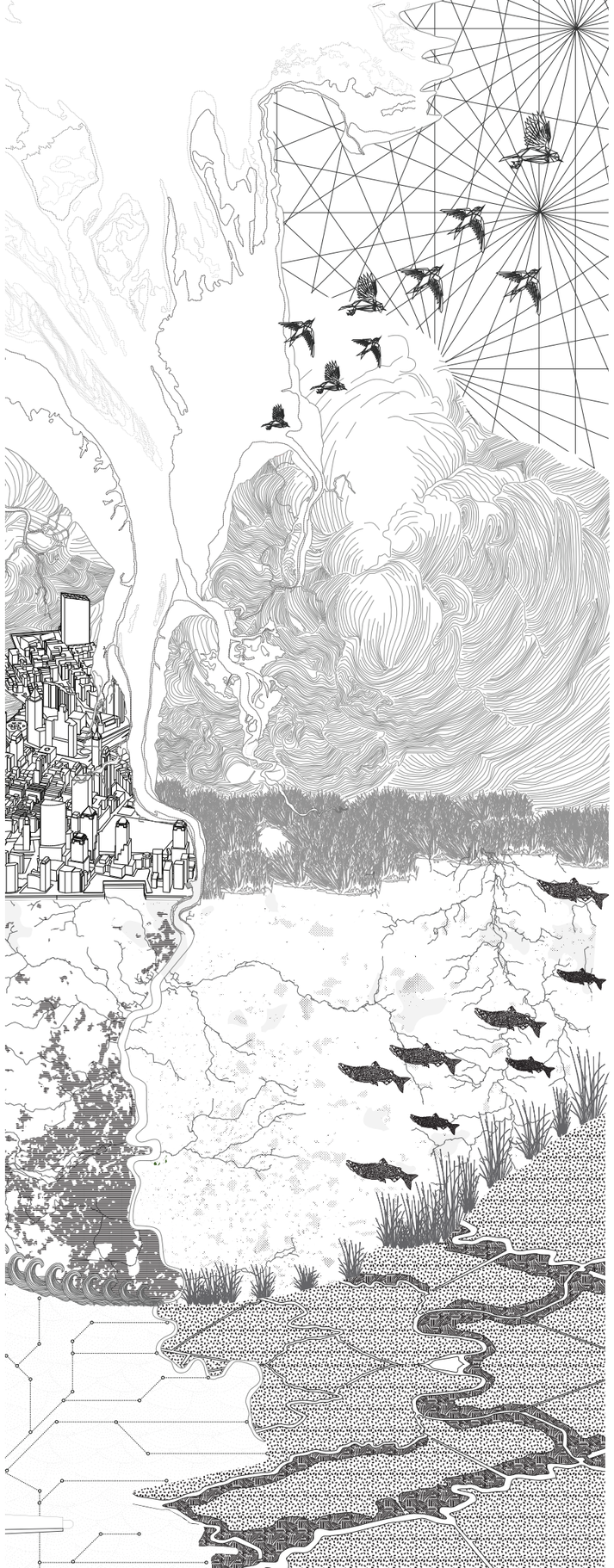


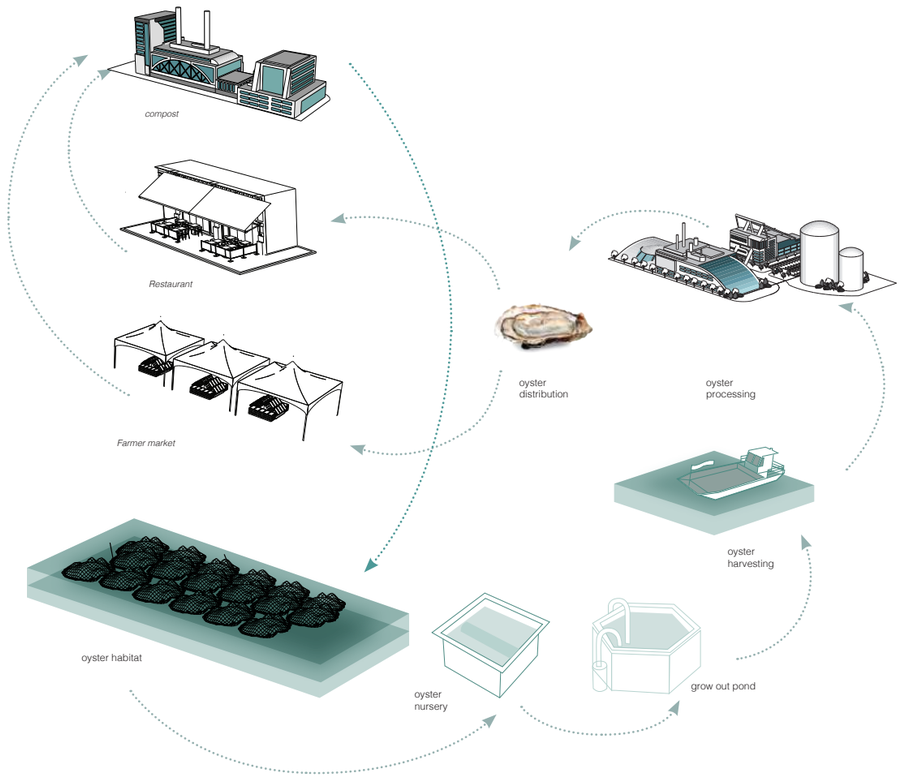
Reversed Risk

Protective productive cycle based on tidal force in estuarine territories

Author:
Alexandra M. Farmazon
student number - 4597680

Supervisors:
Dr. ir. T. Kuzniecow Bacchin
Dr. Diego Andres Sepulveda Carmona

P2 Report
January, 2018



Problem field
1. Disjunctive global context - climate vulnerability

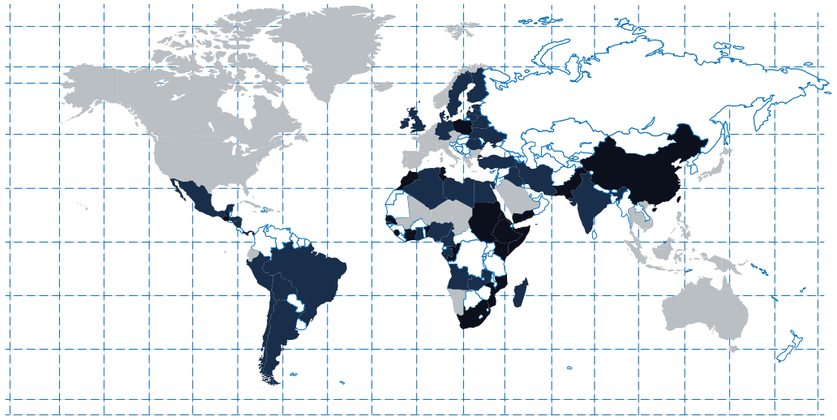
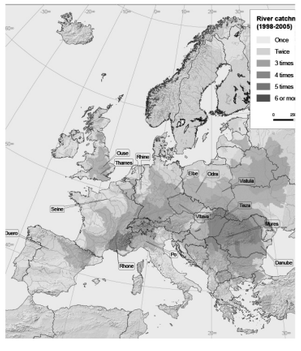
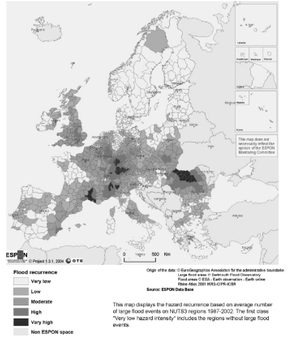


fig.18. Potential environmental impact of climate change

fig.19. Potential economic impact of climate change

fig.20. Sea level rise tendency





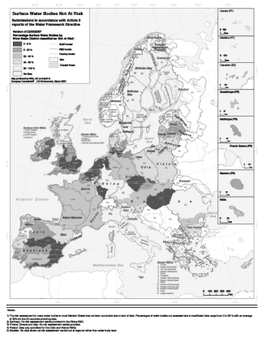


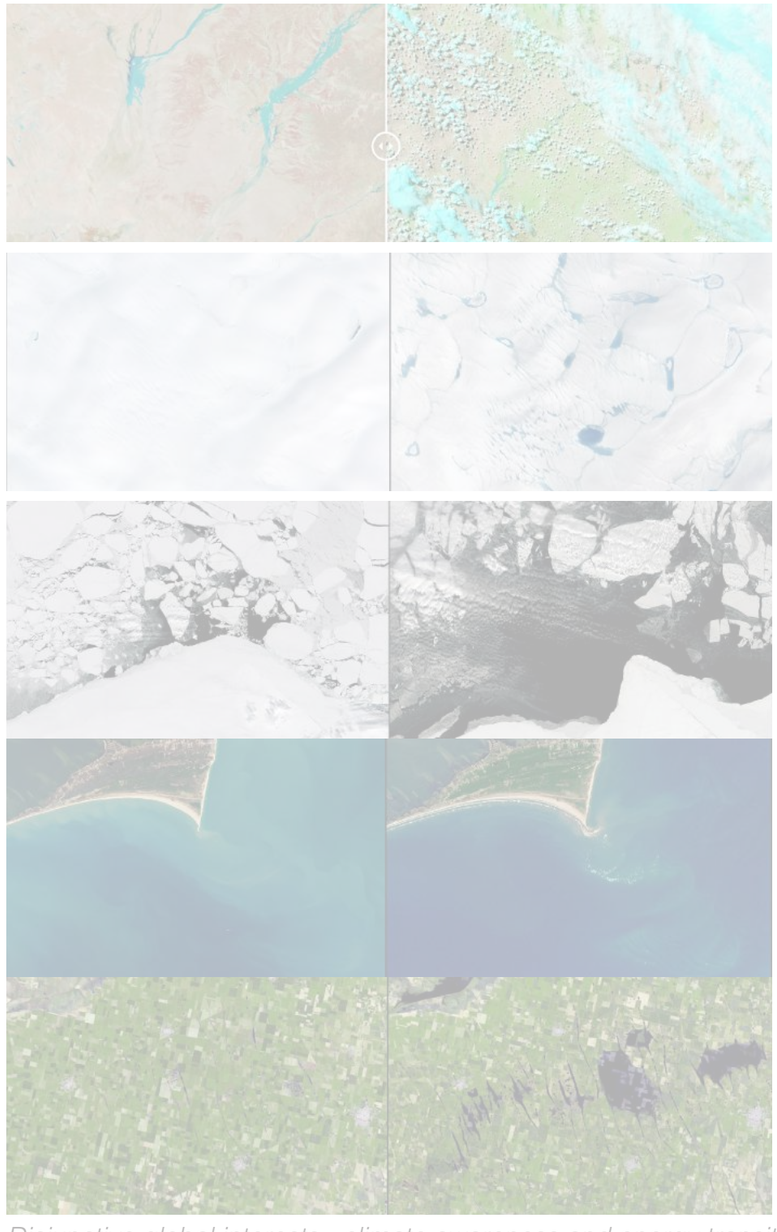
fig.21. River catchments affected by flooding

fig.22. Flood recurrence

fig.23. Surface water bodies not at risk

Problem field
1. Disjunctive global interests - global impact

Disjunctive global interests - climate awareness and energy transition



Disjunctive global interests - climate awareness and energy transition

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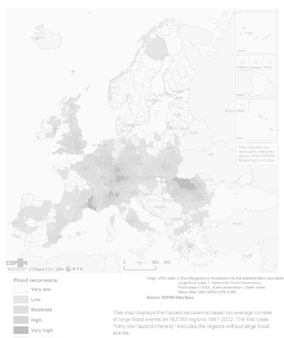

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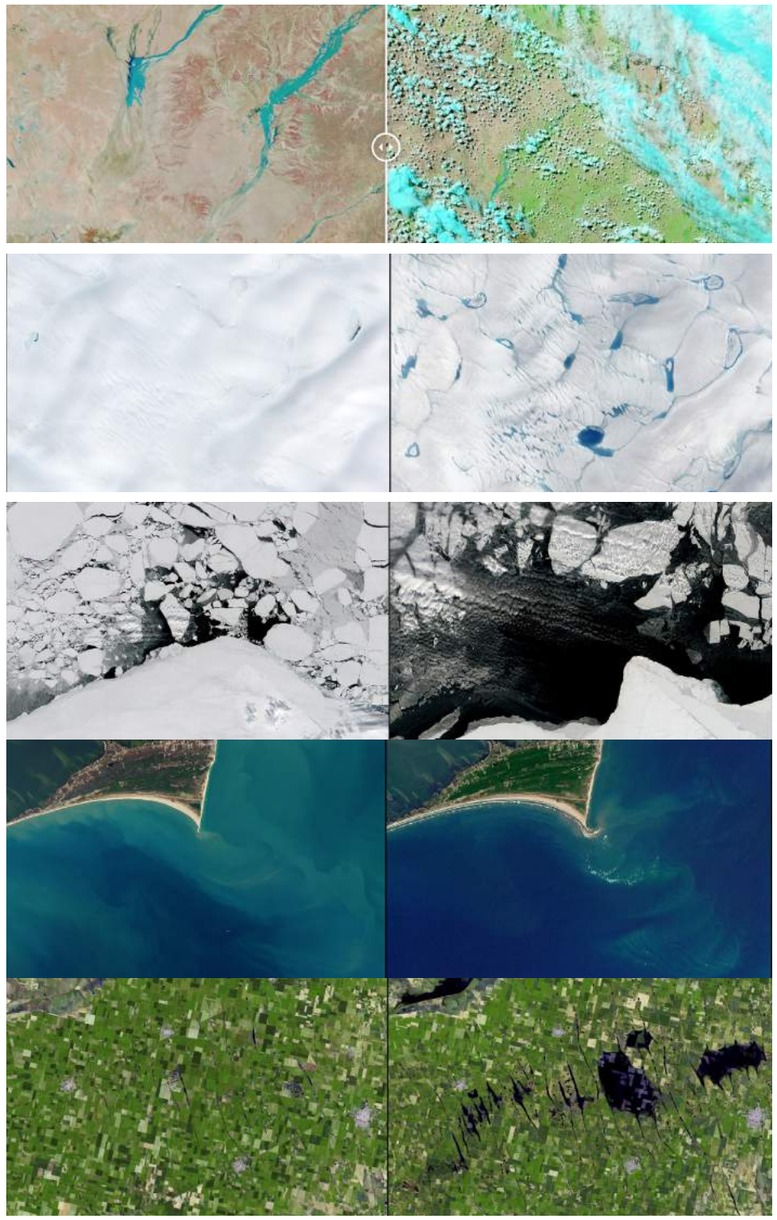


Disjunctive global interests - climate awareness and energy transition

Problem field
2. Disjoint Governmental levels

fig10. Energy transition trend

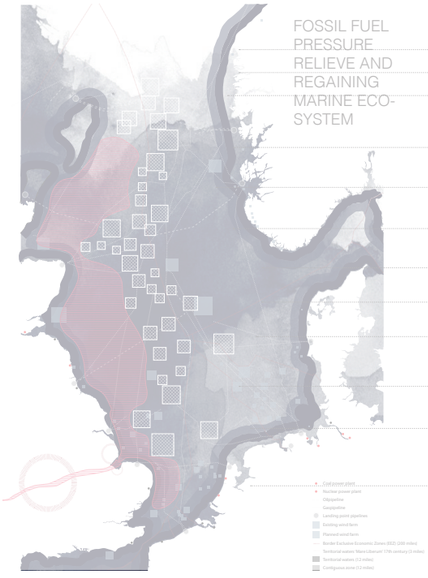
fig11. Climate change trend

fig.10-11. Climate Change and Energy transition global trends, author representation

EXISTING

FOSSIL FUEL PRESSURE

PROJECTIVE



FOSSIL FUEL PRESSURE RELIEVE AND REGAINING MARINE ECO-SYSTEM

UNITED KINGDOM RENEWABLE DEPLOYMENT

- BIOENERGY 9%
- SOLAR 3%
- ONSHORE WIND 6%
- HYDRO 2%
- OFFSHORE WIND 5%

2016 - RENEWABLES 25% OF TOTAL ENERGY PRODUCTION

Problem field
2. Disjoint Governmental levels

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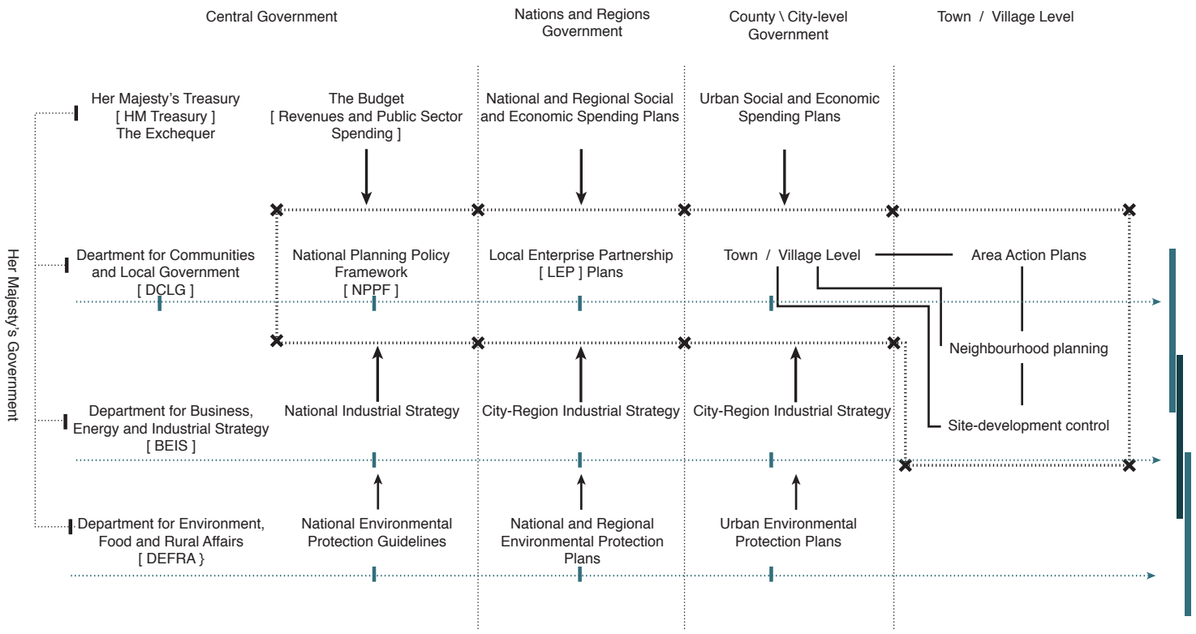

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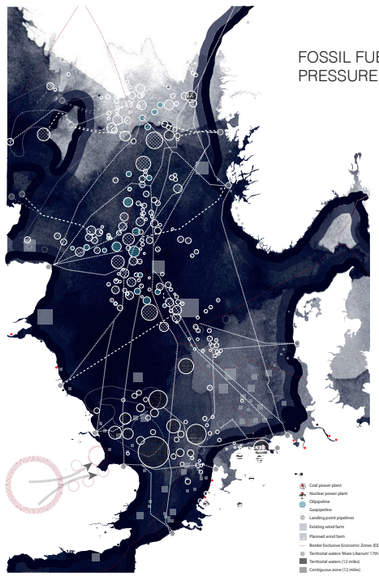

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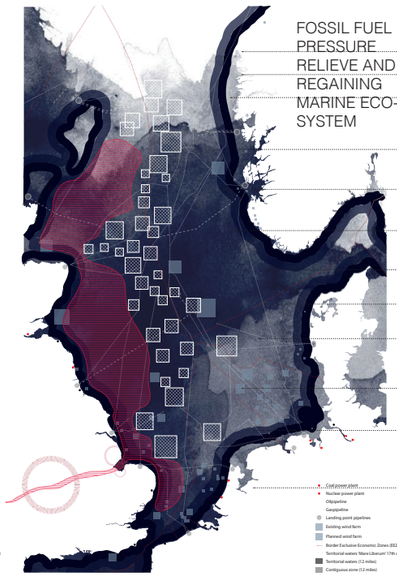

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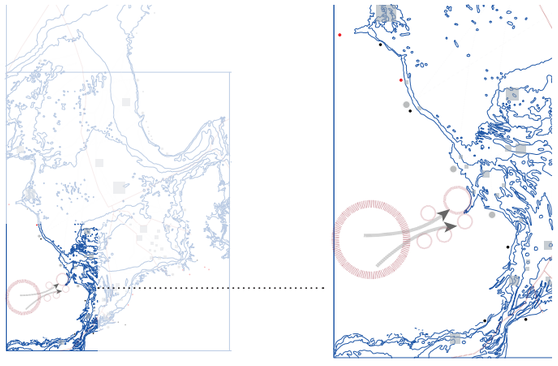

Problem field
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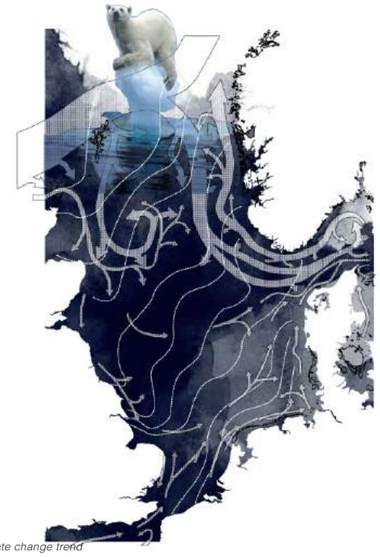
fig10. Energy transition trend



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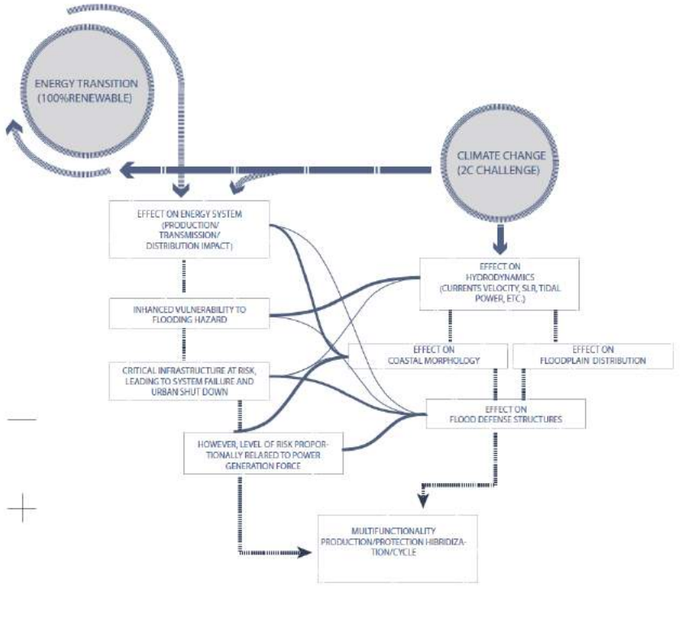
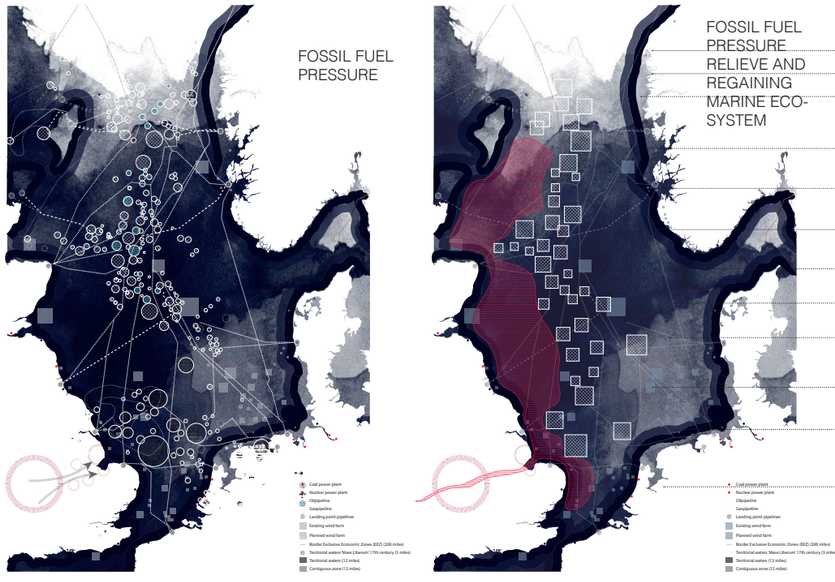


Fig.14. Project fields causalities, representation by author

Fig 15 - 16 -17. - Operational diagrams, representation by author



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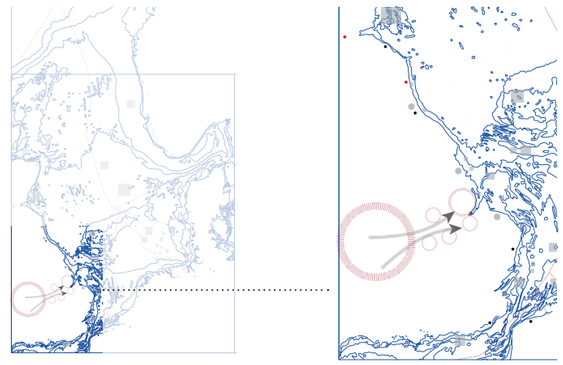
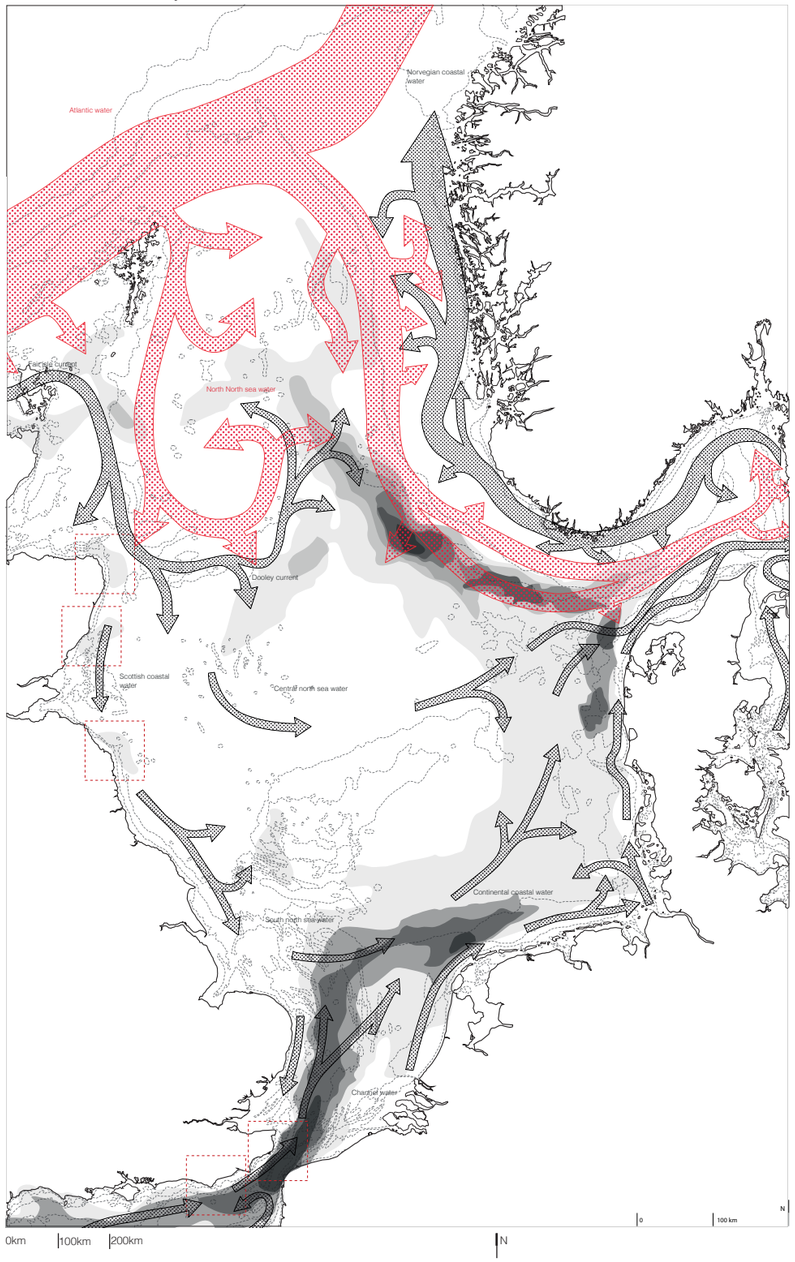


Problem field
4. Interdependent forces towards SLR - the hydrodynamic principles of the North Sea

Currents - direction and velocity

Thames Estuary as a funnel effect



0,01
Velocity vector magnitude
0,1
Warm currents
Cold currents
EVulnerable coastal areas

Problem field
5. Disrupted ecosystems

Temperature of the sea (bottom, thermocline, surface)

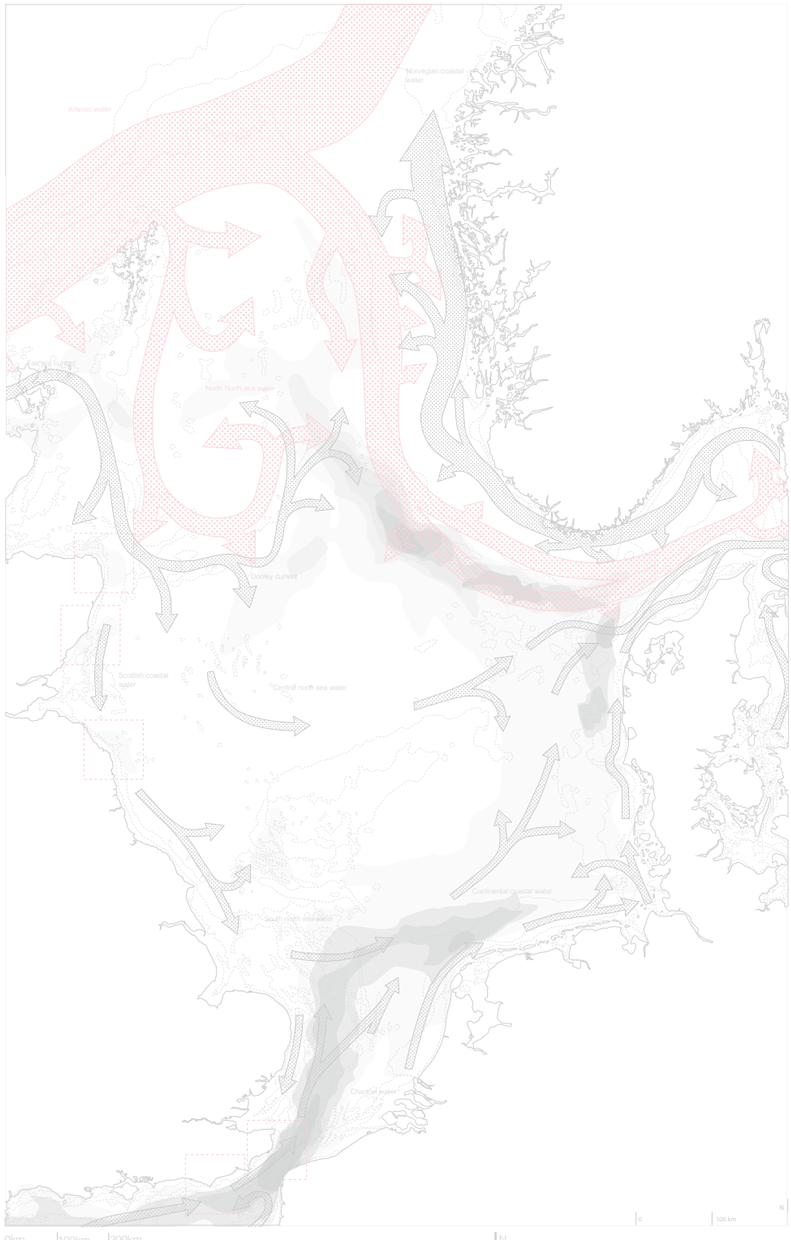
Shifting thermocline affecting local ecosystem distribution

Bottom
11.41-12.20
10.61-11.40
9.80-10.60
9.00-9.79
8.20-8.99
7.40-8.19
6.60-7.39
5.79-6.59
4.99-5.78
4.18-4.98
Thermocline
5 m deep
depth of the thermocline lay-
20m deep
low depth of thermo-cline layer
low depth of thermo-cline layer
dynamic area
Surface
11-12
10.5-11
10-10.5
9.5-10
9-9.5
8.5-9
Seasonal variability:2-7

Problem field
4. Interdependent forces towards SLR - the hydrodynamic principles of the North Sea

Currents - direction and velocity

Thames Estuary as a funnel effect



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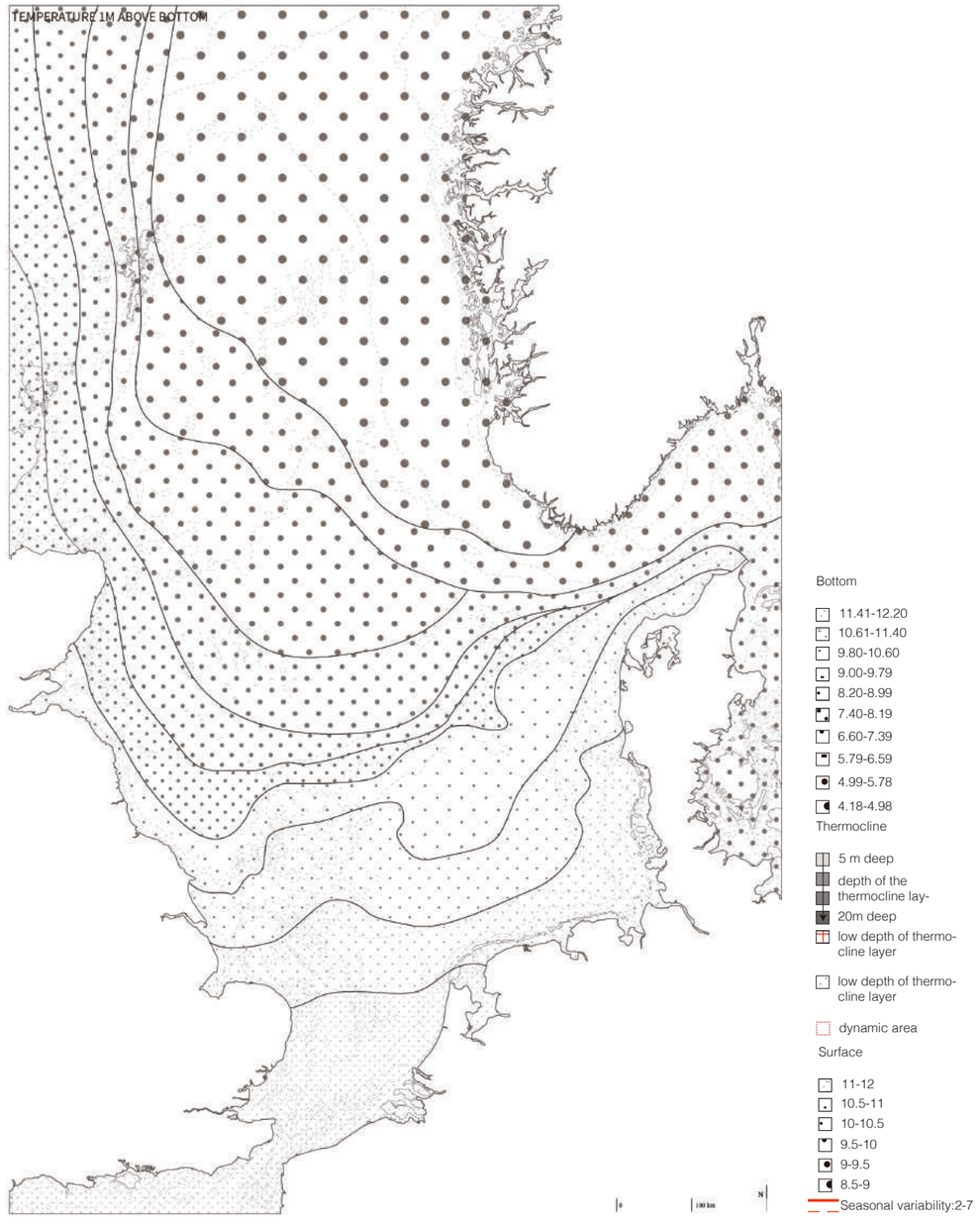

Problem field
4. Interdependent forces towards SLR - the hydrodynamic principles of the North Sea

Projected precipitation flood risk 1951-2012 applied on sub-river basins

Saline | fresh water contact pressure on the river catchment level

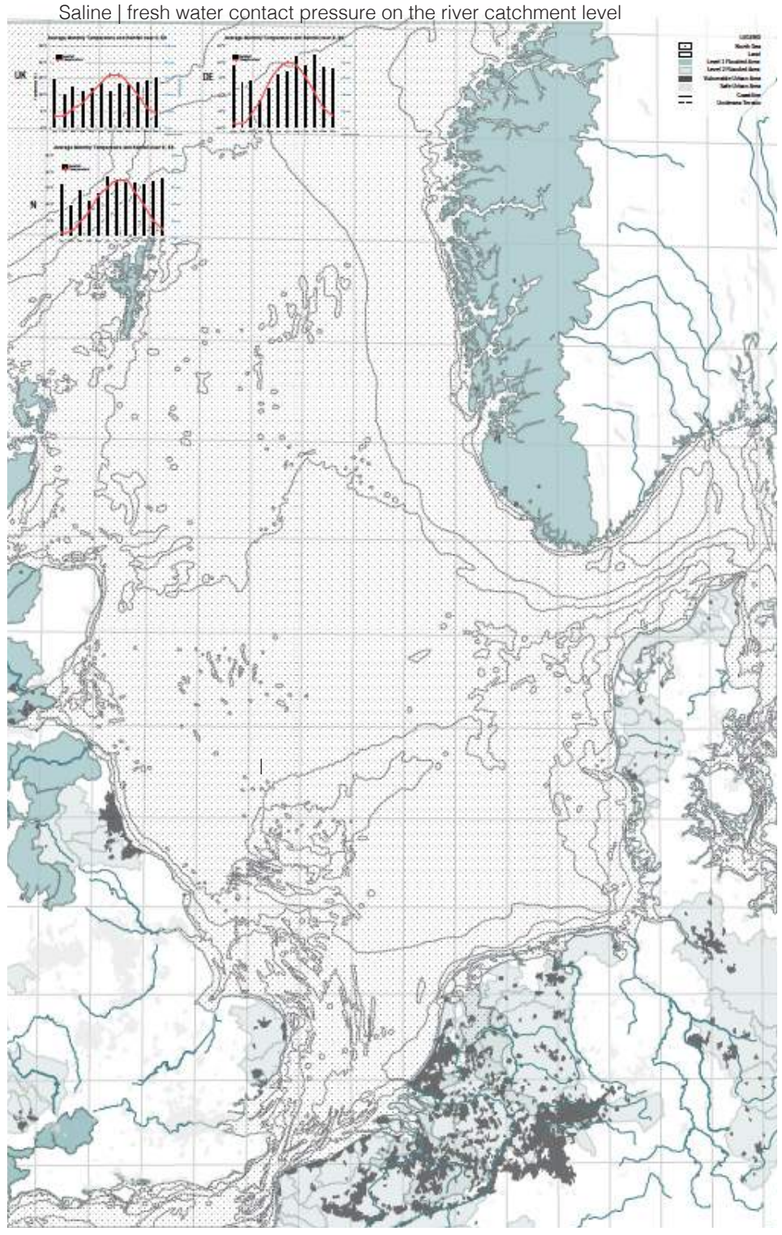

fig. 22-24 - North Sea conditions, representation by author based on information from Deltares

Problem field
4. Interdependent forces towards SLR - the hydrodynamic principles of the North Sea

Increase in the height of a 50-year return period extreme water level event

Estuarine mouth as storm surge sponge

fig. 22-24 - North Sea conditions, representation by author based on information from Deltares

Projected precipitation flood risk 1951-2012 applied on sub-river basins

Saline | fresh water contact pressure on the river catchment level

fig. 24. Precipitation

fig. 22-24 - North Sea conditions, representation by author based on information from Deltares

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4. Interdependent forces towards SLR - the hydrodynamic principles of the North Sea

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Estuarine mouth as storm surge sponge

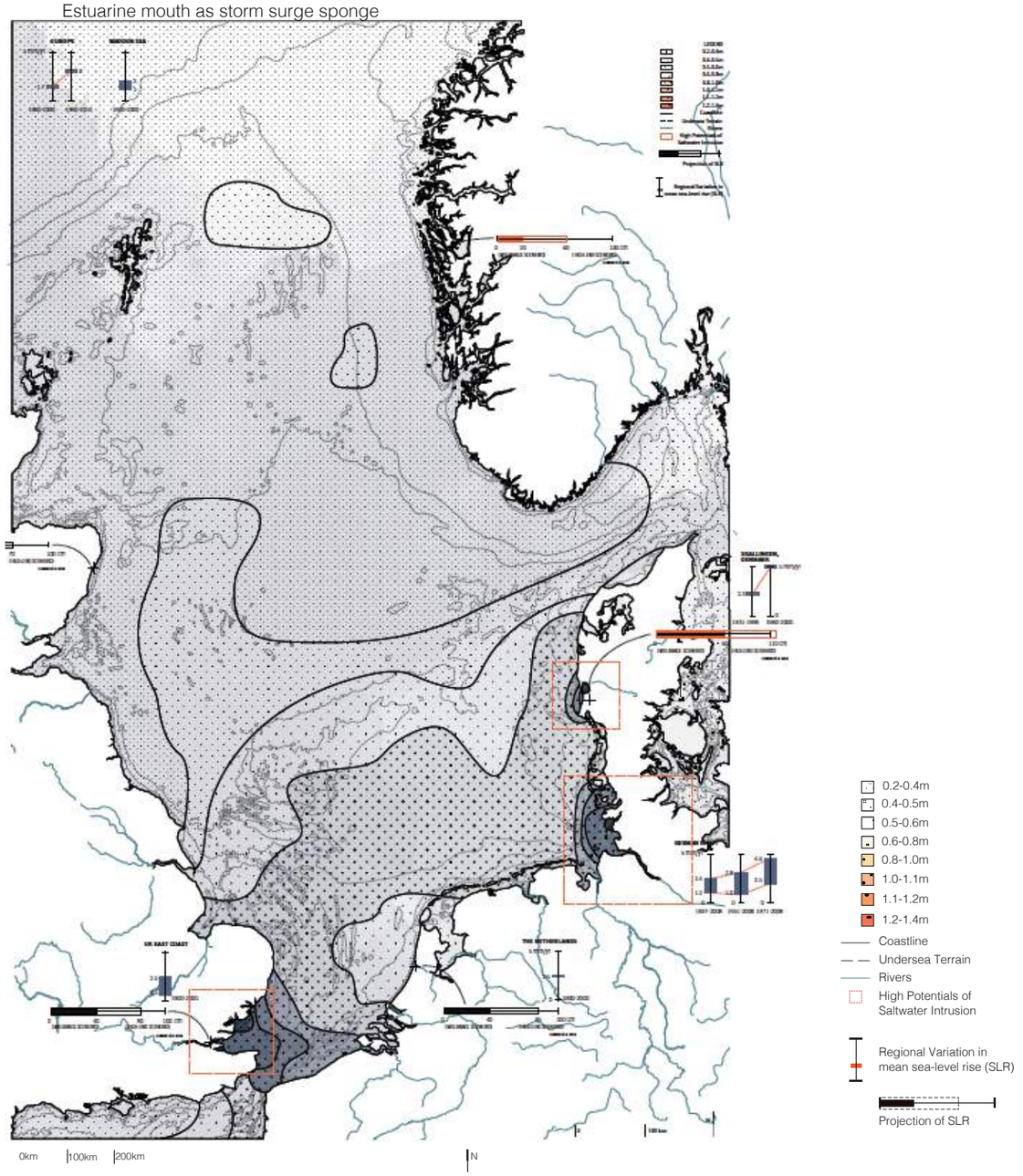
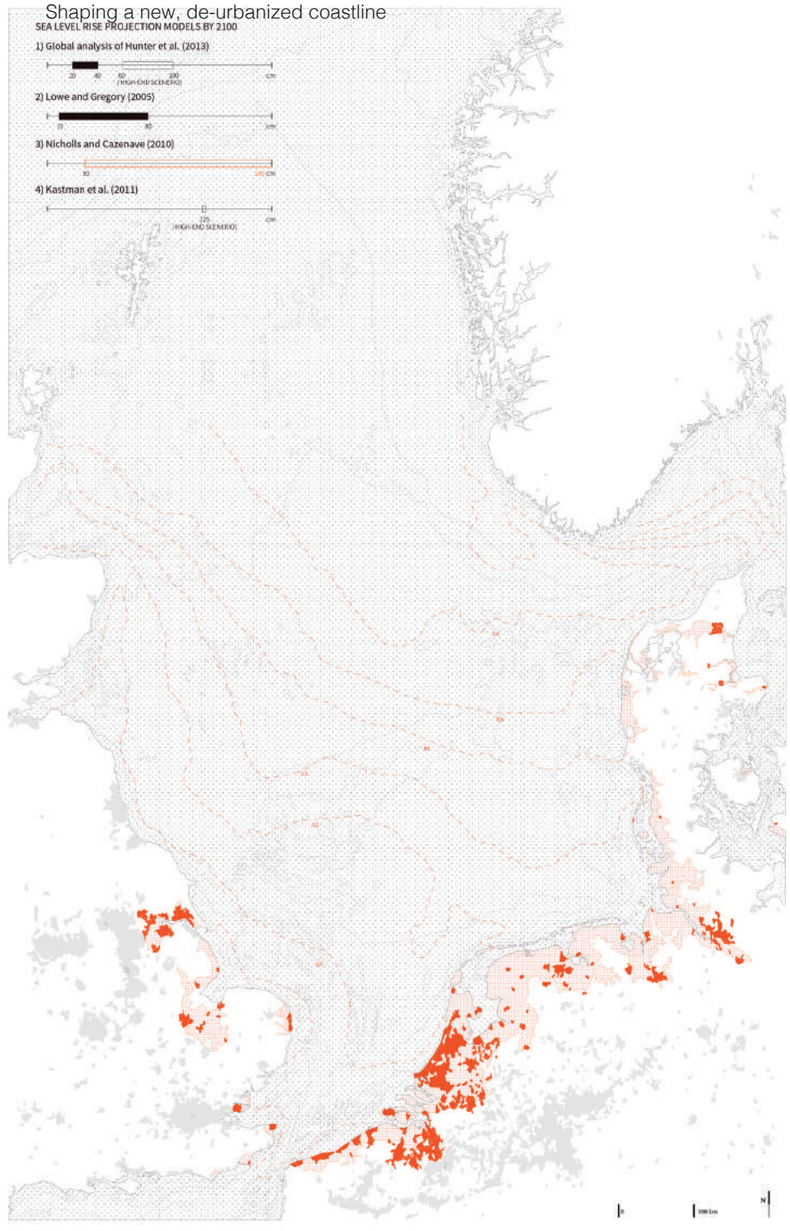


fig. 22-24 - North Sea conditions, representation by author based on information from Deltares

Problem field
4. Interdependent forces towards SLR - the hydrodynamic principles of the North Sea

Projection and influence of extreme sea level rise

Shaping a new, de-urbanized coastline



Problem field - the estuarine condition
Problem statement

Projected effects on coastline morphology in the absence of intervention

fig 36. New extreme coastline

fig. 36 - Representation made by author

Projection and influence of extreme sea level rise

Shaping a new, de-urbanized coastline

Projected effects on coastline morphology in the absence of intervention

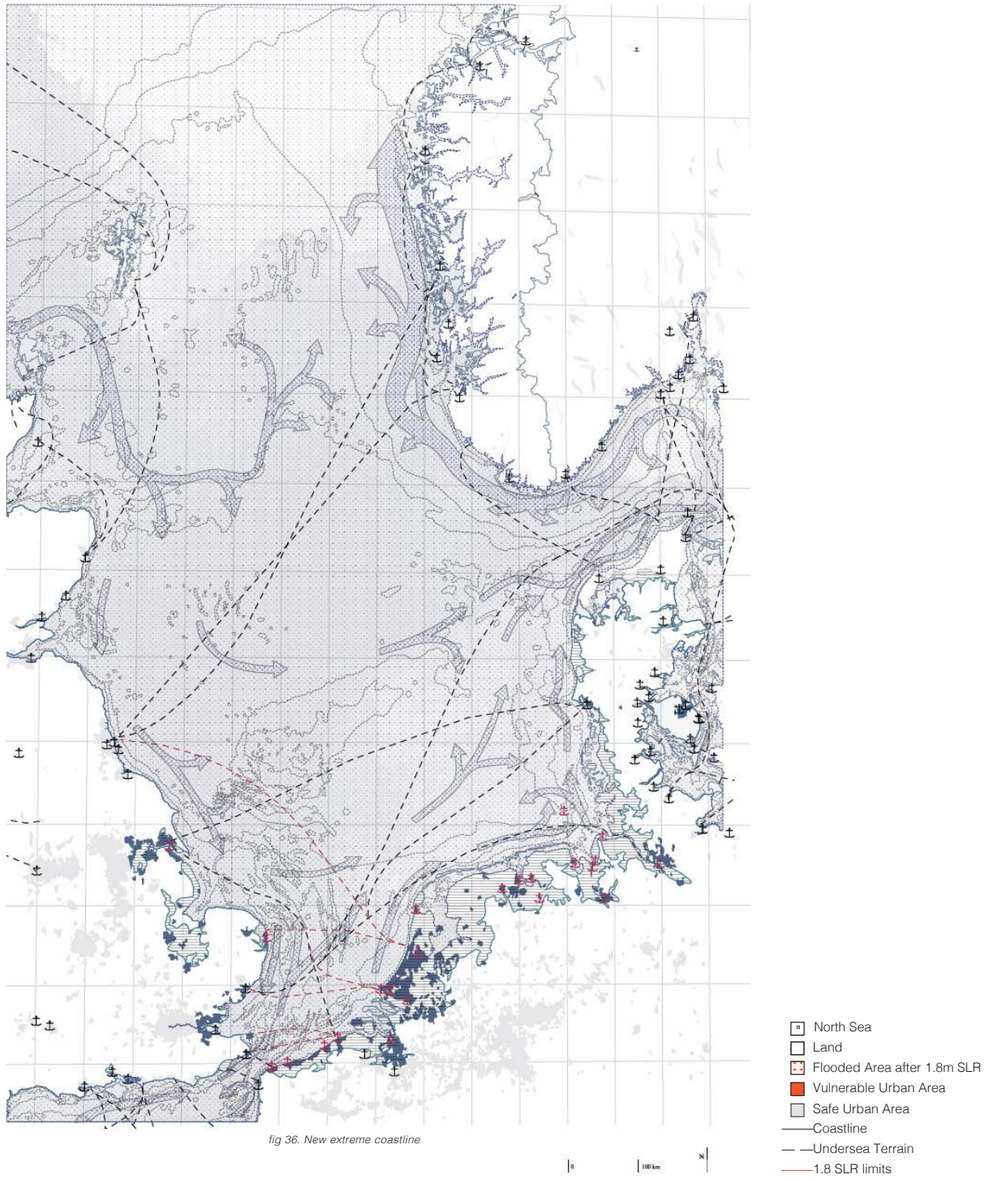


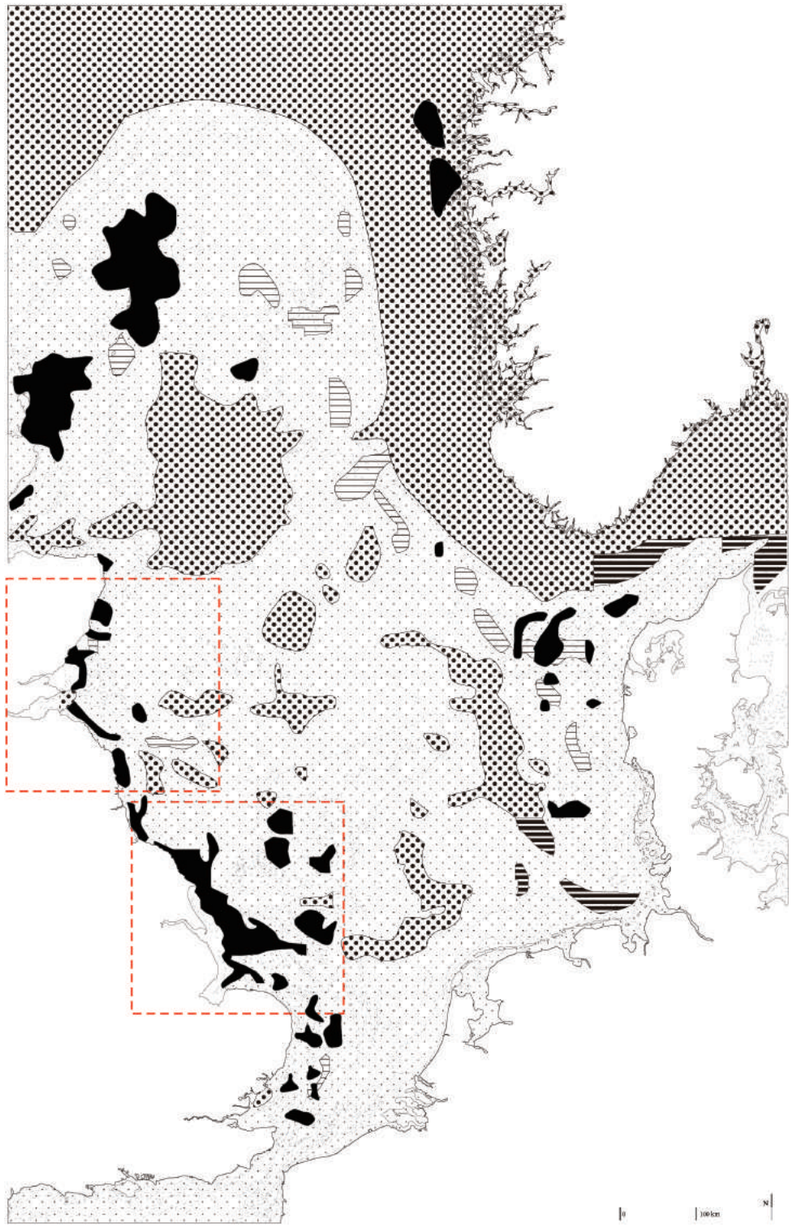
fig 36. New extreme coastline

fig. 36 - Representation made by author

Problem field
6. Disjoint coastlines - accretion vs sedimentation

Aggregated sedimentation

Argilous and low infliltration levels concentrated on the Thames Estuary



Problem field
6. Disjoint coastlines - accretion vs sedimentation

River discharge

Patterns of sediment flow that facilitate coastal realignment

Aggregated sedimentation

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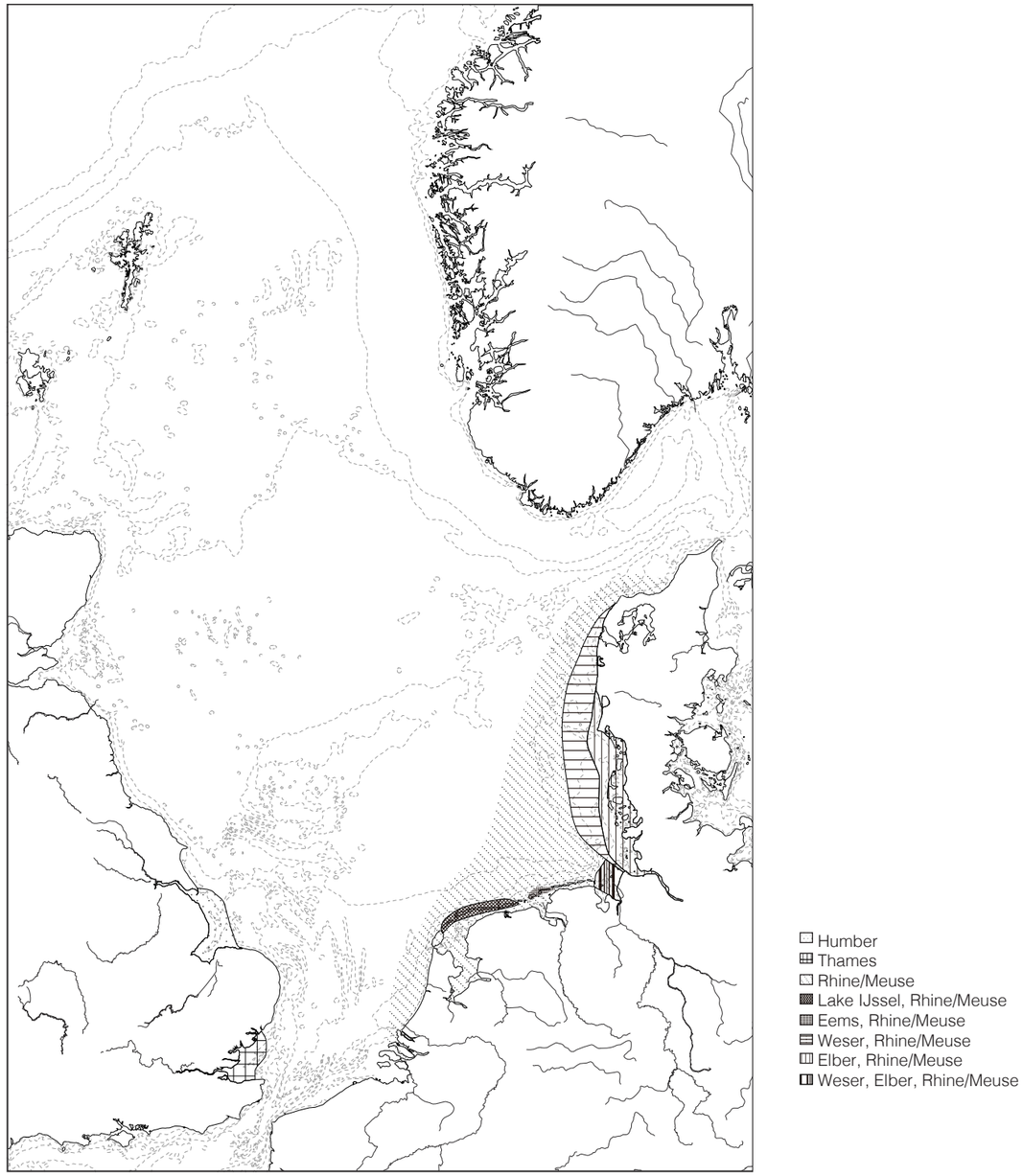

