COLOPHON

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REVERSE TO REBOOT
URBAN Landscape INFRASTRUCTURE DESIGN BASED ON CARRYING CAPACITY OF LANDSCAPE STRUCTURE
TOWARDS A NEW URBANIZATION LOGIC
ACKNOWLEDGMENT

These incredible ten months have witnessed my growth and a big jump as an urbanist.

I have a lot of people to thank for this incredible journey and would like to start with my mentors.

I would like to thank both my mentors Taneha Kuzniecow Bacchin and Fransje Hoomeijer for their patience, constant guidance, critical and amazing insights. Taneha encouraged and pushed me to get out of my comfort zone to explore the new urbanization logic, bringing me the courage and enthusiasm in my graduation project, also supported me with amazing and innovative advice and ideas. Fransje gave me great support in the area of subsurface and water management, and gave me comfort when I was so stressed. And a special thanks to Hamed Khosravi and Filippo laFleur for their support and help within these ten months.

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J. Chen
# INTRODUCTION

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During the group research and the observation in the field trip, my motivation of this study is stimulated by upcoming climate change related hydrological threat happening in the North Sea context. The threat consists of two aspects.

Firstly, according to the North Sea Region Climate Change Assessment (Quante et al., 2016) and group research, in the context of climate change happening in the North Sea, the speed of SLR (sea level rise) has been faster and faster during the last five decades. Besides, the speed of SLR is various in different locations, since there are main three reasons causing the sea level rise, the thermal expansion of the oceans (about 1mm per year), melting of mountain glaciers around the world (about 1mm per year) and the retreat of the world’s polar ice-sheets (about 0.7mm per year). In general, the SLR around the Denmark coastline is the fastest, then goes Germany, UK and the Netherlands. Furthermore, when the high speed of SLR meets the lower terrain, the salt water intrusion will happen, especially in the estuary area, therefore, the coast of the Thames Estuary in UK, the Elbe Estuary in Germany, the Varder Estuary in Denmark are the vulnerable areas which will suffer from salt water intrusion (See Fig.0-1) (Lowe et al., 2005) Considering different locations and other affected elements, projection models of SLR have different results. In the group research, we compared four projection models which predict the sea level rise in the next 100 years, to 2100. And the most high-end model is from Nicholls and Cazenave (2010), which has the extreme value of SLR, 180cm. If there are no sea-defend facilities, half of the Netherlands, the north of Germany, West Denmark as well as south-east UK will be flooded, most of human settlements there will be involved in this process (Quante et al., 2016). (See Fig.0-2)

Secondly, trends in annual land precipitation are positive almost everywhere over the North Sea region for the period 1951–2012. The map of projective precipitation (Figure 0-3) shows that the greatest increase in precipitation is observed in winter especially along the west coast of Norway, over southern Sweden, parts of Scotland, England, Netherlands and Belgium. Therefore, in the short-term period, influenced by the record or extremely heavy rainfall, the coastal areas around the North Sea, especially the estuary areas, tend to face with a higher possibility of surface water flood and fluvial flood.

Considering the change of sea level rise and precipitation in the North Sea Area, the coastline in this context may has a huge change in 100 years later, see Figure 0-4, the coastal areas in south-east UK, west NL, DE and DK may be flooded in the future without human interventions. However, due to the uncertainty of the future change, these areas between the existing coastline and the projective coastline also have great potentials in the future if systematically applying appropriate resilient and adaptive interventions in these areas. Furthermore, these areas also can be a kind of interface, between the North Sea and inlands, between the human system and the natural system, to enhance the ecological services and reboot the further social and economic development at the same time.

Base on the Group Research, considering the diversity of coastal types and geological typologies, I would like to choose the Thames Estuary area in the southeast UK as the next step of exploration of my graduation project.
0.1 THE NORTH SEA CONTEXT

Fig. 0.1
Source: Made by author, based on the data from Lowe and Gregory (2005).

