[Re]Natured Economy

From pollutants to productive landscapes

P5 Presentation I 29/06/2018
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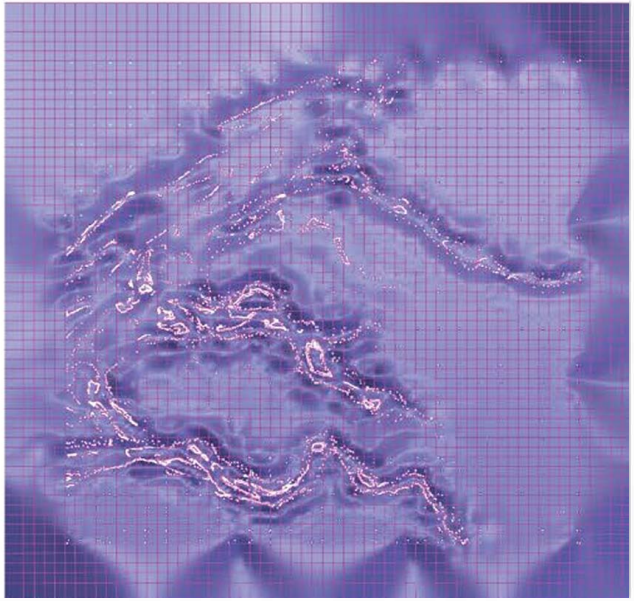


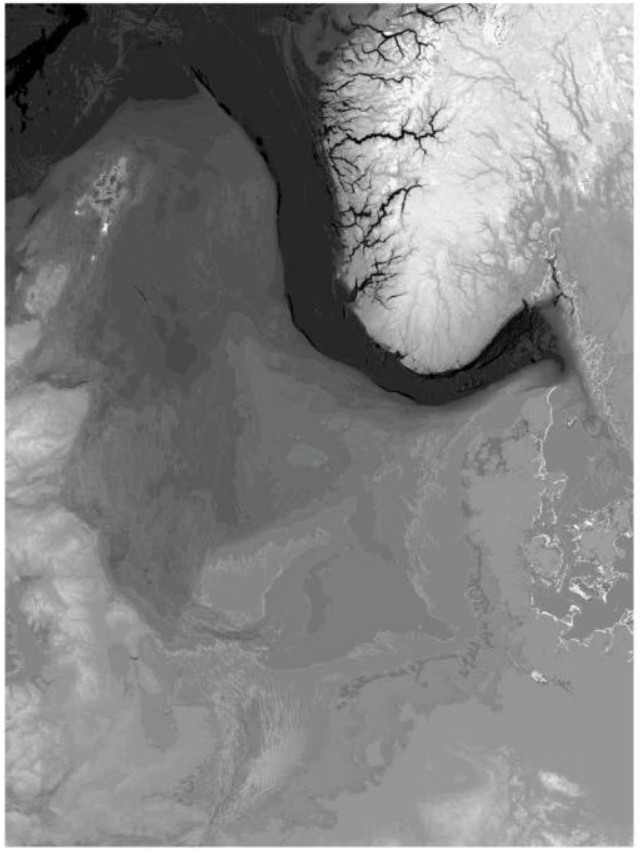
Introduction

Ecology, economy and the demise of dualisms

"[..] nature is not "just there." It is *historical*."

MOORE, J. 2015. Capitalism in the Web of Life: Ecology and the Accumulation of Capital. London: Verso

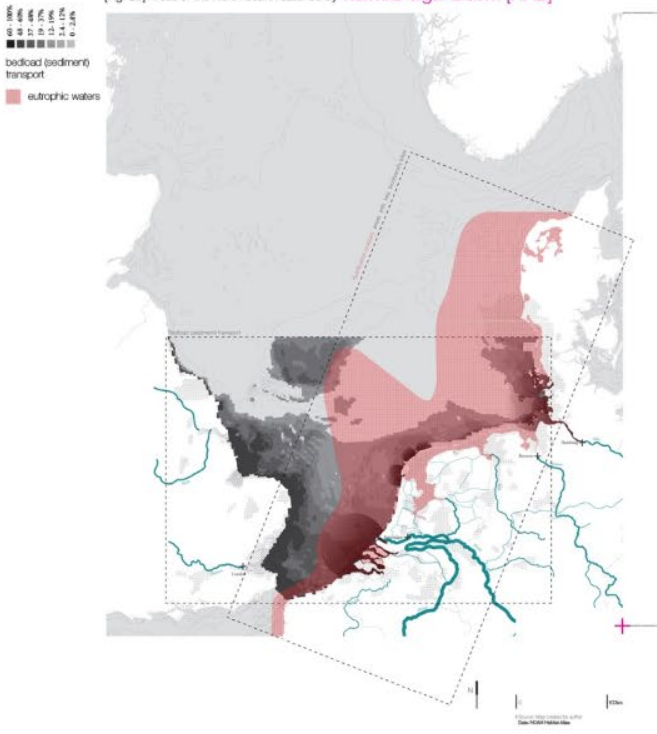
[Fig. 1] Map of the North Sea_Altimetry-Bathymetry



The North Sea perspective

Eutrophication

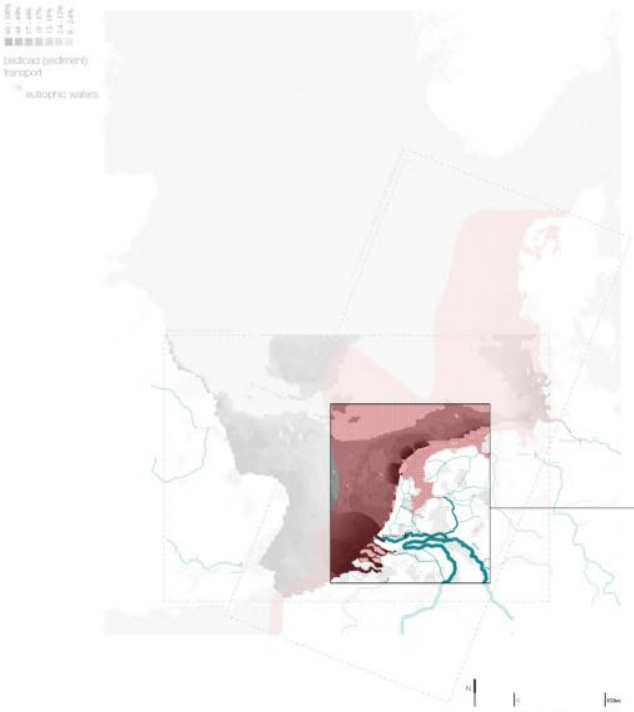
[Fig. 2b] Areas of the North Sea threatened by harmful algal bloom [HAB]

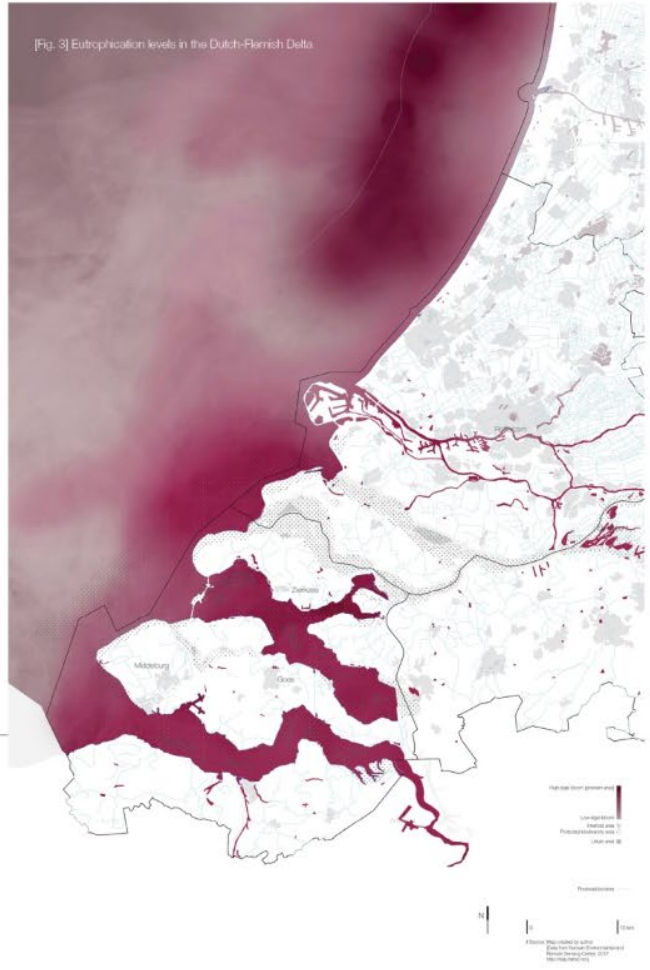


[Fig. 2a] Key biodiversity areas of the North Sea

Location: Dutch-Flemish Delta

Eutrophication levels

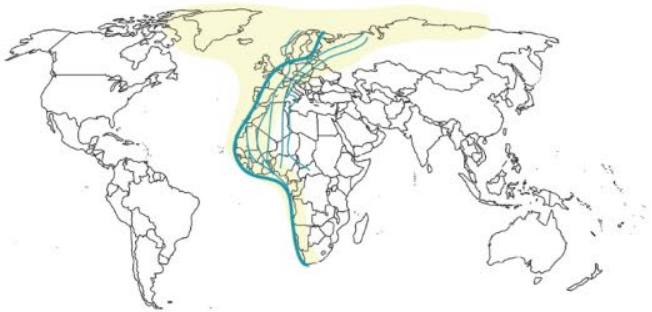




Problem field

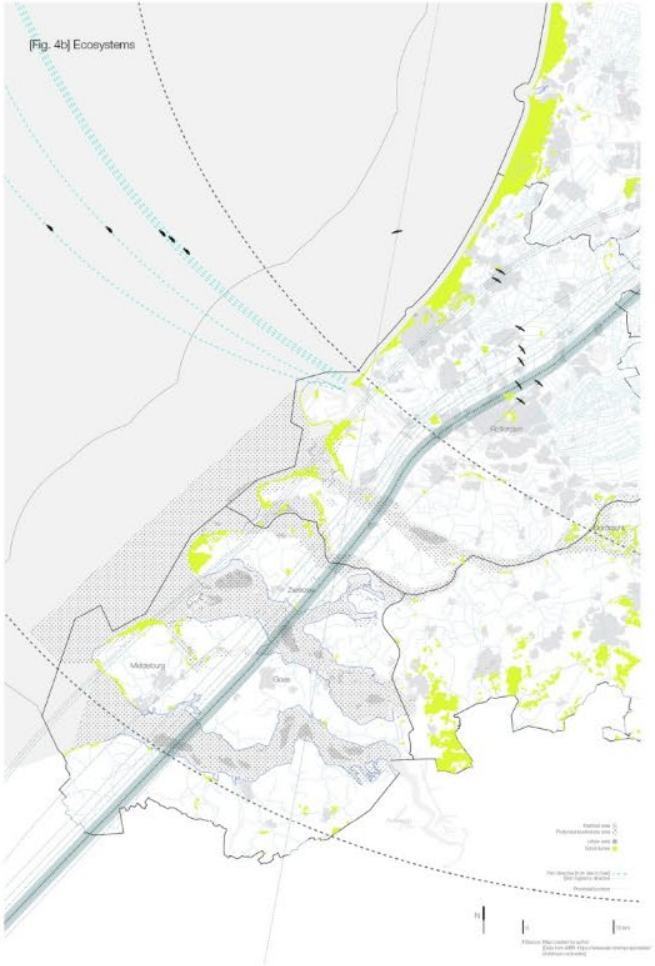
[Part 1: Depletion of ecoservices]

[Fig. 4a] Migration pathways for species [Europe-Africa]



Source: Diagram made by author based on data from goo.gl/fR1XB6

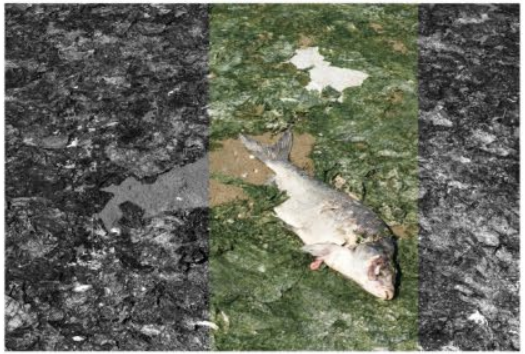
[Fig. 4b] Ecosystems



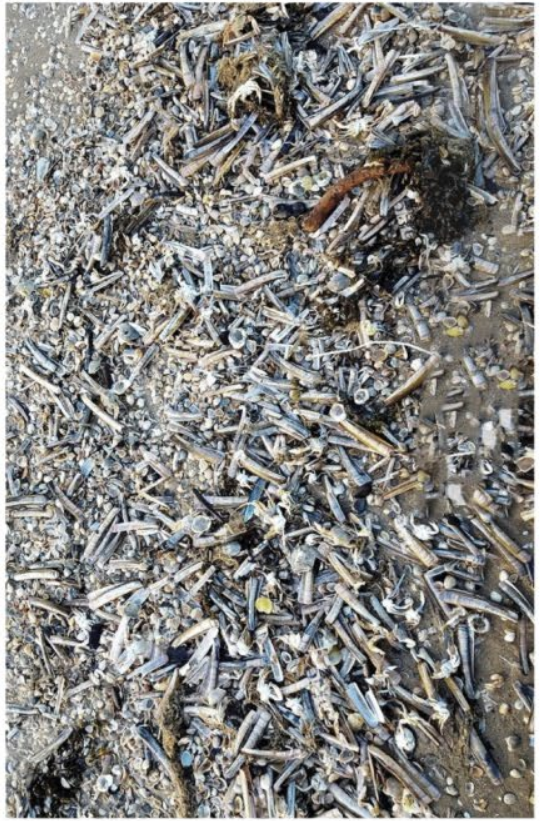
Problem field

[Part 1: Depletion of ecoservices]

[Fig. 4c] Dead fish on seaweed on beach at low tide, North Sea coast, Netherlands



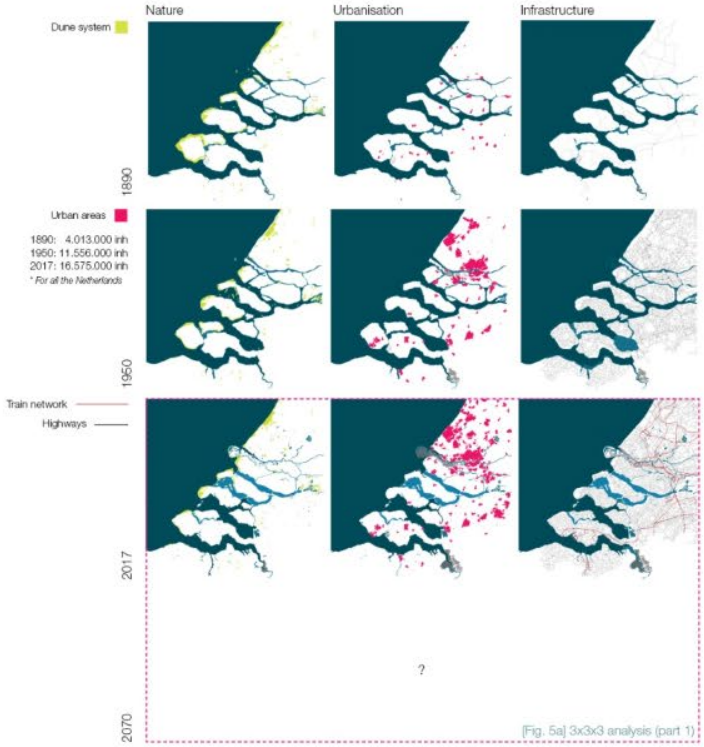
|| Source: Alamy, goo.gl/yRL23M [shortened (left) and goo.gl/Uopc6e [shortened] (right)]



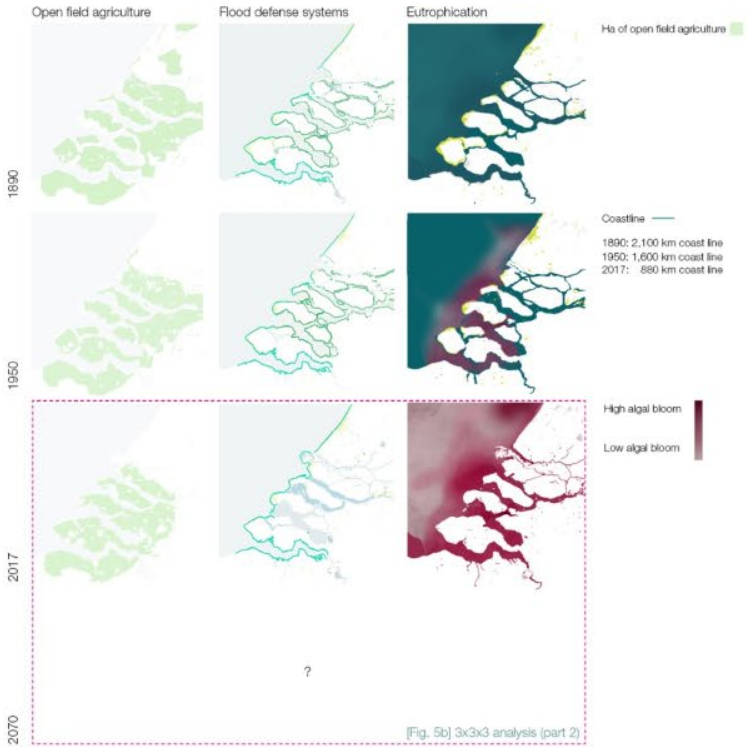
[Fig. 4d) Dead crabs with razor clams on the beach of North Sea, Netherlands

Problem field

[Part 2: Sea level rise_Non-versatile economy_Depletion of resources]



[Fig. 5a] 3x3x3 analysis (part 1)

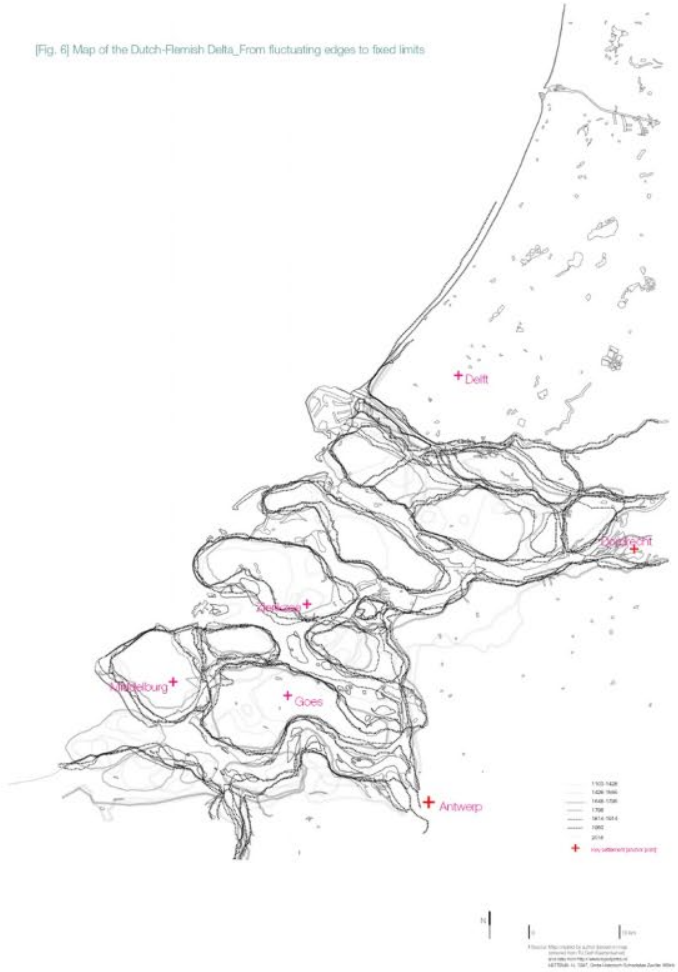


[Fig. 5b] 3x3x3 analysis (part 2)

Problem field

[Part 2: Sea level rise_Non-versatile economy_Depletion of resources]

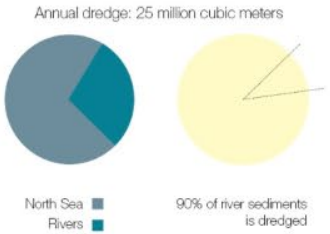
[Fig. 6] Map of the Dutch-Flemish Delta_From fluctuating edges to fixed limits



Problem field

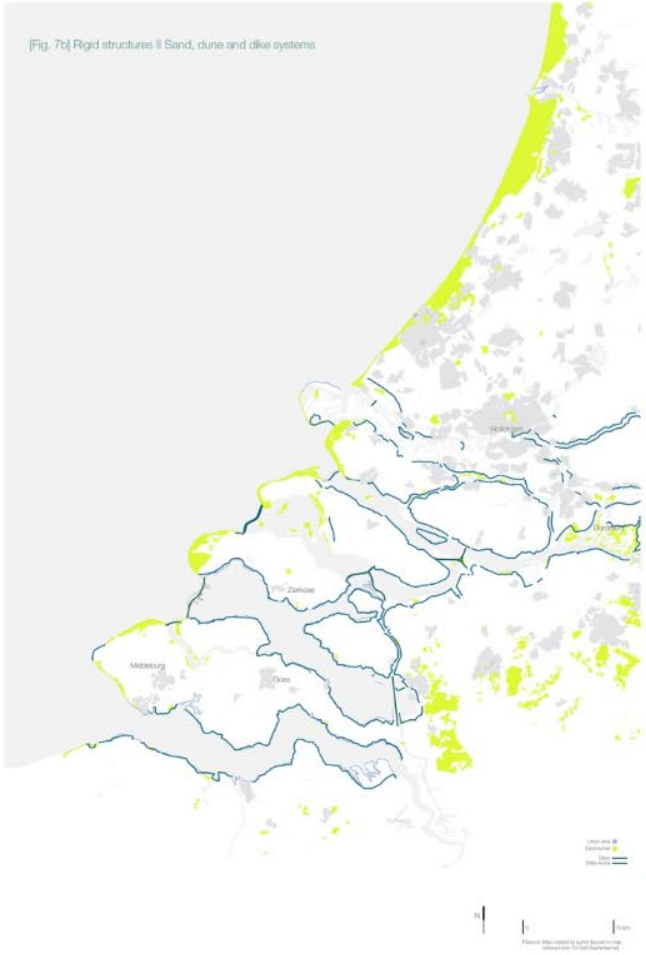
[Part 2: **Sea level rise**_Non-versatile economy_Depletion of resources]

[Fig. 7a] Anthropogenic activities



|| Source: VEN, G.P. VAN DE. 2004. Man-made lowlands. History of water management and land reclamation in the Netherlands. Utrecht: Uitgeverij Matrijs.

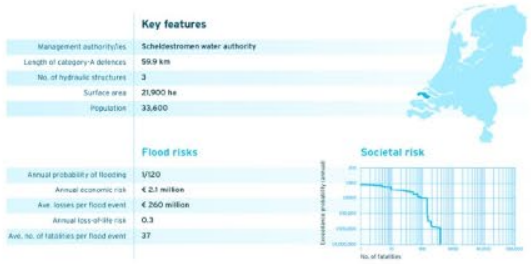
[Fig. 7b] Rigid structures || Sand, dune and dike systems



Problem field

[Part 2: **Sea level rise**_Non-versatile economy_Depletion of resources]

[Fig. 8a] Excerpt from The National Flood Risk Analysis for the Netherlands (2017)



Key features

Management authority/ies	Scheldestromen water authority
Length of category-A defences	59.9 km
No. of hydraulic structures	3
Surface area	21,900 ha
Population	33,600

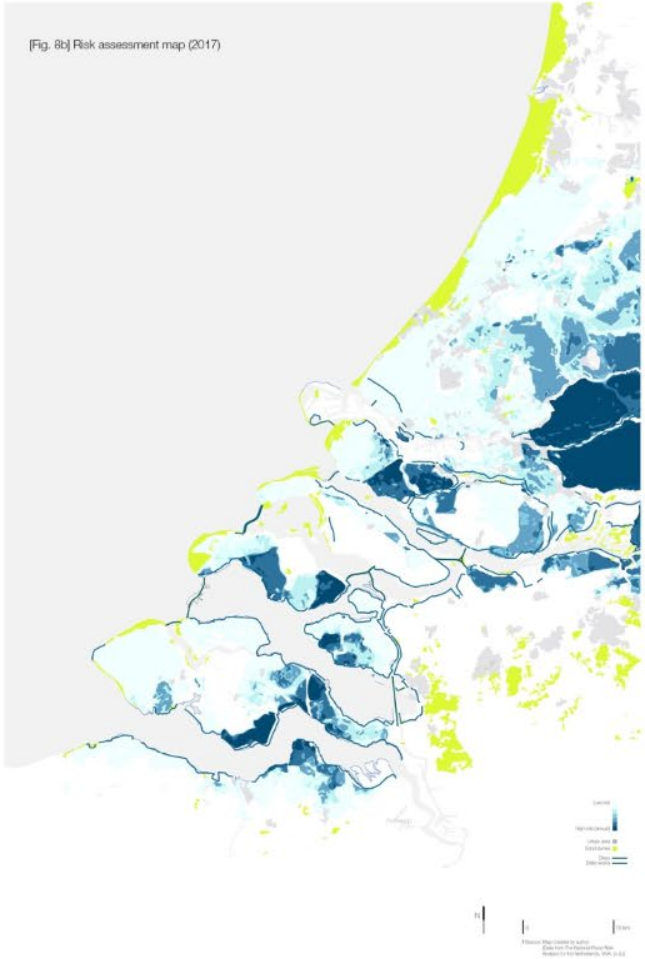
Flood risks

Annual probability of flooding	1/120
Annual economic risk	€ 2.1 million
Ave. losses per flood event	€ 260 million
Annual loss-of-life risk	0.3
Ave. no. of fatalities per flood event	37

Societal risk

Source: Diagram made by author based on data from https://www.helpdeskwater.nl

[Fig. 8b] Risk assessment map (2017)



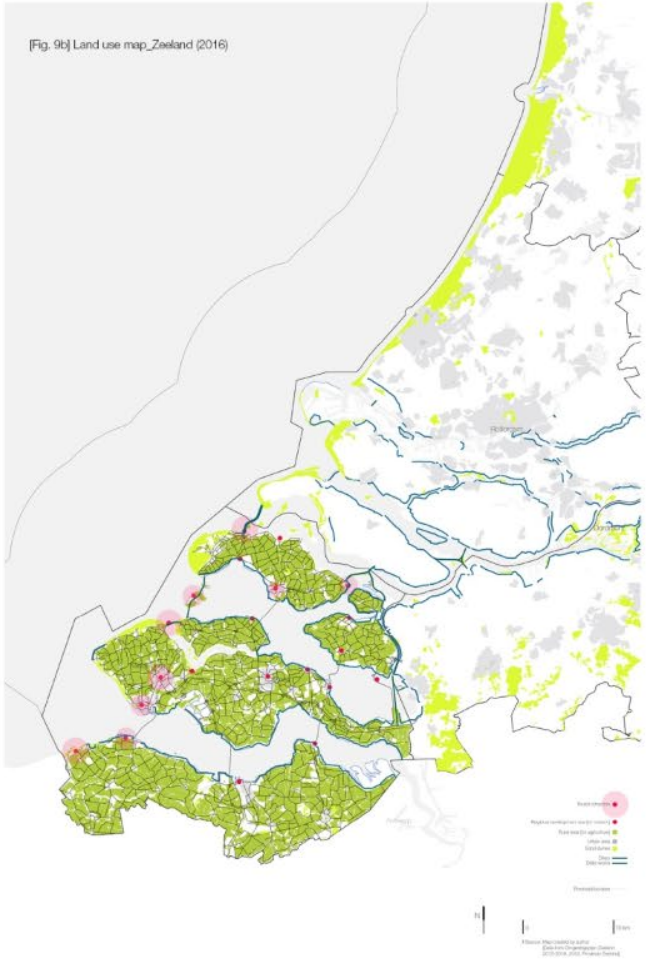
Problem field

[Part 2: Sea level rise_**Non-versatile economy**_Depletion of resources]

[Fig. 9a] Land uses_Zeeland ll An unvaried economy

ll Source: CBS, 2016

[Fig. 9b] Land use map_Zeeland (2016)