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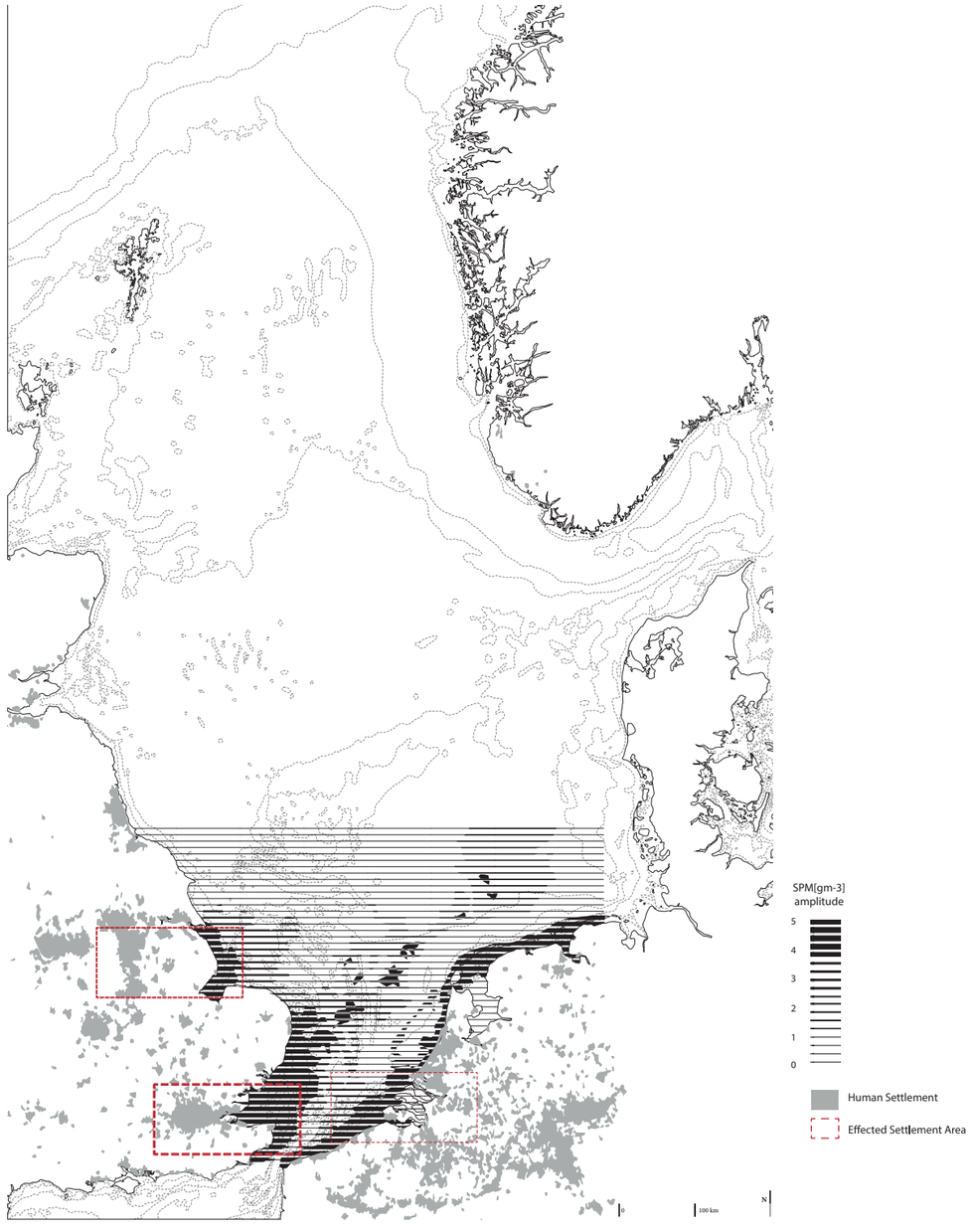

Problem field
6. Disjoint coastlines - accretion vs sedimentation

Coastline bedrock and management

Coastal errosion

fig 24. Coastal conditions

River discharge

Patterns of sediment flow that facilitate coastal realignment

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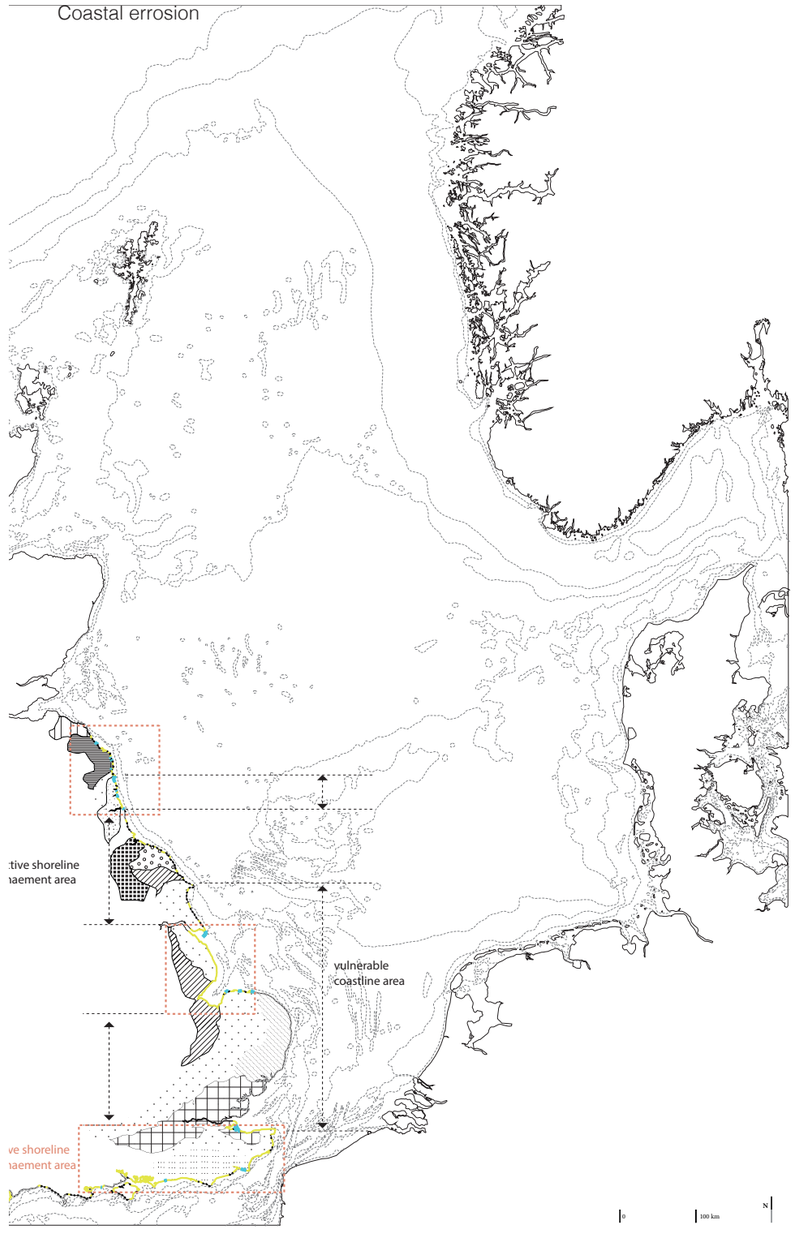


0km 100km 200km N

fig 24. Coastal conditions

Antithetic | Dualistic | Symbiotic

fig.1. Thames River Plume in the North Sea, https://earthobservatory.nasa.gov/Search/index.php?q=north+sea

The weavering territories - A paradox

Political denial and individual action

Divided governmental levels

Disjunctive global interests - climate awareness and energy transition

Interdependent forces - the hydrodynamic principles of the North Sea

Disrupted ecosystems

"...the great floodgates of the wonder-world swung open..."

Hermann Melville, Moby Dick

fig.6. Moby Dick- What if...

The weavering territories - A paradox

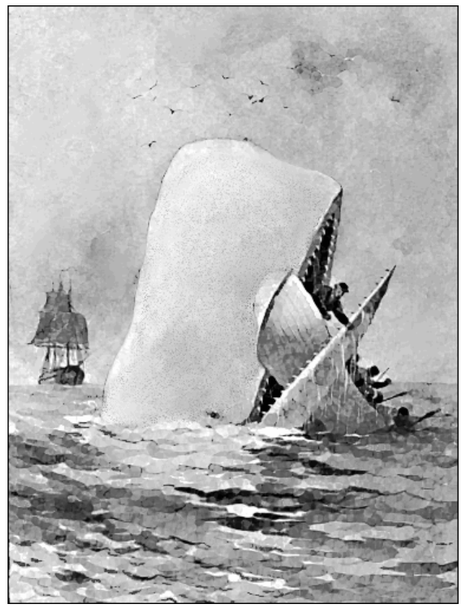
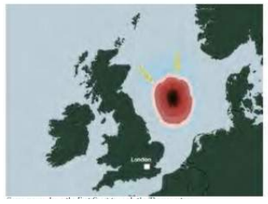


fig.6. First cover of Hermann's Melville Moby Dick, https://commons.wikimedia.org/wiki/File:Moby_Dick_p510_illustration.jpg

Problem field - the estuarine condition
Tidal force formation and flow patterns

Tidal surge occurence



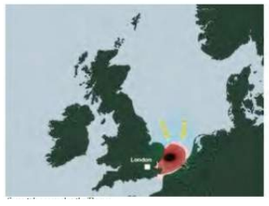


fig 37. Tidal surge path

TIDAL SURGE OCCURENCE

fig 38. Coastal territories at risk from tidal surge

fig 41. Thames estuary saline.freshwater distribution

fig. 37,39 -Extract from Thames Vision 2100, https://www.gov.uk/government/publications/thames-river-basin-management-plan fig 38 - https://www.eea.europa.eu/data-and-maps/indicators/storms-and-storm-surges-in-europe-1/assessment-1

Problem field - the estuarine condition
Tidal surge effects and impact

Critical infrastructure at risk due to tidal surge

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The Telegraph

Aerial footage: Thames bursts its banks flooding thousands of homes

2016

EveningStandard

Thames Flooding: Cars and people trapped by rising waters after river bursts its banks

EXPRESS

Uh oh! Cars swamped as Thames bursts its banks in West London

Table 2.1 Assets and people at risk in the tidal Thames floodplain

350 sq km land area
55 sq km designated habitat sites
1.25 million residents (plus commuters, tourists and other visitors)
Over 500,000 homes
40,000 commercial and industrial properties
£200 billion current property value
Key Government buildings
over 3100 hectares of sensitive heritage sites
400 schools
16 hospitals
8 Power stations
More than 1000 electricity substations
4 World Heritage sites
Art galleries and historic buildings
167 km of railway
35 Tube stations
51 Rail stations (25 mainline, 25 DLR, 1 international)
Over 300 km of Roads

fig 44. Energetic system at risk

fig. 37,39 -Extract from Thames Vision 2100, https://www.gov.uk/government/publications/thames-river-basin-management-plan
fig 38 - https://www.eea.europa.eu/data-and-maps/indicators/storms-and-storm-surges-in-europe-1/assessment-1

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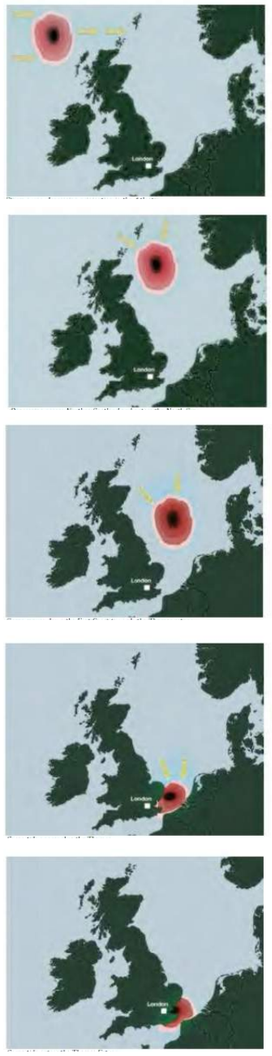

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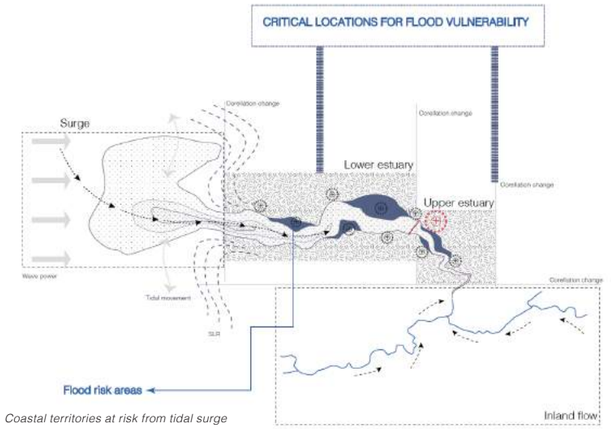

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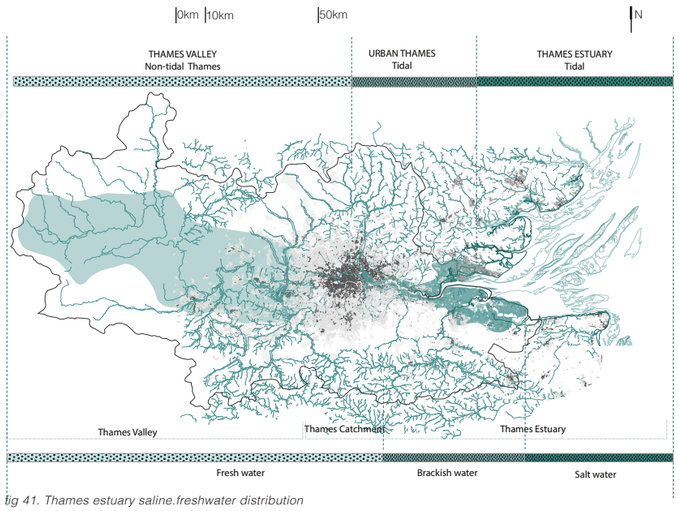

fig 41. Thames estuary saline.freshwater distribution

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fig 44. Energetic system at risk

0km 10km 50km N

fig. 37,39 -Extract from Thames Vision 2100, https://www.gov.uk/government/publications/thames-river-basin-management-plan
fig 38 - https://www.eea.europa.eu/data-and-maps/indicators/storms-and-storm-surges-in-europe-1/assessment-1

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TIDAL SURGE OCCURENCE

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fig. 37,39 -Extract from Thames Vision 2100, https://www.gov.uk/government/publications/thames-river-basin-management-plan fig 38 - https://www.eea.europa.eu/data-and-maps/indicators/storms-and-storm-surges-in-europe-1/assessment-1

Problem field - the estuarine condition
Tidal surge effects and impact

Critical infrastructure at risk due to tidal surge

2014

The Telegraph

Aerial footage: Thames bursts its banks flooding thousands of homes

2016

EveningStandard.

Thames Flooding: Cars and people trapped by rising waters after river bursts its banks

2018

EXPRESS

Uh oh! Cars swamped as Thames bursts its banks in West London

ROWS of cars were left flooded after the River Thames burst its banks in London today.

Table 2.1 Assets and people at risk in the tidal Thames floodplain

350 sq km land area
55 sq km designated habitat sites
1.25 million residents (plus commuters, tourists and other visitors)
Over 500,000 homes
40,000 commercial and industrial properties
£200 billion current property value
Key Government buildings
over 3100 hectares of sensitive heritage sites
400 schools
16 hospitals
8 Power stations
More than 1000 electricity substations
4 World Heritage sites
Art galleries and historic buildings
167 km of railway
35 Tube stations
51 Rail stations (25 mainline, 25 DLR, 1 international)
Over 300 km of Roads

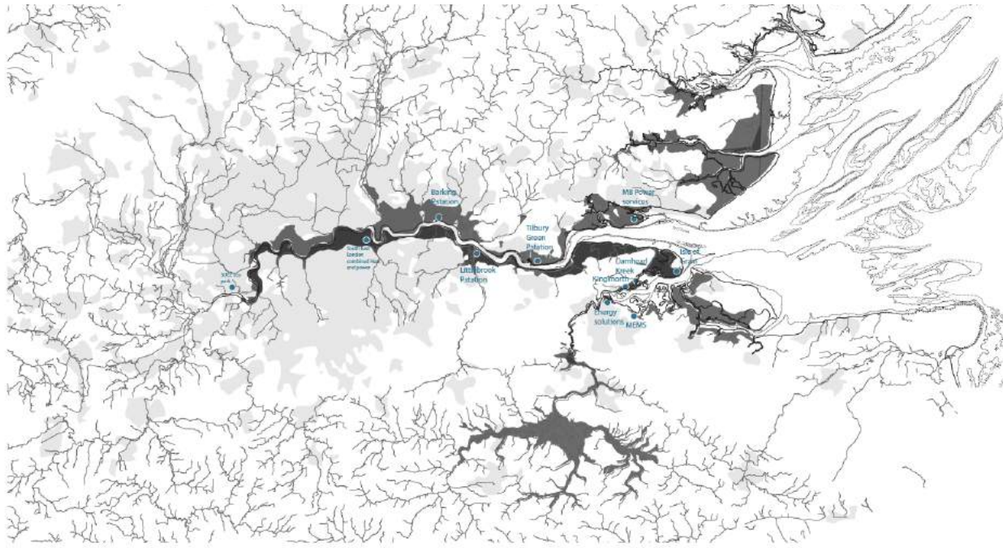


fig 44. Energetic system at risk

fig. 37,39 -Extract from Thames Vision 2100, https://www.gov.uk/government/publications/thames-river-basin-management-plan

fig 38 - https://www.eea.europa.eu/data-and-maps/indicators/storms-and-storm-surges-in-europe-1/assessment-1

Trans-scalar approach
The current seen as a causality cascade

The dynamic shaping forces of the North Sea

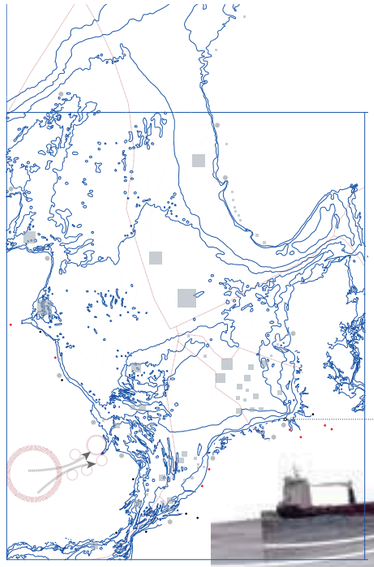


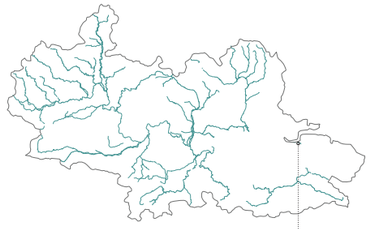
fig12. Hydrology projection image

HYDROLOGY

Dynamic climate change triggers general changes of hydrology in North Sea, as well as the extreme weather like flooding and heavy rain. Our group focus on the research of different aspects of hydrology and the the relation between it and human settlement. From tidal amplitude, sea level rising, coastline erosion, etc, our mappings project the extreme climate effect on coastline morphology and global economy.

fig.12. Hydrology abstractization, D-i group work

Local coastal erosion, ecosystem depletion and storm surge flooding



RIVER BASIN

Hierarchy of affected areas

CRITICAL AREAS

Priority intervention and coastal managed realignment

PRIORITY CRITICAL AREAS

AREA BASED DESIGN

The key location as pilot project

The project is focused on the dialogue between scales, the conditions that the context poses on the specific design area, aiming at constructing a coherent system of intervention areas.

Problem field - the estuarine condition
Problem statement

Projected effects on coastline morphology in the absence of intervention

SLR - TIDAL SURGE FORMATION PATTERN AND FLOOD RISK IMPACT ON THE URBAN SYSTEM AND PRODUCTIVE CYCLE

NATURAL HABITAT AT RISK - MARSHLAND SURFACE REGRESSION AND SPECIES ENDANGERMENT

LACK OF TIDAL POWER INTEGRATION INTO THE REGIONAL PRODUCTION CYCLE

How to best integrate energy transition and the dynamics of climate change through the performative design of a flood defense system enhancing the productive cycle of the Thames Estuary Region ?

Hydrology and ecology

Analysis – 1. What is the specificity of an estuarine territory in relation to hydrodynamics?
Synthesis – 2. How can hydrodynamics shape the coastline/riverbank in a highly urbanized estuarine territory?
Performance – 3. How can ongoing externalities such as uncertainty of economic shifts, transforming economic model for energy production, etc. increase the vulnerability of an urbanized estuarine territory?

Landscapes of power

Analysis – 1. What types of clean energy can be applied in estuarine territories?
Synthesis – 2. How can hydrodynamics be integrated within the urban system? How can hydrodynamics be integrated within the energy cycle? What is the pattern of production and use of power in a transitional territory?
Performance – 3. To what extent can energetic landscapes can be adapted to re-nature processes with multi-functional purposes - protection/production?

How to best integrate energy transition and the dynamics of climate change through the performative design of a flood defense system enhancing the productive cycle of the Thames Estuary Region ?

Risk and spatial projection

Analysis – 1. What is the current attitude to managing risks from tidal and storm surge in the UK? What are the urban growth variables that can influence further interventions?
Synthesis – 2. To what extent can landscape be understood and conditioned as an operative ground for energetic infrastructure system to address frequent flooding, storm surges and sea level rise?
Performance – 3. How can modulating landscape ecology and spatializing suitability contribute simultaneously to risk reduction and economic development (raised area value)?

Theoretical approach implications

Analysis (Research) – 1. What would be a precise methodological approach to identifying criteria that define vulnerability/ adaptability?
Synthesis – 2. To what extent can a trans-scalar approach reveal simultaneously governance levels of policy implementation, natural and urban system causalities as well as economic effects of hybrid critical infrastructure?
Performance (Design) – 3. What is an open-ended design process and how can it address the complexity of energetic and defense systems in urbanized
estuarine territories? / What plans and systems of governance does The Thames Estuary need in order to achieve an integrated investment model between flood management and energetic production?

Hypothesis - the English paradigm shift
The 5 stages of Medieval London

From hard to soft interventions towards flood prevention

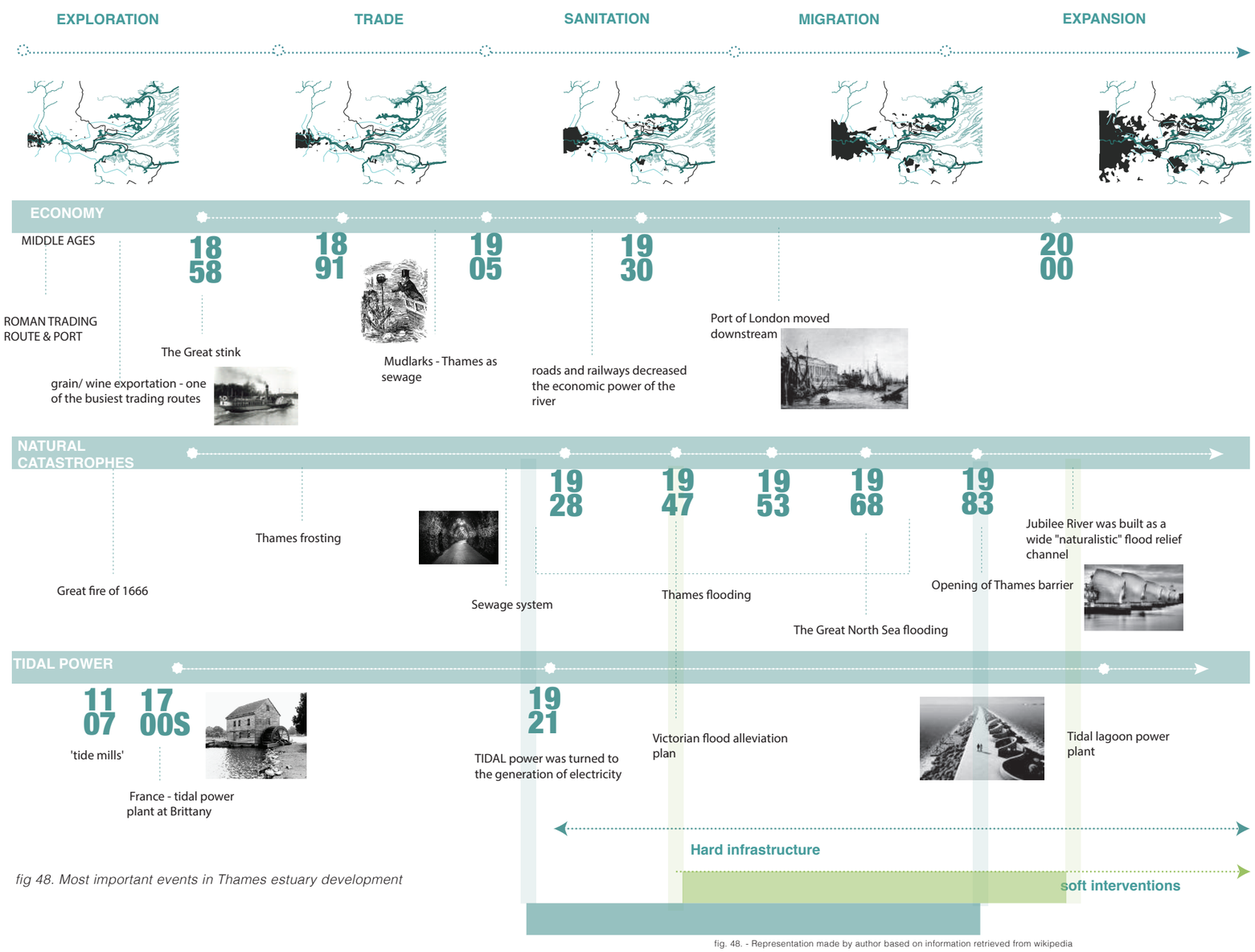


fig 48. Most important events in Thames estuary development

Hypothesis - the English paradigm shift
Reference project

Learn from the Dutch - Room for the river applicable principles

fig 48. Room for the rover project Nijmeigen

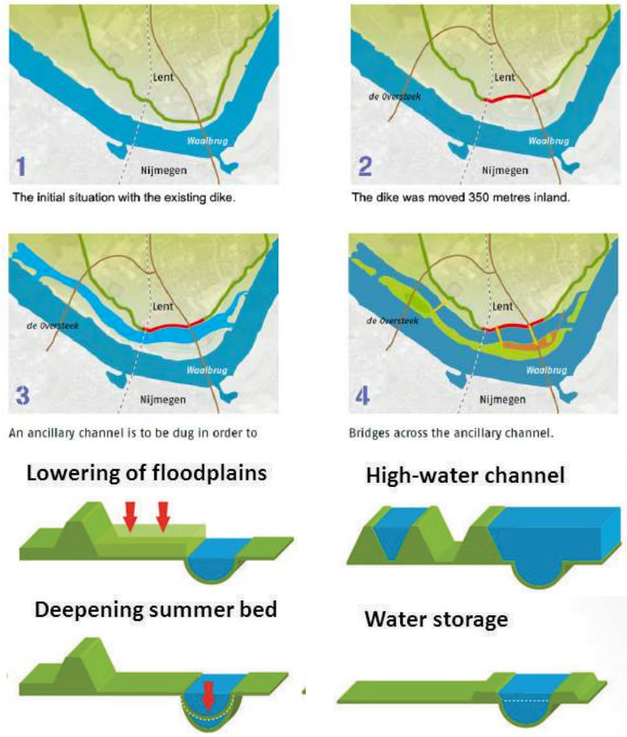


fig. 48. - Representation made by author based on information retrieved from wikipedia

Hypothesis - the English paradigm shift
Trans-scalarity and the systemic approach

From tidal surge risk to productive | protective dualism

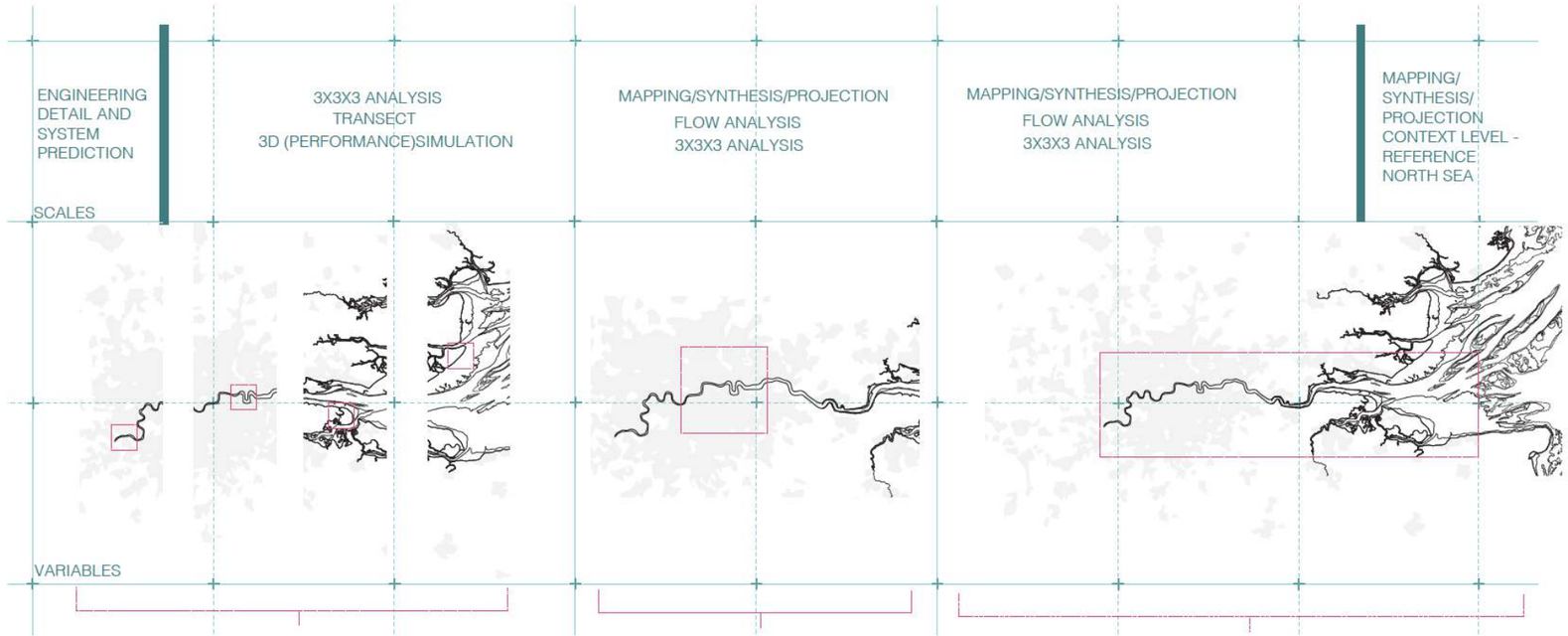


fig 52. Theoretic representation of thesis approach - multiscalarity and systemic performance

Hypothesis - the English paradigm shift
Trans-scalarity and the systemic approach

From tidal surge risk to productive | protective dualism

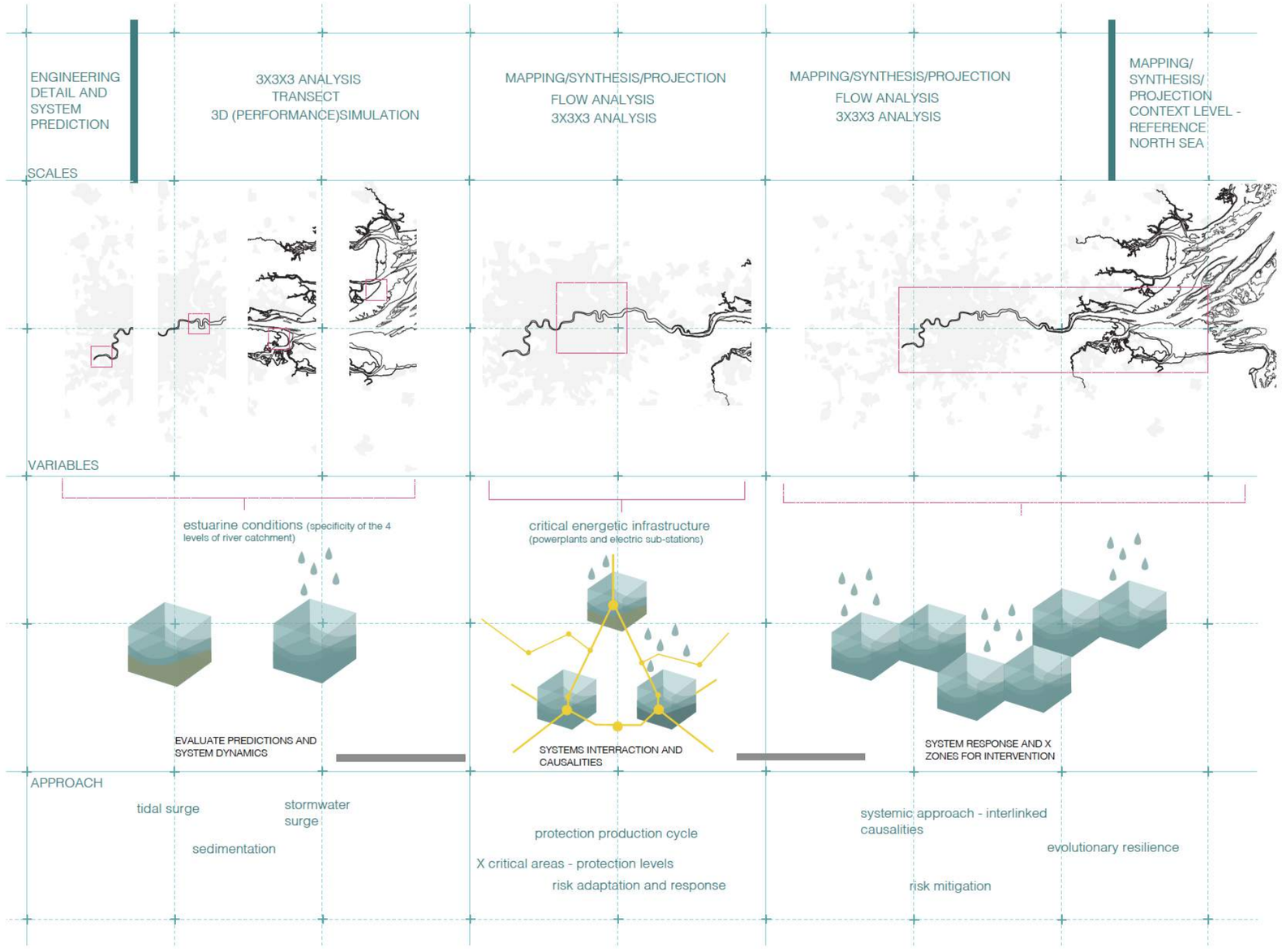


fig 52. Theoretic representation of thesis approach - multiscalarity and systemic performance

Methodology
From hydrodynamics to spatial intervention

Towards a new integrated protective | productive infrastructure on the Thames Estuary

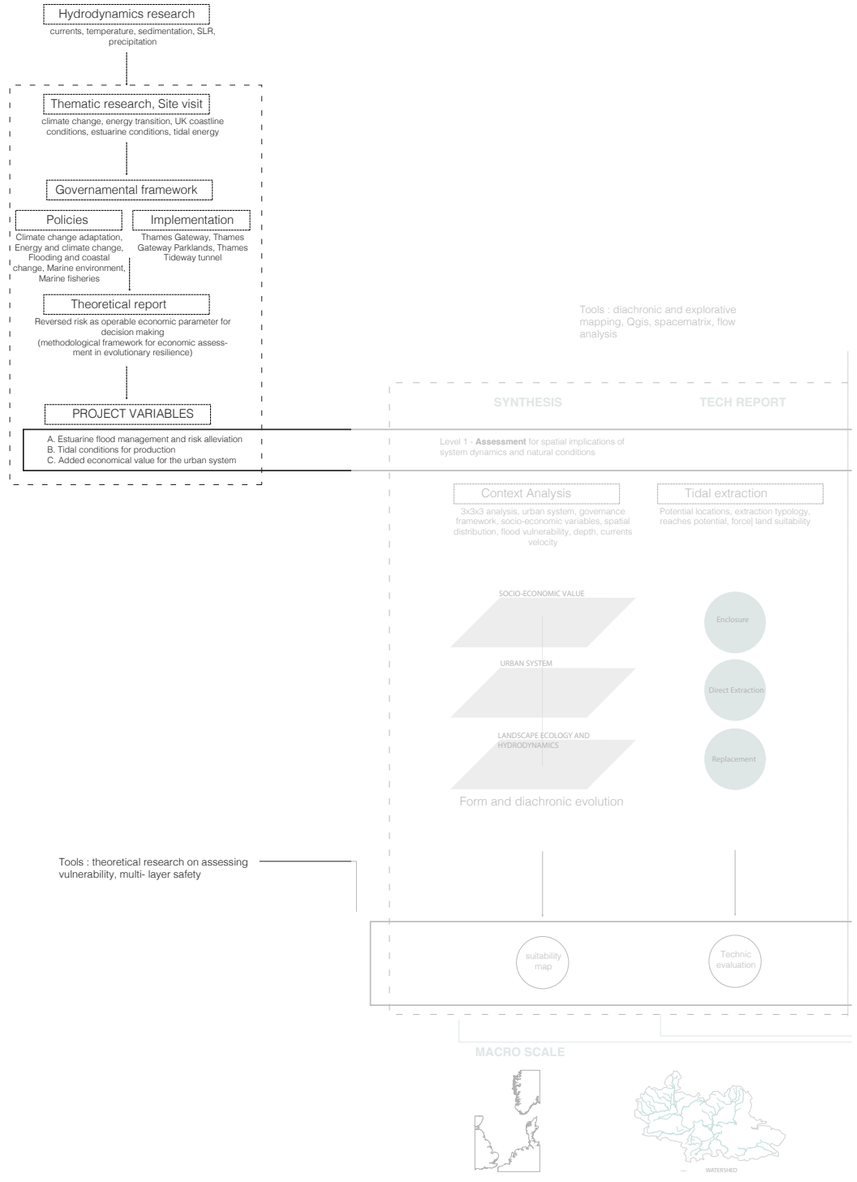
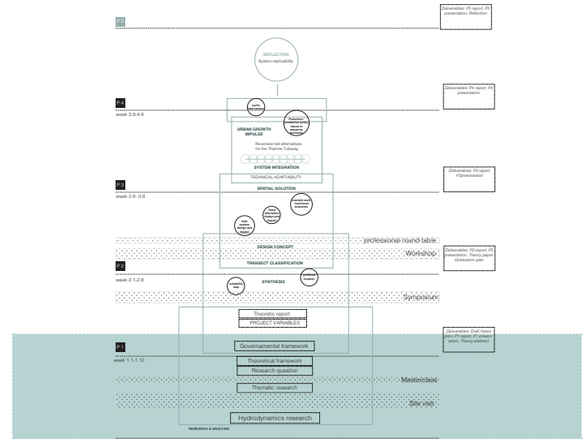


fig 53. Methodological diagram



Tools : transect study, scenario approach, visualisation

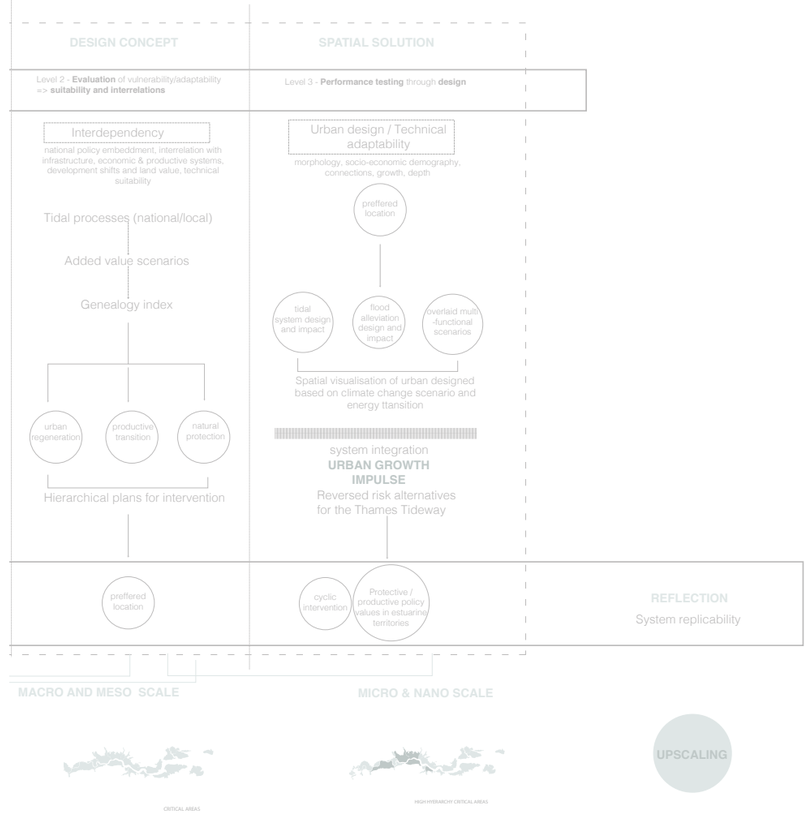


Fig. 53 - Methodology and steps, Representation made by author

Methodology
From hydrodynamics to spatial intervention

Towards a new integrated protective | productive infrastructure on the Thames Estuary

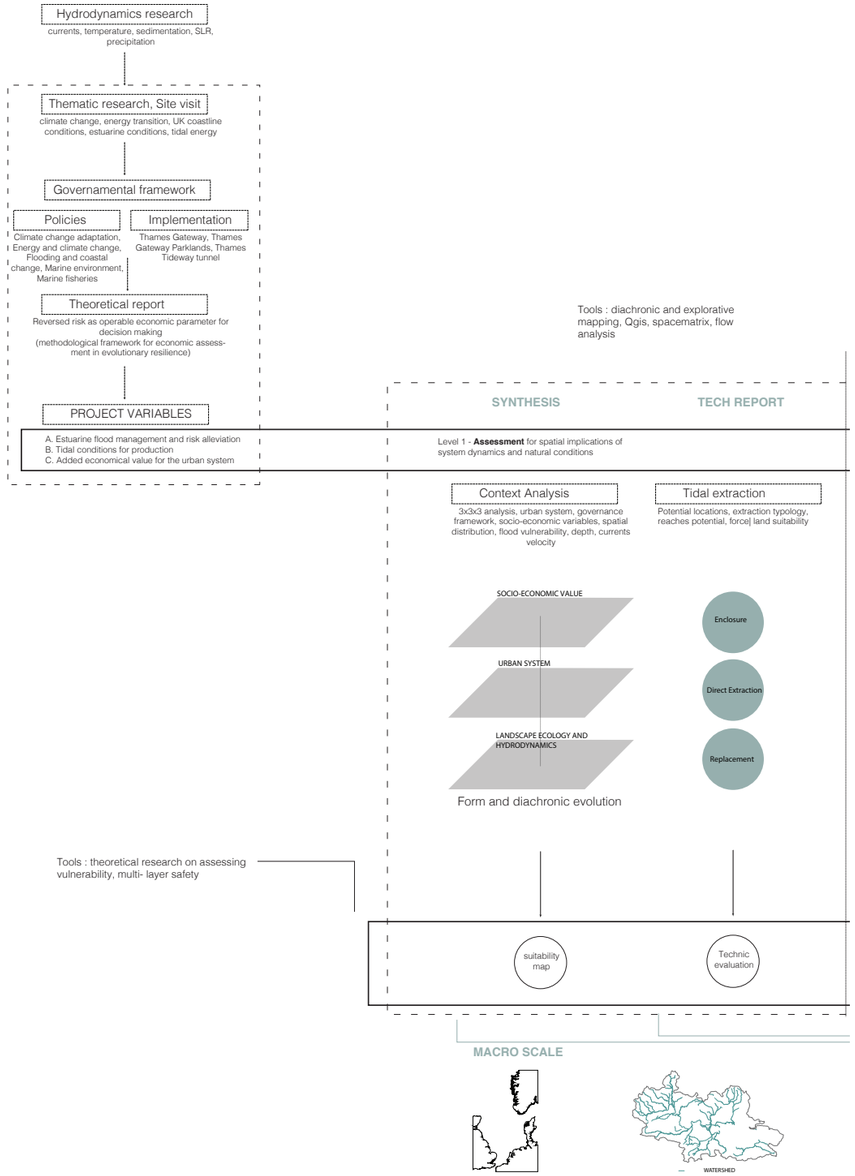


fig 53. Methodological diagram

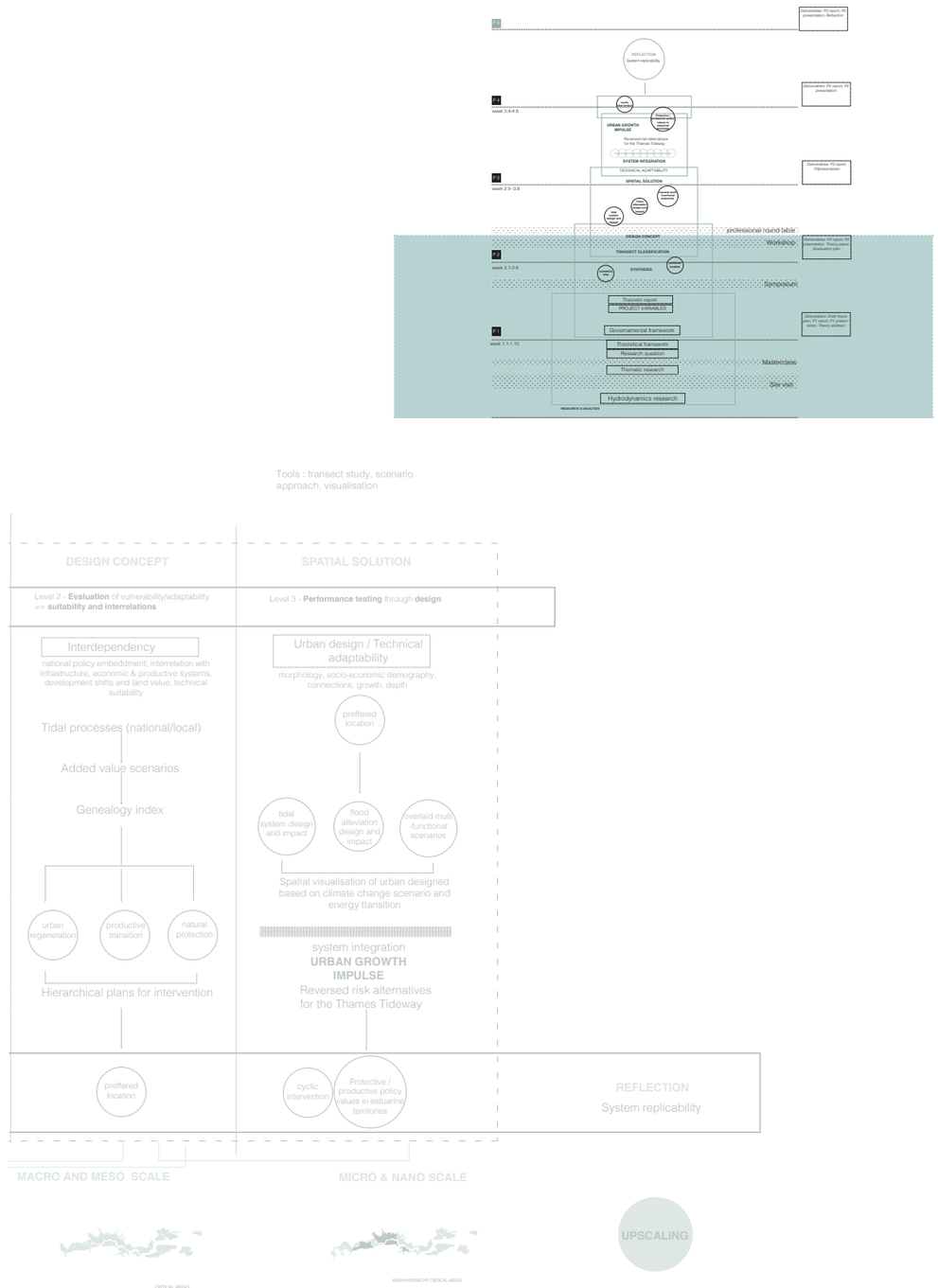


Fig. 53 - Methodology and steps, Representation made by author

Methodology
From hydrodynamics to spatial intervention

Towards a new integrated protective | productive infrastructure on the Thames Estuary

