TU Delft | The European Post-master in Urbanism | Graduation Project

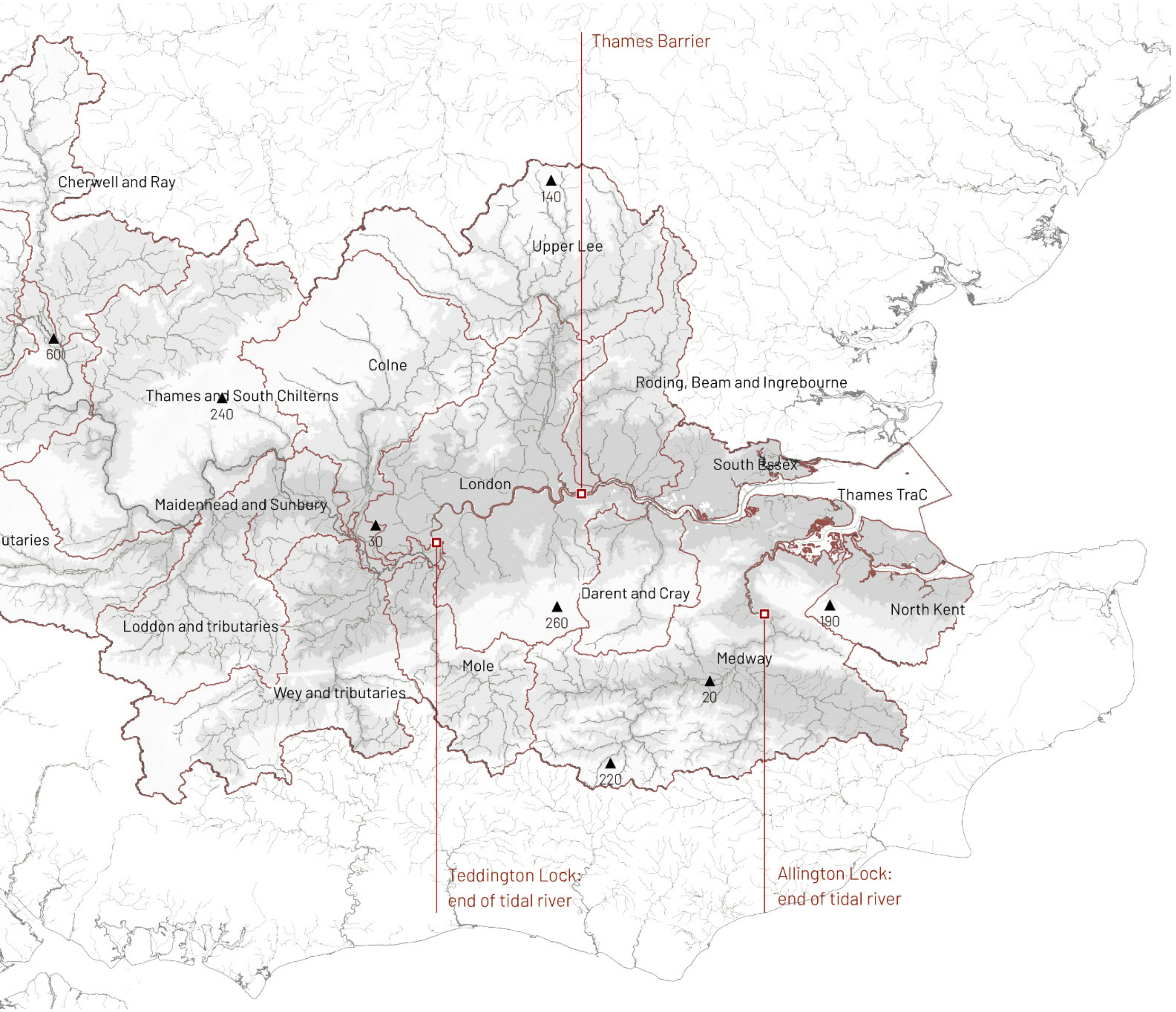
Resilient Medway River Landscape

Adaptive Design Strategies for a Sustainable Coastal Landscape

Yu-Wen Lin (5090881)

P5 Presentation | 5th July, 2021

1st mentor: Dr. Steffen Nijhuis
2nd mentor: Dr. Daniele Cannatella


Thames Barrier
Cherwell and Ray
140
Upper Lee
60
Colne
Roding, Beam and Ingrebourne
Thames and South Chilterns
240
South Essex
London
Thames TraC
Maidenhead and Sunbury
30
utaries
Darent and Cray
260
190
North Kent
Loddon and tributaries
Medway
Mole
20
Wey and tributaries
220
Teddington Lock:
end of tidal river
Allington Lock:
end of tidal river

CONTENT

PART 1

INTRODUCTION AND METHODOLOGICAL FRAMEWORK

Resilient Medway River Landscape—
Adaptive Design Strategies for a
Sustainable Coastal Landscape

EMU Graduation
Yu-Wen Lin

Motivation

FASCINATION

Fascination

Climate Change
New design approach are needed

The Esthetic of River Landscape
Interface between river and cities

Research Interest 1: Risk of Flooding

- What are the causes of flooding?
- Climate crisis as a global quest: How could we confront it? What planning and design strategies can we propose?

Research Interest 2: River and Cities

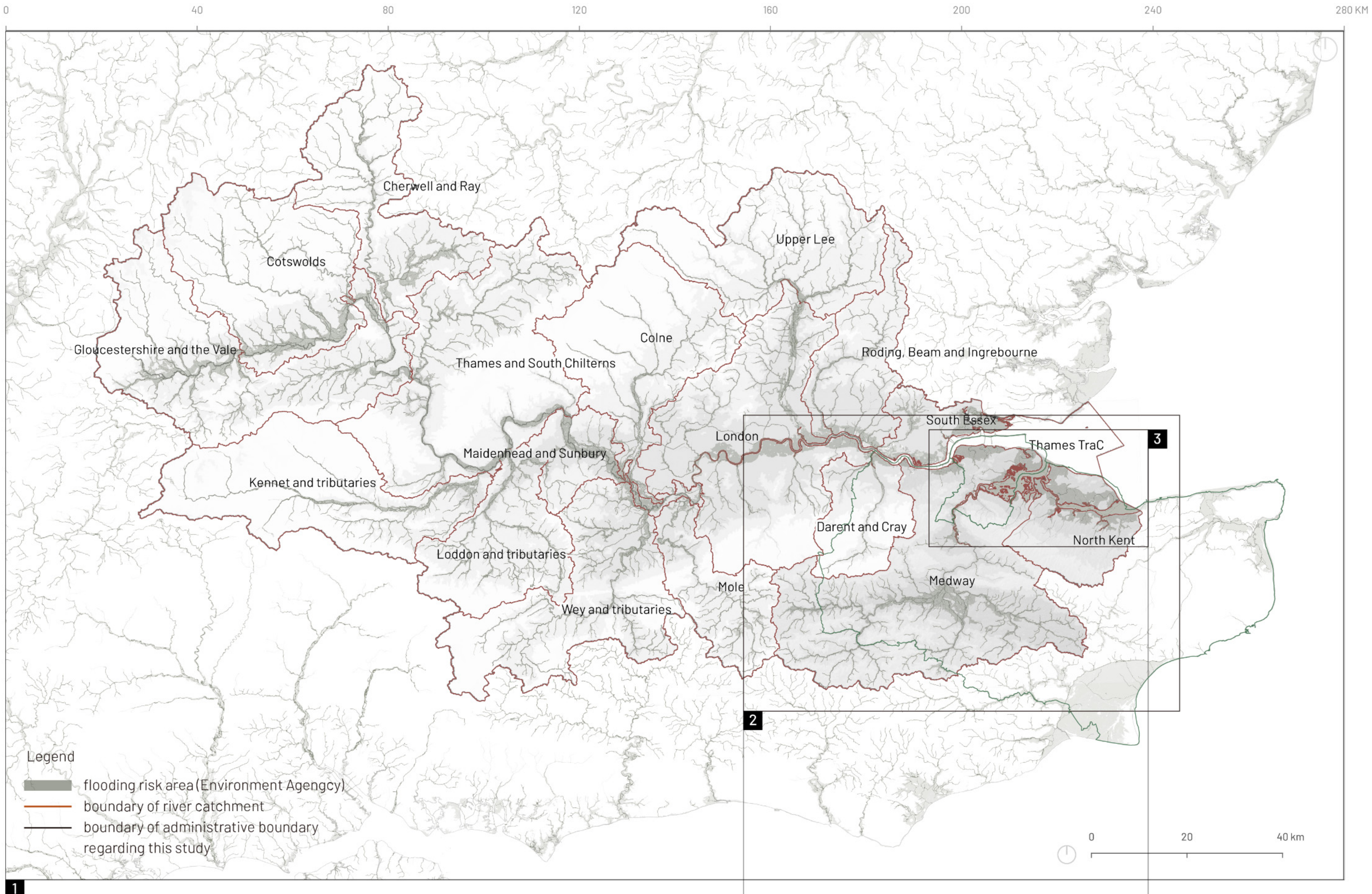
- What are the relationships between cities and rivers?
- What are the characteristics of different parts of the watershed?
- What are the design strategies to deal with flooding risk?

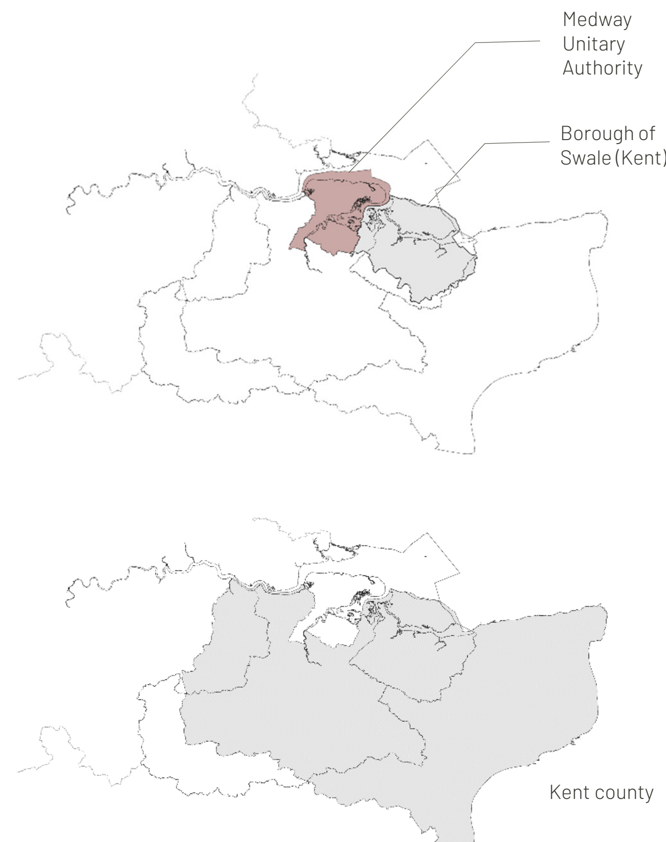
Application Site
River Medway estuary, River Thames basin, The UK

Fig. Oxford 2007 flood.
Source: https://www.oxfordmail.co.uk/news/15427077.2007-floods-10-years-part-two-city-swamped/.

Content of work

RIVER MEDWAY ESTUARY





River Thames basin

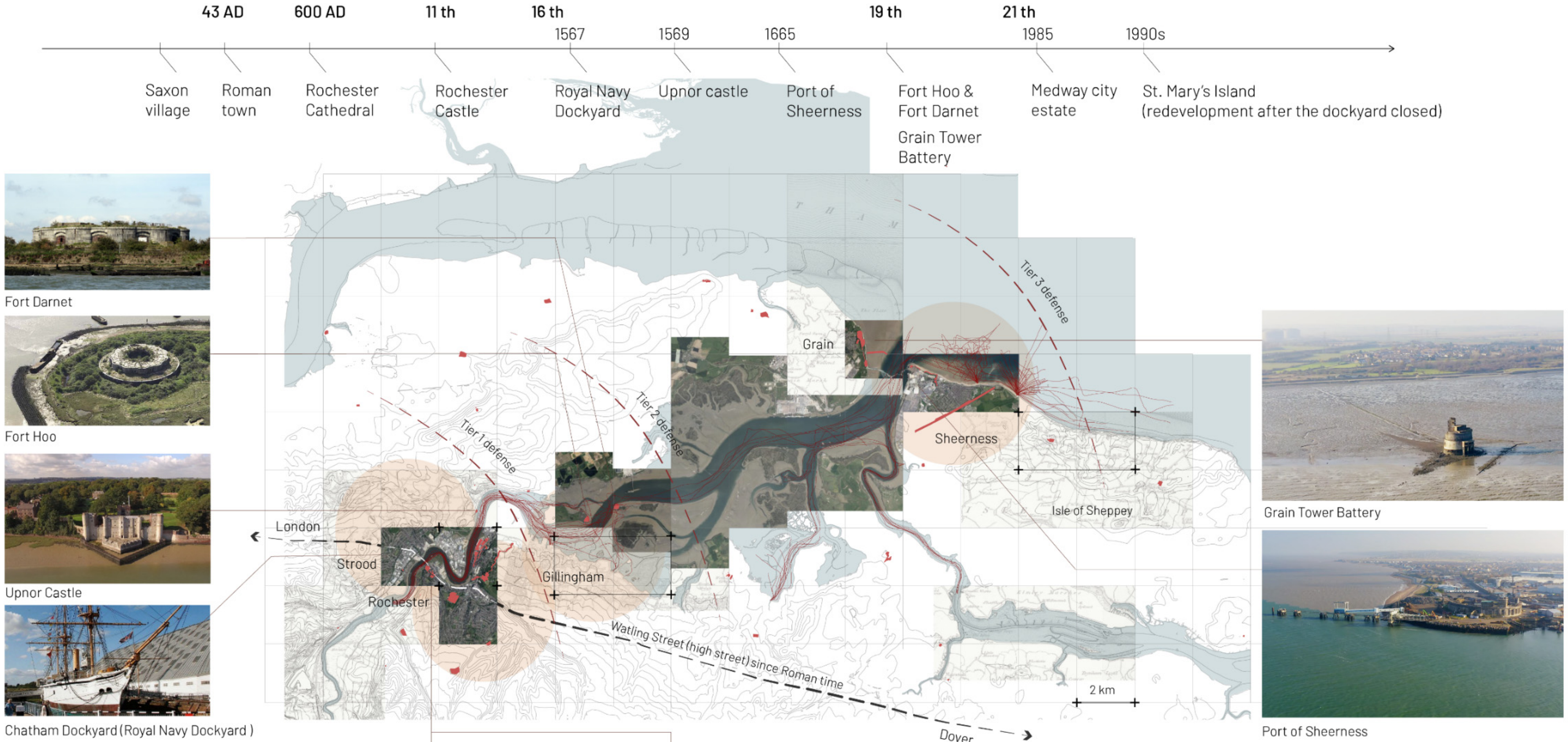
River Medway sub-catchment and
North Kent (The Swale) sub-catchment

River Medway estuary

Het verbranden van de Engelse vloot bij Chatham, juni 1667, tijdens de Tweede Engelse Zeeoorlog (1665-67).
The burning of the English fleet at Chatham, June 1667, during the Second Anglo-Dutch War (1665-67).
Source: Rijksmuseum Amsterdam.

Content of work

AN AREA SHAPED BY MILITARY AND MARITIME HISTORY



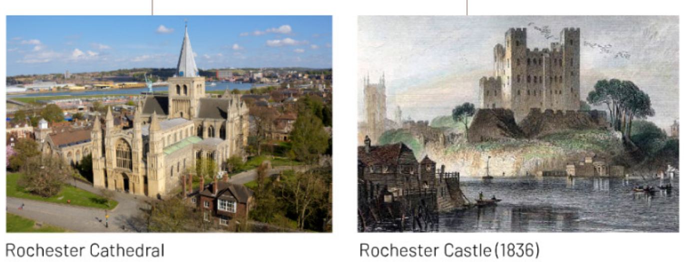


Fig. Historic timeline of Medway towns.
Source: Ordnance Survey; Image of Sheerness: Oszibusz Drone Photo and Video; Other photos: Visit Medway Website.

Aerial images show the extent of flooding in Yalding, a town in the upper stream of River Medway. Image source: Hawkeye Aerial Media.

Coastal erosion: The 'forgotten' community left to fall off a cliff. July 2020. Source: BBC news. https://www.bbc.com/news/uk-england-53367000.

Problem field

CLIMATE CHANGE IN KENT AND MEDWAY

1. Sea level rise 0.8-0.9 m, accompanied by north sea surge with an additional 1 to 3 m
2. Natural erosion of coastline
3. Intertidal habitats losses

Probabilistic projections of median temperature and rainfall at 50th percentile for "Scenario RCP8.5"

	South East England						London
	Change in mean temperature			Change in rainfall			Projected sea level rise
	Annual	Summer	Winter	Annual	Summer	Winter	
2040	+1°C to 2°C	+2°C to +3°C	+1°C to +2°C	-10% to +10%	-20% to -30%	+10% to +20%	0.16-0.29m
2080	+4°C to 5°C	+5°C to +6°C	**+3°C to +4°C**	-10% to +10%	-30% to -50%	**+20% to +30%**	**0.39-0.80m**
2100	-	-	-	-	-	-	**0.90m**

Table of climate change key figures in Kent and Medway.
Source: The Climate Change Risk and Impact Assessment for Kent and Medway (CCRIA) and Thames Estuary 2100.

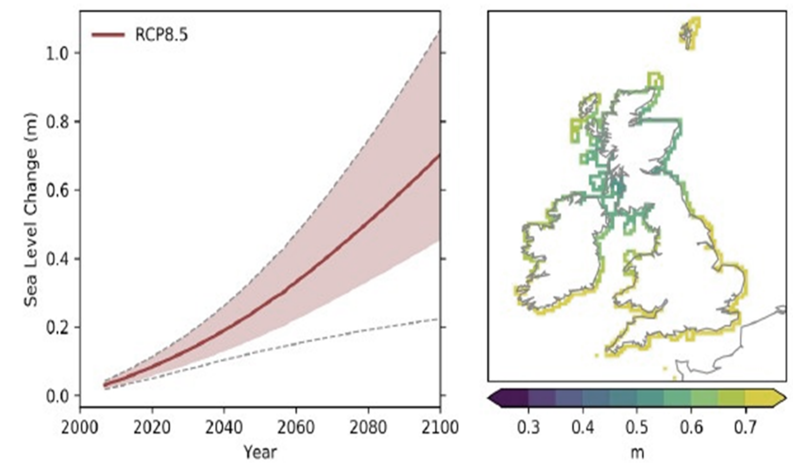
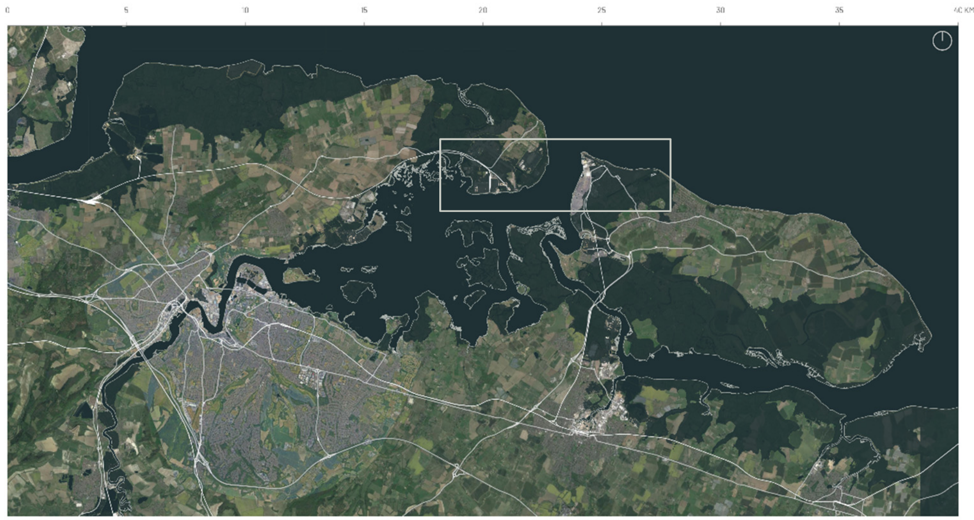


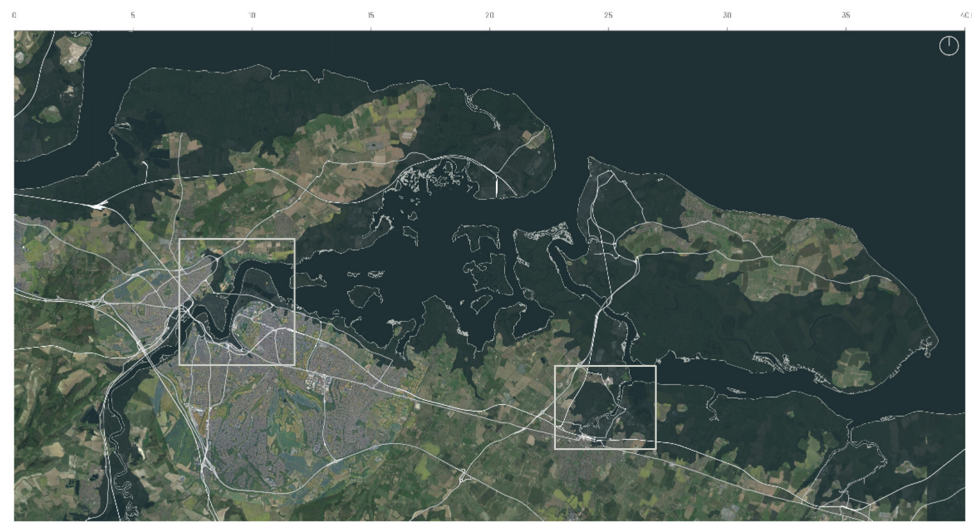
Fig. Time series of time-mean sea level change and the spatial pattern of change at 2100 in the highest emission scenario—Scenario RCP 8.5. Source: UKCP18 Science Overview Report. 2018. Met Office.



