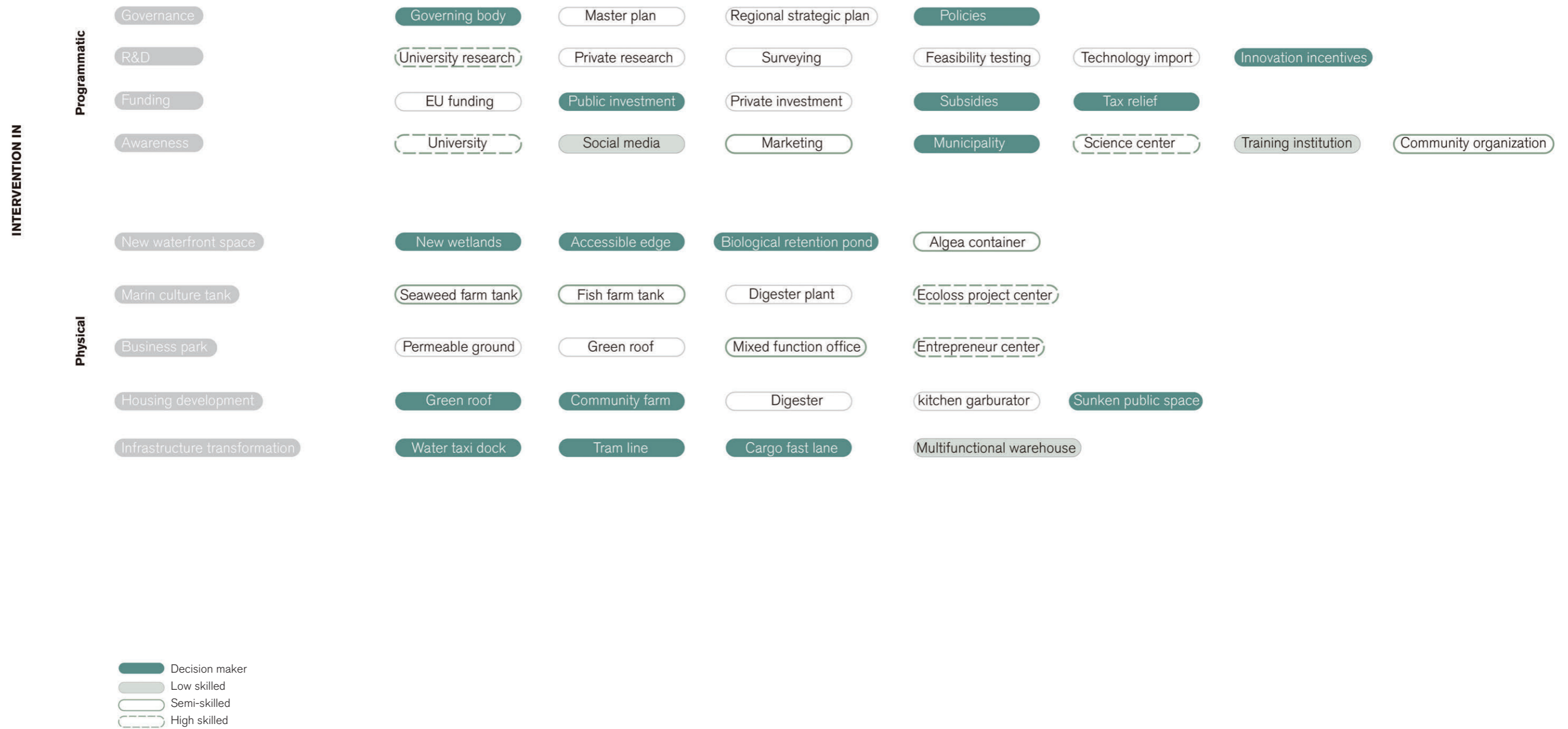
Proposed goals and interconnection of stakeholders



Source: map created by author.