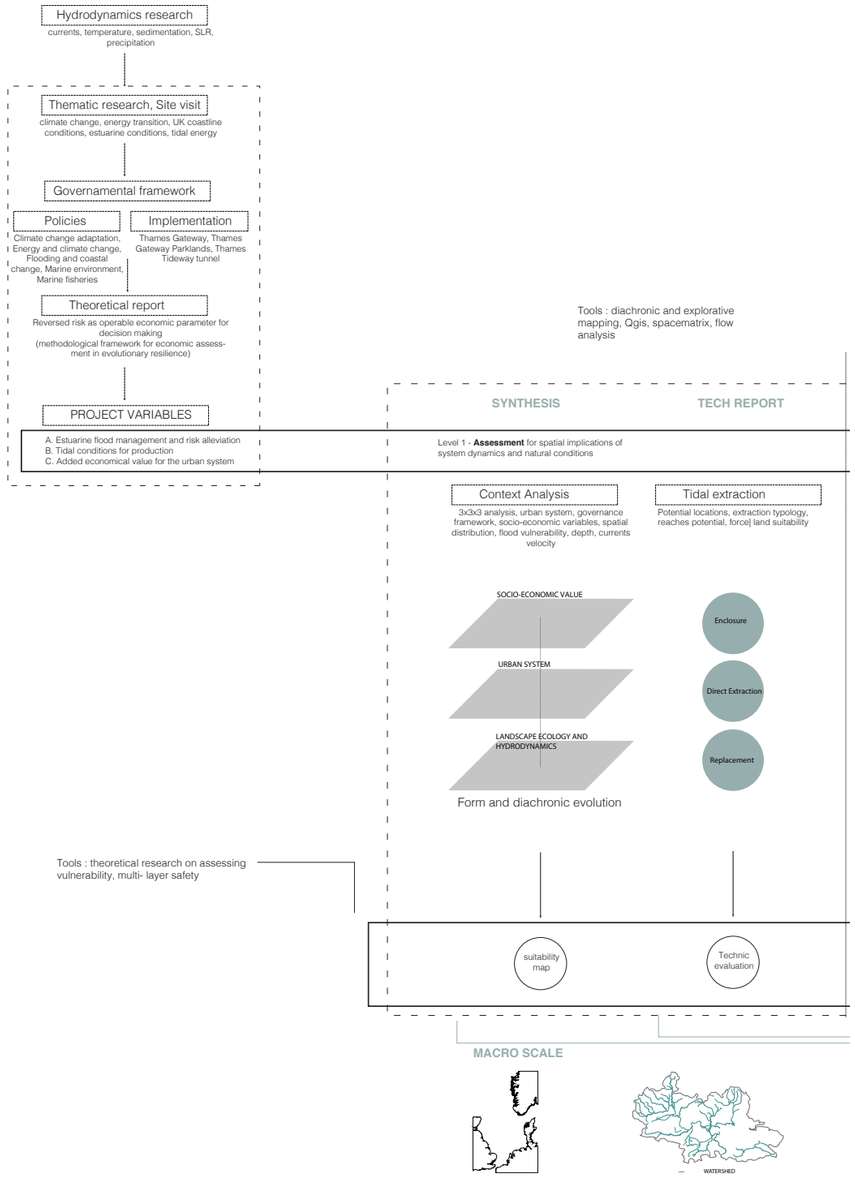
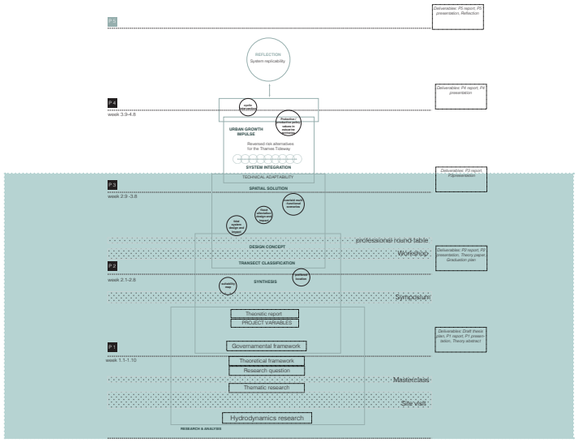


fig 53. Methodological diagram



Tools : transect study, scenario approach, visualisation

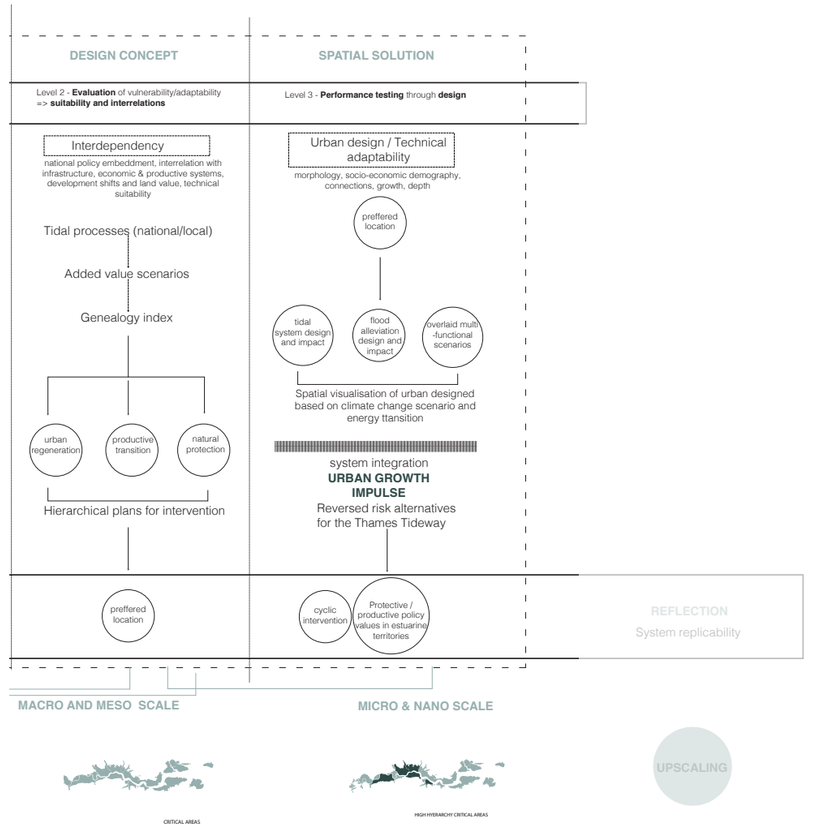


Fig. 53 - Methodology and steps, Representation made by author

Methodology
From hydrodynamics to spatial intervention

Towards a new integrated protective | productive infrastructure on the Thames Estuary

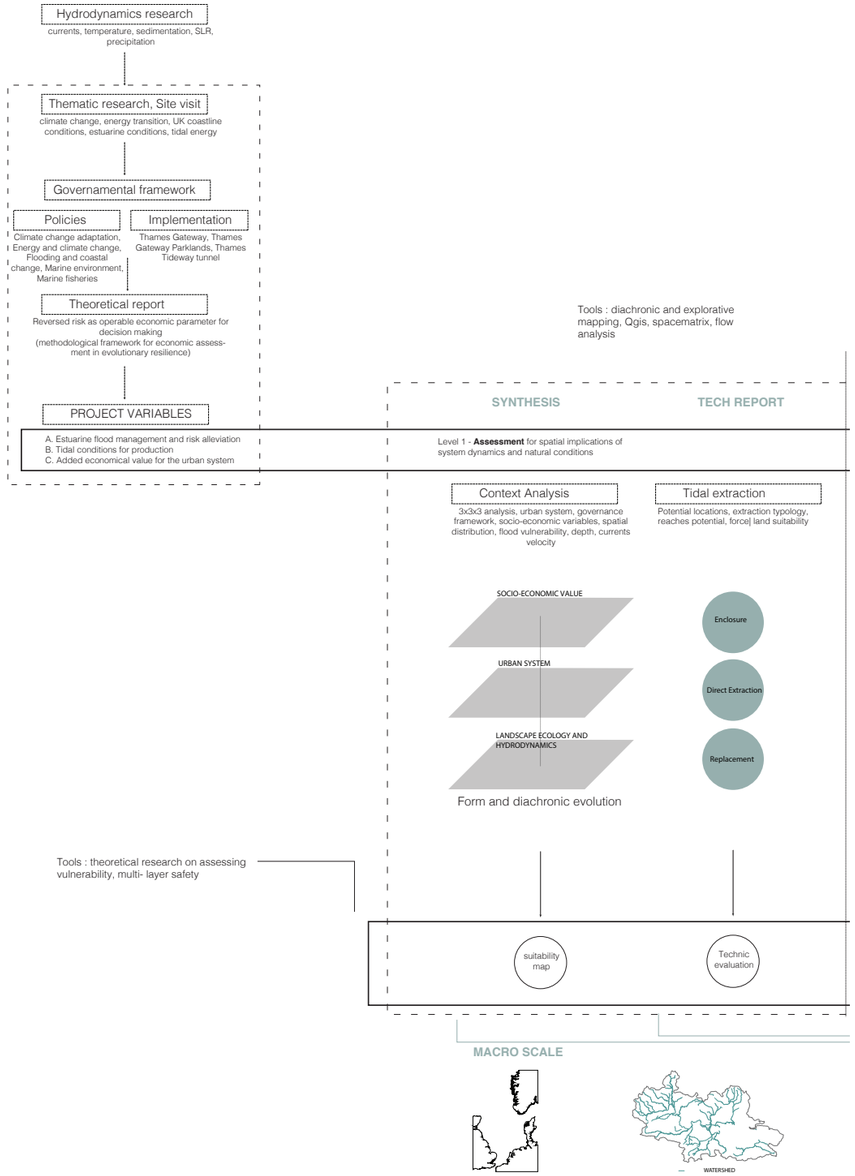
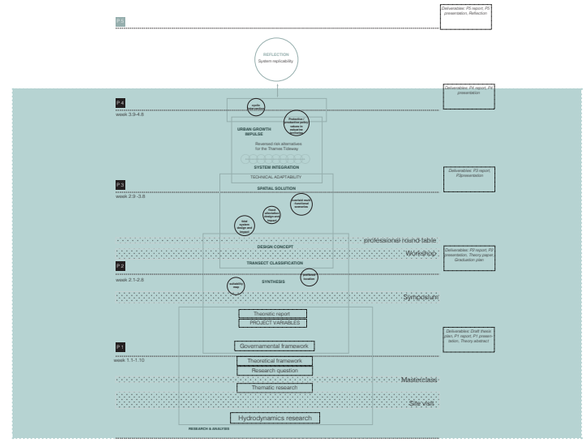


fig 53. Methodological diagram



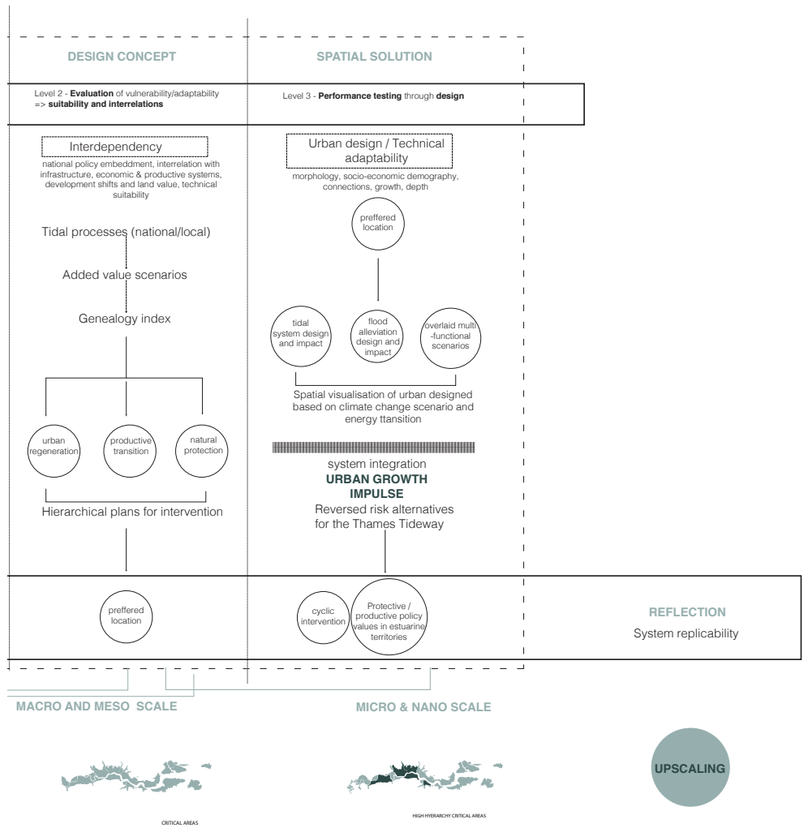


Fig. 53 - Methodology and steps, Representation made by author

Expected output
A protective productive landscape with enhanced ecosystem services

Towards a new integrated protective | productive infrastructure on the Thames Estuary

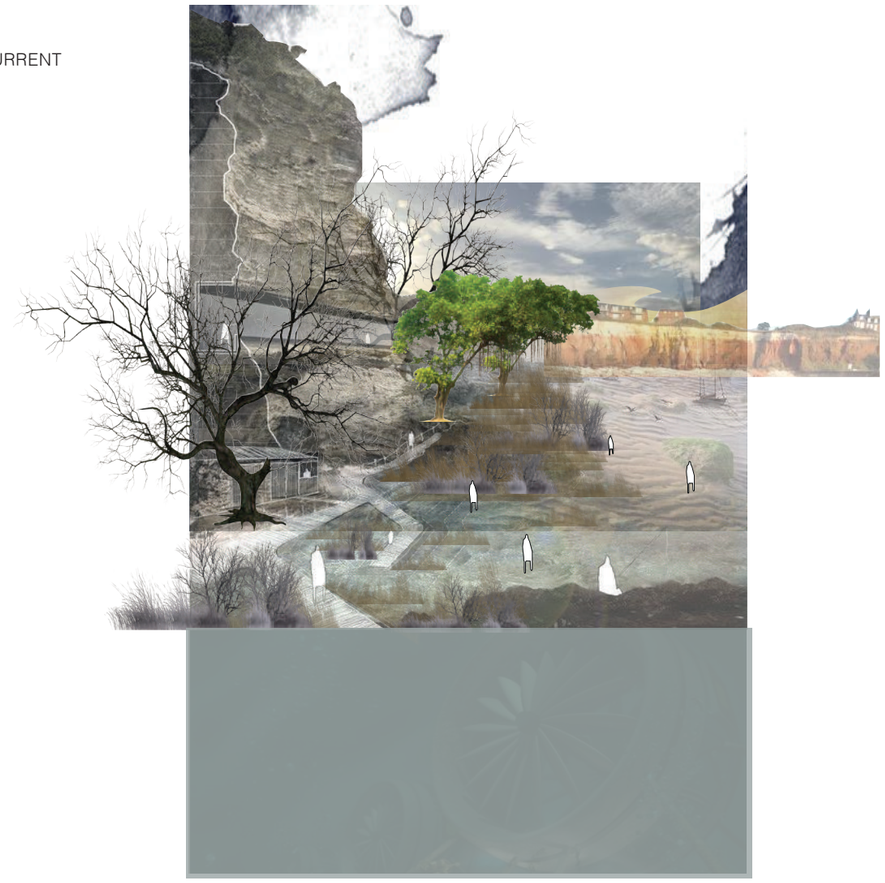
fig 50-51. Existing green spaces and prospective systemic approach

HIGH TIME

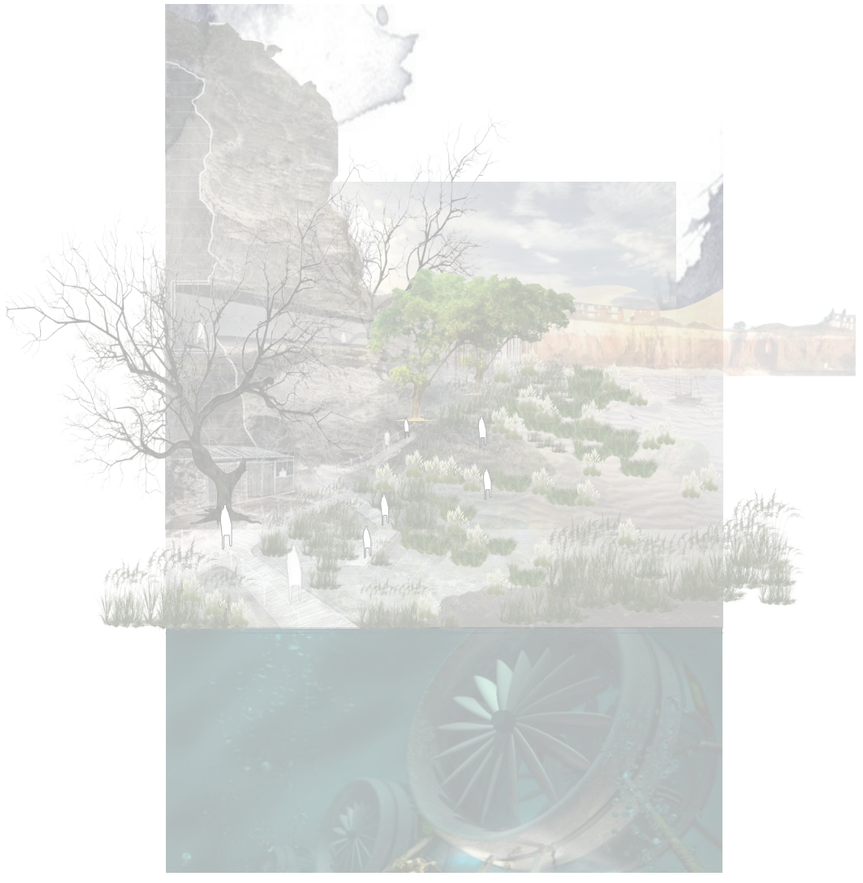
Fig. 50-51 - Projective images, Representation made by author

LOW TIDE

CURRENT



PROJECTIVE



Expected output
A protective productive landscape with enhanced ecosystem services

Towards a new integrated protective | productive infrastructure on the Thames Estuary

fig 50-51. Existing green spaces and prospective systemic approach

HIGH TIME

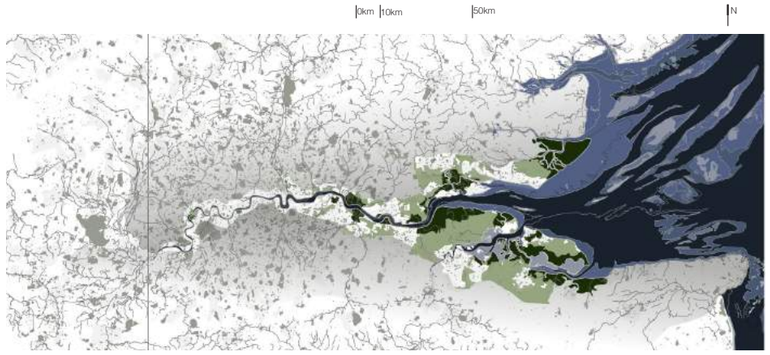
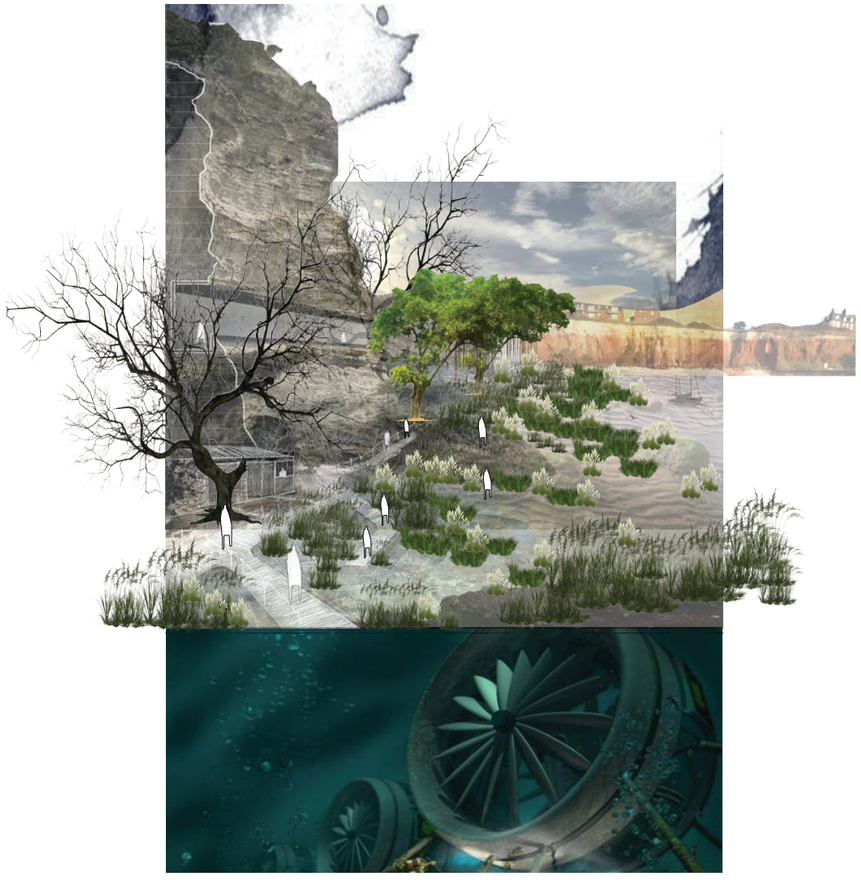


Fig. 50-51 - Projective images, Representation made by author

LOW TIME

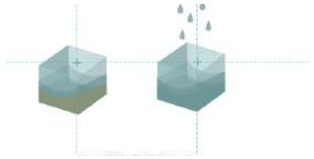
CURRENT

PROJECTIVE

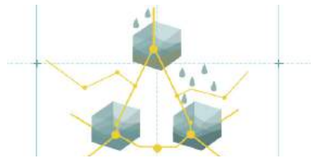


Research by Design - Supportive data
Factors that influence managed coastal realignment

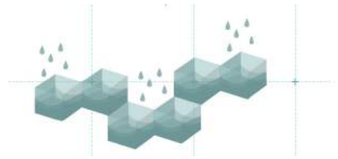
Suitability criteria



Define suitability locations



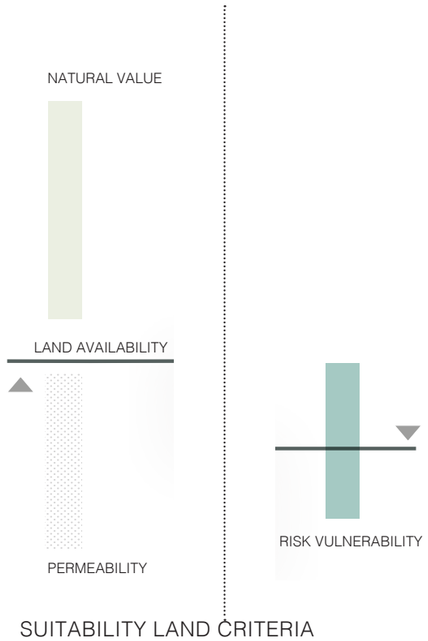
Define tidal potential



Define intervention priority and adequacy

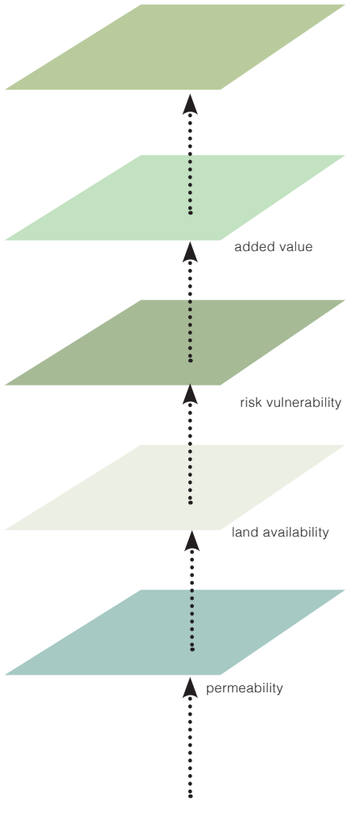
DUTCH APROACH FOR FLOOD RISK

MULTI-LAYERED SAFETY



SUITABILITY LAND CRITERIA

ADDITIONAL
ANALYSIS
ACCORDING



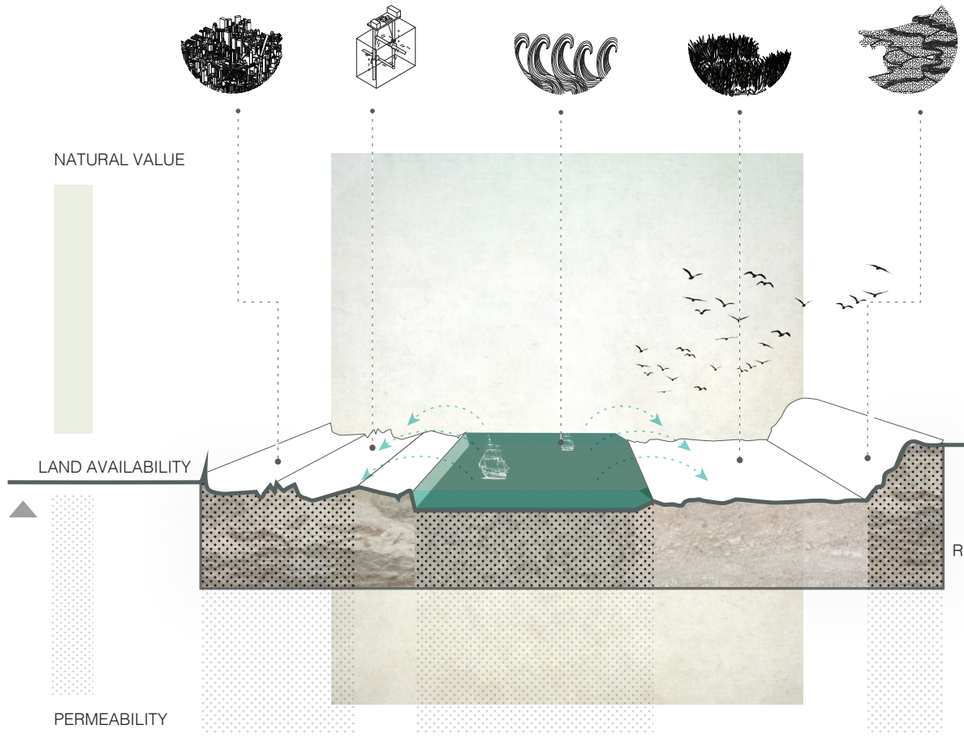


fig 56. Suitability values projection

Research by Design - Supportive data
Factors that influence managed coastal realignment

Seabed sediment pattern

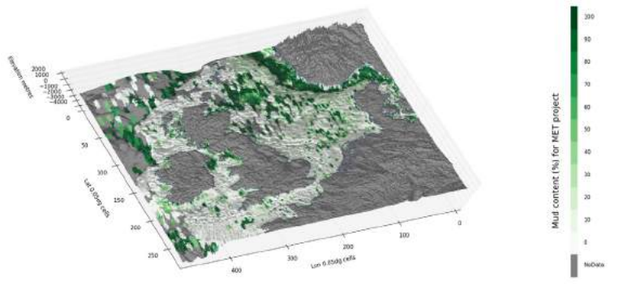


fig 82. North sea mud content values and distribution

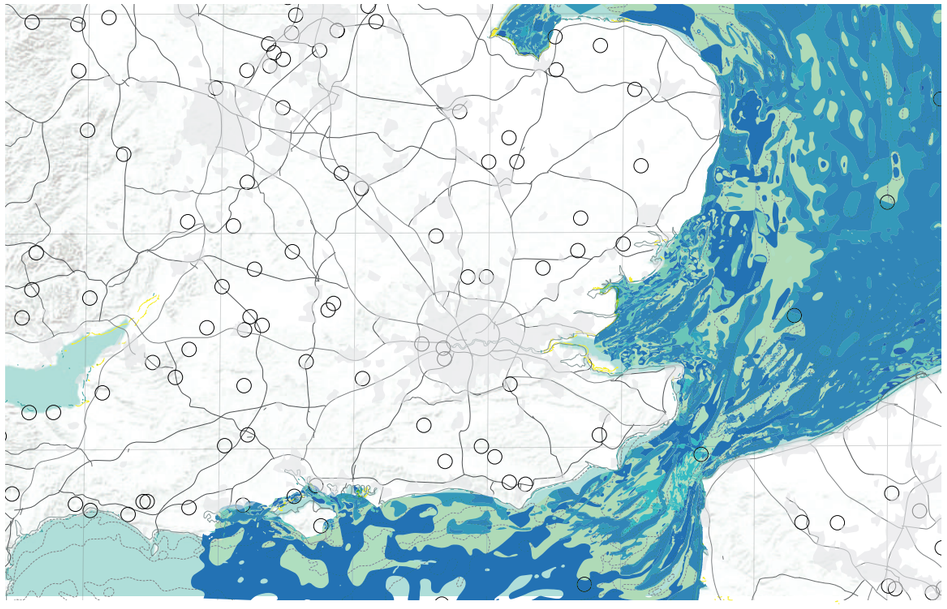


fig 82. Seabed dredging patterns

0km 100km N

http://instaar.colorado.edu/~jenkinsc/dbseabed/coverage/index.html

North Sea Dredging Values

37.306.665 t/y
Netherlands

2.506.502t/y
Denmark

30,567,000 t/y
Germany

5.202.858 /y
United Kingdom

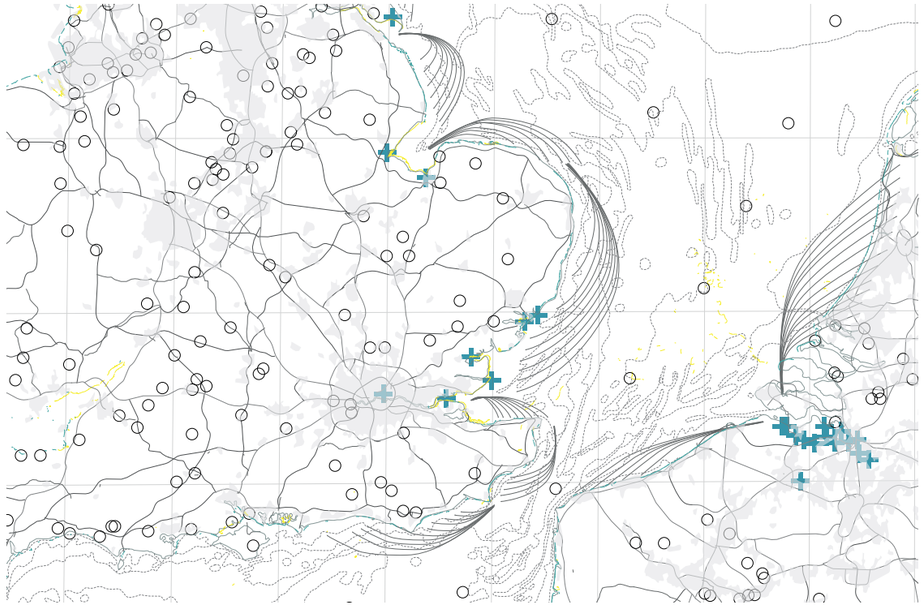


fig 83. North Sea dredging locations

0km 100km N

Research by Design - Supportive data
Factors that influence managed coastal realignment

Soil typology

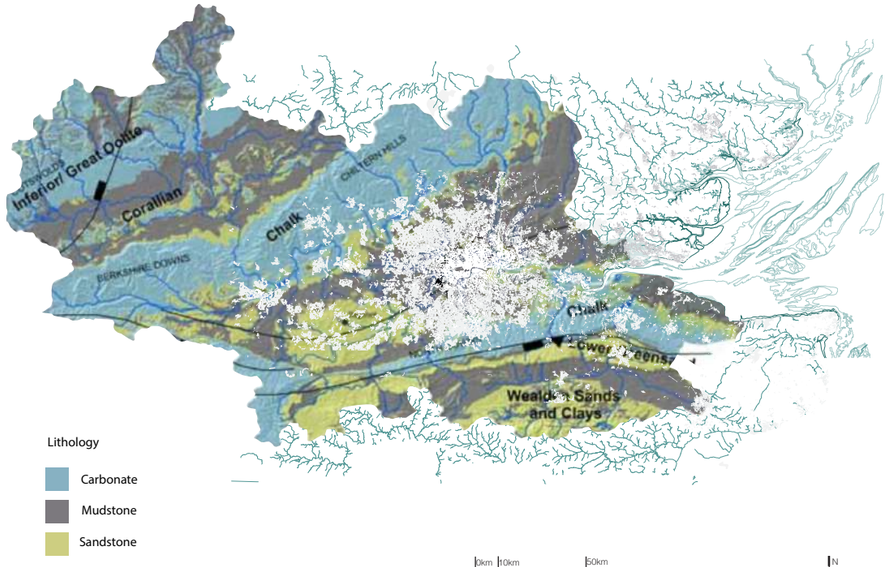


fig 86. Soil typology

Sites of scientific interest

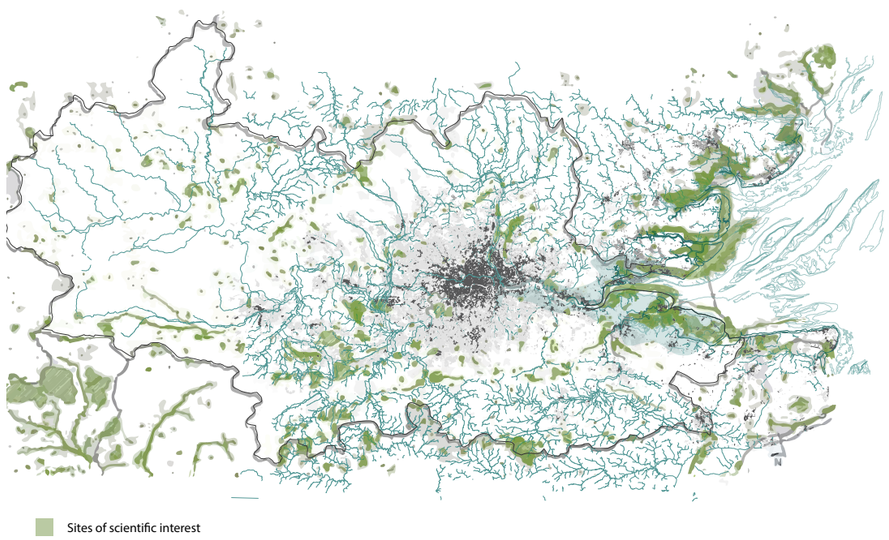


fig 87. Sites of scientific interest

Nature 200 Protection zones

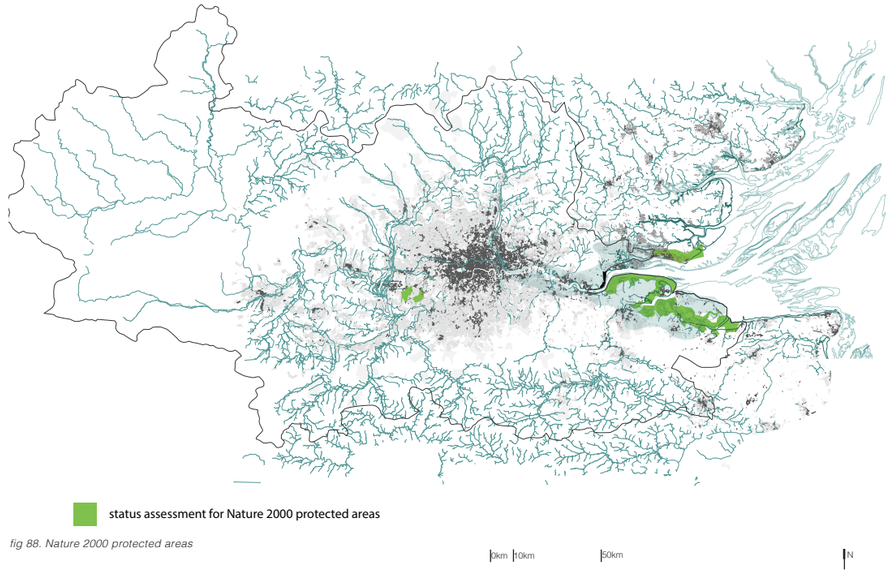


fig 88. Nature 2000 protected areas

Shellfish waters directive

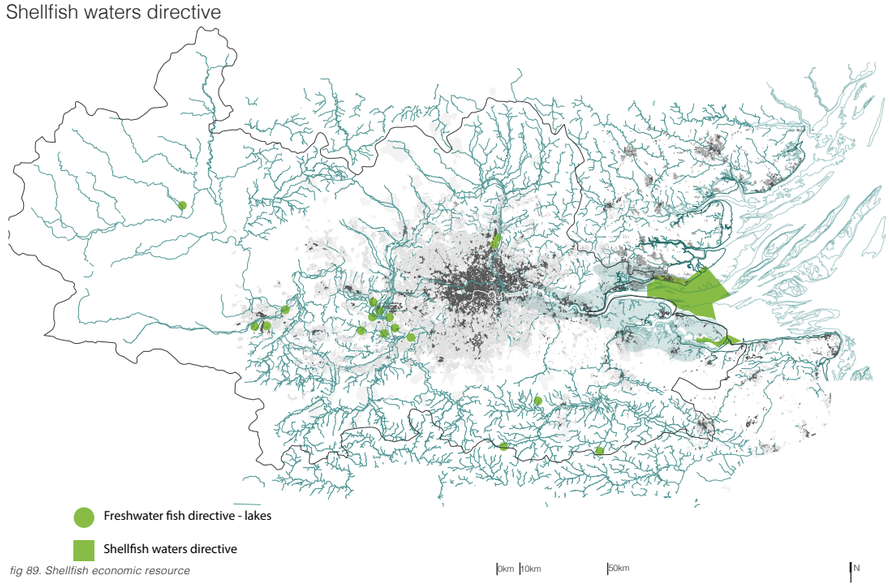


fig 89. Shellfish economic resource

Research by Design - Supportive data
Factors that influence managed coastal realignment

Lithology - influence on the urban system

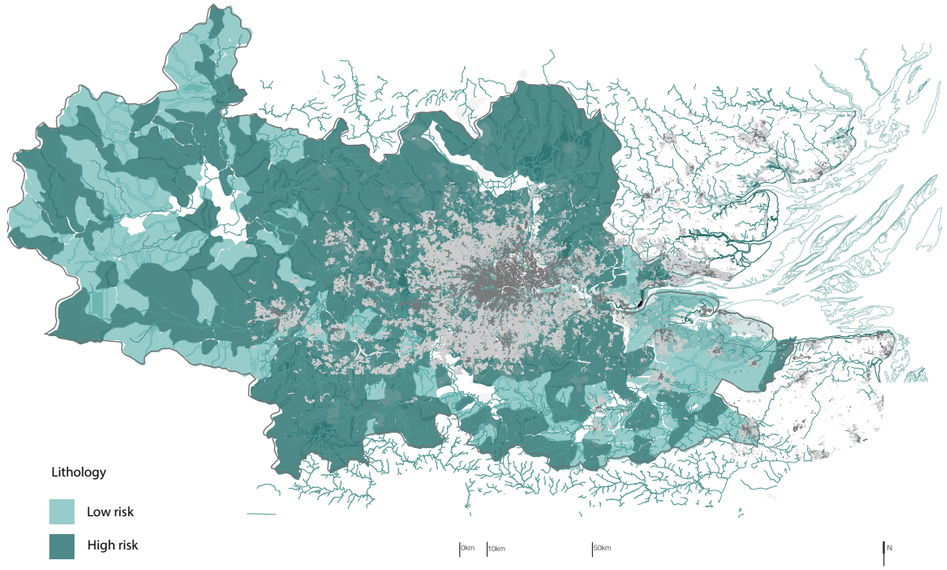
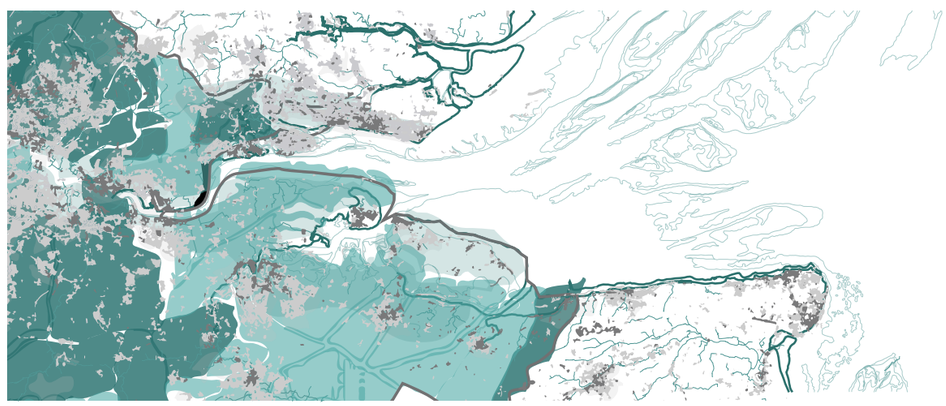


fig 84. Lithology level of risk

For a sustainable intervention, there are additional risk to be considered, as land structure, so that the projected land manipulations can follow their growth plan.



WATER FLOW PREASURES AT RISK

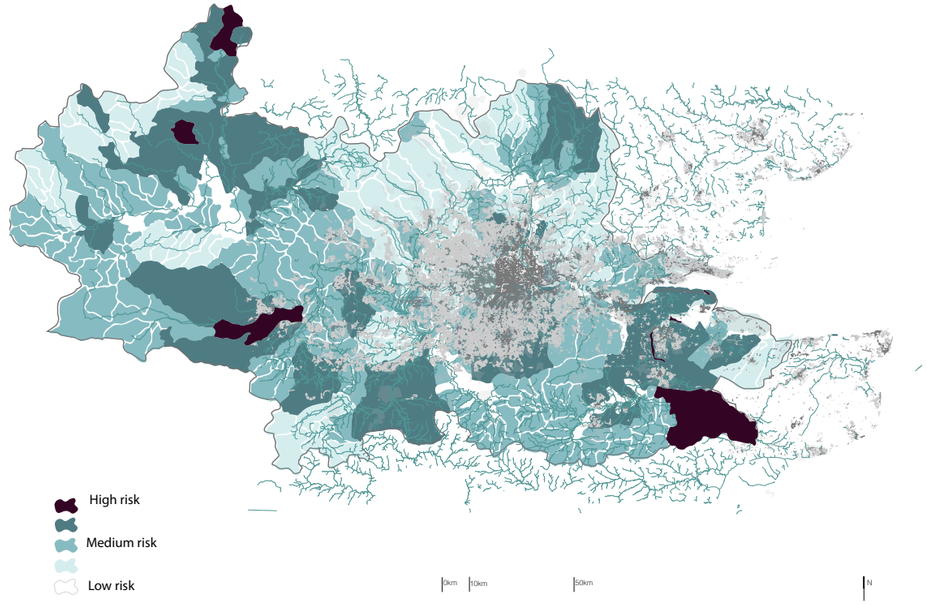
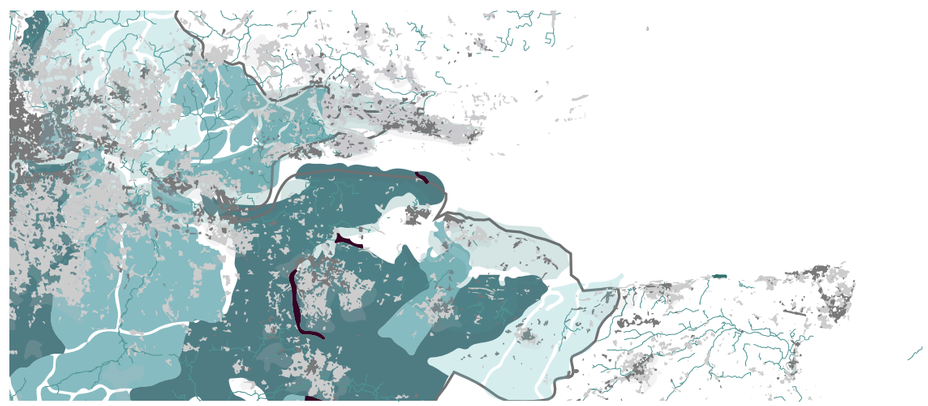


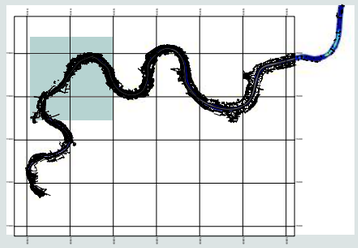
fig 85. Surface water level of risk

A renaturing intervention would have a dual effect, as it will alleviate also the freshwater rivers at risk.



Research by Design - Supportive data
Tidal force distribution along Thames Estuary

Tidal reach analysis



Potential : tidal islands

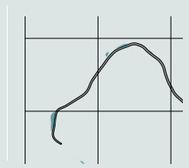
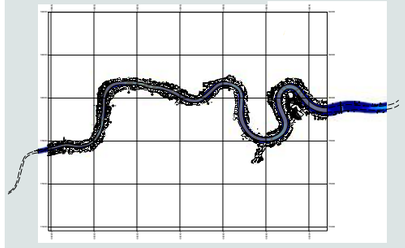


fig 73. Tidal reach one (retrieved from Port of London)



Potential : no clear potential

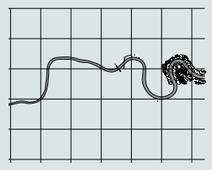
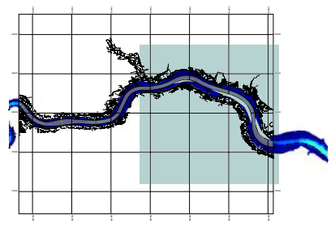


fig 74. Tidal reach two (retrieved from Port of London)



Potential : Jenningtree (10h)

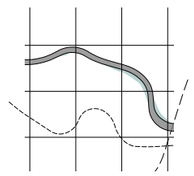
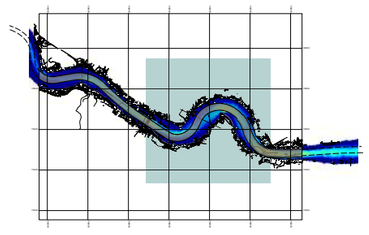


fig 75. Tidal reach three (retrieved from Port of London)



Potential : Broadness (16h)

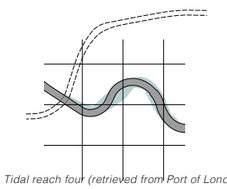
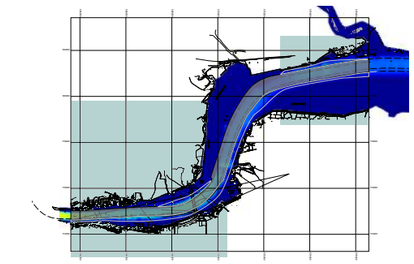


fig 76. Tidal reach four (retrieved from Port of London)



Potential : Gravesend (9h)

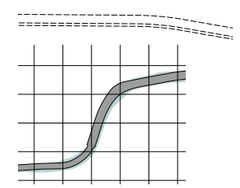
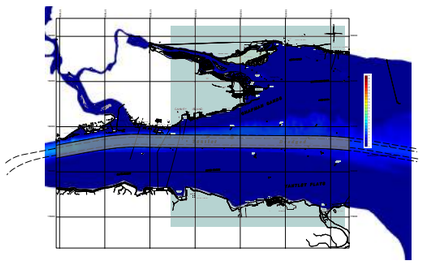


fig 77. Tidal reach five (retrieved from Port of London)



Potential : Yantlet flats (6h)

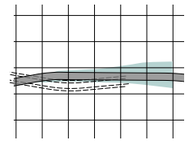
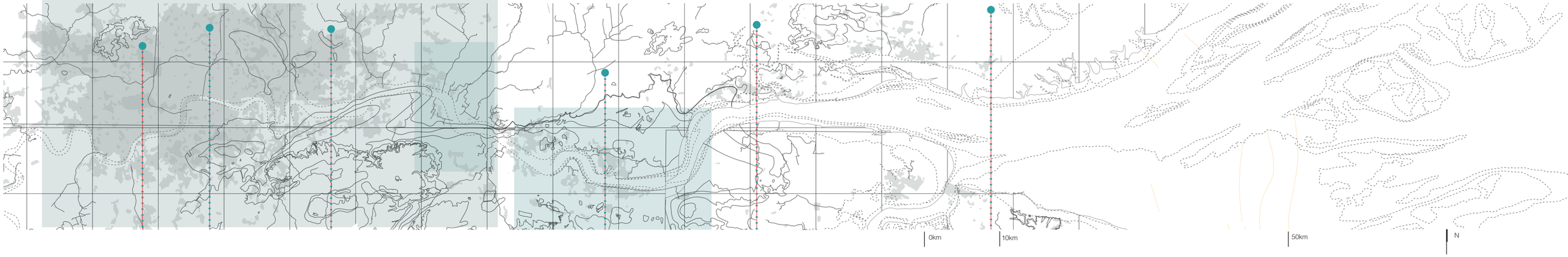
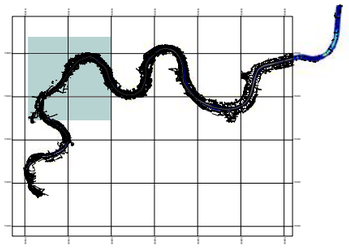


fig 78. Tidal reach six (retrieved from Port of London)



Research by Design - Supportive data
Tidal force distribution along Thames Estuary

Tidal reach analysis



Potential : tidal islands

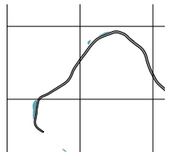
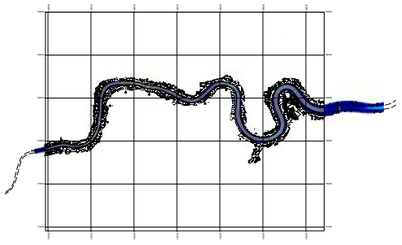


fig 73. Tidal reach one (retrieved from Port of London)



Potential : no clear potential

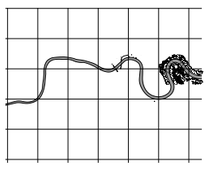
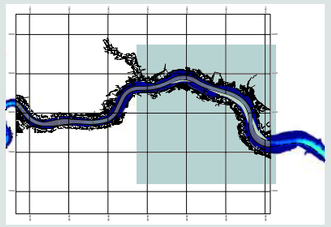


fig 74. Tidal reach two (retrieved from Port of London)



Potential : Jenningtree (10h)

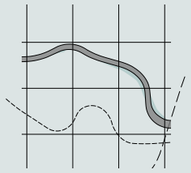
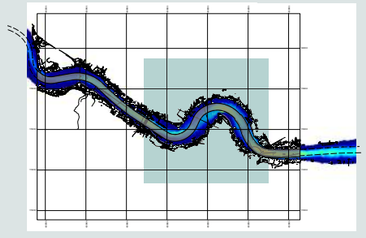


fig 75. Tidal reach three (retrieved from Port of London)



Potential : Broadness (16h)

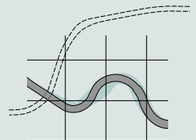
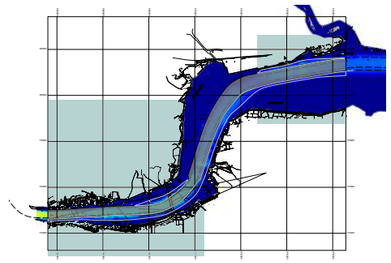


fig 76. Tidal reach four (retrieved from Port of London)



Potential : Gravesend (9h)

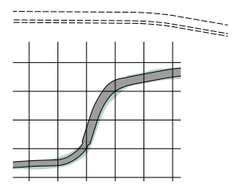
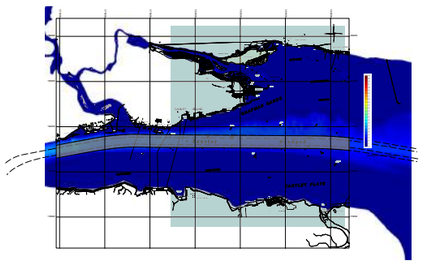


fig 77. Tidal reach five (retrieved from Port of London)



Potential : Yantlet flats (6h)

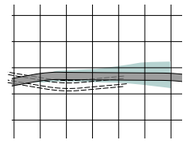
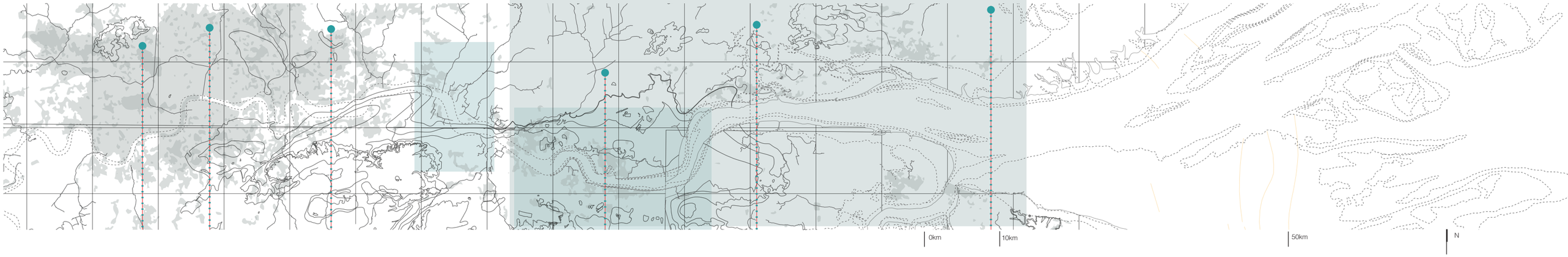
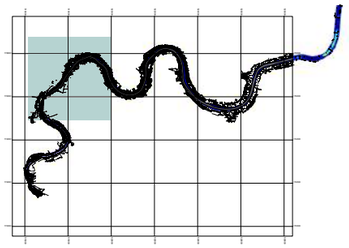


fig 78. Tidal reach six (retrieved from Port of London)



Research by Design - Supportive data
Tidal force distribution along Thames Estuary