A. Synthesis map of sea level in 3 m= current Spring high tide

B. Synthesis map of sea level in 4 m= rise 1 m (Thames 2100 scenario)

C. Synthesis map of sea level in 5 m= rise 2 m (Thames 2100 scenario)



D. Synthesis map of sea level in 10 m= rise 7M (an extreme version in this study)

Problem field

SCENARIO OF SEA LEVEL RISE

Scenarios
1. Rise 0.8m by 2080 (Scenario RCP8.5)
2. Rise 0.9m-2m by 2100 (Thames 2100)
3. North sea surge: additional 1 to 3m
4. Scenarios in this study: 7m

Influential zone
A. Sea port
B. Flooding of low-lying cities: Medway, Chatham, Sittingbourne
C. Submerged of low-lying cities
D. Similar to C., but in a wider range

Data source: LIDAR Composite DTM 2019. Developed by author.
The white lines are the current road systems.

Low-lying cities (Medway City Estate)

Interface between river and urban: Low spatial quality, difficult to experience water (Chatham)

Sea level rise will lead to coastal squeeze for intertidal habitat. (Grain)

PROBLEM STATEMENT

1. Climate change magnifies the uncertainties of flooding risks from the sea and the hinterland. Sea-level rise, inland water discharge, aging flood defense, and coastal erosion are the main challenges for the Medway river estuary. Intertidal habitats are going to be submerged by the rising sea and thus lose the ecological gradient.

2. The capacity of the Medway river estuary to adapt to flood risks and the uncertainties associated with climate change is weak due to the intensification of industrial uses, urban development, and port construction. This degrading leads to the loss of flood buffers and the loss of recreational value of the river landscape.

Methodological framework

THEORY: RESILIENCE

"Resilience is about cultivating the capacity to sustain development in the face of expected and surprising change and diverse pathways of development and potential thresholds between them (Folke, 2016)."

Interpretation of resilience → Resilience in relation to flooding risks and climate adaptation

Engineering Resilience

Ecological Resilience

Resilience in
Social-ecological Systems

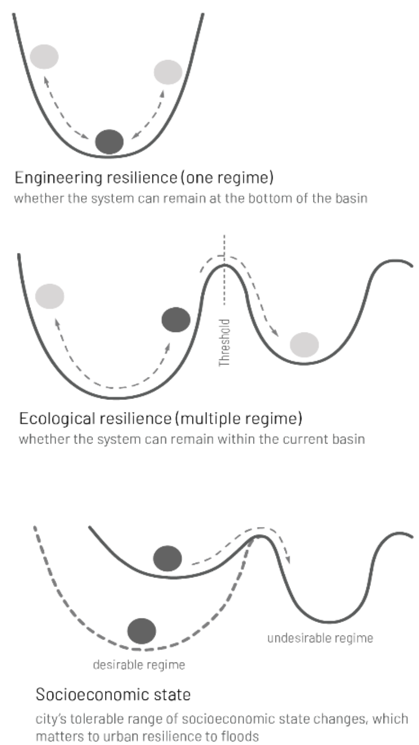


Fig. Ball-and-cup schematic diagram of resilience. The cup represents the region in the state space or basin of attraction, in which the system tends to remain, and includes all possible values of system variables of interest. The ball represents the state of the system at any given time. Diagrams are adapted from Liao (2012).

Flood defense infrastructure
(hard engineering)

Projects

A. Room for the river, Delta program (NL)
B. Robust Adaptive Framework for Dutch Delta (NL)
C. Thames Estuary 2100 (UK)
D. Flood resilience areas for multi-layered safety (EU)

Resilience → **Adaptability**, **Transformability**

RESEARCH OBJECTIVE

Develop and apply design strategies for a more resilient Medway River Estuary addresses flooding, urban, and ecological development.

RESEARCH QUESTIONS

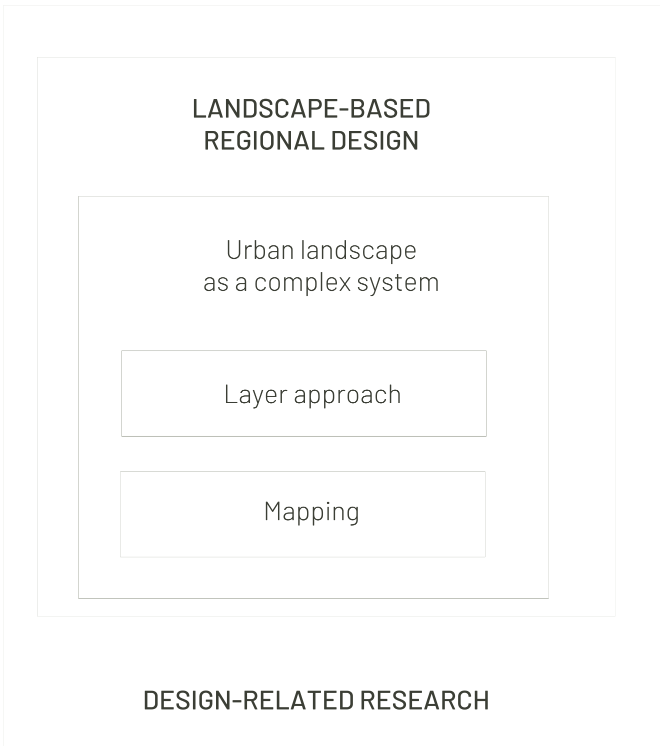
1. How does the socio-ecological system of the Medway River Estuary function?
    1) How did the urban landscape adapt and transform over time?
    2) What are the challenges and potentials for the Medway River Estuary?

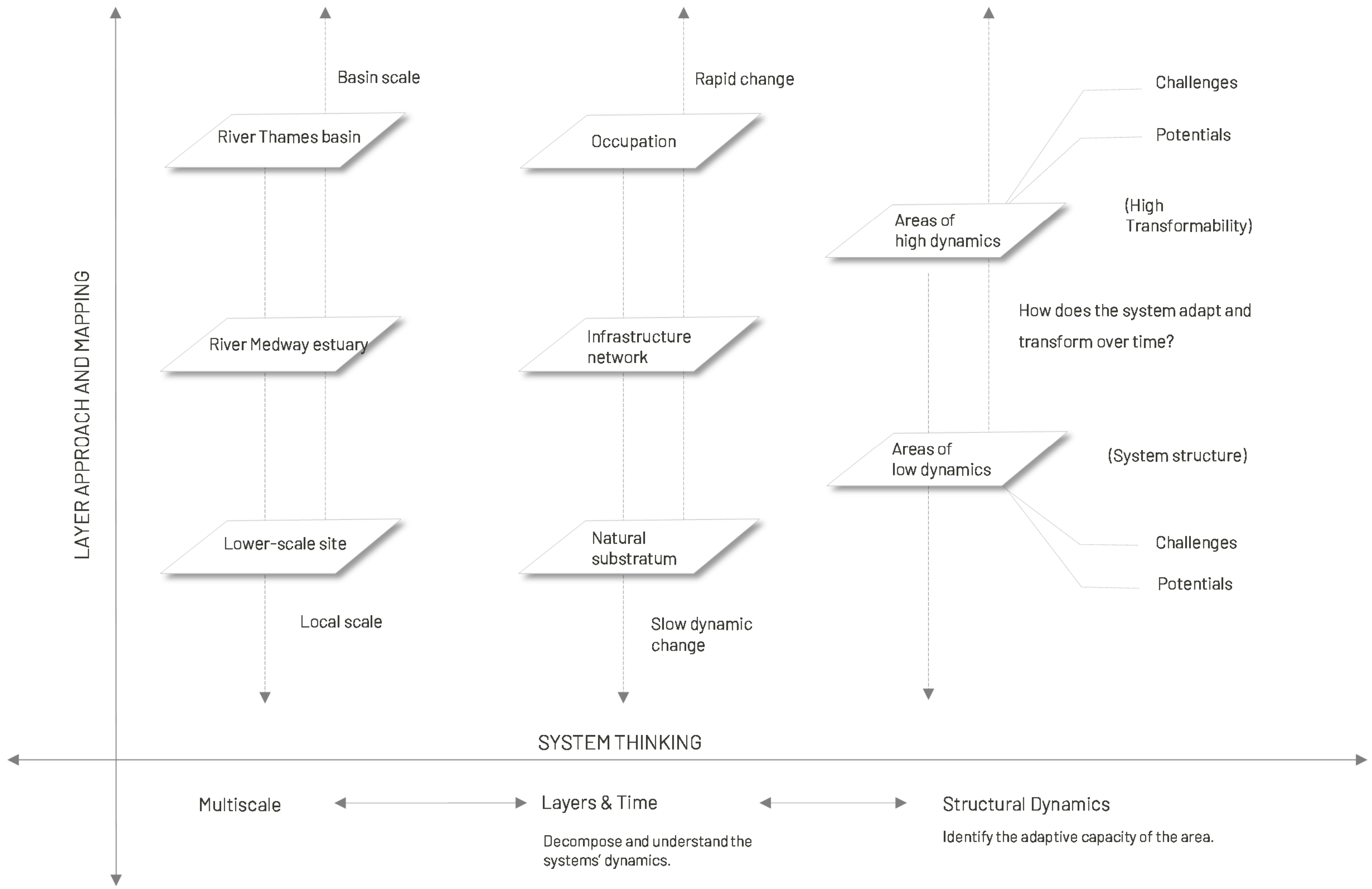
2. What design strategies and principles are suitable for flood mitigation and socio-ecological inclusive development?
    1) What design principles and strategies for resilient landscape can be applied in the Medway river estuary?
    2) What are the spatial strategies for the different parts of the watershed in the Medway river landscape?

3. How to apply the design strategies and principles in Medway River Estuary to increase its socio-ecological resilience?

Research strategy

LANDSCAPE-BASED REGIONAL DESIGN





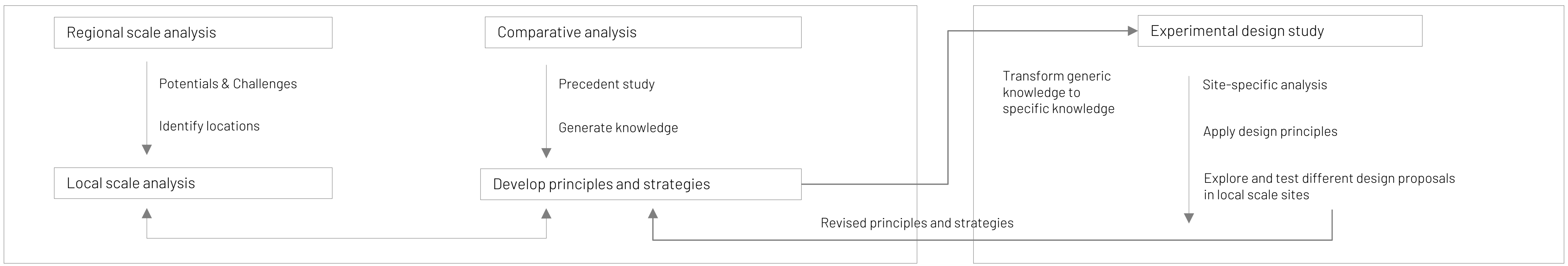
Research strategy

DESIGN-RELATED RESEARCH

DESIGN RESEARCH

RESEARCH-BY-DESIGN

RESEARCH-DESIGN RELATION



The design-related research diagram is adapted from Nijhuis & Bobbink (2012).

RESEARCH QUESTION	RQ 1. How does the socio-ecological system of the Medway River Estuary function?	RQ 2. What design strategies and principles are suitable for flood mitigation and socio-ecological inclusive development?	RQ 3. How to apply the design strategies and principles in Medway River Estuary to increase its socio-ecological resilience?
EXPECTED OUTCOME	Ch 3. Analysis	Ch 4. Principles and strategies	Ch 5. Design application & Ch 6. Regional scheme
RESEARCH STRATEGIES	• Layer approach and mapping • Scenario study	• Layer approach and mapping • Precedent study	• Research by design

PART 2

ANALYSIS

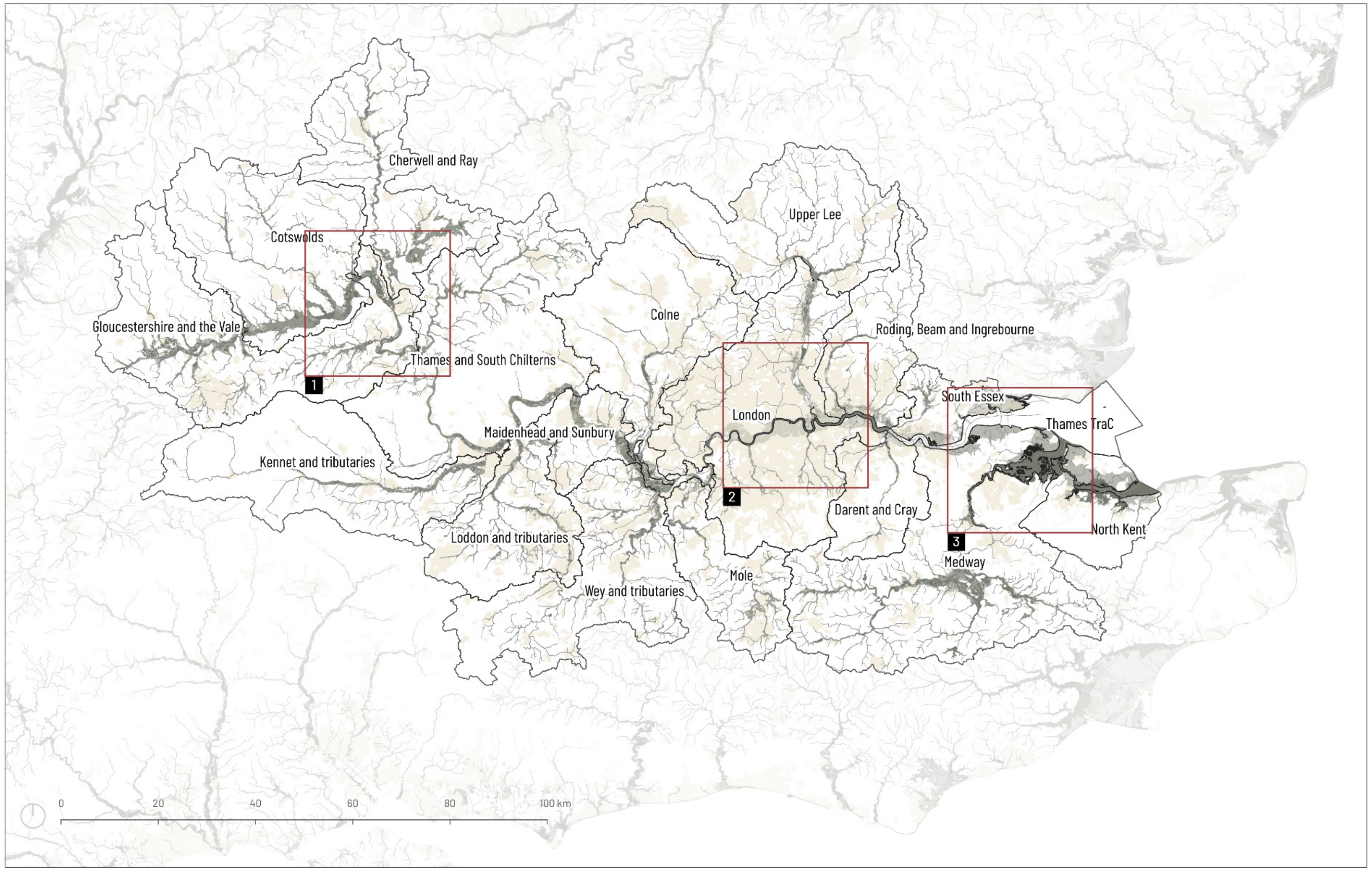
RQ1. How does the socio-ecological system of the Medway River Estuary function?

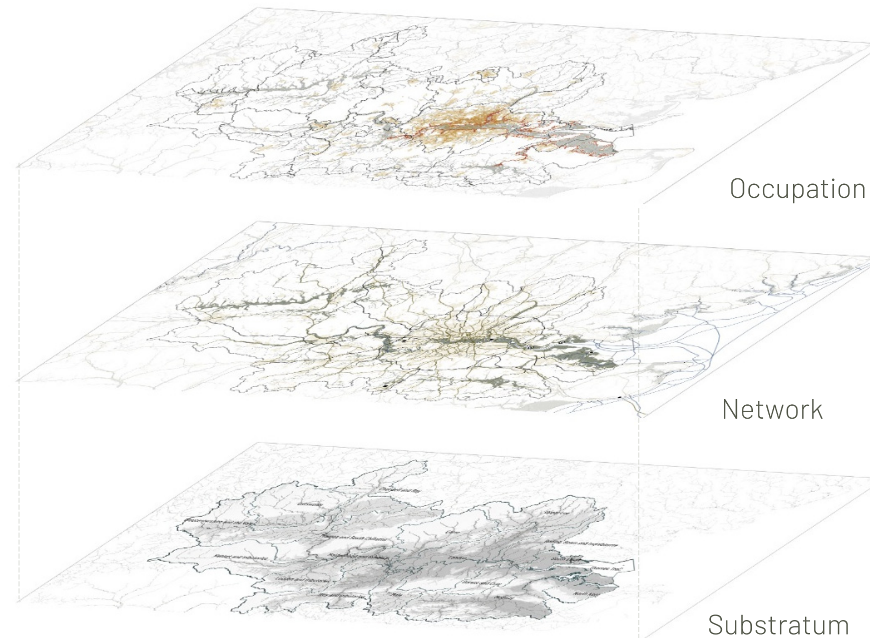
Resilient Medway River Landscape— Adaptive Design Strategies for a Sustainable Coastal Landscape

EMU Graduation
Yu-Wen Lin

Analysis

SCALING THROUGH THE THAMES RIVER BASIN





Legend

- Comparison site
- Rivercourse
- Boundary of sub-catchment in the Thames River basin
- Urban

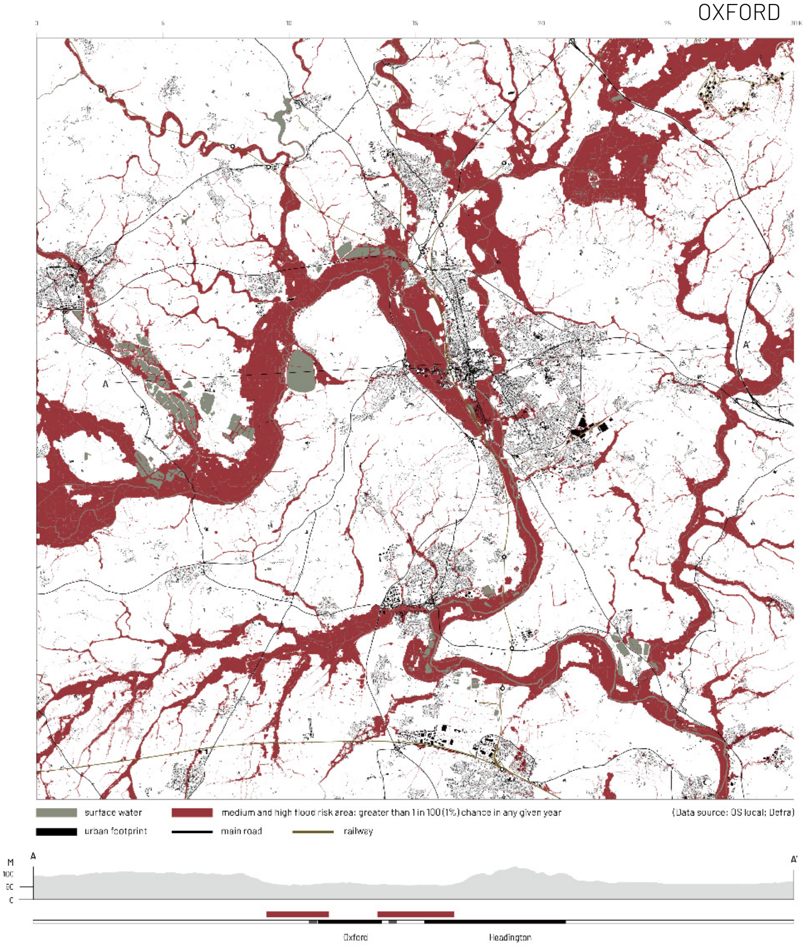
Risk of Flooding from Rivers and Sea

- High: each year, there is a chance of flooding of greater than 1 in 30 (3.3%).
- Medium: each year, there is a chance of flooding of between 1 in 30 (3.3%) and 1 in 100 (1%).
- Low: each year, there is a chance of flooding of between 1 in 100 (1%) and 1 in 1000 (0.1%).
- Very Low: each year, there is a chance of flooding of less than 1 in 1000 (0.1%).