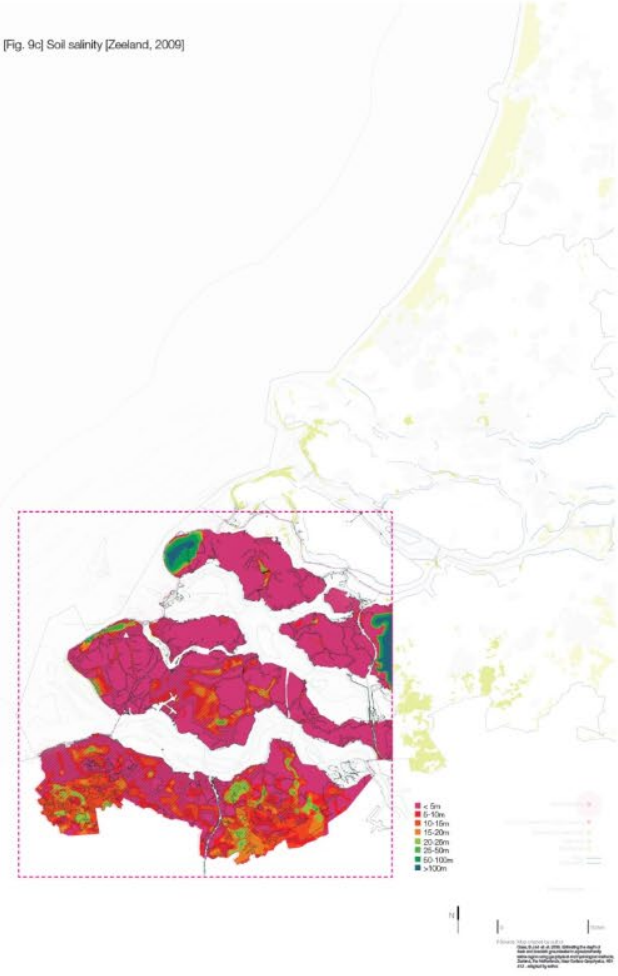
Problem field

[Part 2: Sea level rise_**Non-versatile economy**_Depletion of resources]

[Fig. 9d] Tulip field. Location: Aardenburg

Source: TrekEarth, https://www.trekearth.com/gallery/Europe/Netherlands/South/Zeeland/Aardenburg/photo1492442.htm

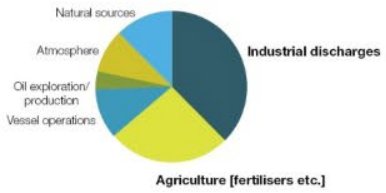
[Fig. 9c] Soil salinity [Zeeland, 2009]



Problem field

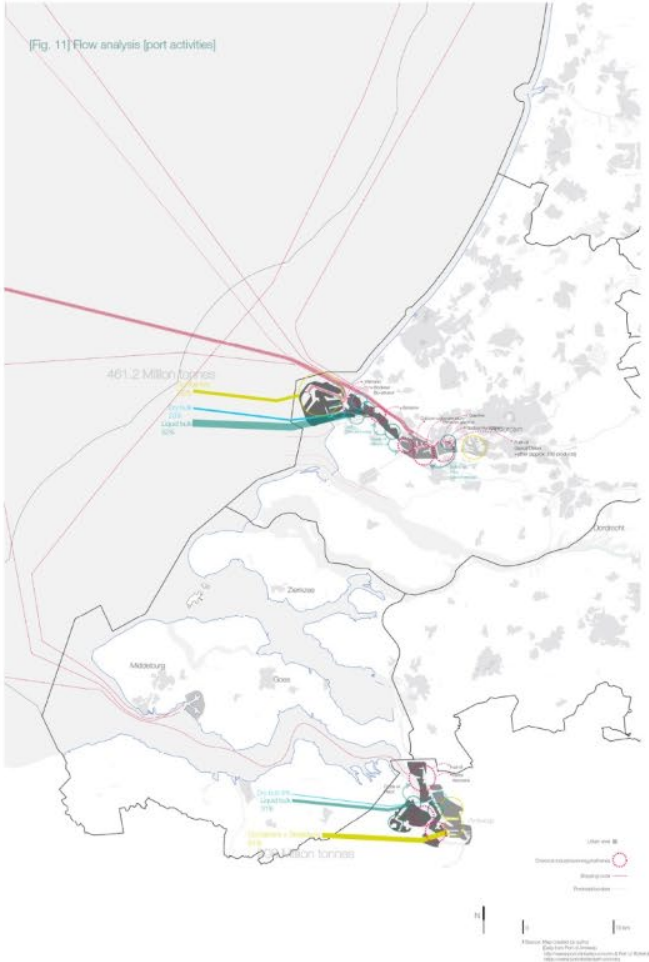
[Part 2: Sea level rise_Non-versatile economy_**Depletion of resources**]

[Fig. 10] Pollution Sources



Source: Diagram made by author based on data from http://plymsea.ac.uk/1745/1/Johns_and_Reid_2001.pdf

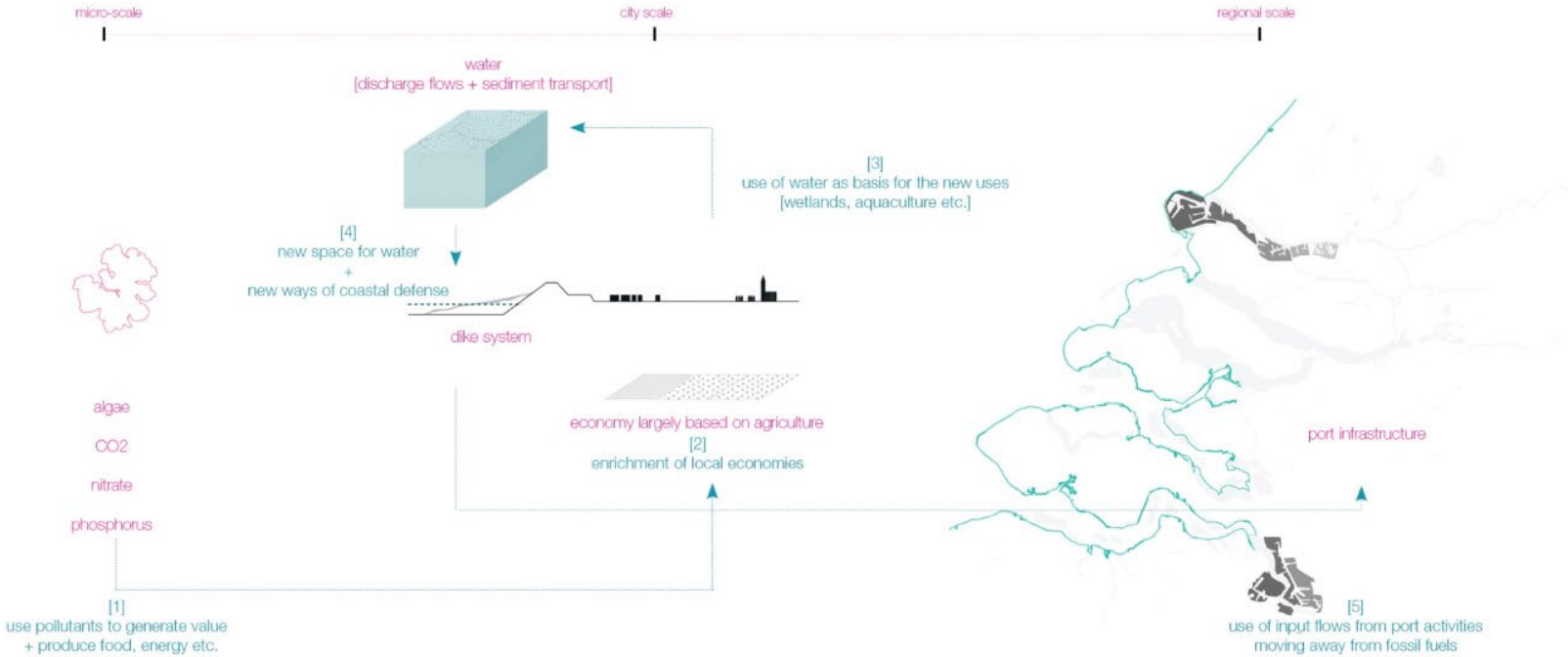
[Fig. 11] Flow analysis [port activities]



Research question

What kind of **shift in production** could subvert negative trends [pollution, sea-level rise, reliance on resources fast depleting] to generate value and facilitate a resilient, yet sustainable economy?

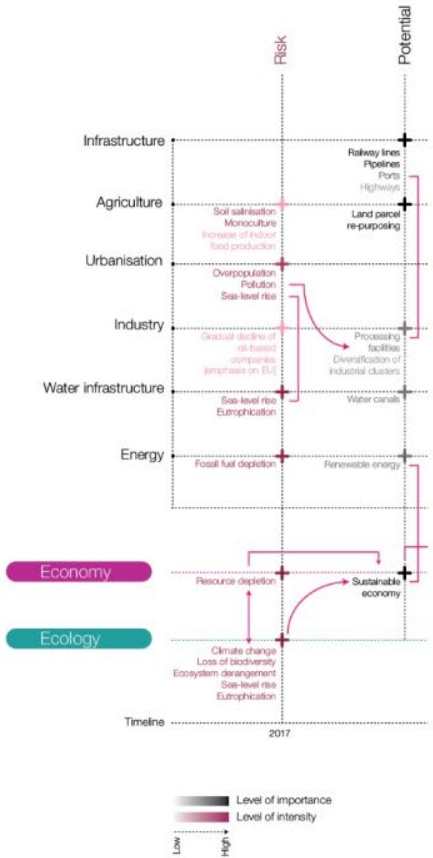
Hypothesis
From pollutants to productive landscapes



Source: Diagram made by author

Principles matrix [key factors]

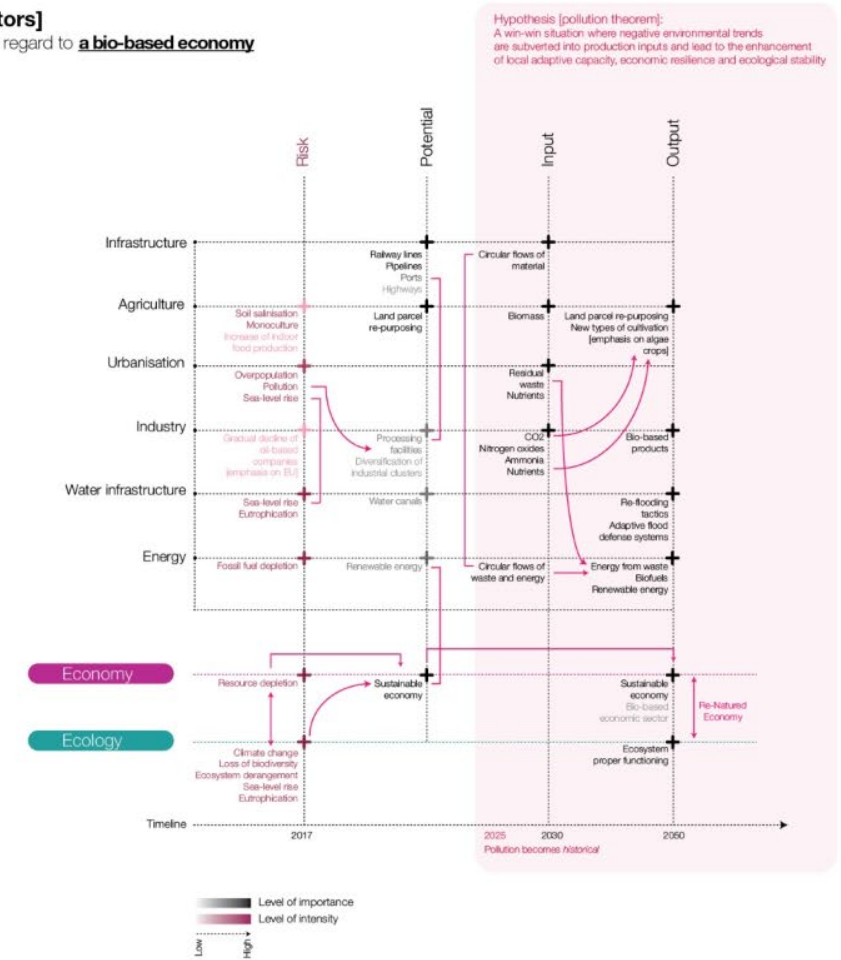
Risk and potential in contemporary growth-oriented economy



Source: Diagram made by author

Principles matrix [key factors]

Expected inputs and outputs with regard to **a bio-based economy**



Source: Diagram made by author

Expected output
Evolutionary perspective

Source: Diagram made by author

Research by design [data & spatial factors]
Urbanisation trends

[Fig. 11] Population data - Zeeland

Demographic data - region: Zeeland		
	2015	2016
Population on 1 January		381.252
Live born children	380.726	3.459
Deaths	3.604	3.885
Arrivals in municipality	3.930	
Due to immigration	3.597	4.050
Due to intermunicipal moves	12.510	13.686
Departures from municipality		
Due to emigration	2.568	2.607
Due to intermunicipal moves	12.689	14.388
Net corrections	2	1
Population growth	526	316
Population on 31 December	381.252	381.568

Fact: Zeeland remains the least populated province of the Netherlands
Overall trend: **Population declines**
Younger population moves to surrounding provinces

Source: Diagrams made by author. Data from: CENTRAAL BUREAU VOOR DE STATISTIEK (CBS). 2017. Population dynamics; birth, death and migration per region. Retrieved from goo.gl/sPPYcG [Last access: 05/01/2108, 14:26]

Research by design [data & spatial factors]

Agricultural census

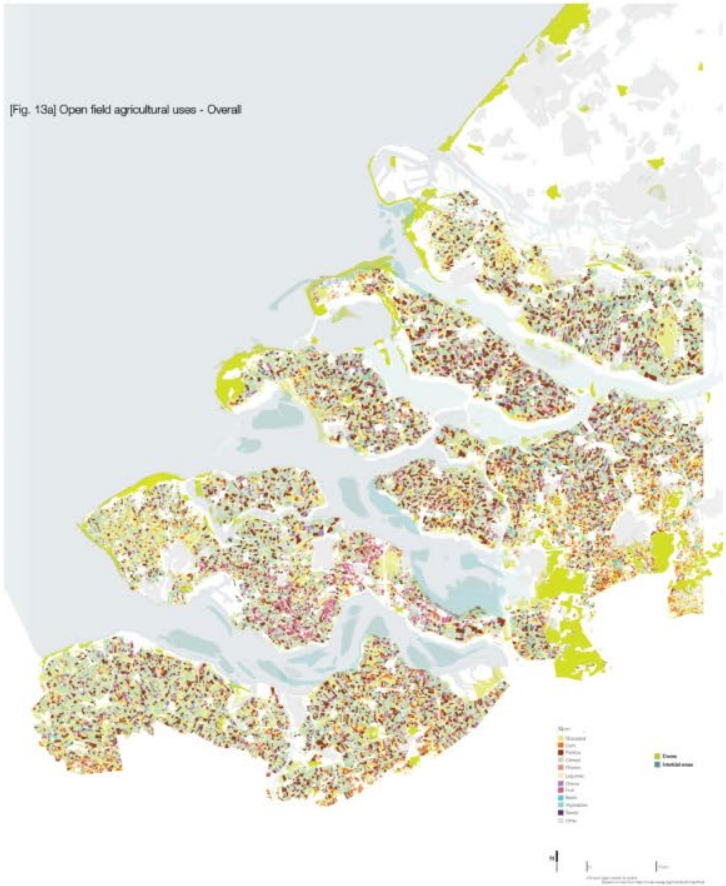
[Fig. 12] Agricultural uses + cash flows in the Netherlands

Investment cost and yearly cash flows of agricultural land uses in the Netherlands:

Agricultural land use	Investment costs(€/ha)	Maximum yearly gross revenues (€/ha)	Yearly fixed production costs (€/ha)	Maximum yearly net revenues (€/ha)	Average net revenues in total area (€/ha)	
Dairy farming	14,269	7000	–2555	1187	619	[moderate revenues]
Arable farming	7257	7038	–3629	1923	203	[low revenues]
Vegetable growing	14,890	17,942	–8209	4478	1798	
Fruit growing	35,858	17,813	–6897	5589	2967	
Flower growing	26,254	39,916	–19,552	7222	–2801	[underperforming]
Tree nursery	35,055	49,440	–28,598	9628	622	[moderate revenues]

Proposed agricultural land use:
Aquaculture for algae production + fish farming

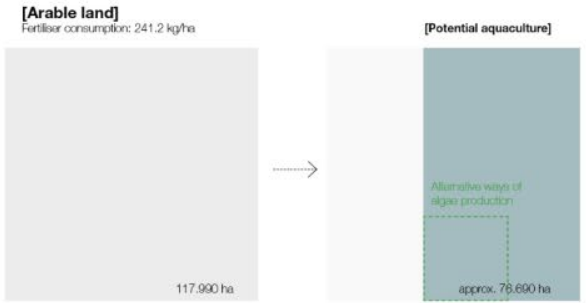
[Fig. 13a] Open field agricultural uses - Overall



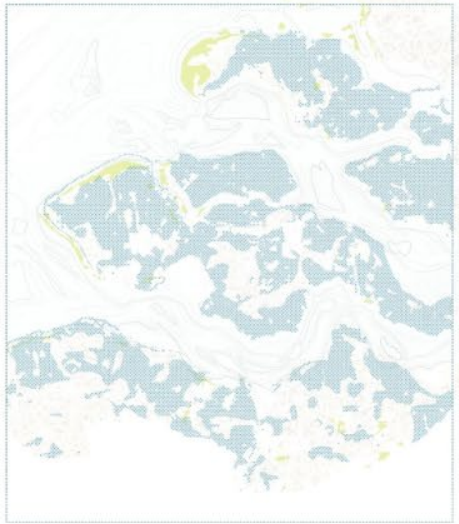
‖ Source: Diagrams made by author. Data [29a] from: DIOGO, V. et al. 2015. An economic theory-based explanatory model of agricultural land-usepatterns: The Netherlands as a case study, *Agricultural Systems*, 139, 1–16

Research by design [data & spatial factors]

Ha suitable for aquaculture + re-flooding strategies [Zeeland]



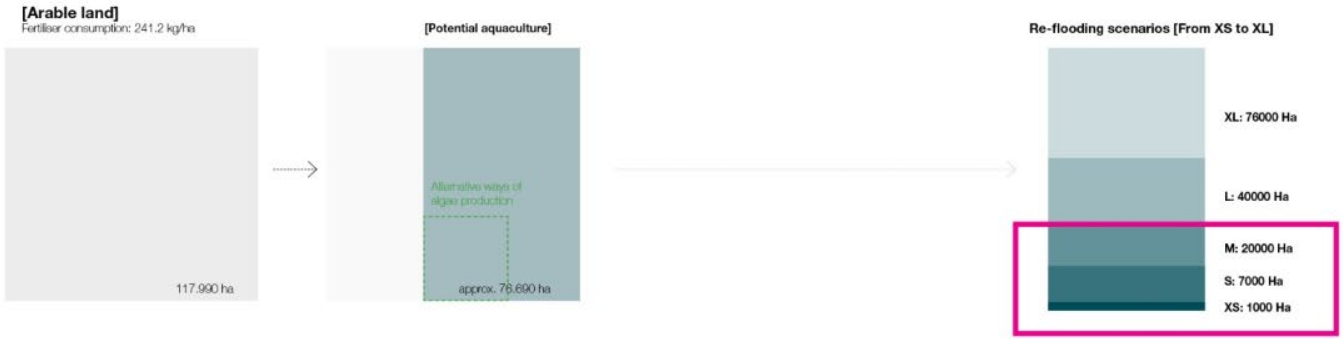
[Fig. 13b] Areas suitable for aquaculture [as retrieved by: PROVINCIE ZEELAND. 2016]



Source: Diagrams made by author. Data from: PROVINCIE ZEELAND. 2016. Omgevingsplan Zeeland 2012-2018, Provincie Zeeland, p. 117.

Research by design [data & spatial factors]

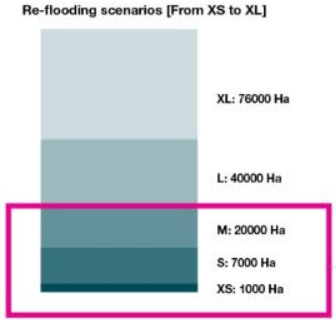
Selected scenarios

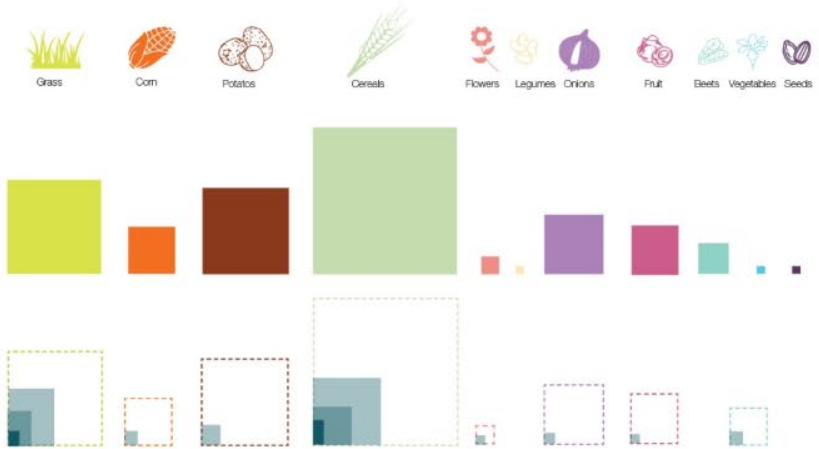


Source: Diagrams made by author. Data from: PROVINCIE ZEELAND. 2016. Omgevingsplan Zeeland 2012-2018, Provincie Zeeland, p. 117.

Research by design [data & spatial factors]

Ha of agricultural products that can be re-purposed for algae production + de-poldering + aquaculture



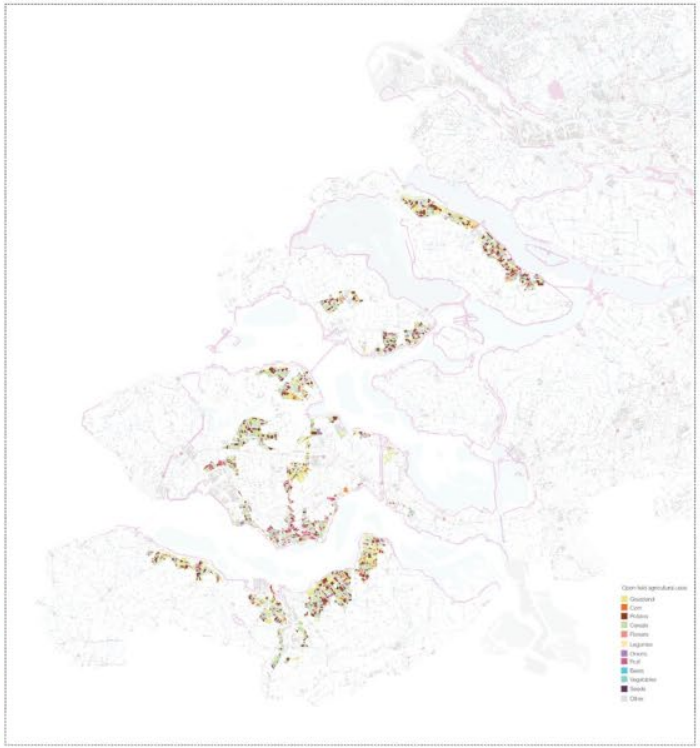


*Schematic representation of the ha proportion of each product

Source: Diagrams made by author

Macro-scale

Spatial representation of scenario S [7000 Ha]



7000 Ha

Products replaced

Macro-scale

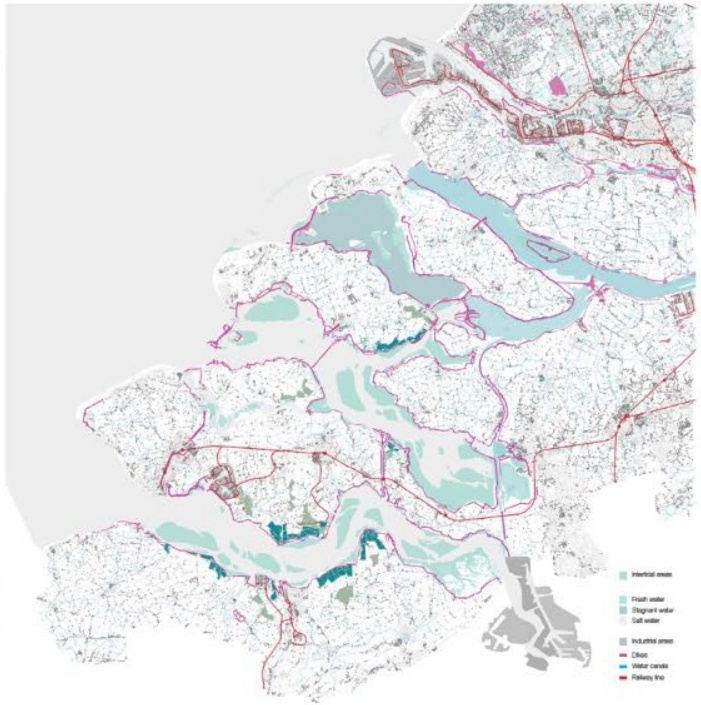
Spatial development [step 1]

Algae crops

First 5 years

High risk areas
High soil salinity

2000/7000 Ha



Stakeholders development [dispersed]

Macro-scale

Spatial development [step 2]

Algae crops

First 5 years

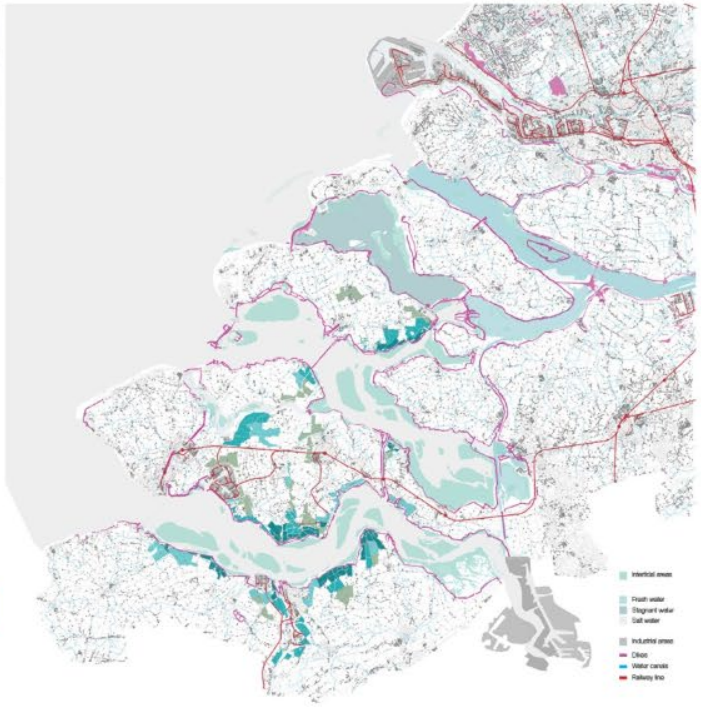
High risk areas
High soil salinity

5-8 years

8-15 years

High risk areas
High soil salinity
Underperfoming crops

5000/7000 Ha



Stakeholders development **[establishing connections]**

Macro-scale

Spatial development [step 3]