Tidal reach analysis



Potential : tidal islands

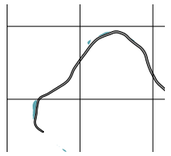
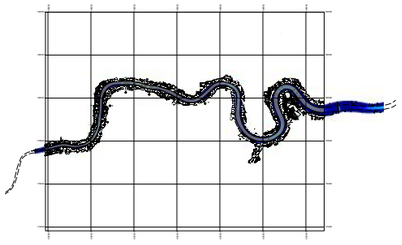


fig 73. Tidal reach one (retrieved from Port of London)



Potential : no clear potential

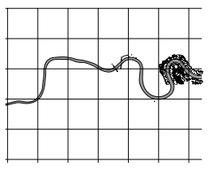
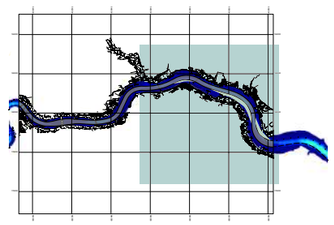


fig 74. Tidal reach two (retrieved from Port of London)



Potential : Jenningtree (10h)

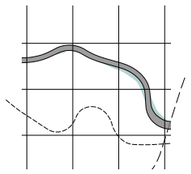
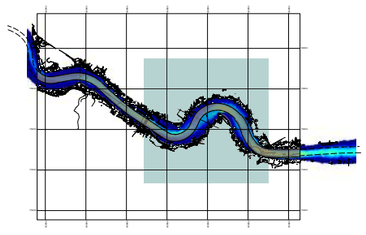


fig 75. Tidal reach three (retrieved from Port of London)



Potential : Broadness (16h)

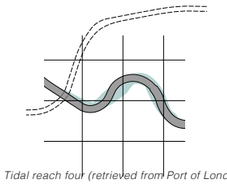
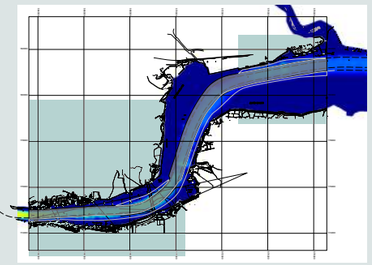


fig 76. Tidal reach four (retrieved from Port of London)



Potential : Gravesend (9h)

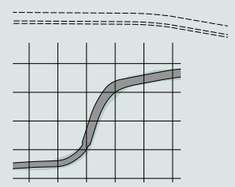
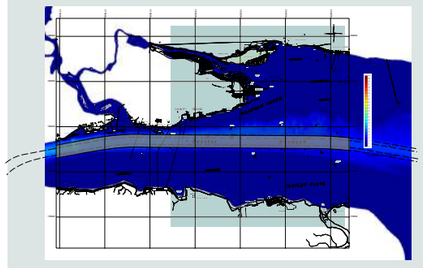


fig 77. Tidal reach five (retrieved from Port of London)



Potential : Yantlet flats (6h)

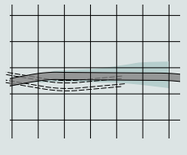
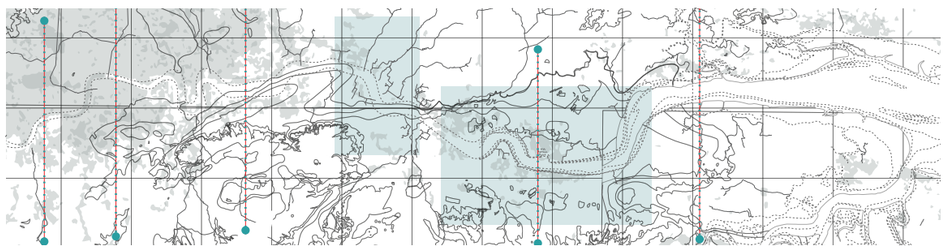


fig 78. Tidal reach six (retrieved from Port of London)

Research by Design - Supportive data
Tidal force distribution along Thames Estuary

Tidal reach analysis



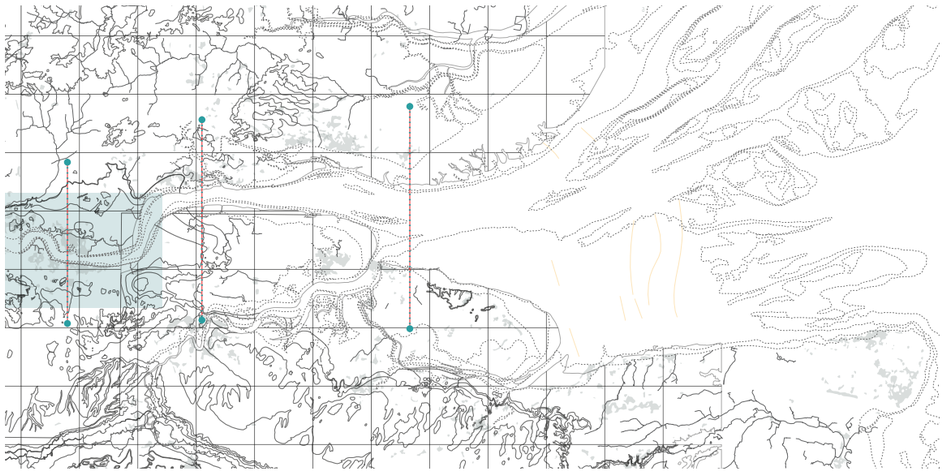
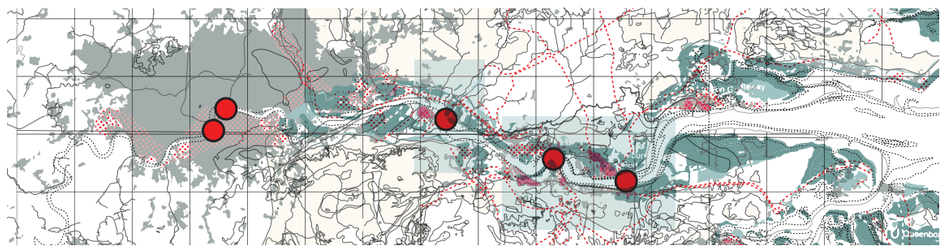


fig 81. Thames dual typology for intervention - land/water intervention



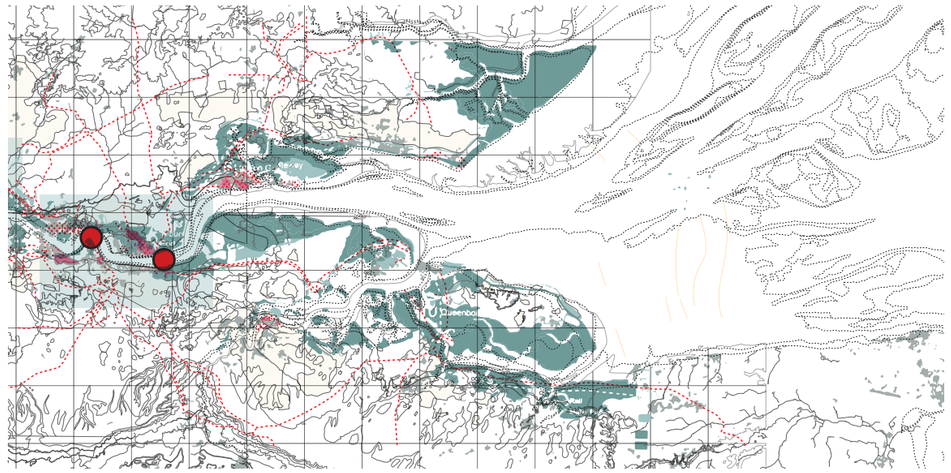
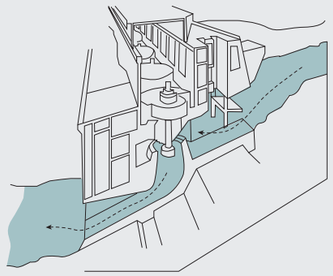


fig 71. Conclusion - land -water suitability

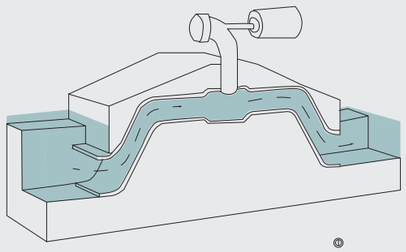
Research by Design - Supportive data
Tidal force distribution along Thames Estuary

Enclosure technology

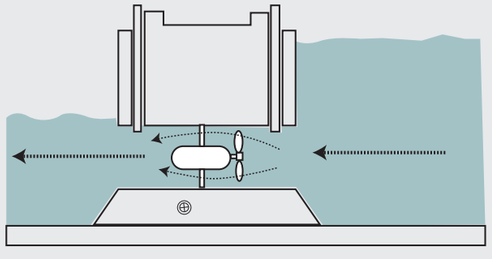
Tidal burried barrage

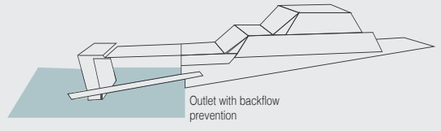


Siphon air turbine



Turbine tunnel



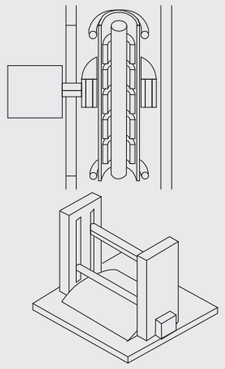


SCIENTIFIC RELEVANCE
Current sustainability concerns address carbon, water and transit, however they are all interconnected by energy. The more optimal the energy system responds to the natural processes of the urbanity and the natural unpredictability, the more efficient a metropolis

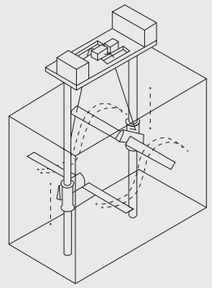
fig 94. Tidal enclosure technology

River flow extraction

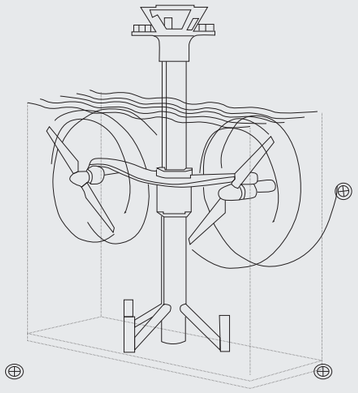
Vivace converter



Pulse stream 100



Open centre turbine



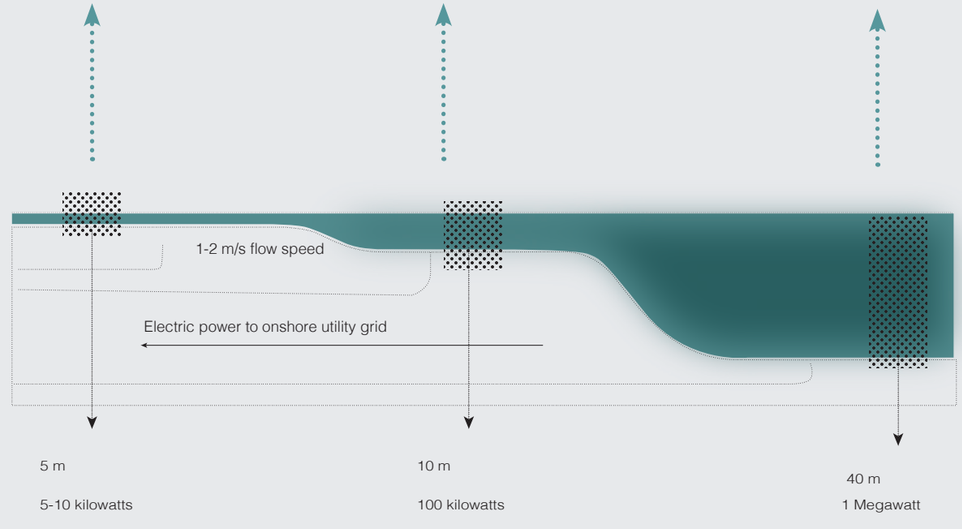


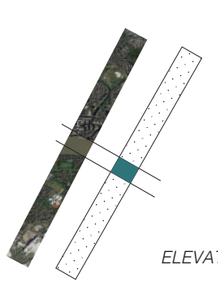
fig 95. Tidal extraction technology

Research by Design - Location assessment
Transect criteria revealing landscape potential and urbanisation intensity

Revealing Thames Genome

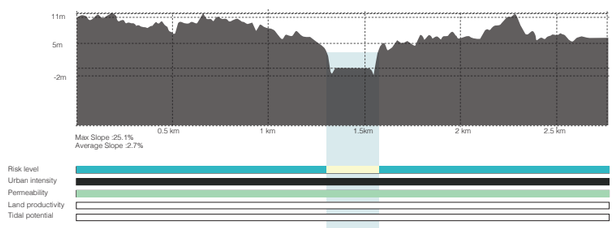
TIDAL THAMES - URBAN BANKS

PRODUCTIVITY AND OCCUPANCY PATTERN



ELEVATION MODEL

SLOPE



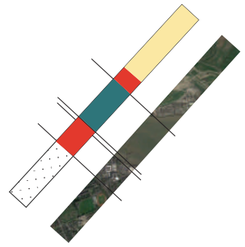
WATER INTEGRATION

SUITABILITY CRITERIA

risk level
urban intensity
permeability
land productivity
tidal potential

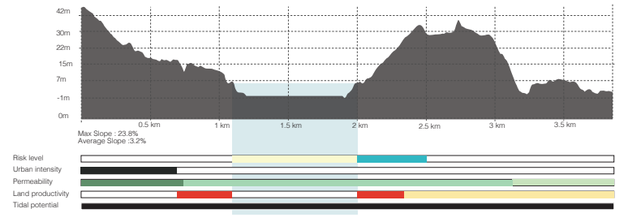
TIDAL THAMES - ESTUARINE MOUTH

PRODUCTIVITY AND OCCUPANCY PATTERN



ELEVATION MODEL

SLOPE



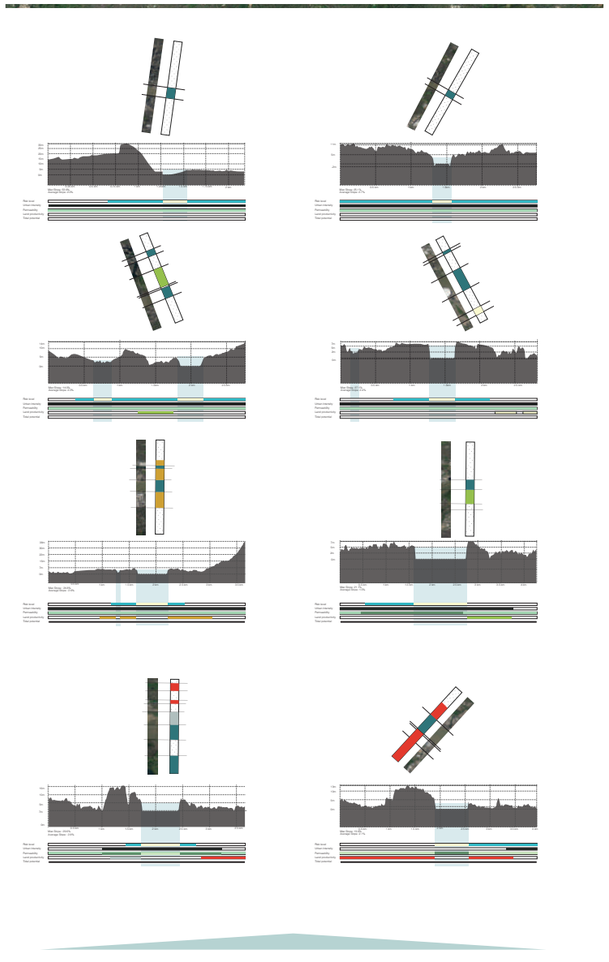
WATER INTEGRATION

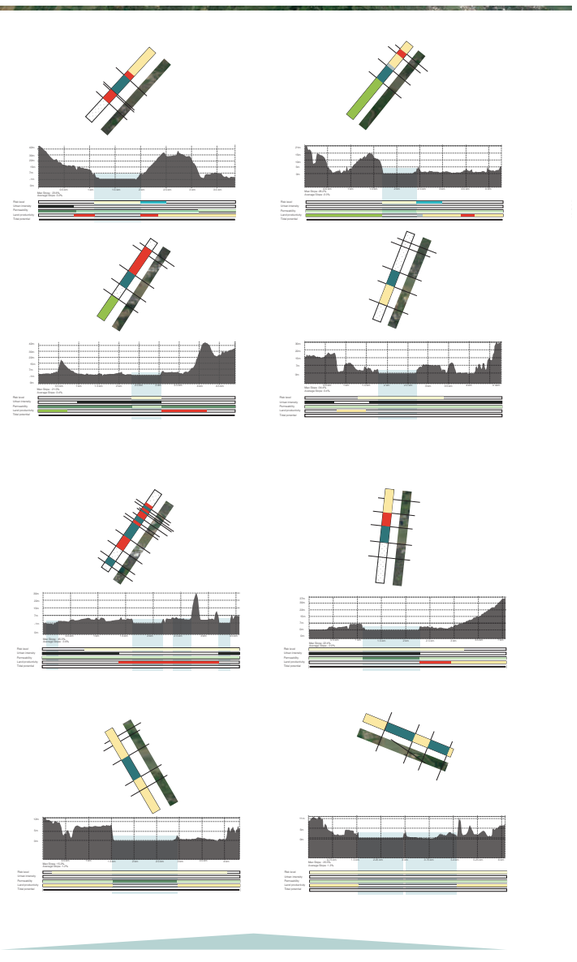
SUITABILITY CRITERIA

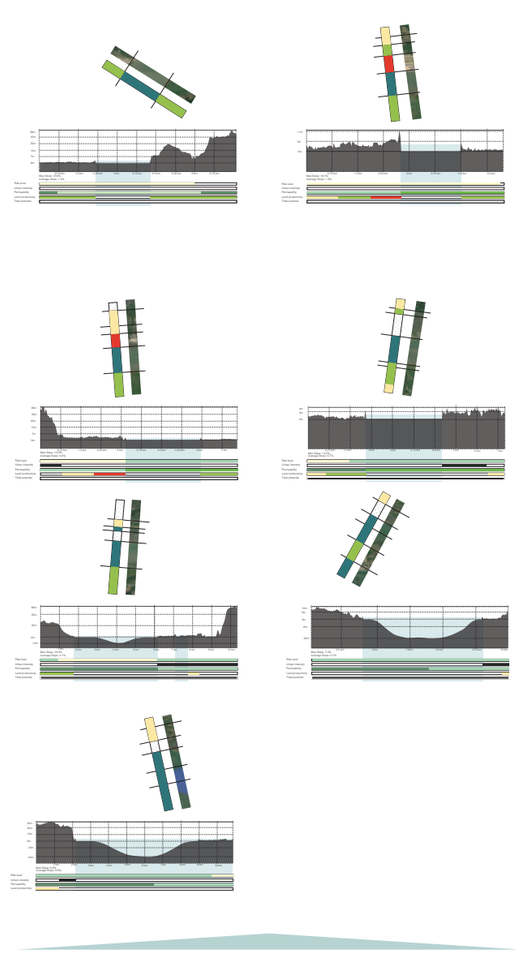
risk level
urban intensity
permeability
land productivity
tidal potential

Research by Design - Location assessment
Transect criteria revealing landscape potential and urbanisation intensity

Revealing Thames Genome

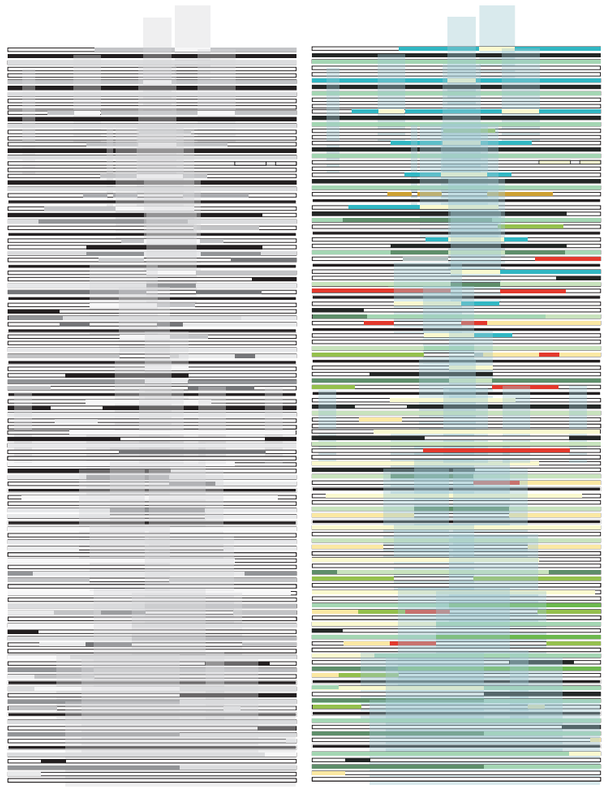


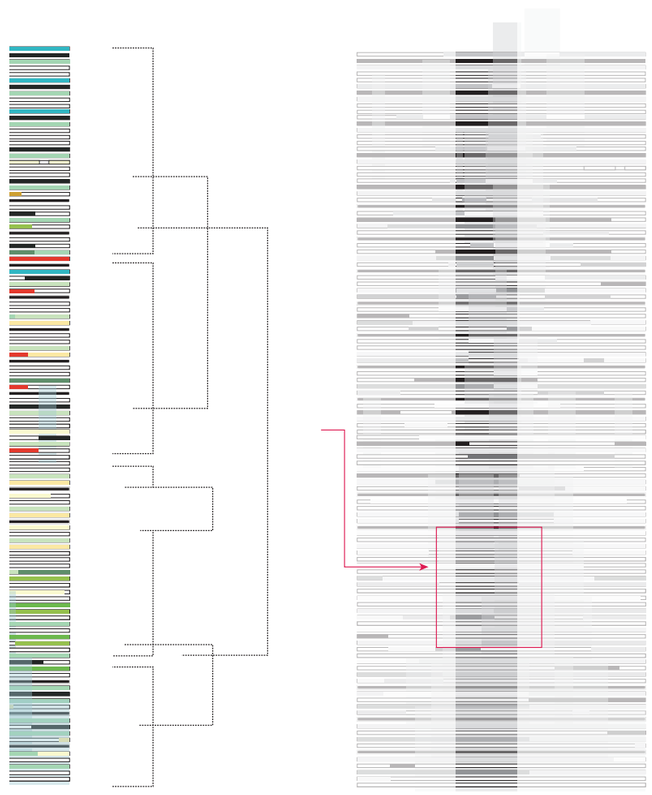


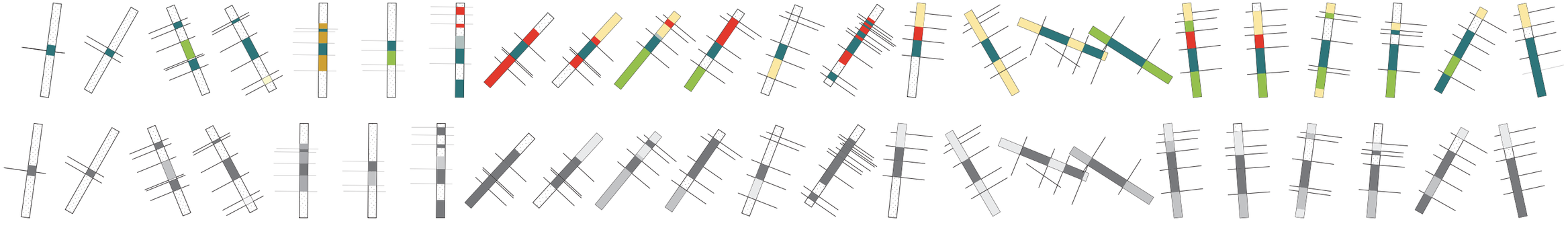


Research by Design - Location assessment
Transect criteria revealing landscape potential and urbanisation intensity

Revealing Thames Genome - Intervention Gradients







Research by Design - Location assessment

Transect criteria revealing landscape potential and urbanisation intensity

Value Table - Hierarchical structure

No.	TIDAL SURGE RISK LEVEL			URBAN INTENSITY			PERMEABILITY			TIDAL POTENTIAL		SOIL PRODUCTIVITY			TOTAL VALUE	SITE INTENSITY	INTERVENTION SCALE			INTERVENTION TYPOLOGY	TIMEFRAME		
1	1					5	0			0		0			6	L0	S	M	L	1	I	II	III
2	1					5	0			0		0			6	L0	S	M	L	1	I	II	III
3	1					5	0			0		0			6	L0	S	M	L	1	I	II	III
4	1					5	0			0		0			6	L0	S	M	L	1	I	II	III
5	1					5	0			0			3		9	L0	S	M	L	1	I	II	III
6	1					5		3			3	0			12	L0	S	M	L	1	I	II	III
7	1				3				5		3		3		15	L0	S	M	L	1	I	II	III
8	1				3				5		3			5	17	L0	S	M	L	1	I	II	III
9	1				3				5		3			5	20	L0	S	M	L	1	I	II	III
10	1			0					5		3		3		12	L0	S	M	L	1	I	II	III
11	1				3			3			3		3		12	L0	S	M	L	1	I	II	III
12		2				5			5	0			3		15	L0	S	M	L	1	I	II	III
13		2			3				5	0				5	15	L0	S	M	L	1	I	II	III
14		2			3				5		3			5	18	L0	S	M	L	1	I	II	III
15		2		0					5		3			5	15	L0	S	M	L	1	I	II	III
16		2		0					5	0				5	12	L0	S	M	L	1	I	II	III
17		2			0				5	0			3		13	L0	S	M	L	1	I	II	III
18		2		0				3		0			3		8	L0	S	M	L	1	I	II	III
19			3	0				3		0			3		9	L0	S	M	L	1	I	II	III
20			3		3			3			3		3		15	L0	S	M	L	1	I	II	III
21			3		3		0				3		3		12	L0	S	M	L	1	I	II	III
22			3		3		0				3	0			9	L0	S	M	L	1	I	II	III
23			3		3		0			0			3		9	L0	S	M	L	1	I	II	III

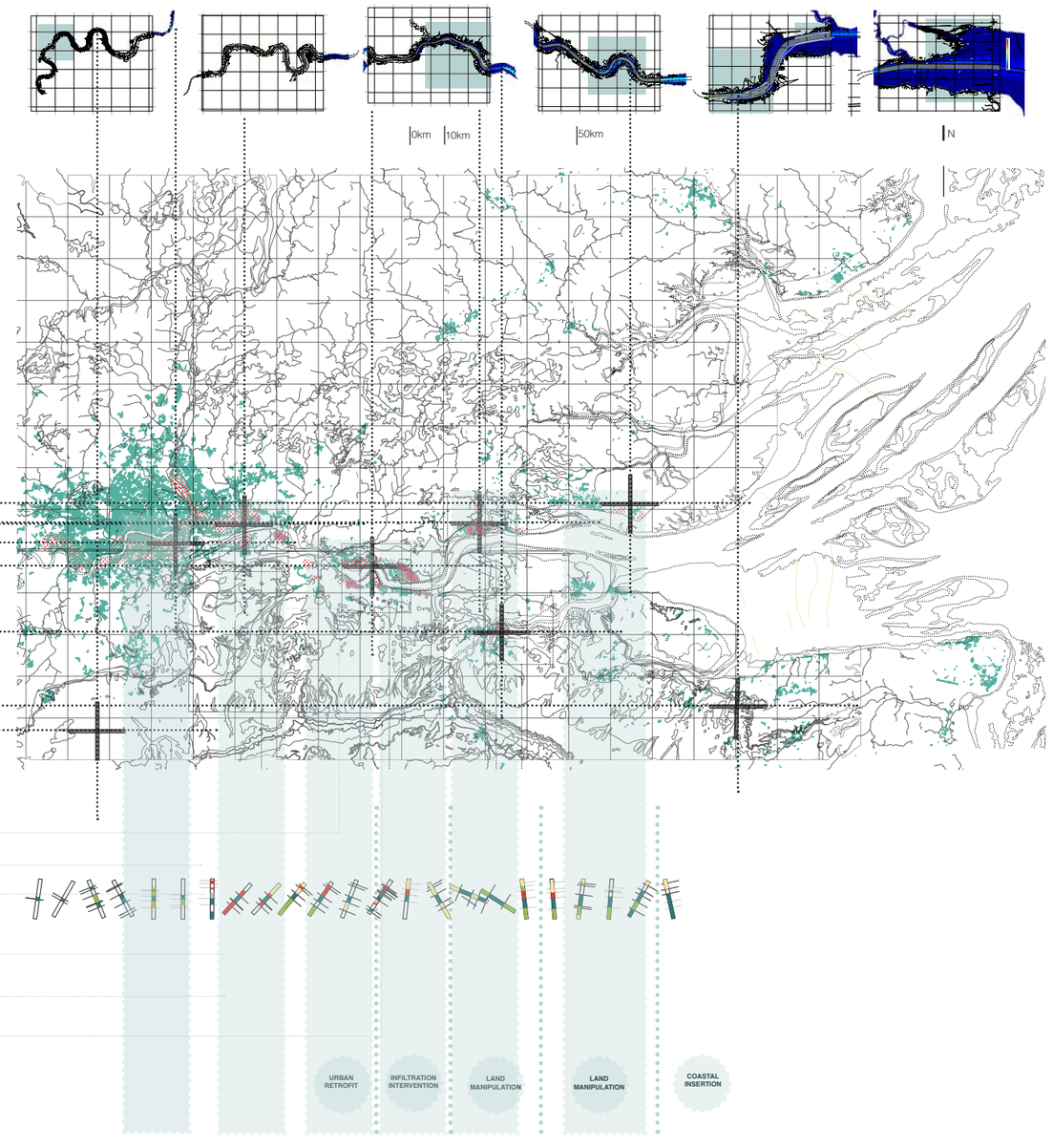
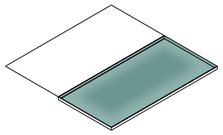


fig 65-68. Suitability layers

Research by Design - Location assessment
Transect criteria revealing landscape potential and urbanisation intensity

Genealogies - Pairing site intensity

L0

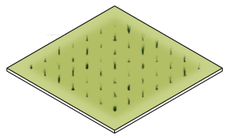


COASTAL

1
3
4
6
7
10

Creek enhancement

L1

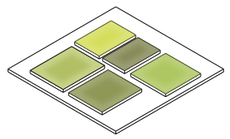


OPEN GRASSLAND

1
2
3
4
5
6
7
8
9
10
1
12
13
14

Engineered energetic pond

L2

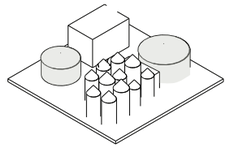


AGICULTURAL

1
2
3
4
5
6
8
9
11

river redirection
affluent pressure
hierarchical irrigation
swamp conditions(tidal lagoon)

L3

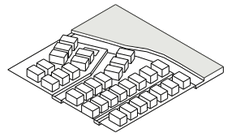


INDUSTRIAL &
LOGISTICS

2
3
4
5
6
8

infiltration
surface permeability
artificial creek with conduit
substrate drain pipelines
storage tank geocellular
transformation stations

L4

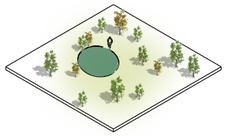


LOW DENSITY
URBAN

2
3
5
8
11

new integrated urban living
(aquaculture +housing)
refloodable areas
green-blue belt
transformation stations
wetland control
artificial creek discharge

L5



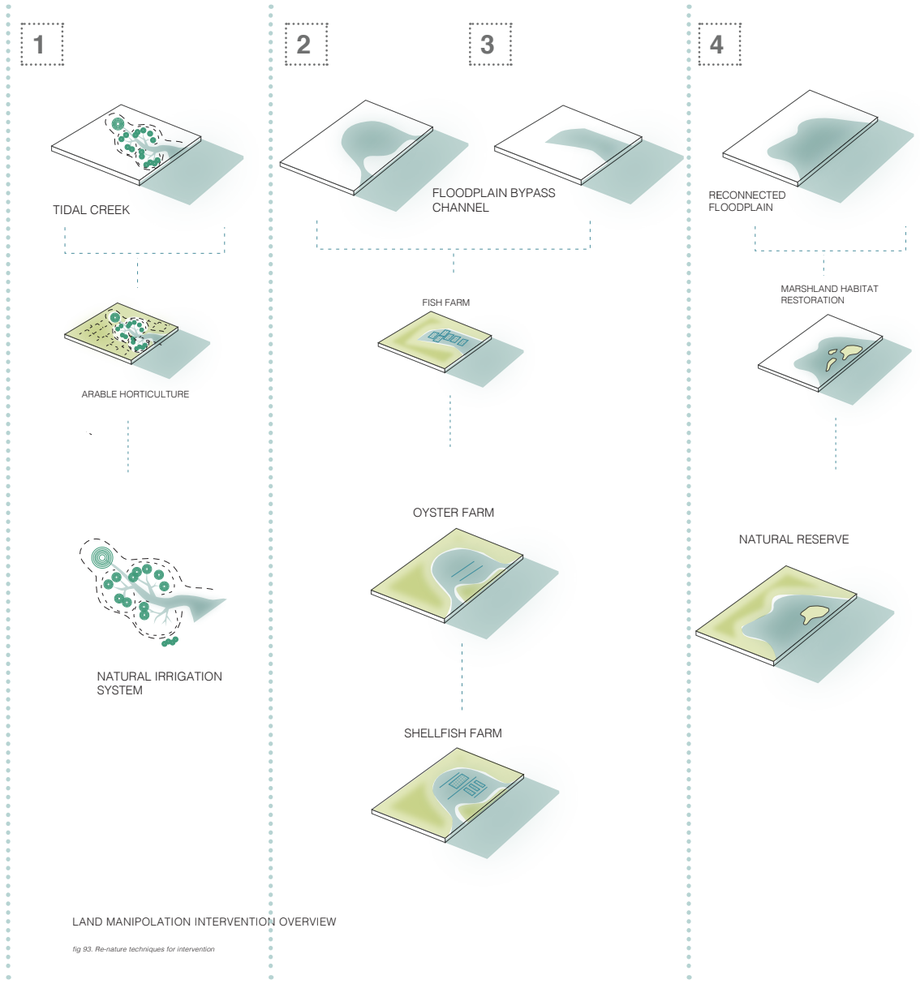
NATURAL
BIODIVERSITY SITE

9
5
8
11

perimetral relief
artificial discharge
gentle remediation techniques
induced species repopulation

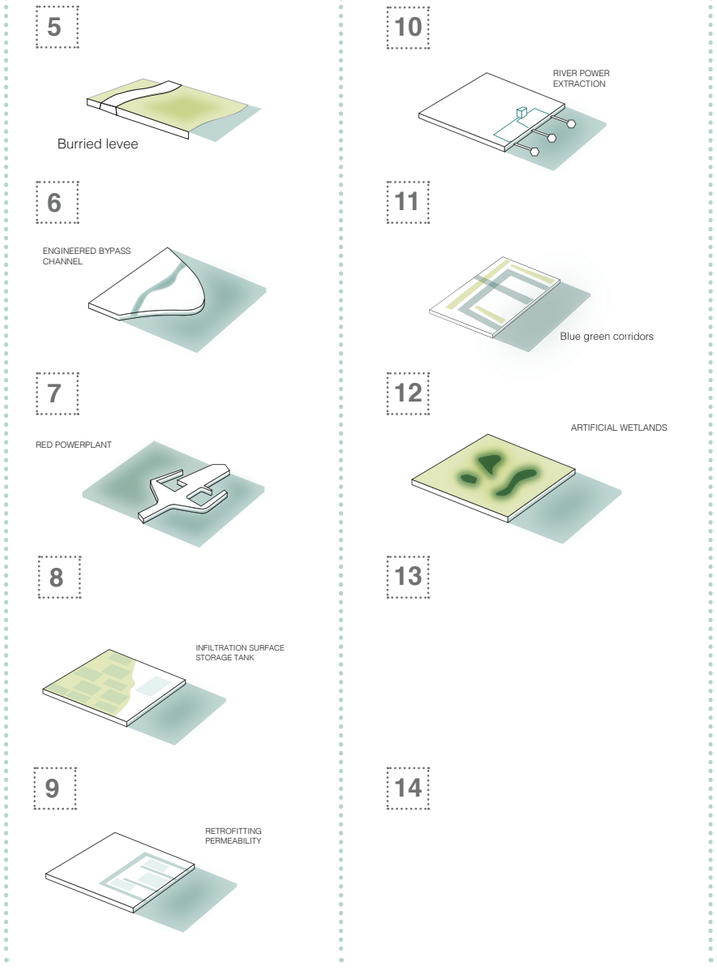
Research by Design - Location assessment
Transect criteria revealing landscape potential and urbanisation intensity

Genealogies - Intervention guide



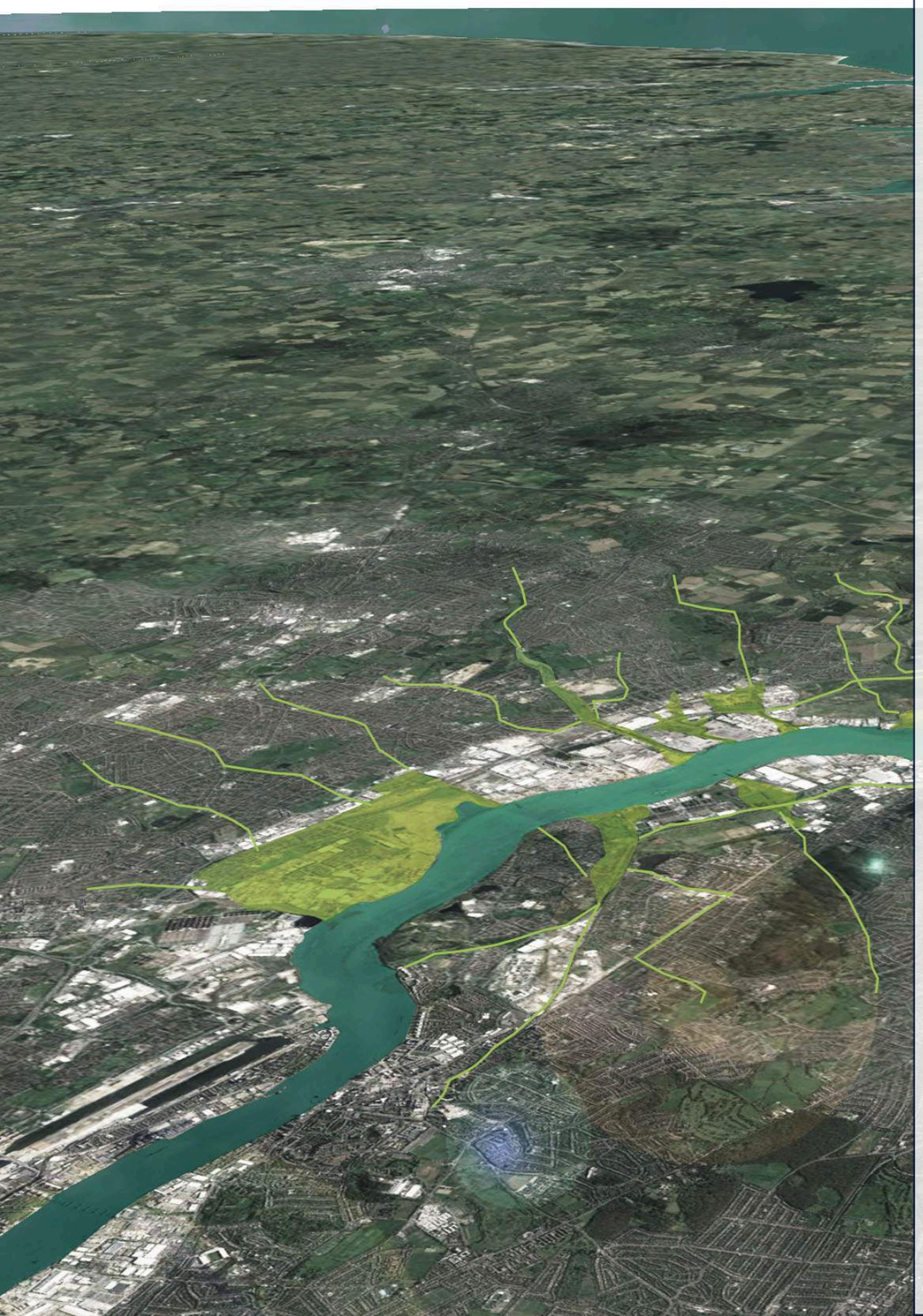
LAND MANIPOLATION INTERVENTION OVERVIEW

fig 93. Re-nature techniques for intervention



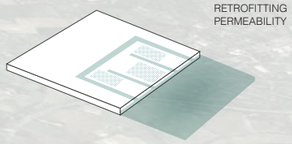
Spatial applicability

Research by Design - Location assessment
Location assessment



Spatial applicability

Barking reach power station



Rainham

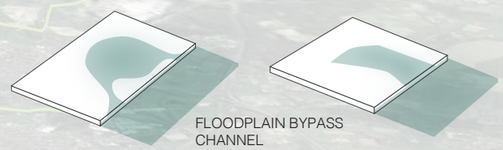
ENGINEERED BYPASS CHANNEL

Spatial applicability

Research by Design - Location assessment
Location assessment

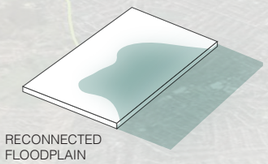
Spatial applicability

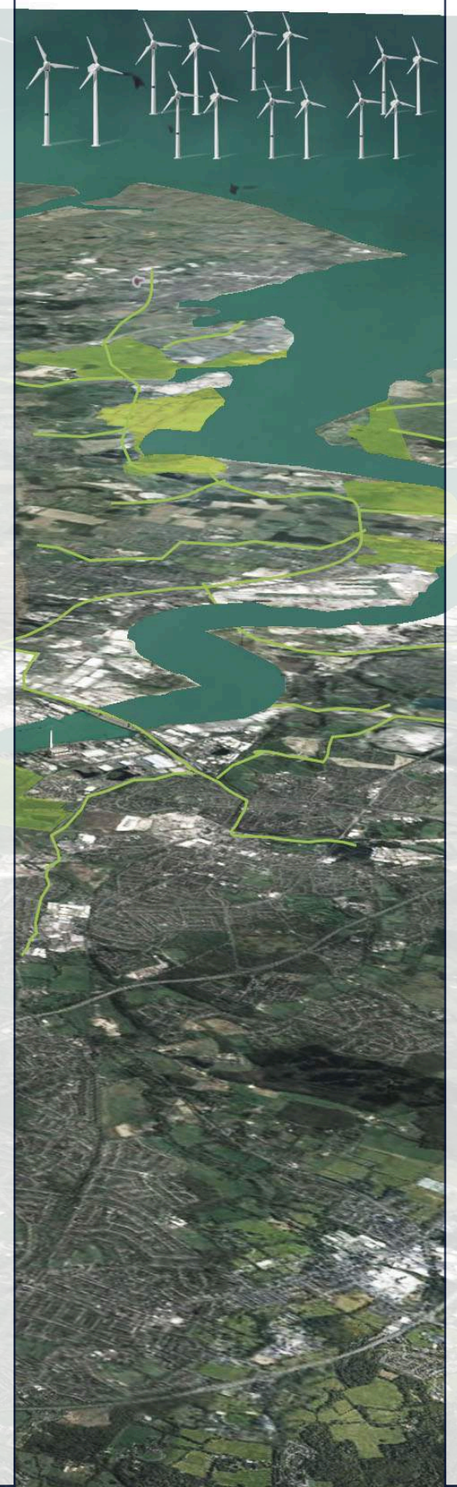
Tillbury power station



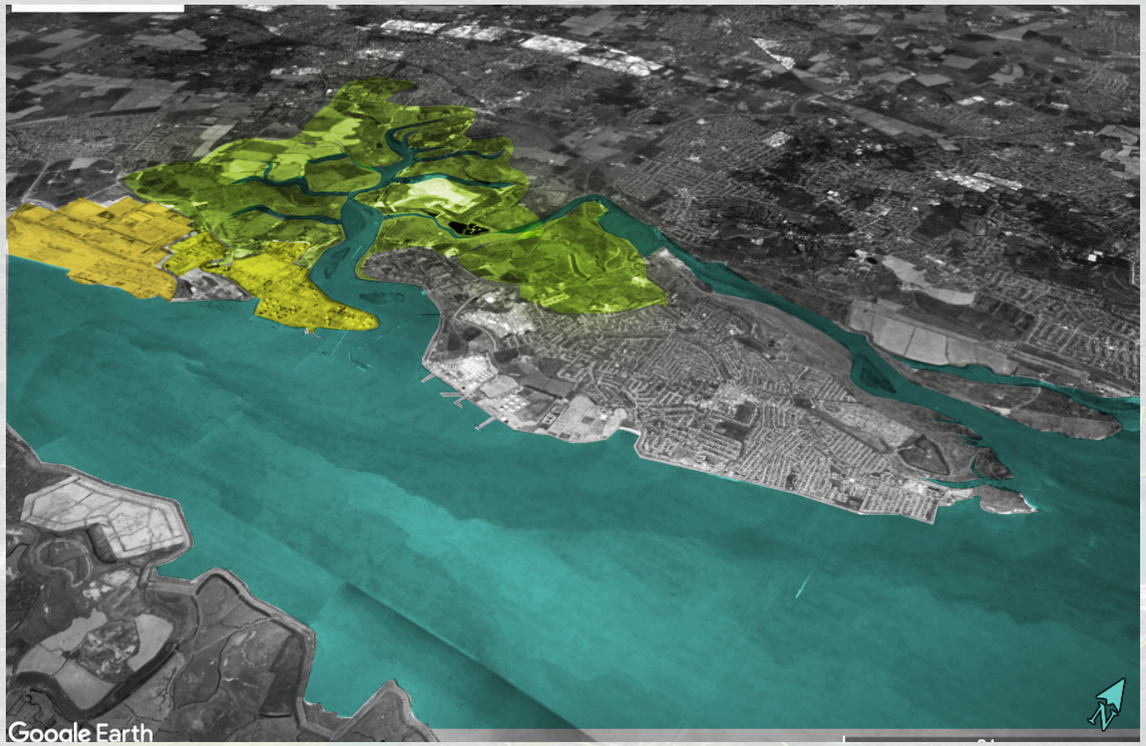
Spatial applicability

Kingsnorth power station

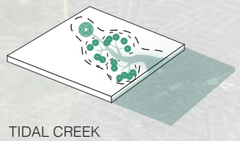




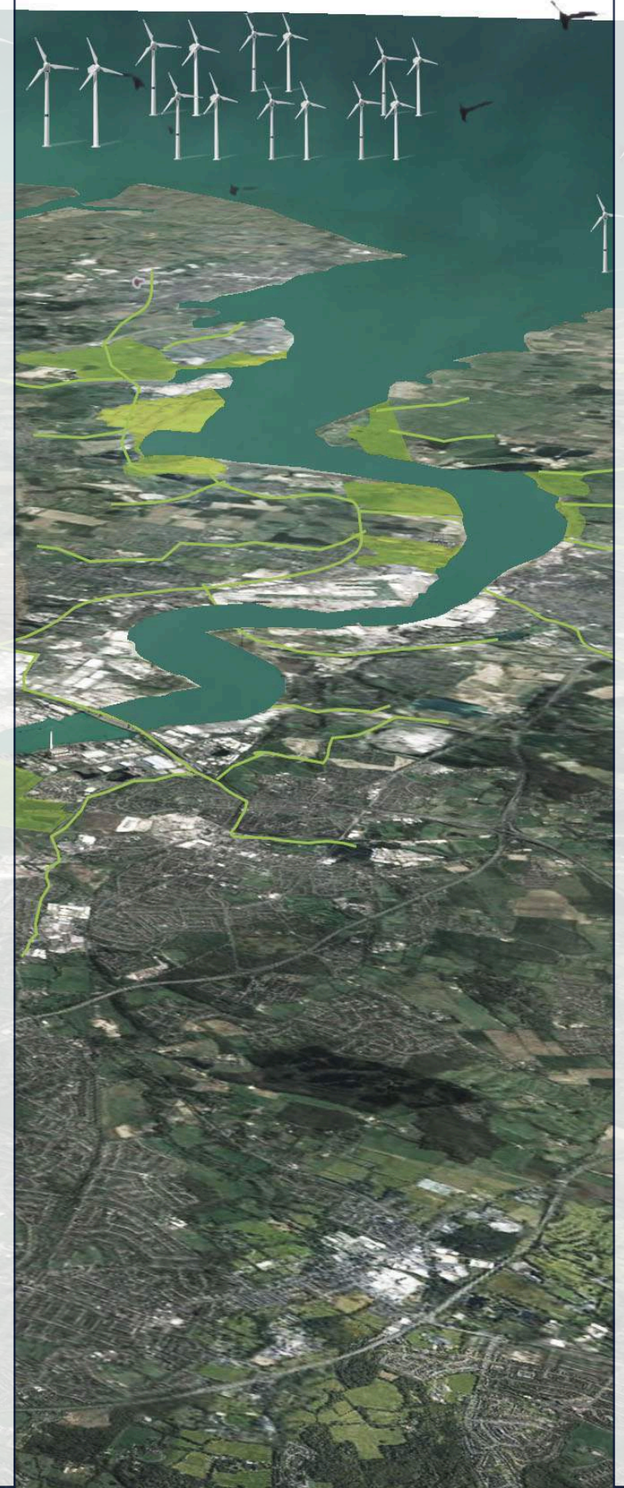
Spatial applicability



Canvey island

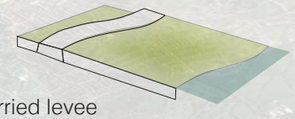


TIDAL CREEK

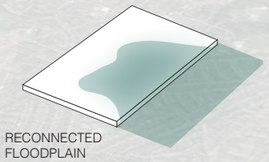


Spatial applicability

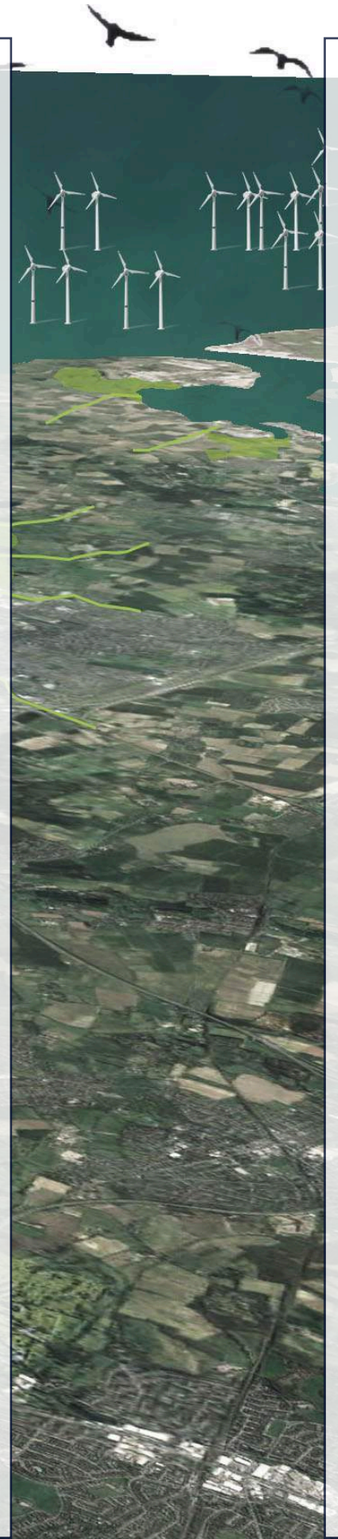
Uptown



Burried levee



RECONNECTED
FLOODPLAIN



Research by Design - Location assessment
Location assessment

Spatial applicability

Spatial applicability

Canvey island

TIDAL CREEK

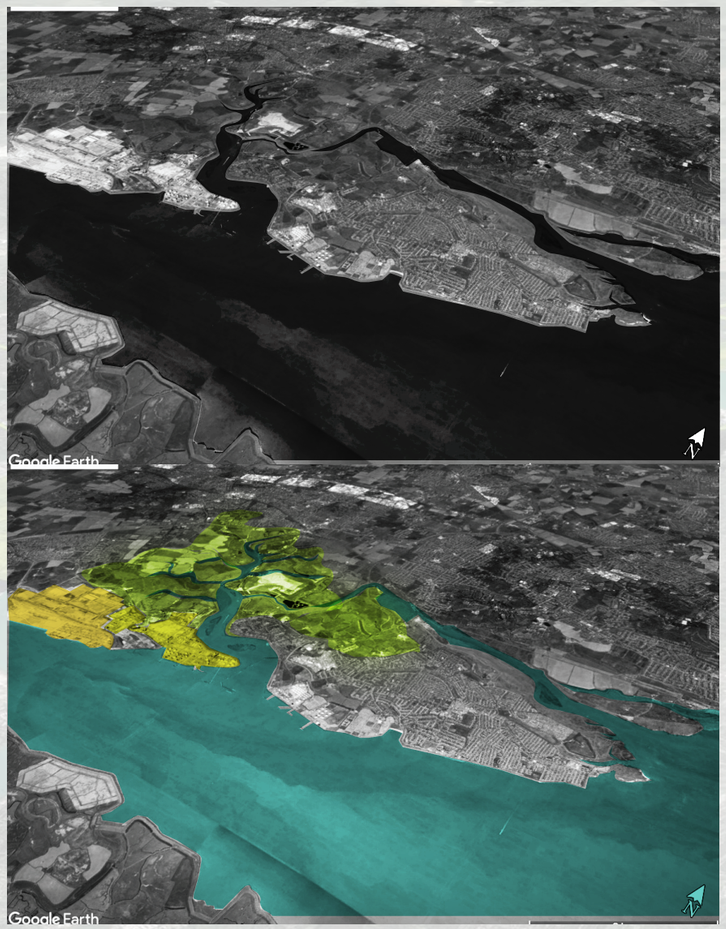
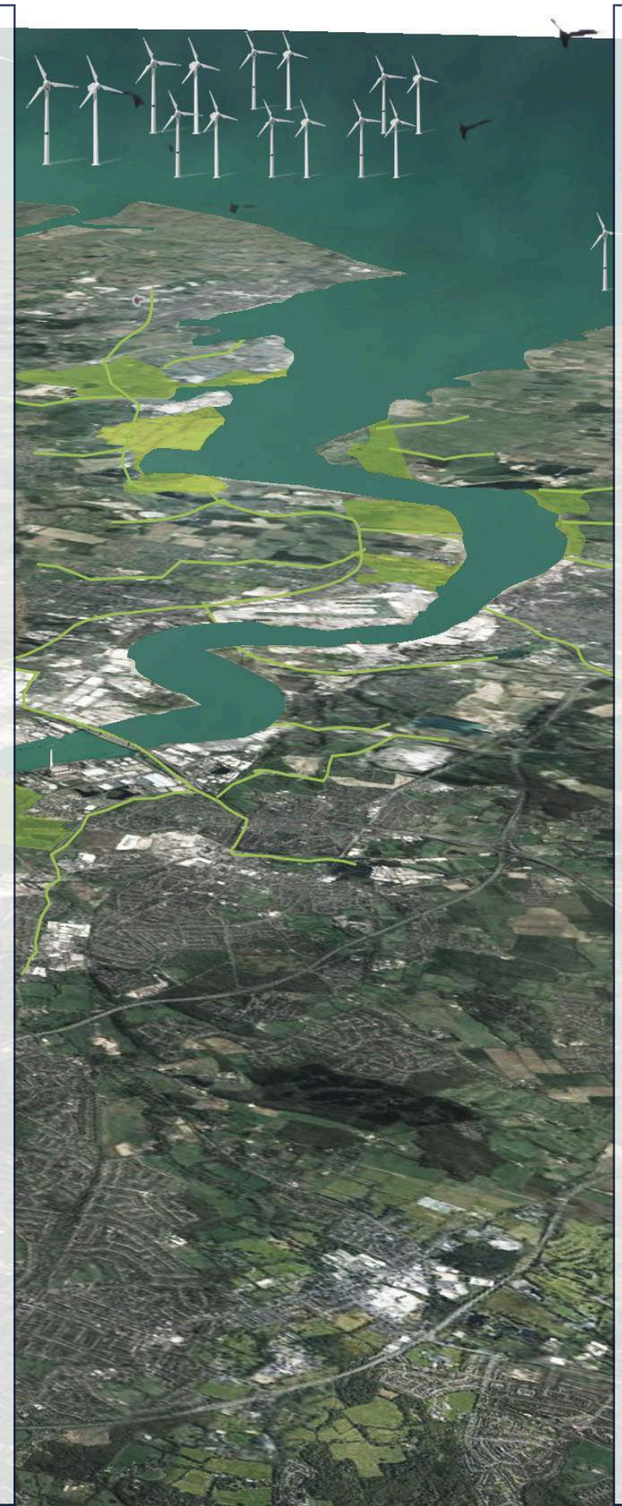