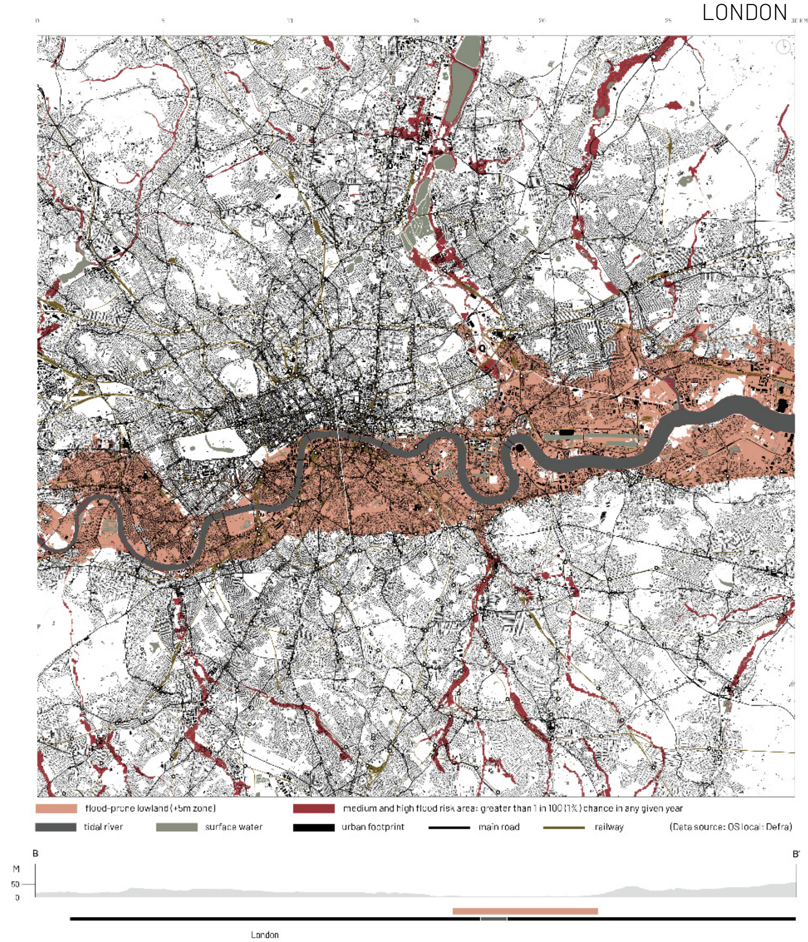
(Source: Environmental Agency, 2020)

Data Source: Landuse: Corine landcover 2018. River and flood: Environment Agency. Population: ONS, mapped by author. Road and green space: OS Local

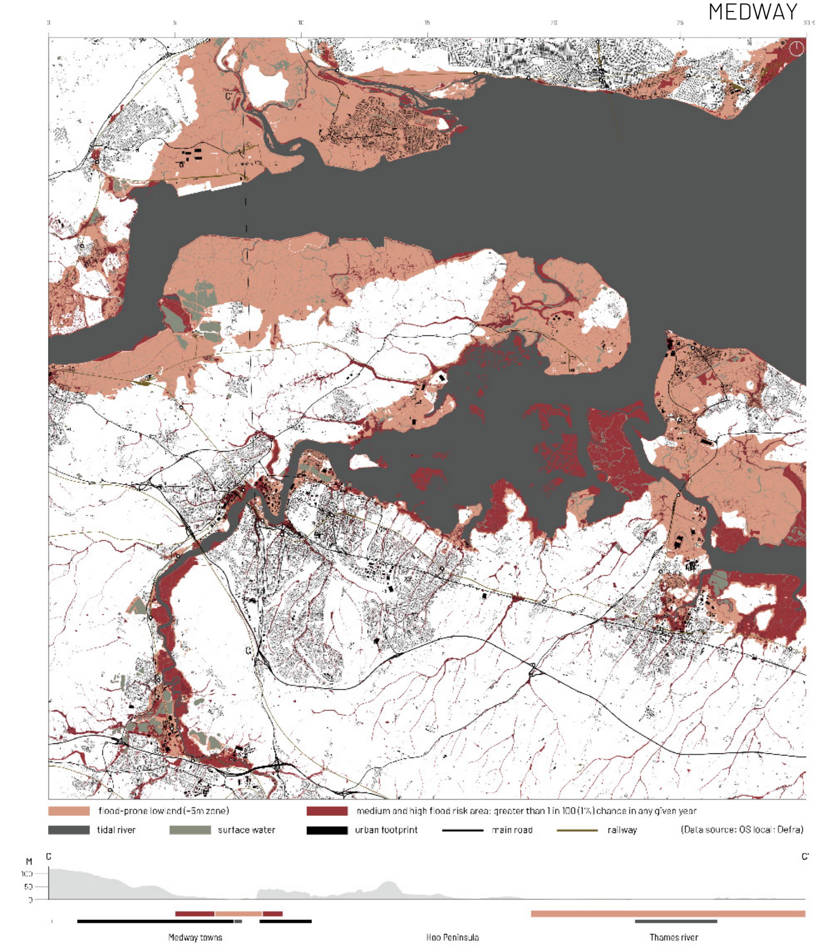
OXFORD



LONDON



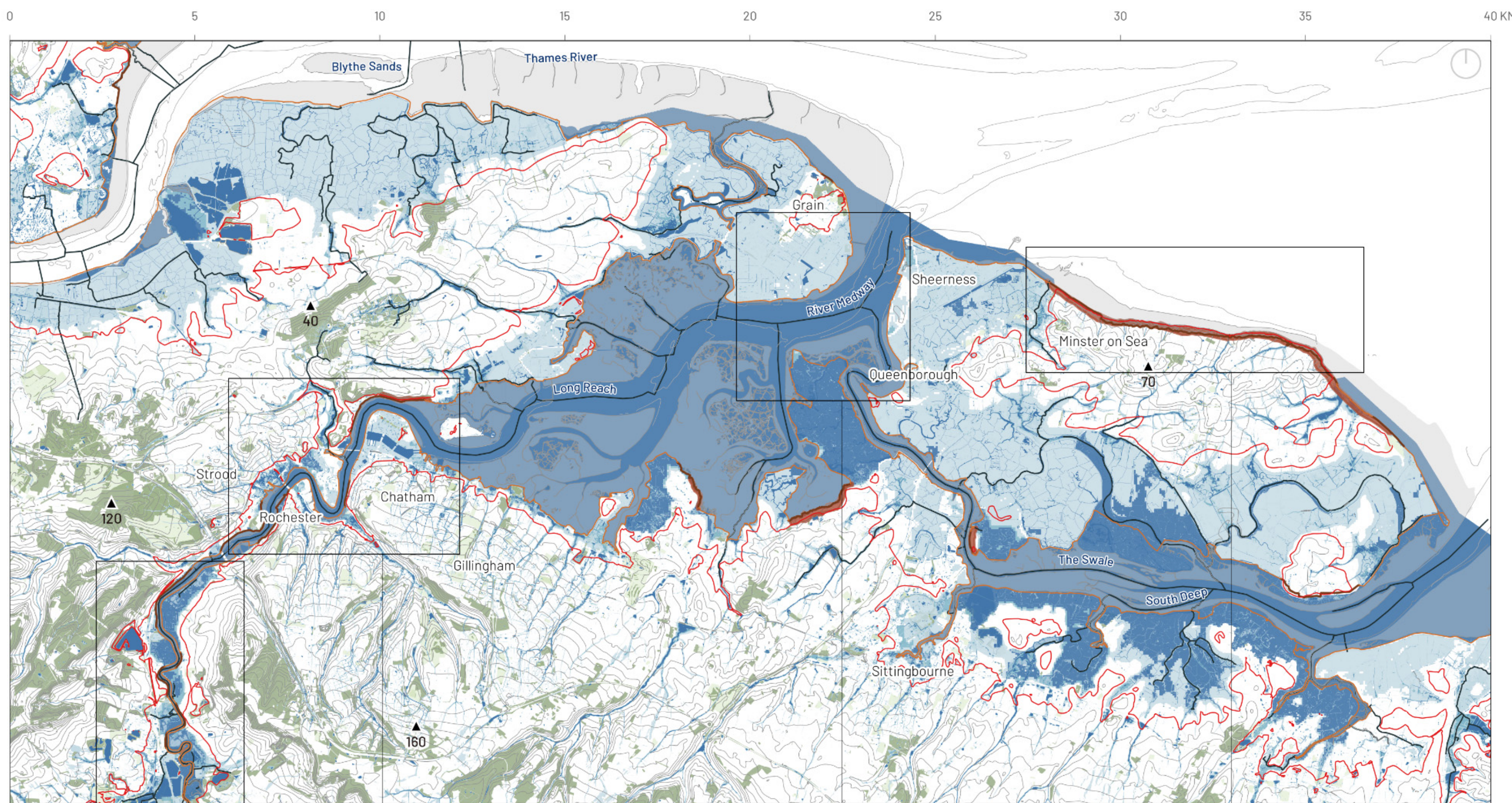
MEDWAY

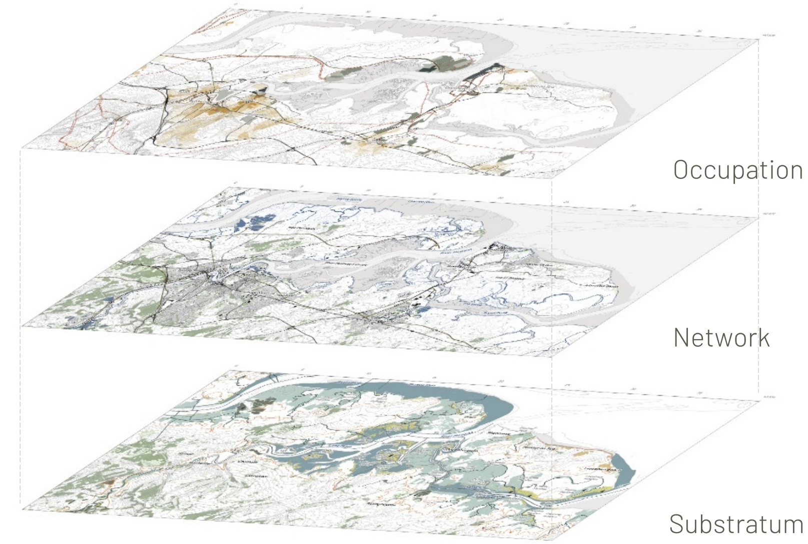


	Oxford	London	Medway
Characteristics	Broad river valley Unleashed river, relief channel, controlled river City locates in valley and on the high ground	Flat alluvial plain Channelized river, high ground and embankment Densely populated city locates on river plain	Wide range of geographical difference (hills, valley, alluvial plain) Estuary City located on the high ground, close to the river or the sea
Strategies	1. Redesign of dike: setback/ naturalizing 2. Relief channel / green belt/ room for the river (increase retention time and space) 3. Re-forestation and re-vegetation (increase sponge capacity)	1. Drainage design in the built environment (increase retention space) 2. Redesign of dike, emphasizing on waterfront interface 3. Re-vegetation of urban green system (increase sponge capacity)	1. Redesign of dike: setback/ naturalizing (increase retention space in flood plain) 2. Coastal management 3. Restoration of tidal habitat dynamics 4. Waterfront city redevelopment

Analysis

UNDERSTANDING OF THE RIVER MEDWAY ESTUARY





Legend

- rivercourse
- foreshore
- contour line (10m interval)
- low-lying zone: lower than 10m
- woodland
- open space
- coastal erosion zone

Coastal erosion risk (NCERM, 2018)

- erodible flood defense
- floodable flood defense

Risk of Flooding from Rivers and Sea (Environmental Agency, 2020)

- High: each year, there is a chance of flooding of greater than 1 in 30 (3.3%).
- Medium: each year, there is a chance of flooding of between 1 in 30 (3.3%) and 1 in 100 (1%).
- Low: each year, there is a chance of flooding of between 1 in 100 (1%) and 1 in 1000 (0.1%).

Halling-Snodland valley
-last part of tidal river
-meanders in valley
-residential town

Bend of River Medway
-interface between valley and estuary
-floodplain underwent brownfield transformation
-major urbanization area

-River Medway joining River Thames esturay
-The Swale joining from the west

Costal erosion on Isle of Sheppey

Analysis

WORKING WITH TIDE

Tidal range

Neap tide: -1.4~1.8m (3.2m)
Spring tide: -2.8~ 3.2m (5.8m)

Habitats connected to tide

Example: 1.8m, neap tide high tide level, around 75% of the time the patch could expose to air. If it is lower, then it could be a mudflat habitat.

Vulnerable to sea level rise

If sea level rise, the current intertidal vegetation, such as reeds, might be flooded.

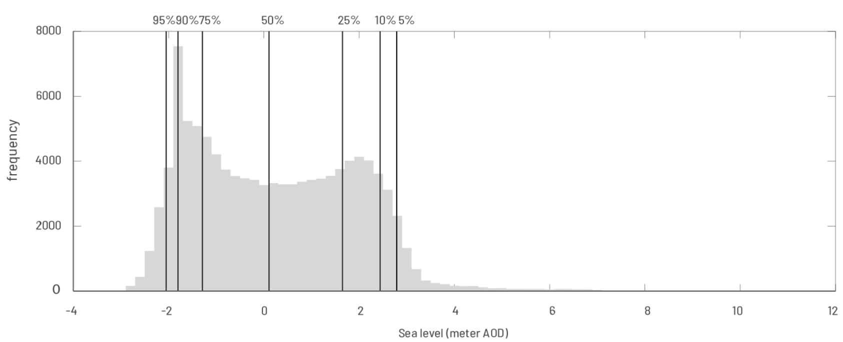


Fig. Histogram of sea-level recording at 15-minutes intervals in three years at Sheerness (from 2015 to 2017) converted to OD. Data source: British Oceanographic Data Centre (BODC). Sheerness tide gauge. https://www.ntslf.org/tides/datum). Developed by author.

	total days in a year	current tidal height	Official projection figure in Thames 2100 sea level+ 0.9m	sea level+ 2m	Scenarios in this study sea level+ 4m	sea level+ 7m
5th percentile	18.25	**2.788**	**3.688**	**4.788**	**6.788**	**9.788**
10th percentile	36.50	**2.440**	3.340	4.440	6.440	9.440
25th percentile	91.25	**1.650**	2.550	3.650	5.650	8.650
50th percentile	182.50	**0.109**	1.009	2.109	4.109	7.109
75th percentile	273.75	**-1.290**	-0.390	0.710	2.710	5.710
90th percentile	328.50	**-1.802**	-0.902	0.198	2.198	5.198

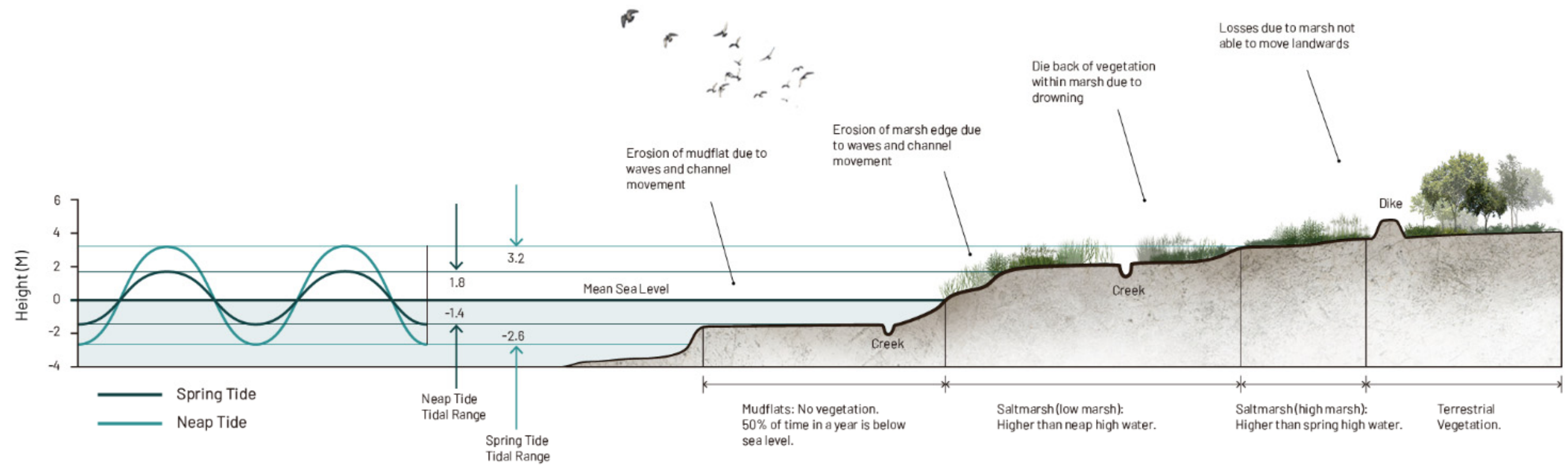
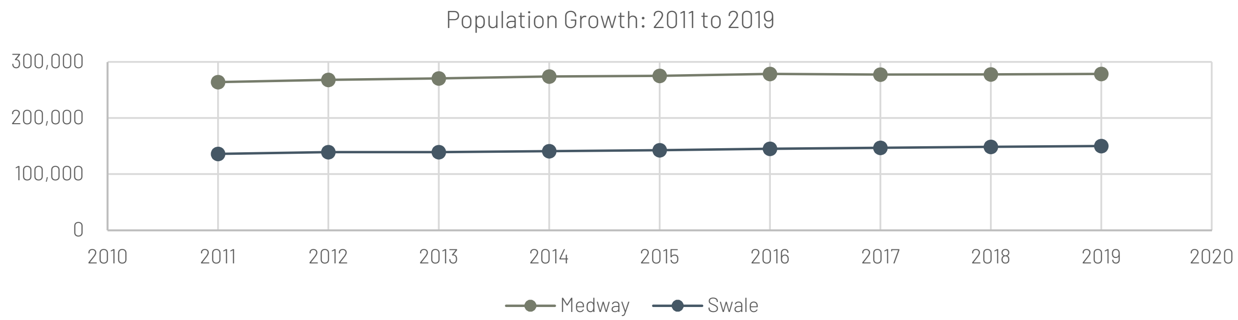


Table. Original data and the transformation of the datum system.

Fig. Tidal section and habitats connected to it. Developed by author.

Analysis

A STEADILY GROWING AREA



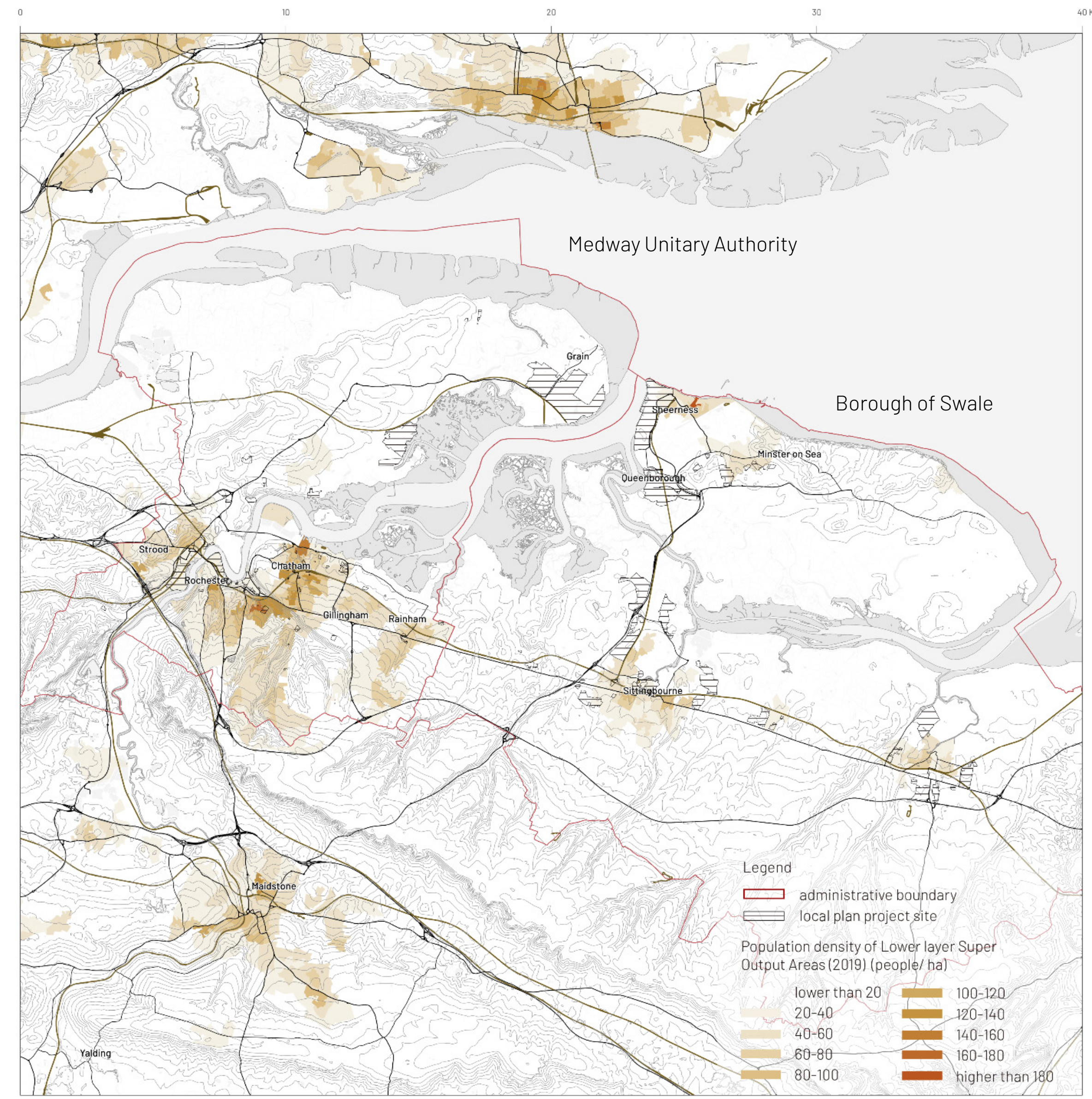
	District		Neighborhood with the highest density	
	Medway Unitary authority	Swale Borough	Medway 022A	Swale 001C
Population (2019)	278,556	150,082	2,176	1,780
Area (ha)	19,203	37,340	12.82	9.47
Population density	14.51	4.02	169.73	187.96

Table 1. Population density: 2019

	District		The fastest-growing neighborhood	
	Medway Unitary authority	Swale Borough	Medway 004A	Swale 004G
Population (2011)	263,925	135,835	2,019	1,829
Population (2019)	278,556	150,082	2,835	3,124
Growth (2011-2019)	5.54%	10.49%	40.42%	70.80%

Table 2. Population growth

Data source: Office for National Statistics (ONS), Medway Local Plan, and Swale Local Plan. Developed by author.