Fig. 0.2
0.1 THE NORTH SEA CONTEXT

0.1 THE NORTH SEA CONTEXT

Fig. 0-4
Source: Made by author, based on the group research.
Considering the diversity of coastal types and geological typologies, and the dynamics in the North Sea context, I will zoom into Thames Estuary Area in the southeast UK to formulate my motivation and further the problem field of this graduation project.
0.2 THE THAMES ESTUARY CONTEXT

Overview of Flood Area in Thames Estuary Area

Then we zoom into the Thames Estuary Area to have an overview of the flood situation in this context. The Fig. 0-6 shows the flood locations are mainly located in the lower estuary area, and most of the middle and upper estuary areas are benefits from the flood defences as the map showing. Furthermore, in the lower estuary, comparing the north coast and the south coast, we can see that, although the south part has a large flooded area, but the main settlements still benefit from the flood defences. However, the north lower estuary area are totally without protection and exposed to the up coming hydrological threats.

Density of Population in Thames Estuary Area

When it comes to the soil sealing degree of Thames Estuary Area, according to the research under the EU CORINE programme, over 220km² of the UK's land surface was transformed from farmland, forests or wetlands to urban development in just six years up to 2012, and the speed is still accelerating. (European Environment Agency, 2016) Furthermore, considering the high degree of soil sealing in the Thames Estuary Area (Figure 0-7), the sealed land condition will exacerbate the impact of flood (especially the pluvial flood), which causing the worse loss of property and life. The Figure 0-7 clearly shows the distribution of soil sealing degree, except the Great London Area, Southend in the north bank and the Medway UA in the south bank of lower estuary has significant high degree of soil sealing, which means once flood occurs in the north bank, the inefficiency of surface permeability will exacerbate the effects of the floods.

Degree of Soil Sealing

Besides, the high degree of soil sealing will also block the various natural processes which happen in the soil, and also block the paths for wildlife.

When it comes to the soil sealing degree of Thames Estuary Area, according to the research under the EU CORINE programme, over 220km² of the UK's land surface was transformed from farmland, forests or wetlands to urban development in just six years up to 2012, and the speed is still accelerating. (European Environment Agency, 2016) Furthermore, considering the high degree of soil sealing in the Thames Estuary Area (Figure 0-7), the sealed land condition will exacerbate the impact of flood (especially the pluvial flood), which causing the worse loss of property and life. The Figure 0-7 clearly shows the distribution of soil sealing degree, except the Great London Area, Southend in the north bank and the Medway UA in the south bank of lower estuary has significant high degree of soil sealing, which means once flood occurs in the north bank, the inefficiency of surface permeability will exacerbate the effects of the floods.

Density of Population in Thames Estuary Area

Besides, the Thames Estuary Area is one of the areas which have the highest population density. As for the population density distribution in Thames Estuary, the Fig.0-8 shows that the London area has the highest population density in this context, the density is over 100,000 per hectare. Except the London City, the population density of authority units around the river sides is over the average value. When we zoom into the lower estuary areas that have high flood risk, it is clear that the council of Southend-On-Sea has the highest population density, and is even twice the density of the second highest population density, which means the north bank of lower estuary may have more loss when the flood event occurs. The location of flood, soil sealing degree and the population density stimulates my motivation of the graduation project and also influences the geographical location choice of this project.

Degree of Soil Sealing
According to the former context description and my personal interest, the site for this graduation project must meet several conditions, based on these conditions, I choose the following scales in this graduation project (Fig. 0-9).

### COLLECTIVE EFFECT OF RIVER AND SEA
1. The site should be located in the estuary area where is affected by both river water and sea water.

### HYDROLOGICAL THREATS
3. The site should have several hydrological threats.

### HIGH DENSITY CITY
2. The site should have high density of population and high degree of soil sealing.

### LIMITED SPACE & WEAK ECOLOGY SERVICE
4. The landscape infrastructure in the site should be weak and the open space should be limited.

The project will start with the geographic context which is the North Sea, Anglian River Basin and Thames River Basin. As the former analysis and context description shows, in the context of North Sea, I continued the group exploration, and how the dynamics of hydrology system specifically influence the Thames Estuary and what kinds of opportunities and threats come from the sedimentation process and sea level rise.

Then the macro scale is the Thames Estuary, in this scale, on the one hand, the flood location overview, population density and degree of soil sealing were analysed in the former part to help to define the motivation and location choice. On the other hand, the Thames Gateway Project and South Essex Green Grid Project in this scale also help to analyse the social-economic requirements from the regional level and define the new roles and functions, then develop the problem field and problem statement.