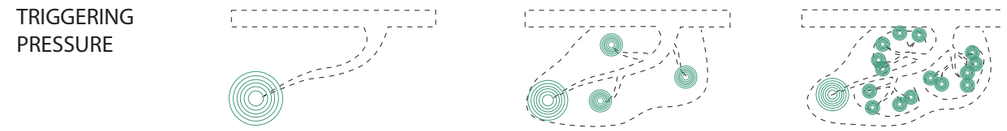
fig 102. Project 7 - Canvey island



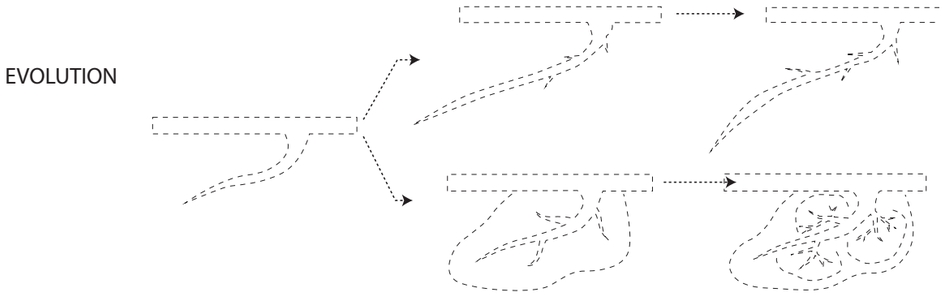
Research by Design - Location assessment
Location assessment

fig 105. Canvey island project - selected location

Creek triggers and evolution



WITHOUT CONTROL

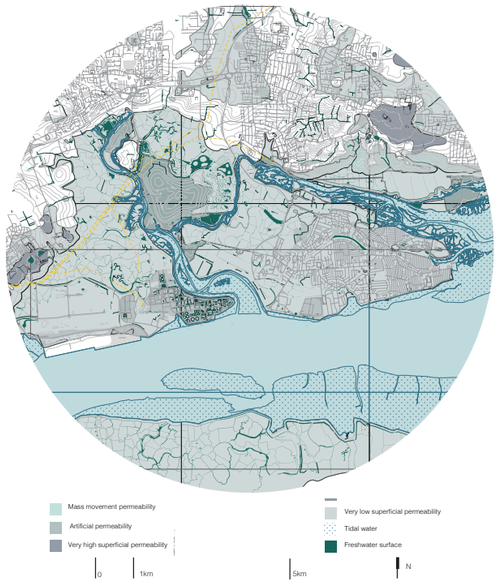


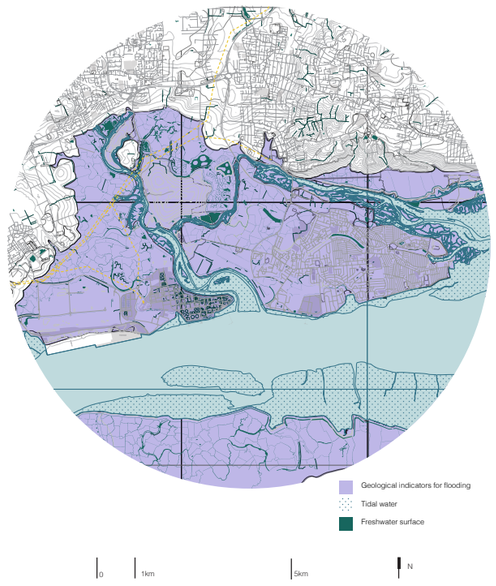
WITH CONTROL

fig 106. Tidal creek pressure points and predicted evolution

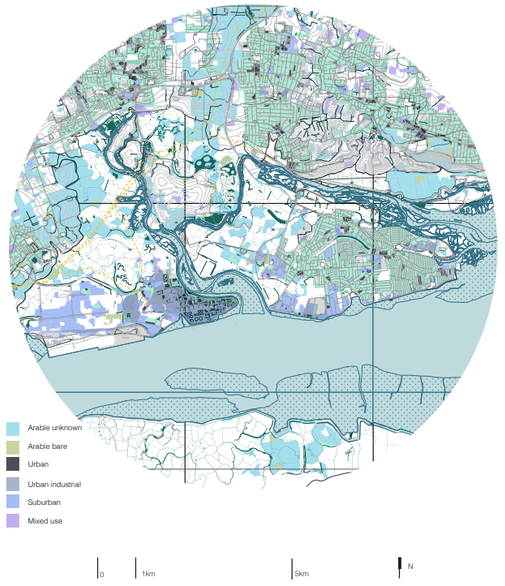
Research by Design - Location assessment
Location assessment

Preffered location - permeability analysis





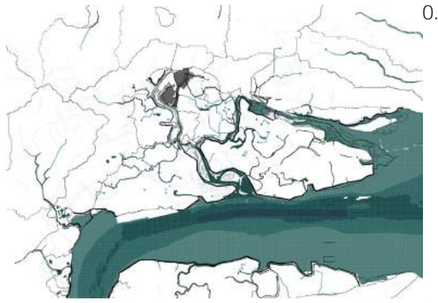
Preffered location - available land for intervention

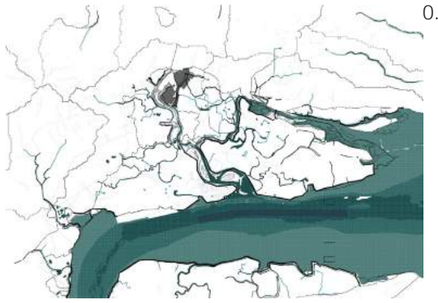


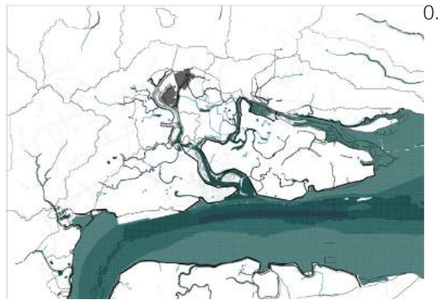
Preffered location - intense urban areas

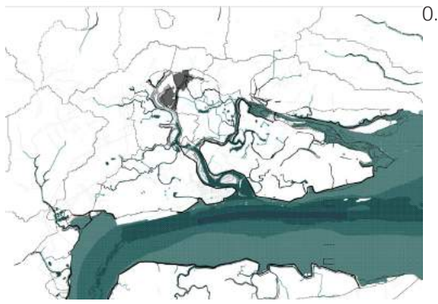
Design
Defining flooding pattern

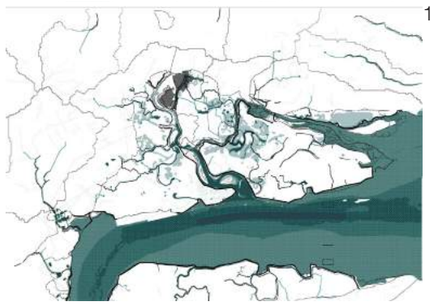
0-2m Sea level rise hypothesis

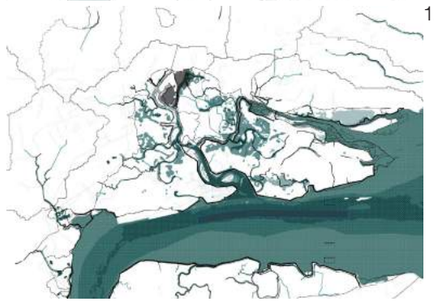


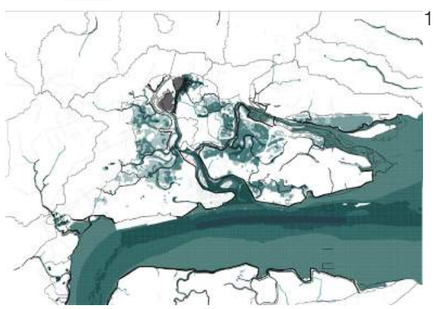


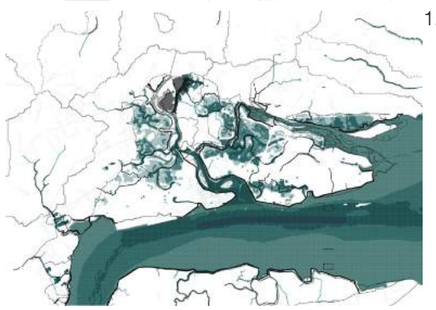


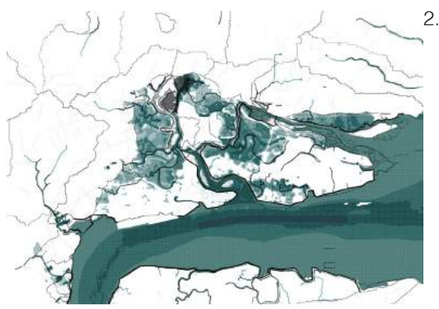




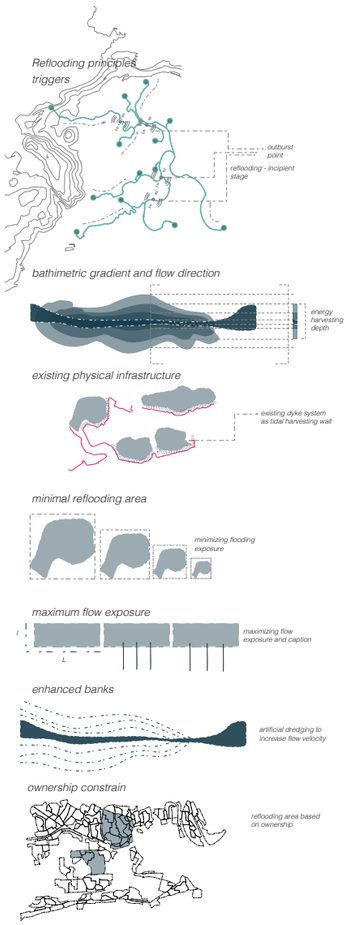






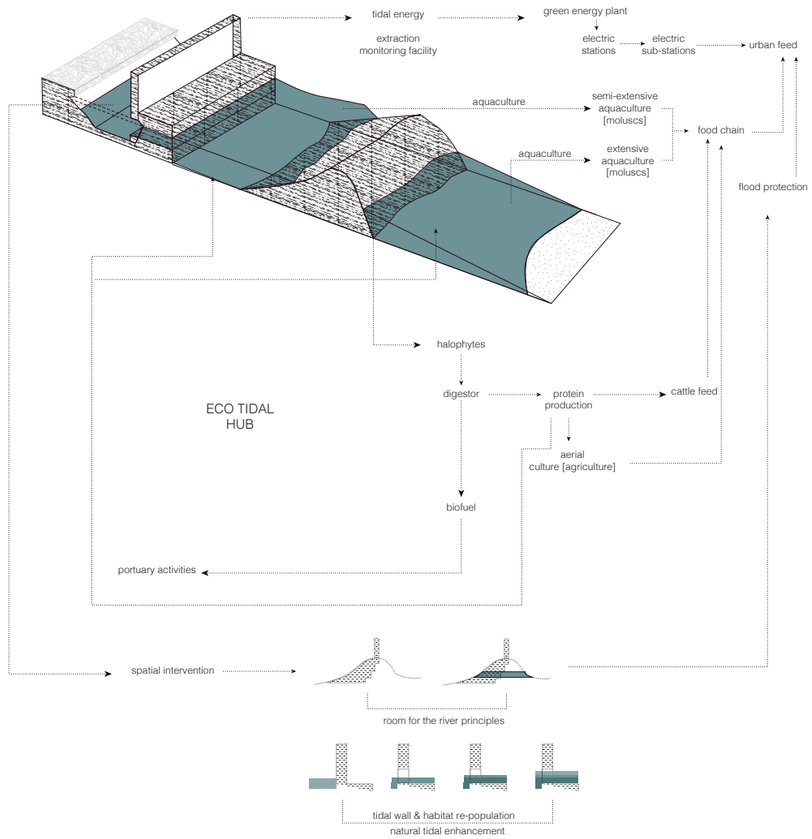


Reflooding principles



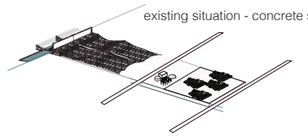
Design
Spatial consequence - Intervention timeline

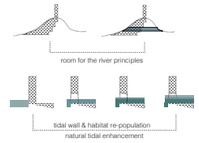
Design framework - spatial translation



Proposed integration cycle

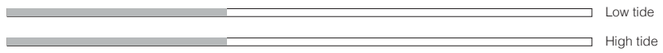
Implementation stage





Managed coastal realignment intervention

Salinity intrusion



Activated stakeholders

MR	Managed Realignment	E	Environmental well-being	Ui	Urban intensification
F	Flood protection	Fp	Food productivity	S	Societal integration
P	Energy Production				

Programming

fp	Amateur fishing pond	h	Halophyte farm	tp	Tidal energy processing substation	sb	Food storage banks	tp	Enzymatic hydrolosis of halophytes
of	Oyster farming	m	Mixed farming	td	Tidal energy distribution station	cp	Compost plant	td	Bio-fuel energy plant
sf	shellfish farming	hv	harvesting center	fm	Local food market	lr	Local restaurant	fm	Microbial fermentation

Spatial typology resulted

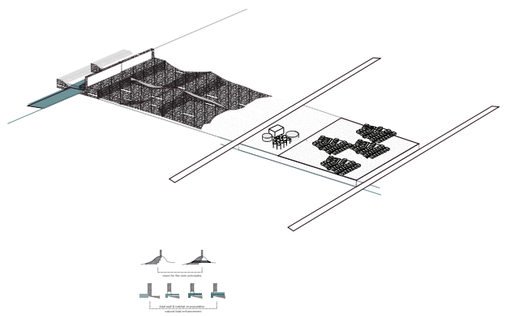
FARMING MODULES

SALINE WATER INTEGRATION

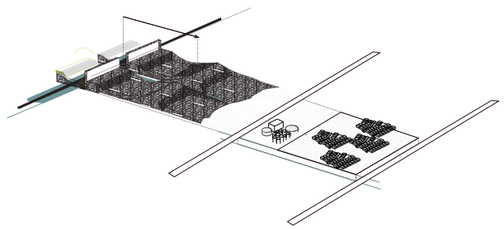
Design
Spatial consequence - Intervention timeline

Design framework - spatial translation

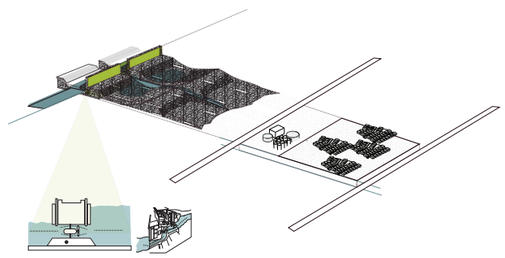
existing situation - concrete seawall



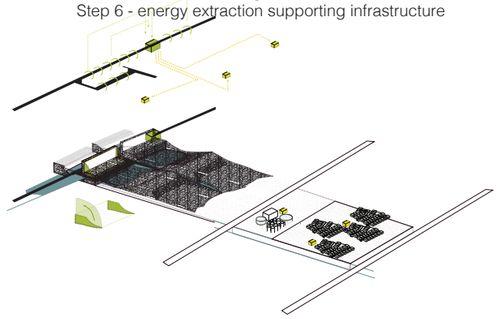
Step 1 - mudflat extraction
Step 2 - local seawall infilitration



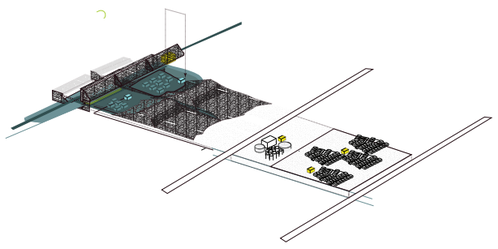
Step 3 - seawall replacement to tidal wall | tidal barrier barrage
Step 4 - activation of first tier of reflooding triggers



Step 5 - wall - pond realignment
Step 6 - energy extraction supporting infrastructure



Step 7- total pond reflooding
Step 8 - shellfish harvesting infrastructure - oyster nursery ponds



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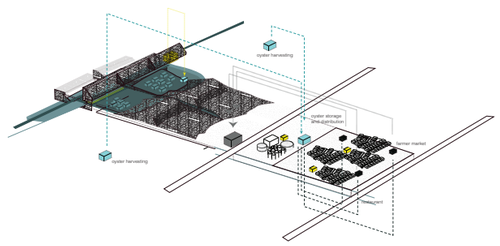
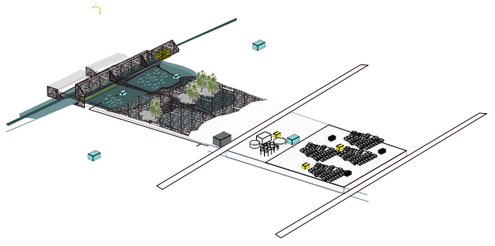
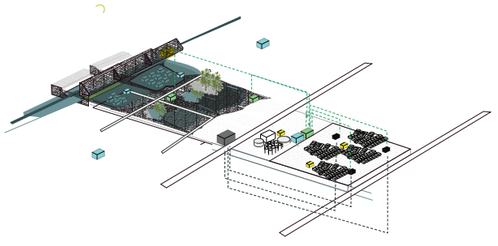


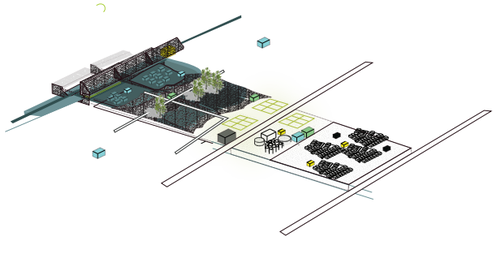
Step 9- second tier trigger activation
Step 10 - halophite species insertion



Step 11- second tier reflooding
Step 10 - halophite supporting infrastructure



Step 12- hydroponics and mixed agriculture
Step 13 - new housing typologies



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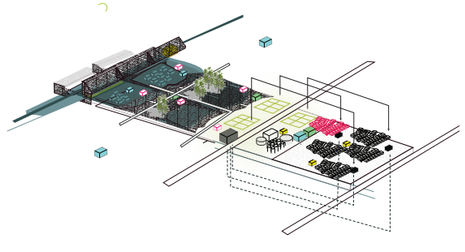
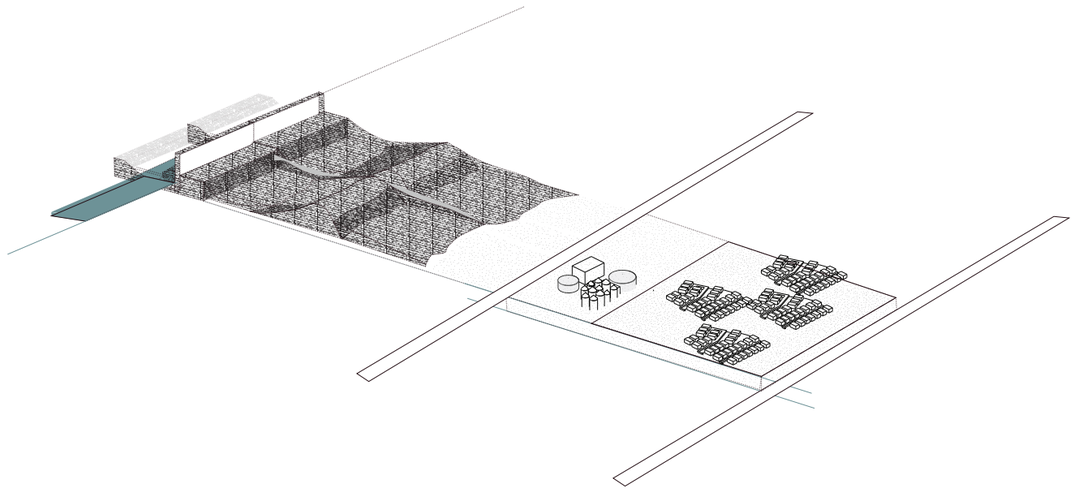
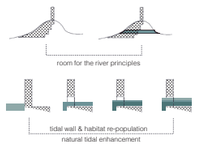


Design
Spatial consequence - Intervention timeline

Design framework - spatial translation

existing situation - concrete seawall





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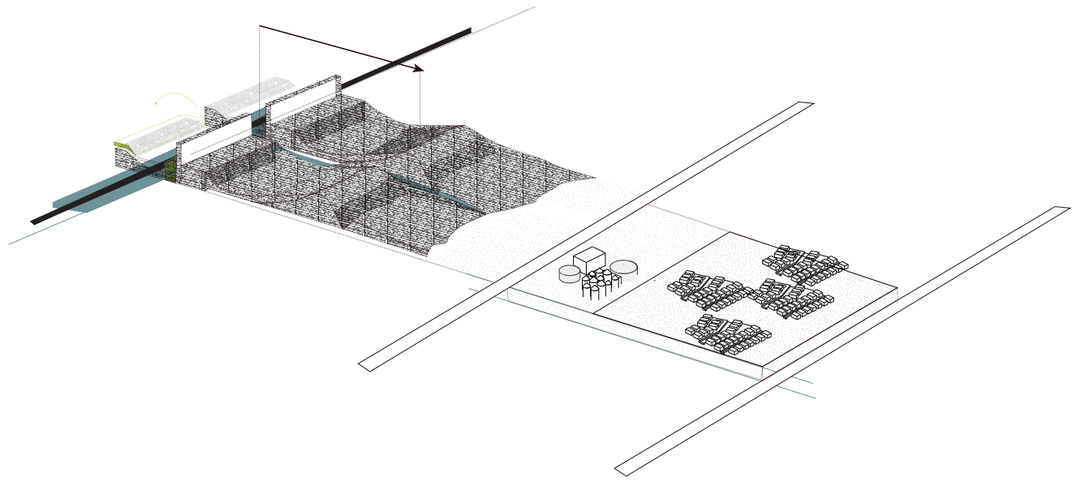

Design
Spatial consequence - Intervention timeline

Design framework - spatial translation

Step 3 - seawall replacement to tidal wall | tidal barrier barrage
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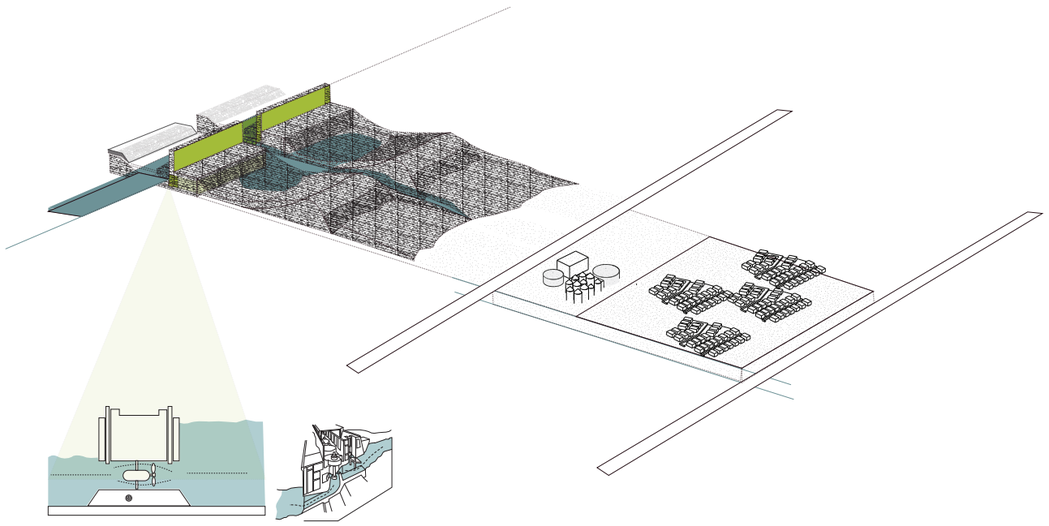
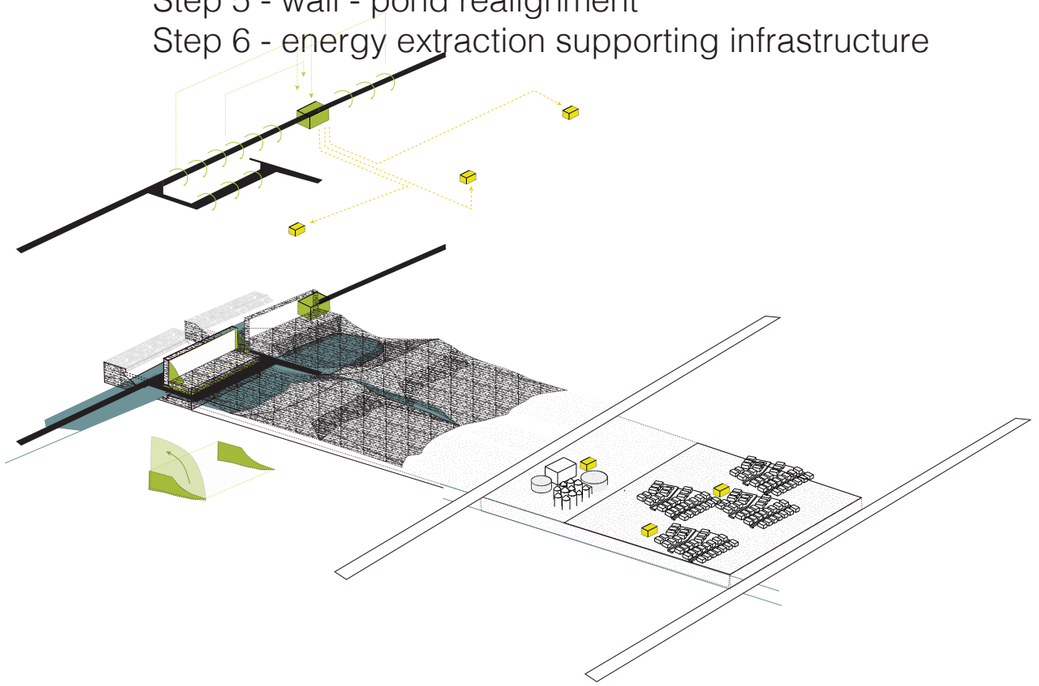


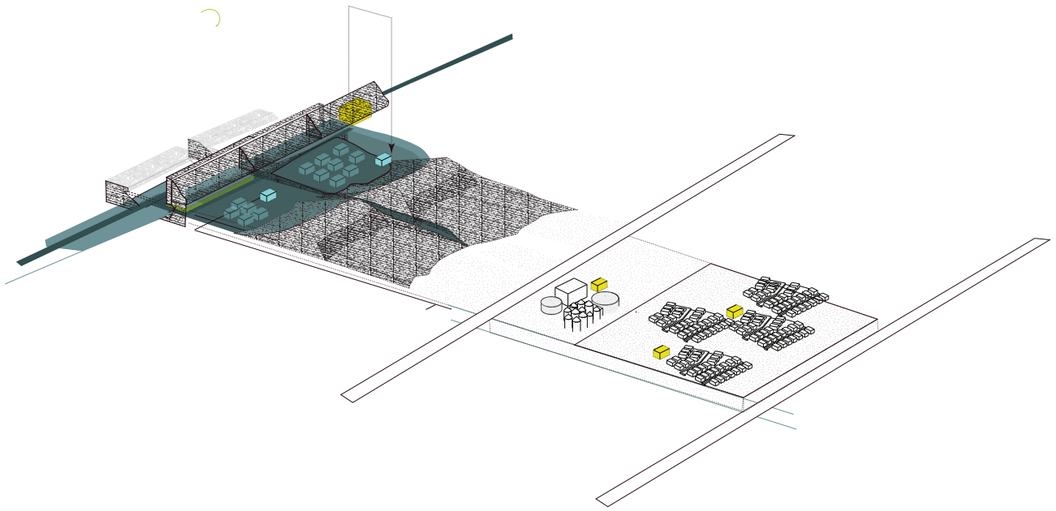
Step 5 - wall - pond realignment
Step 6 - energy extraction supporting infrastructure



Design
Spatial consequence - Intervention timeline

Design framework - spatial translation

Step 7- total pond reflooding
Step 8 - shellfish harvesting infrastructure - oyster nursery ponds



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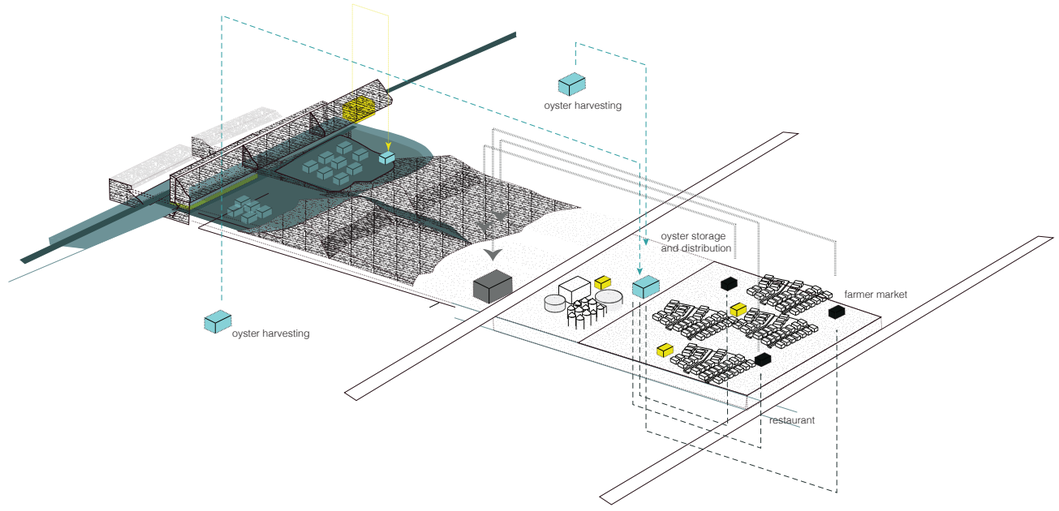

Design
Spatial consequence - Intervention timeline

Design framework - spatial translation

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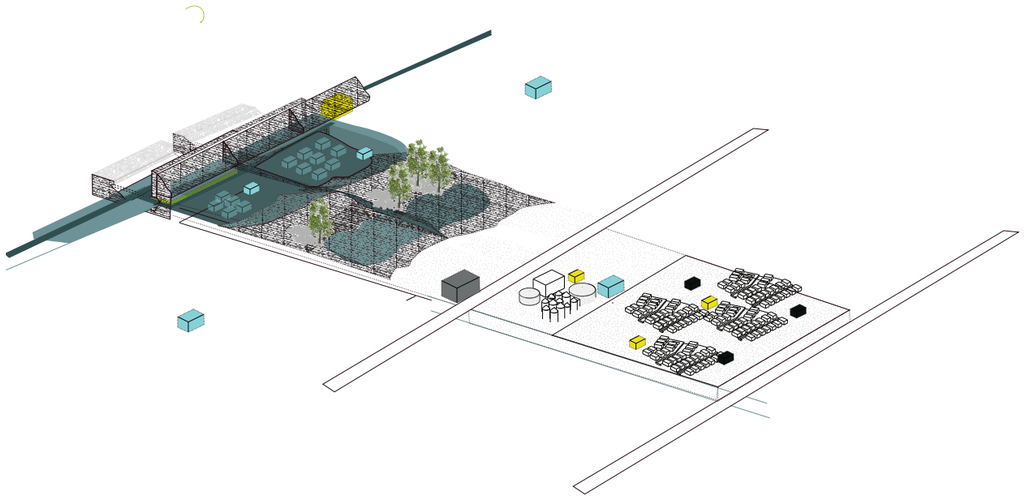

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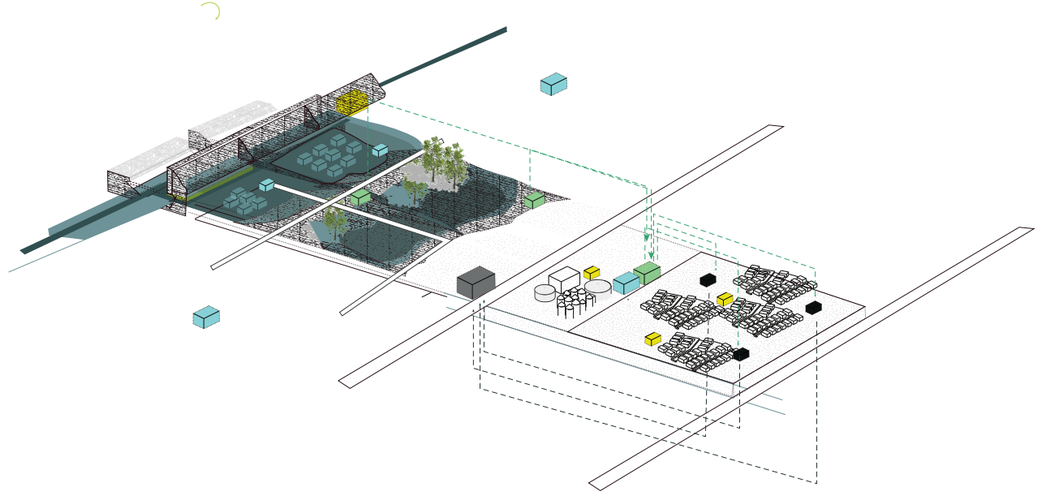
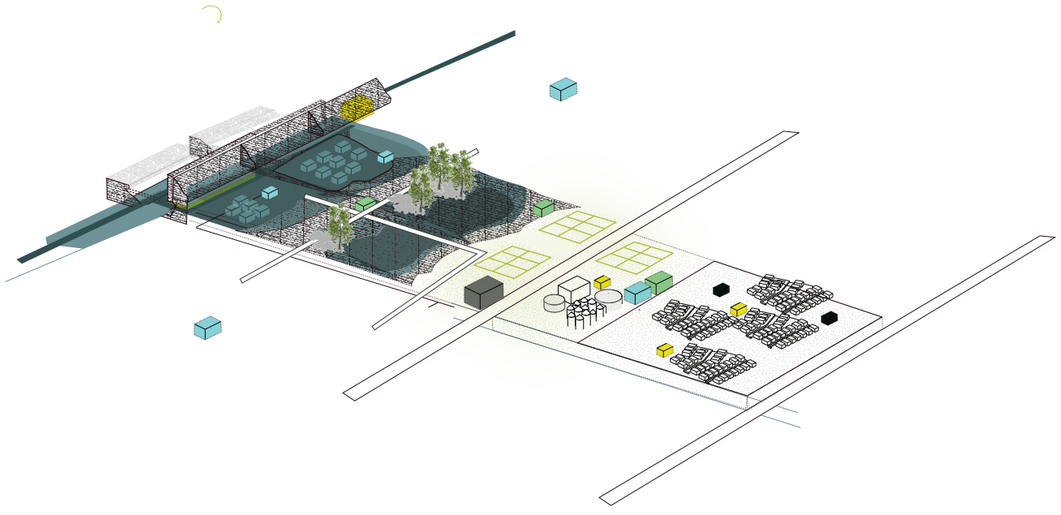


Design
Spatial consequence - Intervention timeline

Design framework - spatial translation

Step 12- hydroponics and mixed agriculture
Step 13 - new housing typologies



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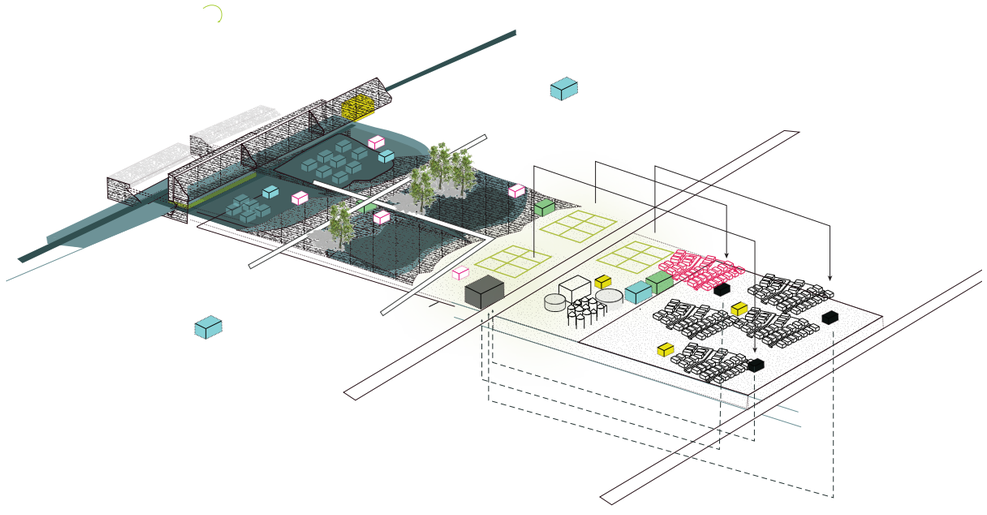
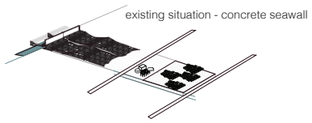
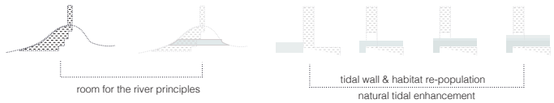


Design
Spatial consequence - Intervention timeline

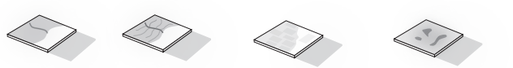
SLR Hypothesis - maximum scenario

1 Implementation stage





2 Managed coastal realignment intervention



3 Salinity intrusion

4 Activated stakeholders

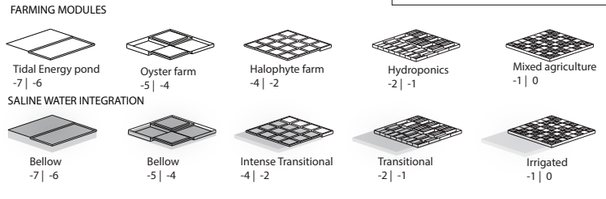
MR	Managed Realignment	E	Environmental well-being	Ui	Urban intensification
F	Flood protection	Fp	Food productivity	S	Societal integration
P	Energy Production				

5 Programming

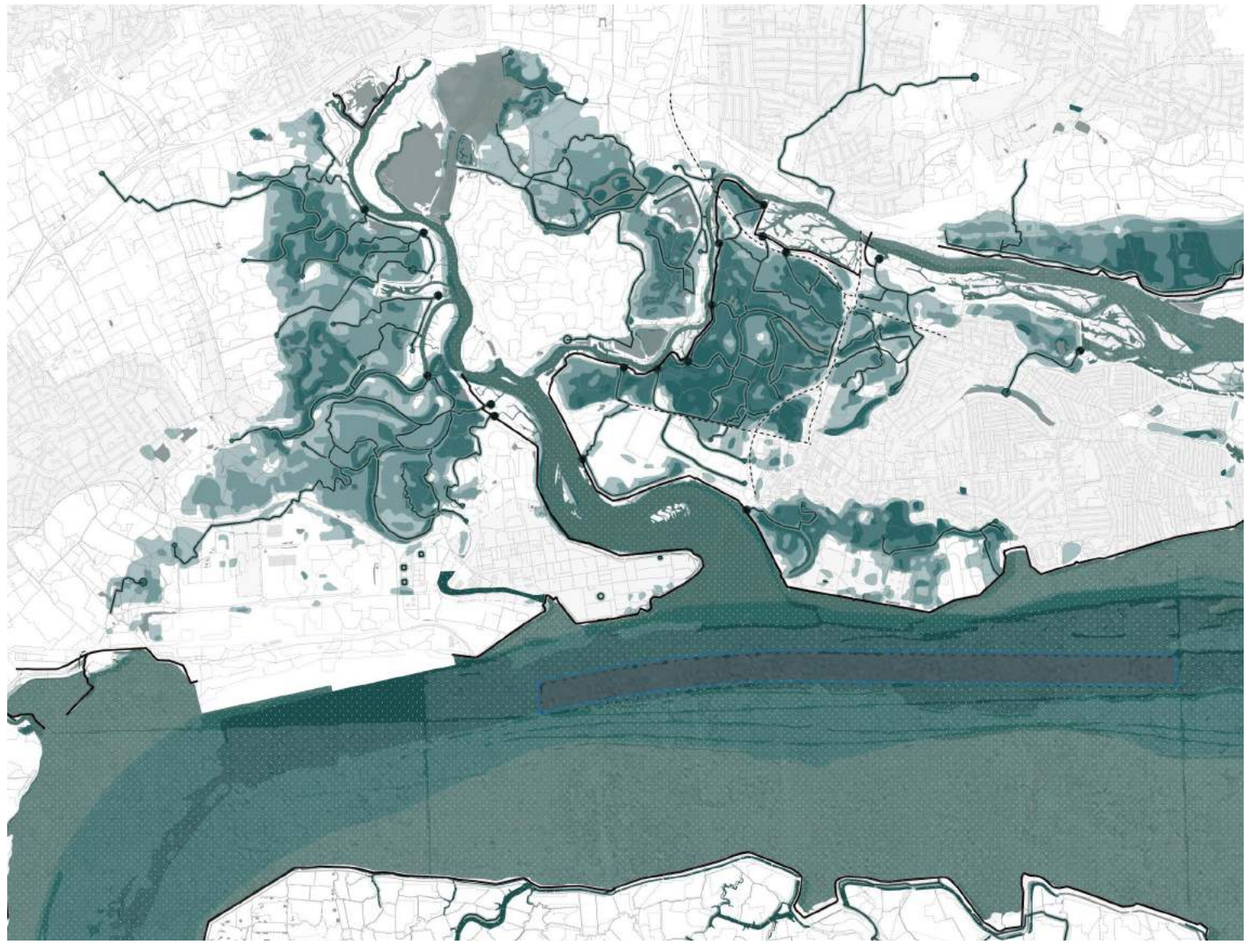
fp	Amateur fishing pond	h	Halophyte farm	tp	Tidal energy processing substation	sb	Food storage banks
of	Oyster farming	m	Mixed farming	td	Tidal energy distribution station	cp	Compost plant
sf	shellfish farming	hv	harvesting center	fm	Local food market	lr	Local restaurant

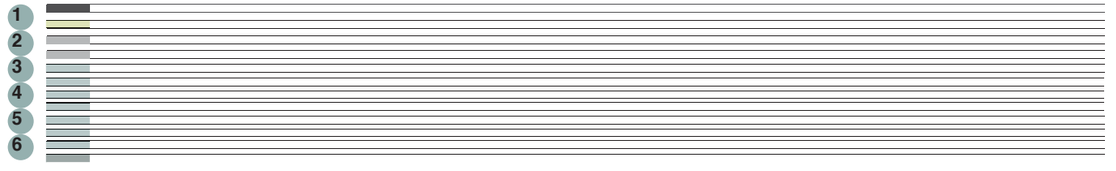
tp	Enzymatic hydrolosis of halophytes		
td	Bio-fuel energy plant		
fm	Microbial fermentation		

6 Spatial typology resulted



Scenario for maximum refloodability in the event of SLR and dike low performance

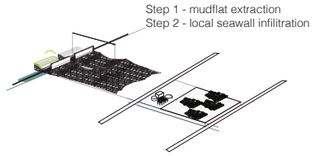


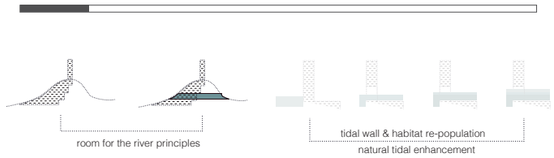


Design
Spatial consequence - Intervention timeline

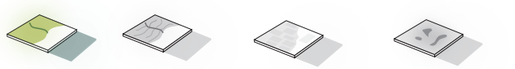
Tidal reach depth - aim >5m

1 Implementation stage

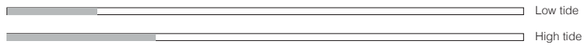




2 Managed coastal realignment intervention



3 Salinity intrusion



4 Activated stakeholders

- MR Managed Realignment
- F Flood protection
- P Energy Production
- E Environmental well-being
- Fp Food productivity
- Ui Urban intensification
- S Societal integration

5 Programming

- fp Amateur fishing pond
- of Oyster farming
- sf shellfish farming
- h Halophyte farm
- m Mixed farming
- hv harvesting center
- tp Tidal energy processing substation
- td Tidal energy distribution station
- fm Local food market
- sb Food storage banks
- cp Compost plant
- lr Local restaurant
- tp Enzymatic hydrolosis of halophytes
- td Bio-fuel energy plant
- fm Microbial fermentation

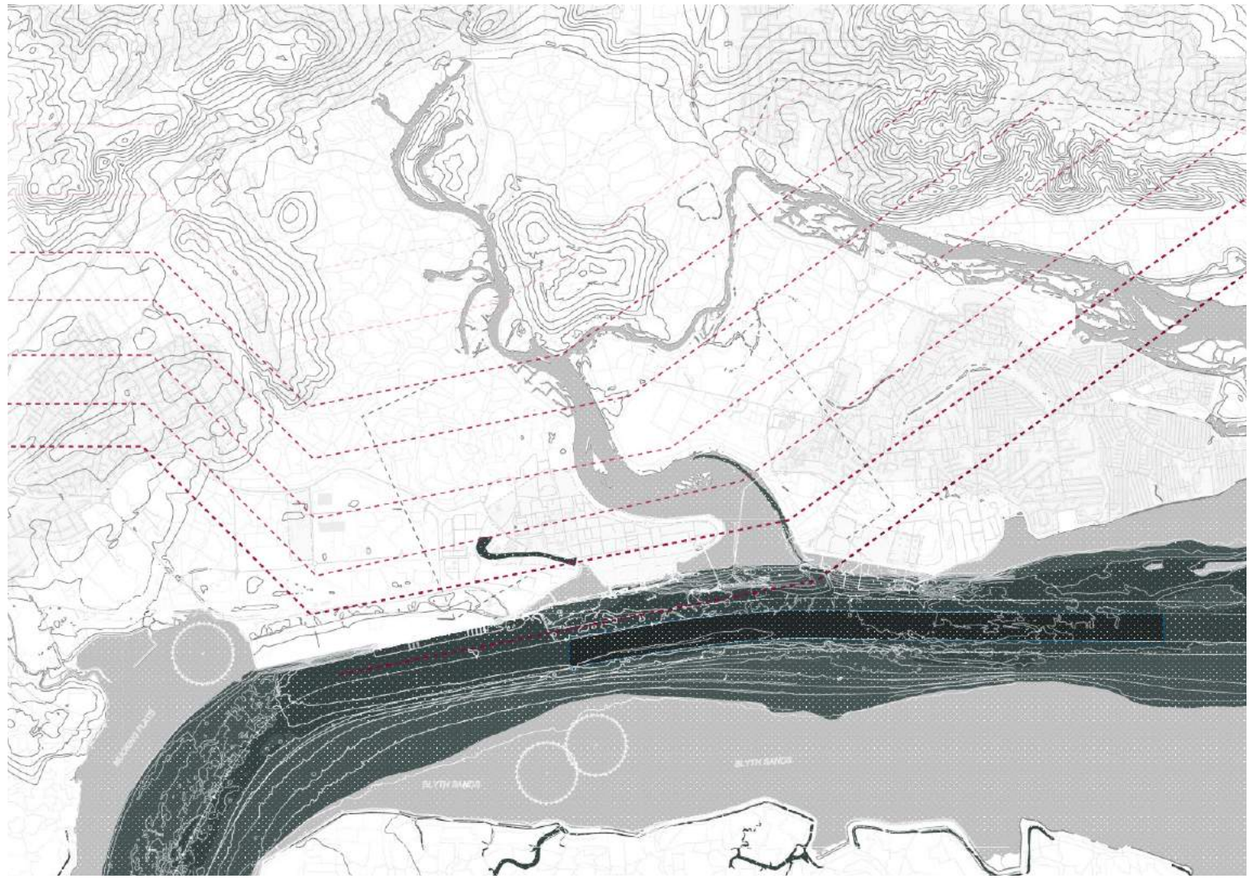
6 Spatial typology resulted

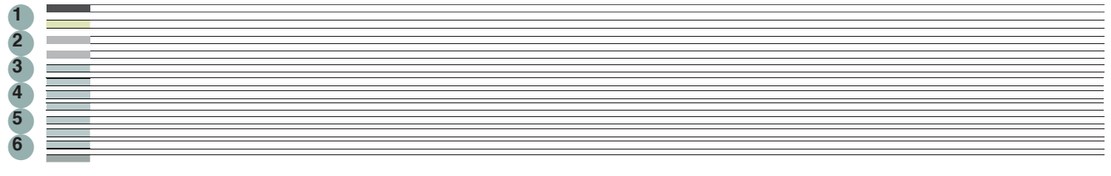
FARMING MODULES

SALINE WATER INTEGRATION

Inland reach of favourable tidal power depths

Scenario for maximum refloodability in the event of SLR and dike low performance

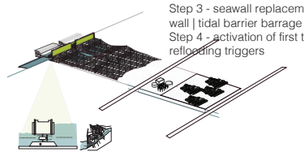




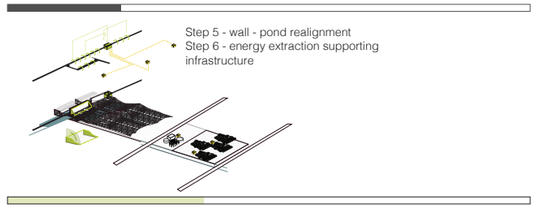
Design
Spatial consequence - Intervention timeline

Engineered flooded areas - surface and performance

1 Implementation stage

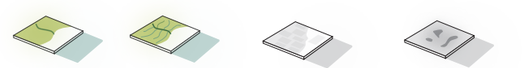


Step 3 - seawall replacement to tidal wall | tidal barrier barrage
Step 4 - activation of first tier of reflooding triggers



Step 5 - wall - pond realignment
Step 6 - energy extraction supporting infrastructure

2 Managed coastal realignment intervention



ARTIFICIAL RIVER | IRRIGATION PATTERN | INFILTRATION SURFACE STORAGE TANK | ARTIFICIAL WETLANDS

3 Salinity intrusion

Low tide
High tide

4 Activated stakeholders

MR	Managed Realignment	E	Environmental well-being	Ui	Urban intensification
F	Flood protection	Fp	Food productivity	S	Societal integration
P	Energy Production				

5 Programming

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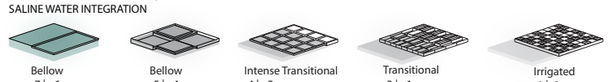
6 Spatial typology resulted