Algae crops

First 5 years

High risk areas
High soil salinity

5-8 years

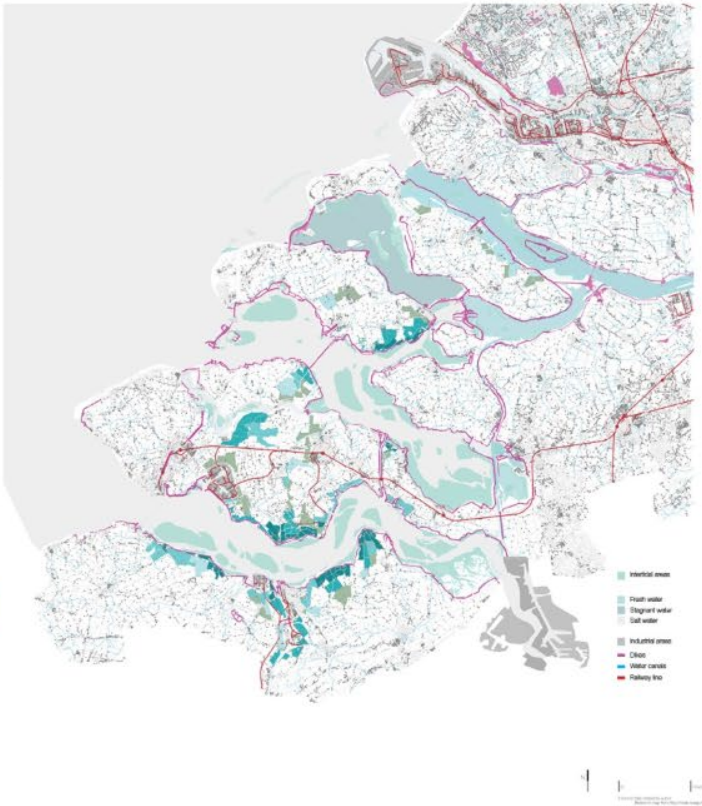
8-15 years

High risk areas
High soil salinity
Underperfoming crops

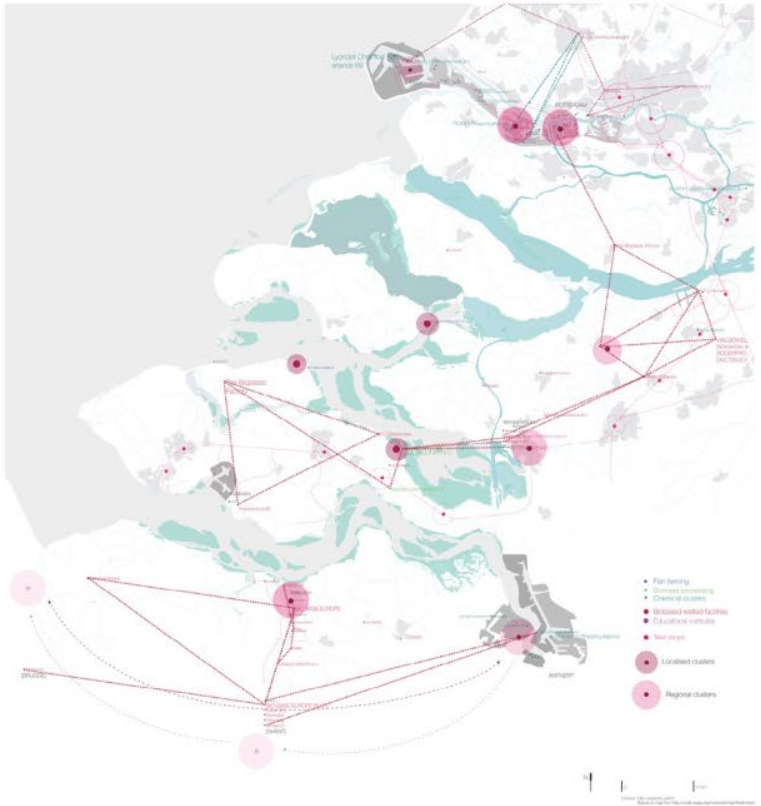
15-20 years

>20 years

7000/7000 Ha

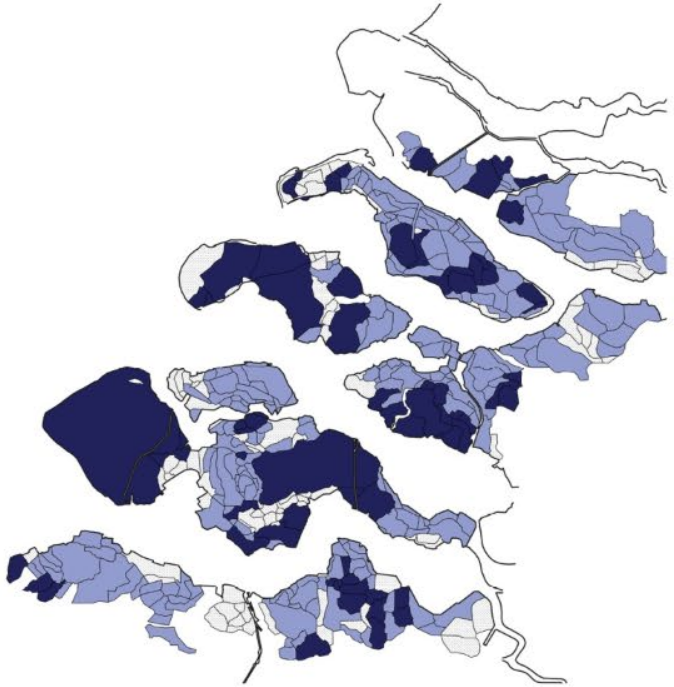


Stakeholders development **[clusters formation]**



Macro-scale

Polder structure [existing]



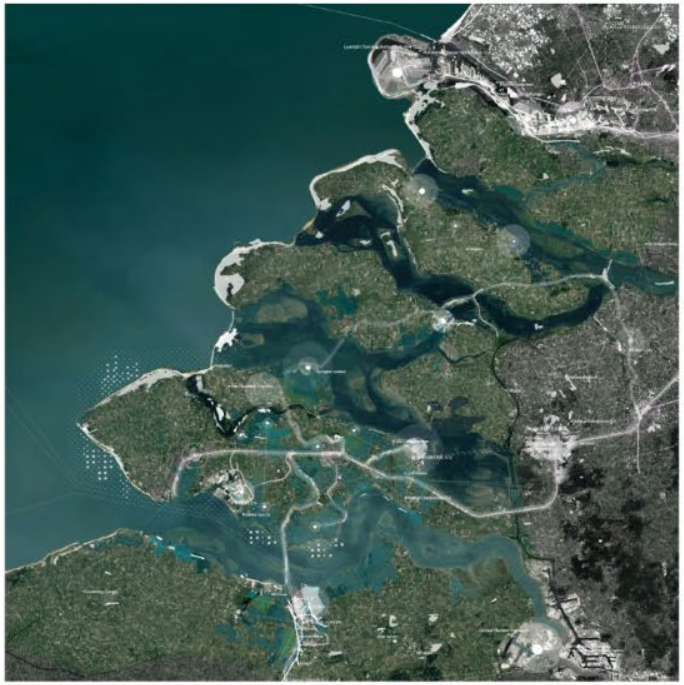
Polders with significant areas below sea level

Low lying polders, up to approx. 2m above sea level

Vessel pockets and those approx. 2 - 10m above sea level

Coastal defences, dikes and dunes

Zeeland 2070+

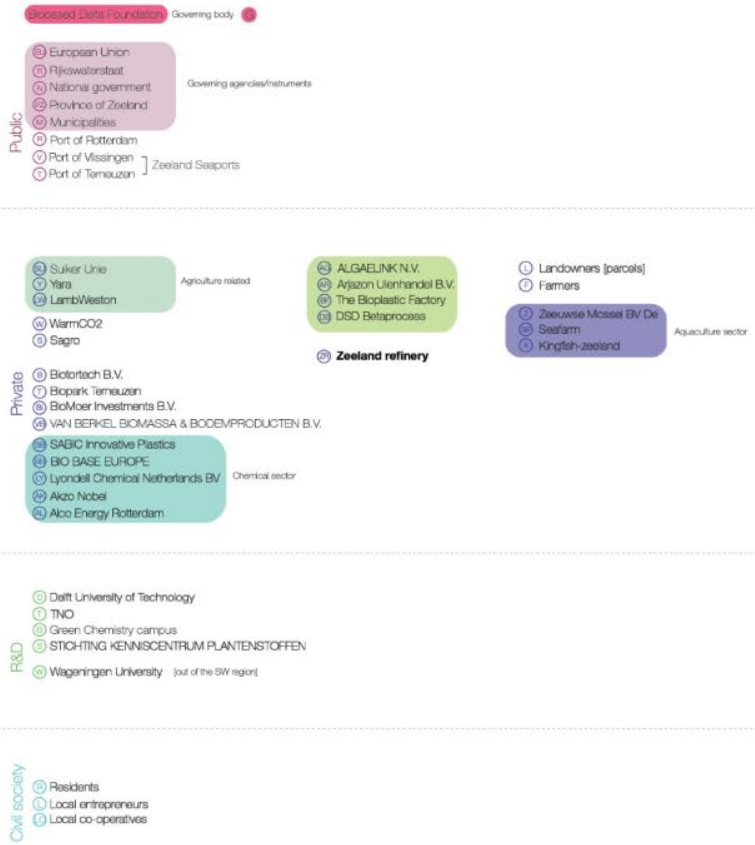


7000/7000 Ha

20000/20000 Ha

From macro to meso-scale

Range of stakeholders



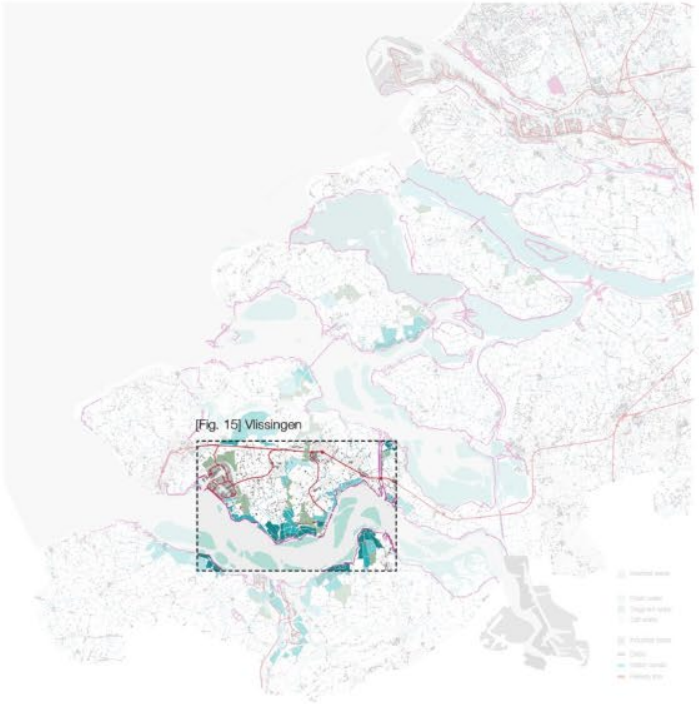
[Fig. 14] Proposed new functions

- Localised biomass plants
- Protein hubs
- Packaging facilities
- Storage managing companies
- Textile industry
- Local restaurants
- Technology centers
- Education facilities
- Algae crops
- Bio-adaptive facade construction
- Lamscoren crops
- Zilte groenten
- Aquaculture [other]

Source: Diagrams made by author. Data from: PROVINCIE ZEELAND. 2016. Omgevingsplan Zeeland 2012-2018, Provincie Zeeland & van HEIJST, M. n.d. The bio-based cluster in the Flemish-Dutch port Delta, Erasmus School of Economics.

Meso-scale

Zoom-in location



Meso-scale

Proposed design scenarios

Re-purposed area:
from 1500 Ha to 5000 Ha

algae
aquaculture

① 1500 Ha

② 3500 Ha

③ 5000 Ha

① Option 1: **Patches + corridors**

[Fig. 16a]

② Option 2: **Zones**

[Fig. 16b]

③ Option 3: **Mixed**

[Fig. 16c]

N

0

10km

† Source: Map created by author

Meso-scale
Scenario 1

algae
aquaculture

1500 Ha

1

Option 1: **Patches + corridors**
Bottom up
[self-steering_space for private initiatives]

2

Option 2: **Zones**

3

Option 3: **Mixed**

N

0

10km

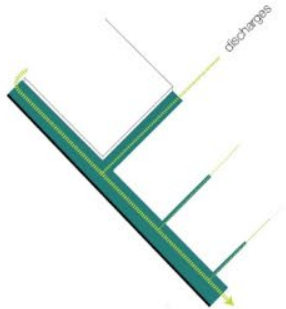
1 Source: Map created by author

Meso-scale

Scenario 1: **Steps**

Existing

(0) Agricultural + industrial discharges end up in the river



Meso-scale

Scenario 1: **Steps**

Step 1

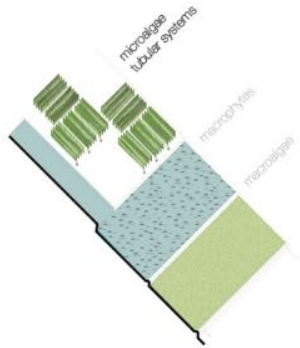
1. Remediation ponds
[macroalgae I macrophytes]

Meso-scale

Scenario 1: **Steps**

Step 2

(2) Microalgae crops
in proximity to reflooded areas

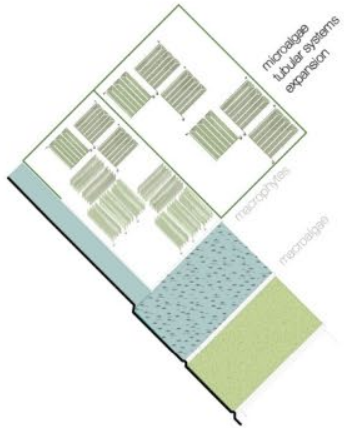


Meso-scale

Scenario 1: **Steps**

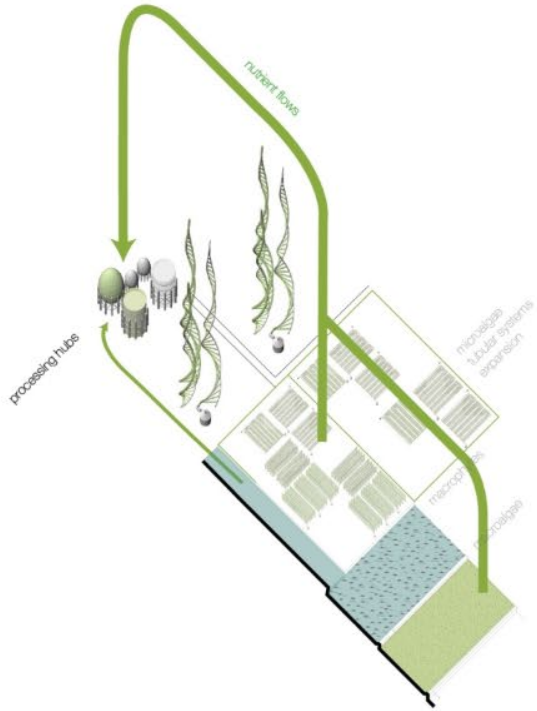
Step 3

③ Microalgae crops [expansion]



Meso-scale

Scenario 1: **Steps**

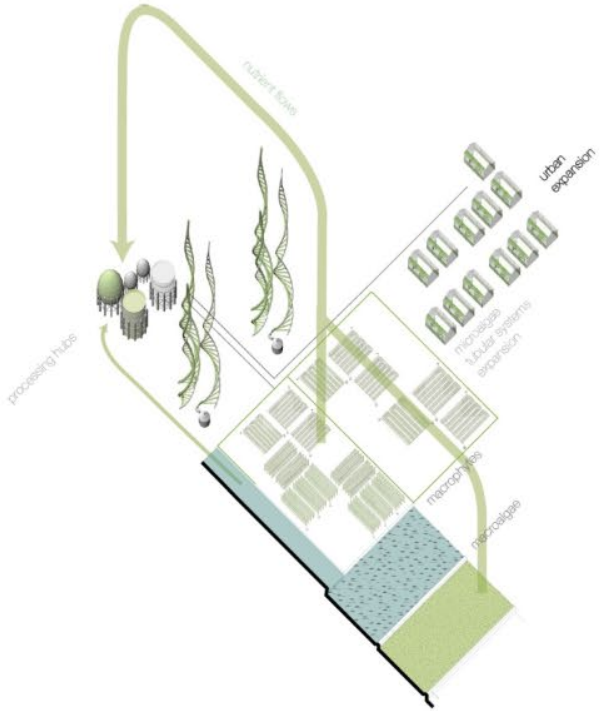


Step 4

(4) Processing facilities
[infrastructure upgrades]

Meso-scale

Scenario 1: **Steps**



Step 5

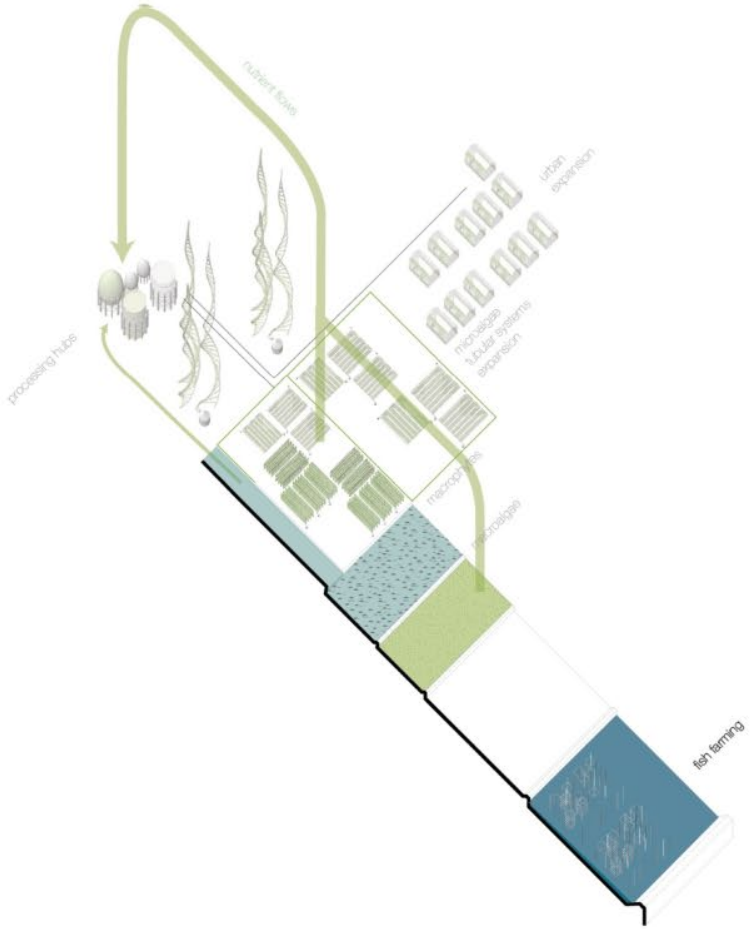
(5) Urban expansion [new homesteads]

Meso-scale

Scenario 1: **Steps**

Step 6

(6) Fish/ouster farming
in proximity to the dike system

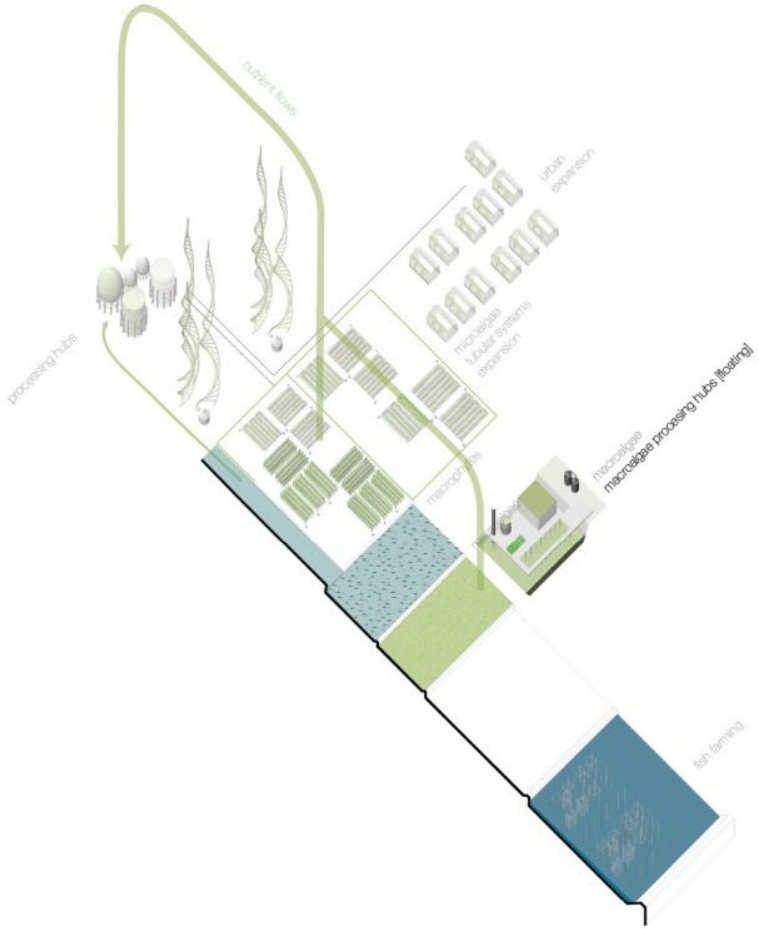


Meso-scale

Scenario 1: **Steps**

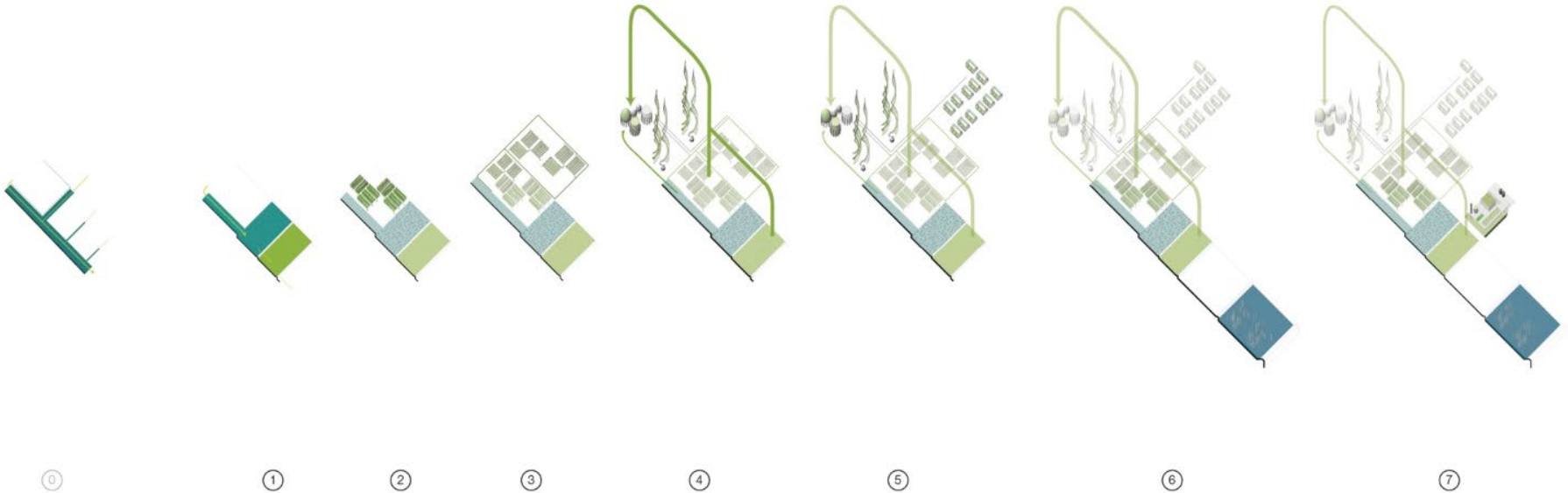
Step 7

(7) Floating processing facilties/hubs



Meso-scale

Scenario 1: **Steps overview**



0 1 2 3 4 5 6 7

[Fig. 17-25a] Steps in sequence

Meso-scale
Scenario 2

Re-purposed area:
from 1500 Ha to 5000 Ha

algae
aquaculture

② 3500 Ha

① Option 1: **Patches + corridors**

② Option 2: **Zones**
Hierarchical steering
[basic interests_flood protection
+underperforming zones of land]

③ Option 3: **Mixed**

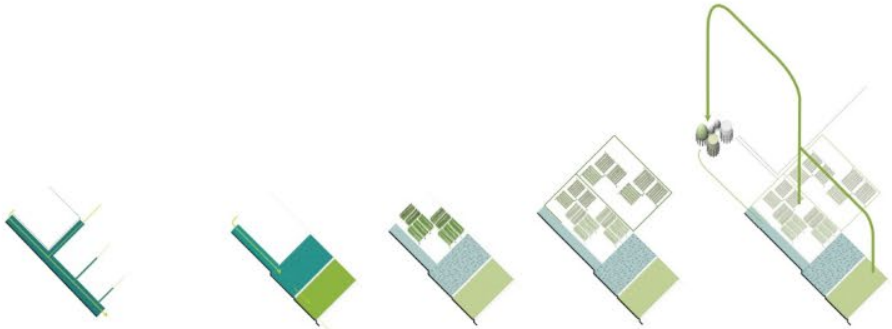
N

0 10km

1 Source: Map created by author

Meso-scale

Scenario 2: **Steps overview**



0 1 2 3 4 5 6

This scenario follows the same line of reasoning and a similar sequence of steps as scenario 1, with slight differences: in this case, **reflooding strategies are prioritised in relation to algae production** as flood protection and environmental stability are the main drivers. The areas selected for reflooding are to be found within the existing polder dikes so that the reflooding processes are facilitated (could even occur naturally if pumping stops) and are able to create **distinct water zones of macroalgae or fish farming**.

[Fig. 17-25b]

Meso-scale
Scenario 3

Re-purposed area:
from 1500 Ha to 5000 Ha

algae
aquaculture

③

5000 Ha

①

Option 1: **Patches + corridors**

②

Option 2: **Zones**

③

Option 3: **Mixed**
Public-private partnerships
[basic interests_flood protection
+space for private initiatives]

N

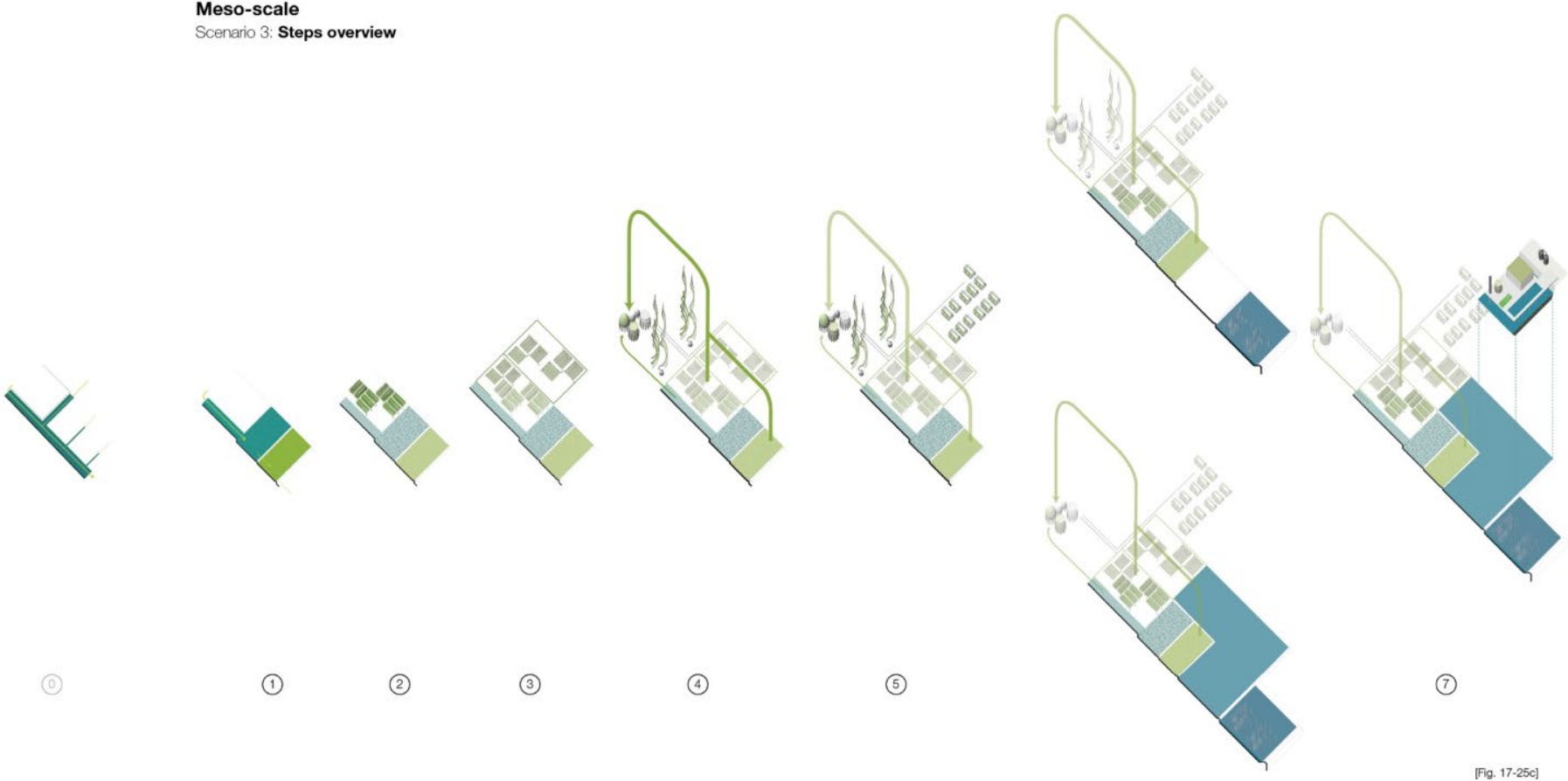
0

10 km

4 Source: Map created by author

Meso-scale

Scenario 3: **Steps overview**



[Fig. 17-25c]