The meso scale will come to the Southend-On-Sea. In this scale, the integrated analysis of social, economic and ecological conditions will be the focus. The urban landscape infrastructure will be discussed in this scale as a territorial strategy, and explore the possibilities to enhance the performance and functions of landscape infrastructure in the context of climate change.

The micro and nano scale is the catchment unit and neighborhoods inside, these scales will be the site for urban design and test how to integrate the requirements from environmental, social and economic aspects, and explore the new approaches for the urban design in the high-density area under the climate change related hydrological issues.

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### 0.4 MOTIVATION OF THE STUDY

Inspired by the group research and the context exploration, my motivation of this graduation project is gradually formulated. In the context of the North Sea and Thames Estuary, we know that in the future, the settlements, which are located in the coastal area, are facing with the hydrological upcoming threats from the sea and inland (coastal, fluvial and pluvial flood). However, in the process of socio-economic development, the natural landscape had been sealed and transformed into the solid artificial land. Besides, in the site I choose in this project, where is high density, space is limited, while ecological services had been weakened severely. In this context, there are huge challenges in the future, due to the old development process. Based on this basic contextual information, I would like to explore the possibility of resilient and adaptive design approach in the high density areas, to explore the planning and design approach to reverse the sealed artificial land into a porous surface which also create new social cohesions to support the development. That is, Reverse to Reboot.

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*Ian L. McHarg*
1 PROJECT FIELD: FROM MACRO TO MESO SCALE

1.1 PROBLEM FIELD (MACRO SCALE ANALYSIS)
1.2 PROBLEM STATEMENT
1.3 RESEARCH QUESTION
1.4 HYPOTHESIS AND OBJECTIVES
1.5 THEORETICAL FRAMEWORK
1.6 METHODOLOGY FRAMEWORK
1.7 RELEVANCE
1.8 TIME-WORKING SCHEDULE
1.1 PROBLEM FIELD

1.1.1 The Urbanization Process of Southend in Thames Estuary

To understand the urbanization process of Southend in Thames Estuary Context, I made the 3x3x3 analysis in Thames Estuary scale (the macro scale), see Fig.1-1,2,3,4. In the macro scale, the it is clear that, the rapid expansion and boosting of Southend during the early twentieth century benefited from the good transport connections with London. When we review more closely at Southend’s history, we can see that Southend originally was a small village if Prittlewell, where people make a living from fishing and agriculture. In the 1790s, when the landowner sold off the land, and the Grand Hotel and Grove Terrace were built, at that time, the development of Southend was slow because the connection between the Southend and London depends on the stage-coaches. Until the 19th century, the railways connected to Southend, the process of soil and land sealing was accelerating to support the construction projects in Southend, which turned Southend into a tourist attraction and a dormitory town for city workers ever since. From the 1960s onwards, due to the single residential function and tourism, Southend started to decline. However, around 6.5 million tourists still come to Southend each year. In the recent decade, the latest round of opportunities for development and transformation is coming. Southend faces challenges at the crossroads of transformation. The single function and limited space and the fragile ecosystem performance have become the major obstacles. (See Fig 1-1)

In the overview of the urban growth of Southend, we can simply conclude the urbanization paradigm in the past (especially in the rapid development period, 1850s to 1960s). The basic logic behind this process can be illustrated as Fig 1-2 shows. The economic driver leads the land selling, and further stimulates the occupation of the land and transport infrastructure, and the improvement of infrastructure will further exacerbate the occupation of the land. The result behind this process is the erosion and fragmentation of the landscape, from Fig.1-3, we can see, in the rapid development period of Southend, the quantitative changes of occupation, infrastructure and landscape.
1.1 PROBLEM FIELD
1.1.1 The Urbanization Process of Southend in Thames Estuary

![Maps showing urbanization process from 1900 to 2017](image)

**Legend**
- Sea Water
- Saltmarsh
- Fresh Water
- Forest
- Farmland and Artificial Greenland
- Grass
- Main Roads (1900)
- Roads (1900)
- Railways
- Motorway
- Primary Road
- B Roads
- A Roads
- Urban Areas
- Suburban Areas

Source: Made by author, based on the information from Digimap, online maps and spatial data of Great Britain.
1.1 PROBLEM FIELD

1.1.1 The Urbanization Process of Southend in Thames Estuary

Summary: It is time to reverse the old urbanization paradigm.