FARMING MODULES

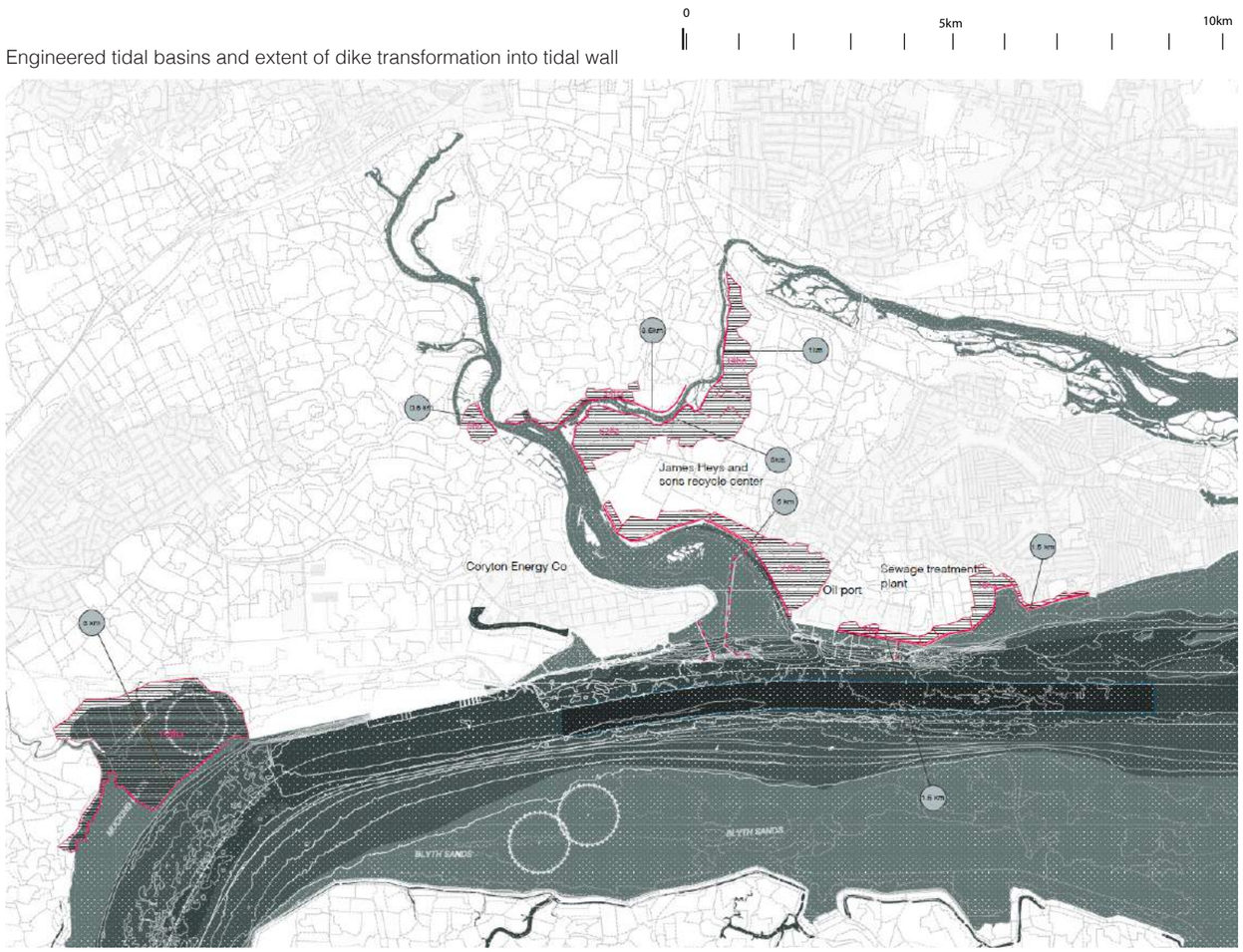
Tidal Energy pond -7 | -6 | Oyster farm -5 | -4 | Halophyte farm -4 | -2 | Hydroponics -2 | -1 | Mixed agriculture -1 | 0

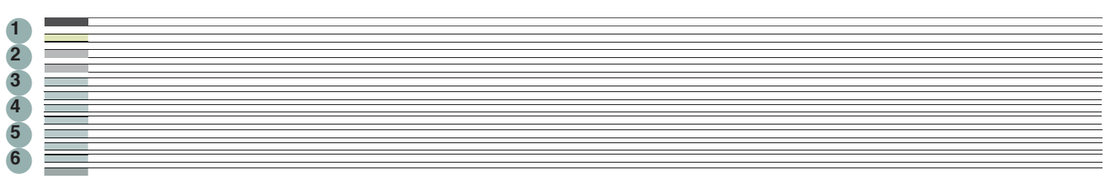
SALINE WATER INTEGRATION



Bellow -7 | -6 | Bellow -5 | -4 | Intense Transitional -4 | -2 | Transitional -2 | -1 | Irrigated -1 | 0

Engineered tidal basins and extent of dike transformation into tidal wall

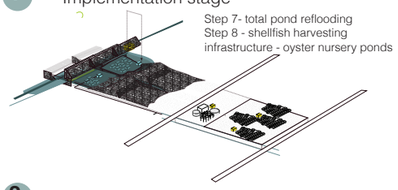


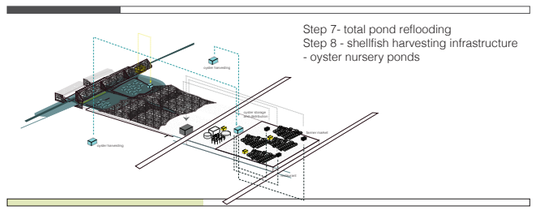


Design
Spatial consequence - Intervention timeline

Natural consequences - waterways integration

1 Implementation stage





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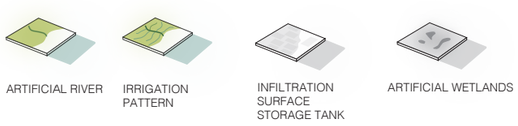

3 Salinity intrusion

4 Activated stakeholders

- MR Managed Realignment
- F Flood protection
- P Energy Production
- E Environmental well-being
- Fp Food productivity
- Ui Urban intensification
- S Societal integration

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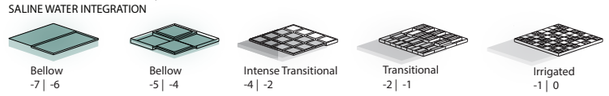
- hv harvesting center
- tp Tidal energy processing substation
- td Tidal energy distribution station
- fm Local food market
- sb Food storage banks
- cp Compost plant
- lr Local restaurant
- tp Enzymatic hydrolosis of halophytes
- td Bio-fuel energy plant
- fm Microbial fermentation

6 Spatial typology resulted

FARMING MODULES

SALINE WATER INTEGRATION



Existing surface water and interraction with new reflooded basins

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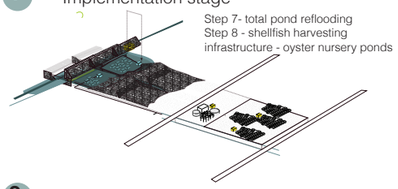
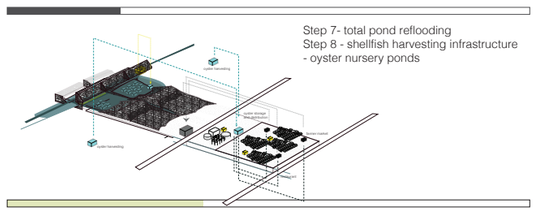
Design
Spatial consequence - Intervention timeline

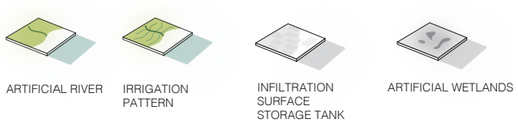
Natural consequenes - hierarchical watershed

1 Implementation stage





2 Managed coastal realignment intervention



3 Salinity intrusion

4 Activated stakeholders

MR	Managed Realignment	E	Environmental well-being	Ui	Urban intensification
F	Flood protection	Fp	Food productivity	S	Societal integration
P	Energy Production				

5 Programming

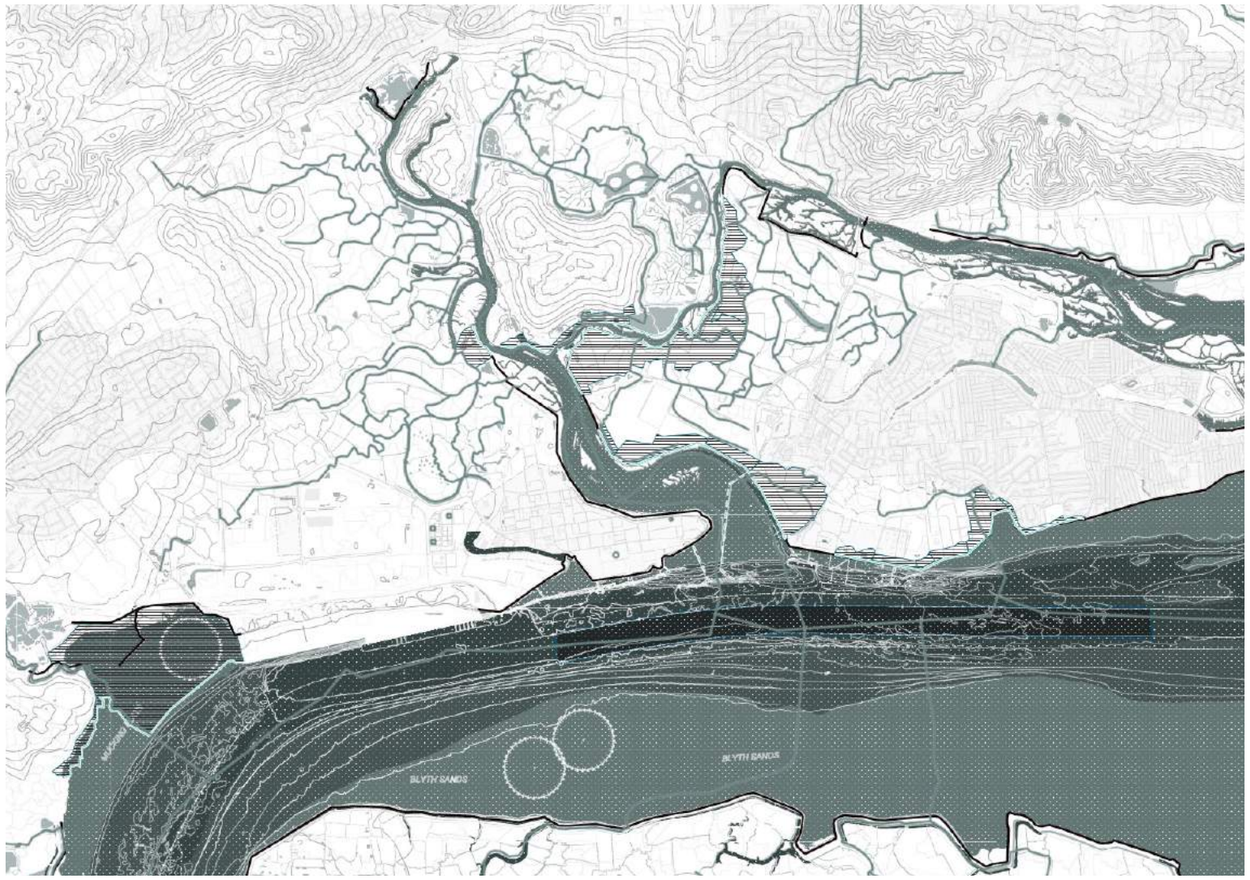
fp	Amateur fishing pond	h	Halophyte farm	tp	Tidal energy processing substation	sb	Food storage banks	tp	Enzymatic hydrolosis of halophytes
of	Oyster farming	m	Mixed farming	td	Tidal energy distribution station	cp	Compost plant	td	Bio-fuel energy plant
sf	shellfish farming	hv	harvesting center	fm	Local food market	lr	Local restaurant	fm	Microbial fermentation

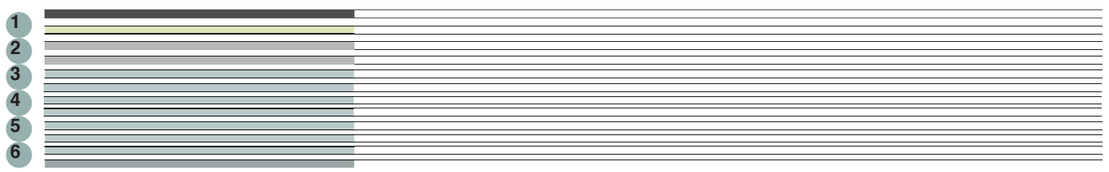
6 Spatial typology resulted

FARMING MODULES

SALINE WATER INTEGRATION

Existing surface water and interraction with new reflooded basins - additional water flows inducing hierarchy

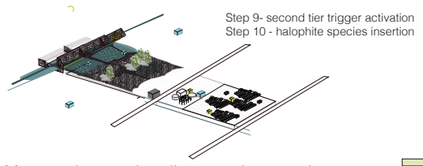




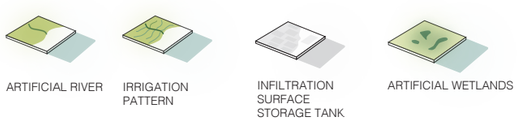
Design
Spatial consequence - Intervention timeline

Natural consequences - outburst triggers

1 Implementation stage



2 Managed coastal realignment intervention



3 Salinity intrusion

4 Activated stakeholders

- MR Managed Realignment
- F Flood protection
- P Energy Production
- E Environmental well-being
- Fp Food productivity
- Ui Urban intensification
- S Societal integration

5 Programming

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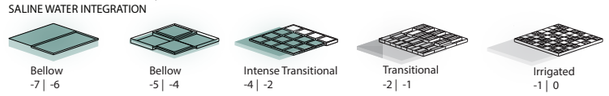
- lr Local restaurant
- tp Enzymatic hydrolosis of halophytes
- td Bio-fuel energy plant
- fm Microbial fermentation

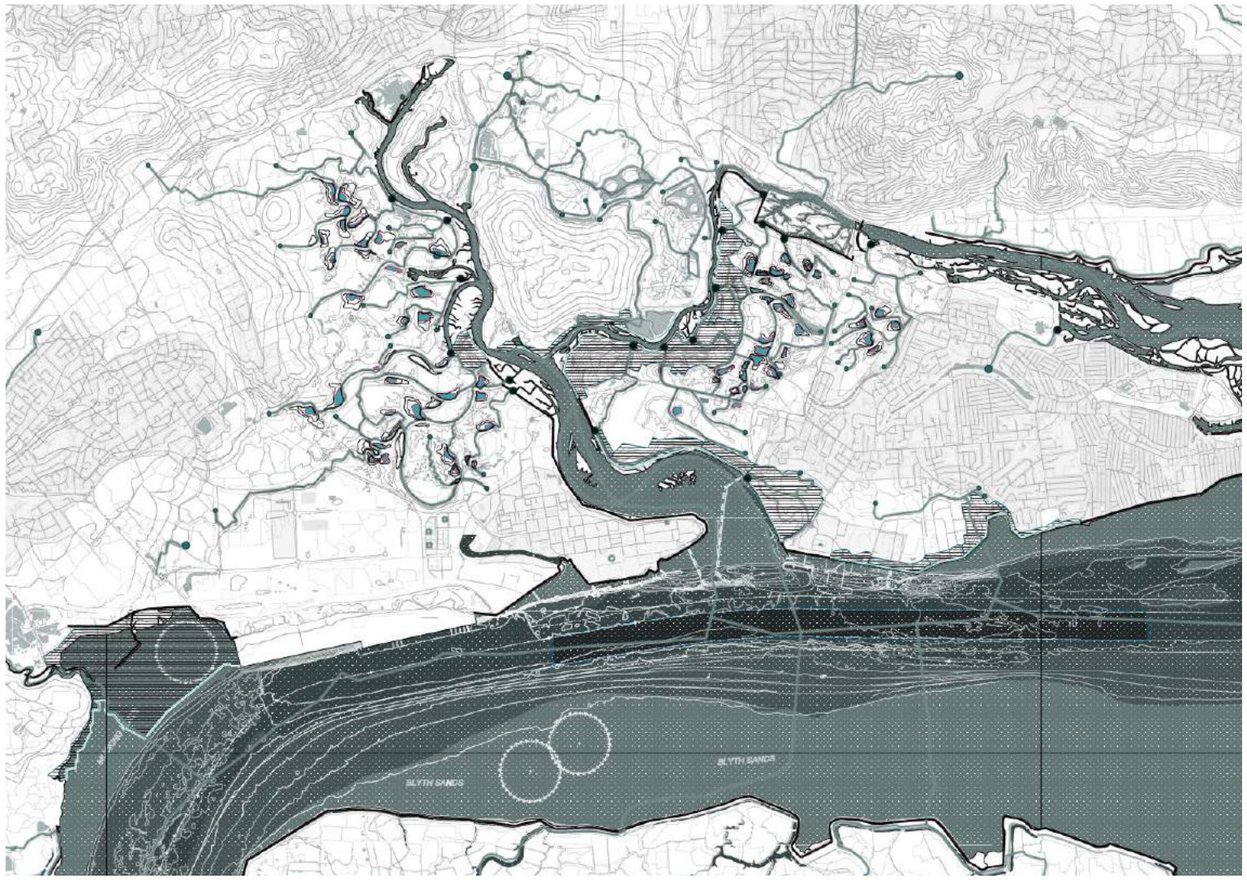
6 Spatial typology resulted

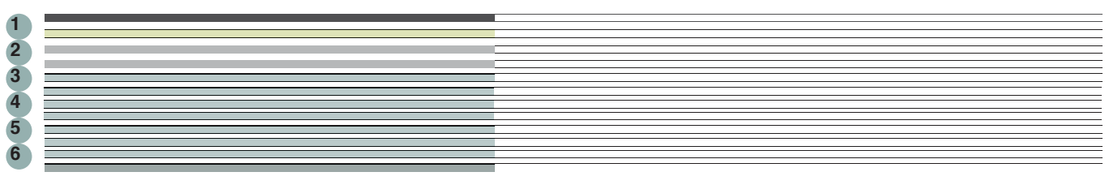
FARMING MODULES

SALINE WATER INTEGRATION



Lowest surfaces on a river's trajectory that are most susceptible to begin flooding

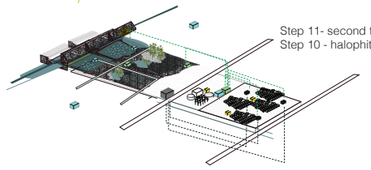




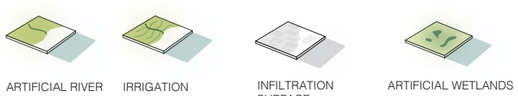
Design
Spatial consequence - Intervention timeline

Natural consequences - low tide creek formation

1 Implementation stage



2 Managed coastal realignment intervention



3 Salinity intrusion

4 Activated stakeholders

- MR Managed Realignment
- F Flood protection
- P Energy Production
- E Environmental well-being
- Fp Food productivity
- Ui Urban intensification
- S Societal integration

5 Programming

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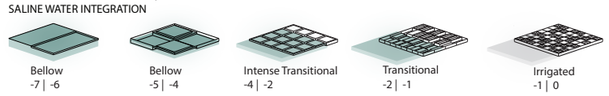
- tp Enzymatic hydrolosis of halophytes
- td Bio-fuel energy plant
- fm Microbial fermentation

6 Spatial typology resulted

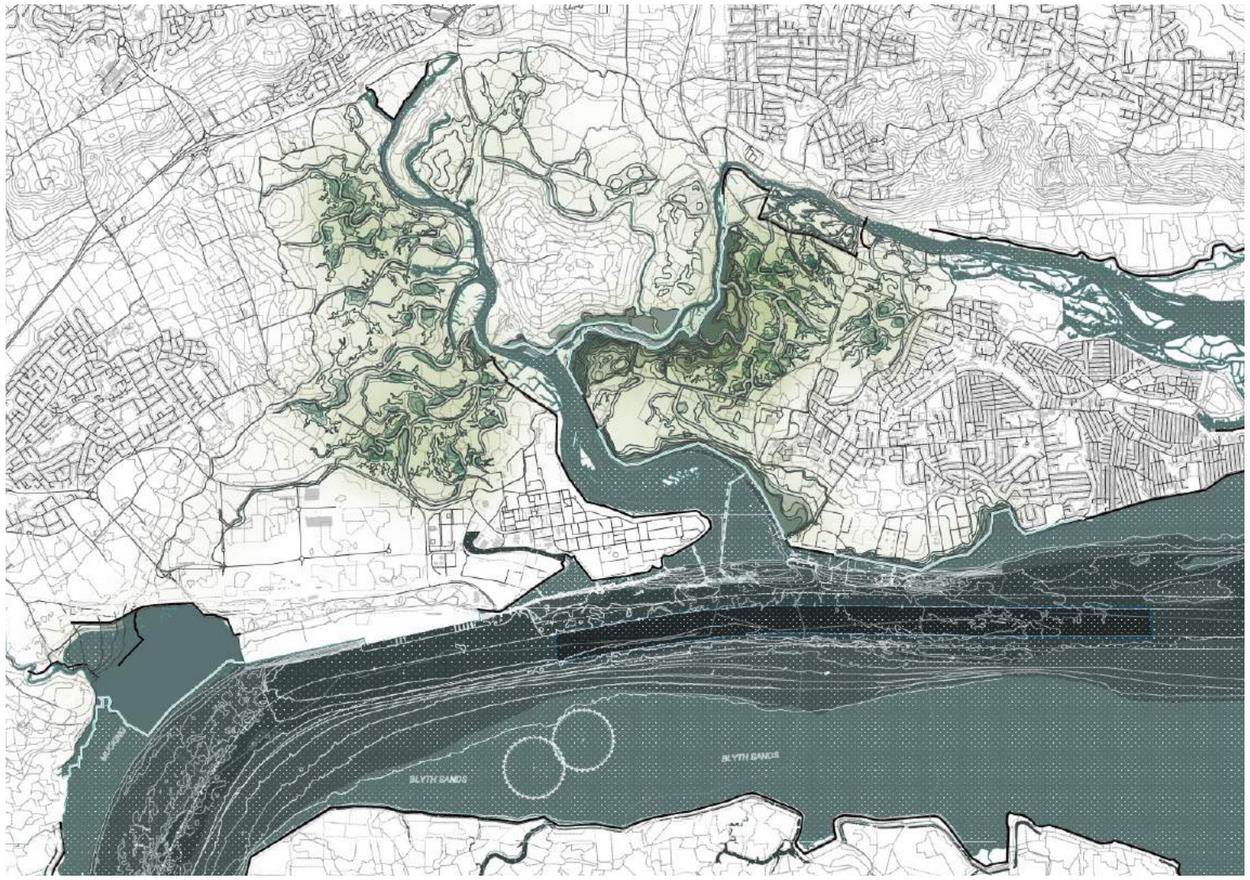
FARMING MODULES

SALINE WATER INTEGRATION



0 5km 10km

Flooding pattern and natural creek evolution



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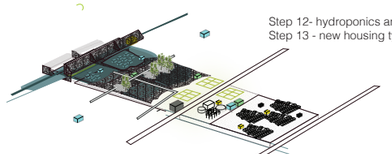
Design
Spatial consequence - Intervention timeline

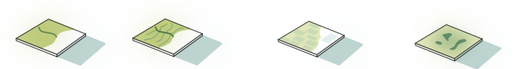
Natural consequences - high tide creek formation

1 Implementation stage



Step 12- hydroponics and mixed agriculture
Step 13 - new housing typologies

2 Managed coastal realignment intervention



ARTIFICIAL RIVER
IRRIGATION PATTERN
INFILTRATION SURFACE STORAGE TANK
ARTIFICIAL WETLANDS

3 Salinity intrusion

Low tide
High tide

4 Activated stakeholders

- MR Managed Realignment
- F Flood protection
- P Energy Production
- E Environmental well-being
- Fp Food productivity
- Ui Urban intensification
- S Societal integration

5 Programming

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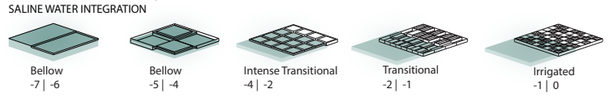
- sb Food storage banks
- cp Compost plant
- lr Local restaurant
- tp Enzymatic hydrolosis of halophytes
- td Bio-fuel energy plant
- fm Microbial fermentation

6 Spatial typology resulted

FARMING MODULES

Tidal Energy pond -7 | -6
Oyster farm -5 | -4
Halophyte farm -4 | -2
Hydroponics -2 | -1
Mixed agriculture -1 | 0

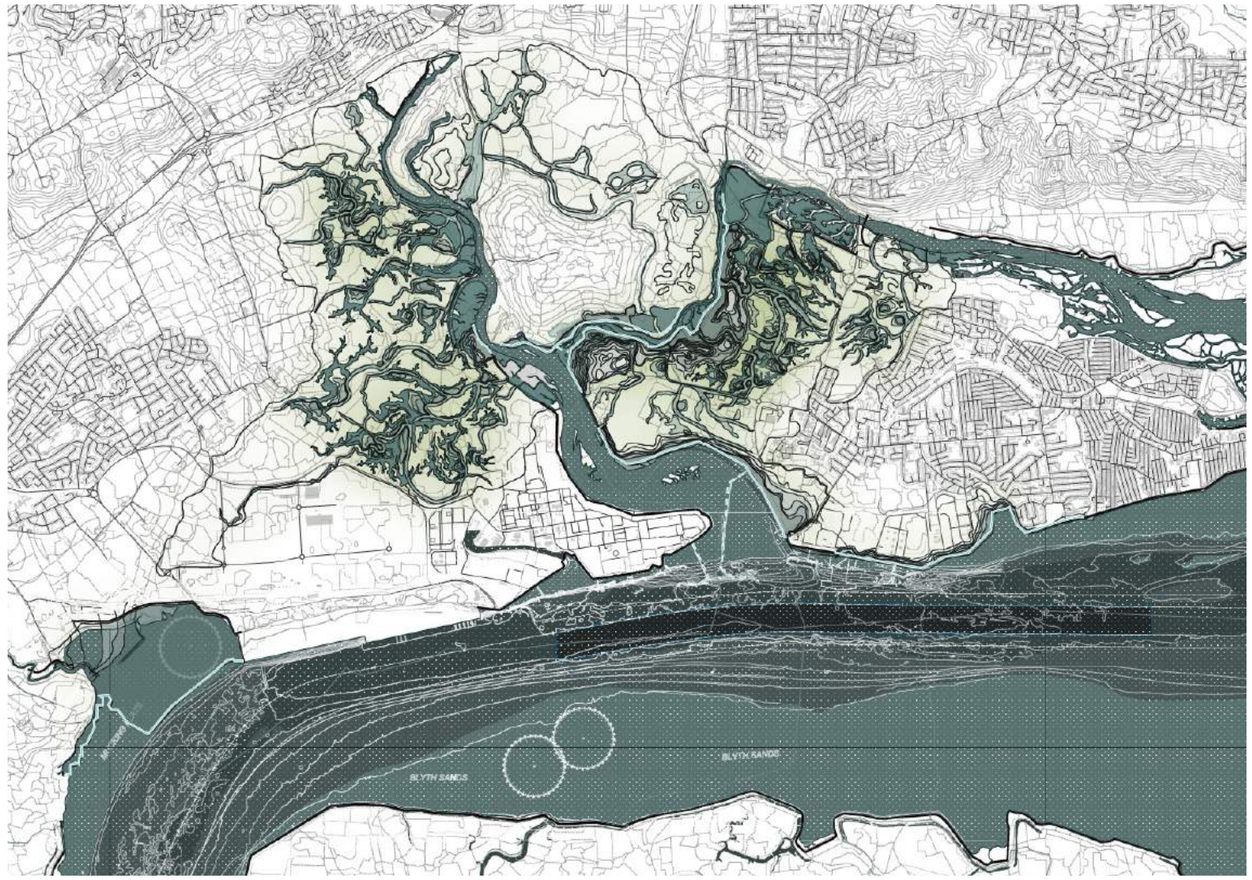
SALINE WATER INTEGRATION



Bellow -7 | -6
Bellow -5 | -4
Intense Transitional -4 | -2
Transitional -2 | -1
Irrigated -1 | 0

0 5km 10km

Flooding pattern and natural creek evolution



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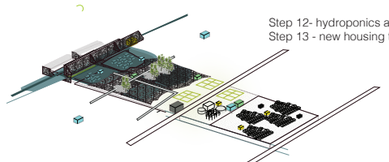
6

Design
Spatial consequence - Intervention timeline

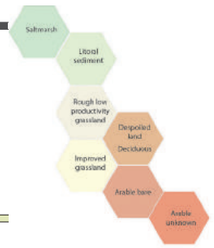
Productive consequence - agricultural shift

1 Implementation stage

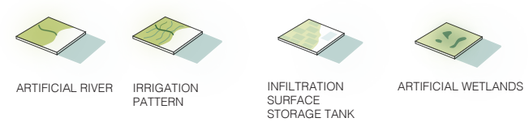


Step 12- hydroponics and mixed agriculture
Step 13 - new housing typologies

30% existing agricultural productivity



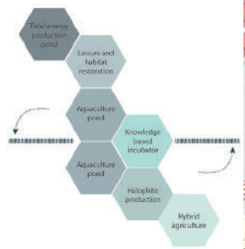
2 Managed coastal realignment intervention



ARTIFICIAL RIVER
IRRIGATION PATTERN
INFILTRATION SURFACE STORAGE TANK
ARTIFICIAL WETLANDS

3 Salinity intrusion

80% aquaculture productivity



4 Activated stakeholders

- MR Managed Realignment
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- P Energy Production
- E Environmental well-being
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- lr Local restaurant
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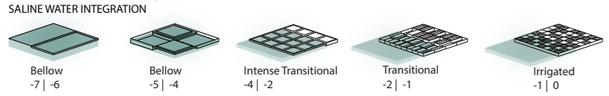
- td Bio-fuel energy plant
- fm Microbial fermentation

6 Spatial typology resulted

FARMING MODULES

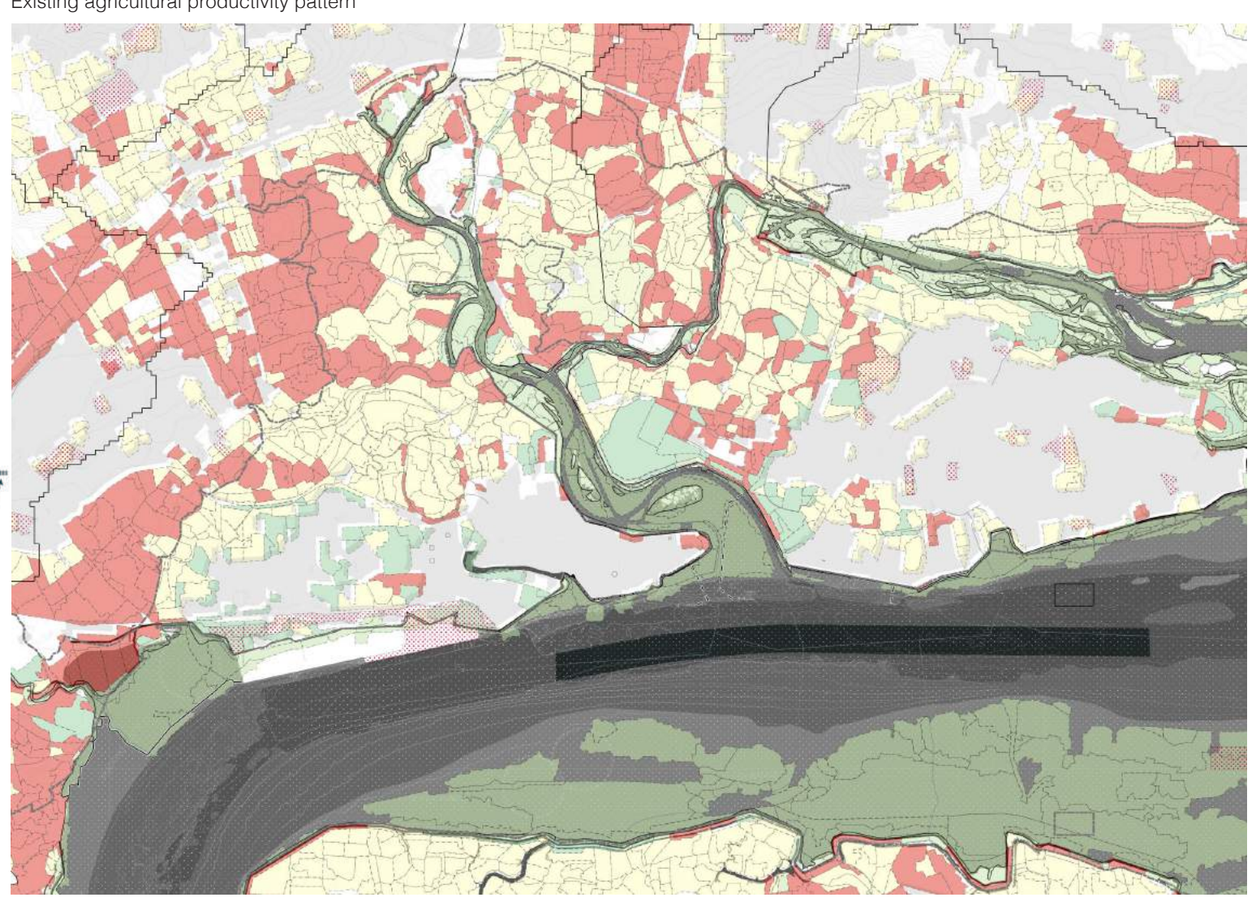
Tidal Energy pond -7 | -6
Oyster farm -5 | -4
Halophyte farm -4 | -2
Hydroponics -2 | -1
Mixed agriculture -1 | 0

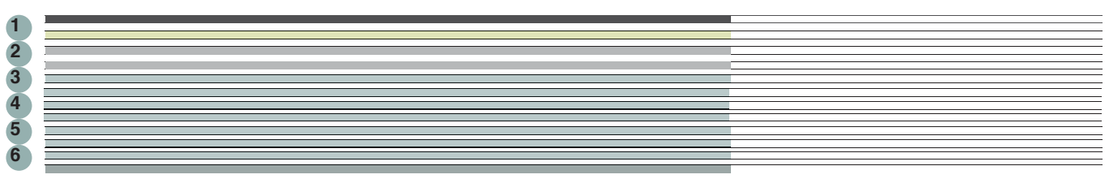
SALINE WATER INTEGRATION



Bellow -7 | -6
Bellow -5 | -4
Intense Transitional -4 | -2
Transitional -2 | -1
Irrigated -1 | 0

Existing agricultural productivity pattern

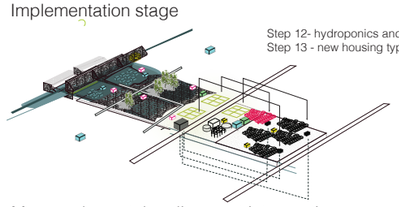




Design
Spatial consequence - Intervention timeline

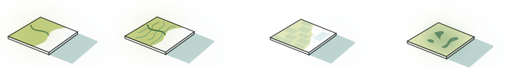
Productive consequences - agricultural shift

1 Implementation stage



Step 12- hydroponics and mixed agriculture
Step 13 - new housing typologies

2 Managed coastal realignment intervention



3 Salinity intrusion

Low tide
High tide

4 Activated stakeholders

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- F Flood protection
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5 Programming

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- tp Enzymatic hydrolosis of halophytes
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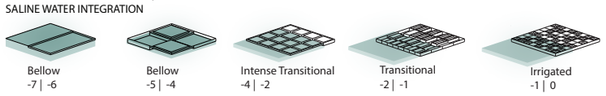
- fm Microbial fermentation

6 Spatial typology resulted

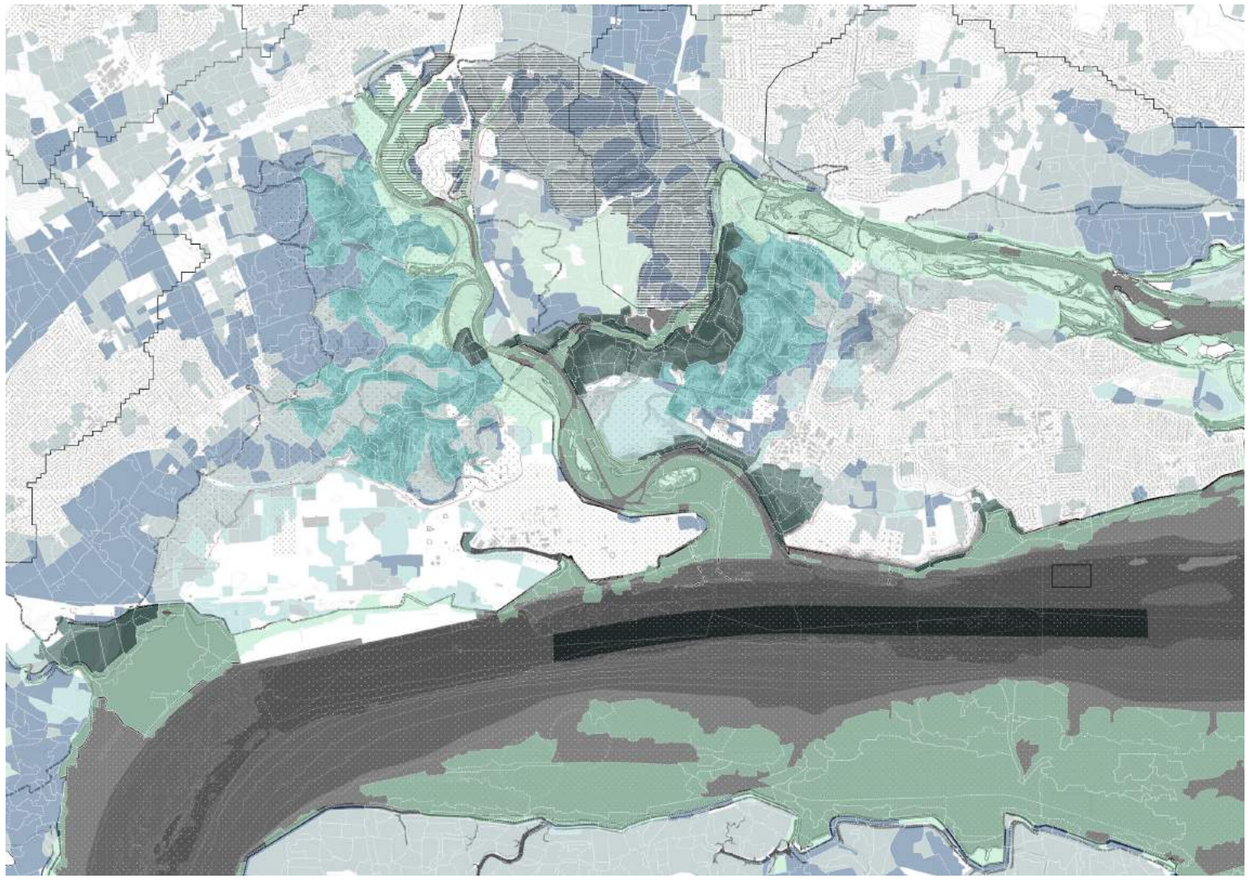
FARMING MODULES

SALINE WATER INTEGRATION



0 5km 10km

Proposed agricultural productivity pattern - aquaculture and mixed agriculture



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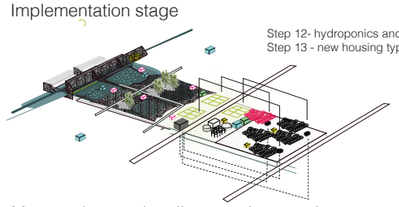
Design
Spatial consequence - Intervention timeline

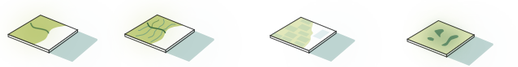
Productive consequences - oyster flows

1 Implementation stage



Step 12- hydroponics and mixed agriculture
Step 13 - new housing typologies

2 Managed coastal realignment intervention



ARTIFICIAL RIVER
IRRIGATION PATTERN
INFILTRATION SURFACE STORAGE TANK
ARTIFICIAL WETLANDS

3 Salinity intrusion

Low tide
High tide

4 Activated stakeholders

- MR Managed Realignment
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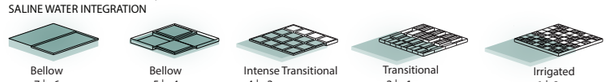
6 Spatial typology resulted

FARMING MODULES

Tidal Energy pond -7 | -6
Oyster farm -5 | -4
Halophyte farm -4 | -2
Hydroponics -2 | -1
Mixed agriculture -1 | 0

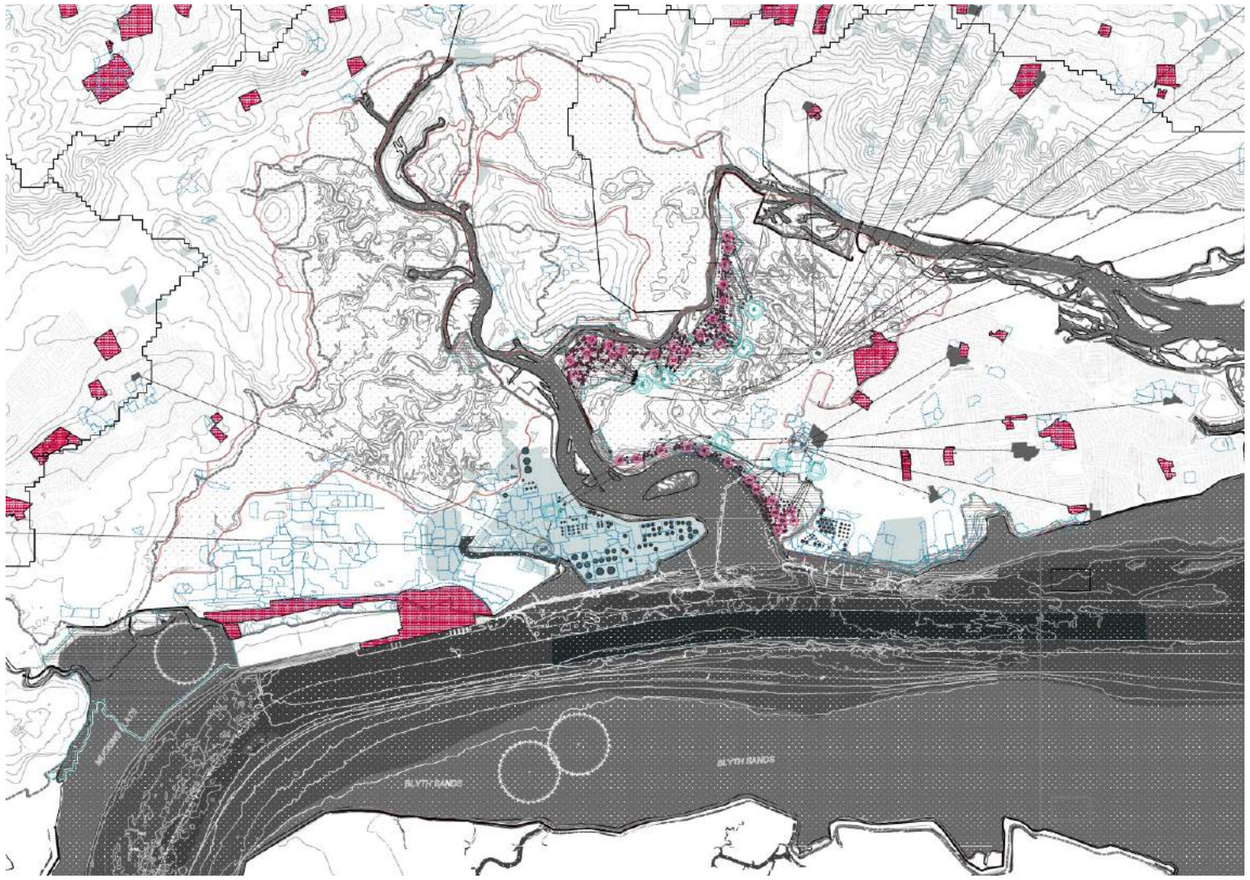
SALINE WATER INTEGRATION



Bellow -7 | -6
Bellow -5 | -4
Intense Transitional -4 | -2
Transitional -2 | -1
Irrigated -1 | 0

0 5km 10km

Locations for supporting infrastructure for oyster cycles



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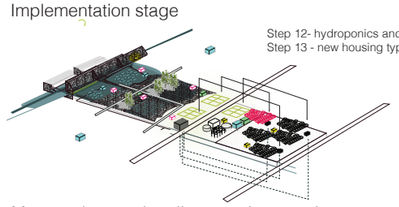
Design
Spatial consequence - Intervention timeline

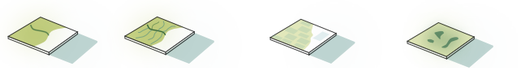
Productive consequences - halophyte flows

1 Implementation stage



Step 12- hydroponics and mixed agriculture
Step 13 - new housing typologies

2 Managed coastal realignment intervention



ARTIFICIAL RIVER
IRRIGATION PATTERN
INFILTRATION SURFACE STORAGE TANK
ARTIFICIAL WETLANDS

3 Salinity intrusion

Low tide
High tide

4 Activated stakeholders

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6 Spatial typology resulted

FARMING MODULES

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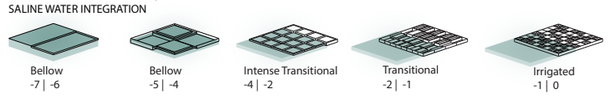
Oyster farm -5 | -4
Halophyte farm -4 | -2
Hydroponics -2 | -1
Mixed agriculture -1 | 0

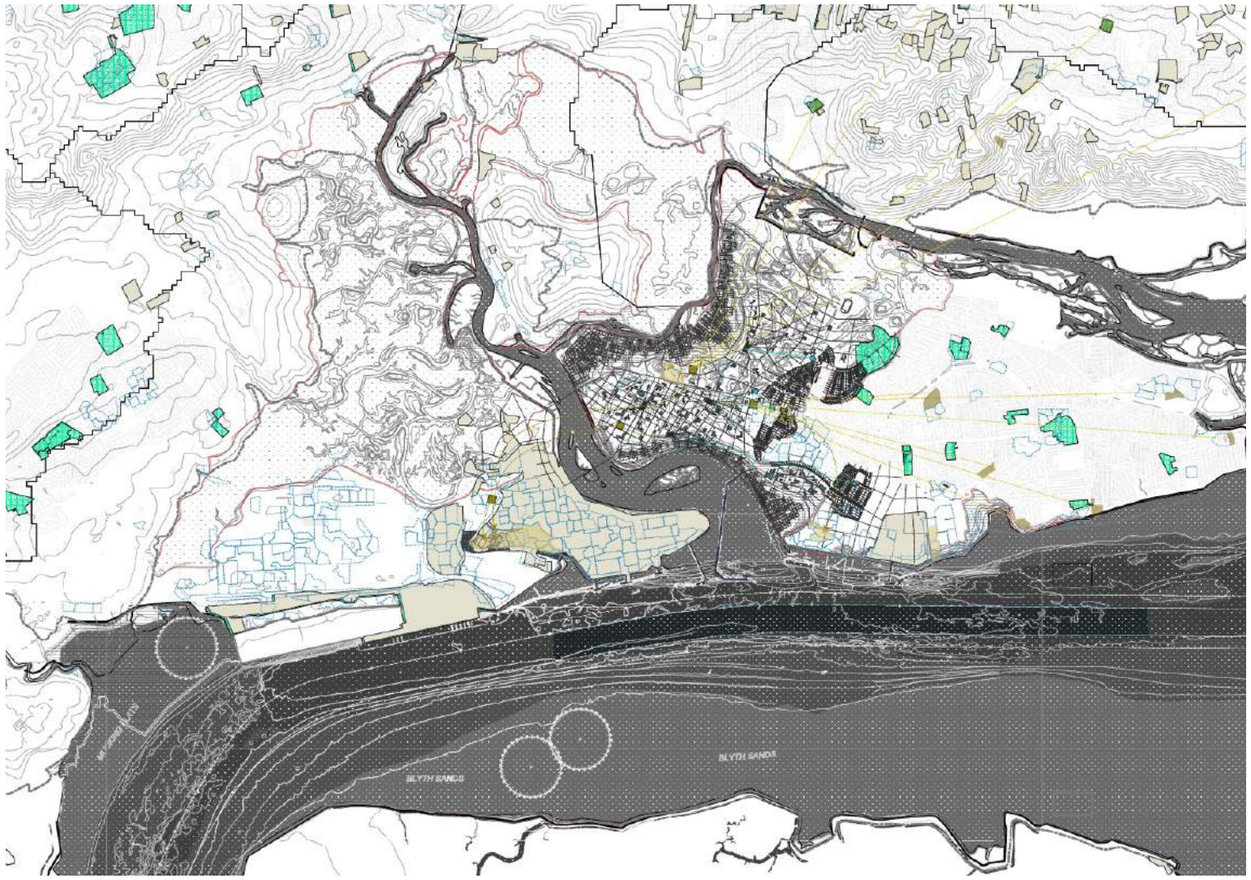
SALINE WATER INTEGRATION



Bellow -7 | -6
Bellow -5 | -4
Intense Transitional -4 | -2
Transitional -2 | -1
Irrigated -1 | 0

0 5km 10km

Locations for supporting infrastructure for halophyte cycles



1
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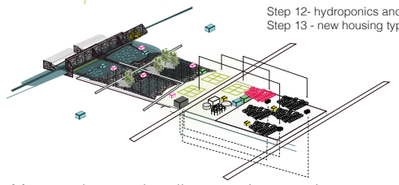
Design
Spatial consequence - Intervention timeline

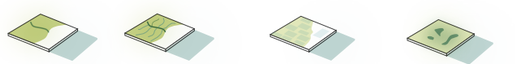
Governance consequences - proposed stakeholders

1 Implementation stage



Step 12- hydroponics and mixed agriculture
Step 13 - new housing typologies

2 Managed coastal realignment intervention



ARTIFICIAL RIVER
IRRIGATION PATTERN
INFILTRATION SURFACE STORAGE TANK
ARTIFICIAL WETLANDS

3 Salinity intrusion

Low tide
High tide

4 Activated stakeholders

- MR Managed Realignment
- F Flood protection
- P Energy Production
- E Environmental well-being
- Fp Food productivity
- Ui Urban intensification
- S Societal integration

5 Programming

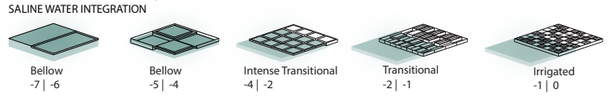
- fp Amateur fishing pond
- of Oyster farming
- sf shellfish farming
- h Halophyte farm
- m Mixed farming
- hv harvesting center
- tp Tidal energy processing substation
- td Tidal energy distribution station
- fm Local food market
- sb Food storage banks
- cp Compost plant
- lr Local restaurant
- tp Enzymatic hydrolosis of halophytes
- td Bio-fuel energy plant
- fm Microbial fermentation

6 Spatial typology resulted

FARMING MODULES

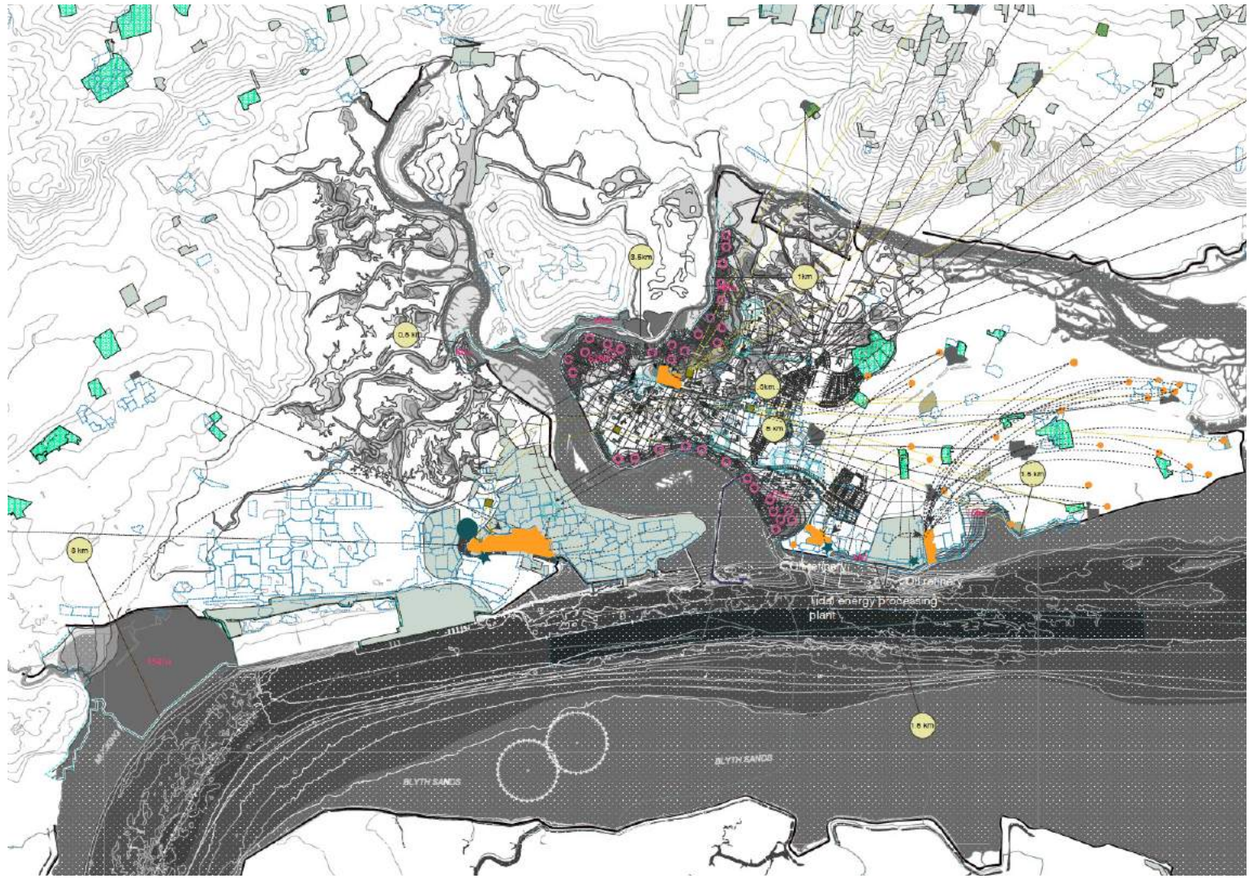
Tidal Energy pond -7 | -6
Oyster farm -5 | -4
Halophyte farm -4 | -2
Hydroponics -2 | -1
Mixed agriculture -1 | 0