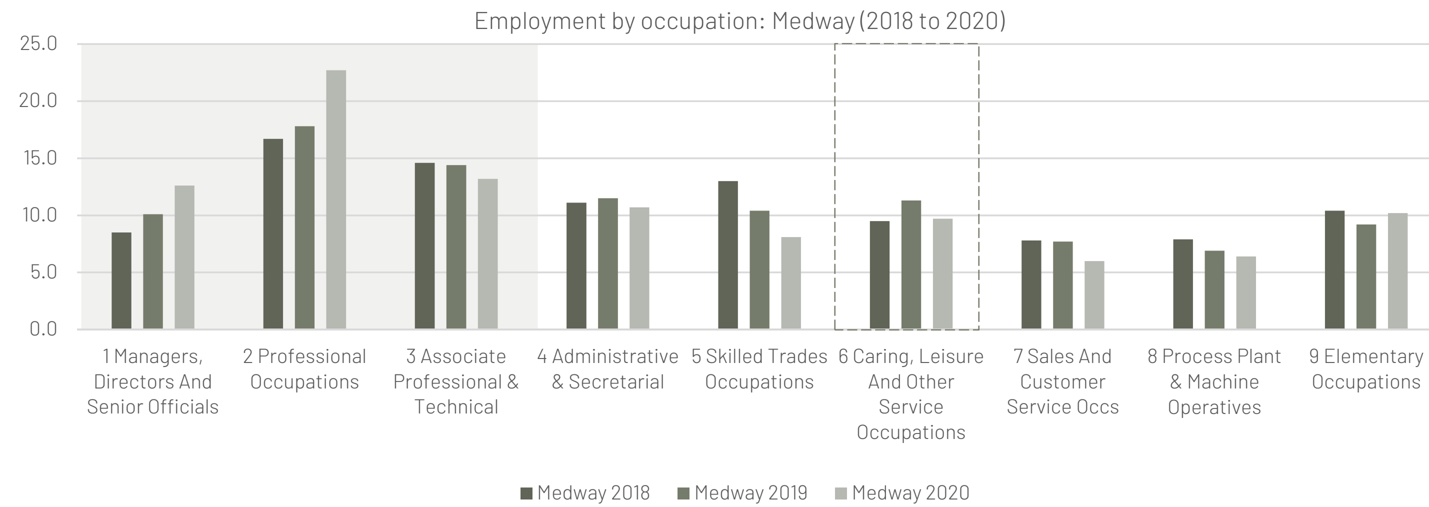
ECONOMIC TRANSFORMATION

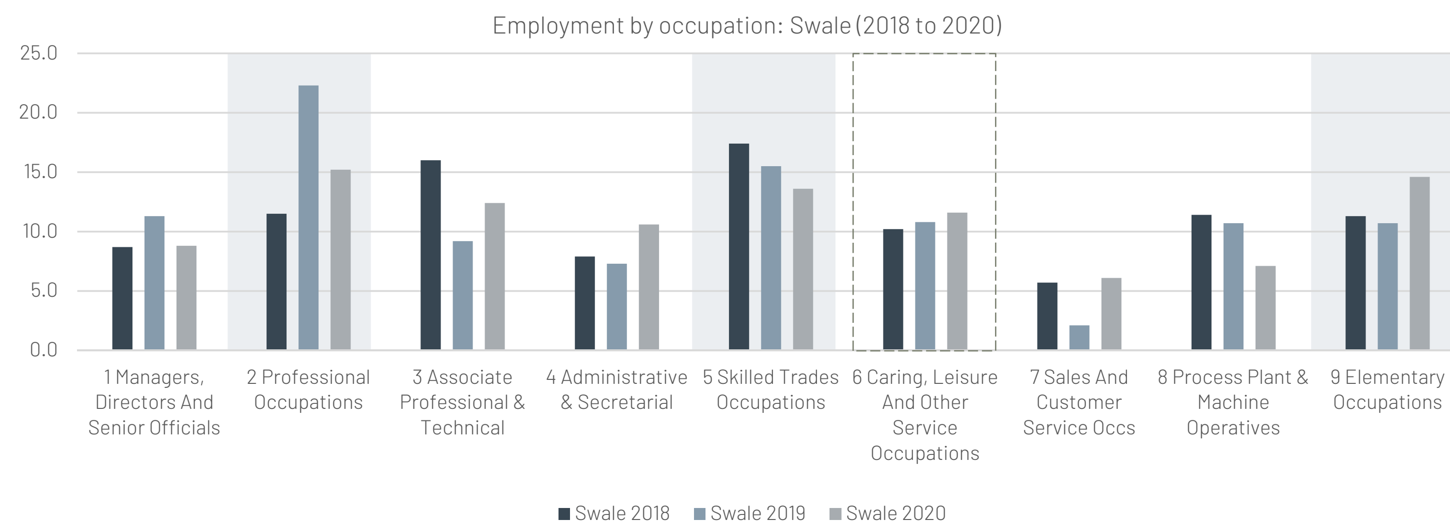
- Medway: from traditional manufacturing industries to service sector
- Swale: major occupation groups are 2,5, and 9.
- Tourism industry potential: both boroughs have a steady 10% of "Caring, Leisure, And Other Service Occupations."

MEDWAY	2018	2019	2020	Growth (2018-2020)
Total population	277,855	278,556	-	-
Economic activity (aged 16-64) population	144,100	144,400	138,100	-6,000
Total of occupation group 1-5	92,600	92,100	90,200	-2,400
Total of occupation group 6-9	51,600	50,200	43,400	**-8,200**

SWALE	2018	2019	2020	Growth (2018-2020)
Total population	148,519	150,082	-	-
Economic activity (aged 16-64) population	64,500	66,600	67,200	2,700
Total of occupation group 1-5	37,100	42,900	41,400	4,300
Total of occupation group 6-9	23,300	22,500	26,800	3,500

Data source: Official Labour Market Statistics (Nomis). Developed by author.



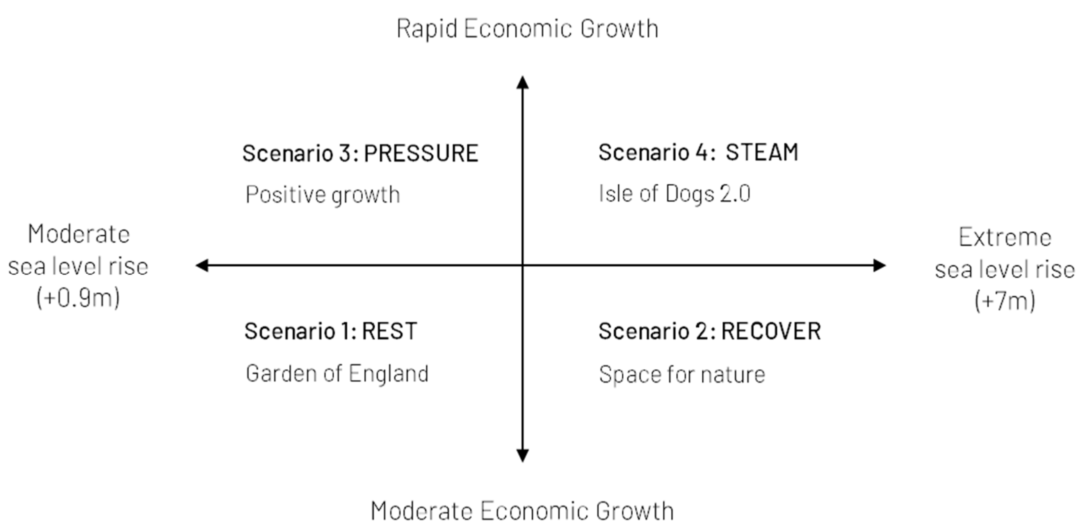


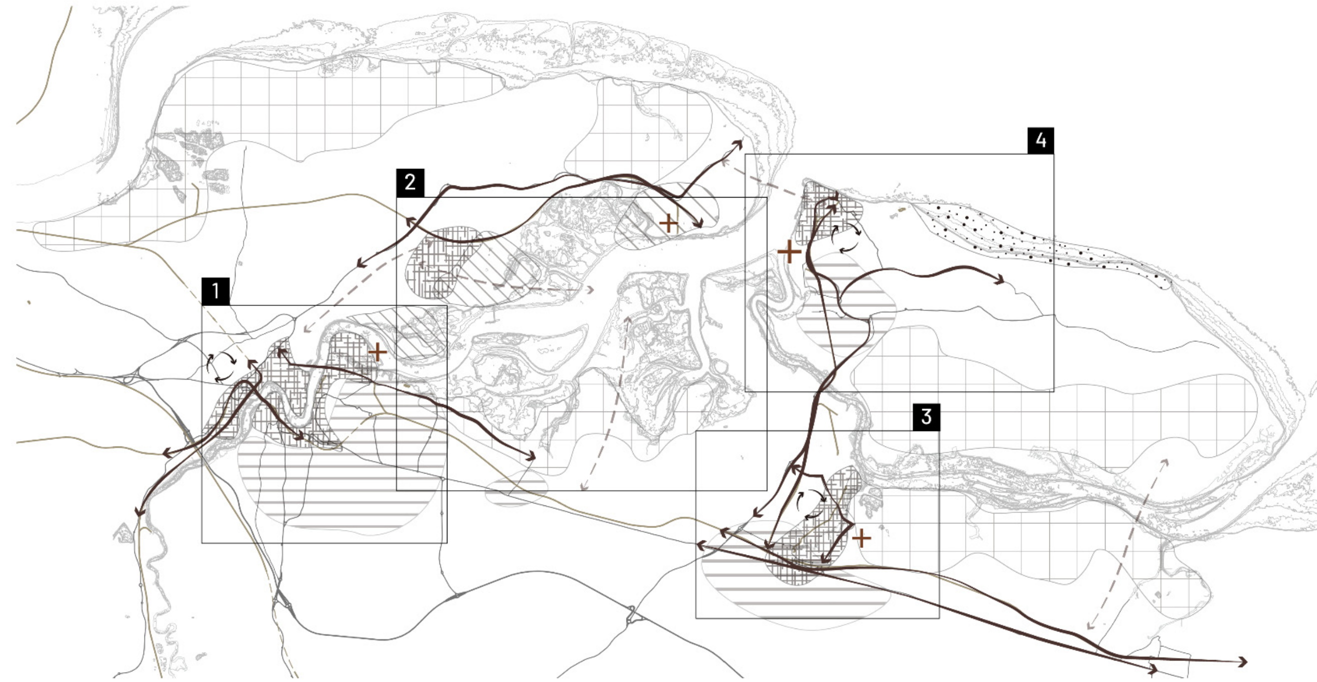
Analysis

SCENARIO STUDY

Scenario study is one of the foreseen study methodologies that are available for exploring the future in the face of complexity and uncertainty of the environment.

1. Push forward some extremes
2. Learning from the overlapped location and identify key intervention clusters





Category 1: Critical location
Areas that change in both scenarios, but in a different way and under the influence of different driving forces.

- critical road infrastructure enhancement
- space for tidal river
- flood-proof strategy for coastal city
- regeneration of urban centers
- industrial transition

Category 2: Optional location
Areas that change in one scenario, but do not change in another scenario.

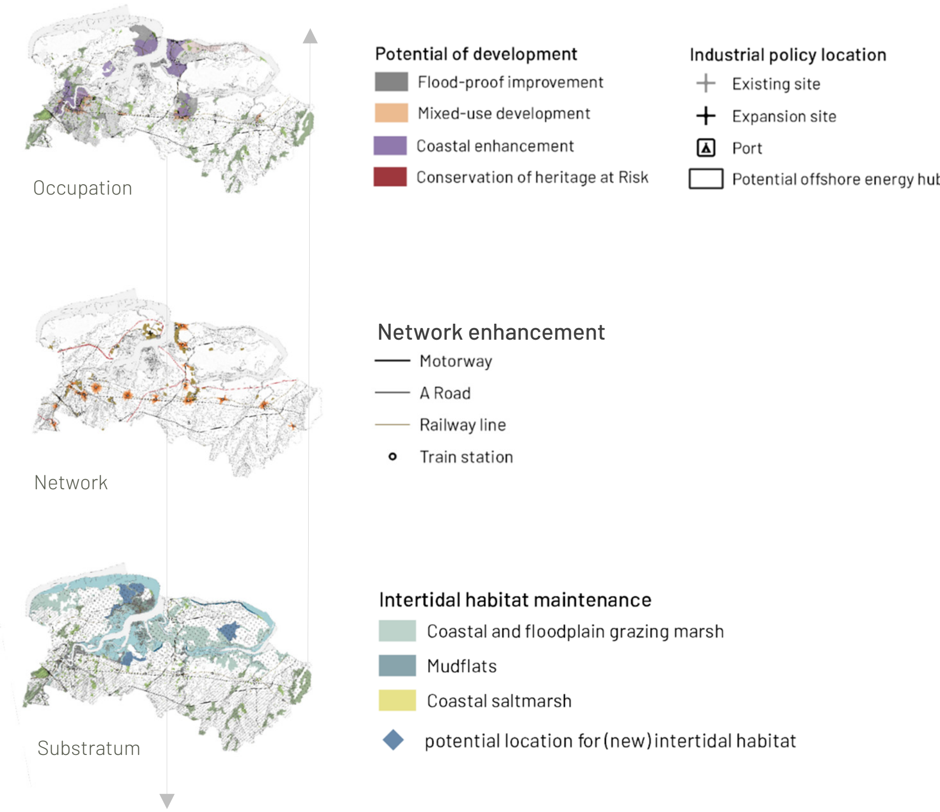
- reclamation of land by connecting current islands
- expansion of port area and adjacent industrial zone
- coastline protection scheme
- new network connection

Key cluster

1. Medway and Chatham: transitional urban waterfront
2. Medway estuary: restore ecosystem surrounding by industrial zones
3. Sittingbourne: industry and logistic center of Swale
4. Isle of Sheppey: combined issues of flood protection, port development, and livelihood safeguarding

Conclusion of analysis

POTENTIAL MAP AS THE BASIS FOR UPCOMING DESIGN ASSIGNMENT



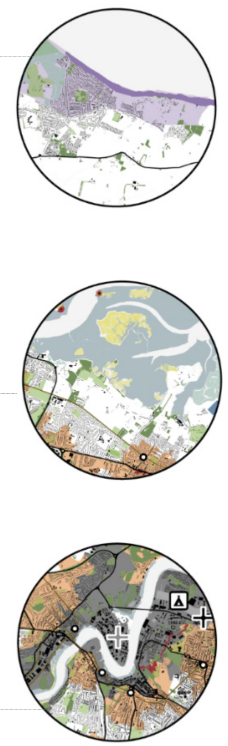
PART 3

STRATEGIES AND PRINCIPLES

RQ2. What design strategies and principles are suitable for flood mitigation and socio-ecological inclusive development?

IDENTIFICATION OF LOWER-SCALE SITES

Potential map with strategic locations



	CHARACTERISTICS	URGENCIES	DESIGN STRATEGIES
Minster on sea coastline (Isle of Sheppey)	Rural: open space, pasture, and residential use	Coastal cliff erosion	Barrier islands and coastal nourishment Coastal park Recreation & Eco-tourism
Lower Rainham coastline	Rural: open space, pasture, and residential use	Coastal squeeze and natural erosion of the intertidal habitats	Restoration of habitat gradient Adaptive zone
Medway City Estate	Urban: industrial	Industrial zone on flood-prone plain Congestion	Space for tidal river Waterfront tidal park Mixed-use development

Strategies and principles

PRECEDENT STUDY

Restoration of tidal habitat, regional scale cases in NL

Kwelderlandschap / Saltmarsh Pilot Marconi

Location	Delfzijl, Eems- Dollard estuary, NL
Time	2021
Feature	The project restored salt marshes by reusing sludge. It improves water quality, created a nature reserve, and contributed to coastal safety and the attractiveness of the coast.

De Kleine Polder

Location	Eems- Dollard estuary, NL
Time	2019
Feature	The project aimed to restore natural gradient, create space for birds and fish, and introduce recreational areas on the urban side.

Coastline protection cases in UK

Sandscaping Scheme of Bacton to Walcott

Location	North Norfolk coast, UK
Time	2019
Feature	UK's first sandscaping scheme

Jaywick Sea Defence System

Location	Essex coast, UK
Time	1980s
Feature	Fish tail offshore coastal breakwater

Restoration of tidal habitat, micro scale cases in NL

Floating Marsh Mattresses

Location	Markermeer, NL
Time	2019
Feature	placed close to share/ funtioned ad wave attenuator

Pre-grown Cord Grass Mats

Location	Eastern Scheldt, NL
Time	2012~
Feature	It is used in higher intertidal zone for consolidation and stabilization of tidal flats, and for the creation/restoration of pioneer salt marsh zones.

Managed realignment cases in UK

Salt Fleet Flats

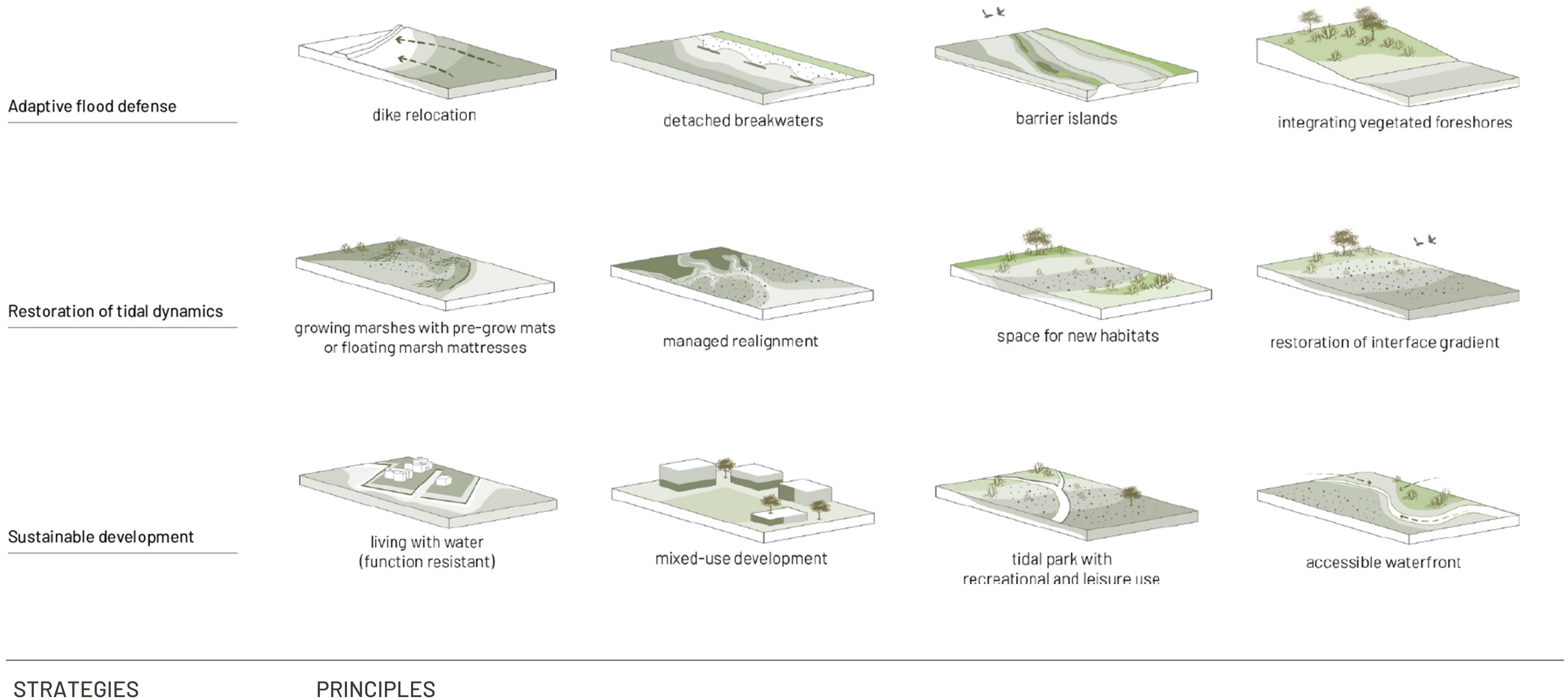
Location	Thames river, UK
Time	1997 - 2005, and 2006 - 2011
Feature	The flats was created on grazing land by reducing the ground level, using the material arising to create a new 2.4km-long flood defence embankment and breaching the existing flood defence to allow the site to be flooded.

Wallasea Island Managed Retreat

Location	Wallasea, UK
Time	1997 - 2005, and 2006 - 2011
Feature	Large wetlands are reconstructed that form a nature area to compensate wetlands and bird habitat losses; a flood storage facility and a recreational area.

Strategies and principles

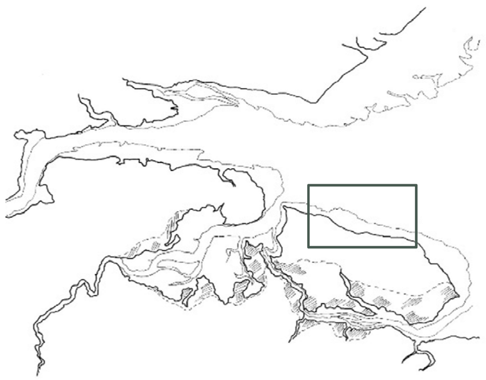
PROPOSED DESIGN PRINCIPLES



PART 3

DESIGN EXPLORATION

RQ 3. How to apply the design strategies and principles in Medway River Estuary to increase its socio-ecological resilience?



Resilient Medway River Landscape—
Adaptive Design Strategies for a
Sustainable Coastal Landscape

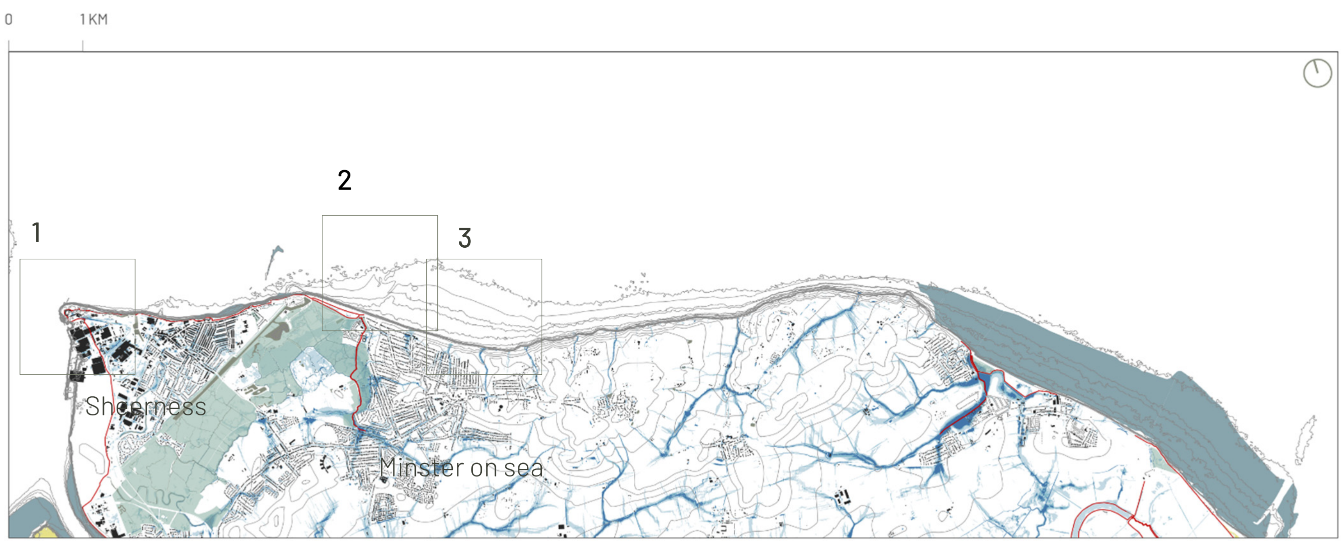
EMU Graduation
Yu-Wen Lin

Site 1. Minster coastline management

COASTAL CLIFF EROSION AND RETREAT

How to increase the adaptability of the Minster coastline under coastal cliff erosion and shoreline retreat?