Meso-scale

Scenario 3: **Year 0**

[Fig. 25] Stakeholders

[Fig. 26a] Timeline

[Fig. 27a] Step

[Fig. 28a] Design scenario

Meso-scale

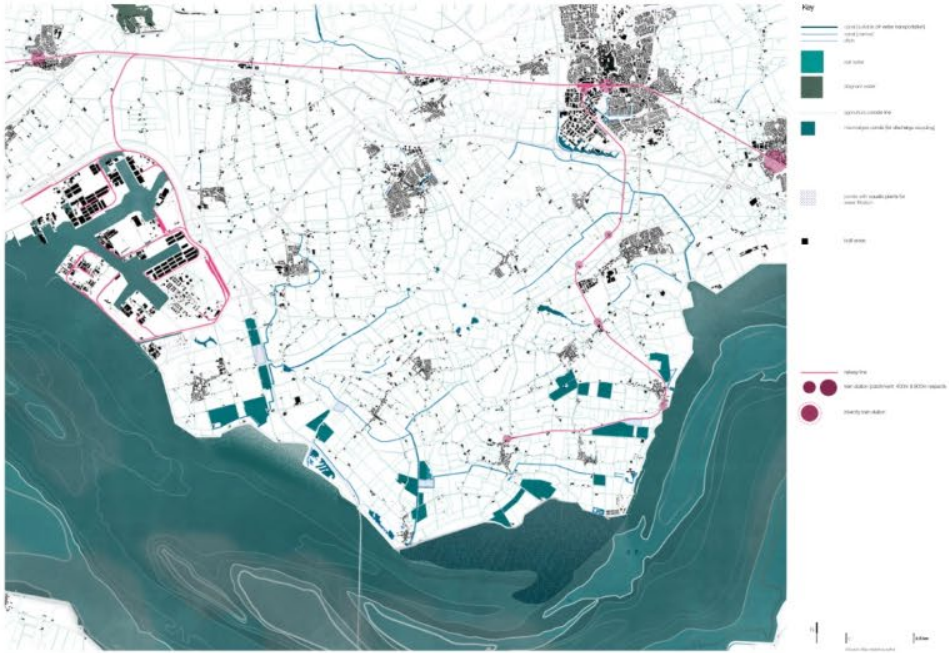
Scenario 3: **Year 5**

[Fig. 25] Stakeholders

[Fig. 26b] Timeline

[Fig. 27b] Step

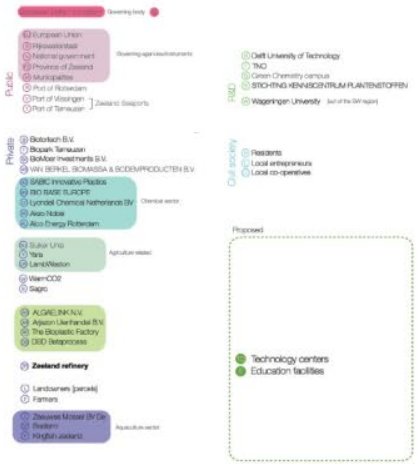
[Fig. 28b] Design scenario



Meso-scale

Scenario 3: **Year 15**

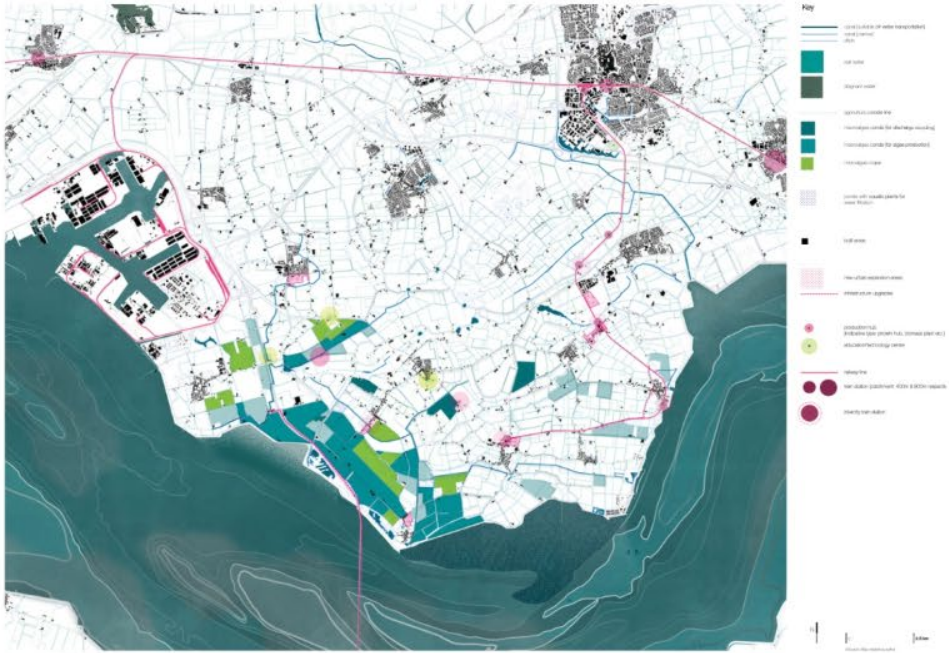
[Fig. 25] Stakeholders



[Fig. 26c] Timeline

[Fig. 27c] Step

[Fig. 28c] Design scenario



Meso-scale

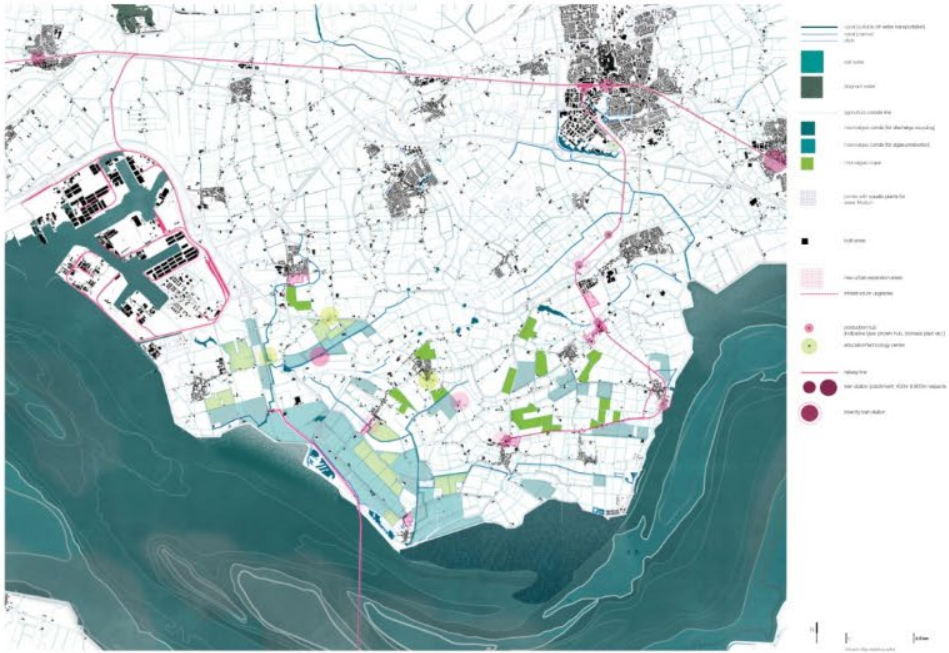
Scenario 3: **Year 25**

[Fig. 25] Stakeholders

[Fig. 26d] Timeline

[Fig. 27d] Step

[Fig. 28d] Design scenario



Meso-scale

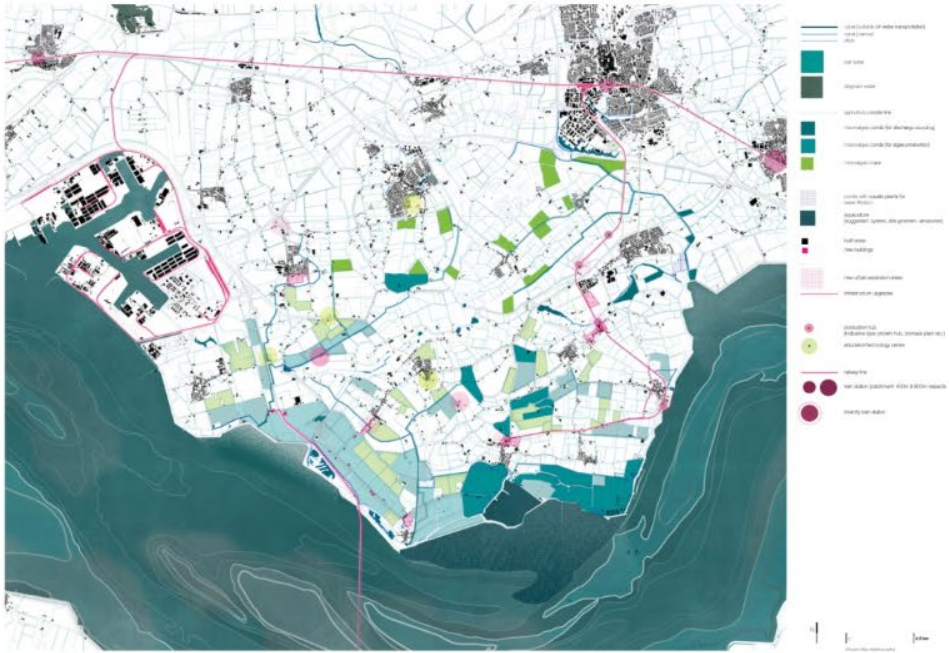
Scenario 3: **Year 35**

[Fig. 25] Stakeholders

[Fig. 26e] Timeline

[Fig. 27e] Step

[Fig. 28e] Design scenario

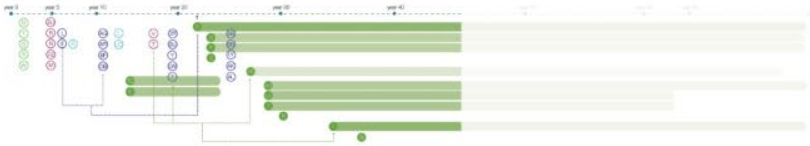


Meso-scale

Scenario 3: **Year 45**

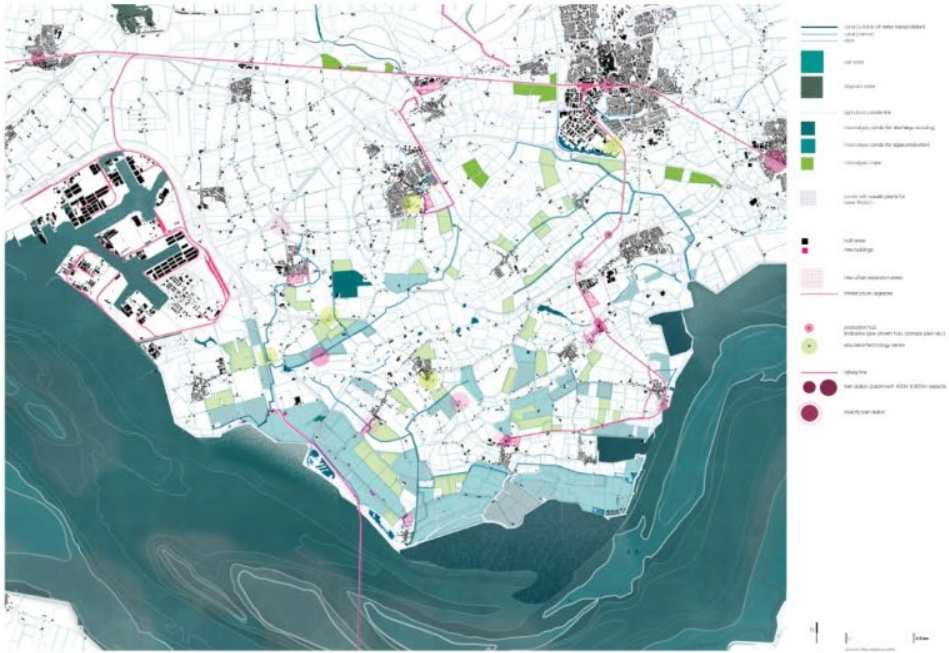
[Fig. 25] Stakeholders

[Fig. 26f] Timeline



[Fig. 27f] Step

[Fig. 28f] Design scenario

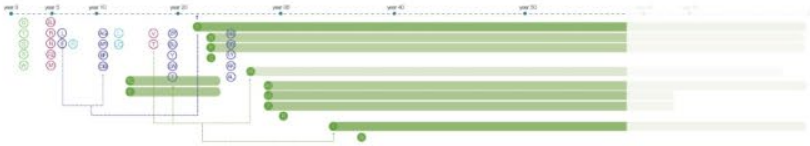


Meso-scale

Scenario 3: **Year 55**

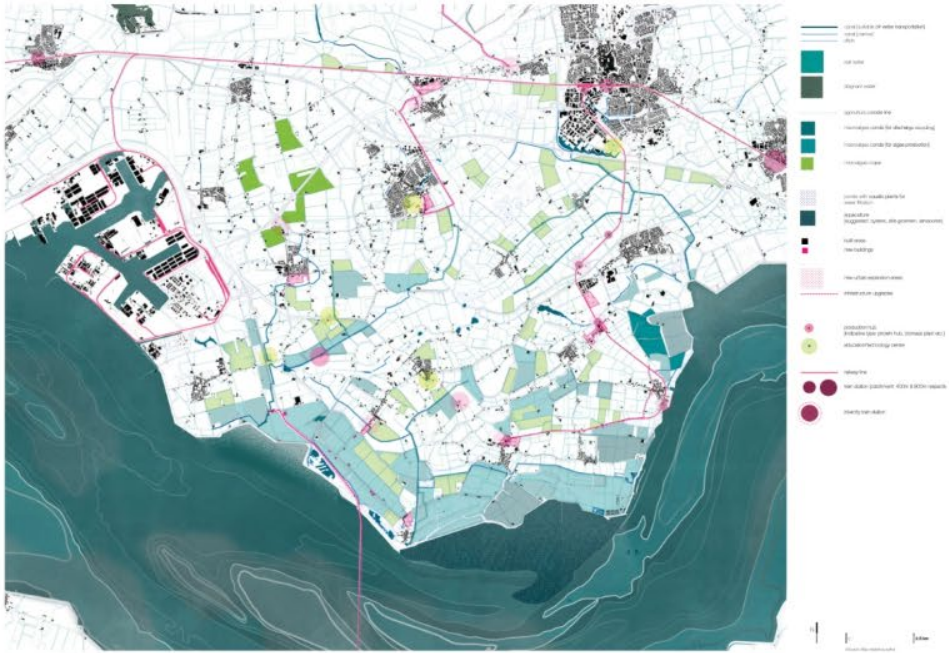
[Fig. 25] Stakeholders

[Fig. 26g] Timeline



[Fig. 27g] Step

[Fig. 28g] Design scenario

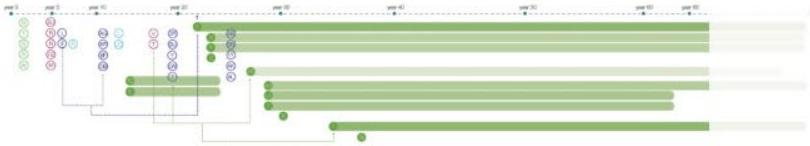


Meso-scale

Scenario 3: **Year 65**

[Fig. 25] Stakeholders

[Fig. 26h] Timeline

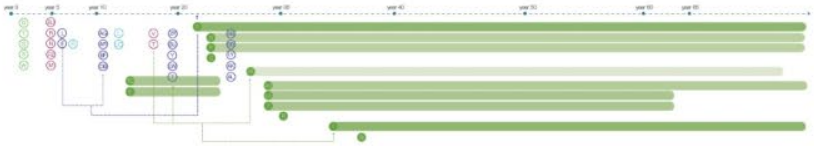


[Fig. 27h] Step

[Fig. 28h] Design scenario

Meso-scale
Scenario 3: **Year 70**

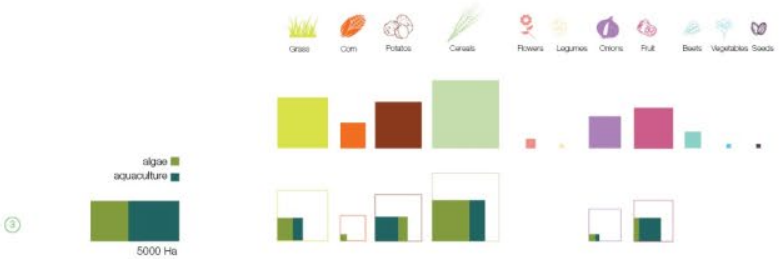
[Fig. 26i] Overall timeline



[Fig. 28i] Design scenario

Meso-scale

Scenario 3: **Land re-purposed**



[Fig. 29a] Replaced open field agricultural uses

Meso-scale

Scenario 2: **Land re-purposed**

[Fig. 29b] Replaced open field agricultural uses

Meso-scale

Scenario 1: **Land re-purposed**

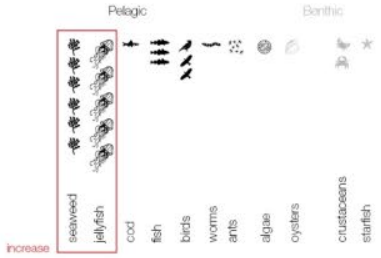
②

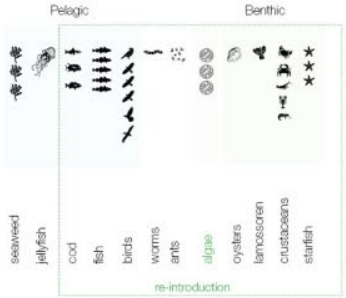
[Fig. 29c] Replaced open field agricultural uses

Meso-scale

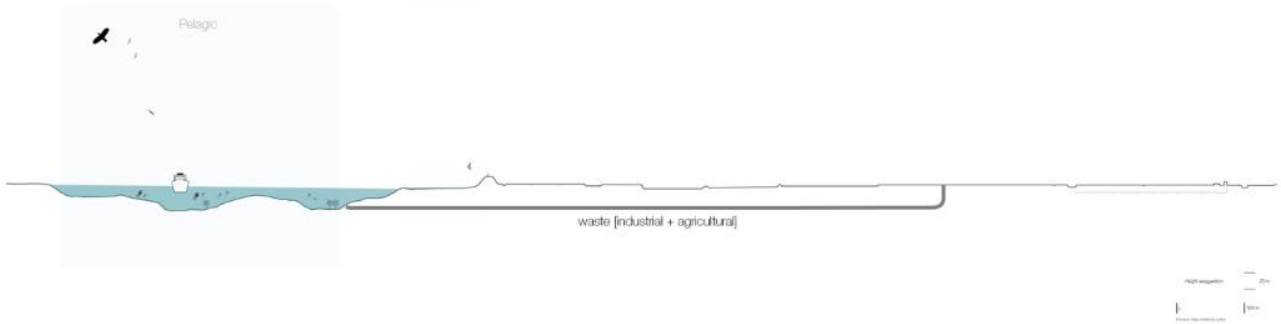
Scenario 1: **Ecoservices**

[Fig. 30a] Species

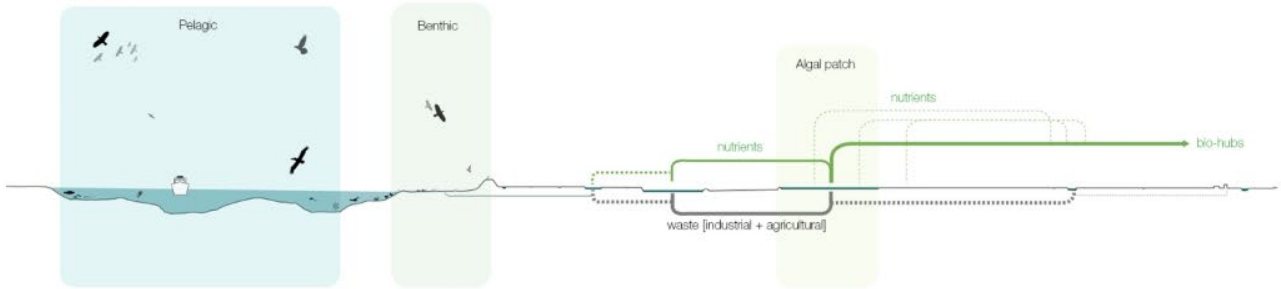




[Fig. 30d] Existing section



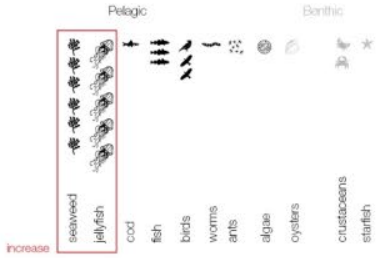
[Fig. 30e] Proposed section



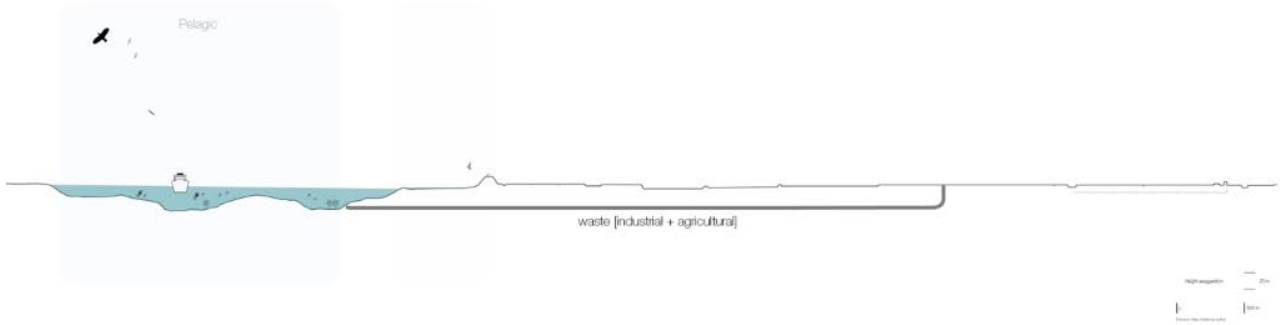
Meso-scale

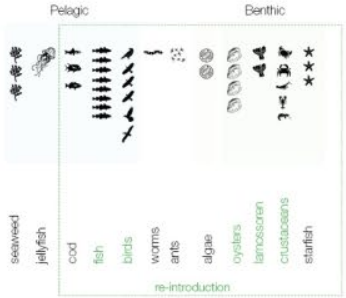
Scenario 2: **Ecoservices**

[Fig. 30b] Species

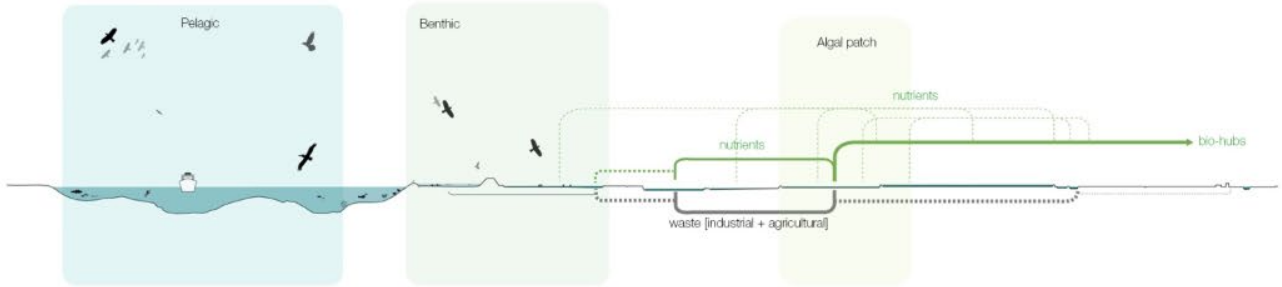


[Fig. 30d] Existing section





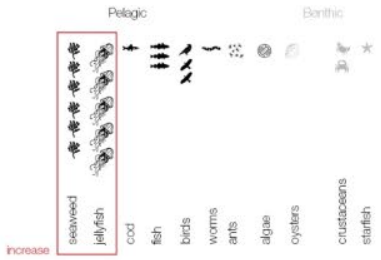
[Fig. 30f] Proposed section

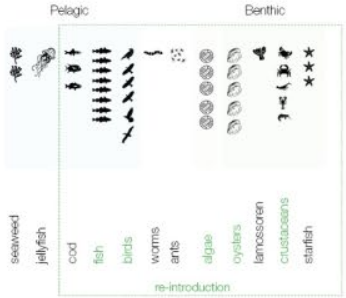


Meso-scale

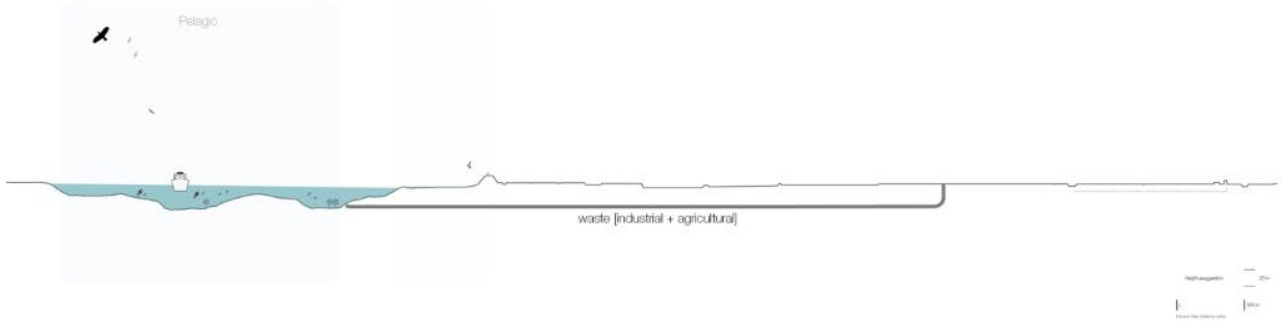
Scenario 3: **Ecoservices**

[Fig. 30c] Species

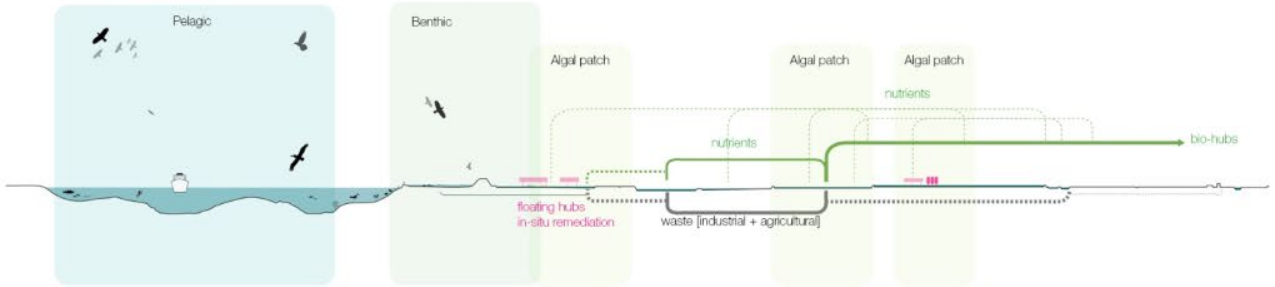




[Fig. 30d] Existing section

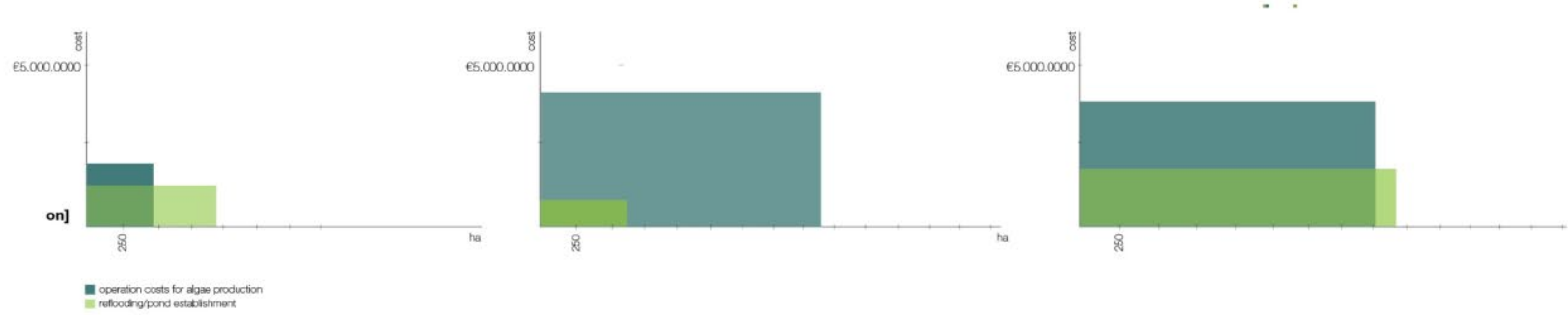


[Fig. 30g] Proposed section



Meso-scale
Evaluation: Cost

[Fig. 31a] Cost estimation for each scenario



Option 1: **Patches + corridors**

Option 2: **Zones**

Option 3: **Mixed**

[Fig. 31b] Calculations index

€5.000/ha of growth pond area for site clearing and pond levees
€5.000/ ha for paddle wheels [if applicable]

pond parcelation
Small to medium: 0.2ha -0.5ha -0.8ha -1ha
Large; >1ha <3ha
Extra large: >3ha

€7.000/ha for algae harvesting

Total capital investment: €40.000 per hectare
including: €10.000/ha for operation costs

ll Data from: BENEMANN, J.R., VAN OLST, J.C., MASSINGILL, M.J., WEISSMAN, J.C., &. BRUNE, D.E. 2002. The Controlled Eutrophication Process: Using Microalgae for CO2 Utilization and Agricultural Fertilizer Recycling, Proceedings of the 6th International Conference on Greenhouse Gas Control Technologies, 2, 1433–1438. Japan, Kyoto.