From the former analysis, we can see that, from the 19th century, the natural landscape had been controlled by the human in favour of socio-economic growth. The causal relation among the land consumption, urban sprawl and soil sealing in the Thames Estuary Area has become clearer. Regions and cities were controlled by railway, highway and energy infrastructure, and the natural landscape had been transformed into the urban occupation.

Obviously, this type of human-centred, socio-economic oriented development paradigm mentioned above had achieved remarkable success in geopolitics and economy. However, the soil surface, as a complex combination of abiotic and biotic elements, is an essential system regulating the sophisticated interactions among the hydrosphere, lithosphere and atmosphere, this development process had also disrupted numerous natural processes happening in the natural system, more seriously, ecosystem services related to the hydrology have been depleted gradually. (Pileri 2013) When it comes to climate change, the situation has been worse. Due to the sea level rise and extreme precipitation events caused by climate change, Thames Estuary and Southend will face with more serious hydrological threats and hazards, like tidal flood and pluvial flood.

We can see, from 60s of twentieth century, the views, which are exclusively human-centred, started to be widely challenged, the rethinking of nature and human also request the shift of the urban development logic, from human-centred, socio-economic oriented one to nature-come-first, sustainable one. In this context, it is high time to shift the social-economic urbanization paradigm to the sustainable development paradigm.

Regional Regeneration Project: Thames Gateway

Upcoming Pressure from Regional Development

The aim of Thames Gateway project has two aspects, one is to boost the economy of the whole Thames estuary region, including London, Kent and Essex through the development of marshland, farmland and brownfield; another one is to relieve the massive housing and job demand and pressure in London by regenerating town centres and building new towns from scratch, complete with new business space, shops, schools, parks and transport links (Fig.1-5). However, considering the given projections of sea level rise (Quante et al., 2016), building so many homes and facilities, which are so close to the Thames Estuary, causes people’s concern. Furthermore, the wider environmental impact on water supplies, the transport infrastructure and the scarce natural resources.

Under this regional development context, Southend (short for Southend-On-Sea) is transforming from seaside resort into a cultural and economic center of the Thames Gateway. Until 2012, the new college campus brings 20,000 students to Southend, the shopping center, conference center and etc. are being redeveloped. Besides, the student community, the leisure complex and 1,650 additional homes are planned. All these projects and plannings pose a huge pressure on Southend. It means more land will be sealed for the happening development.

1.1.2 Pressure of Social/Economic Reboot

Regional Regeneration Project: Thames Gateway

Upcoming Pressure from Regional Development

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1.1 PROBLEM FIELD

1.1.3 Environmental Pressure

Short-term but Urgent Issue: Pluvial Flood

Influenced by the record or extremely heavy rainfall as well as the insufficient surface-water run-off system, the northwest part and the whole southern part of the Southend-on-Sea repeatedly suffered from pluvial floods (Fig.1-6). The surface-water flooding is usually associated with short duration, high intensity rainfall that is unable to soak into the ground and/or enter drainage systems. It can quickly run off land and result in localised flooding, besides, two-thirds of the widespread flooding experienced in July 2007 was the result of surface water runoff in urban areas. (Southend-on-Sea BC SFRA, 2010)

Long-term Process: Sea Level Rise + Coastal Flood

Considering the long term climate change, in the context of upcoming sea level rise process, the speed of Thames Estuary area has been faster and faster, and whose rising speed is one of the three fastest speed of SLR in the North Sea (Howard et al., 2014). Besides, there are four locations around the coastline of Southend suffering the coastal flood, see Fig.1-6. If the extreme SLR (1.8m) projection model (Lowe and Gregory, 2005) for yr2100 become a reality, the tidal flood (coastal flood) hazard will be more serious than expected in the long term. For long term sustainable development, it is urgent to prepare and introduce sea-defend interventions or pose the focus on the coastline adaptive design.