- South part of the island is low-lying marshes and nature reserve
- North part is the economic center and under protection
  - Port of Sheerness: deep-water access port (-20m)
  - Connected to the historic center
- Minster-on-sea
  - 76 meters above sea level
  - Main residential cluster with public investment according to the local plan of Swale



1


2


3


Site 1. Minster coastline management

IDENTIFY THE URGENCIES

Bathymetry

- The potential intervention section is around 0 to -5 meters depth and has a 1 in 470 gentle slope.

Urgency: 200 meter's retreat over the next 100 years

- All areas apart from the Leas have a high annual erosion rate, which would encounter a 200 meters' retreat over the next 100 years (Environment Agency, 2018)

Conclusion: the priority section to protect->

- Minster Sea Cliff Defence to Bugsby's Hole

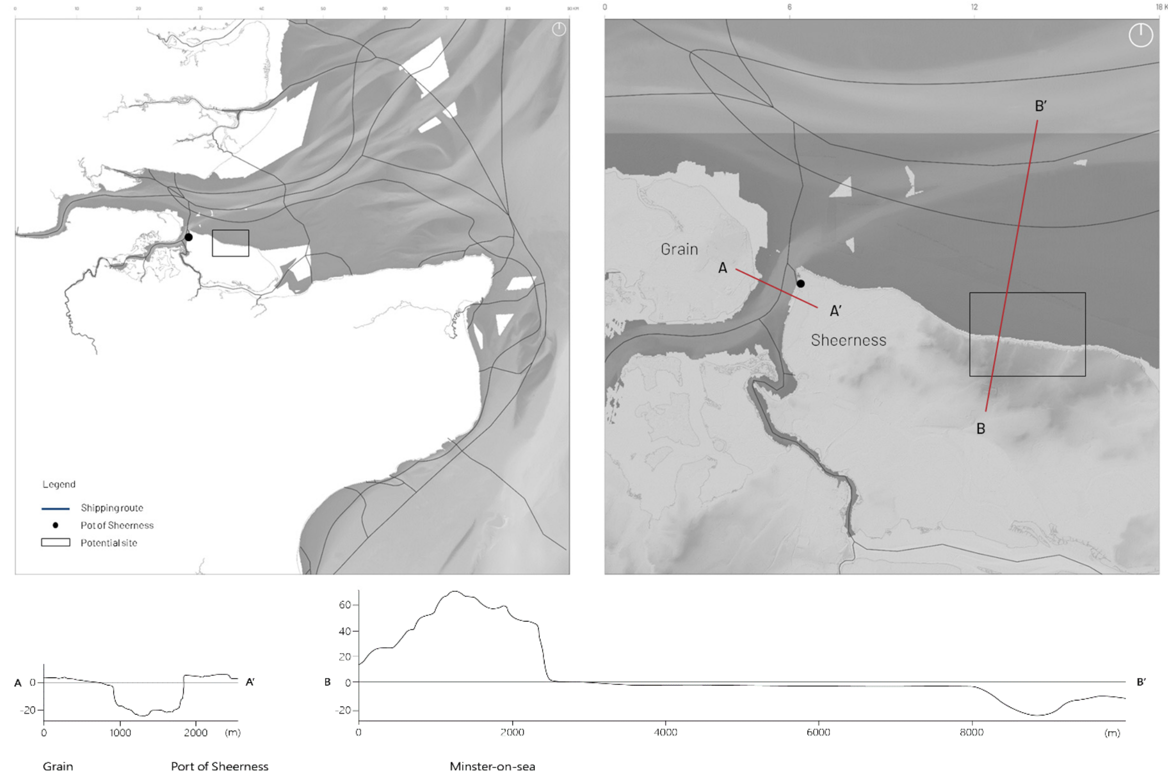


Fig. Bathymetric maps and section diagrams. Data source: Defra, Marine DEM.

Projected future cumulative retreat (m)

Year	Leysdown-on-Sea (BA8.2 & 9.1)	Warden Bay Defended (BA9.2)	Warden Bay Undefended (BA10.1 & 9.2)	Barrows Brook to Warden Point (BA 10.1)	Hen Brook to Barrows Brook (BA 10.1)	Bugsby Hole to Hen Brook (BA 10.1)	Minster to Bugsby Hole (BA10.1)	Minster Cliffs sea defence (BA 11.1)	The Leas (BA 11.1)
2015	0	0	0	0	0	0	0	0	0
2065	125	28	125	214	116	100	89	100	17
2115	290	193	290	496	269	231	206	231	38

Table. Summary of the cumulative shoreline retreat for the North Sheppey Cliff under a 'Do Nothing' scenario.
Source: Environment Agency. (2018).Mapped by Mott MacDonald.

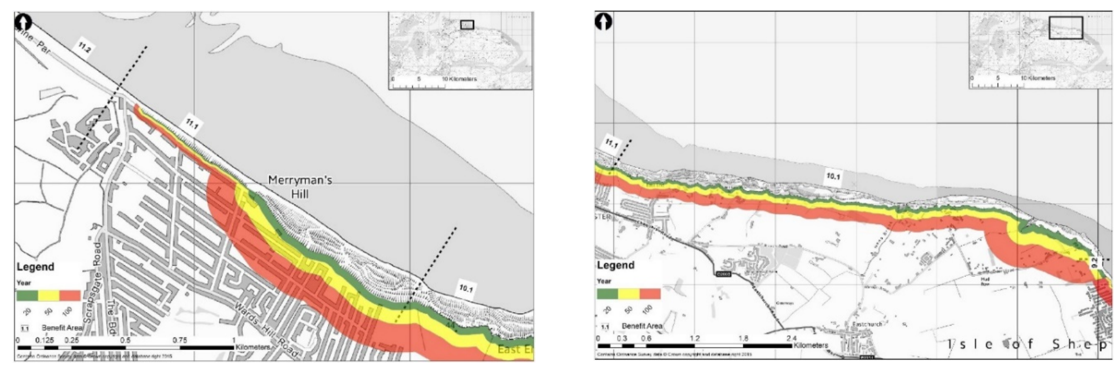
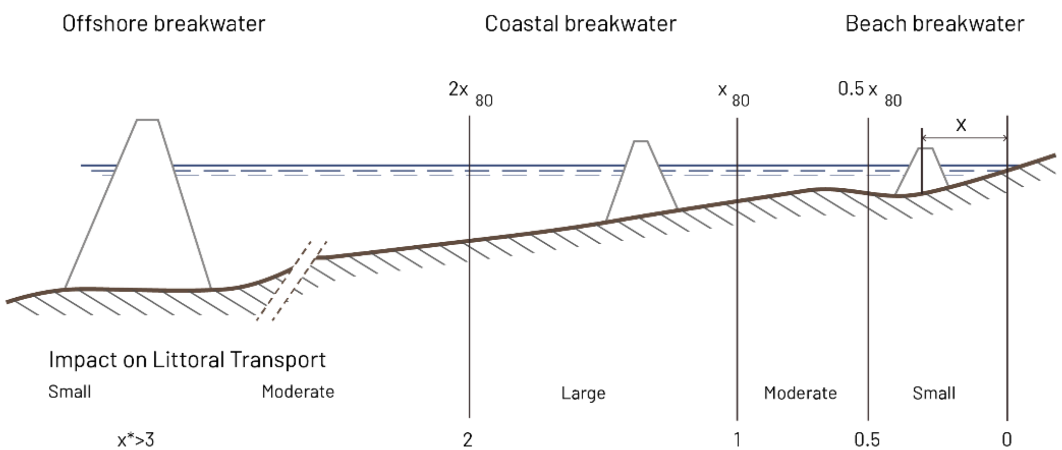


Fig. Coastal Retreat projection (Minster to Bugsby's Hole). Source: Environment Agency. (2018).Mapped by Mott MacDonald.

Site 1. Minster coastline

DESIGN RESEARCH AND INITIAL DESIGN CONCEPTS

1. Coastal breakwater as backbone
2. Nature-based solution perspective: combination of ecosystem elements and hard engineering approaches
3. Multifunction: coastal protection, restoration of ecosystem, and recreational use



Dimensionless Breakwater Distance: $x^* = \frac{x}{x_{80}}$

L_B	Length of the breakwater
x	Breakwater distance to shoreline
x_{80}	Surf-zone width, approximately 80 % of the littoral transport takes place landwards of this line

Fig. Type of detached breakwaters. Source: adapted from DHI (2017).

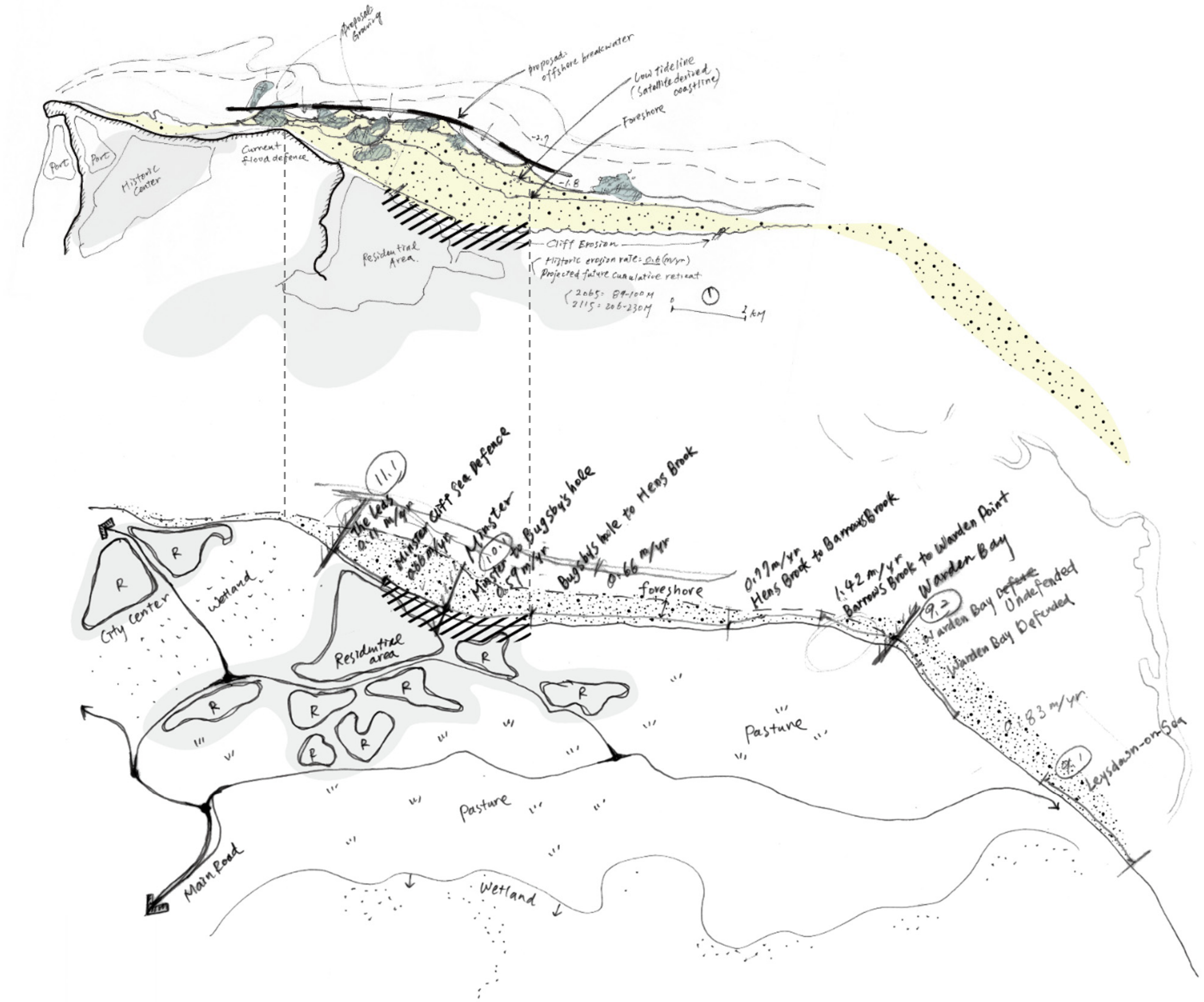


Fig. conceptual sketches mapped the potential location of offshore breakwaters

Site 1. Minster coastline

MAPPING THE POTENTIAL

Objective

1. Shoreline protection (total length: 2000~5000 meters)
2. Protect major housing cluster (15,670 inhabitants)

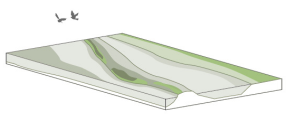
Legend

- Existing flood defense
- Major road
- Major housing cluster
- Potential site for interface design
- Surf zone
- Potential zone for coastal intervention

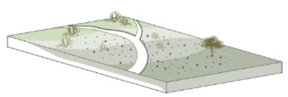
Site 1. Minster coastline

PROPOSAL

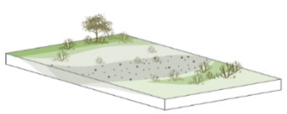
Nature-based interventions to increase coastal resilience



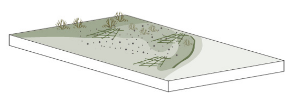
barrier islands



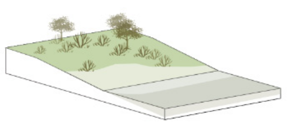
tidal park with
recreational and leisure use



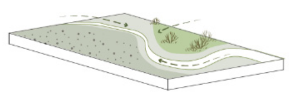
space for new habitats



growing marshes with pre-grow mats
or floating marsh mattresses



integrating vegetated foreshores



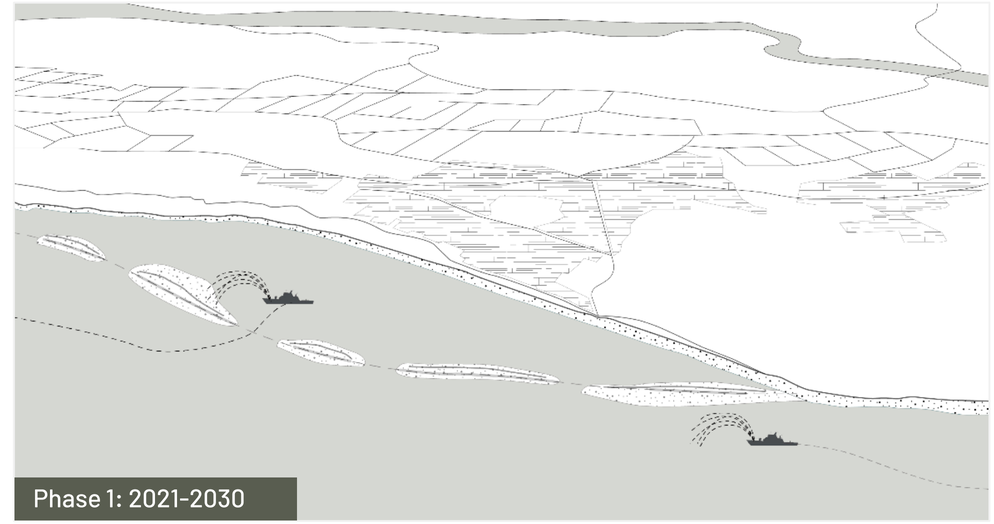
accessible waterfront

Site 1. Minster coastline

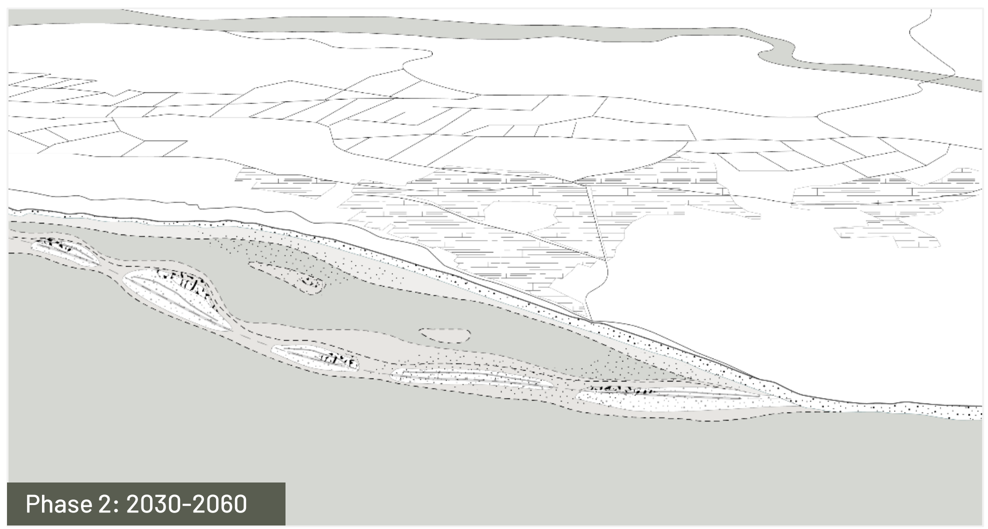
A GROWING SYSTEM

Balance of natural formative elements:
Wind, wave, tidal force, species interaction.

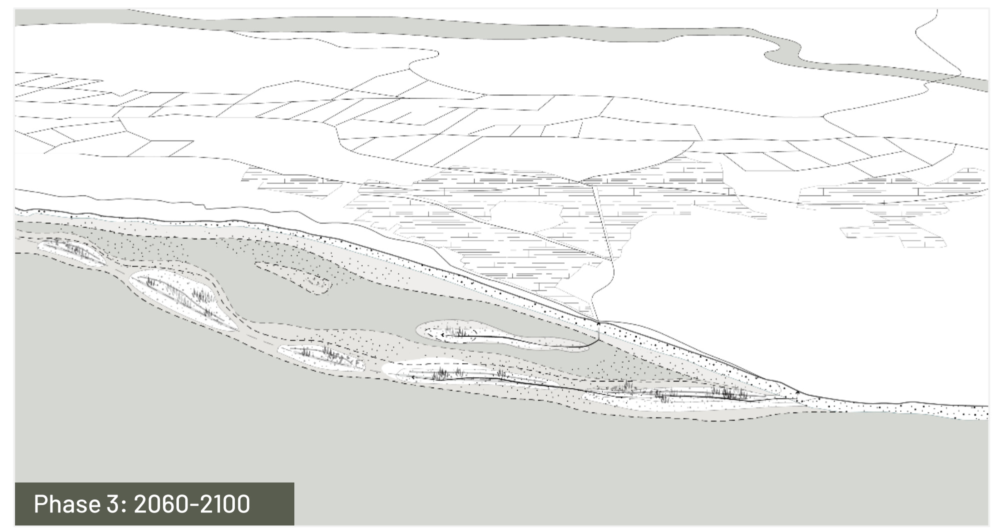
0. Current shoreline



A. Breakwater construction
B. Mud motor: deposit of dredged sediment around breakwater



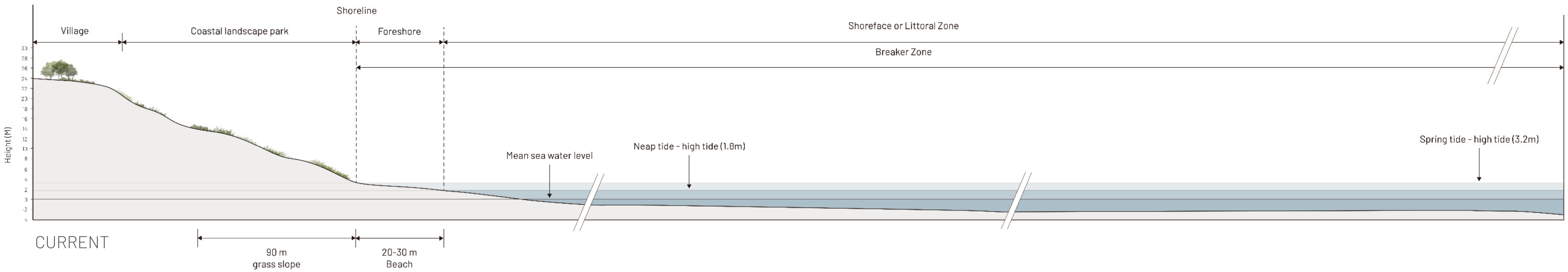
C. Wind, waves, and tides disperse the sediment along the island chain.
Mudflat landscape forms.
D. Pre-grown cord grass mats are installed.