Meso-scale
Evaluation: Benefit

[Fig. 31c] Benefit assessment for each scenario

Option 1: **Patches + corridors**

Option 2: **Zones**

Option 3: **Mixed**

‖ Data from: THE INSTITUTION OF ENVIRONMENTAL SCIENCES. 2013. Ecosystem services assessment: How to do one in practice. Retrieved from: https://www.the-ies.org/sites/default/files/reports/ecosystem_services.pdf [Last access: 20/05/2017, 21:34]

Meso-scale

Scenario 1

Meso-scale

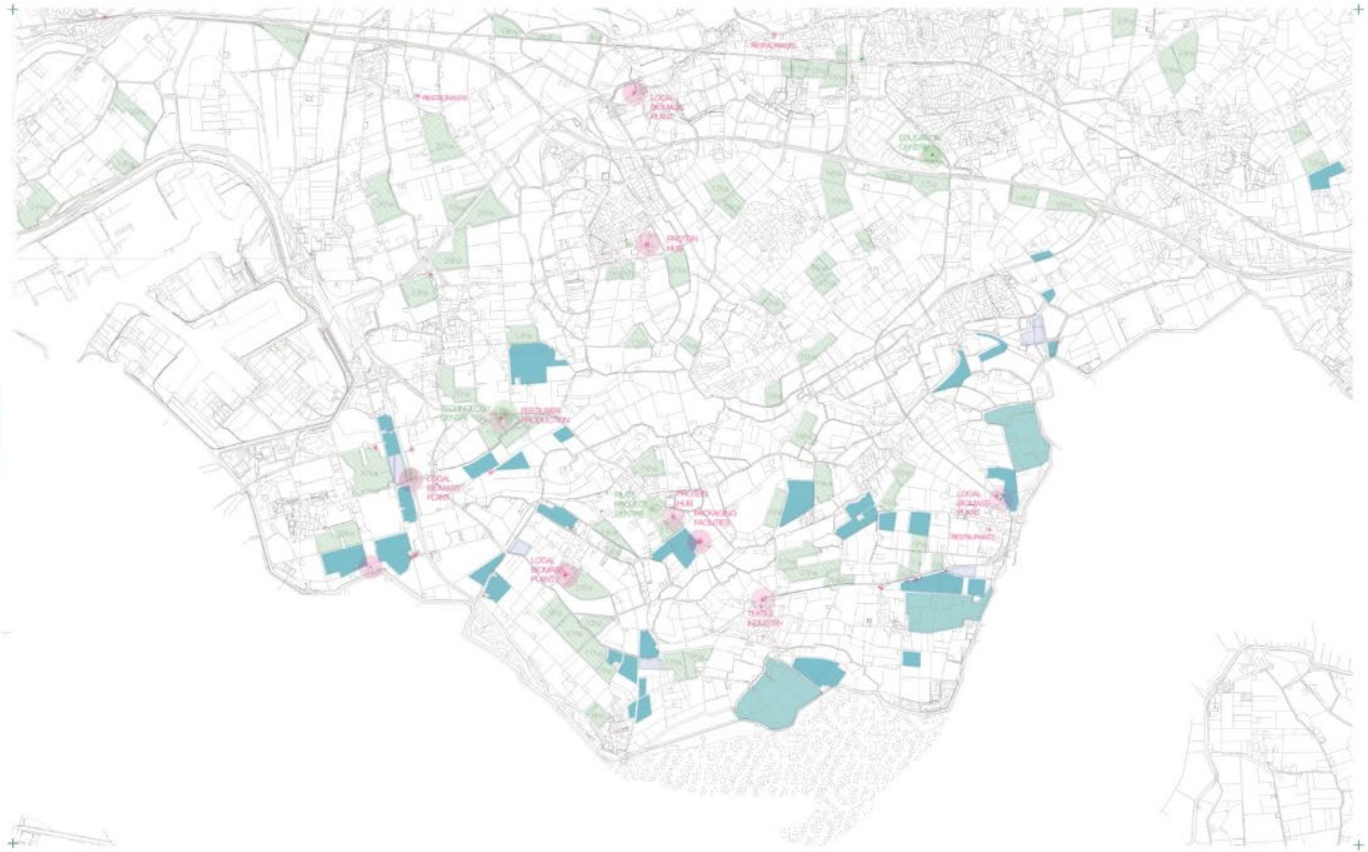
Scenario 2

Meso-scale

Scenario 3

Meso-scale

Scenario 1: Flow analysis



Meso-scale

Scenario 1: Flow analysis

Manure input (tonnes):
nitrates: approx. 3,500
phosphates: approx. 2,000
[for whole Zeeland]

this part:
3,500/8 tonnes
for nitrates
2,000/8 tonnes
for phosphates

Meso-scale

Scenario 1: Flow analysis

Manure input (tonnes):
nitrates: approx. 3,500
phosphates: approx. 2,000
[for whole Zeeland]

this part:
3,500/8 tonnes
for nitrates
2,000/8 tonnes
for phosphates

Meso-scale

Scenario 1: Flow analysis

algae crops
remediation ponds (macro algae)
remediation ponds (macrophytes)
macroalgae aquaculture

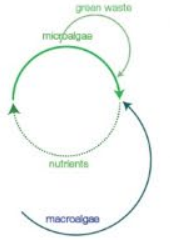
Algae production
Micro-algae outdoors
Micro-algae indoors
Algae trees
New wetlands and aquaculture
Macro-algae open water production
Industrial infrastructure upgrades
Nutrient network
CO2 capturing

Manure input (tonnes):
nitrates: approx. 3,500
phosphates: approx. 2,000
[for whole Zeeland]

this part:
3,500/8 tonnes
for nitrates
2,000/8 tonnes
for phosphates

Meso-scale

Scenario 1: Flow analysis



algae crops
remediation ponds [macro algae]
remediation ponds [macrophytes]
macroalgae aquaculture

nutrients extracted from the environment: remediation

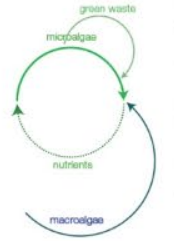
Manure input (tonnes):
nitrates: approx. 3,500
phosphates: approx. 2,000
[for whole Zeeland]

this part:
3,500/8 tonnes
for nitrates
2,000/8 tonnes
for phosphates

Algae production
Micro-algae outdoors
Micro-algae indoors
Algae trees
New wetlands and aquaculture
Macro-algae open water production
Industrial infrastructure upgrades
Nutrient network
CO2 capturing

Meso-scale

Scenario 2: Flow analysis



algae crops
remediation ponds [macro algae]
remediation ponds [macrophytes]
macroalgae aquaculture

nutrients extracted from the environment: remediation

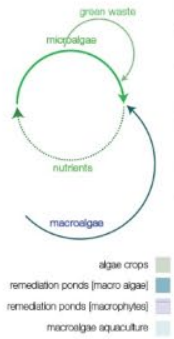
Manure input (tonnes):
nitrates: approx. 3,500
phosphates: approx. 2,000
[for whole Zeeland]

this part:
3,500/8 tonnes
for nitrates
2,000/8 tonnes
for phosphates

Algae production
Micro-algae outdoors
Micro-algae indoors
Algae trees
New wetlands and aquaculture
Macro-algae open water production
Industrial infrastructure upgrades
Nutrient network
CO2 capturing

Meso-scale

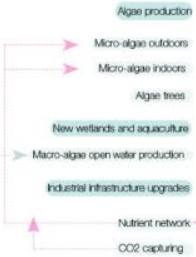
Scenario 3: Flow analysis



nutrients extracted from the environment: remediation

Manure input (tonnes):
nitrates: approx. 3,500
phosphates: approx. 2,000
[for whole Zeeland]

this part:
3,500/8 tonnes
for nitrates
2,000/8 tonnes
for phosphates



Micro-scale

Zoom-in location

Micro-scale

Scenario 3: **Steps**

Existing

(0) Agricultural + industrial discharges end up in the river

Micro-scale
Scenario 3: **Steps**

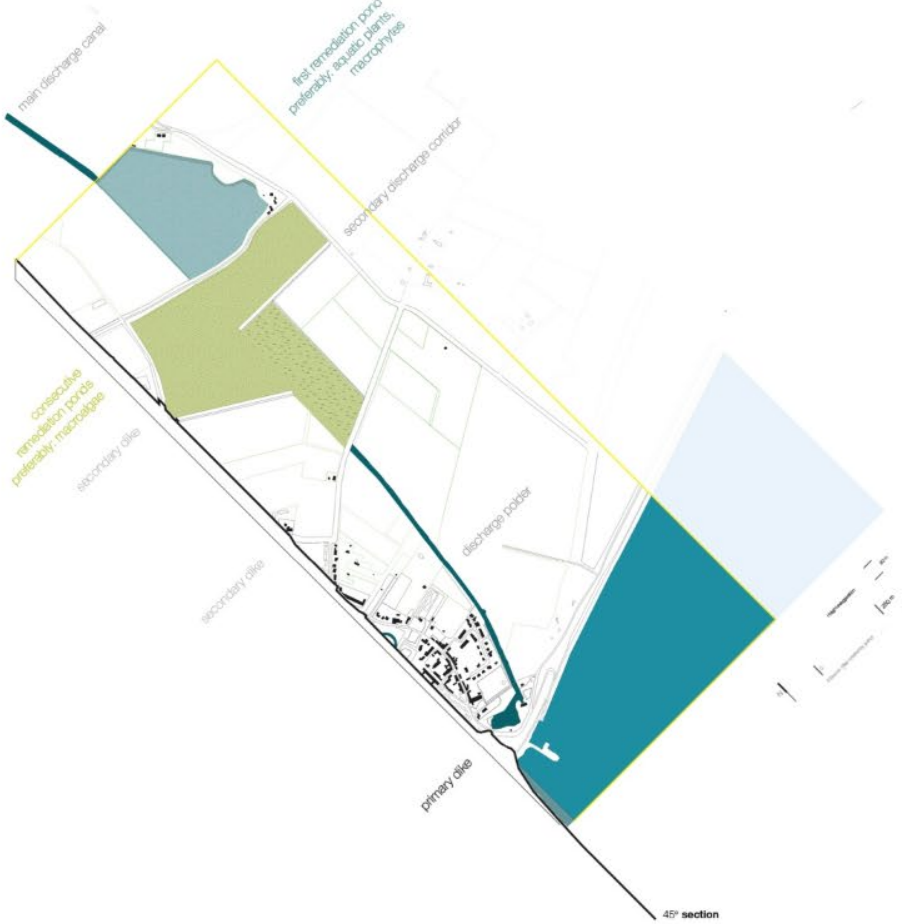
Step 1

(1) Remediation pond
[macro phytes]

Micro-scale
Scenario 3: **Steps**

Step 2 [part 1]

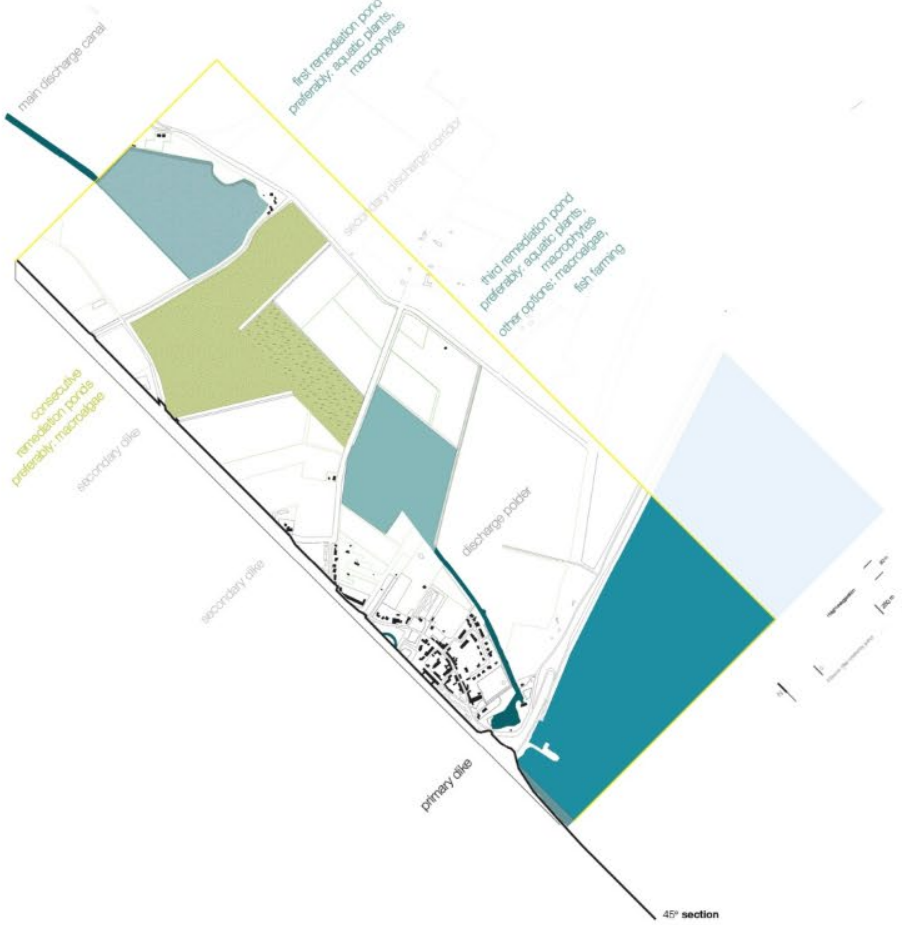
(2) Remediation pond [macroalgae]



Micro-scale
Scenario 3: **Steps**

Step 2 [part 2]

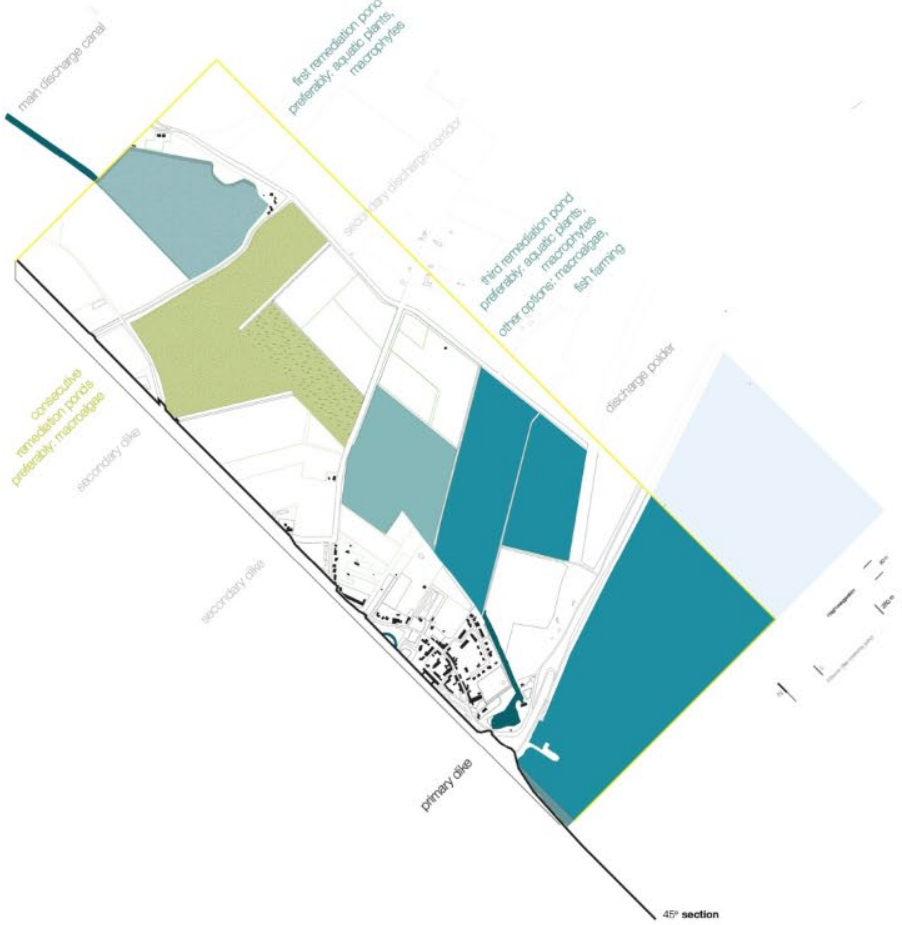
(2) Remediation pond [macro phytes]



Micro-scale
Scenario 3: **Steps**

Step 3

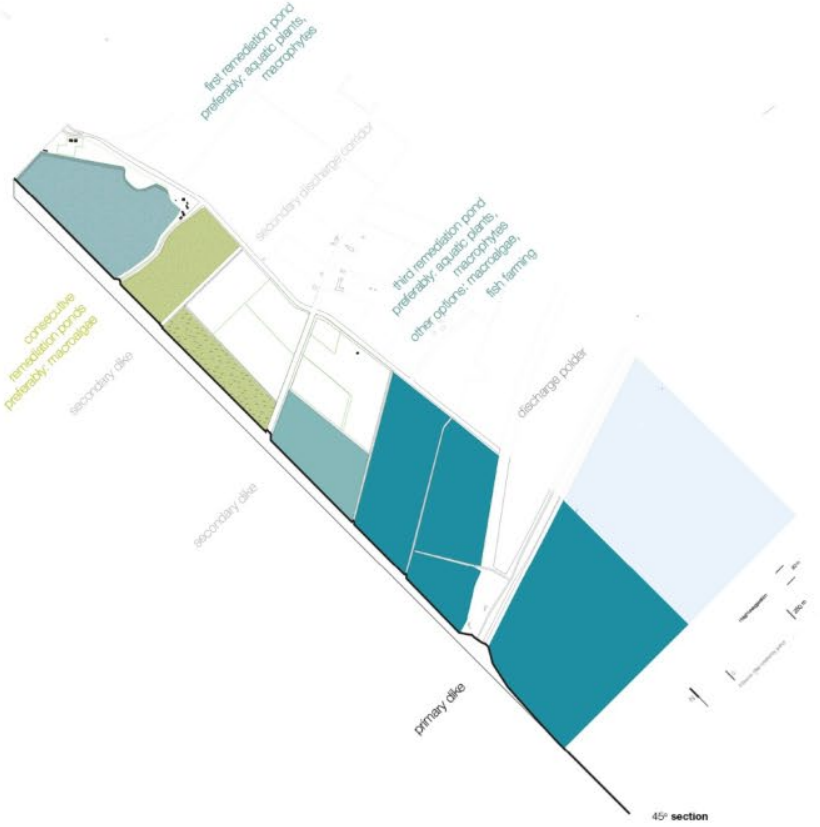
(3) Aquaculture zones
[macroalgae or fish farming]



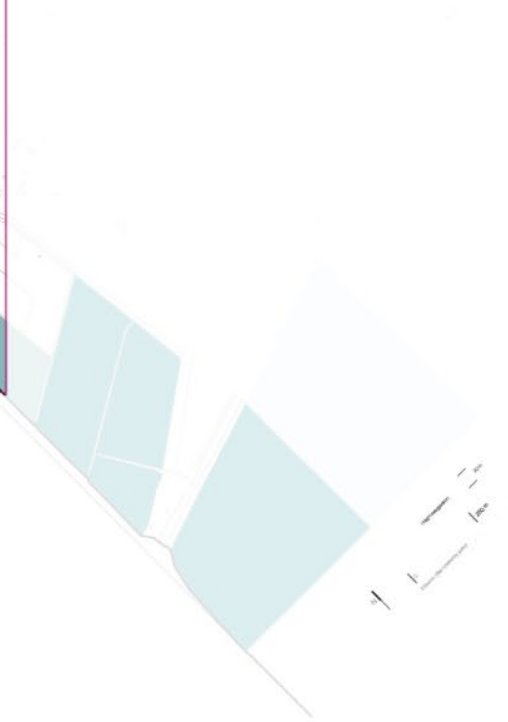
Micro-scale
Scenario 3: **Steps**

Step 4

(4) Aquaculture zones expansion [macroalgae or fish farming]



Micro-scale
Scenario 3: **Steps**

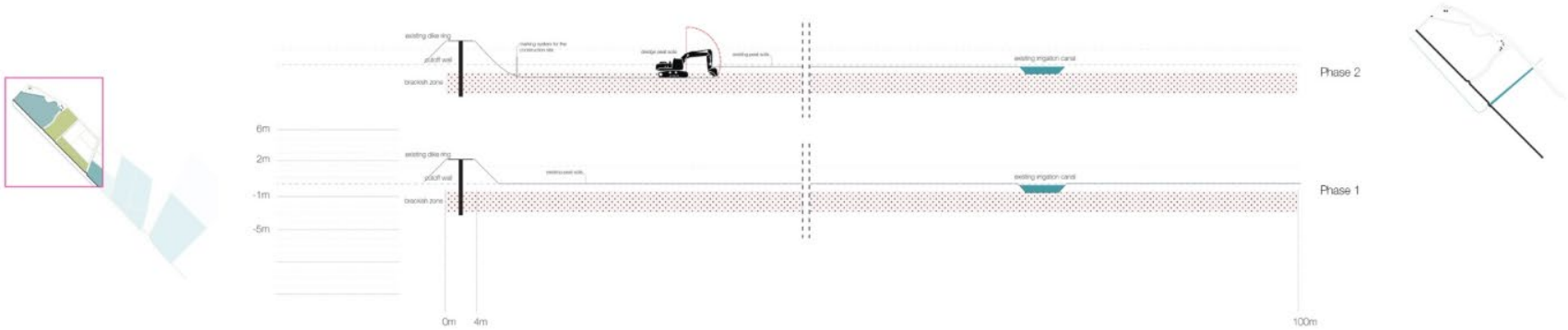


Step 4

④ Aquaculture zones expansion
[macroalgae or fish farming]

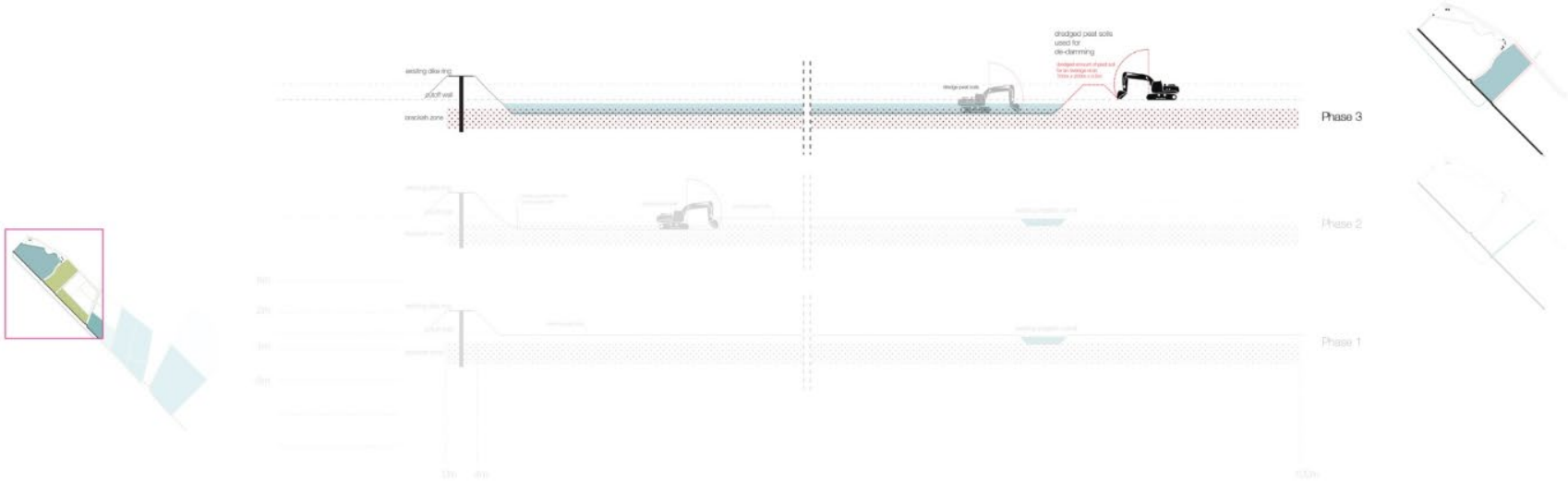
Micro-scale
Scenario 3: **Steps I Infrastructure plans**

[Fig. 32a] Depoldering evolution [former agricultural land]



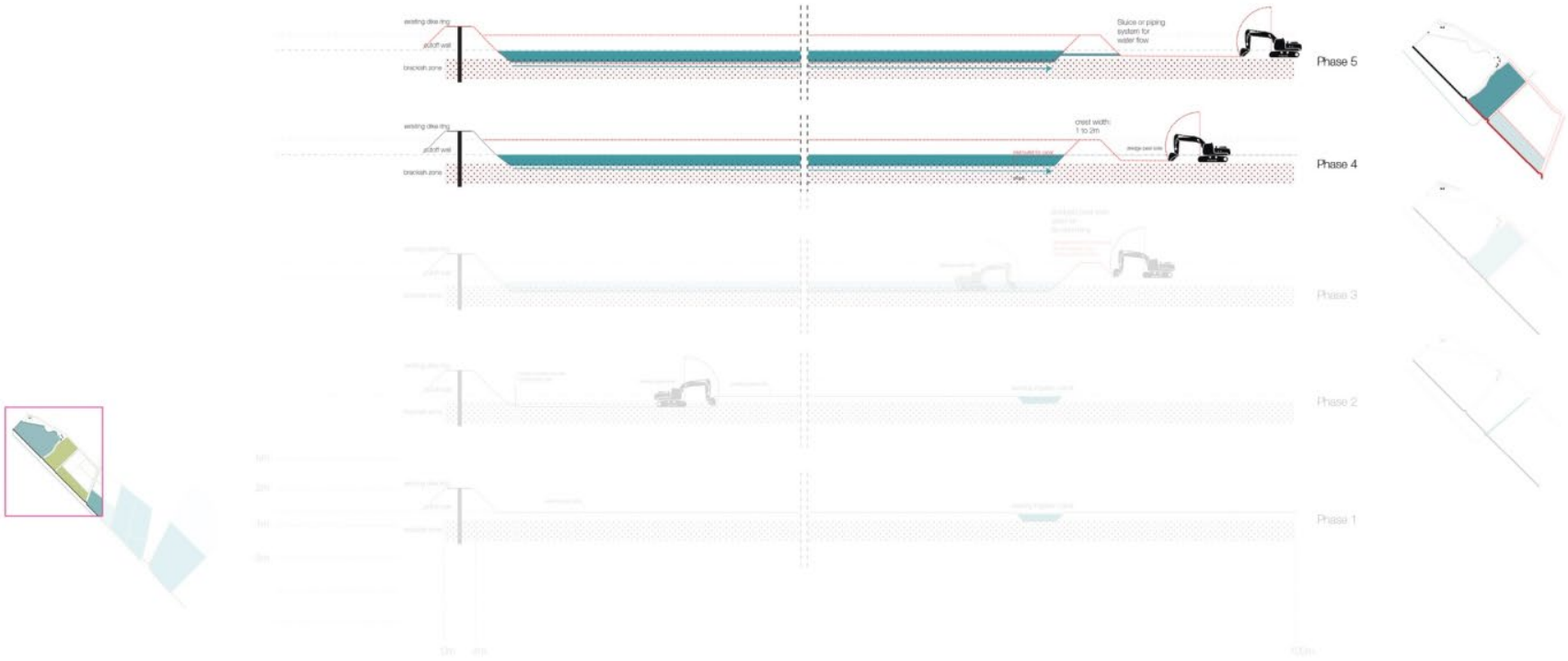
Micro-scale
Scenario 3: **Steps I Infrastructure plans**

[Fig. 32b] Depoldering evolution [former agricultural land]



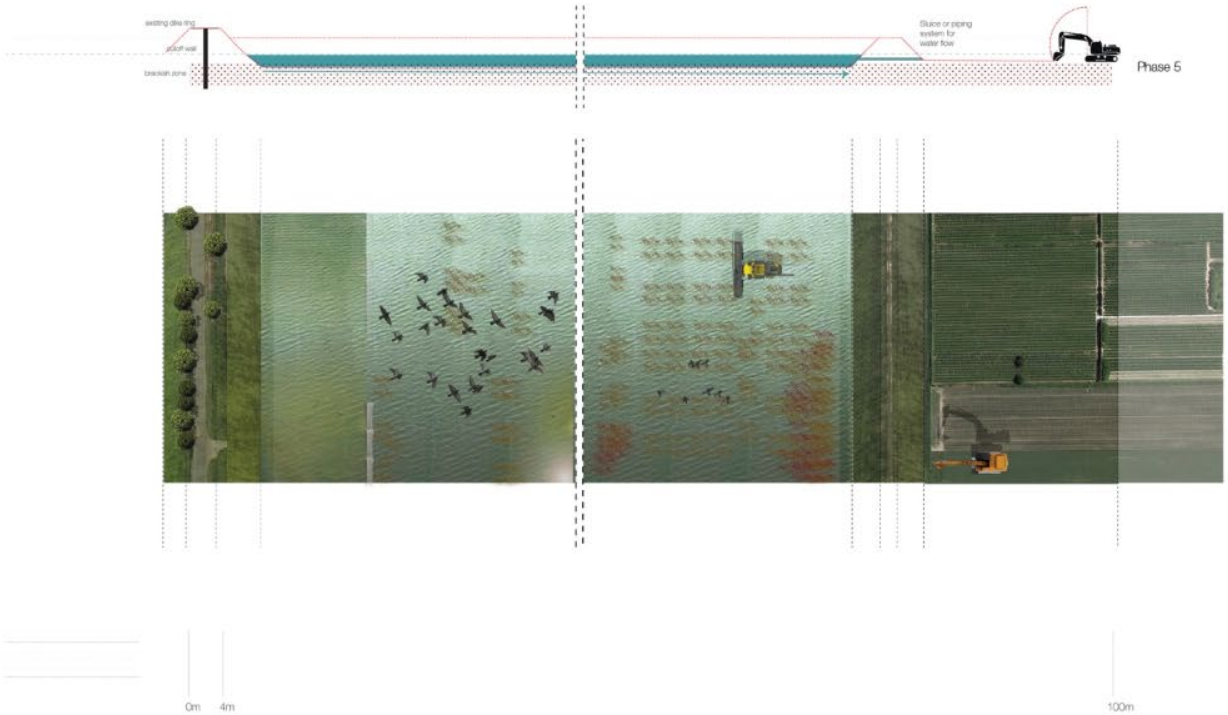
Micro-scale
Scenario 3: **Steps I Infrastructure plans**