Summary

In the long-term, the Southend-On-Sea will face the threat of sea level rise, which also influences the coastal flood, although the process is slow, but long-term strategies are necessary. The pluvial flood in the extreme raining event is the hydrological urgent issue in Southend-On-Sea, which is related to the weak nature performance of landscape infrastructure, the insufficient urban drainage system and the degree of soil sealing. The fluvial flood in Southend is not an urgent issue yet. On account of these upcoming environmental pressure, the landscape infrastructure needs to be upgraded to enhance the performance in the extreme weather events. However, considering the mudflat and the beach is increasing because of the collective effect of river and sea. It can be an opportunity for future interventions. (See Fig. 1-7-8)
1.1 PROBLEM FIELD

1.1.4 Summary: The Limitation and Possibility of Southend-On-Sea

Side Effect of Old Urbanization Paradigm

According to the development process of Thames Estuary and Southend, in the 20th century, Southend benefits from high-speed land sealing and urban development and became a tourist attraction. However, the excessive erosion of the landscape has caused a series of ecological issues, especially related to the hydrological threats. Southend is already the largest town in the Essex area so far, with a large population of 163,377. In a such high-density urban area, the space is already limited, upcoming projects even gradually erode the limited green space for adaptation, the conflict between the social-economic development and hydrologically related environmental issue is gradually forming. Recently, in the context of regional regeneration, under the huge pressure from region, if continuing the old logic of urbanization paradigm, all the expected construction projects will be sealing more land, though the degree of soil sealing in the Southern is already high, which already has a negative impact on the ecology services, and exacerbates the hydrological threats, making Southend in dilemma. A systematic approach is needed to reverse the artificial sealed ground into relatively porous surface to retrofit the ecological performance and to support the urban regeneration.

Actions and Possibility: South Essex Green Grid Project

In such context, the Southend also began to take action to review the balance between the landscape and the urbanization development. South Essex Green Project emphasize the possibility of functional urban landscape infrastructure to reverse the old urbanization paradigm and the possibility of rebooting the local transformation (see Fig. 1-9, 10).

This project is to meet the expectations of a high quality, functional green space network throughout the Thames Gateway, and is to achieve a living system threading through the urban and rural landscape, connecting places that area attractive to people, wildlife and business, and providing clean air, water, energy, minerals and materials. And this project emphasizes the landscape at the heart of the development process and environmental process at the heart of sustainable development and economy. It also points out the importance of environmental infrastructure that protects, enhances and creates new areas of outstanding landscape, riverscape and townscape character; and also make full use of environmental infrastructure to manage flood risk and ameliorate the effects of the effects of climate change (Thames Gateway South Essex Green Grid, 2005).

1.2 PROBLEM STATEMENT

The human-centred, socio-economic oriented development paradigm in during the last two centuries had turned Southend-On-Sea into a high-density town, with a high degree of soil sealing, and suffered from climate-change related hydrological threats. In the short-term, the extremely heavy rainfall and insufficient surface-water run-off system exacerbate the pluvial flood risk in Southend. In the long-term, the extreme SLR (1.8m) projection model (Lowe and Gregory, 2005), reveals that tidal flood will be more serious in the next 100 years. It is high time to shift the social-economic urbanization paradigm to the sustainable development paradigm.

However, the regional regeneration project, Thames Gateway, aims at transforming Southend into a cultural and economic centre, with adding new infrastructure and large construction projects which means more land will be sealed. The pressure from regional development poses a negative impact on the ecology services, and exacerbates the hydrological threats.

At this crossroad of transformation, the space in Southend is already limited, upcoming projects even gradually erode the limited green space for adaptation. It is urgent to reverse the artificial sealed ground into relatively porous surface to achieve flood risk management and to create the new social-economic cohesion at the same time. (See Fig. 1-11)
1.3 RESEARCH QUESTION

Main Research Questions

How to systematically design urban landscape infrastructure and urban programmes based on the carrying capacity of the landscape structure?

Sub-Research Questions

1. Environmental Issue
   N1: What is the carrying capacity of the landscape structure?
   N2: How to systematically design the urban landscape infrastructure as territorial strategy based on carrying capacity of landscape structure?
   N3: What are the characteristics of current rainwater and pluvial flood management and strategies?
   N4: How does the current landscape infrastructure perform when facing environmental threats?