SALINE WATER INTEGRATION



Bellow -7 | -6
Bellow -5 | -4
Intense Transitional -4 | -2
Transitional -2 | -1
Irrigated -1 | 0

0 5km 10km



1
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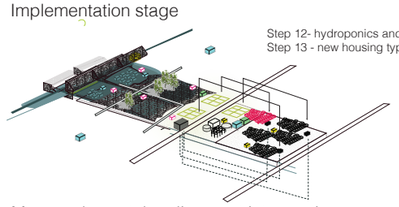
Design
Spatial consequence - Intervention timeline

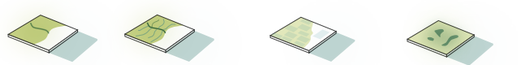
Urban consequences - proposed contact areas for urbanity intensification

1 Implementation stage



Step 12- hydroponics and mixed agriculture
Step 13 - new housing typologies

2 Managed coastal realignment intervention



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IRRIGATION PATTERN
INFILTRATION SURFACE STORAGE TANK
ARTIFICIAL WETLANDS

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Low tide
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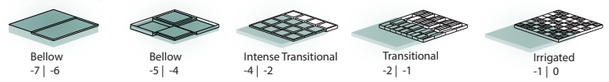
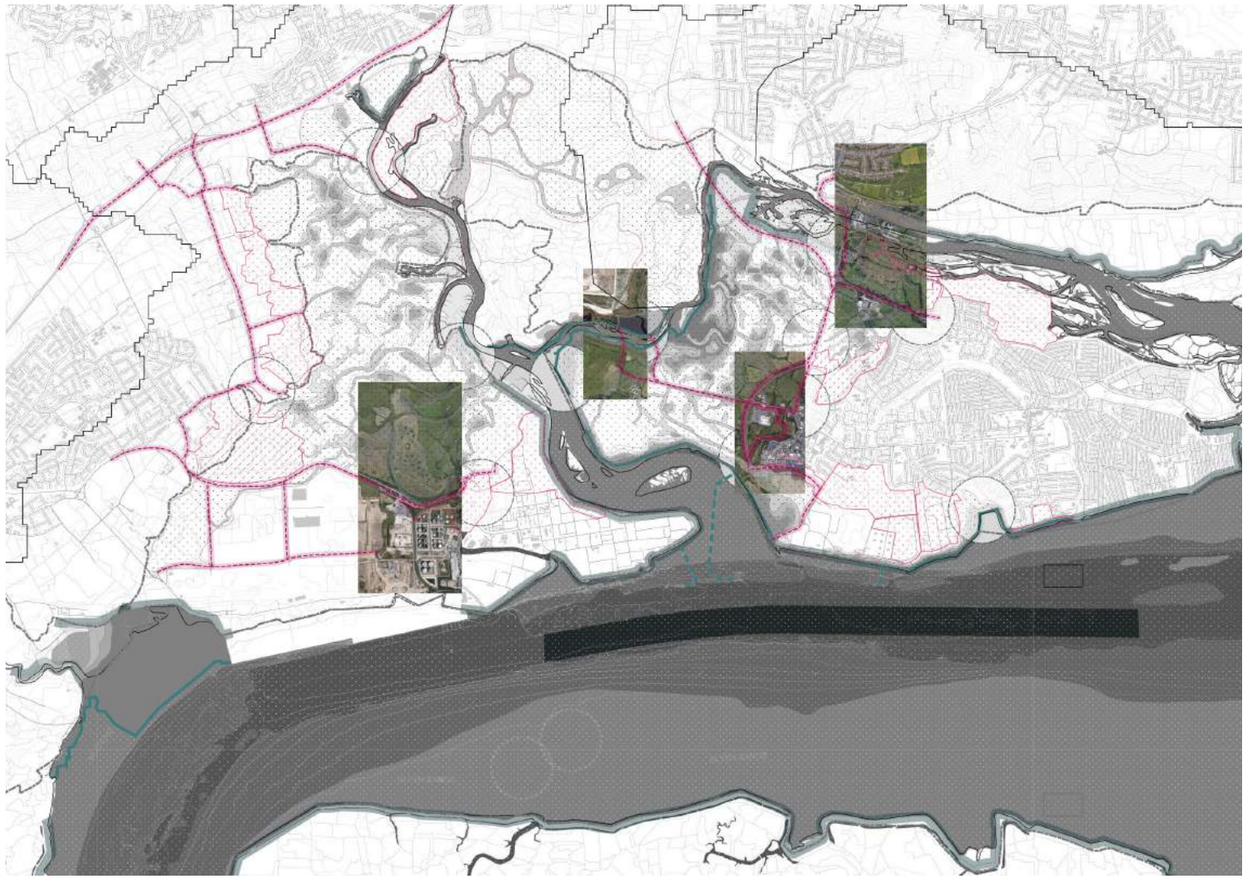


Bellow -7 | -6
Bellow -5 | -4
Intense Transitional -4 | -2
Transitional -2 | -1
Irrigated -1 | 0

0 5km 10km

Locations with typology integration



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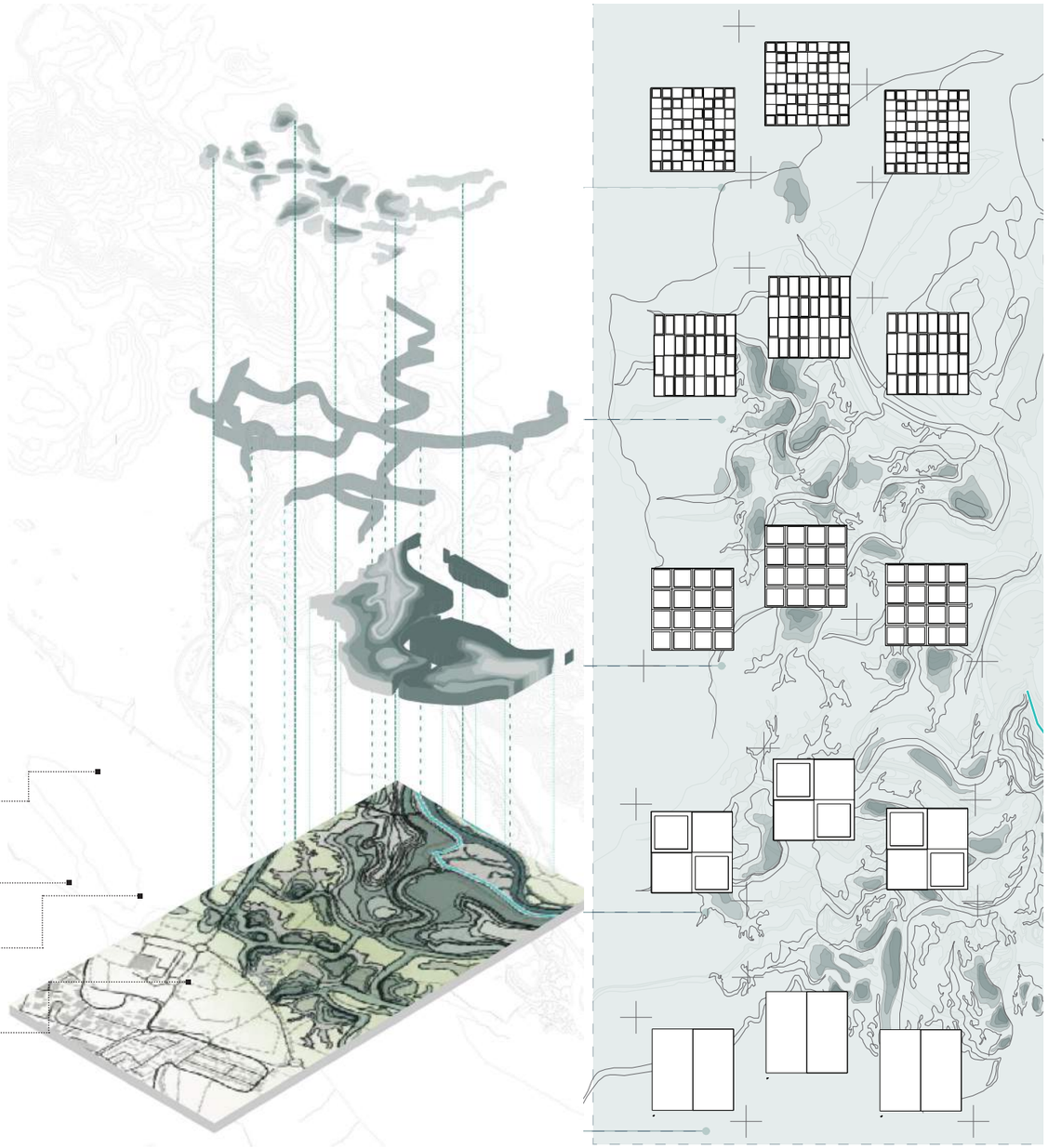
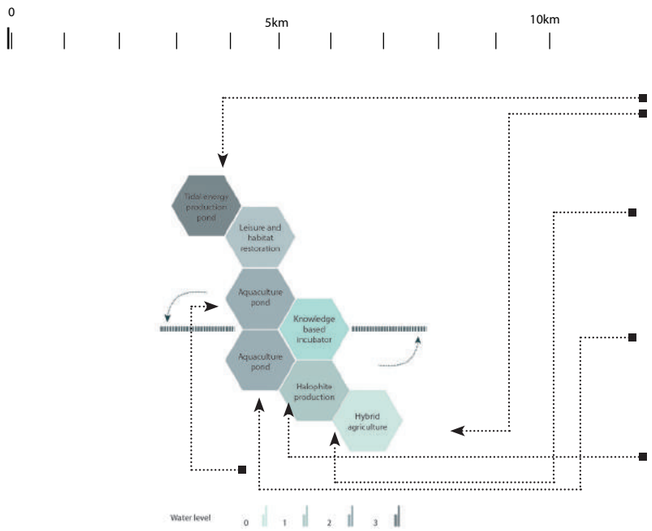
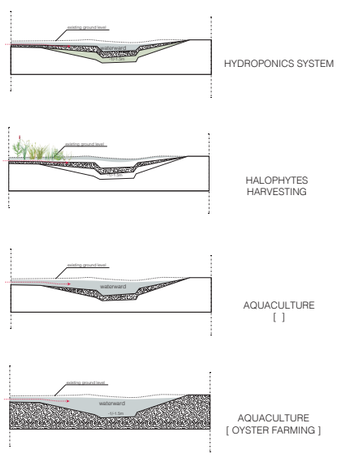
Design
Mezo scale

Productive consequences - pond typology - depth criteria





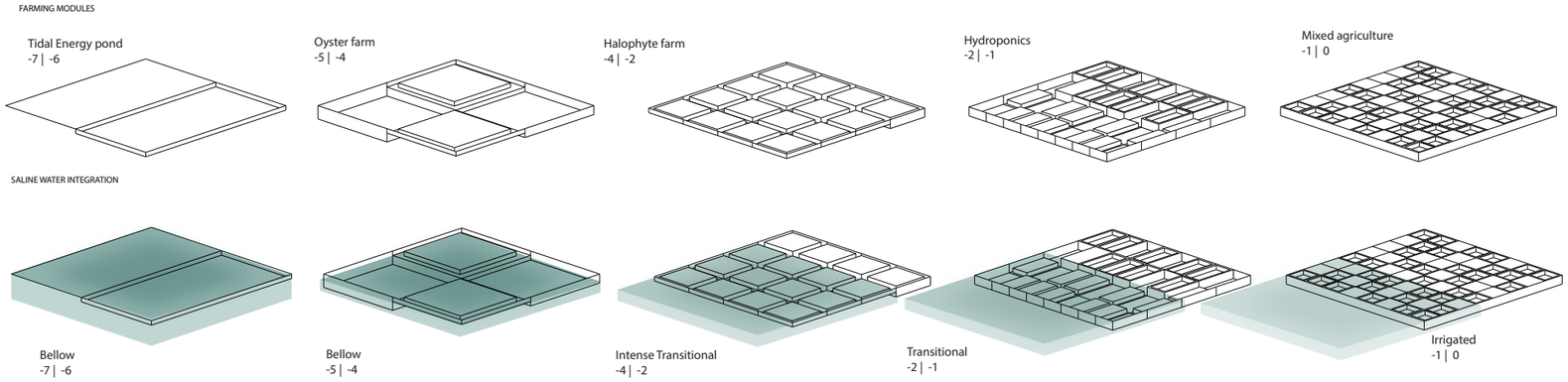
Land use shift

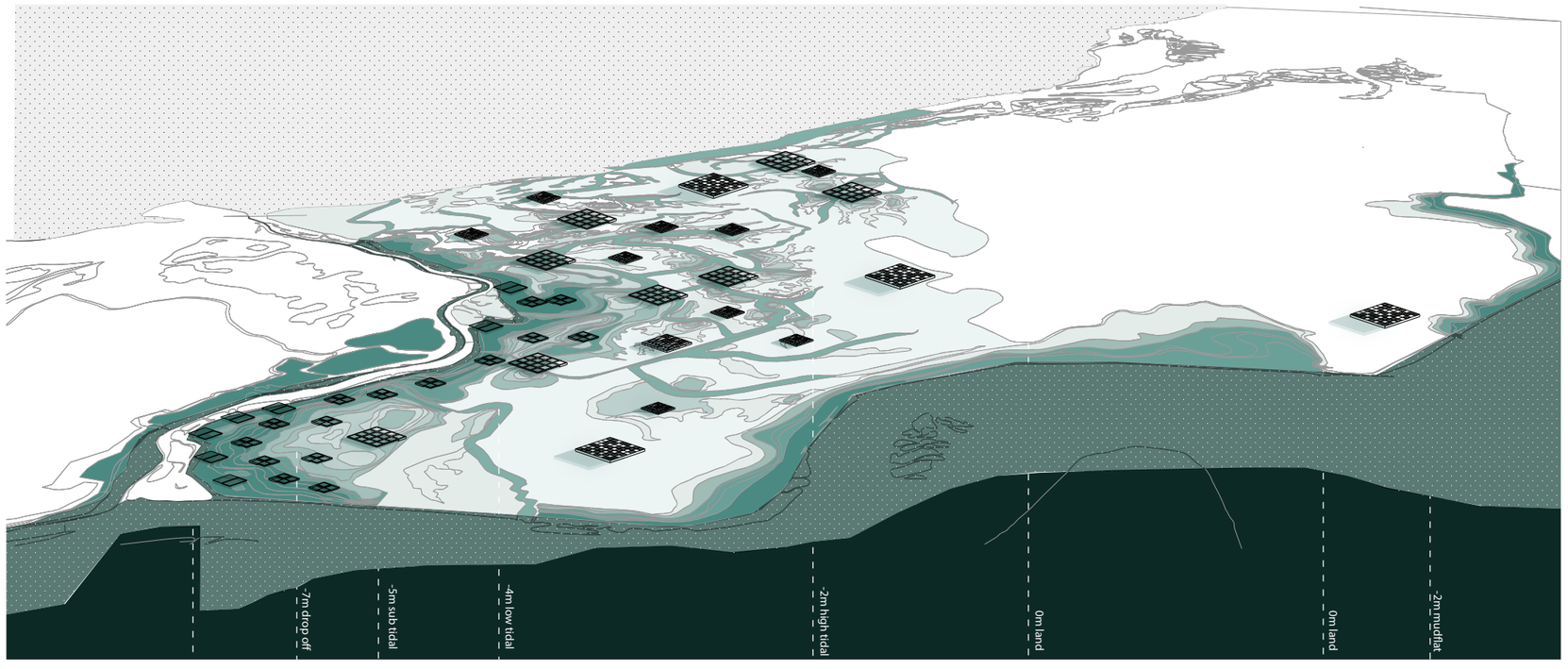


Required depth for different aquaculture levels

Design
Mezo scale

Productive consequences -new agricultural tyology





Design
Mezo scale

Productive consequences -planting pattern

irrigated

celery eggplant garlic tomato pepper

blackcurrant strawberry blueberry watermelon

low intertidal pond

shore crab redrock crab eel grass purple laver

sea lettuce sugar kelp

mid intertidal pond

pickleweed sea beet beach pea sea kale sea spinach dill

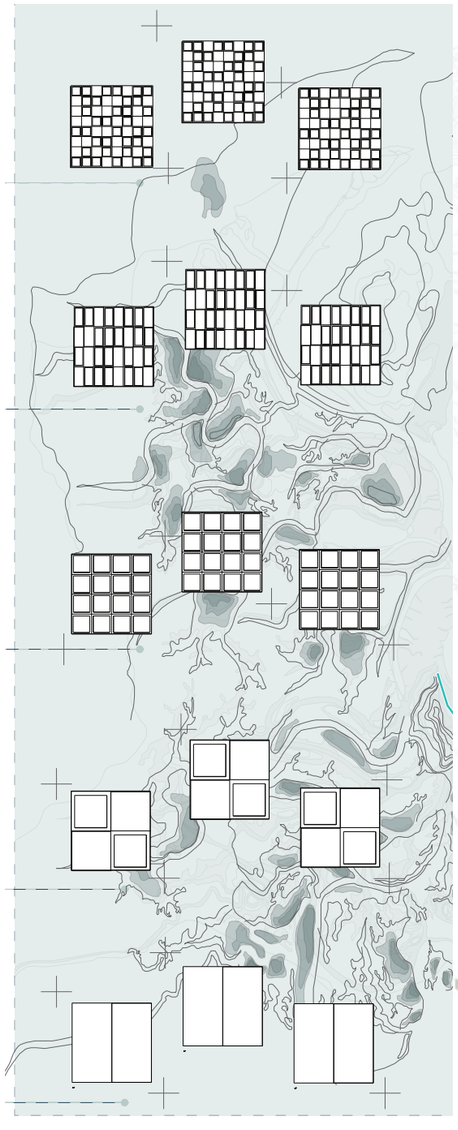
lettuce basil rosemary sage camomille mint

high intertidal pond

oyster clam mussel

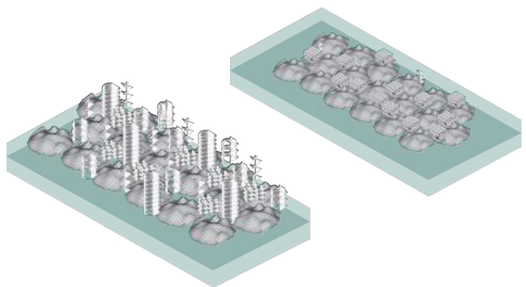
salmon dedduce

energy engineered pond



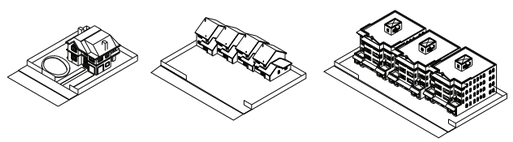
Design
Micro scale

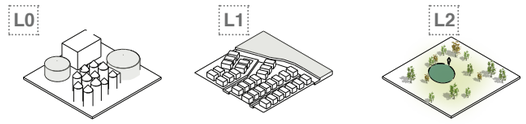
Productive consequences -the hydroponic field

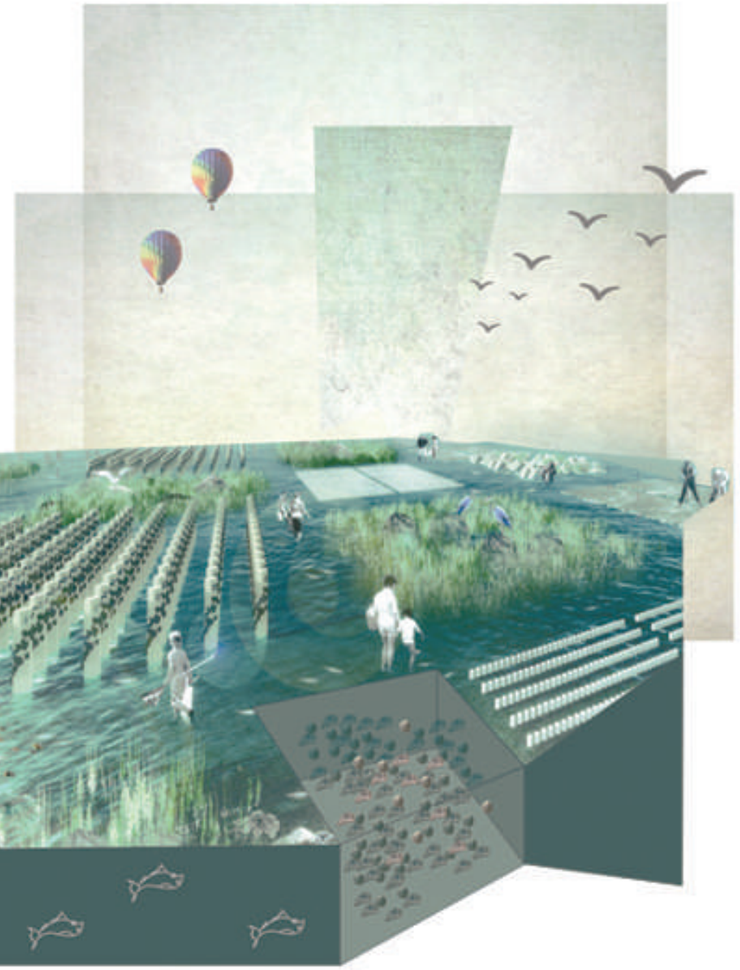


Existing block typology

Existing housing typology

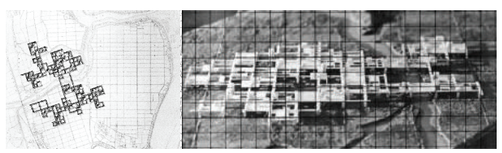




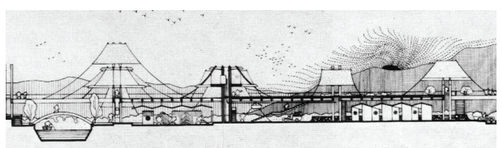


Kurokawa - Agricultural city

Agricultural city plan

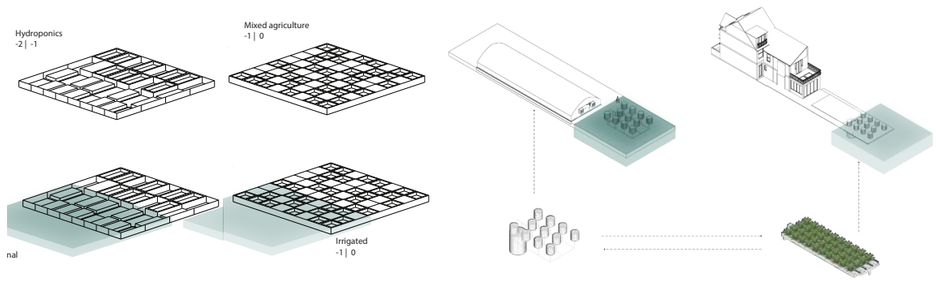


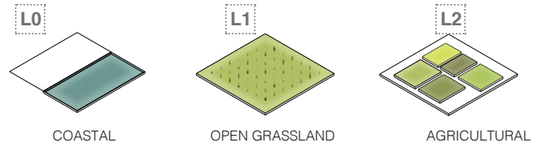
Floating city - section

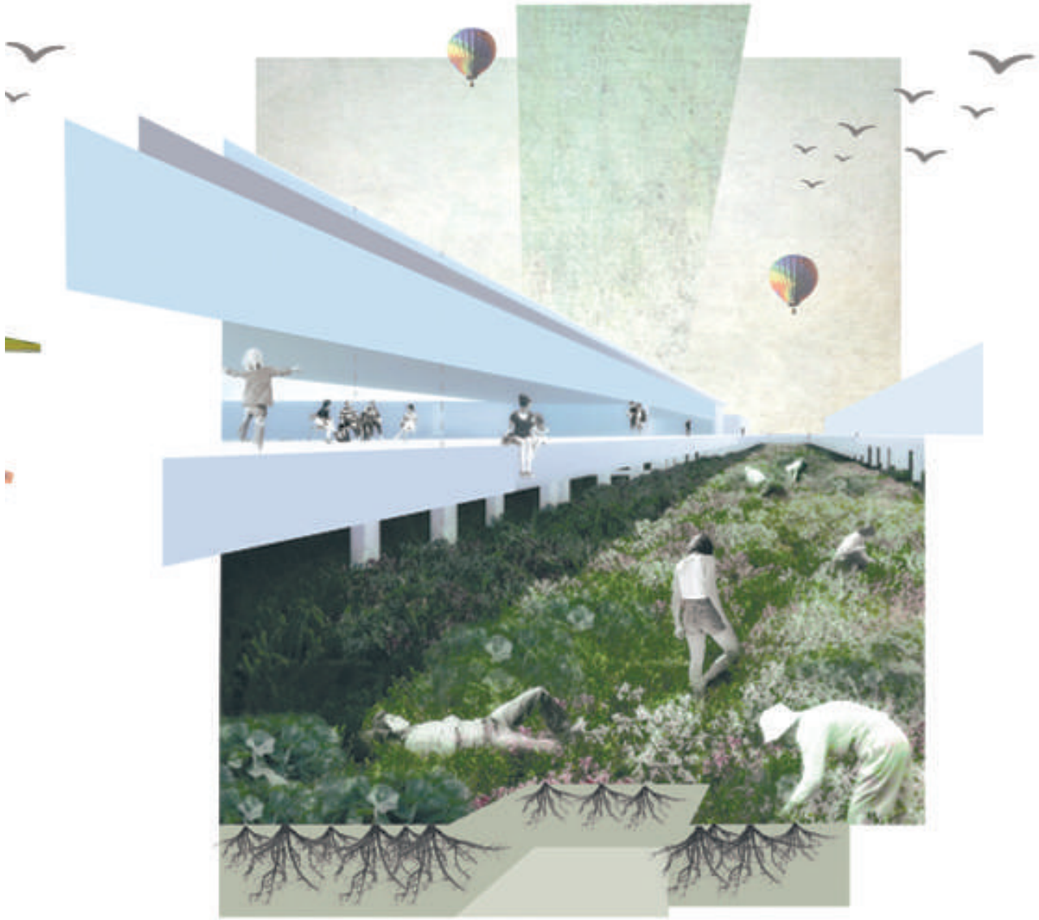


Design
Micro scale

Productive consequences -the halophyte farm

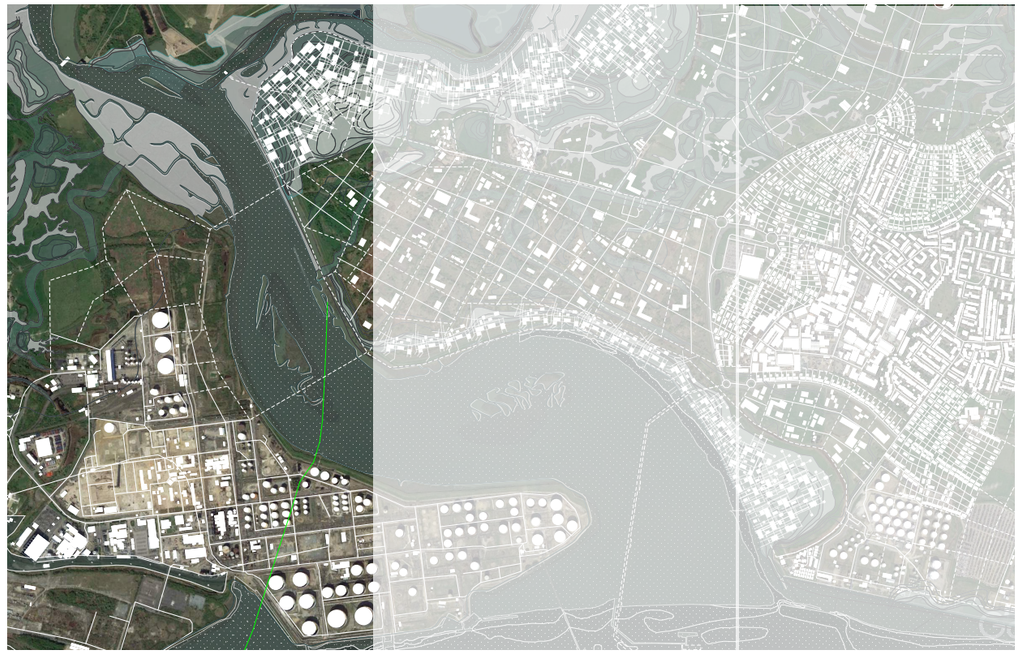




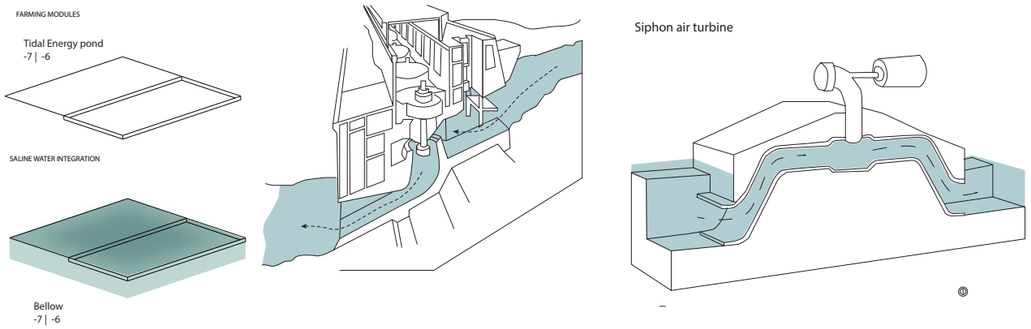


Design
Micro scale

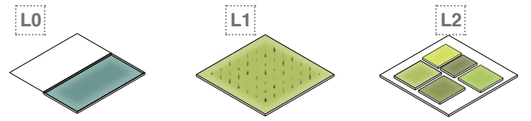
Productive consequences -the energetic pond



Tidal burried barrage

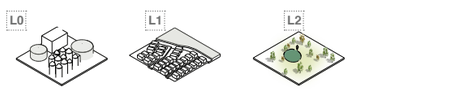


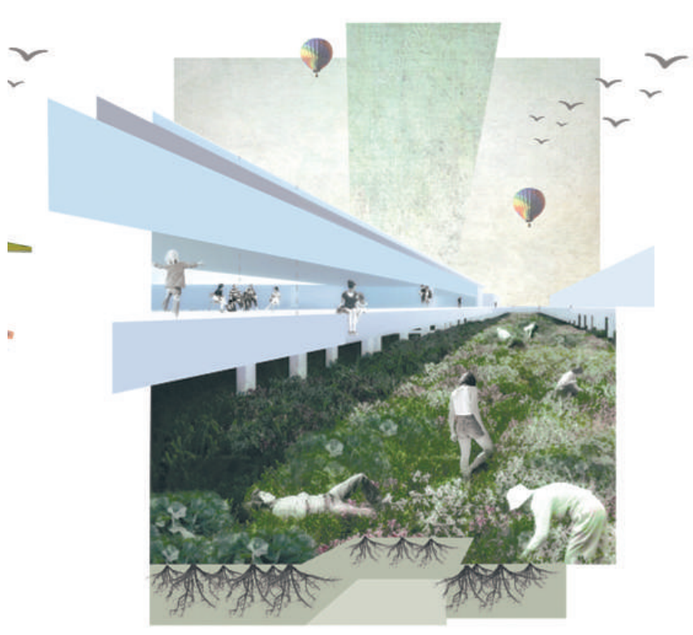
Siphon air turbine



Design
Micro scale

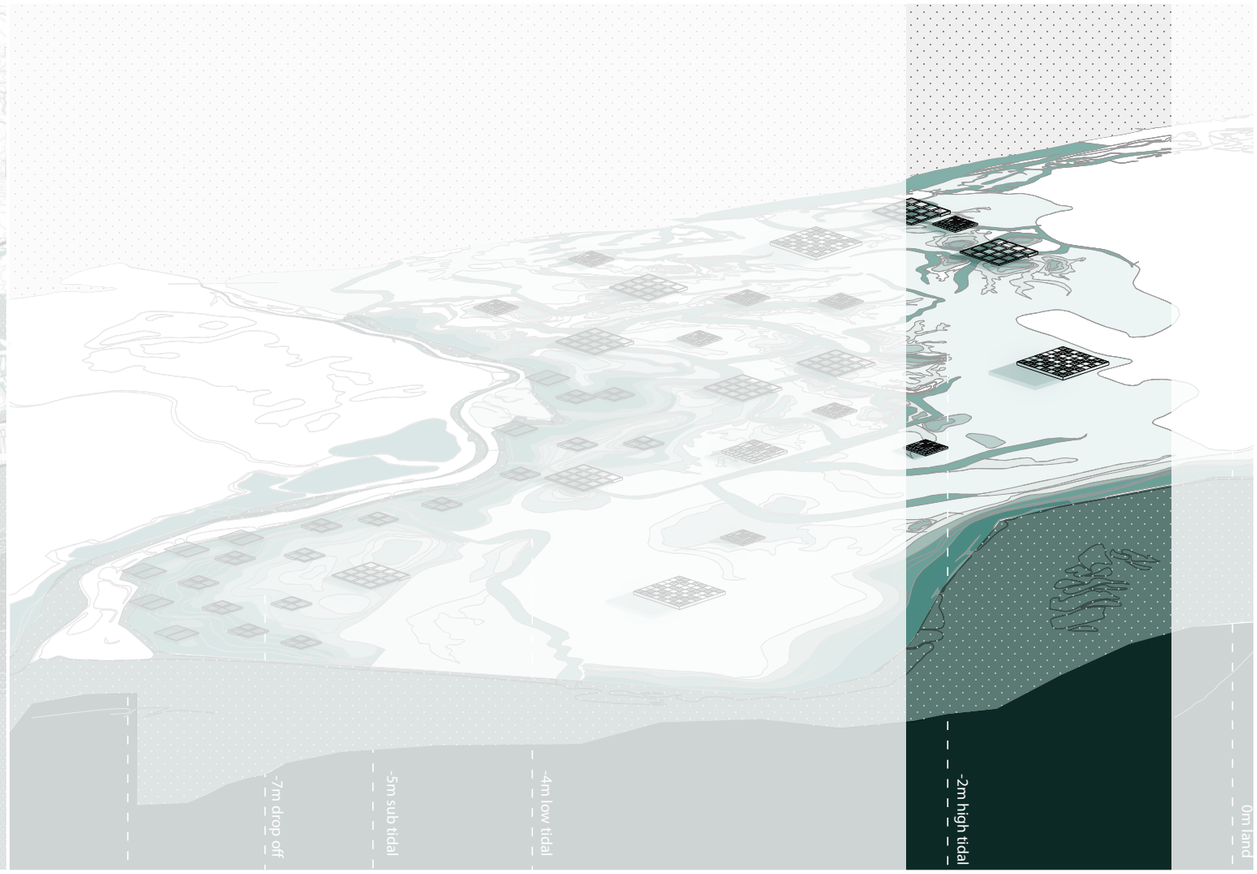
Productive consequences -the energetic pond

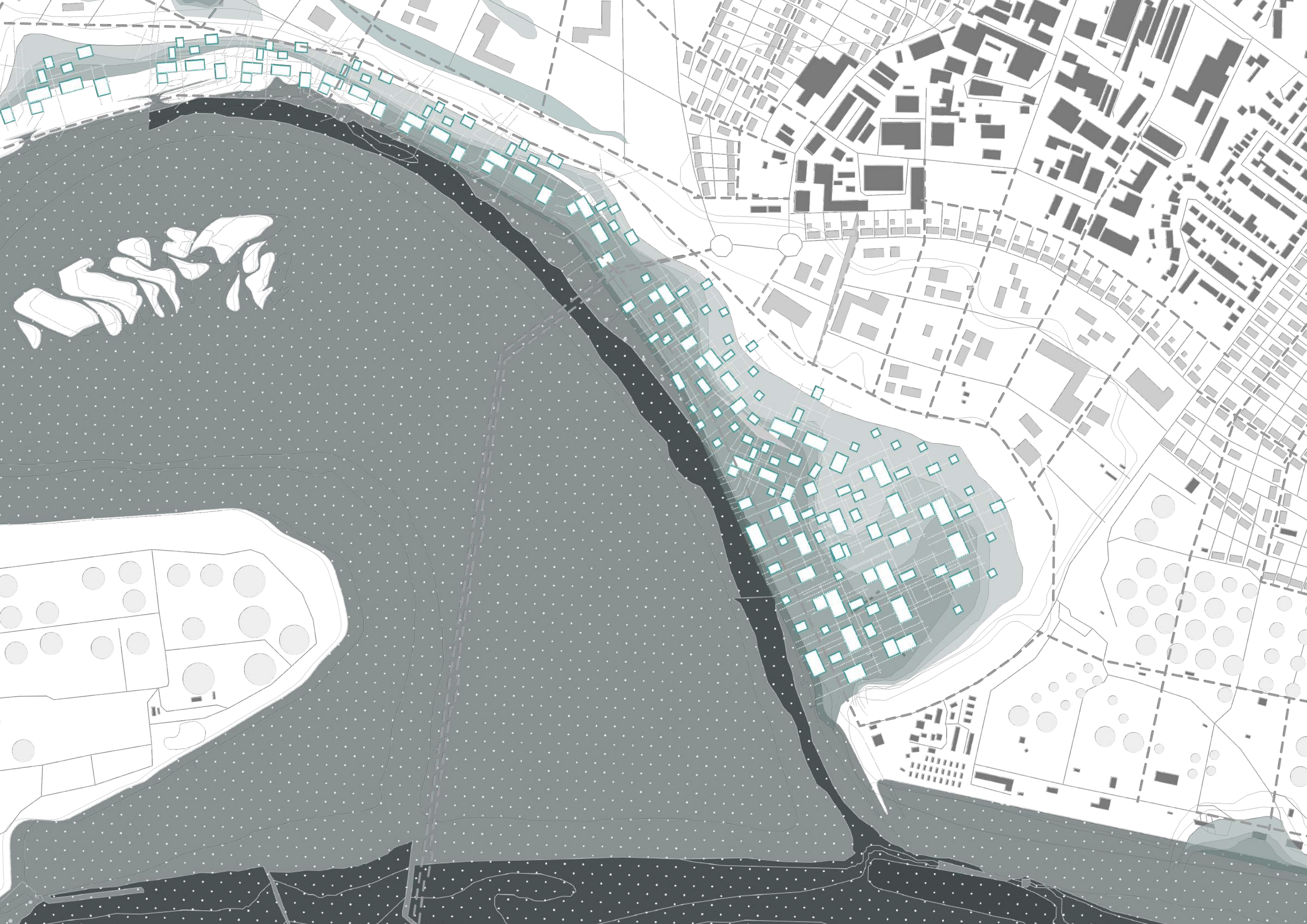




Design
Mezo scale

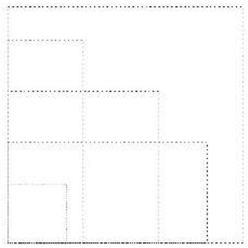
0
5km
10km





Design
Micro scale

Productive consequences -oyster processes



AQUACULTURE RESERVOIR

size and location principles

PROCESSES INVOLVED

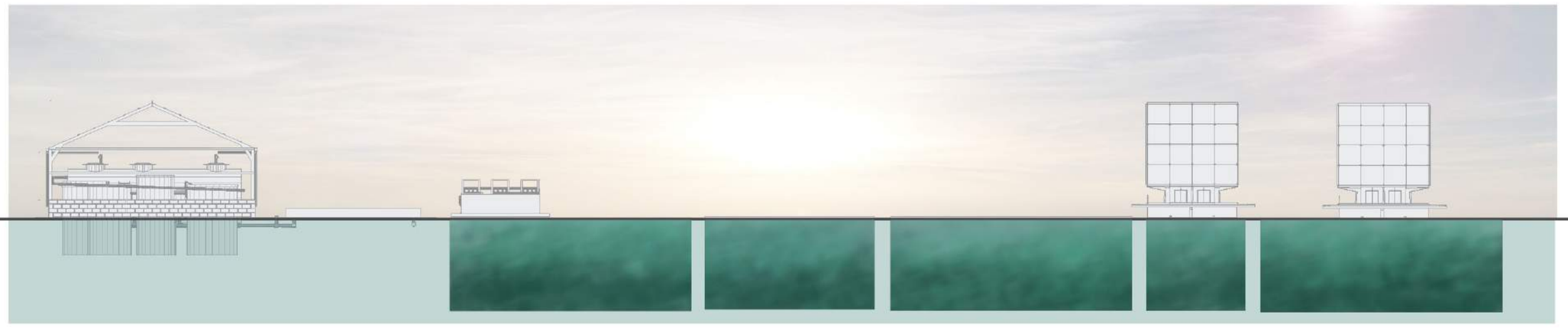
fingerling
rearing pond system

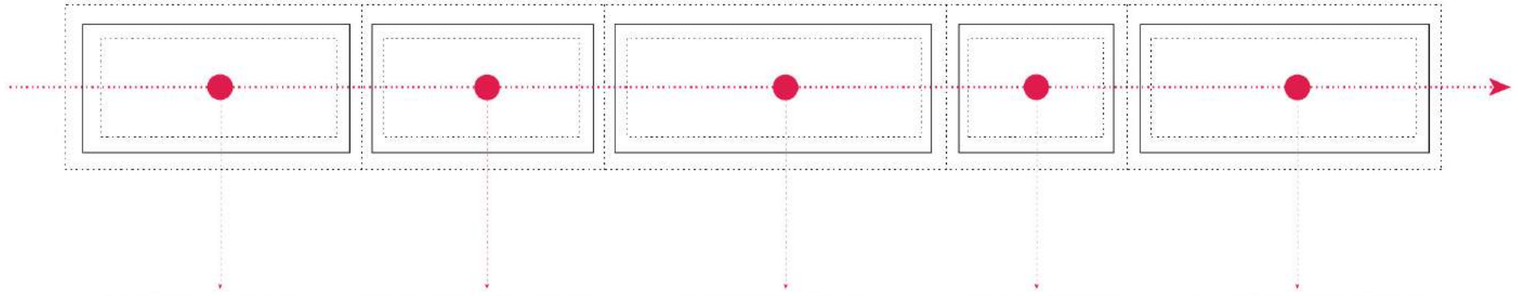
fry/fingerling
nursery + rearing pond system

marketable products

PRODUCTION CYCLE

34 weeks nursery -> harvest





NURSERY POND

TRANSITION POND

REARING POND

PRODUCTION PROCESS

HARVESTING POND

1-1.5 M

1.5-2 M

2.5-3 M

1.5-2 M

1.5-2 M

Design
Micro scale

Productive consequences -oyster processes

PROCESSES INVOLVED
fingerling
rearing pond system
fry/fingerling
nursery + rearing pond system

PRODUCTION CYCLE
34 weeks nursery -> harvest

marketable products

FINGERLINGS
QUARANTINE 2W
NURSERY 3-4W
GROW OUT STAGE 1 7W
GROW OUT STAGE 2 10W
GROW OUT STAGE 3 10W
HARVESTING POND 1W

COLLECTION
PROCESSING
DISTRIBUTION

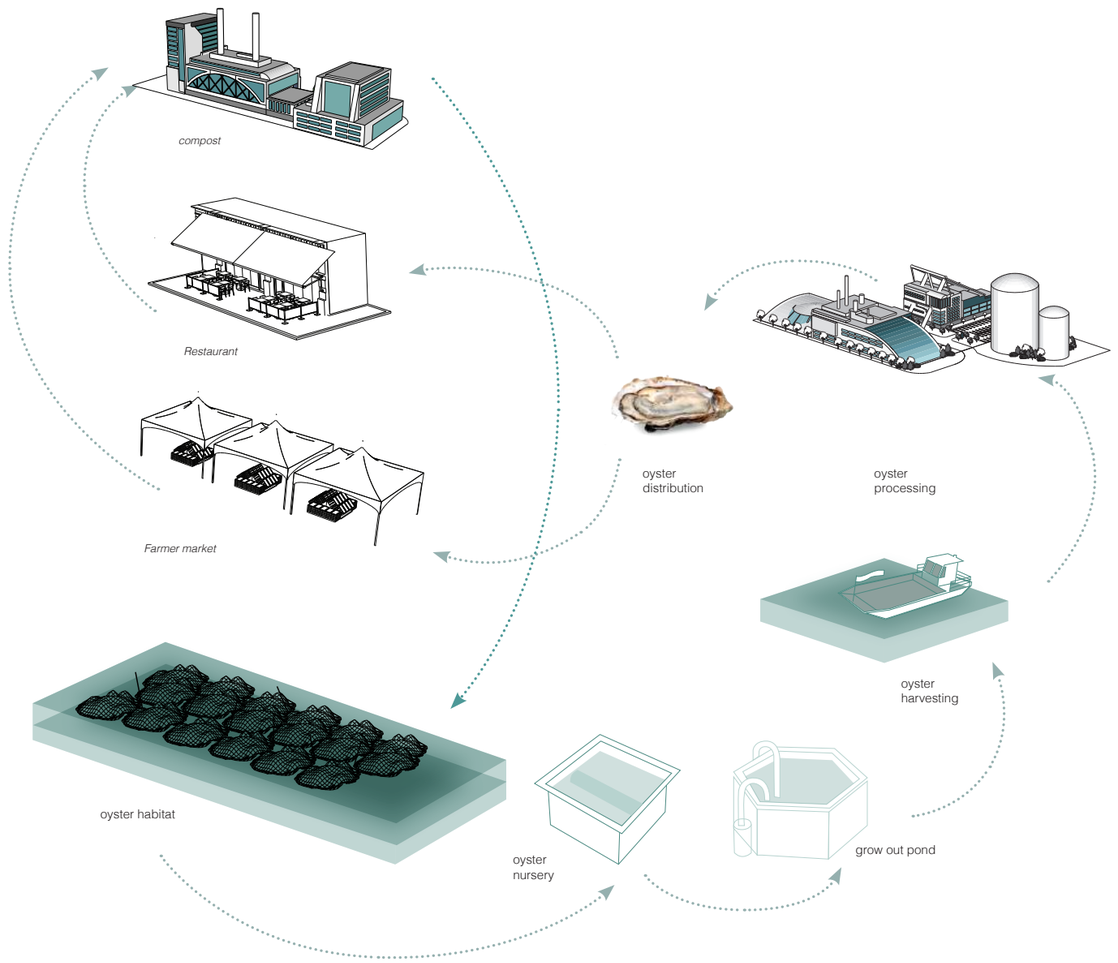
POND TO PLATE

1.25$ - 1.35$ per oyster
total oyster pond surface - 158 ha - infrastructure - energy ponds = 40 ha
1 ha - 58.500$ total yearly expenses
- 33.345$ yearly net income

Total : initial investment : 2.340.000$ - 1.66418935 million British pounds
net income per year : 1.333.800$ - 948 587.928 British pounds

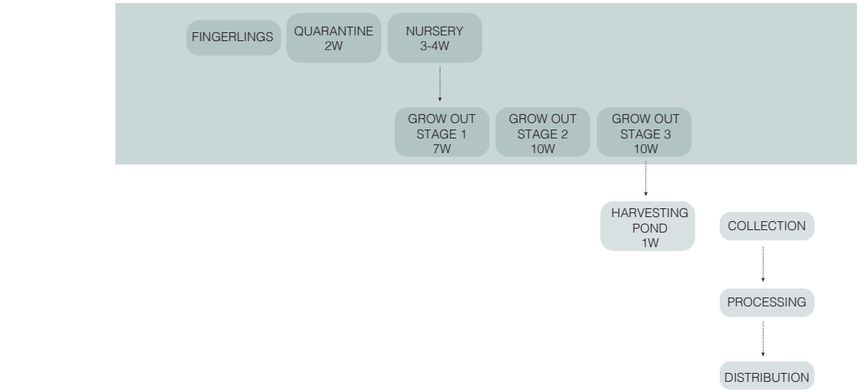
Production: 1 oyster farm - 6200mp >>> 13 tons\ha\year >>> for 40 ha = 520 tons (England production = 150t/year)

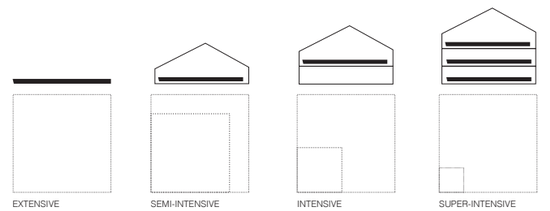
Calculations based on business model for long line system oyster farming - Australia + Thailand