[Fig. 32c] Depoldering evolution [former agricultural land]



Micro-scale
Scenario 3: **Steps I Infrastructure plans**

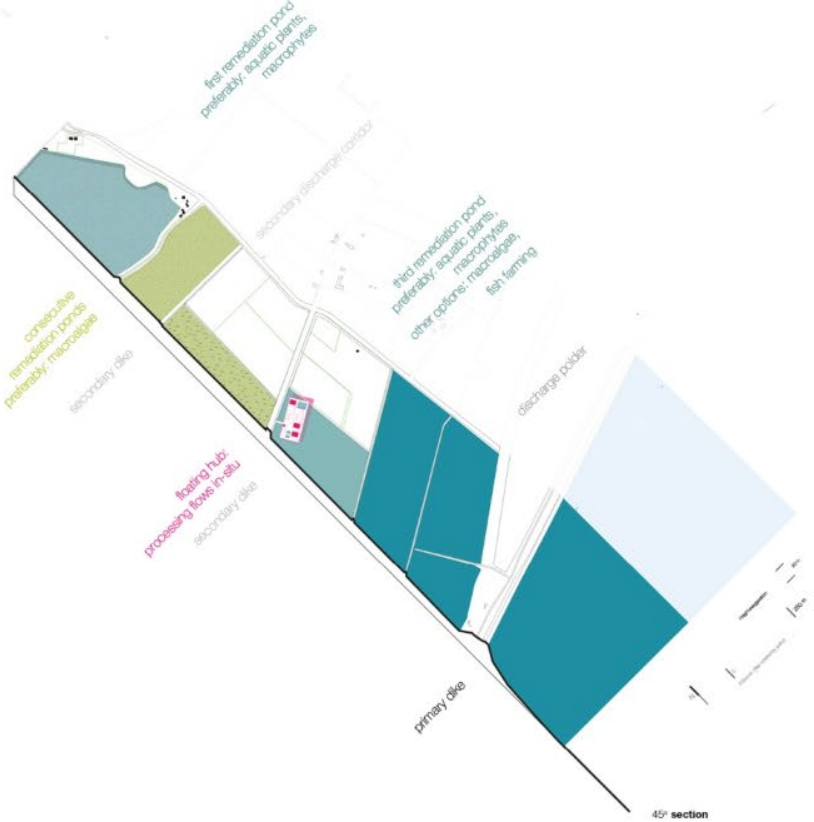
[Fig. 32d] Depoldering evolution [former agricultural land]-visual impact



Micro-scale
Scenario 3: **Steps**

Step 5 [part 1]

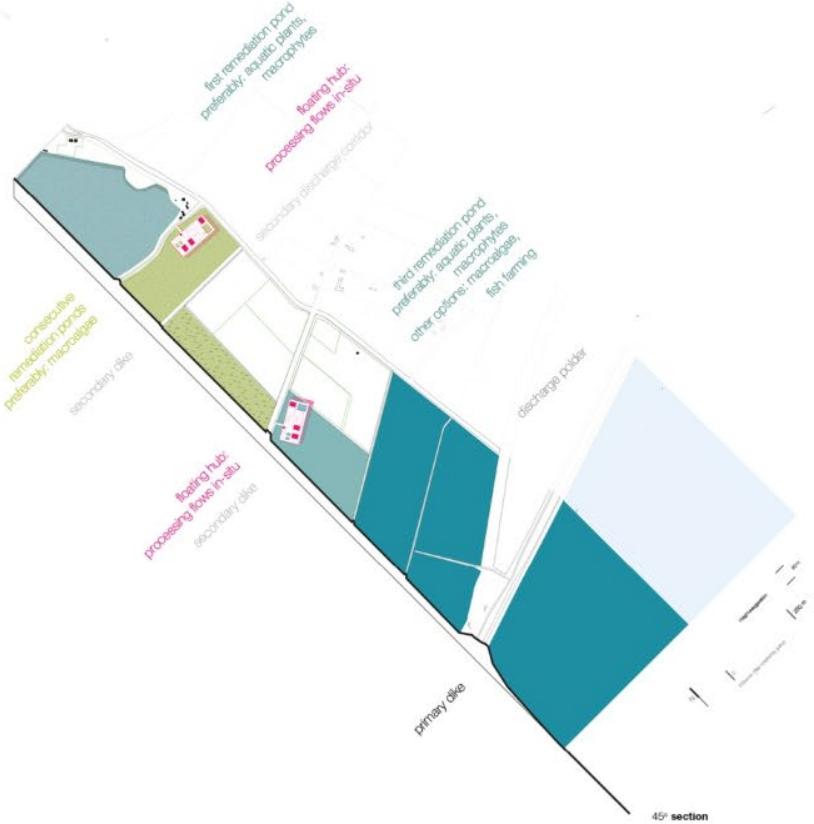
(5) Floating hubs
[processing facilities]



Micro-scale
Scenario 3: **Steps**

Step 5 [part 2]

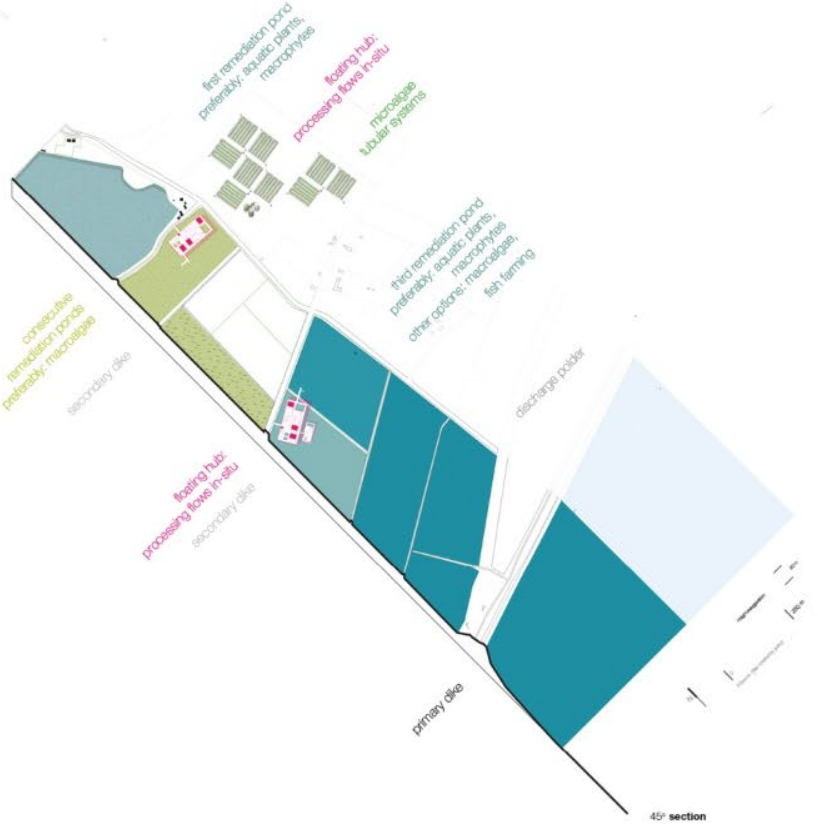
(5) Floating hubs expansion [processing facilities]



Micro-scale
Scenario 3: **Steps**

Step 6

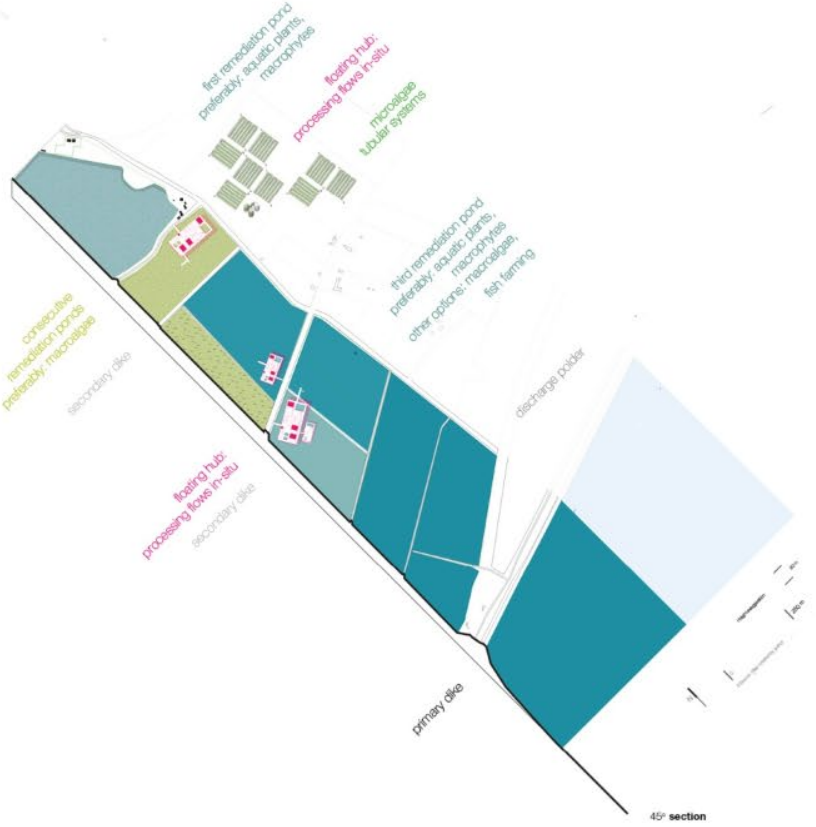
(6) Microalgae crops
[enclosed tubular systems]



Micro-scale
Scenario 3: **Steps**

Step 7

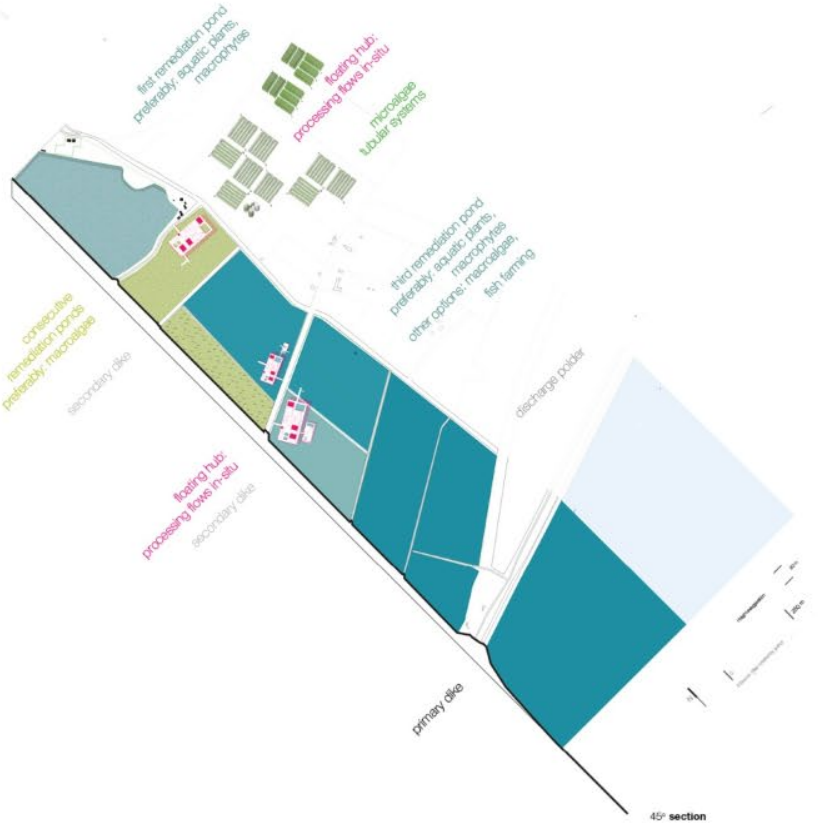
(7) Expansion of hubs and ponds



Micro-scale
Scenario 3: **Steps**

Step 8

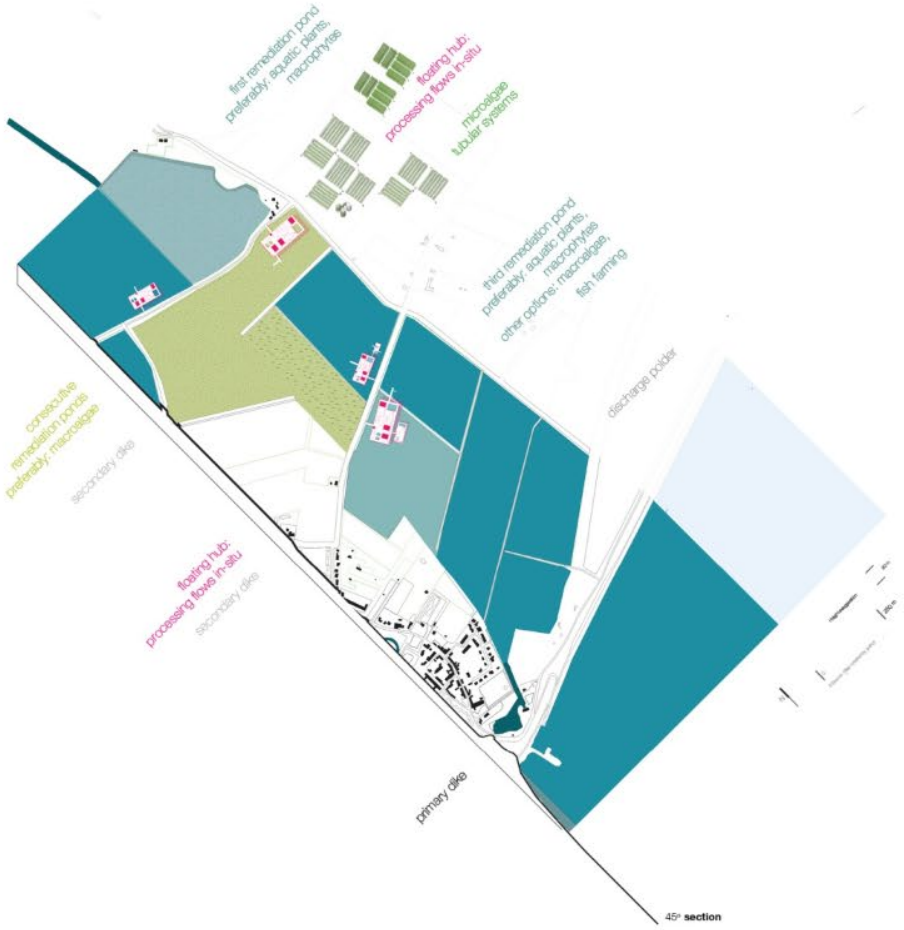
(8) Expansion of hubs and algae crops



Micro-scale
Scenario 3: **Steps**

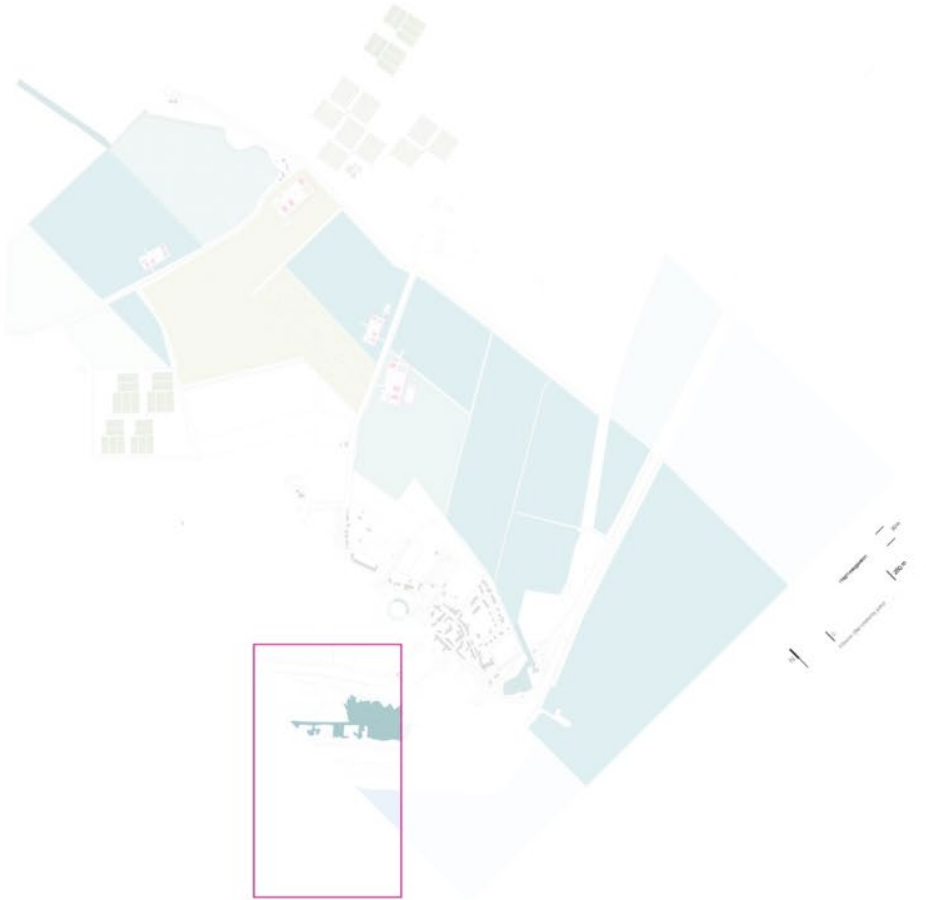
Step 9

(9) Systems expansion



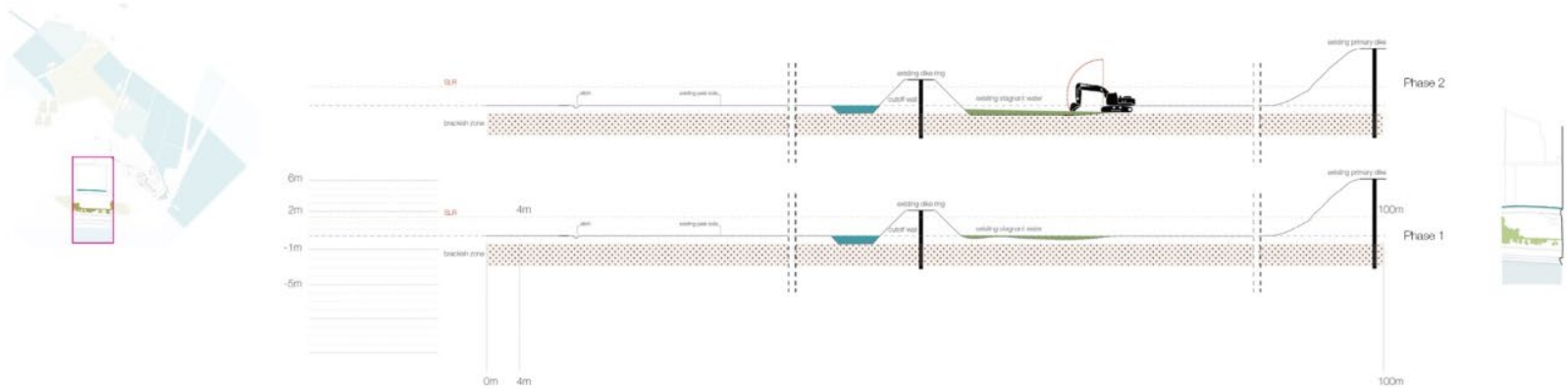
Micro-scale
Scenario 3: **Overview**

Micro-scale
Scenario 3: **Overview**



Micro-scale
Scenario 3: **Overview I Infrastructure plans**

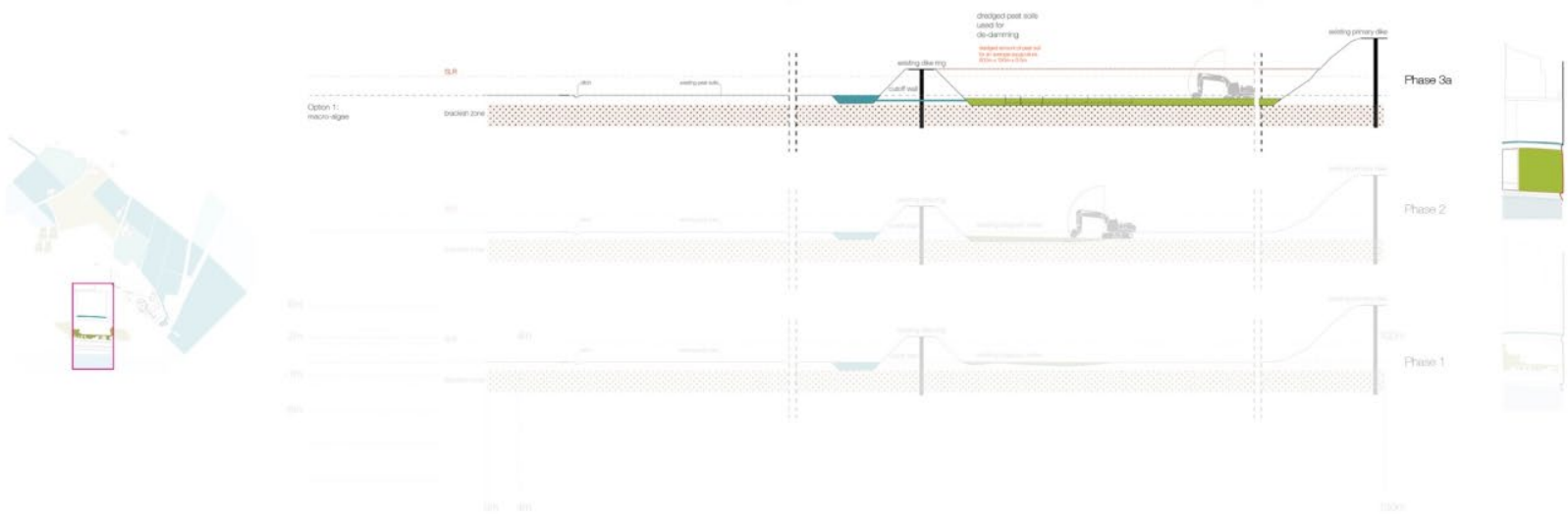
[Fig. 33a] Depoldering evolution [area currently not pumped]



Micro-scale

Scenario 3: **Overview I Infrastructure plans**

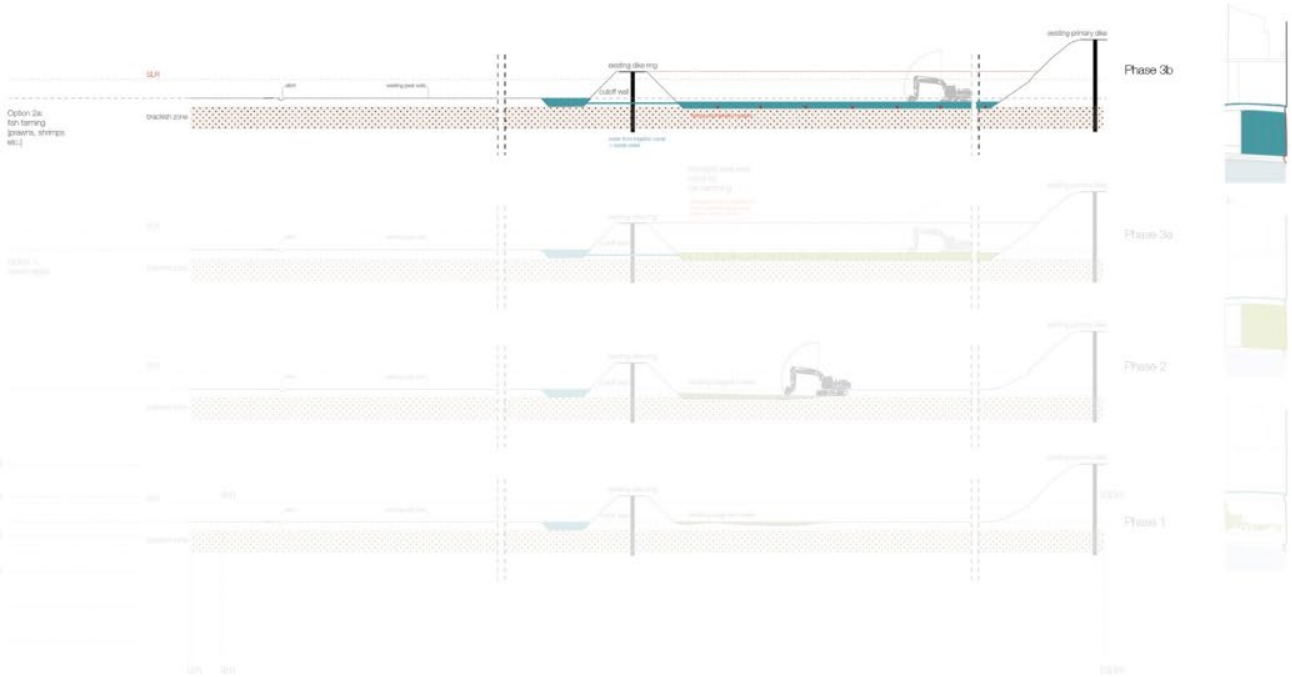
[Fig. 33a] Depoldering evolution [area currently not pumped]



Micro-scale

Scenario 3: **Overview I Infrastructure plans**

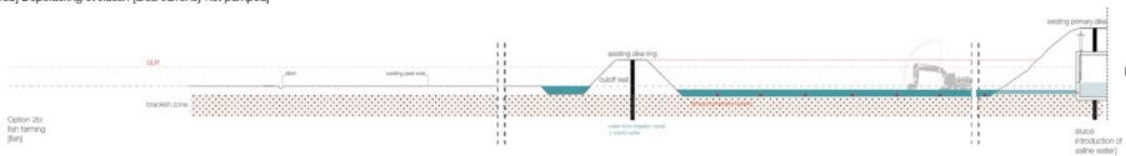
[Fig. 33b] Depoldering evolution [area currently not pumped]



Micro-scale

Scenario 3: **Overview I Infrastructure plans**

[Fig. 33b] Depoldering evolution [area currently not pumped]

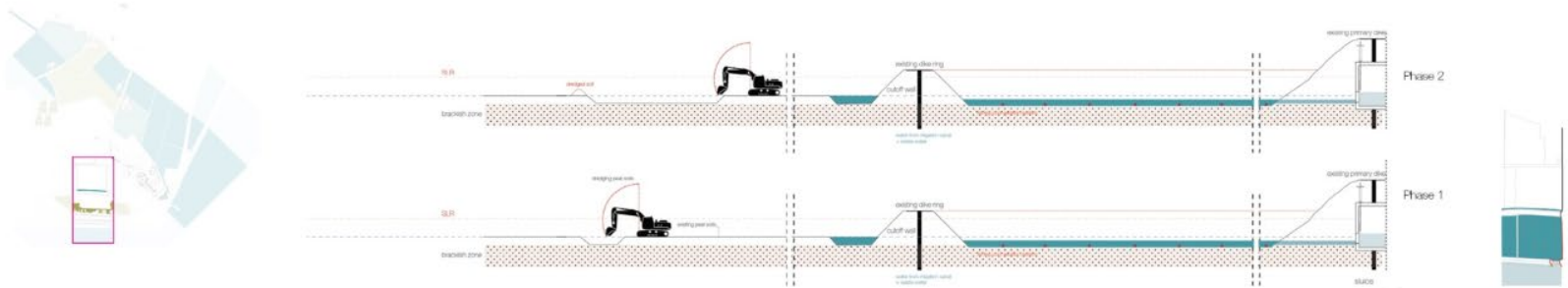


[Fig. 68] Depoldering evolution [area currently not pumped]