2. Social-Economic Regeneration in Southend
   R1: What kinds of social-economic development requirements are Southend-On-Sea asked to respond?
   R2: What kinds of urban programmes are happening in the Southend?
   R3: What are the local demands of urban regeneration process in Southend?

3. How to systematically design urban landscape infrastructure and urban programmes based on carrying capacity of landscape structure?

4. How to achieve the synergy of territorial urban landscape infrastructure and local urban programmes?

5. What is the new urbanization logic based on carrying capacity of landscape structure?

Operational Questions

S1: What is the carrying capacity of the landscape structure?
S2: How to systematically design the urban landscape infrastructure as territorial strategy based on carrying capacity of landscape structure?
S3: How to regulate the urban programmes imbeded in the urban landscape infrastructure matrix based on carrying capacity?
S4: How does the current landscape infrastructure perform when facing environmental threats?
S5: What is the new urbanization logic based on carrying capacity of landscape structure?

Hypothesis

In the large scale, the urban landscape infrastructure will be the territorial strategy, as the 'networks - the space of flows'.

In relatively smaller scale, as a significant component of urban landscape infrastructure, the urban programmes will be the 'nodes - the space of places'.

The synergy of these two systems helps to provide micro climate regulation, flood risk management and new social cohesion, and finally to shift urbanization process into a sustainable development paradigm.

Relation of Problem Statement, Research Question, and Hypothesis

Fig. 1-12

Source: Made by author.
1.4 HYPOTHESIS AND OBJECTIVES

Hypothesis

In the large scale, the urban landscape infrastructure will be the territorial strategy, as the ‘networks: the space of flows’;

In relatively smaller scale, as a significant component of urban landscape infrastructure, the urban programmes will be the ‘nodes: the space of places’;

The synergy of these two systems helps to provide micro climate regulation, flood risk management and new social cohesion, and finally to shift urbanization process into a sustainable development paradigm. (See Fig. 1-13)

Objectives

The general objectives of this project are discussing the possibility of shifting the social-economic oriented urbanization paradigm into sustainable development paradigm; and to explore the multi-scalar approach to reverse the artificial sealed ground into relatively porous surface. Specifically, it is that: (see the projective image, Fig. 1-14)

- To provide micro climate regulation and flood risk management by applying urban landscape infrastructure;
- To achieve new social cohesion by applying urban programmes based on carrying and performative capacity of the landscape structure, so as towards a new urbanization logic based on the carrying capacity of the landscape structure.
1.5 THEORETICAL FRAMEWORK

Complexity of Economic, Ecological and Social Systems

To understand the complexity of economic, ecological and social systems, it is necessary to introduce the term Panarchy first. Panarchy is a term used to describe the hierarchical structure in the combined systems of nature, humans and social-ecological systems. Besides, in this complex hierarchical structure, the combined systems are interlinked in a ceaseless adaptive cycles of growth, accumulation, restructuring, and renewal. (Holling, 2001) In such self-organization systems, uncertainty and structural changes should be accepted since these are inevitable. It is worth emphasizing that, the dynamics and pattern of these systems should be observed in spatial-temporal context, for example, \(3 \times 3 \times 3\) layer analysis, which integrate three physical layers of landscape, infrastructure and built-up environment, in the temporal dimension and in three geographical scales. Through the spatial-temporal approach, the complexity between human system and nature system, and the logic and change of urbanisation can be systematically reviewed and predicted. (Meyer and Nijhuis, 2015)

Another widely accepted model related to the complexity of human and nature system is the Abiotic, Biotic and Cultural (ABC) resource model. (Ahern, 2007) This resource model has the consistent perspectives with landscape ecology theory, and reveals the process of human needs and interactions with the abiotic and biotic systems. Compared with single purpose policy and planning, this multipurpose and multifunctional resource model supports the key paradigms of sustainable principles, which are easier accepted and supported by the public. Above perspectives, also articulate the key of applying urban landscape infrastructure successfully is to combine the key ecological functions and cultural functions through time and across scales. (Ahern, 2007)