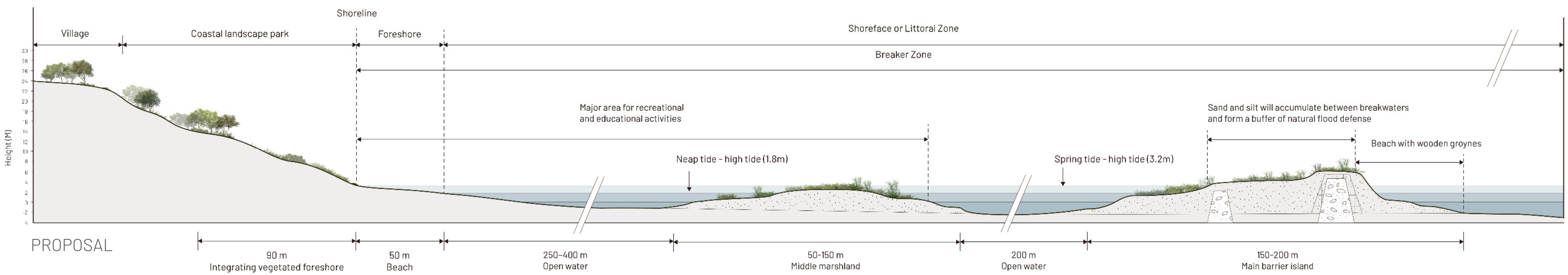


E. Saltmarsh plants capture the sediment and grow the marsh.
F. Development of recreational footpath.

Site 1. Minster coastline

DESIGN DETAIL





Site 1. Minster coastline

CONCLUSION

Nature Dynamics,
Multifunctional program,
Ecological Benefits

CHAPTER 5

DESIGN EXPLORATION

RQ 3. How to apply the design strategies and principles in Medway River Estuary to increase its socio-ecological resilience?

Resilient Medway River Landscape—
Adaptive Design Strategies for a
Sustainable Coastal Landscape

EMU Graduation
Yu-Wen Lin

Site 2. Rainham coastline

URGENCIES IN THE MEDWAY ESTUARY

Saltmarsh loss due to urbanization

Much of the salt marsh area of the estuary has been lost through the removal of material for rick-making in the 19^{th} century, or reclaimed and embanked (Cundy, et al., 2007).

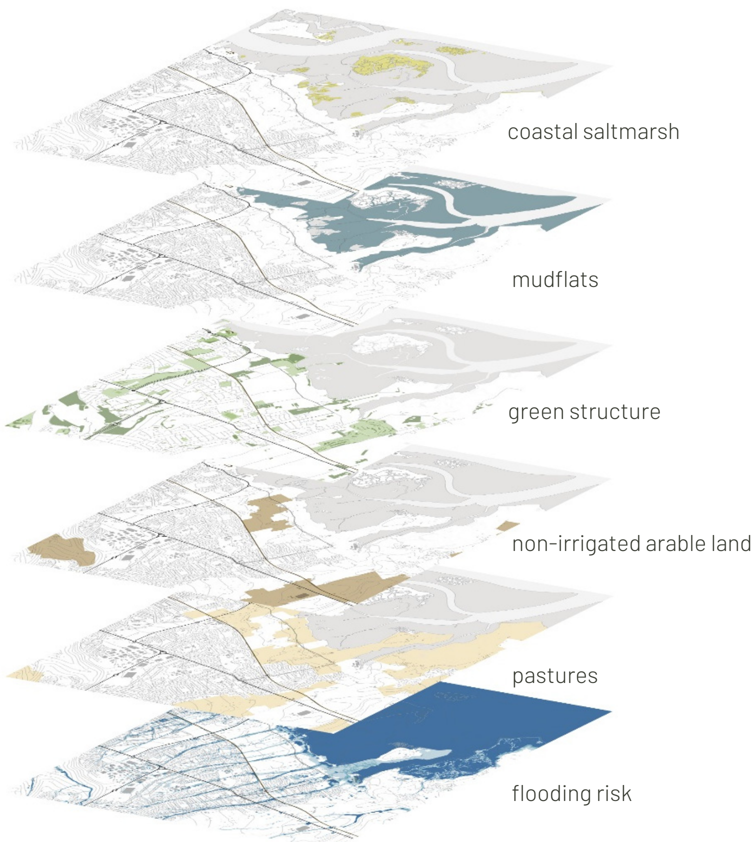
Table. Saltmarsh area losses 1973–1988. Source: Kirby, R. (2013).

	Medway	Swale
Saltmarsh area (1973)	843.8 ha	397.5 ha
Lost by erosion (1973–1988)	180.1 ha	61.6 ha
Percentage of total	21.3%	14.6%

Site 2. Rainham coastline

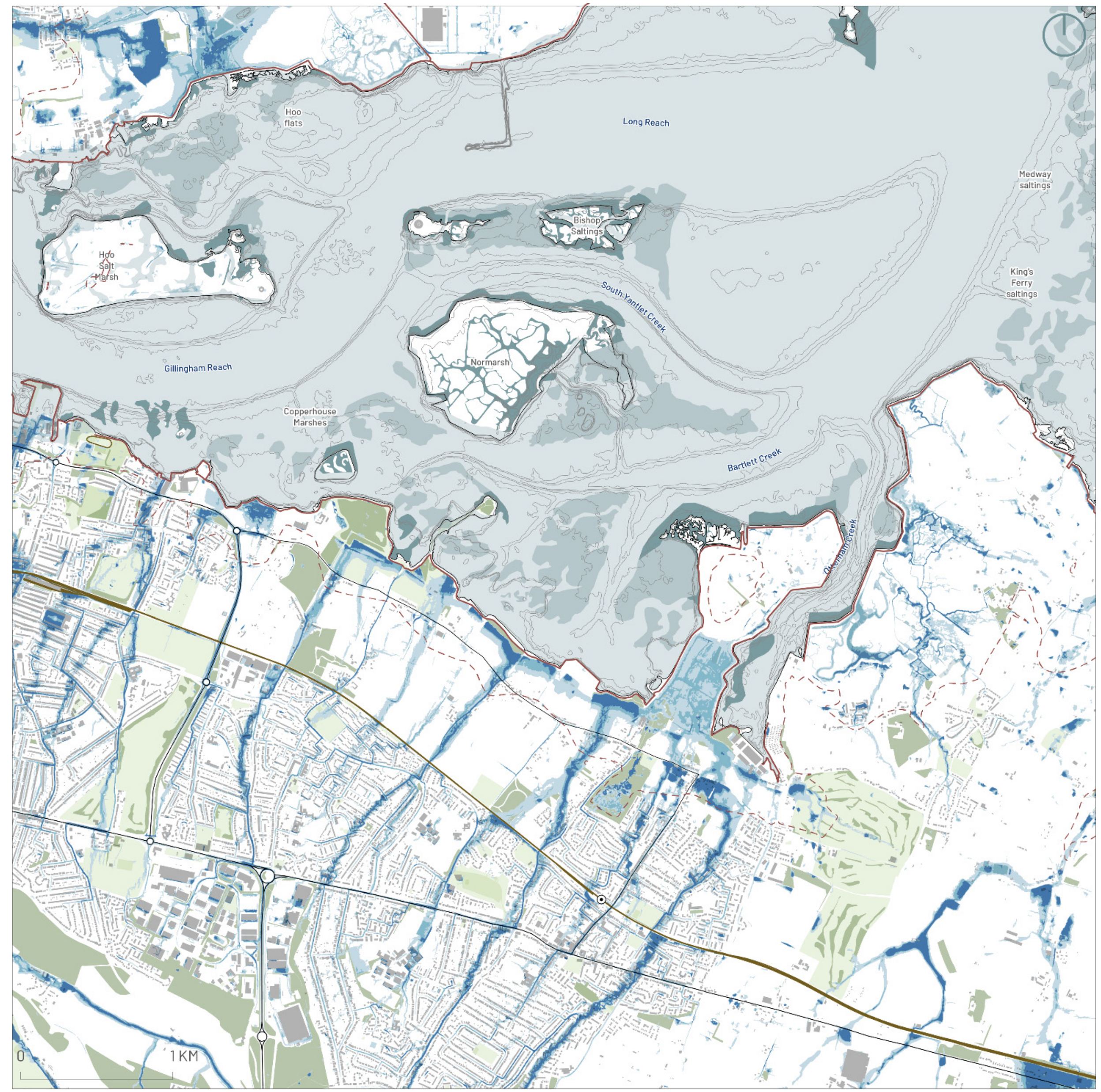
URGENCIES IN RAINHAM COASTLINE

Flood defenses hinder the gradient between land and water



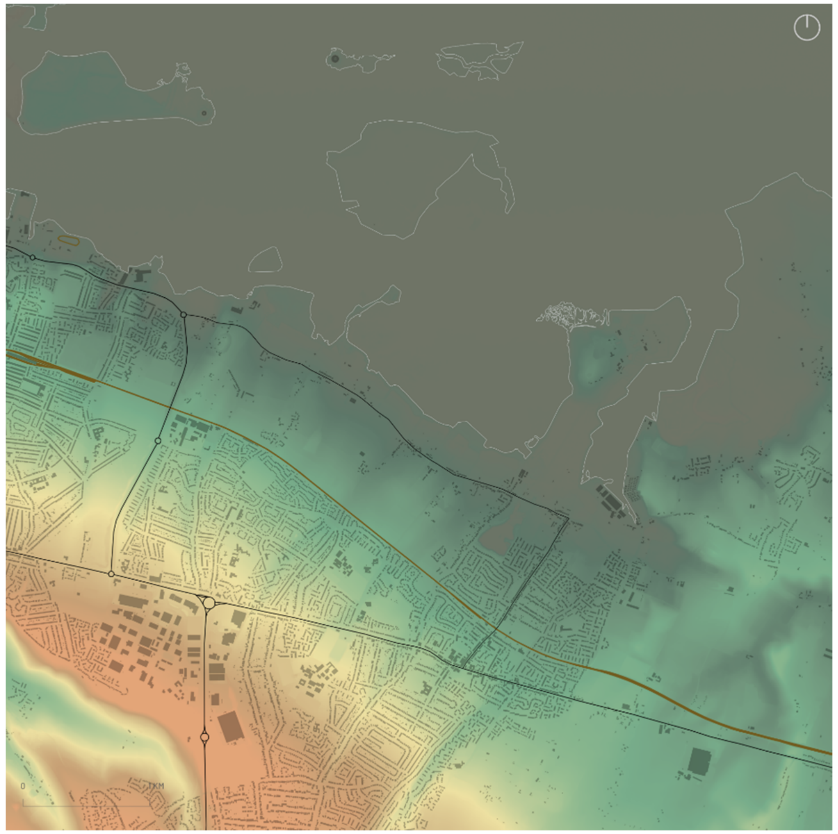
Legend

- Tidal River
- High water line retreating zone (1885 to 1937)
- High water line retreating zone (1937 to 2020)
- High water line
- Satellite derived coastline
- Flood defense
- 10-meter contour line
- Saltmarsh
- Extent of surface flooding: 1 in 30 years
- Extent of surface flooding: 1 in 100 years
- Extent of surface flooding: 1 in 1000 years
- Green space
- Woodland
- Building
- Rainham station
- Railway
- Major road



Site 2. Rainham coastline

DESIGN RESEARCH: HYDROLOGY STUDY



Digital elevation model
as analytic base

Data source: LIDAR Composite DTM 2019

Height (m)

	-0.8		55.2
	10.3		66.3
	21.5		77.6
	32.7		88.8
	43.9		100

Generating streamlines by
hydrology tools through ArcGIS

Legend

- Generated streamline
- Current river stream
- Flood defense
- Surface flooding spots

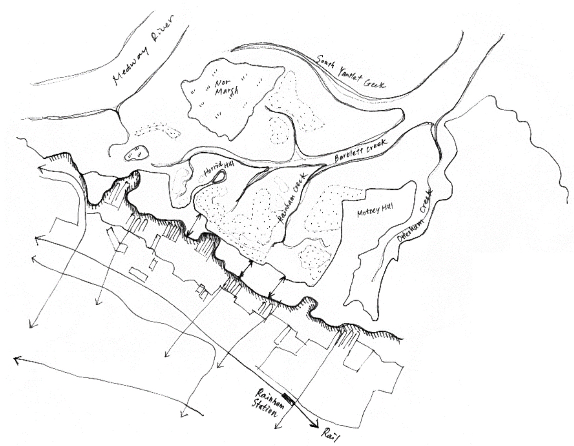
Identify potential new landscape structure according to surface water flow and flooding risk data

Site 2. Rainham coastline

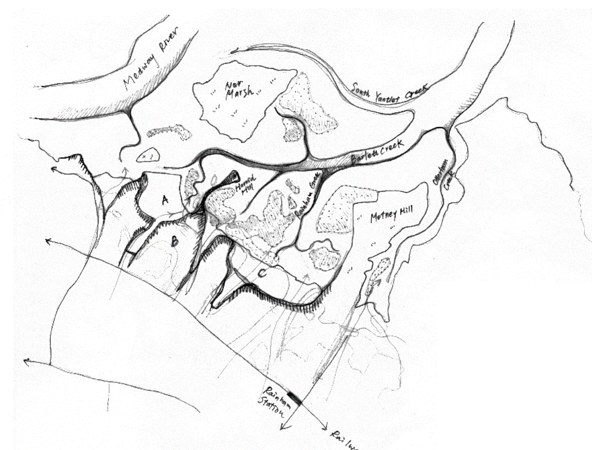
DESIGN EXPLORATION

Current

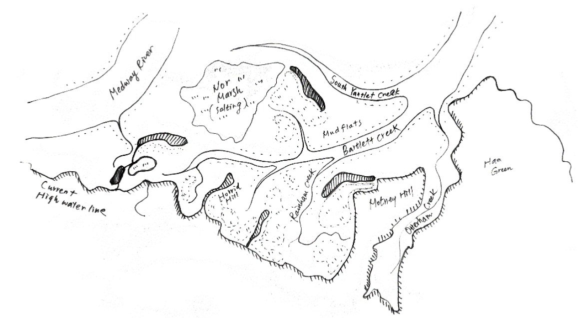
Proposal



Concept 1. Linear buffer



Concept 2. Cut and De-build



Concept 3. Habitat Restoration

INITIAL DESIGN IDEAS

EXPLORATION OF DIFFERENT LAYOUT PLAN

Site 2. Rainham coastline

MAPPING THE POTENTIALS

- Locations to restore tidal habitat
- Space for adaptive flood defense
- Rural land use as the potential

Saltmarsh restoration potential locations are based on bathymetry, flow direction, and the historic pattern of saltmarsh.

Potential locations for habitats to grow toward land.

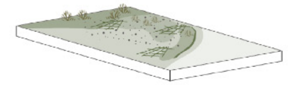
The linear buffer between flood defense and the 10-meter contour line is the potential zone for dike relocation.

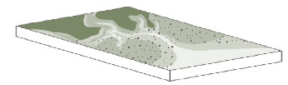
Legend

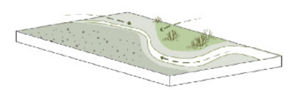
- Saltmarsh
- Potential space for saltmarsh restoration
- Potential growing direction in estuary
- Potential growing direction toward land
- Potential direction of dike relocation
- Adaptive Zone
- Current flood defense
- 10-meter contour line

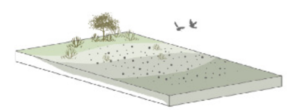
Site 2. Rainham coastline

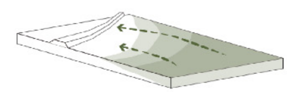
PROPOSED PLAN

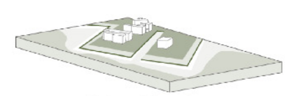

growing marshes with pre-grow mats or floating marsh mattresses


managed realignment


accessible waterfront


restoration of interface gradient


dike relocation


living with water (function resistant)

- growing marshes
- tidal park with pioneer wetland
- managed realignment (pilot)
- managed realignment (reserved land)

- adaptive zone (reserved land) for future climate events
- adaptive flood defense
- recreational or residential block
- footpath and cycling path system
- access to coast

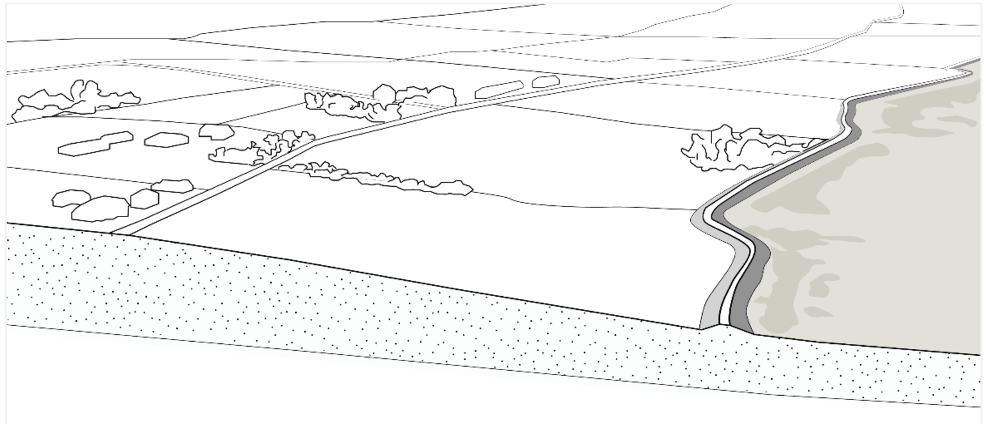
Site 2. Rainham coastline.

A GROWING SYSTEM

Reference projects in UK

Salt Fleet Flats

Wallasea Island Managed Retreat



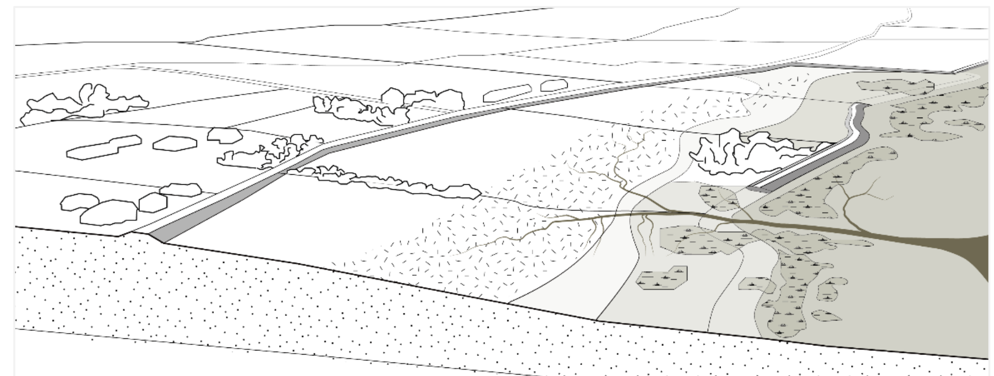
Current shoreline

Phase 1: 2021-2030

Building the new flood defense.

Phase 2: 2030-2060

Excavate current dike structure .
Excavate surface ground to align with existing marshes.

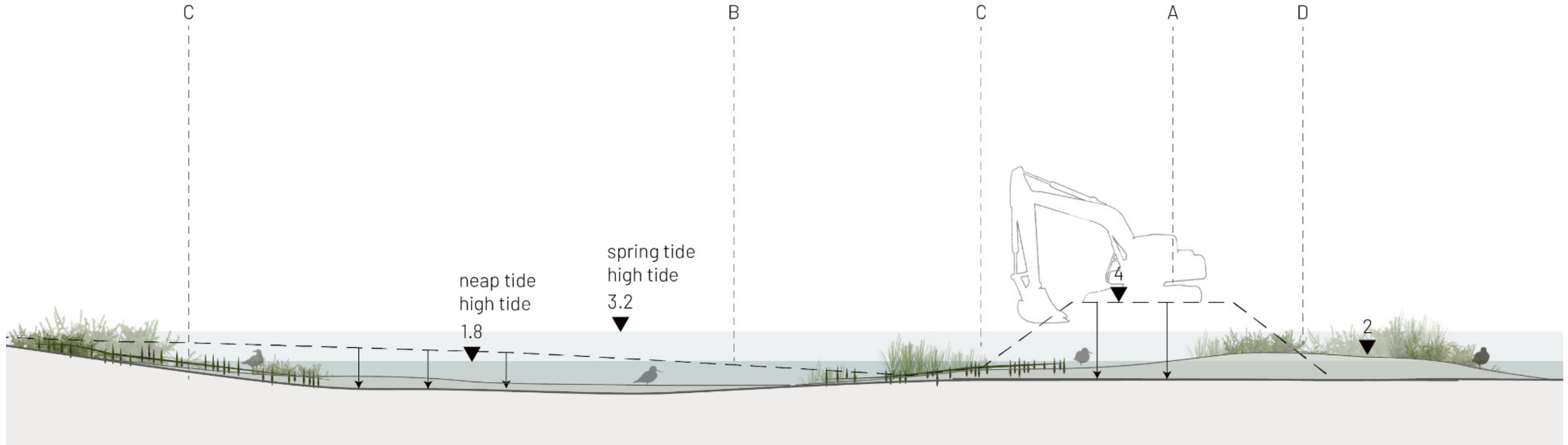


Phase 3: 2060-2100

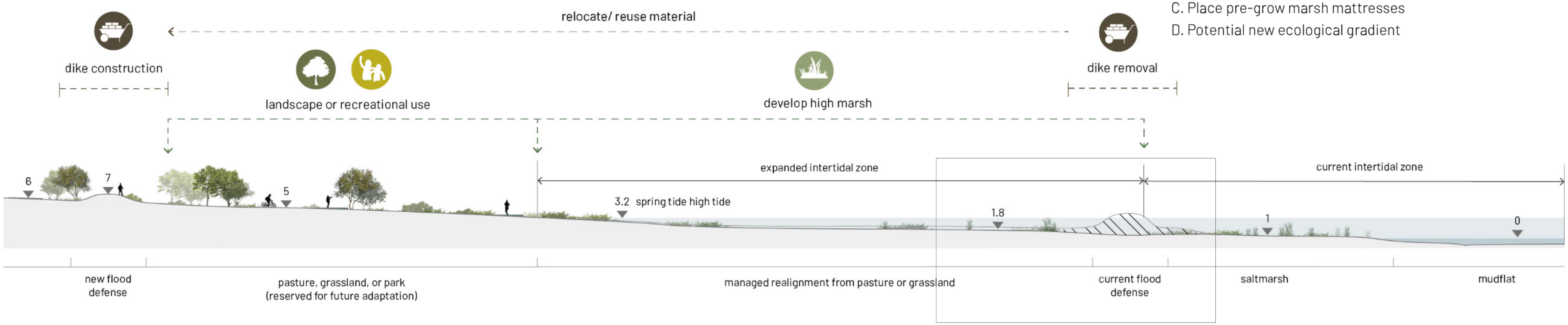
Place pre-grown marsh mattresses.
Space for intertidal habitats to grow.