Micro-scale

Scenario 3: **Overview I Infrastructure plans**

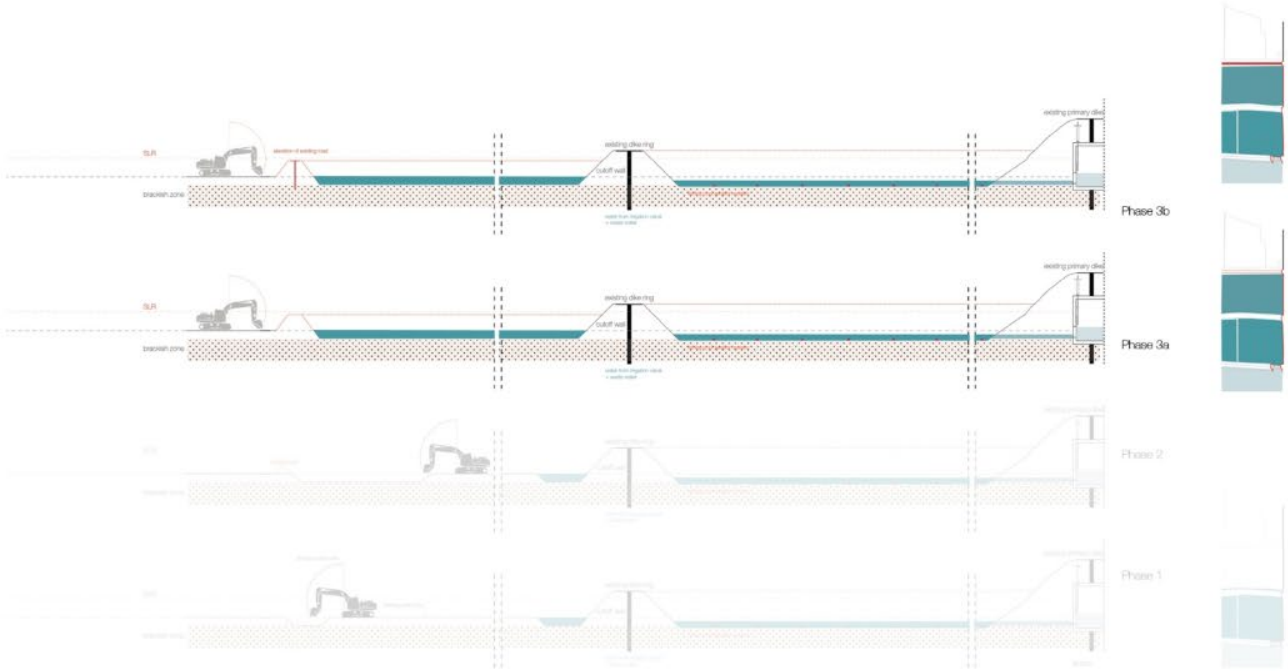
[Fig. 33c] Depoldering evolution + opening up the dike [area currently not pumped]



Micro-scale

Scenario 3: **Overview I Infrastructure plans**

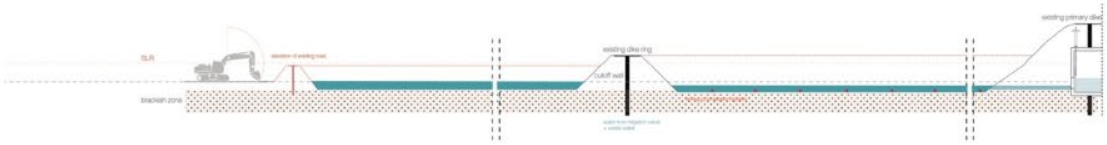
[Fig. 33c] Depoldering evolution + opening up the dike [area currently not pumped]



Micro-scale

Scenario 3: **Overview I Infrastructure plans**

[Fig. 33c] Depoldering evolution + opening up the dike [area currently not pumped]-visual impact

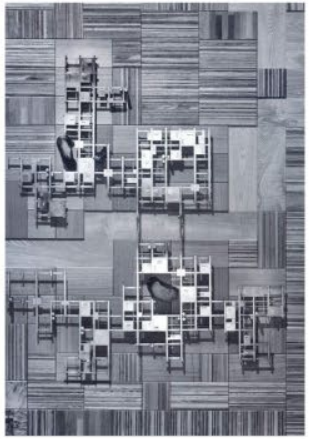


Phase 3b

0m 4m 100m

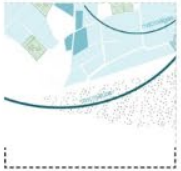
Micro-scale
Scenario 3: **Reference**

[Fig. 33a] Agricultural city (1960), Kisho Kurokawa



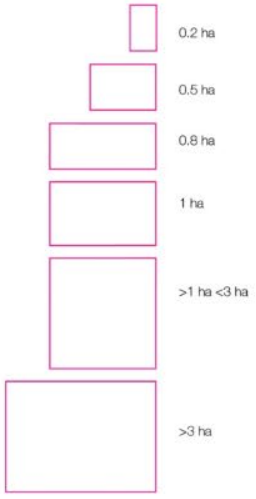
Source: goo.gl/ey52SB

Micro-scale
Scenario 3



Micro-scale

Scenario 3 - Reparcelation options



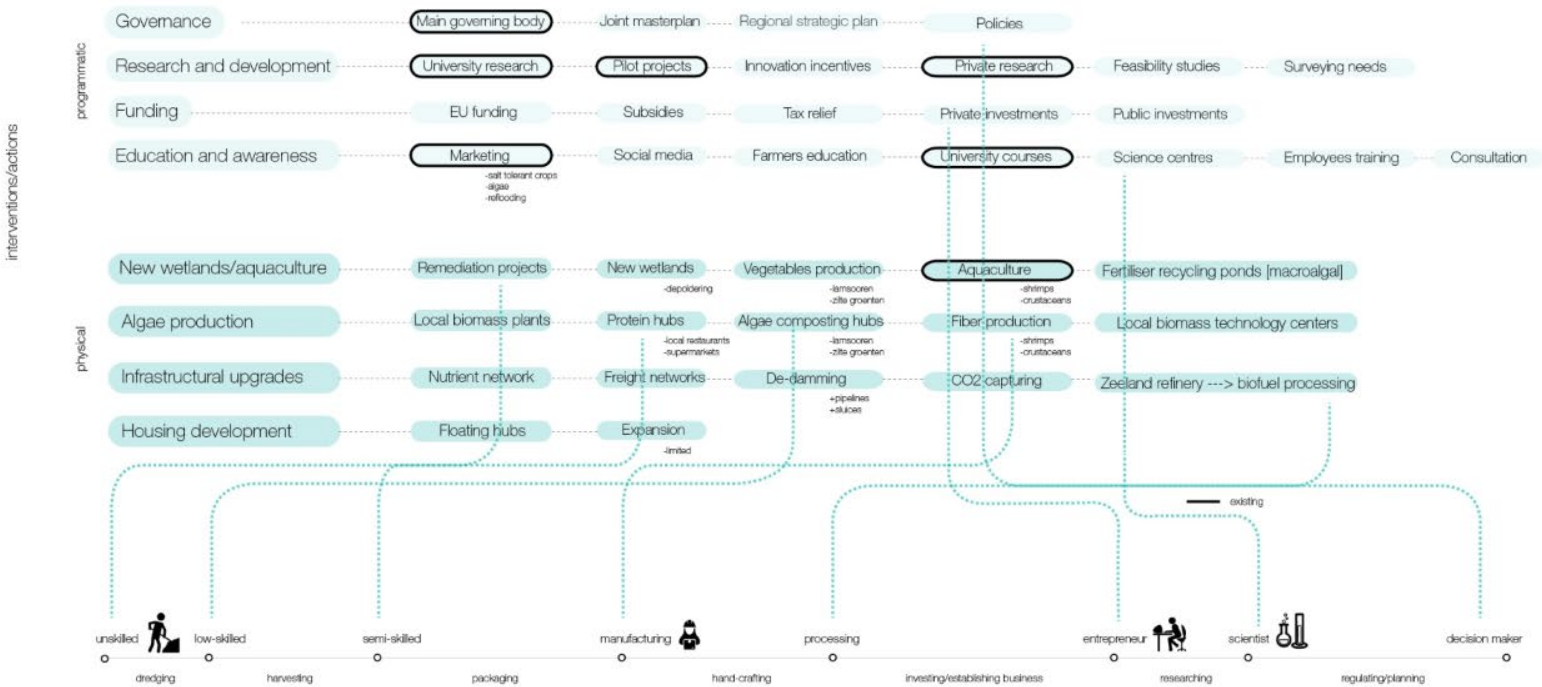
€5.000/ ha for paddle wheels [if applicable]

pond parcelation
Small to medium: 0.2ha -0.5ha -0.8ha -1ha
Large: >1ha <3ha
Extra large: >3ha

Governance

Transition in management [part 1]

[Fig. 34] Matrix showcasing the transition in management and the respective labour force transformation

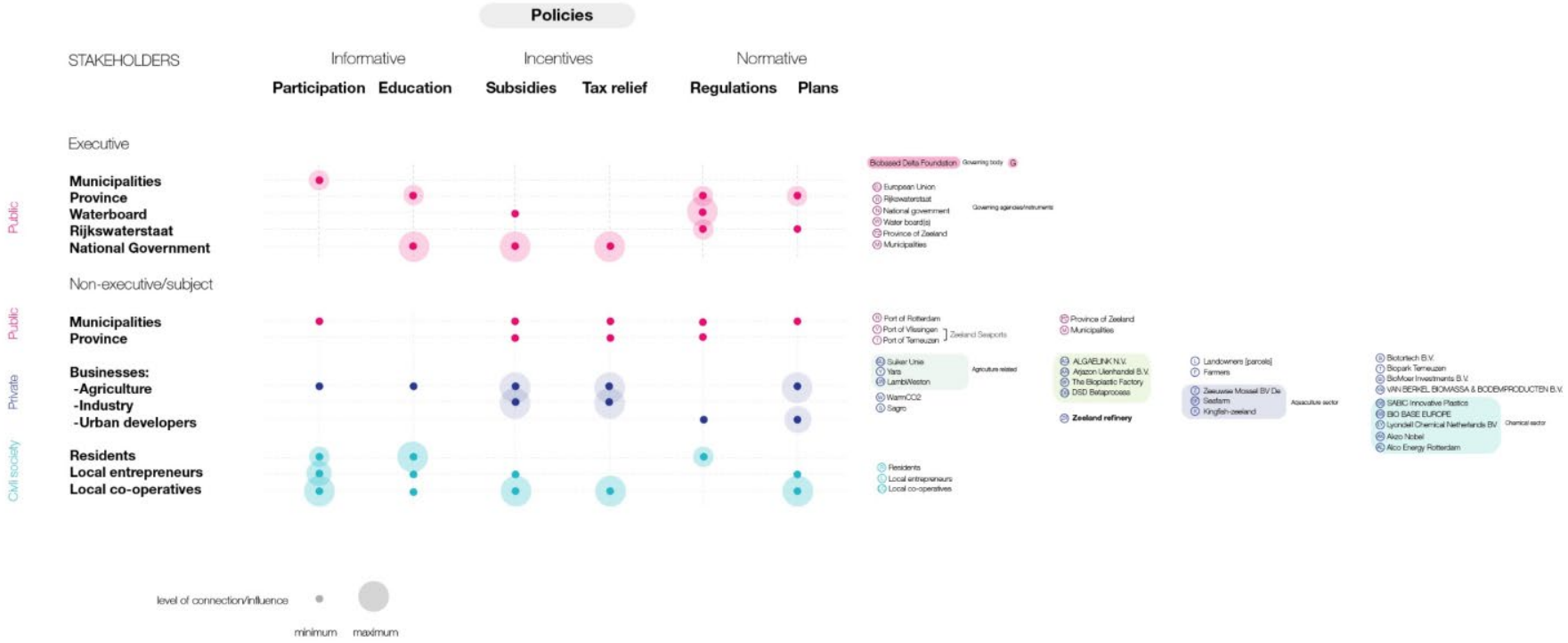


Source: Diagrams made by author

Governance

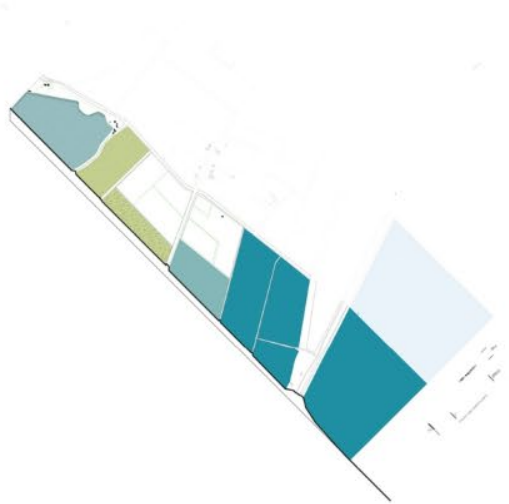
Transition in management [part 2]

[Fig. 35] Policies spectrum



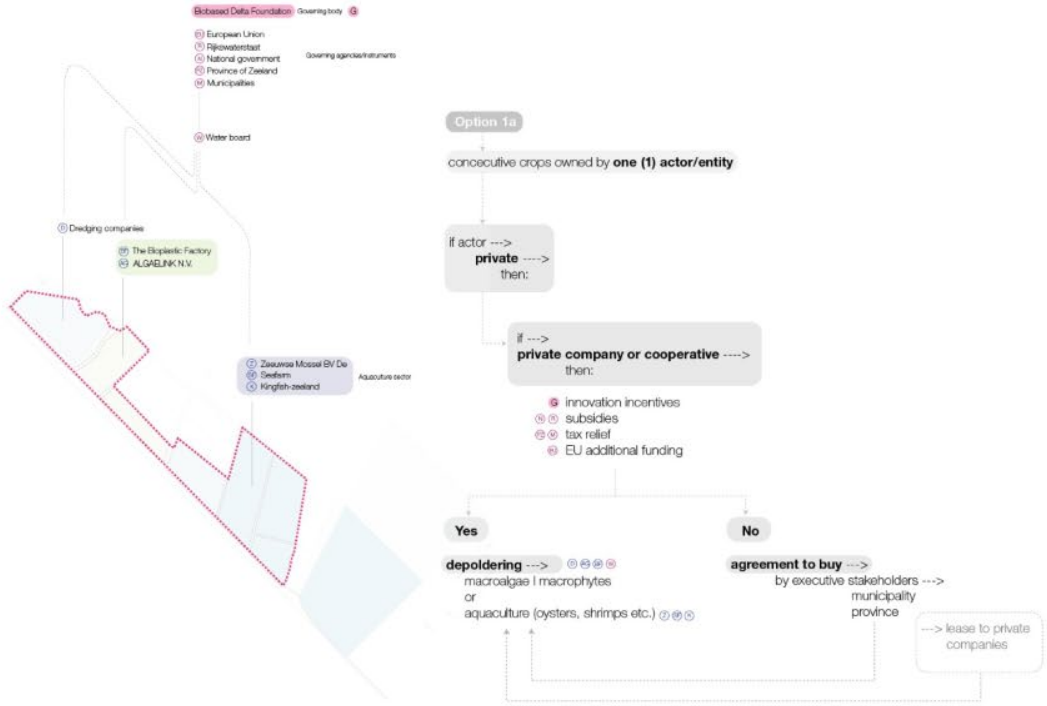
Source: Diagrams made by author

Governance
Model options



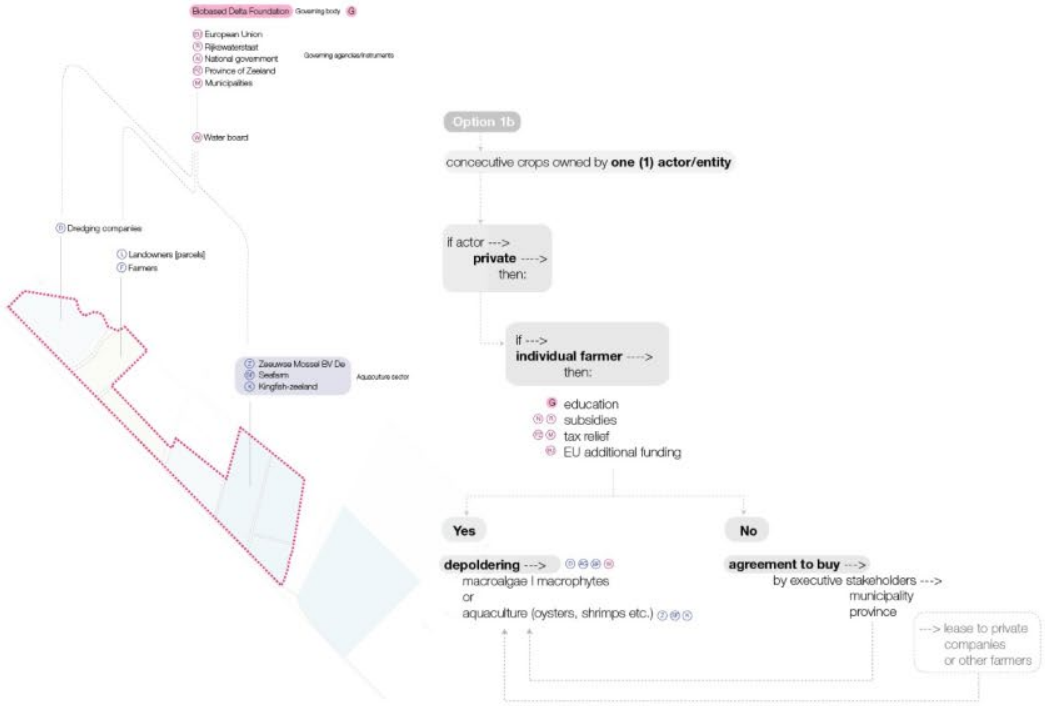
Source: Diagrams made by author

Governance
Option 1a



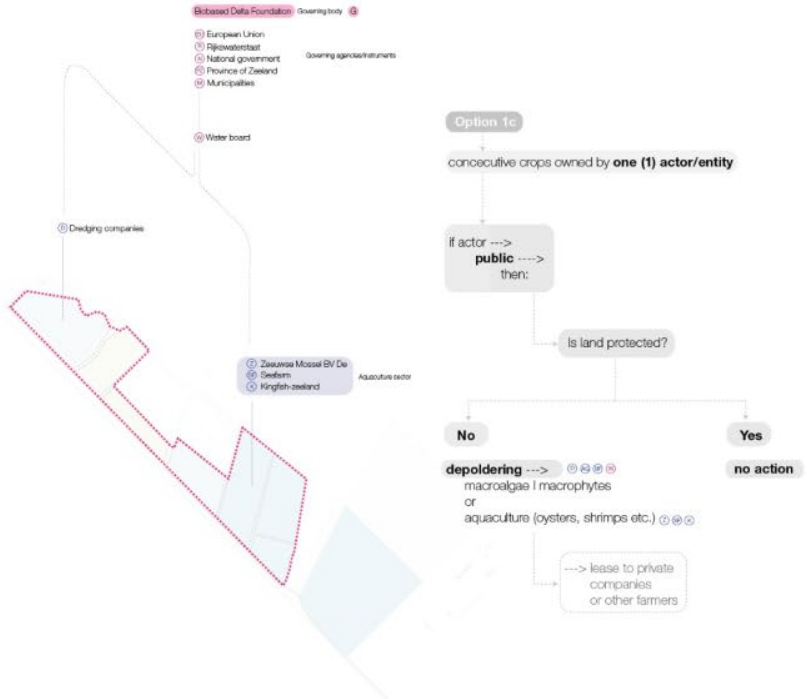
Source: Diagrams made by author

Governance
Option 1b



Source: Diagrams made by author

Governance
Option 1c

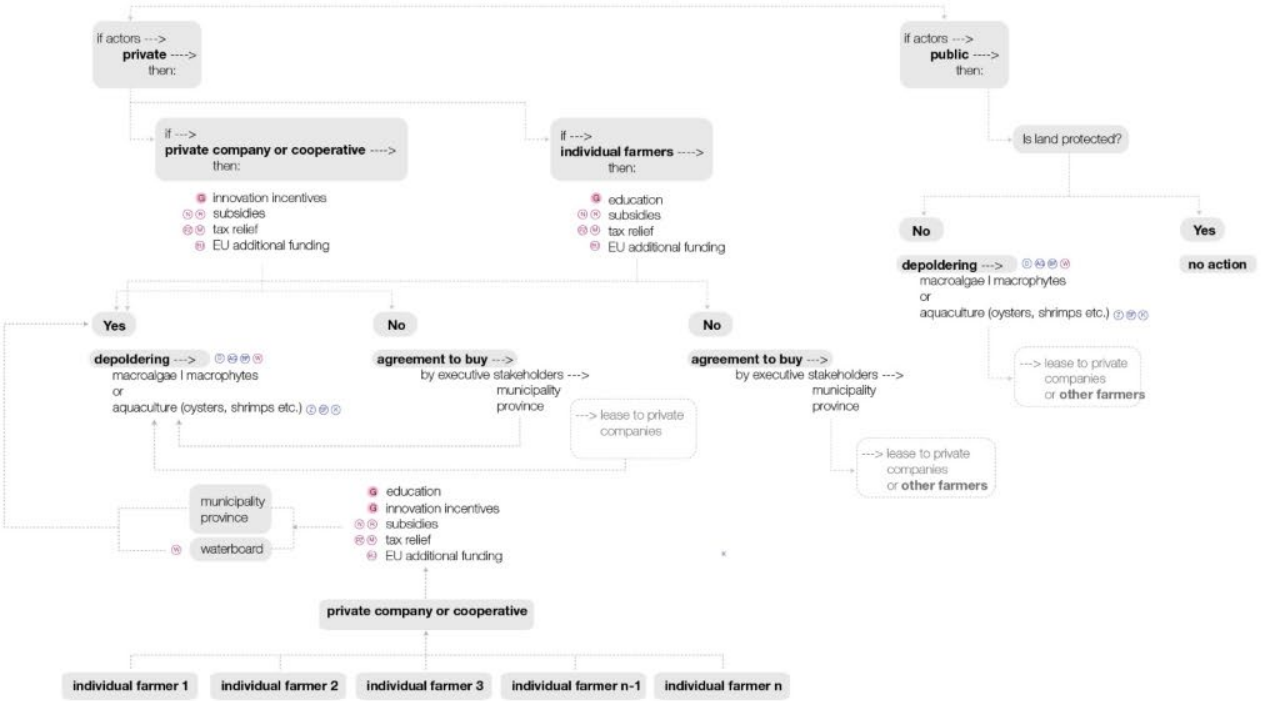


Source: Diagrams made by author

Governance
Option 2

Source: Diagrams made by author

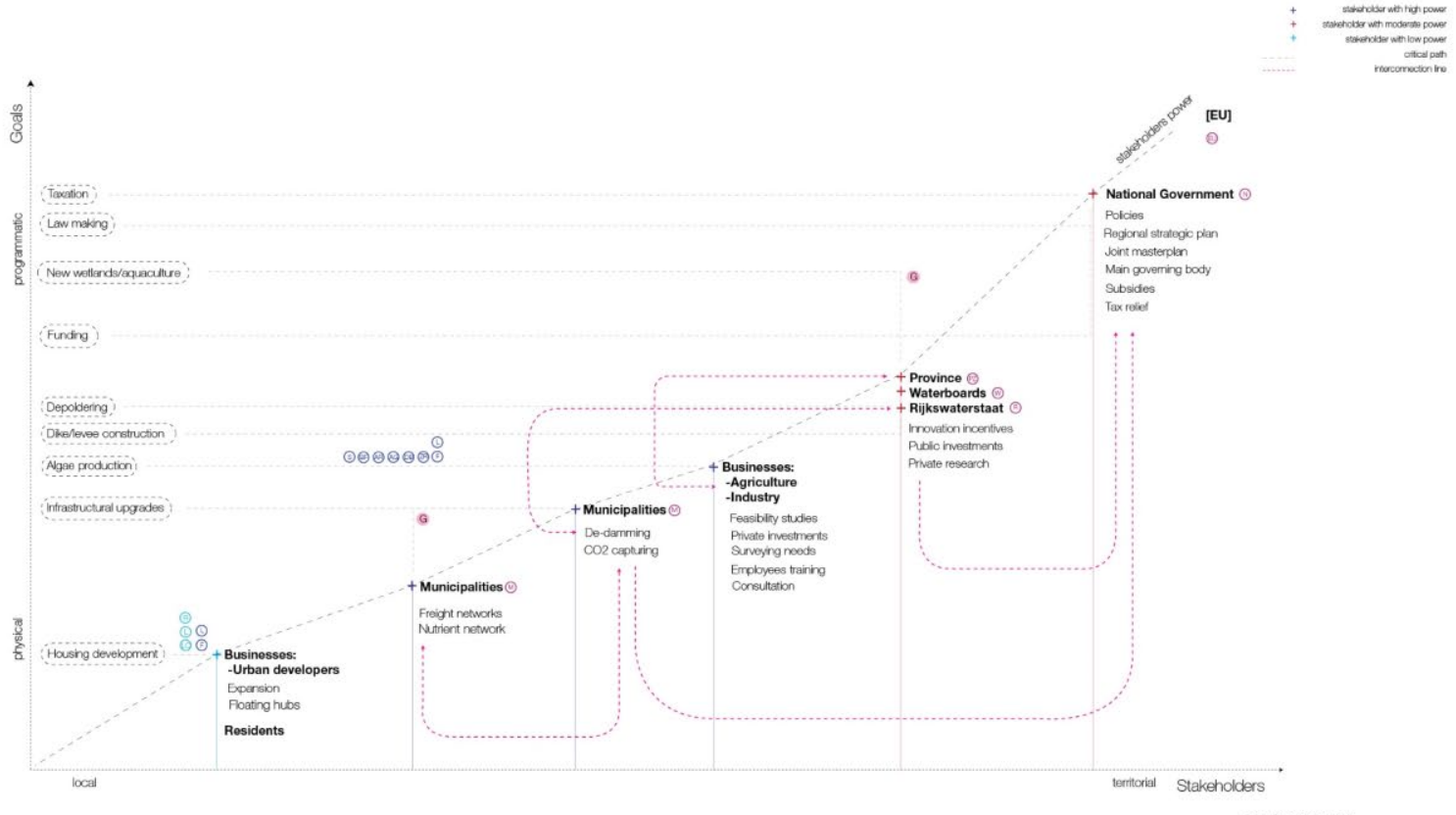
Triggering an emancipatory approach
Networks



Source: Diagrams made by author

Triggering an emancipatory approach

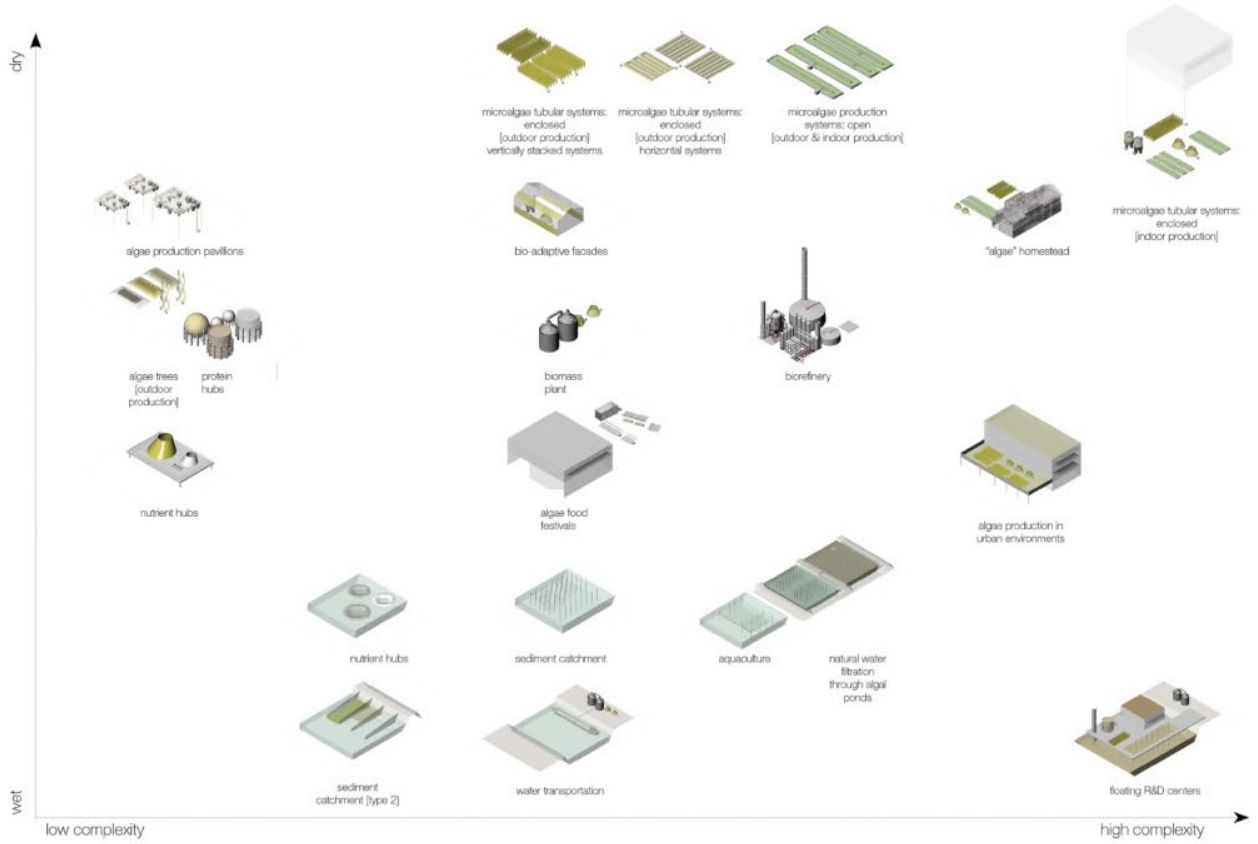
Stakeholders interrelation



Source: Diagrams made by author.