GOVERNANCE

Transition in management and labour force



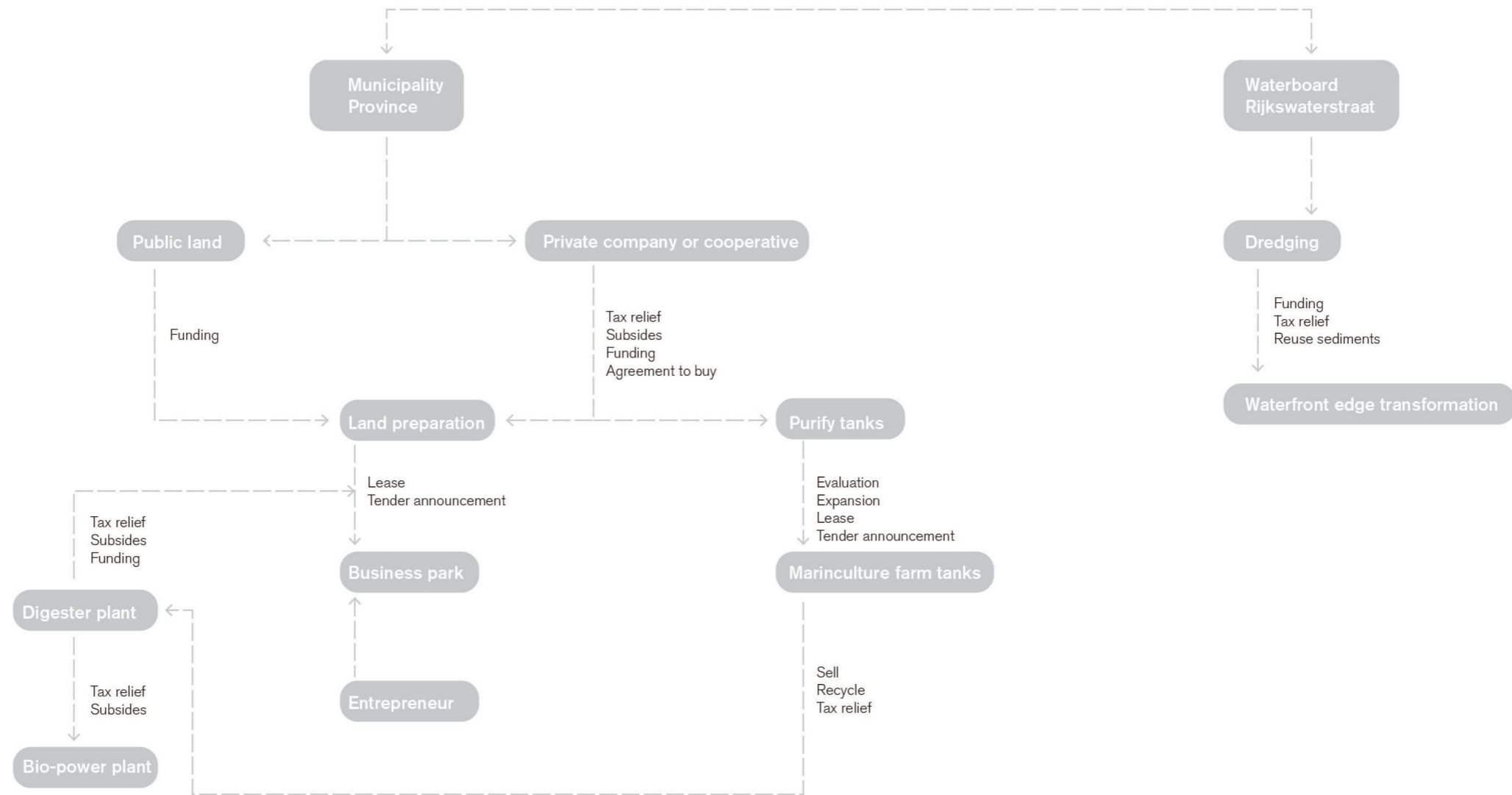
Source: created by author.