Site 2. Rainham coastline. Design detail.

INTERFACE WITH NATURAL GRADIENT



A. Remove current dike structure
B. Excavate surface ground to align with existing marshes
C. Place pre-grow marsh mattresses
D. Potential new ecological gradient



Site 2. Rainham coastline.

CONCLUSION

Restoration of tidal habitats
and river-land interface

CHAPTER 5

DESIGN EXPLORATION

RQ 3. How to apply the design strategies and principles in Medway River Estuary to increase its socio-ecological resilience?

Resilient Medway River Landscape—
Adaptive Design Strategies for a
Sustainable Coastal Landscape

EMU Graduation
Yu-Wen Lin

Site 3. Medway city estate

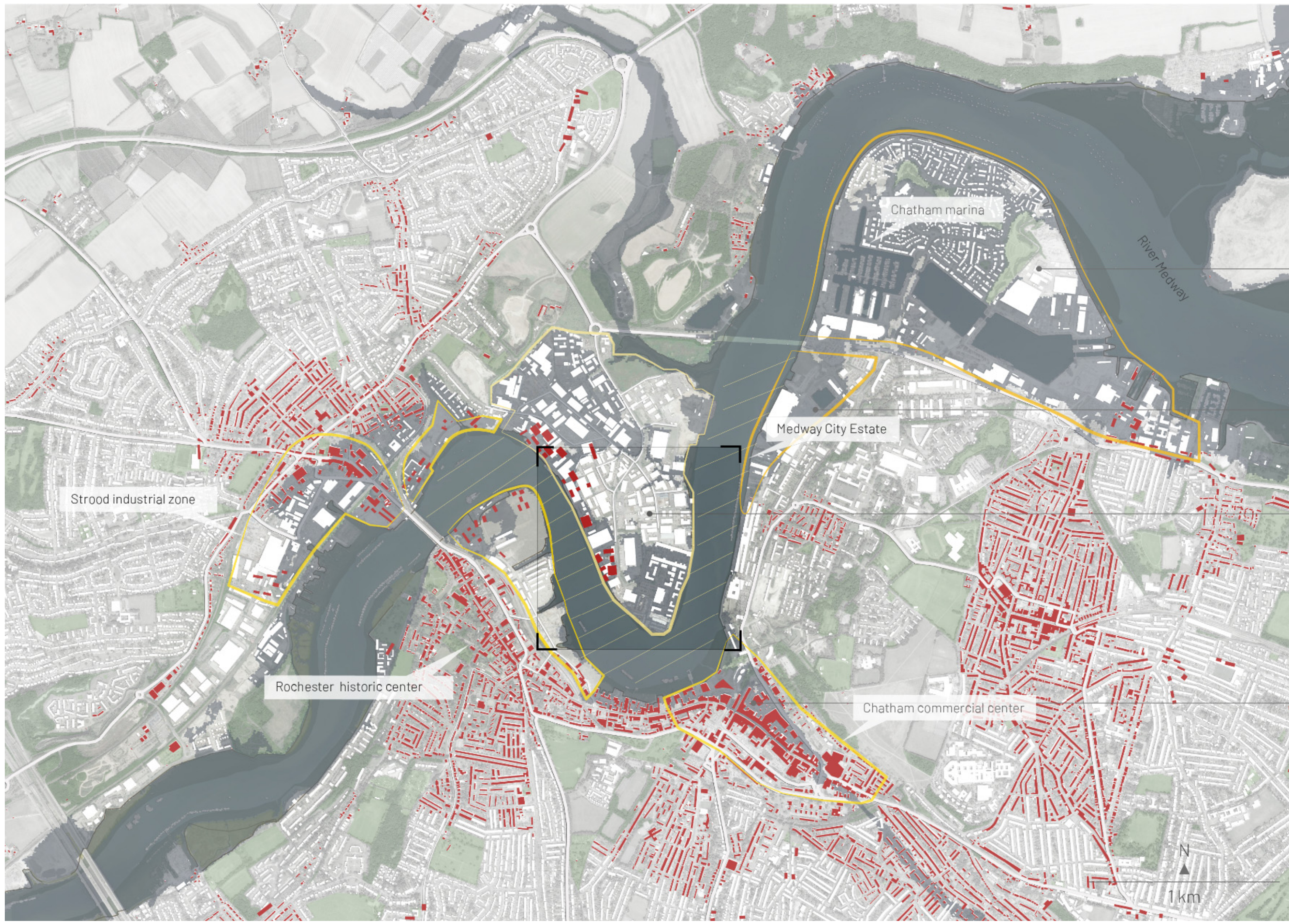
URGENCIES:
LOSS OF FLOOD ADAPTABILITY

A. Rochester castle
B. Rochester cathedral
C. Chatham historic dockyard
D. Medway city estate

Left: Medway city estate in 1939. Image source: Historic England.
Right: Medway city estate in 2021. Image source: Google satellite.

Site 3. Medway city estate

POTENTIAL INTERVENTION SITE



Legend

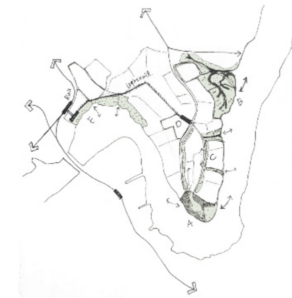
- flooding risk zone (Environment Agency)
- coastal mudflat
- discontinuous part of tidal habitats
- building in 1885 (OS historic map)
- Transformed: redevelopment due to closure of Chatham dockyard in 1984
- Transforming: designated sites in Local Plan
- Un-transformed: industrial use

Redeveloped into:
-St. Mary's Island: residential use
-Chatham marina
-Commercial Port of Chatham

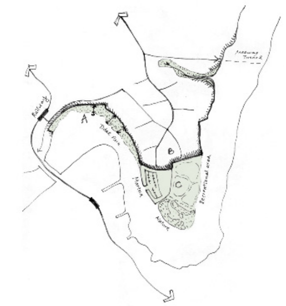
Chatham Historic Dockyard:
Maritime heritage

Medway City Esate
-used to be marshland till the 1980s
-currently an industrial zone

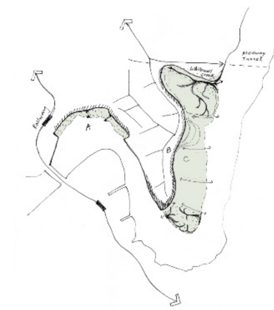
Chatham, Rochester, and Strood water-front: designated as strategic locations in Medway Local Plan



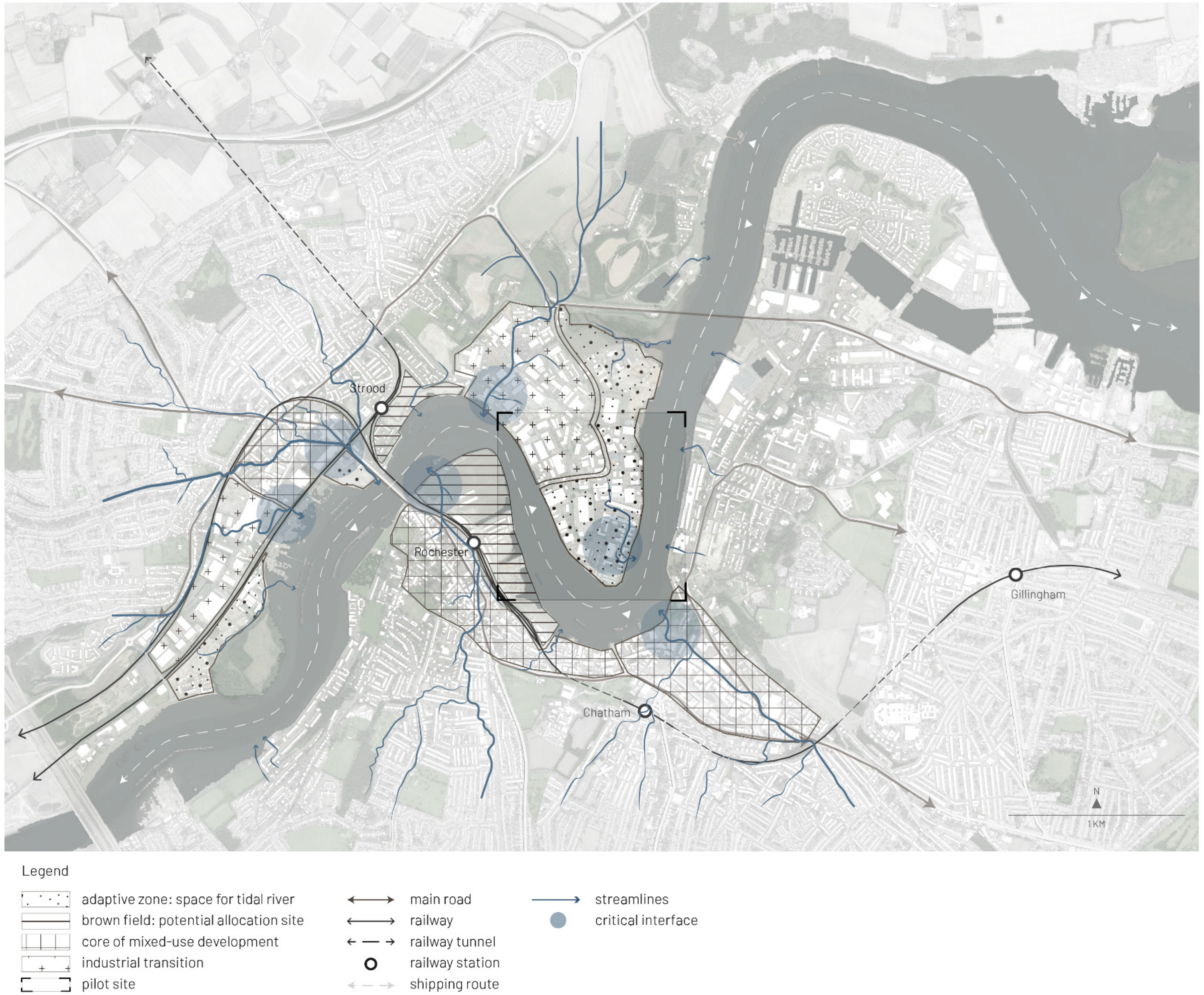
Proposal 1:
Partial intervention.



Proposal 2:
Direct setback



Proposal 3:
Retreating according to historic layout.



Site 3. Medway city estate

DEVELOPMENT STRATEGIES

1. Adaptive zones provide space for tidal river and restore tidal dynamics
2. Brownfields serve as relocation or allocation sites among adjacent development
3. Mixed-use development at city centers provide key services for the adjacent residential areas
4. Riverfront developments need to improve landscape quality and create recreational added values

Site 3. Medway city estate

PROPOSED PLAN AND APPLICATION OF DESIGN PRINCIPLES

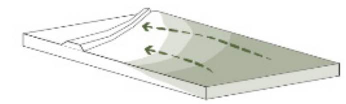
Mixed-use and recreational program: Retail center, marina, and boat clubs.

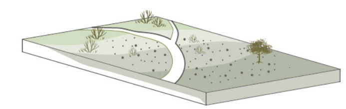
Flood defense landscape park, with multi-purpose meeting spaces

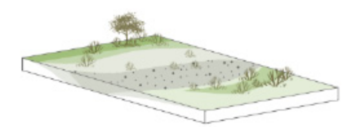
Tidal park: space for tidal river.
Service center of the new nature reserve.

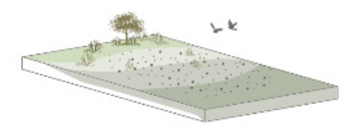
Medway tidal park

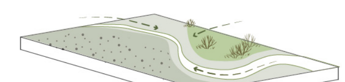
- river (during low tide)
- mudflat: lower than 1.8m
- saltmarsh: higher than 1.8m
- marina
- mixed-use of commercial and industrial zone
- footpath in tidal park
- flood defense and multifunctional community space


dike relocation


tidal park with
recreational and leisure use


space for new habitats


restoration of interface gradient


accessible waterfront

Legend

- pilot site
- main road
- secondary road
- railway
- railway tunnel
- shipping route
- heritage
- railway station
- tourist attraction

Site 3. Medway city estate

RECREATIONAL NETWORK

	Attractions
Heritage	Rochester Castle, Rochester Cathedral, Chatham Historic Dockyard, Upnor Castle, Fort Amherst, Great Lines Heritage Park
Core of water activity	Chatham marina, Medway tidal park marina
Landscape	Medway waterfront, Saxon Shore Way
Ecological education	Medway tidal park

	Mobility types for different users
Leisure and holiday tourists	yachting, sailing, biking
Youth tourists	public transportation (train, bus)
Local commuters	train, bus, automobile

Site 3. Medway city estate

PHASING ACCORDING TO THE TRANSFORMABILITY

	High ◄	► Low
Land use	Mono-function (industrial use)	Mixed-use (industrial, retail, office use)
Stakeholder	Single	Multiple
Plot size	Larger than 2000 m2	Small than 2000 m2
Open space ratio	Higher than 25%	Lower than 25%

Fig. Possible plot division

Phase 1: 2021-2040

1. Relocation.
2. Several open spaces in a single-use plot could be developed into wetlands.
3. The linear plot adjacent to the River Medway is suggested to develop into a landscape structure

Phase 2: 2040-2070

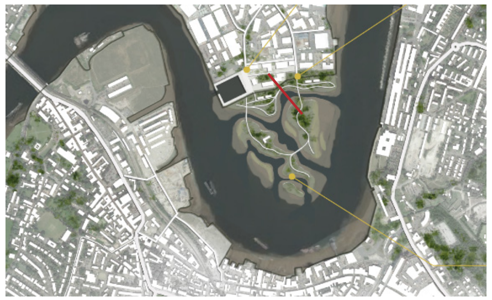
1. Connect the pioneer wetlands to become part of the river system.
2. Construct infrastructure systems, such as the marina and the flood defense.

Phase 3: 2070-2100

1. Programming.
2. Develop mixed-use zones adjacent to the new flood defense landscape park.
3. Develop community spaces/classrooms inside the tidal park.

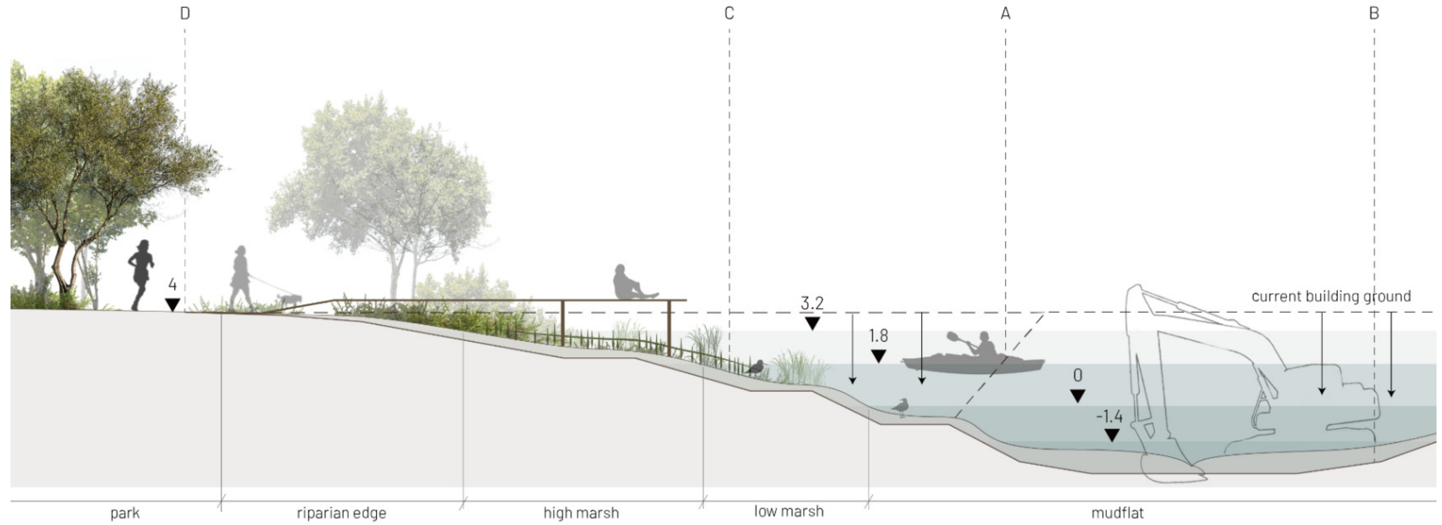
Site 3. Medway city estate

SPACE FOR TIDAL RIVER



Phasing

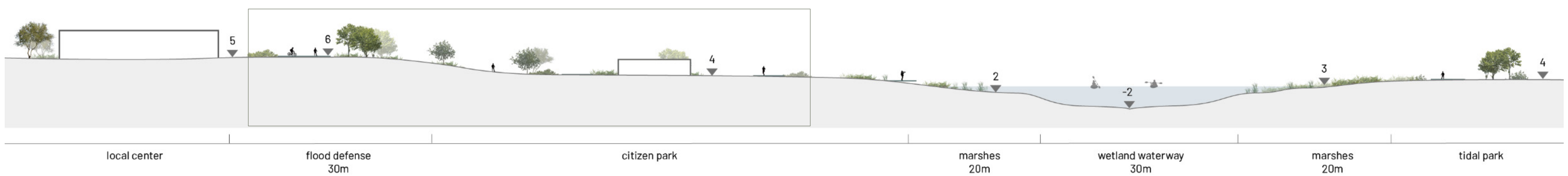
A. Excavate and restore wetland
B. Excavate deeper and connect other wetlands to create water channel
C. Riparian vegetation
D. Tidal park development



Site 3. Medway city estate

SPATIAL QUALITY

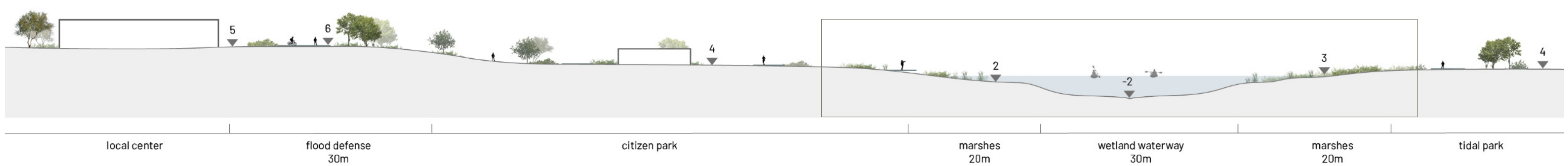
Adapt to sea level rise
Create ecological benefits
Place to work and visit



Design exploration

CONCLUSION

Design strategies and principles are applied in local scale sites to increase the socio-ecological resilience of coastal landscape.



PART 4

VISION ON REGIONAL DEVELOPMENT

Resilient Medway River Landscape—
Adaptive Design Strategies for a
Sustainable Coastal Landscape

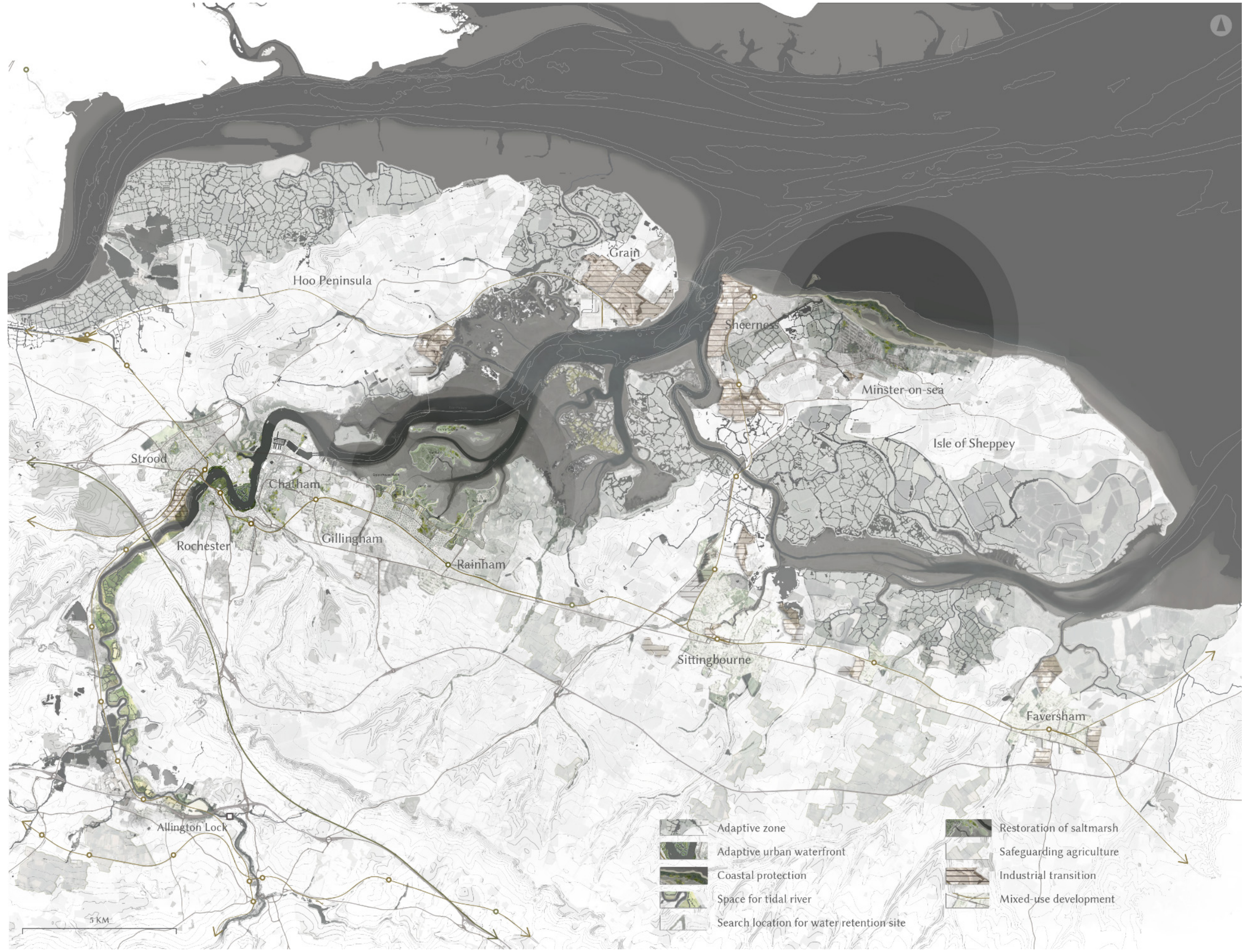
EMU Graduation
Yu-Wen Lin

Landscape strategy

VISION ON REGIONAL DEVELOPMENT

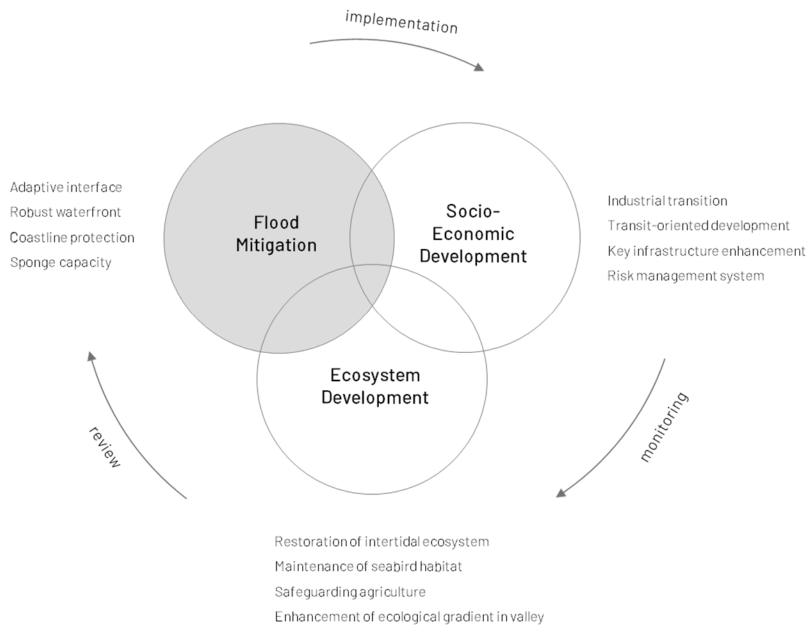
Resilient Medway river landscape

1. Capacity to adapt to uncertainties
    1) Environmental perspective
    2) Anthropocene perspective
2. Resilient development
    1) Complex system
    2) Adapt through time
    3) Governance