[Source: Diagram created by author.

From micro- to nano-scale
Typologies matrix



Nano-scale

Included typologies

[Fig. 36] Algae vineyards 16.00

Source: Diagrams made by author

Nano-scale

Included typologies

[Fig. 36] Algae vineyards 16.00

[Fig. 37] Algae vineyards 23.00

Source: Diagrams made by author

Nano-scale

[Fig. 38a] Existing

Source: Photo retrieved from Google Earth Pro.

[Fig. 38b] Zeeland proposed. Location: Vlissingen

[Fig. 39a] Existing

Source: Photo by author

[Fig. 39b] Zeeland proposed. Location: Vlissingen

Source: Diagrams made by author

Nano-scale

[Fig. 40a] Existing

Source: Photo by author.

[Fig. 40b] Zeeland proposed. Location: Vlissingen

[Fig. 41a] Existing

Source: Photo from Google Earth Pro.

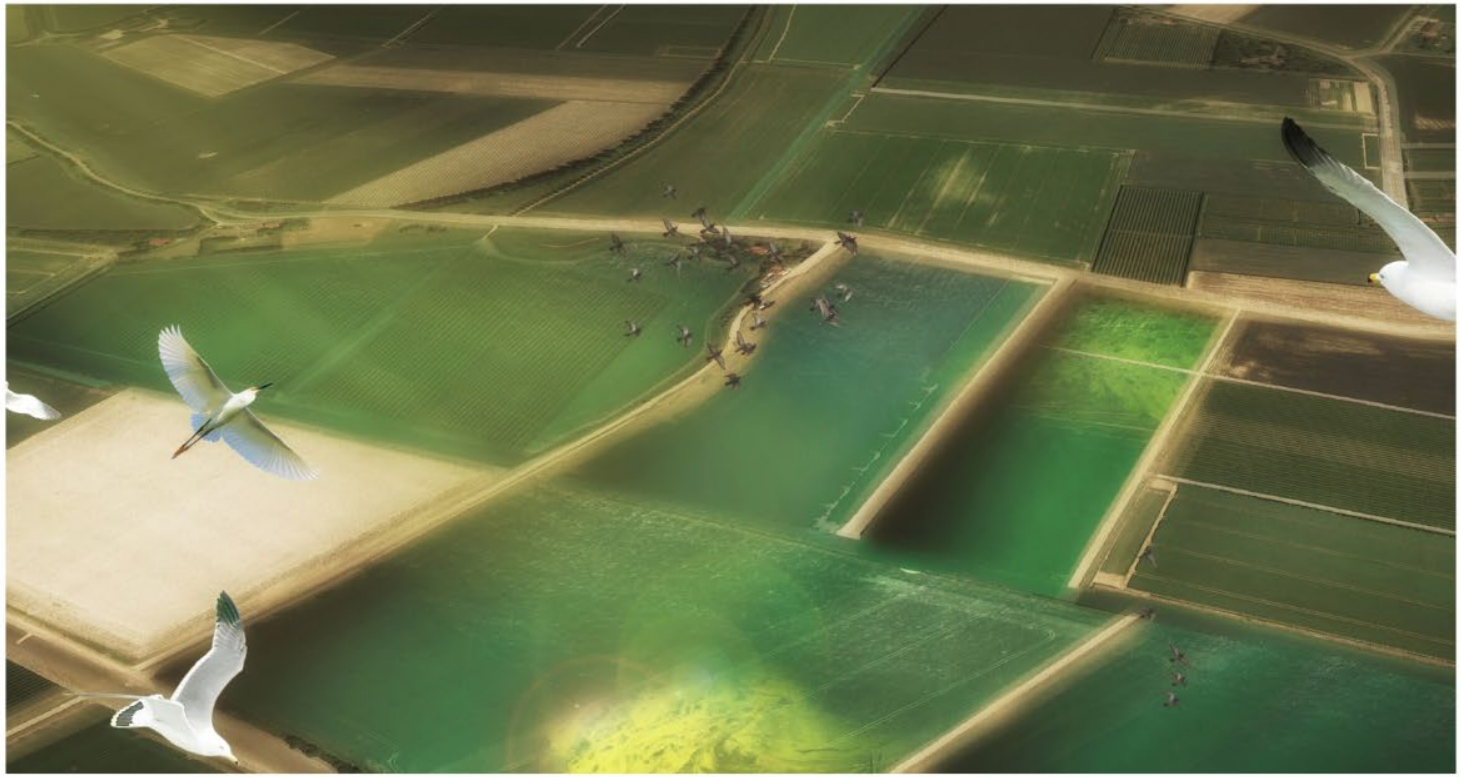
[Fig. 41b] Zeeland proposed. Location: Vlissingen port

Source: Diagrams made by author.

Nano-scale

Included typologies

[Fig. 42] Depoldered lands



Source: Diagrams made by author

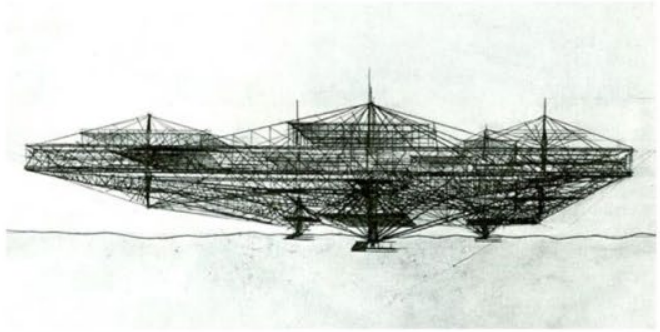
Nano-scale
Floating hubs

Nano-scale
Floating hubs: Reference

[Fig. 43] New Babylon model (1950), Constant Nieuwenhuys

‖ Source: goo.gl/ZUQG5

[Fig. 44] New Babylon sketch (1950), Constant Nieuwenhuys



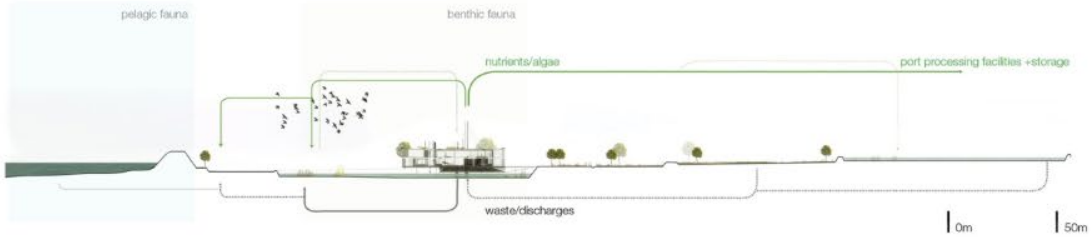
‖ Source: https://veredes.es/blog/en/constant-la-utopia-cobra-vida-miguel-lacasta-codorniu/

Nano-scale
Floating hub

[Fig. 45] Existing situation

[Fig. 46] 80cm Sea Level Rise

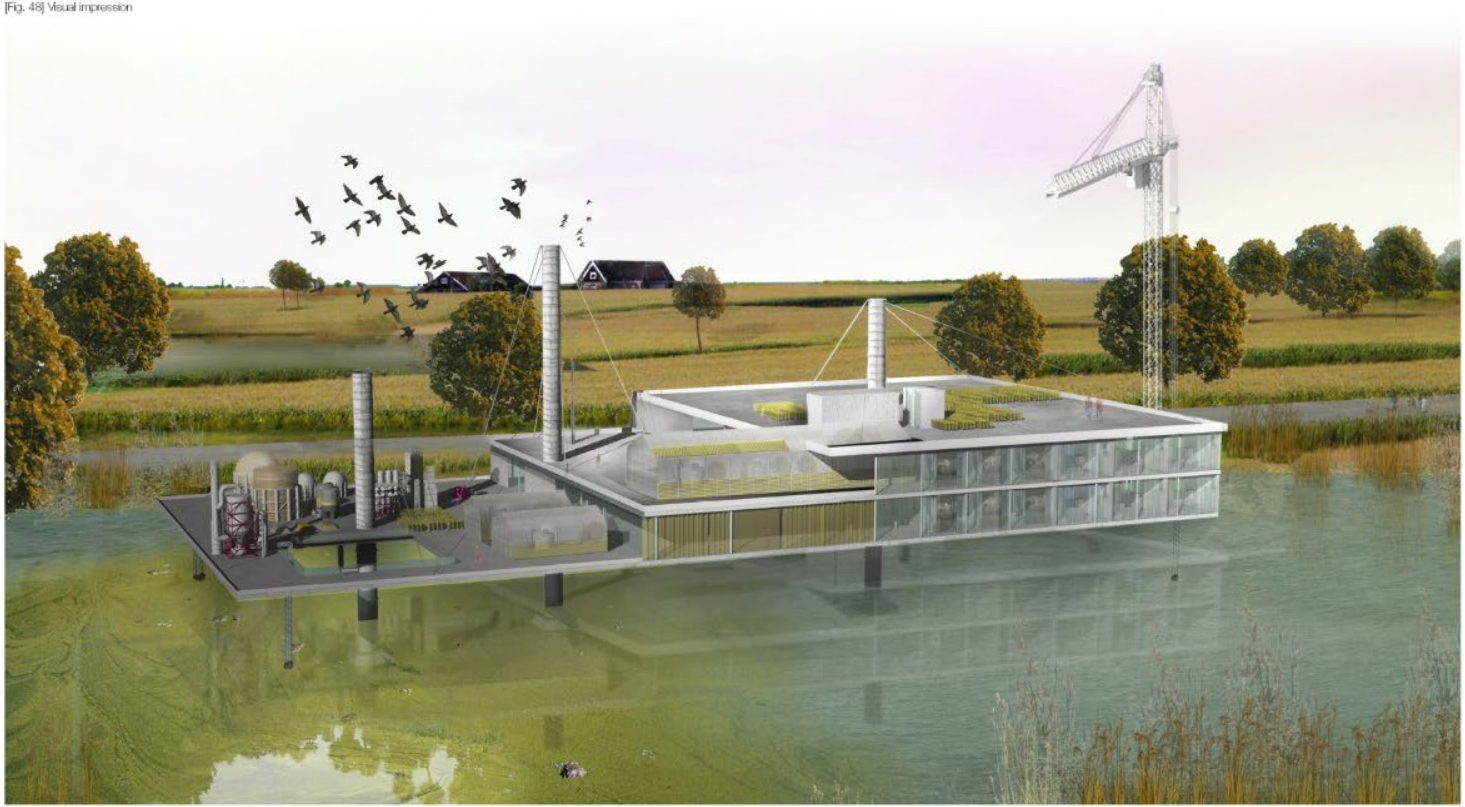
[Fig. 47] Hub section



Source: Diagrams made by author

Nano-scale
Floating hub

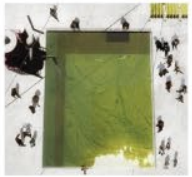
[Fig. 48] Visual impression



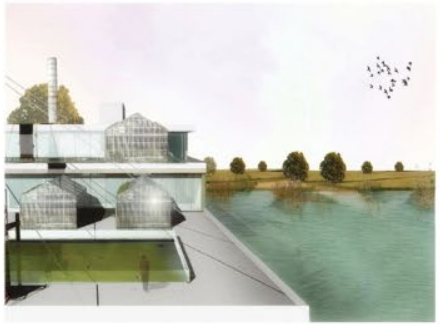
Source: Diagrams made by author

Nano-scale
Floating hub

[Fig. 49] Algae collection point



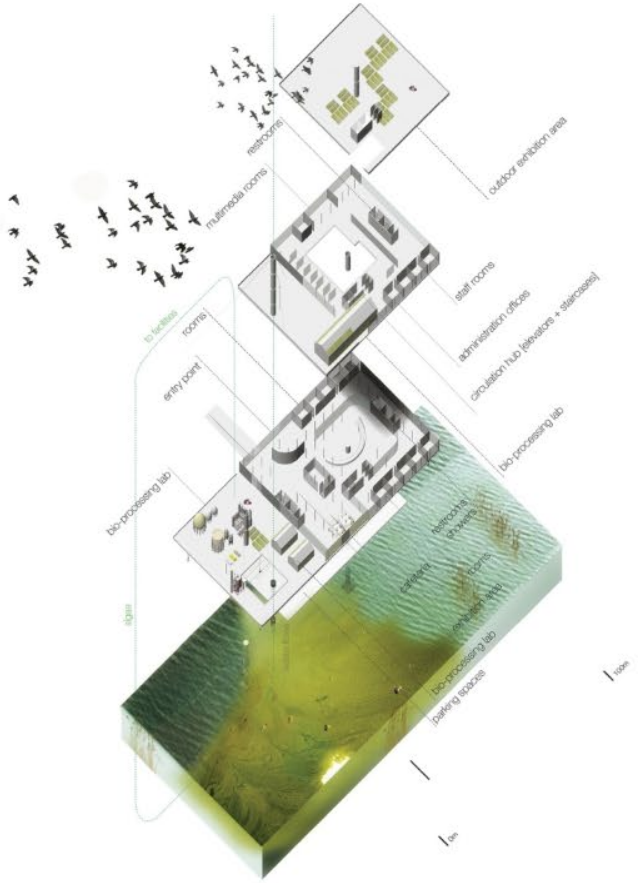
[Fig. 51] Exterior view



[Fig. 50] Algae exhibition area

Source: Diagrams made by author

Nano-scale
Floating hub exploded

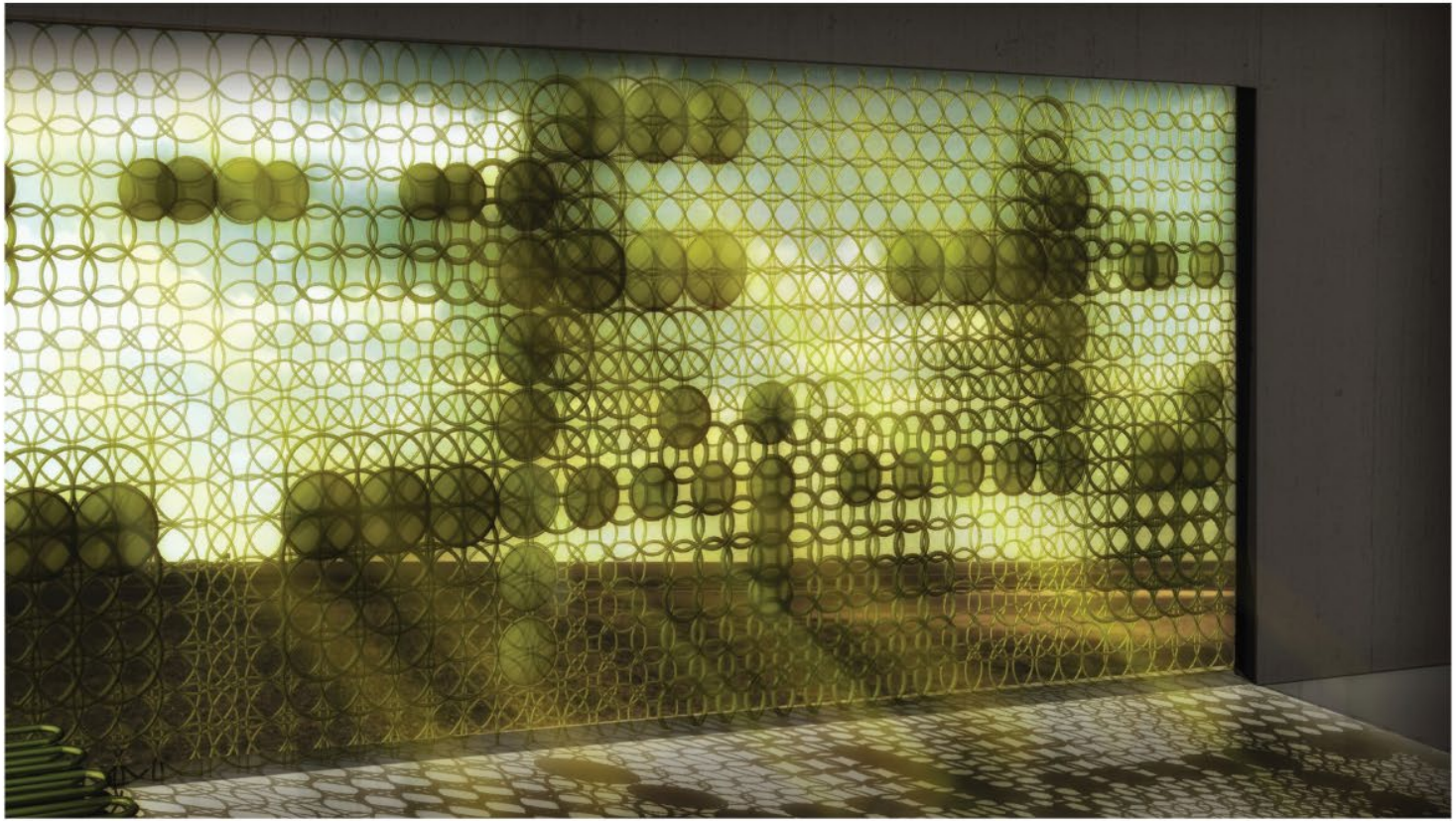


Source: Diagrams made by author

Ultra Nano-scale

Included typologies

[Fig. 52] Bioadaptive facade



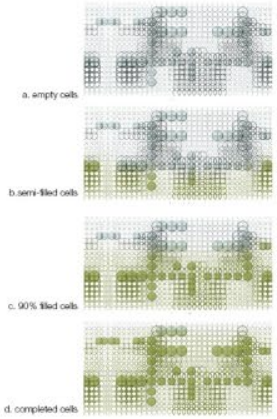
Source: Diagrams made by author

Ultra Nano-scale

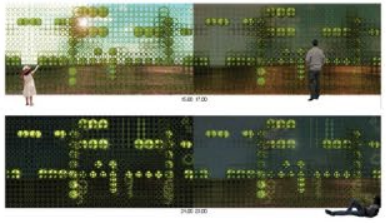
The new "body"

Included typologies

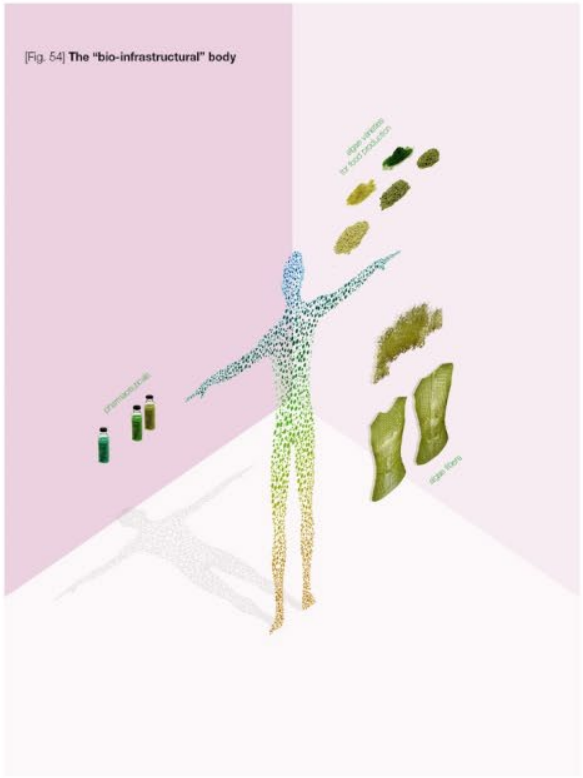
[Fig. 53] Filling cells process



[Fig. 96] Facade throughout the day



[Fig. 54] **The "bio-infrastructural" body**



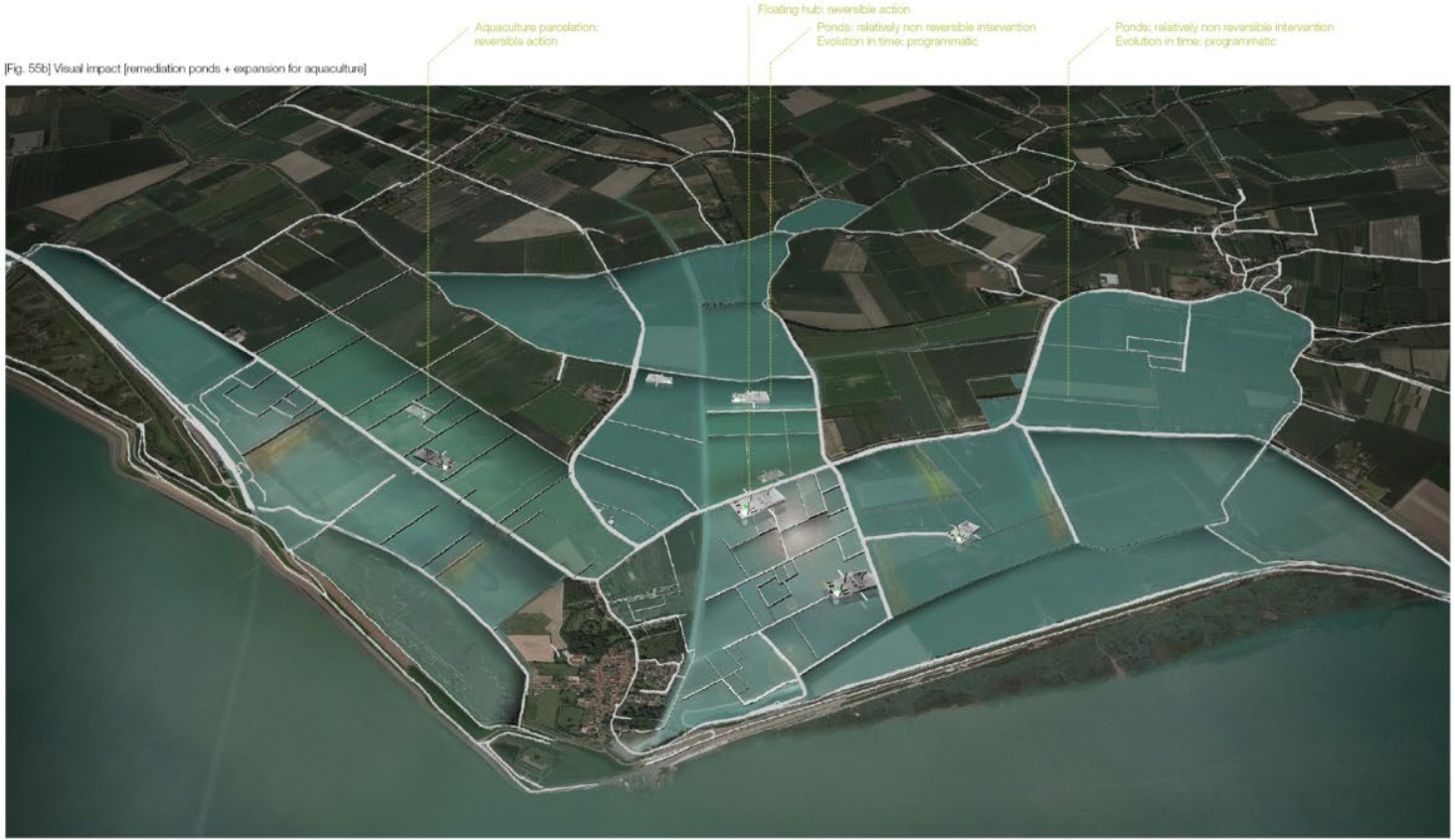
Source: Diagrams made by author

Upscaling
From nano- to meso-scale

[Fig. 55a] Visual impact [remediation ponds]

Upscaling
From nano- to meso-scale

[Fig. 55b] Visual impact [remediation ponds + expansion for aquaculture]



Upscaling
From nano- to meso-scale

[Fig. 55c] Visual impact [Scenario 3 completed]

Upscaling

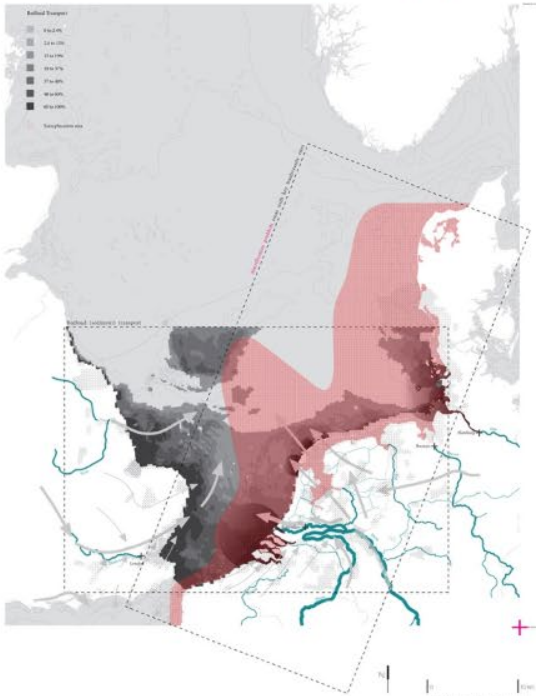
From meso- to macro-scale

[Fig. 55d] Macro scale

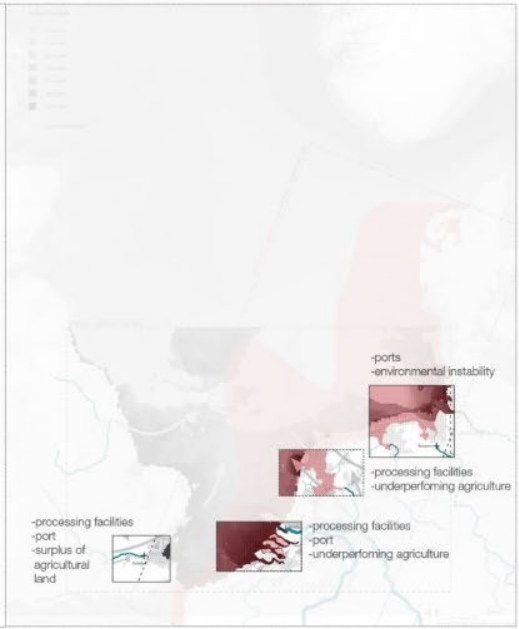
Source: Diagrams made by author

Upscaling
From the Delta to the North Sea

[Fig. 2b] Areas of the North Sea threatened by harmful algal bloom [HAB]



[Fig. 48] Key areas of the North Sea suitable for biobased economy



Upscaling
Transferability matrix

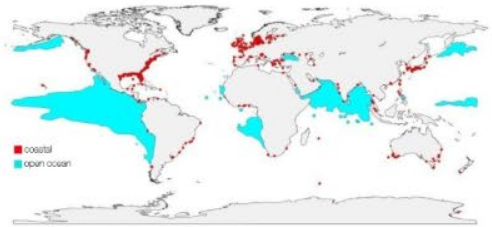
Interventions/actions \ Problems	port facilities in need of repurposing	underperforming crops/ soil salinisation	environmental instability	eutrophication	surplus of agricultural land
Governance	normative policies: plans for biobased activities enhancement incentive policies: subsidies for companies establishment	incentive schemes for new types of crops	-	-	incentive schemes for new types of use or urban expansion
Research and development	-	-	assessment of flora and fauna decrease	monitoring [GIS] aassessment of nitrogen and phoshphorus surplus	-
Funding	-	subsidies/tax relief for new types of crops [salt-tolorant]	-	-	-
Education and awareness	-	-	-	-	-
New wetlands/aquaculture	-	macroalgal ponds 	macrophyte ponds 		incentive schemes for watland establishment/ aquaculture
Algae production	enclosed tubular systems [microalgae] algae trees 	enclosed tubular systems [microalgae] macroalgal ponds 	macroalgal ponds 	consecutive remediation ponds	enclosed tubular systems [microalgae] 
Infrastructural upgrades	biomass plants technology centers processing facilities for biobased products 	de-damming sluices	-	nutrient network algae collections algae compost facilities	-
Housing development	-	incentive schemes for new types of urban expansion [proposed type: floating hubs]	-	-	incentive schemes for new types of urban expansion [proposed type: floating hubs]

Source: Diagrams made by author

Across time and scales

‖ Source [gif]: Brut Nature, https://www.facebook.com/brutnature/videos/2471644639173874/

[Fig. 49] Low oxygen zones



‖ Source: UN Intergovernmental Oceanographic Commission GO2NE working group

Across time and scales

XL

L

M

S

Source: Diagrams made by author.