GOVERNANCE

Implementation approach

Condition 1

Up



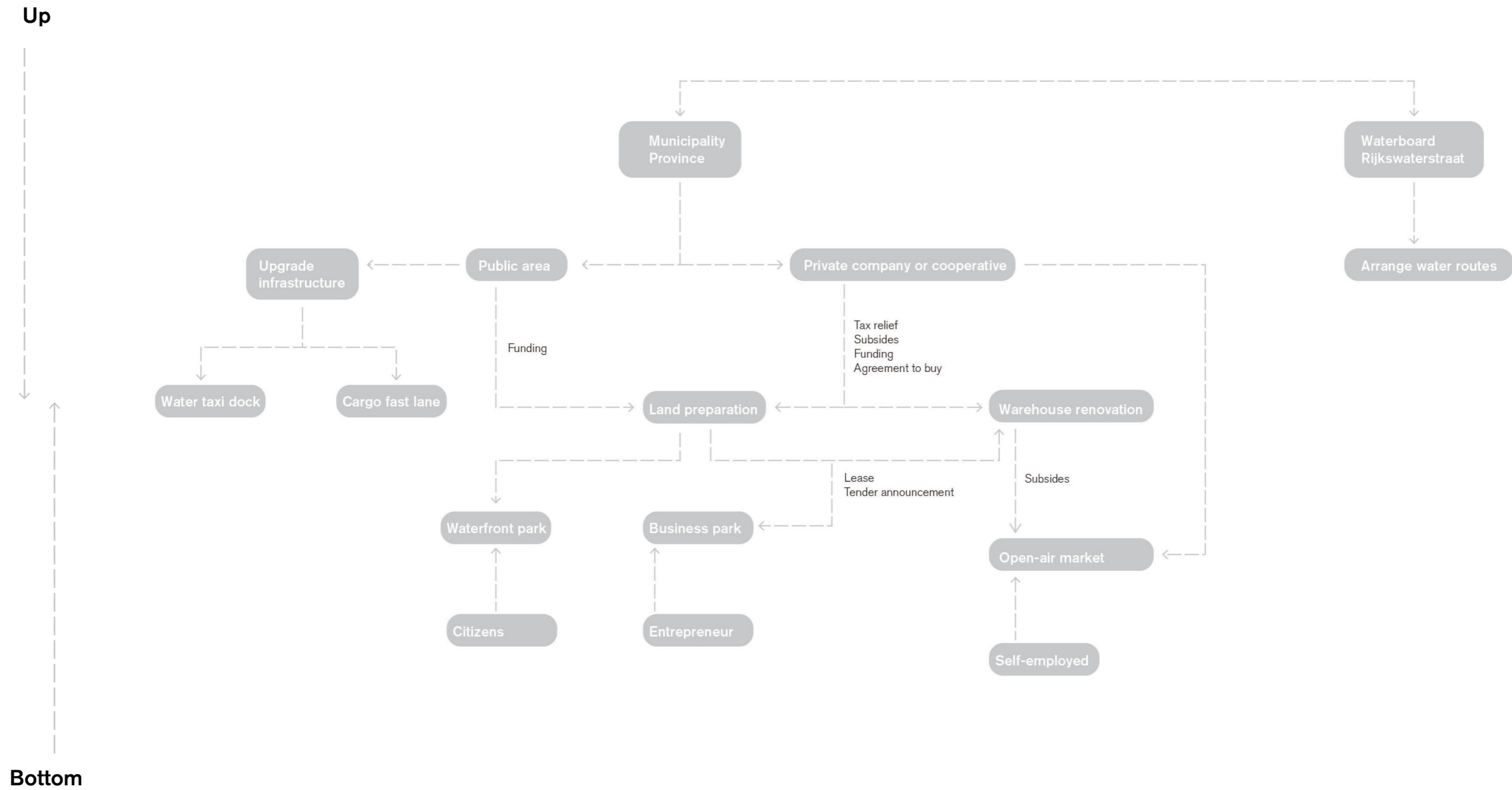
Bottom

Source: created by author.