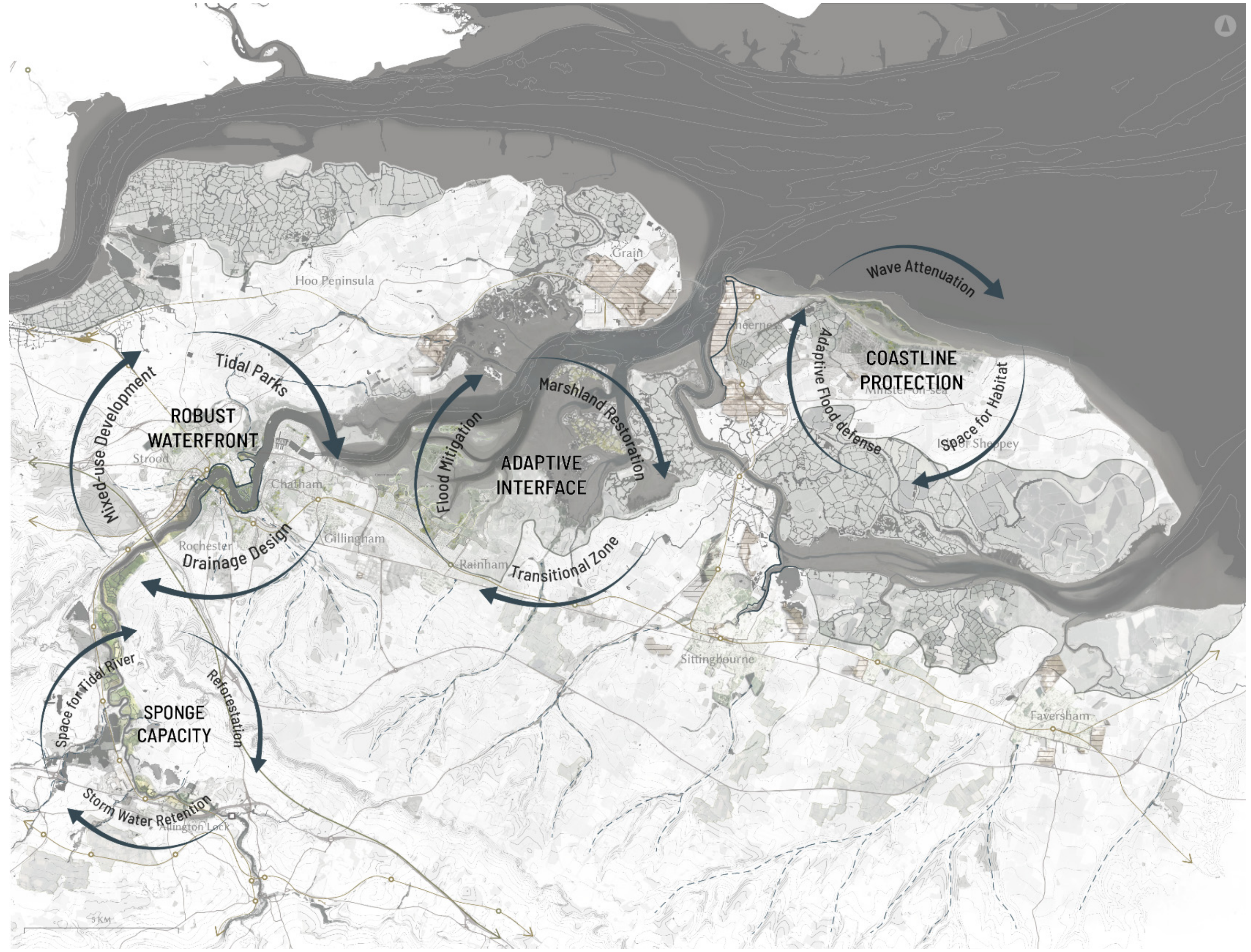


Initial guidelines for implementation

FLOOD MITIGATION STRATEGY



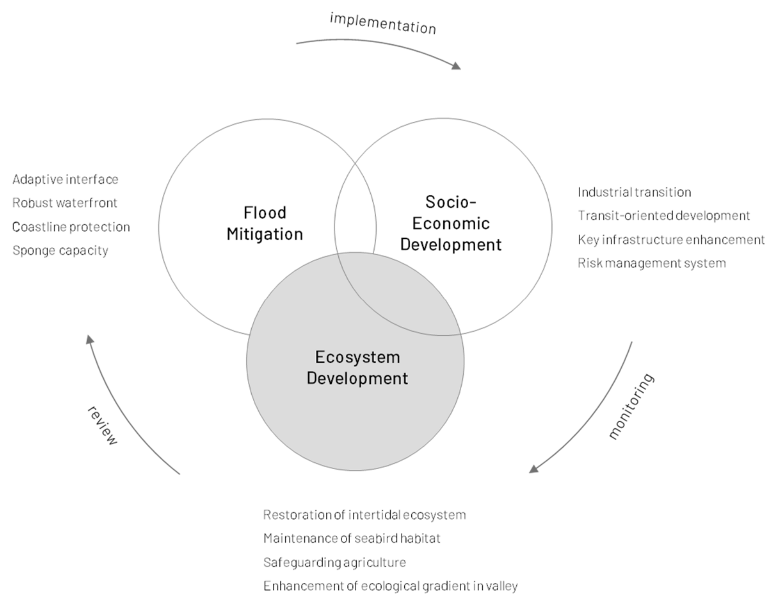
	phase 1: 2021-2030	phase 2: 2030-2070	phase 3: 2070-2100
coastline protection			
robust waterfront			
adaptive interface			
sponge capacity			



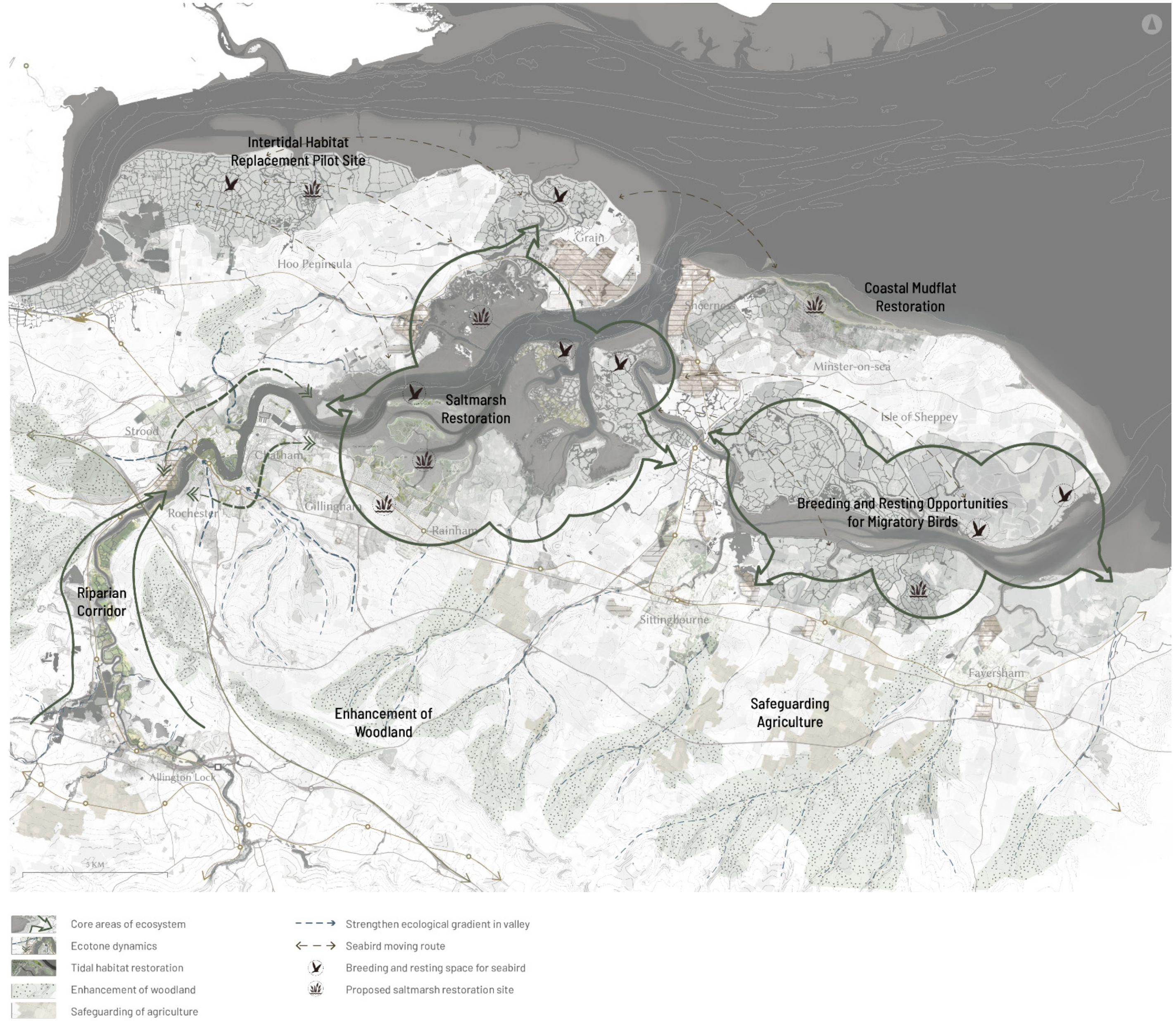
Adaptive zone
Adaptive urban waterfront
Coastal protection
Space for tidal river
Search location for water retention site

Initial guidelines for implementation

ECOSYSTEM DEVELOPMENT

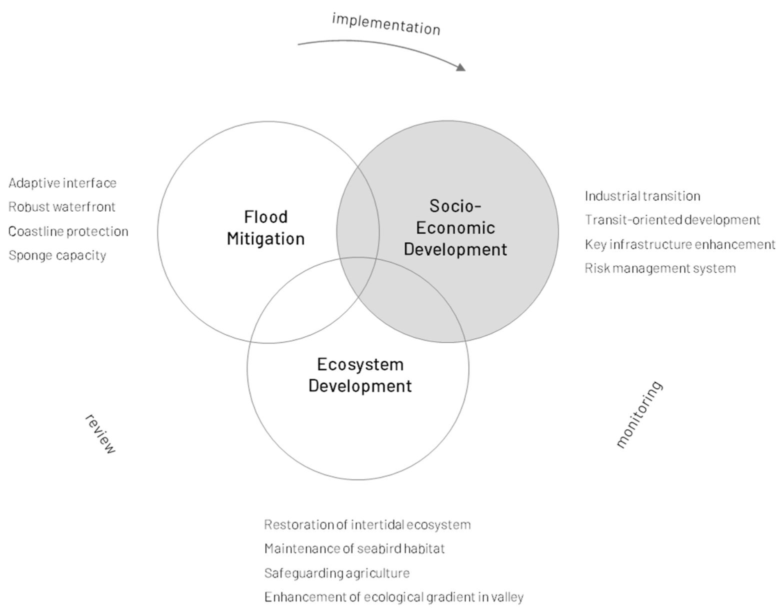


	phase 1: 2021-2030	phase 2: 2030-2070	phase 3: 2070-2100
intertidal habitat realignment and restoration of saltmarsh			
restoration of riparian corridor			
strengthen ecological gradient in the valley			
safeguarding agriculture			

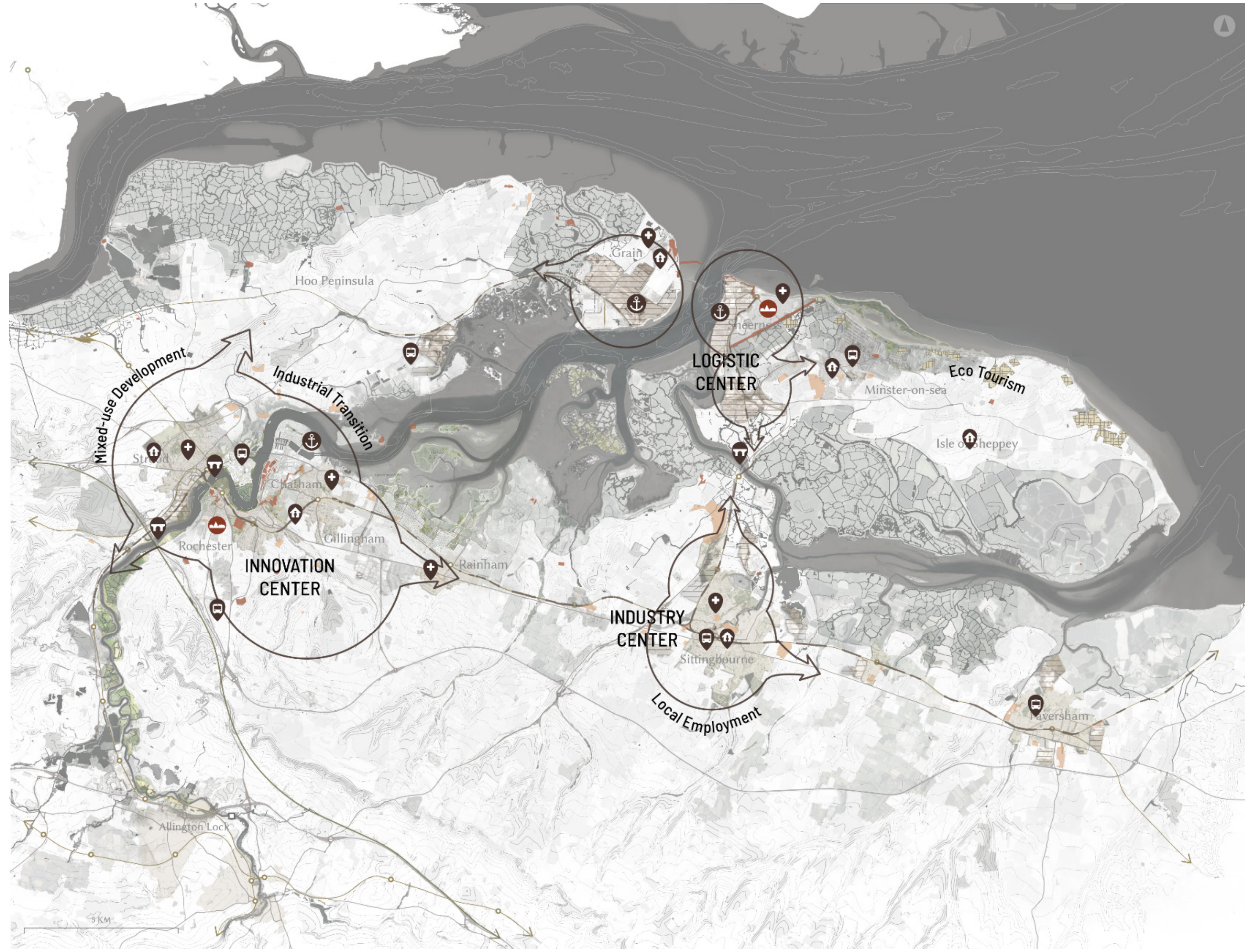


Initial guidelines for implementation

SOCIO-ECONOMIC DEVELOPMENT



	phase 1: 2021-2030	phase 2: 2030-2070	phase 3: 2070-2100
mixed-use or transit-oriented development			
employment allocation			
critical road network improvemt & public services provision			
disaster response plan	← — — — — — — — —		— — — — — — — — — — — — →



Mixed-use development
Transit-oriented development
Industrial transition
Housing allocation (Local Plan)
Holiday chalet site improvement
Heritage maintenance

Public service (shelter) provision
Public service (medical center) provision
Public transportation improvement
Critical infrastructure (bridge) maintenance
Critical infrastructure (railway) maintenance

PART 5

SYNTHESIS AND OUTLOOK

Resilient Medway River Landscape—
Adaptive Design Strategies for a
Sustainable Coastal Landscape

EMU Graduation
Yu-Wen Lin

OVERVIEW OF RESEARCH PROCESS

RESEARCH QUESTION

How does the socio-ecological -system of the Medway River Estuary function?

What design strategies and principles are suitable for flood mitigation and socio-ecological inclusive development?

How to apply the design strategies and principles in Medway River Estuary to increase its socio-ecological resilience?

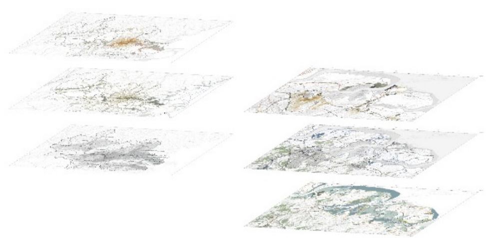
Chapter 3: Analysis

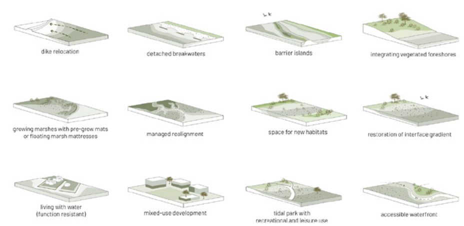
Chapter 4: Principles and strategies

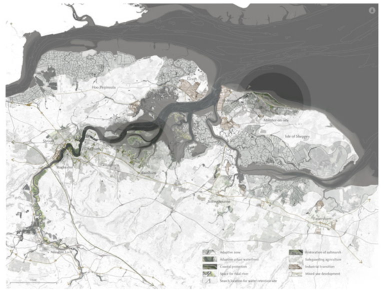
Chapter 5: Design application

Chapter 6: Regional scheme

RESEARCH OUTCOME







RESEARCH-DESIGN RELATION

Design research

- Regional scale analysis
  - Potentials & Challenges
  - Identify locations
- Local scale analysis
- Comparative analysis
  - Precedent study
  - Generate knowledge
- Develop principles and strategies

Research-by-design

Transform generic knowledge to specific knowledge

- Experimental design study
  - Site-specific analysis
  - Apply design principles
  - Explore and test different design proposals in local scale sites

Revised principles

Conclude the study outcome in regional scheme

Synthesis and outlook

LESSONS LEARNED — STUDY OF THE NATURAL PROCESS

1. Learned principles from the natural formative process.

2. Study of the natural formative process inform the designer of design decisions.

- Example: Rainham site
  - Potential locations for saltmarsh restoration: understanding of the formative elements of landscape, i.e. bathymetry, tidal range
  - To identify which locations are above the sea level at a certain percentage of the time in a year and are suitable for plants to grow.
- Example: Rainham site & Medway site
  - The analysis of surface water flow leads to the design decision of the form of dike relocation.
- Example: Sheppey site
  - Understanding of coastal zones: shoreline, foreshore, breaker zone, littoral zone.
  - Study of the type of flood defense infrastructures.

2. Natural dynamics would determine the final design results.

- Example: Sheppey site
  - The shape of the barrier islands may differ from what is drawn in the plan.
  - It is a system designed by the designer, but nature will continue working on it.
  - Adaptive management mechanisms, such as the mud motor, are also needed to increase coastal resilience decades later.

LESSONS LEARNED — ROLE OF URBAN DESIGNER

Motivation

There is a need for developing new design strategies mitigating flooding risks under the uncertainties of climate change.

Lesson (1)
The new approach is the integration of landscape and urbanism expertise.

- Working through multiscale.
- Dealing with wicked development issues.
- Planning and designing public spaces and public domain.
- Methodology: landscape-based approach + design-research.

Lesson (2)
Design as a powerful mean to get a grip of complex challenges.

- Spatial planning and design are inseparable from politics. These characteristics make us sensitive to the change of our living environment and the ever-changing social context and environmental urgencies.
- Design as a powerful instrument to explore possible solutions.

THANK YOU

Resilient Medway River Landscape—
Adaptive Design Strategies for a Sustainable Coastal Landscape

The European Post-master in Urbanism
Yu-Wen Lin

linyuwendy@gmail.com
linyuwen.urbanist@gmail.com