Resilience Theory and Adaptive Management

Resilience as a concept visualises the dynamics of nature caused by disturbances and change. Thus, nature is not in "balance", but constant change. Holling (1973, 1978) defined resilience as the ability of an ecosystem to absorb disturbances, renew itself and continue within a specific state. Since the resilience concept explains that ecosystems have many different alternative stable states, management within this framework has come to focus on how to tip points may be avoided. One approach on management based on the resilience concept is called adaptive management (Holling 1976; Gunderson et al. 1995). In this context, uncertainty must be accepted and that management of natural resources should use the change as a strategy rather than just responding to it. (Barthel et al., 2013) When different aspects of social-ecological systems interact, the resilience will be built. Learning about the external and internal environment leads to improved ability to self-organise in response to such environments. Change is a disturbance that creates conditions for greater diversity. (Folke et al., 2003) It shows the necessity to define the change and diversity of these environments. To adapt to the change and uncertainty of climate change, there are several design components of social-ecological systems need to be focused, that is, green arteries, active ground and performative buildings. (Barthel et al., 2013)

Urban Ecology

Cities are hybrid phenomena, which are not the simple combination of the human system and the ecological system. (Alberti, 2008) The theory of urban ecology is also a hybrid between urban and ecological theory, and explains the mechanisms of behaviour of urban ecosystems. In other words, urban ecology is the study of the interactions between human and ecological processes in urban ecosystems, and explores how these interactions make human and ecological patterns emerge. (Alberti, 2008) The patterns mentioned above means the information of vital underlying processes and structures in urban ecosystems. The integrated model to understand the patterns is the pattern-oriented modelling, POM, which requires to observe patterns through scales and testing the hypothesis of urban ecosystems. (Grimm et al., 2005) Therefore, to analyse the basic patterns like structure and functioning of patches and mosaics through the time and scales is the theoretical tool to understand the interactions between human and ecological systems.

Besides, in such adaptive and nonlinear systems, the existing landscape patterns can only be explained through the existing changes and driving force. Chance events happening locally and regionally reinforce most of the changes in such adaptive systems. (Alberti, 2008) That is, the analysis of local and regional change events through time is also important for the explanation and projections of the further impacts and development in these systems. Again, the spatial-temporal approach mentioned above- \(3 \times 3 \times 3\) layer analysis- is the essential tool to build connections between the historical/existing events and projective changes/patterns and dynamics in urban ecosystems.

Hydrological threats in Urban Ecology

Urban ecosystems provide vital ecological services for urban resident as well as other creatures. (Ahern, 2014) The urban development modifies the natural water resources like rivers and streams, which will also change the volume and delivery of surface runoff in the precipitation process. The sealed surfaces, such as parking lots, roads stop the infiltration process, which will increase the amount and speed of runoff. Once the artificial drainage system cannot support the capacity of water conveyance, the flood will happen in the urbanized watersheds. That is why the floods are larger, and the peak flows are more often in the urban ecosystems. Therefore, several elements of urban systems should be highlighted-the rate of change in hydrology conditions, frequency and timing of the stream flows, run-off volume. (Alberti, 2008) Furthermore, the size and location of the patterns of urban ecosystems. The integrated model to understand the patterns is the pattern-oriented modelling, POM, which requires to observe patterns through scales and testing the hypothesis of urban ecosystems. (Grimm et al., 2005) Therefore, to analyse the basic patterns like structure and functioning of patches and mosaics through the time and scales is the theoretical tool to understand the interactions between human and ecological systems.

Hydrological threats in Urban Ecology (Conceptual Section)

Source: Made by author.