GOVERNANCE

Implementation approach

Condition 2

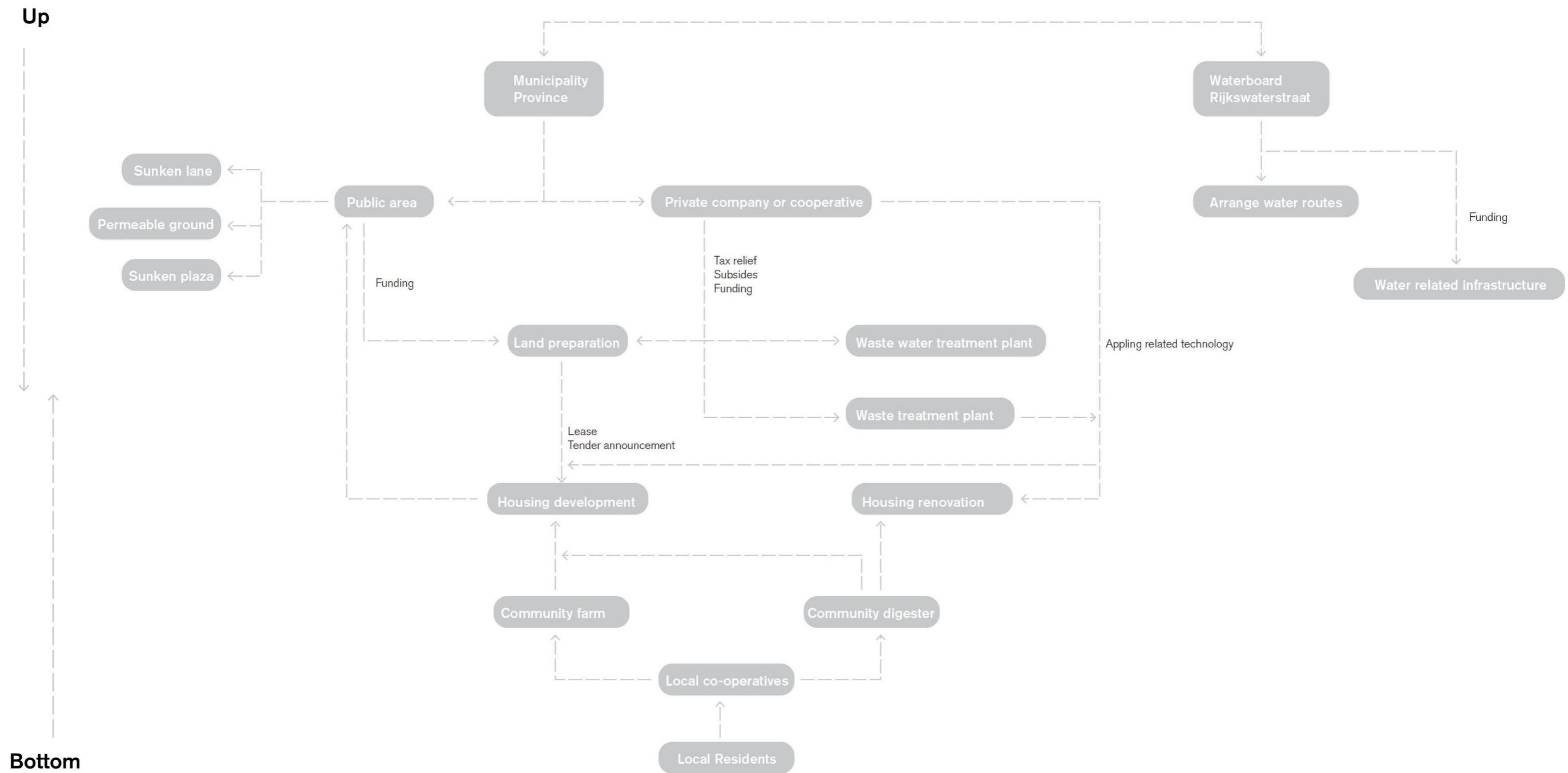


Source: created by author.