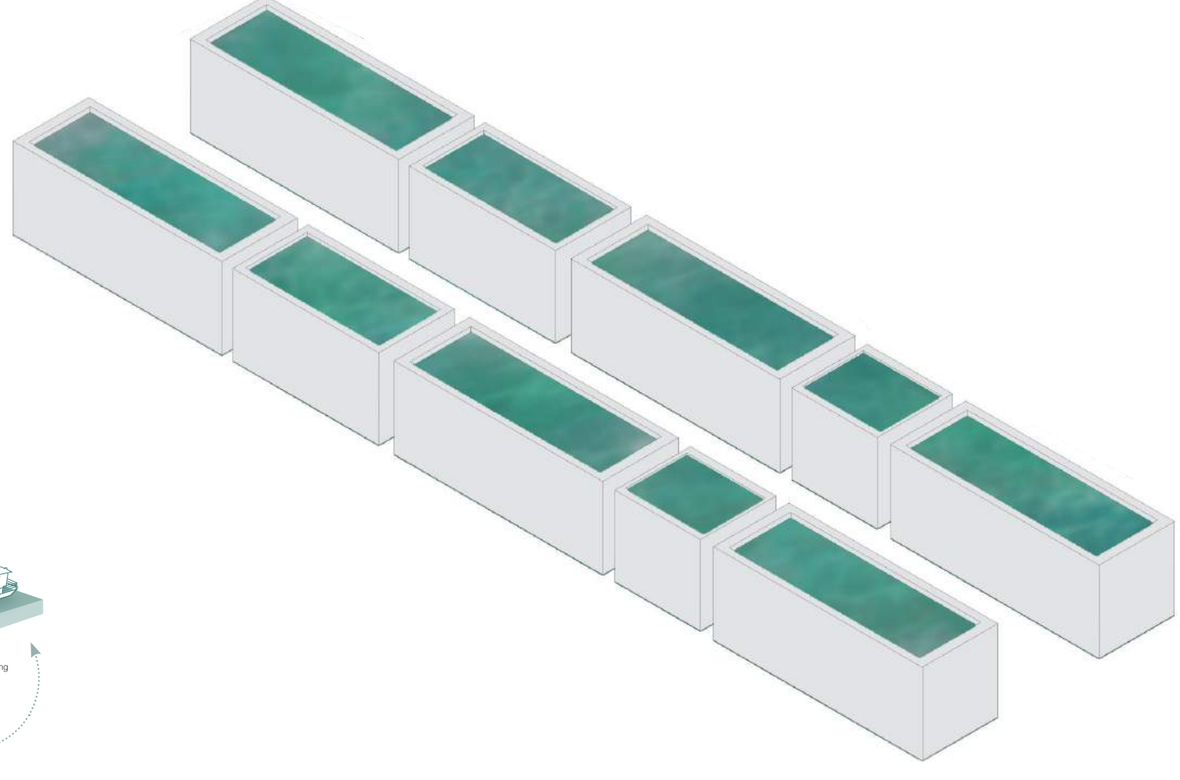


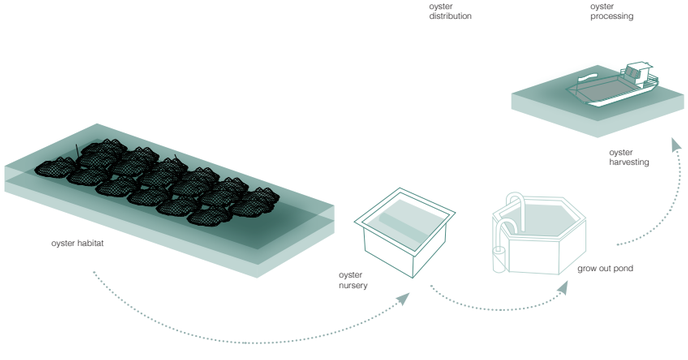
Design
Micro scale

Productive consequences -oyster processes



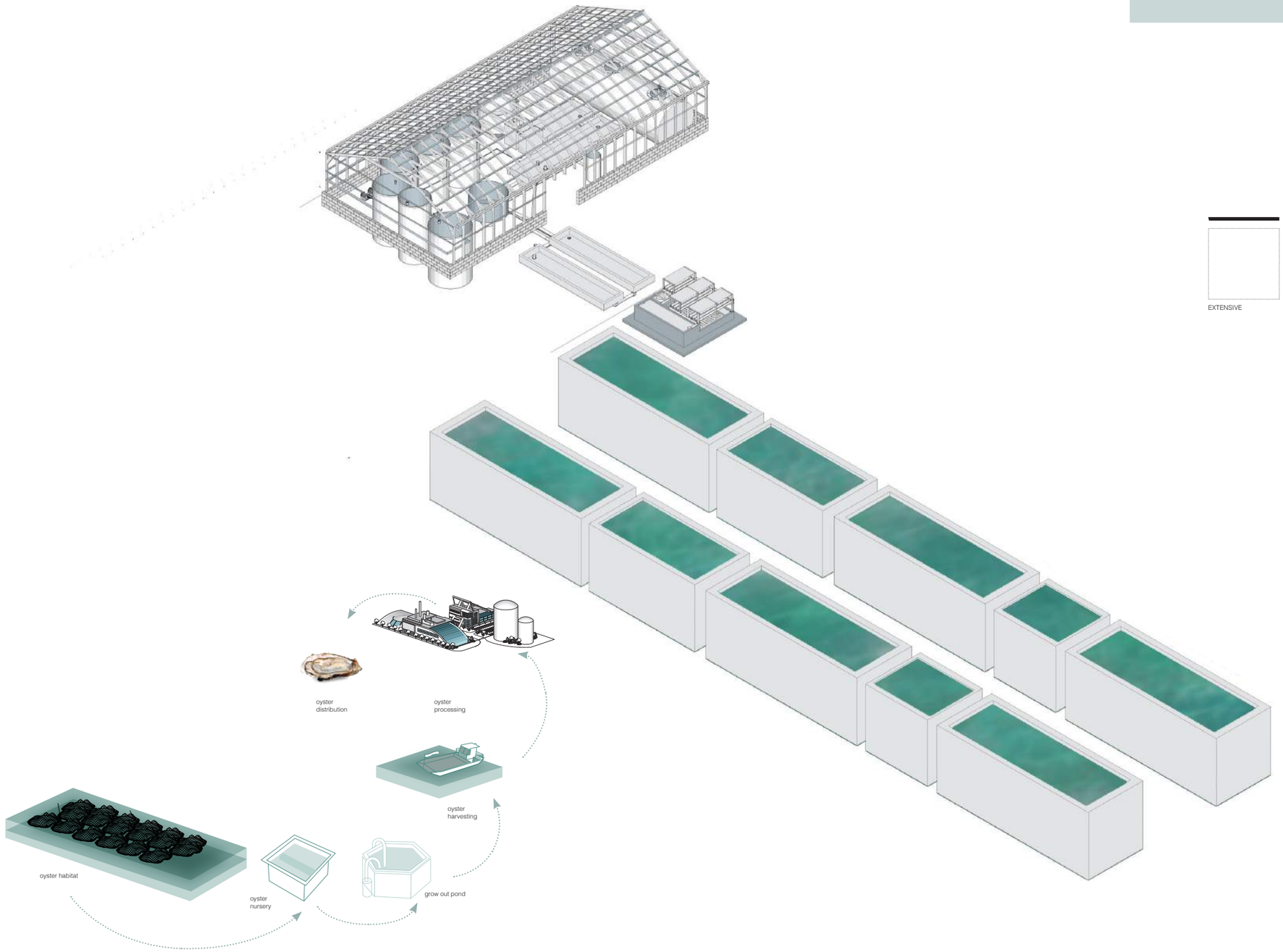


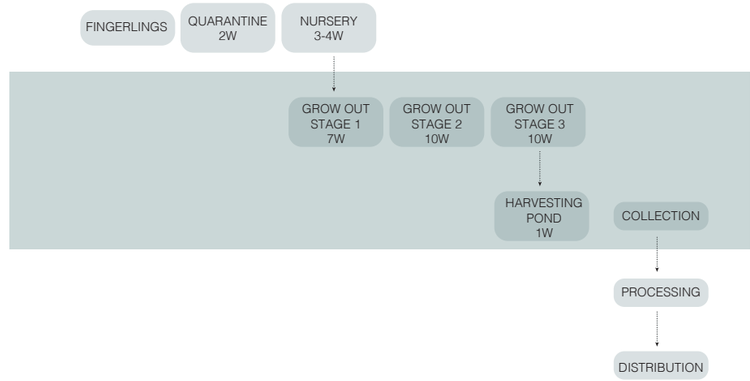


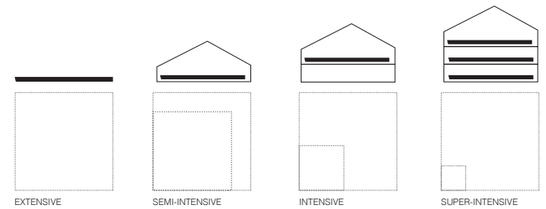


Design
Micro scale

Productive consequences -oyster processes

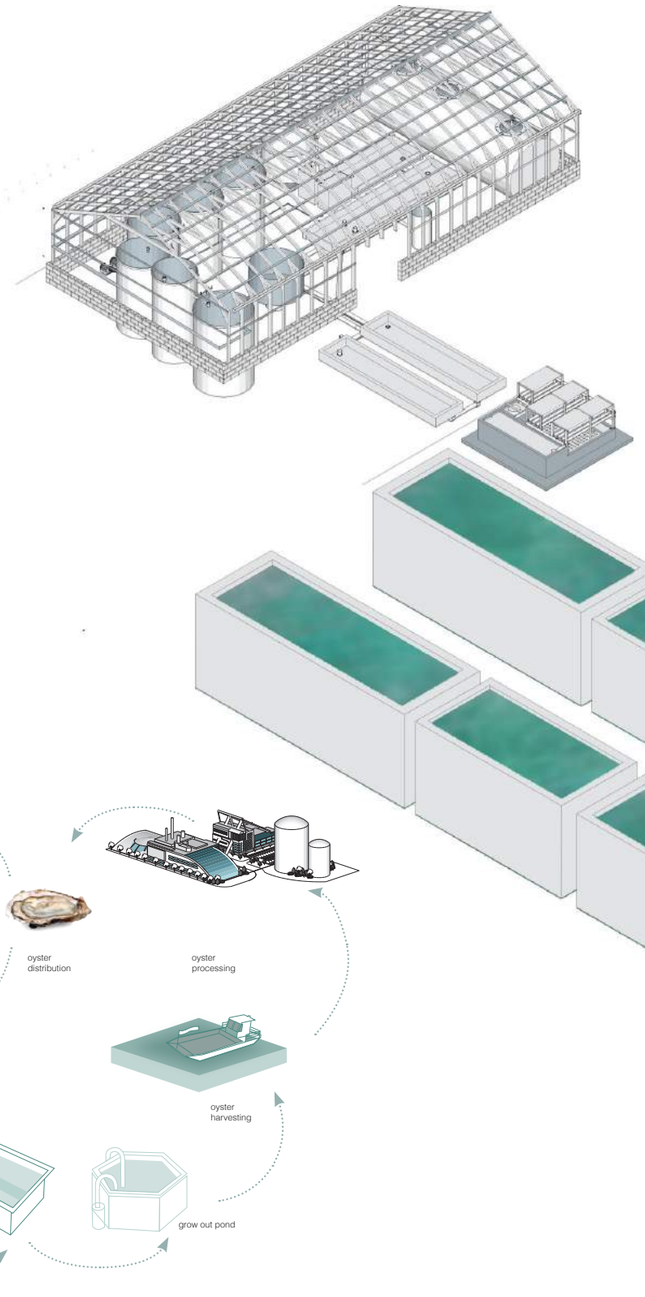


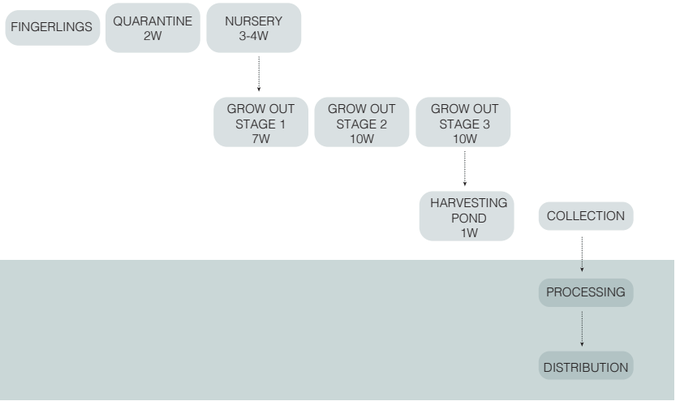


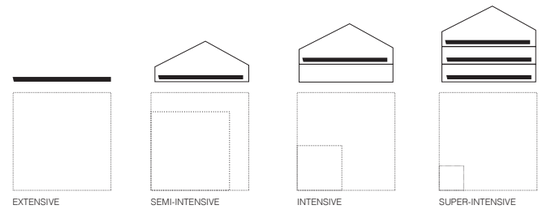


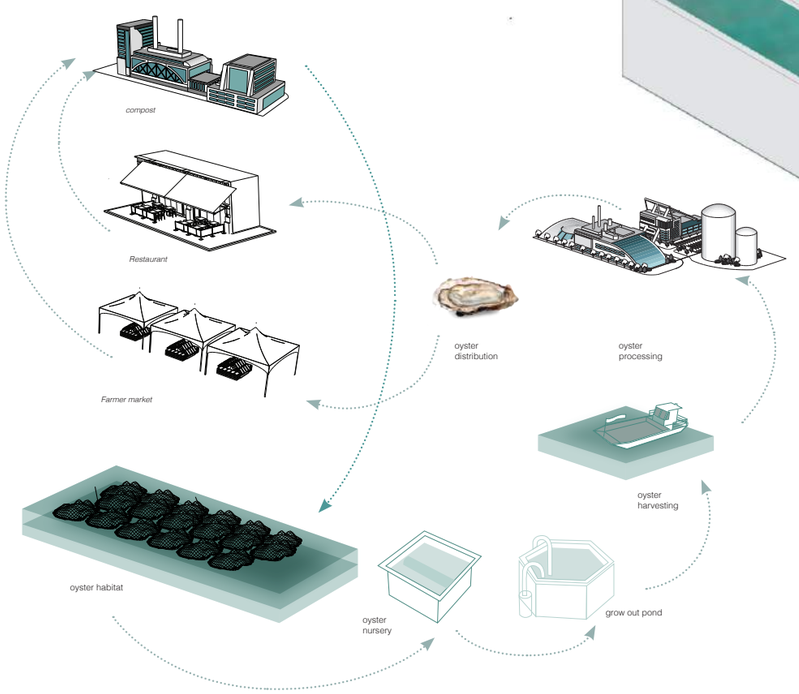
Design
Micro scale

Productive consequences -oyster processes



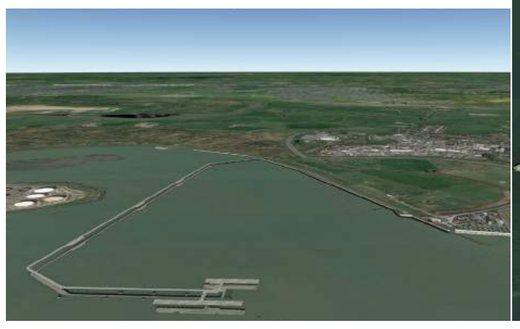






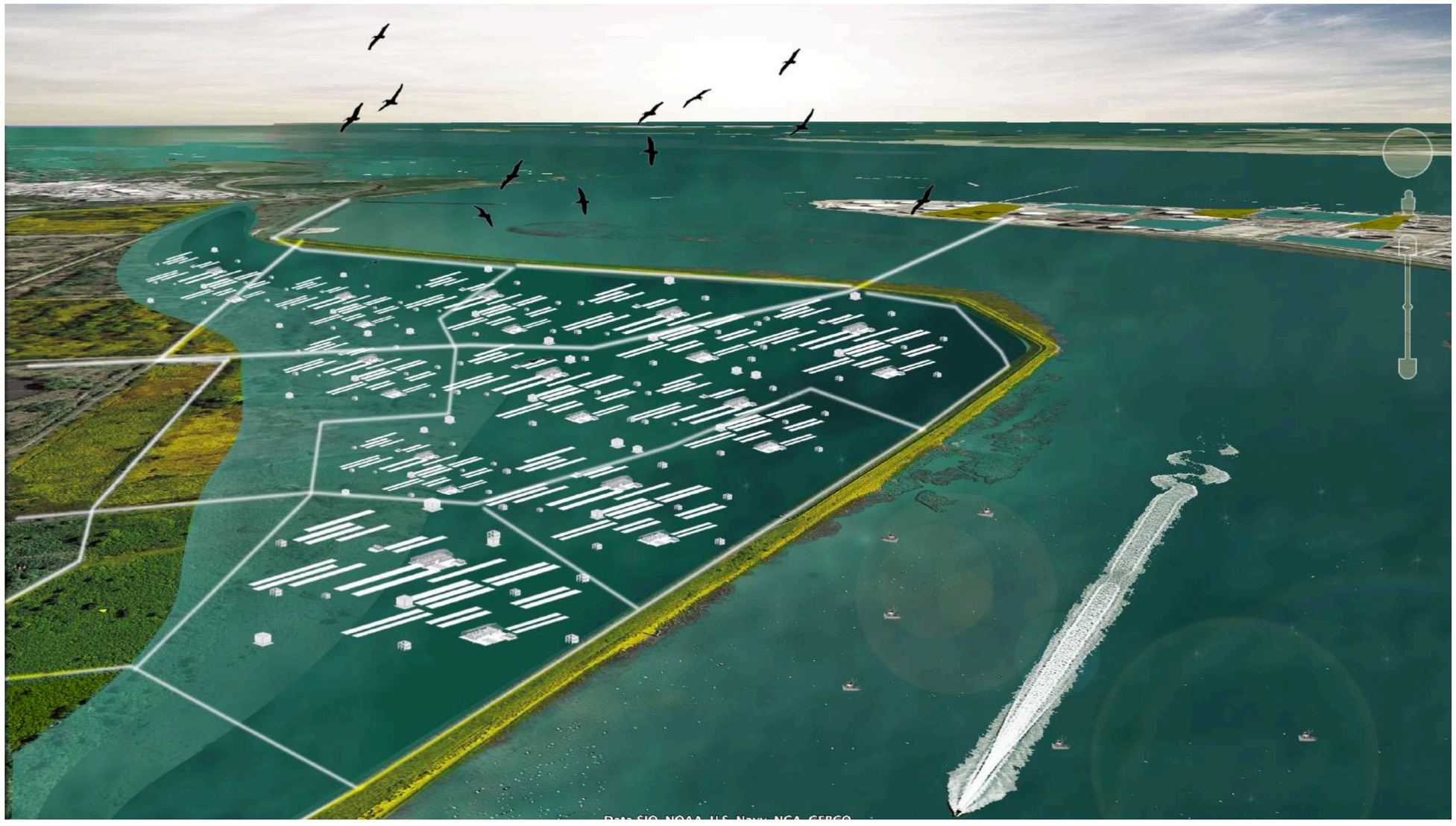
Design
Micro scale

Productive consequences -oyster processes



Design
Micro scale

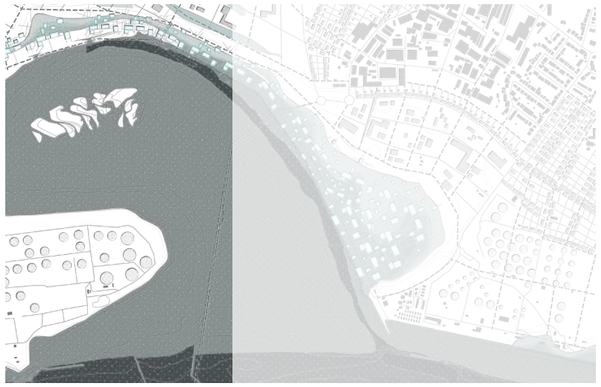
Productive consequences -oyster processes



Design
Micro scale

Strategic development plan - the oyster district in relation to the port

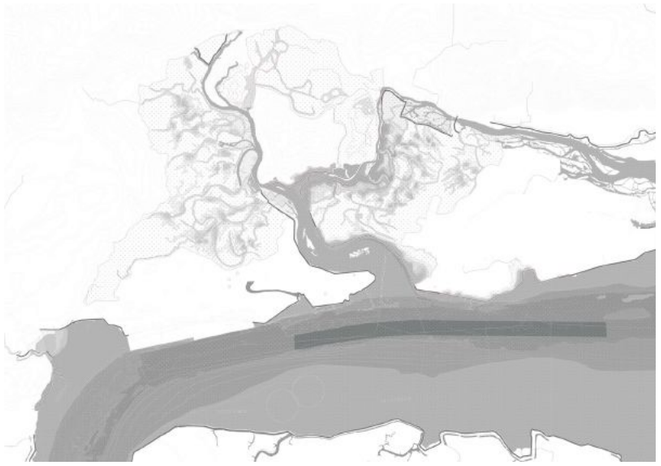
Step 2



Design evaluation - regional scale
Cuantification and supportive infrastructure

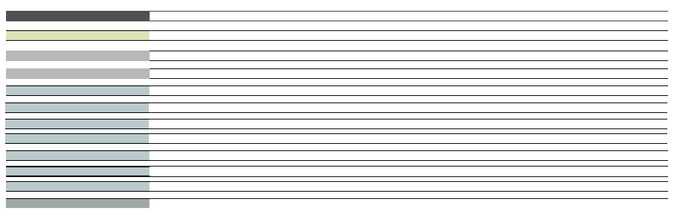
Natural consequences - habitat shift 5yr

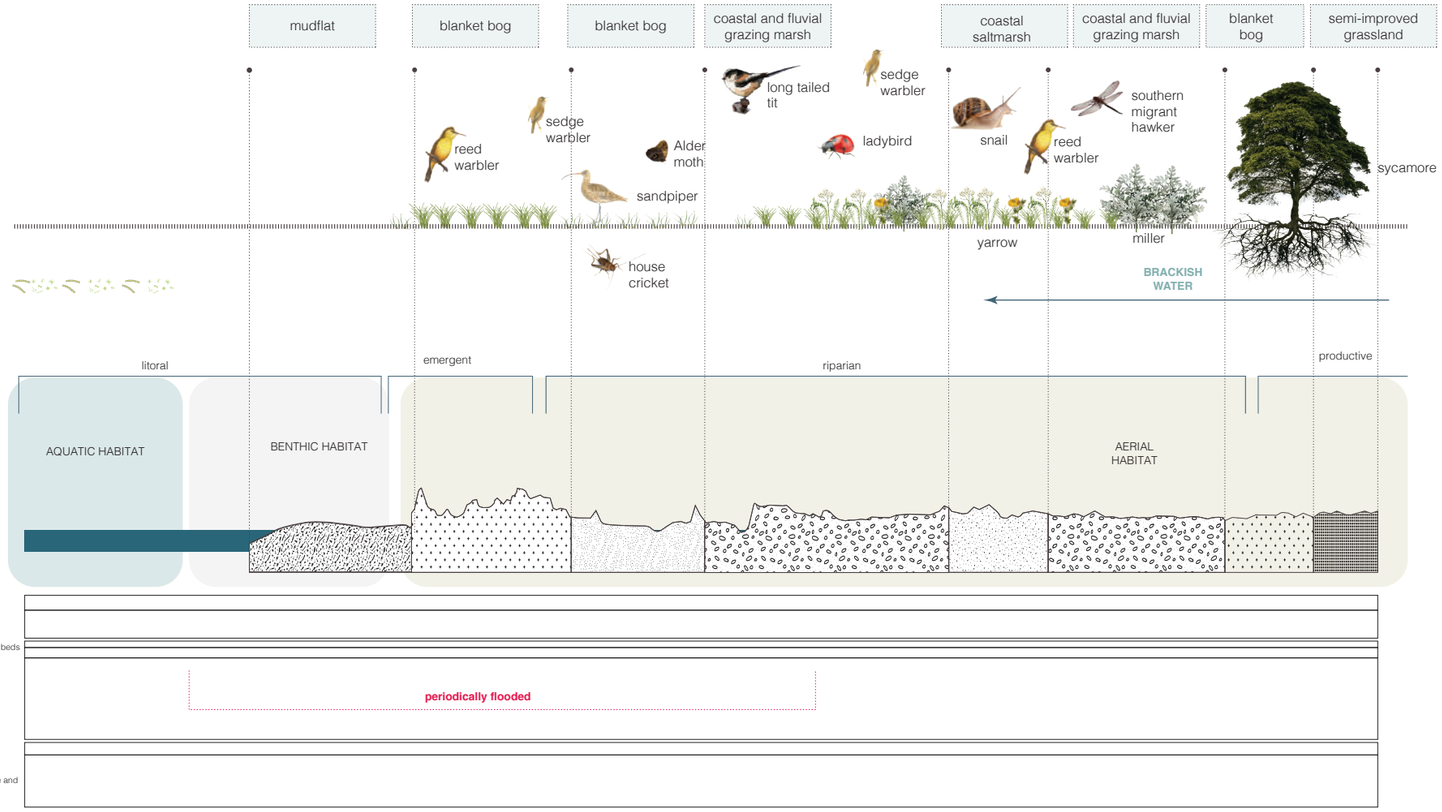
Ecoservices assessment



Salinity intrusion

Habitat gradient

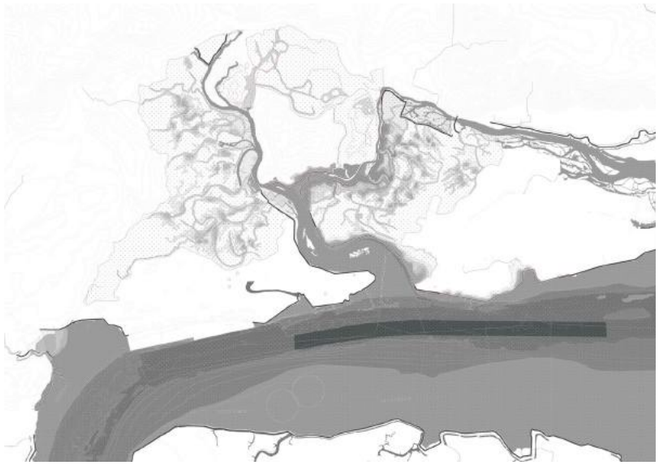




Design evaluation - regional scale
Cuantification and supportive infrastructure

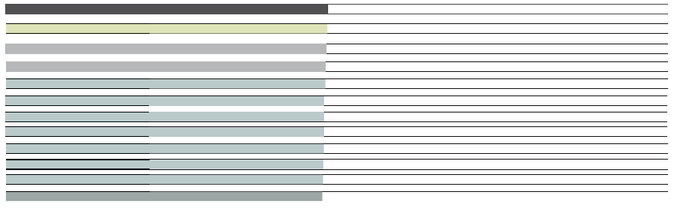
Natural consequences - habitat shift 50yrs

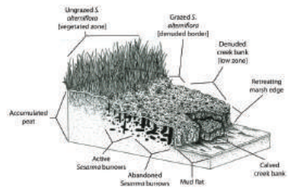
Ecoservices assessment

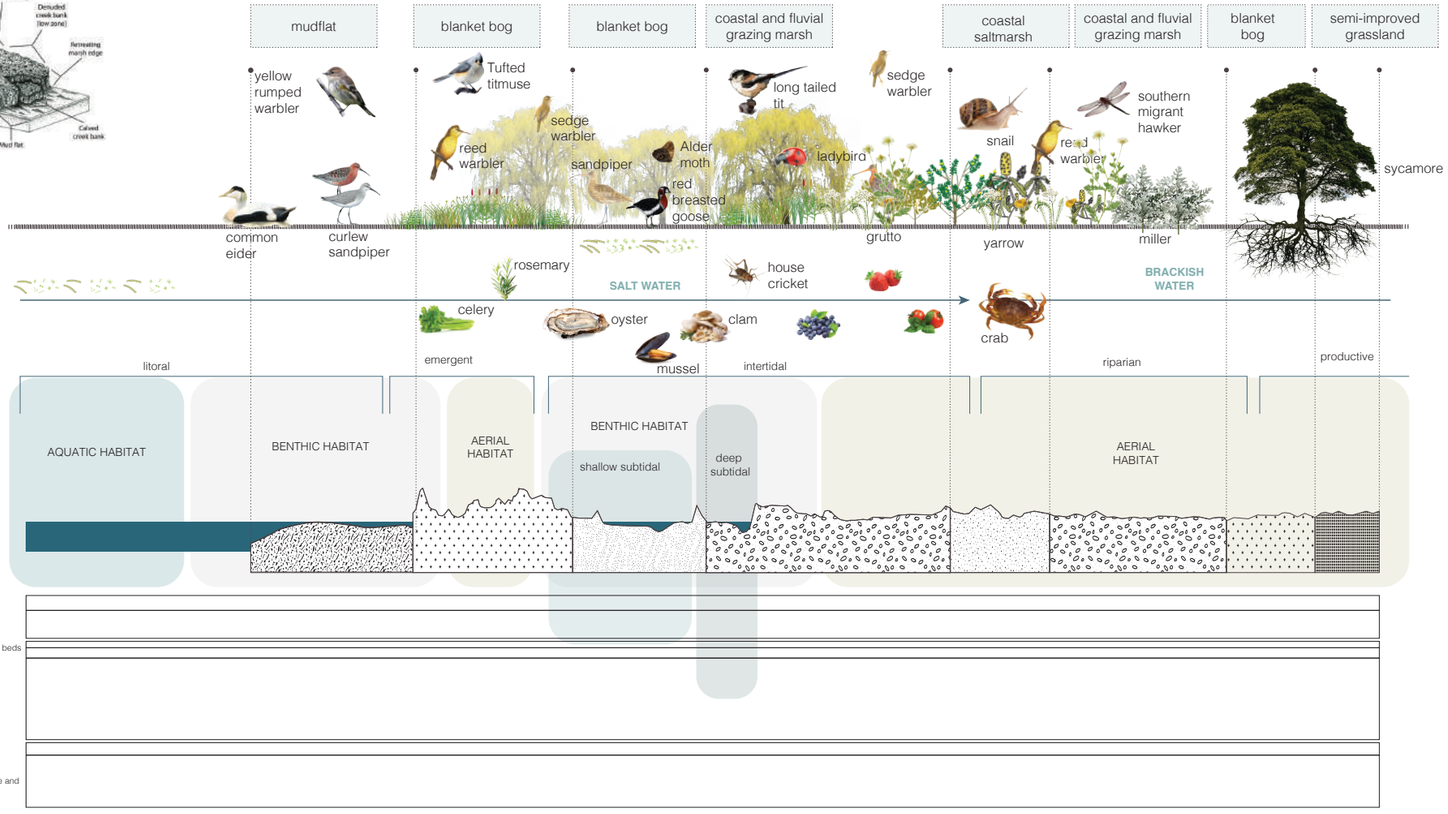


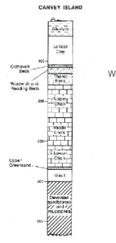
Salinity intrusion

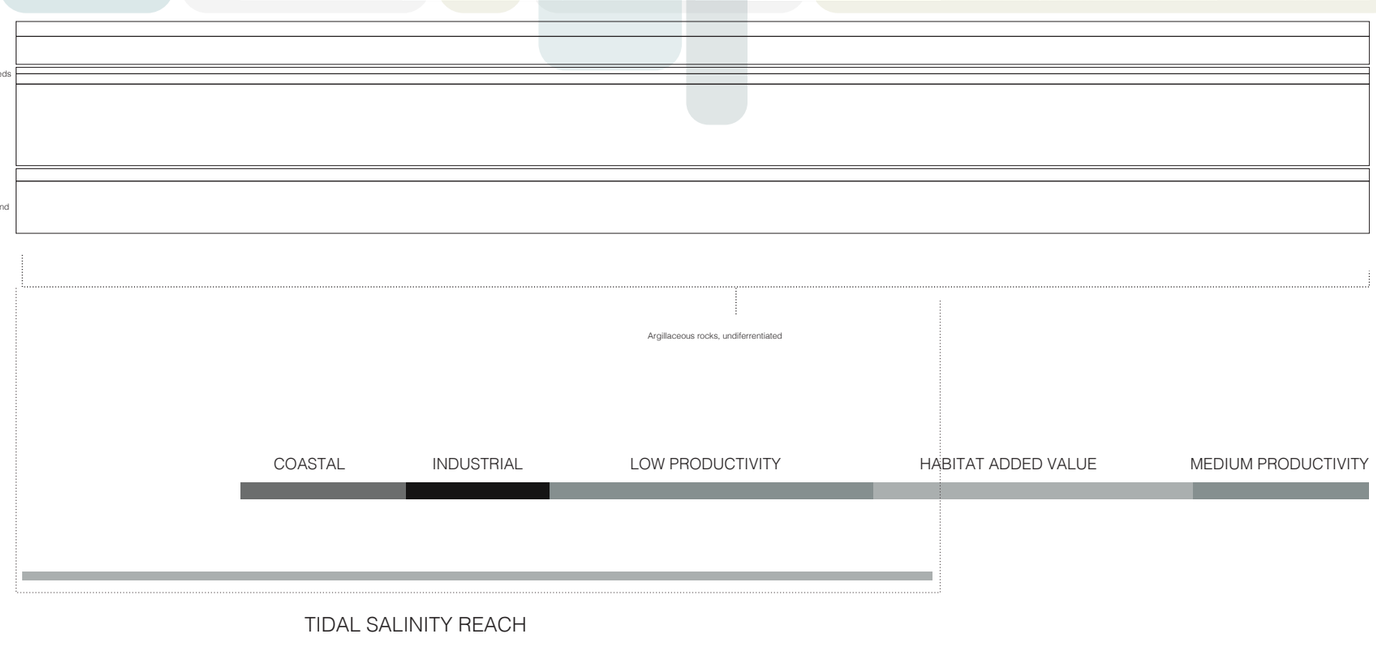
Habitat gradient







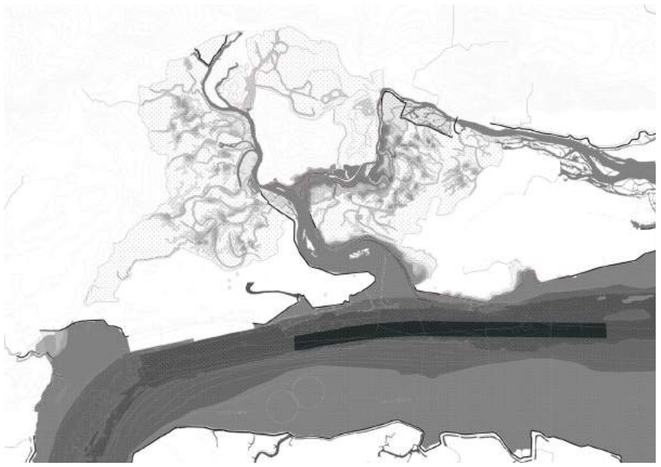




Design evaluation - regional scale
Cuantification and supportive infrastructure

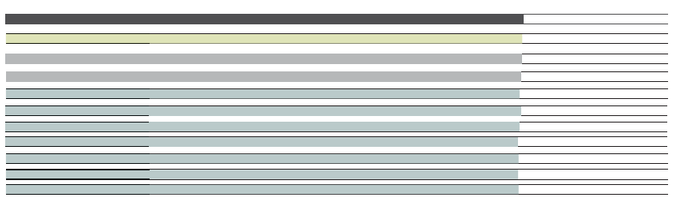
Natural consequences - habitat shift 75yr

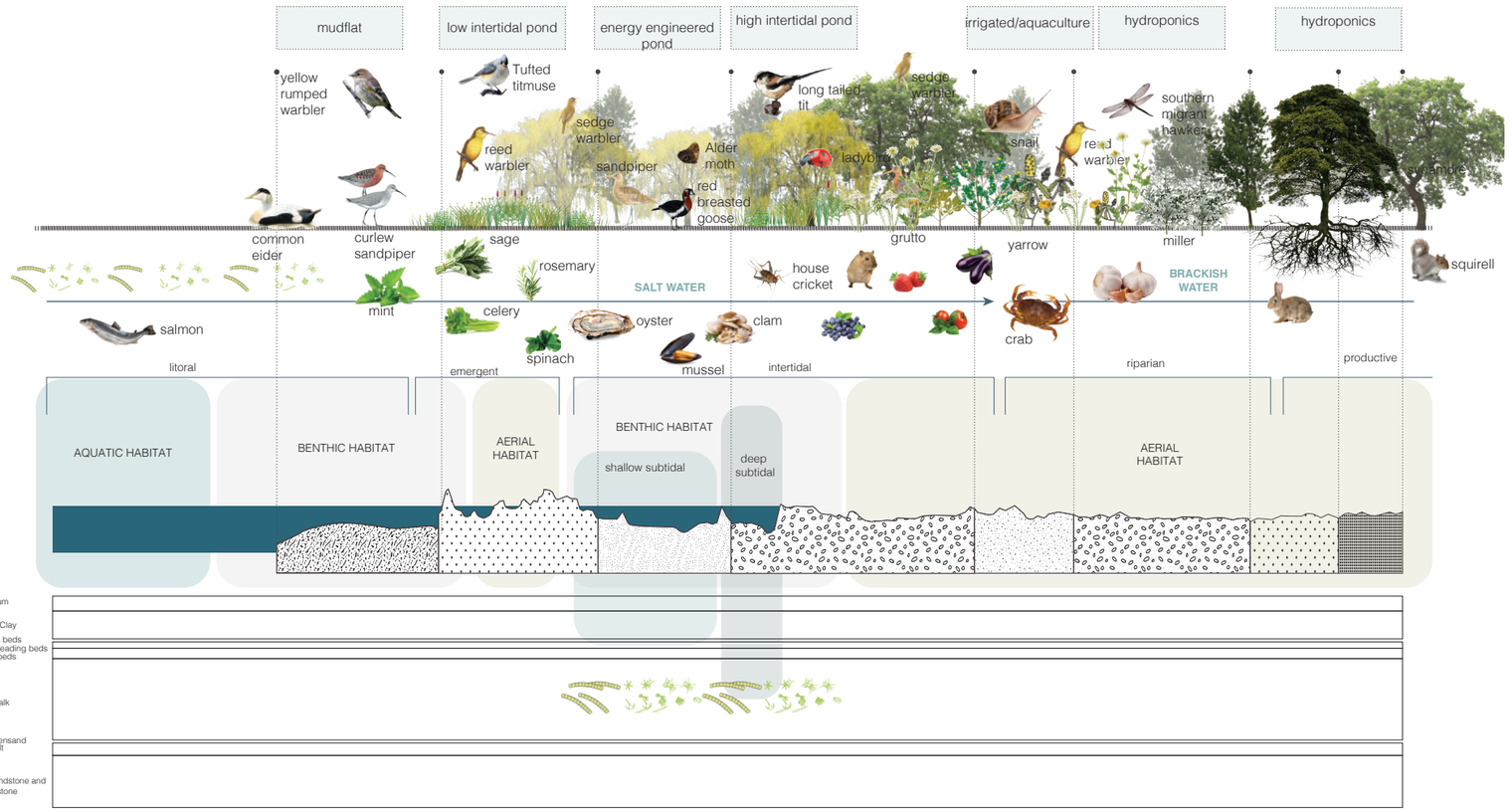
Ecoservices assessment



Salinity intrusion

Habitat gradient





Design
Spatial consequence - Intervention timeline

Energy aim - flows and capacity

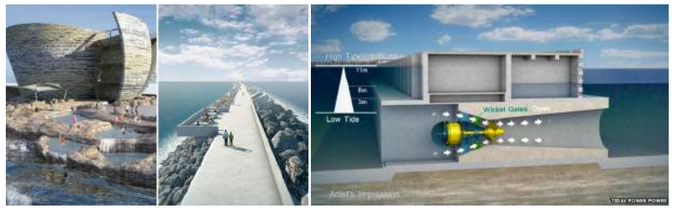
Swansea Tidal lagoon reference

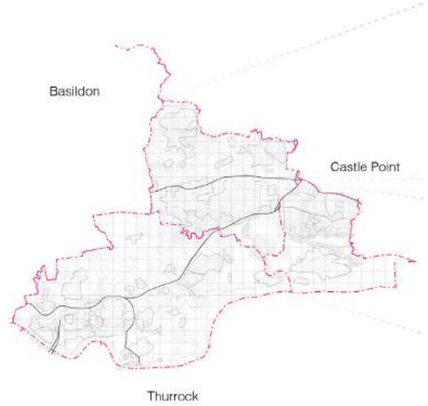
total energy generated per year - 495Gwh
11.5 km of tidal wall ; 5-20 m depth — total house powered 155.000
1 km -43 Gwh at 10-15 average depth
1 km -15 Gwh at 4-6 average depth

1 uk household annual average energy requirements - 2.8 Mwh London region
1GWH - 313 households powered

Intervention eposure - 17 km tidal wall
17 km - 255 Gwh
255 Gwh - 79.815 (80.000 homes)

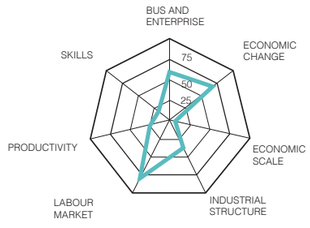
Castle point district - 35.044 households
Basildon district - 72.746 households
Thurrock district - 62.353 households

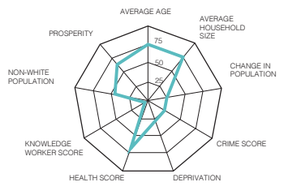


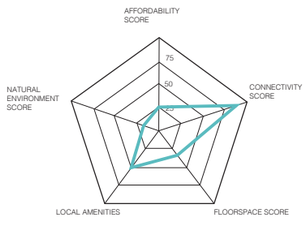


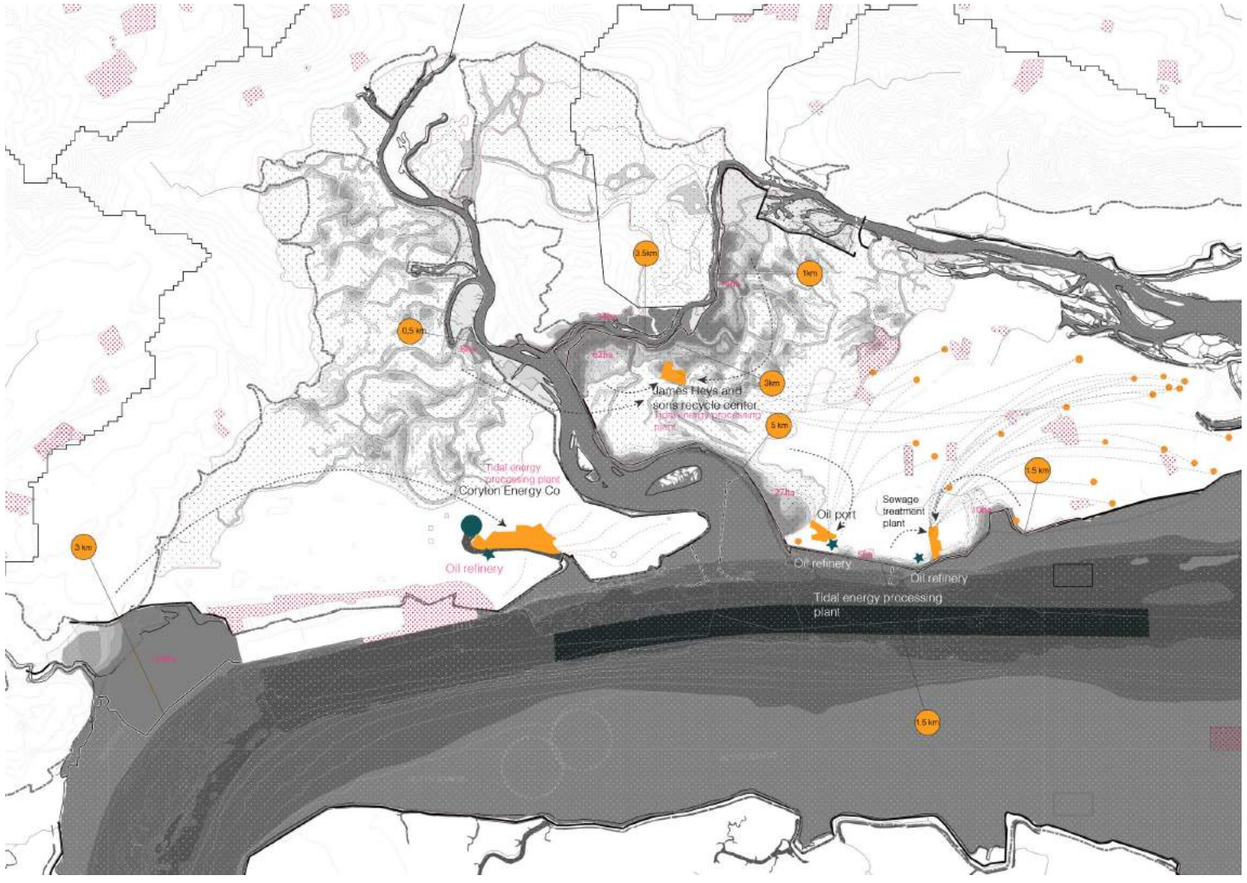
	Castle Point	Thurrock	Basildon
Process plant and machine operatives	9,300	16,600	13,100
Caring, leisure, customer service	8,000	12,700	13,600
Administrative, skilled trade	11,600	22,500	19,500
Managers, professional, technical	15,400	30,800	39,700

CASTLE POINT









Productive | Protective engineered intervention and energy cycle

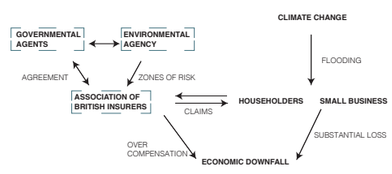
NATIONAL POTENTIAL IMPACT

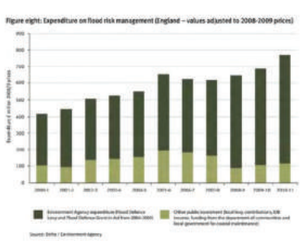
PRODUCTION POTENTIAL

GOVERNANCE FUNDING

fig 114. national potential reflection

DAMAGE SCHEME





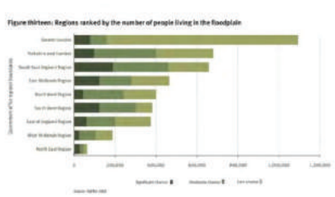
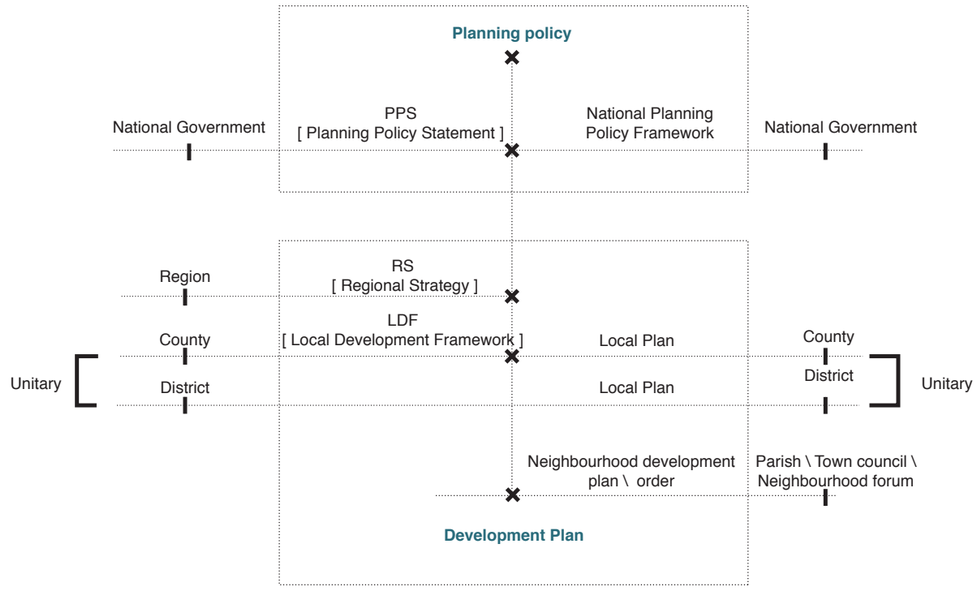
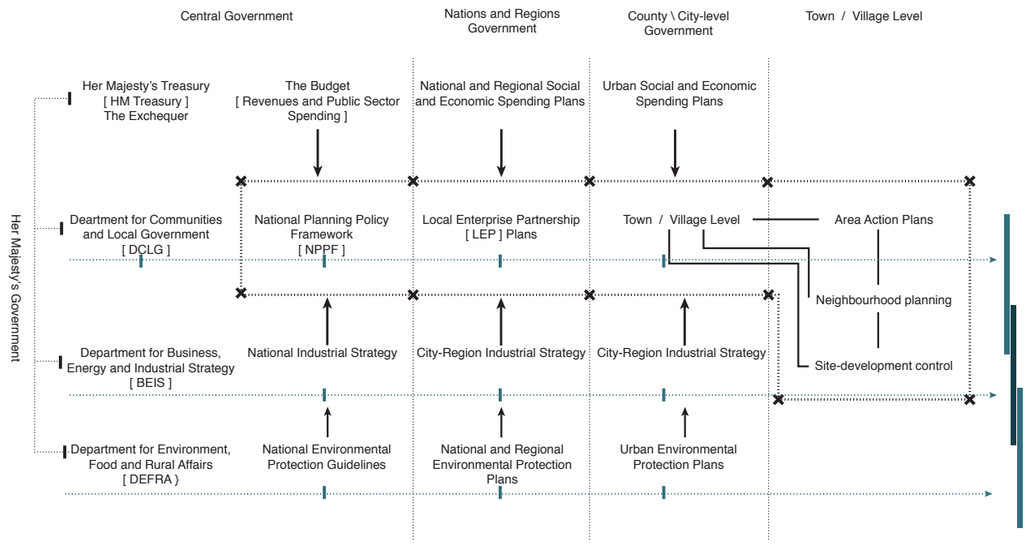
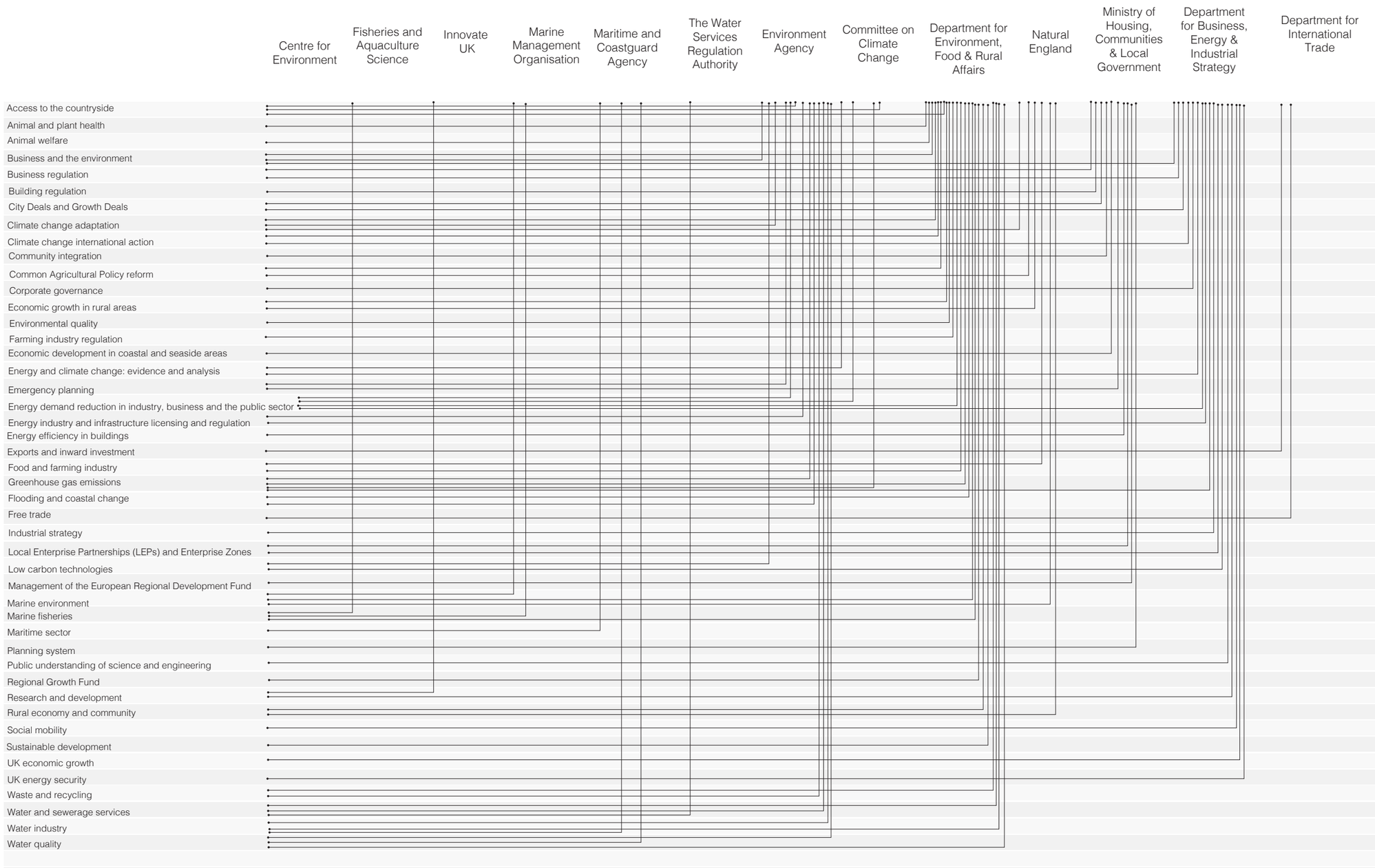


fig 115. Flood situation overview UK

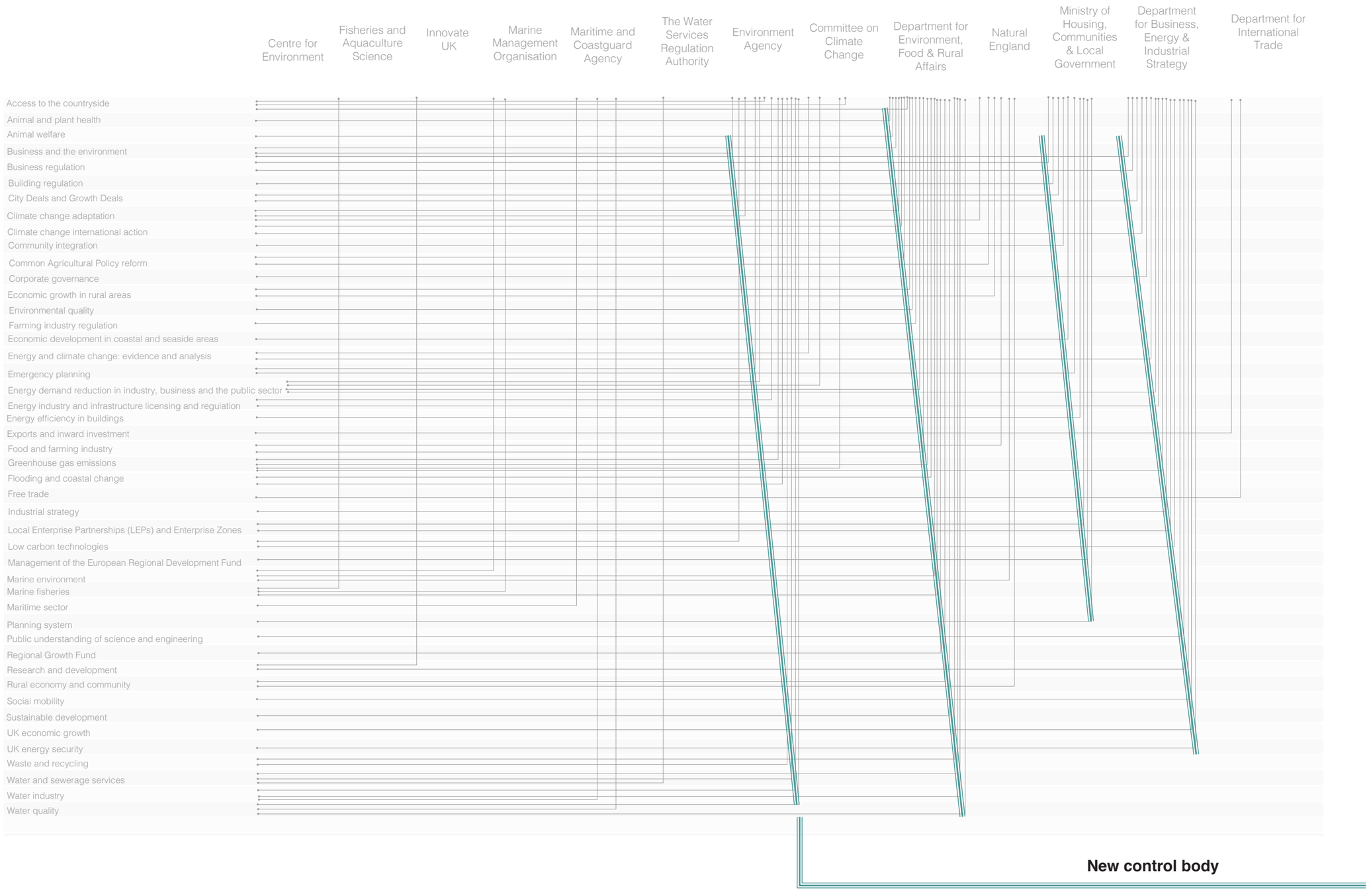




Reflection
Planning sonsequence



Reflection
Planning sonsequence



Research by Design - Location assessment
Location assessment

Spatial applicability