GOVERNANCE

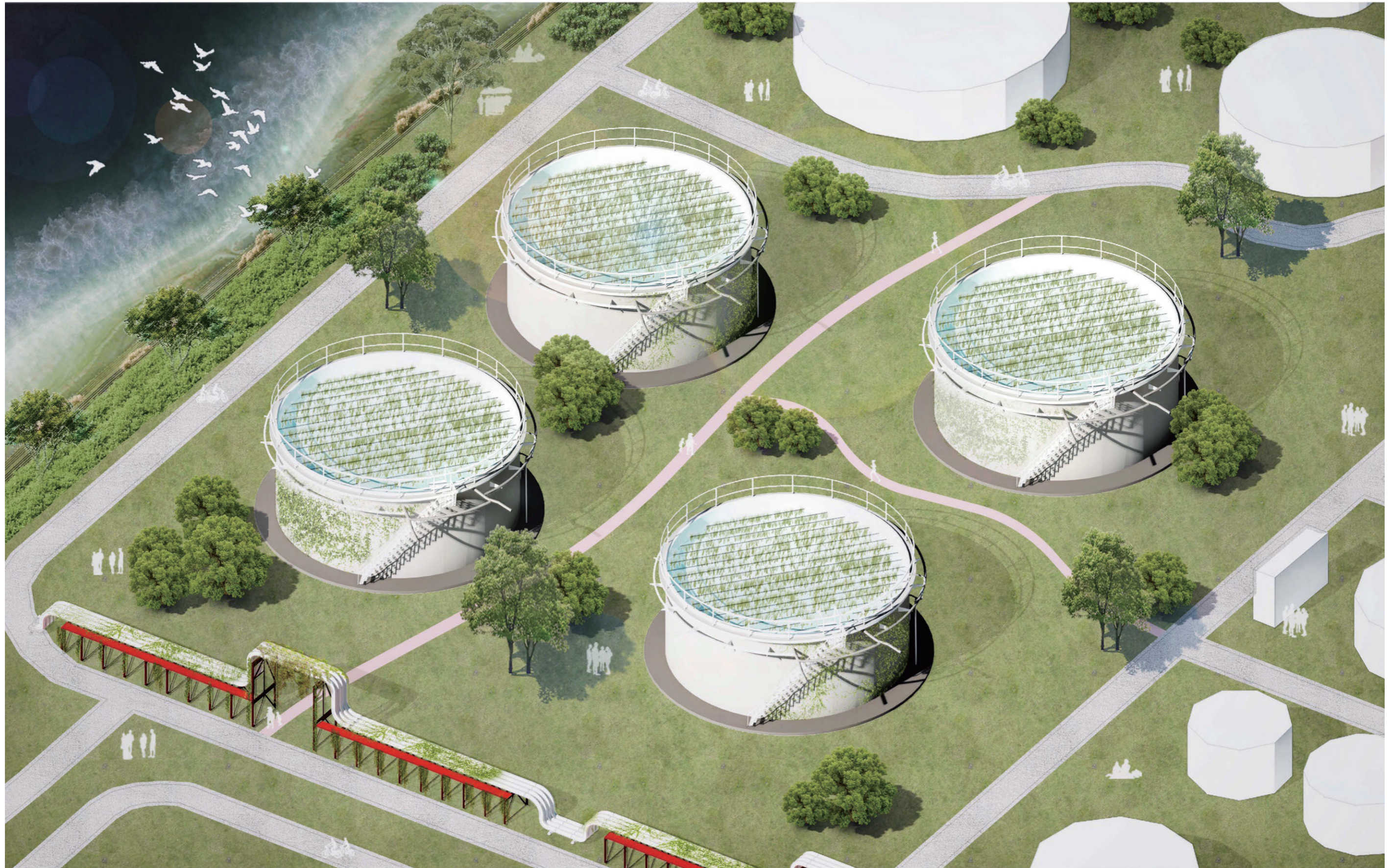
Implementation approach

Condition 3



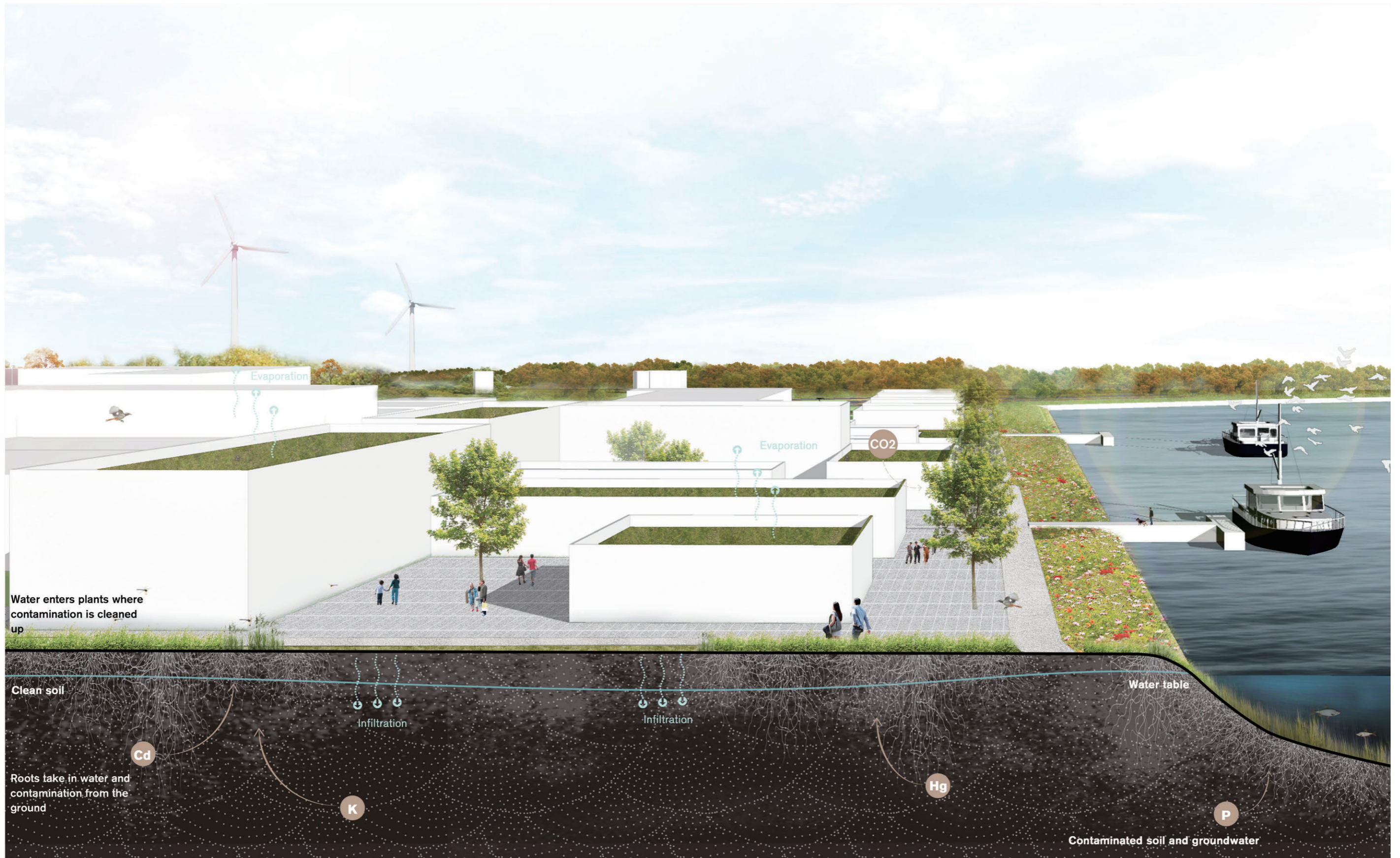
Source: created by author.

Industrial port transformation



Source: Created by author.

Logistics port transformation



Source: Created by author.

Housing transformation



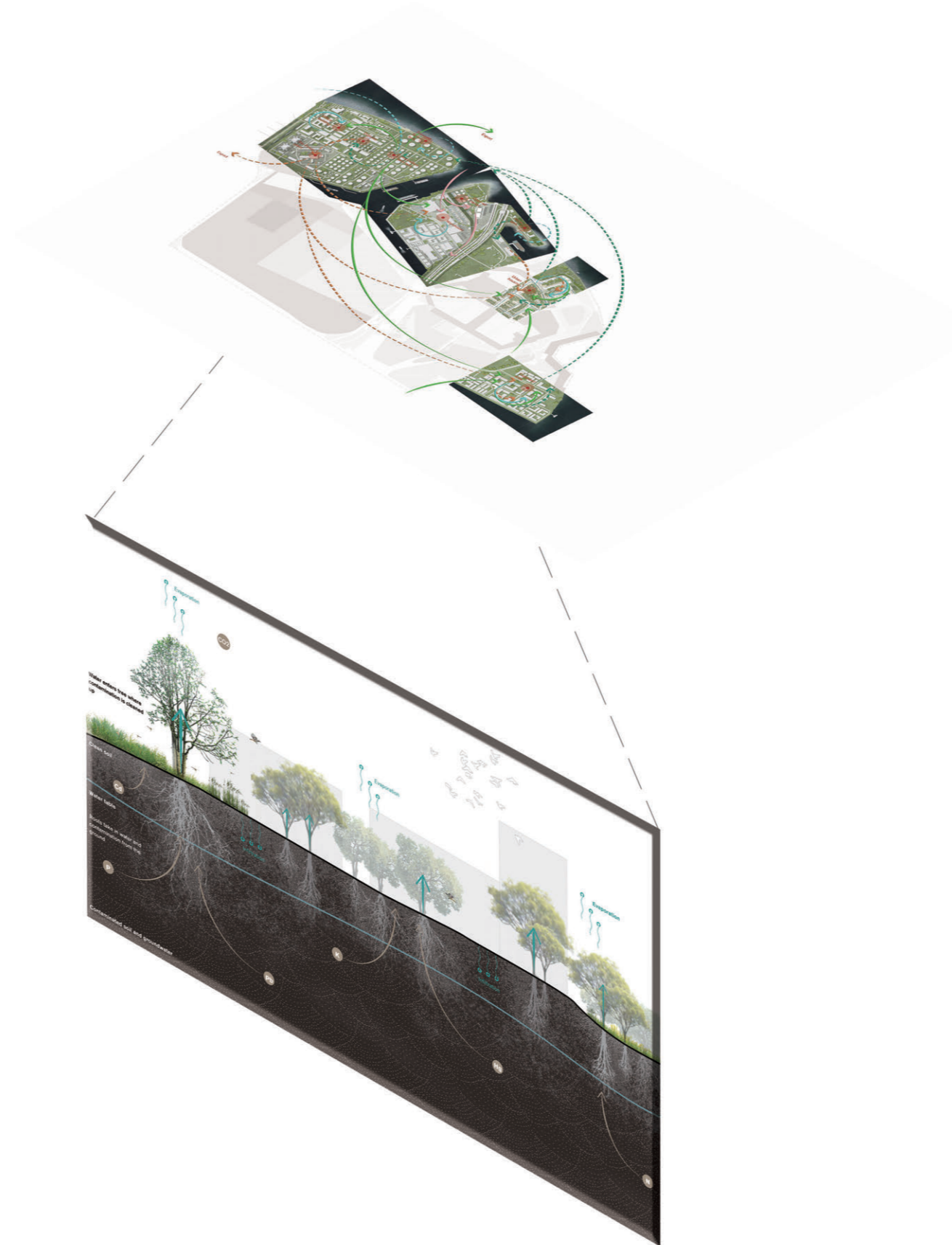
Source: Created by author.

SCALE ADAPTATION, TRANSFERABILITY OF RESULTS

Meso scale



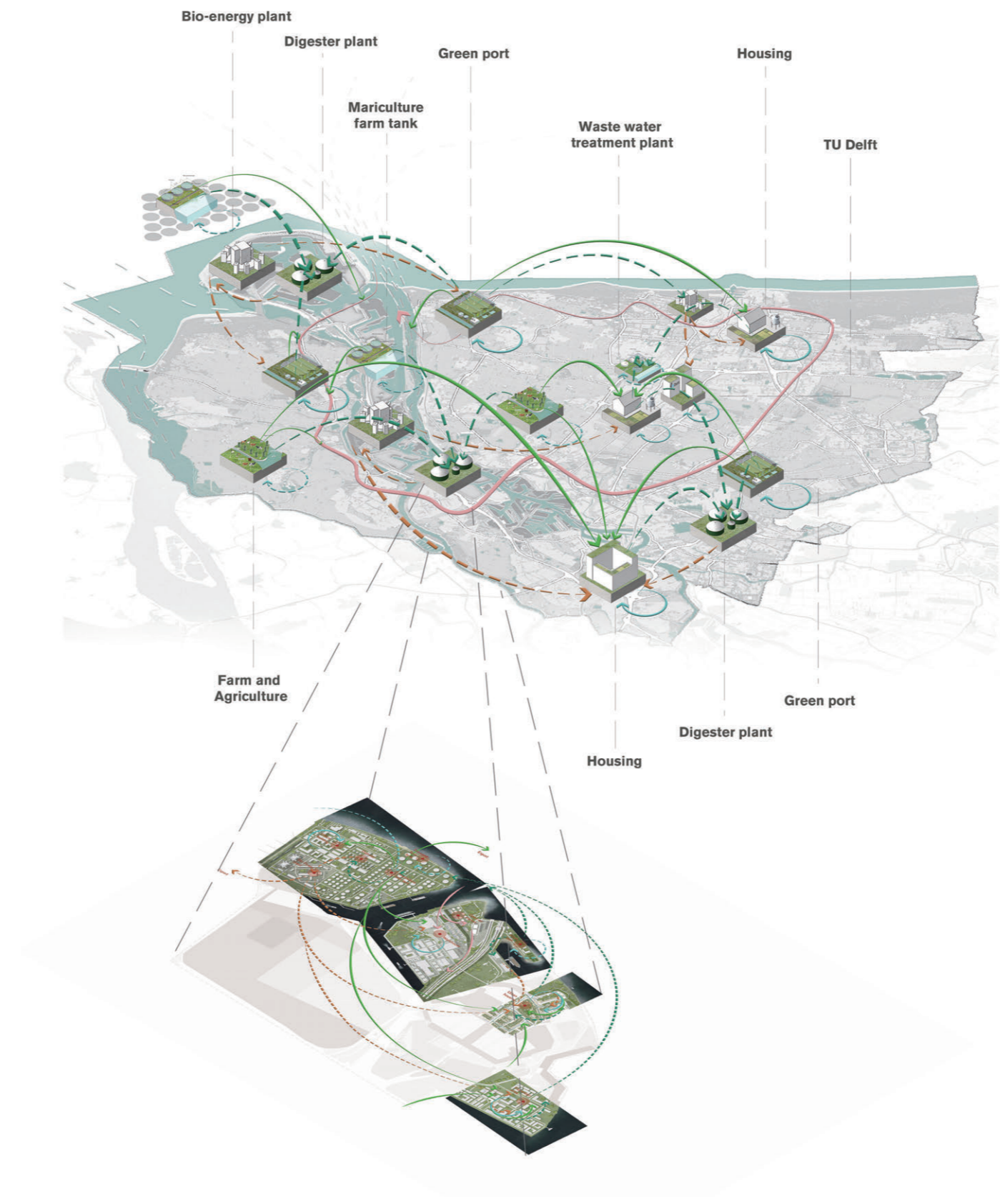
Natural scale



Regional scale



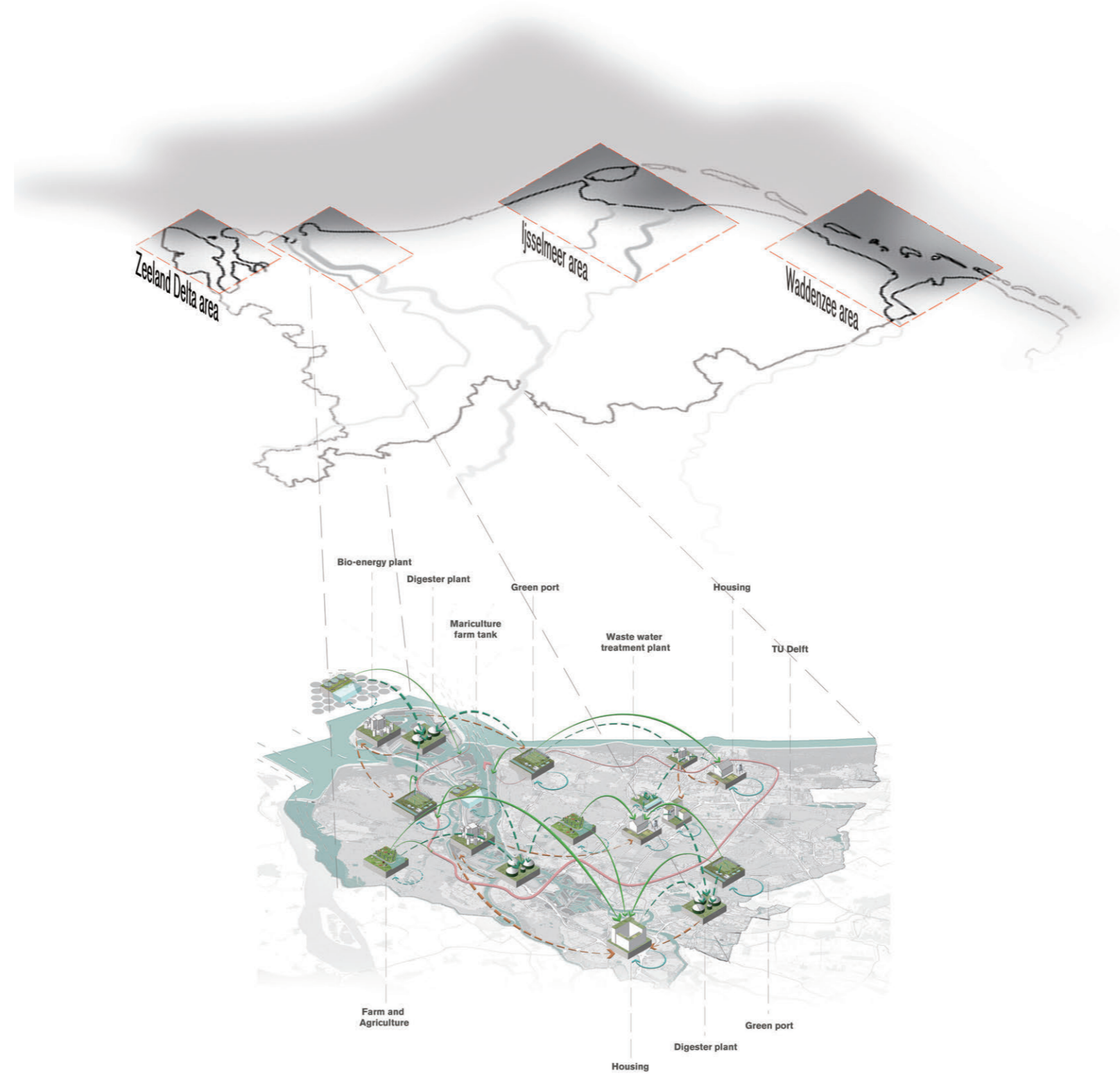
Meso scale



National scale



Regional scale



CONCLUSION

BACK TO THE RESEARCH QUESTIONS

What kind of shift in the economic production system could change the current waste flows between cities and nature to facilitate a sustainable and resilient economy in the Metropoolregio Rotterdam Den Haag (MRDH)?



Production transition
Landscape transition/performative
Infrastructure reuse
Enhancing stakeholder involvement and collaboration

Thank you !

Gracias !

Grazie !

Dank u wel !

谢谢!