[Fig. 1-15]
1.5 THEORETICAL FRAMEWORK

Landscape Ecology

From 1950 to 1980, due to the development of aerial photography, the term, landscape ecology was first used to describe the specific spatial pattern of landscape, and in this phase, the landscape ecology was simply the ecology of regions. (Dramstad et al., 1996) Then the “land mosaic” phase arrived since 1980, when landscape ecology began to emerge as an integrative discipline, including habitat fragmentation, corridors and connectivity, quantitative methodology, heterogeneity and boundaries and so on. During this phase, one of the typical and universal model of landscape ecology from Richard Forman-Landscape Mosaic Model-defined the basic elements of landscape ecology: patch, corridor and matrix. (Forman, 1995)

A patch is a relatively homogeneous area which is not a linear area, and is different from its surroundings. Patches should be analyzed according to their size, number and location, which will tell whether the patches are beneficial or harmful to the functioning of the landscape. (Ahern, 2007) Patches are connected by corridors, a kind of linear land cover type that differs from its context, like a river, canals. (Forman, 1995) The corridor provides landscape connectivity to alleviate the isolation and fragmentation, especially for species movement. (Dramstad et al., 1994) Besides, river and stream systems are also important corridors in the landscape, and the ecological quality of this corridor directly determines the ecological performance in the context of climate-change related hydrological threats. Therefore, the corridor should be analyzed in term of connectivity, width and typology—such as barrier, stepping stones, corridors. (Forman, 1995) The last basic element is the matrix, which is the dominant land type in its context. Matrix has a high degree of connectivity and continuity, with high dynamics in its landscape context. (Forman, 1995) Table 1-1 shows examples of urban landscape elements classified in Land Mosaic Models.

The characteristics of landscape ecology are well defined in three main parts: structure, function and change. The structure of landscape ecology means the spatial pattern of landscape element mentioned above. Functioning is happening through the structure, representing the movement of fauna and flora, flows of water, energy and information communications. When these facilities become multi-functional and integrate technical, aesthetic and social values, these systems, as urban landscape infrastructure, can create conditions for future urban development, and changes for new public space as a transit landscape. (Nijhuis and Jauslin, 2015) The second field is a set of systematic green space networks which maintain the ecosystem values and create social-economic benefits. The land mosaic concept mentioned above is a great example to guide the design process, and to create an interconnected system formed from patches, corridors and matrices. The green landscape infrastructure is important for increasing the run-off capacity in the built environment. The last type is related to the water, and is about coastal and river management (Nijhuis and Jauslin, 2015). When it is in the context of climate-change related hydrological threats, the design focus of this field will be flood control systems and the urban drainage system.

Networks: Urban Landscape Infrastructure as Territorial Strategy

Urban landscape infrastructure is a new approach, as a territorial strategy, to secure the provisioning of ecosystem services in human-dominated landscapes, and performance as structurally system in urban ecosystems towards the future development. (Colding, 2011) This implies that urban landscape infrastructure design is a construction process of landscape itself to create conditions for the future, not a process of adding constructions in landscape. (Nijhuis and Jauslin, 2015) As a kind of spatial design, the design of urban landscape infrastructure emphasizes several characteristics, such as multi-functionality, integration and connectivity, strategies through time, and interdisciplinary design process (Nijhuis and Jauslin, 2015). And the multi-functionality can be identified and assessed according to the ecosystem services which should be maintained or enhanced in urban landscape infrastructure. Besides, the design of urban landscape infrastructure is also about achieving the purpose of providing urban ecosystem services while respecting societal needs and values. (Ahern et al., 2014) Therefore, urban landscape infrastructure can contribute to a more integrative approach towards a new urbanization paradigm where social, economic and ecological systems are inseparably intertwined. (Bacchin et al., 2014)

There are three typical potential fields-transport, green and water landscape infrastructures. (Nijhuis and Jauslin, 2015) The first field consists of diverse modes of facilities related to transportation, energy supply, waste treatment and information communications. When these facilities become multi-functional and integrate technical, aesthetic and social values, these systems, as urban landscape infrastructure, can create conditions for future urban development, and changes for new public space as a transit landscape. (Nijhuis and Jauslin, 2015) The second field is a set of systematic green space networks which maintain the ecosystem values and create social-economic benefits. The land mosaic concept mentioned above is a great example to guide the design process, and to create an interconnected system formed from patches, corridors and matrices. The green landscape infrastructure is important for increasing the run-off capacity in the built environment. The last type is related to the water, and is about coastal and river management (Nijhuis and Jauslin, 2015). When it is in the context of climate-change related hydrological threats, the design focus of this field will be flood control systems and the urban drainage system.

Table 1-1 Examples of Urban Landscape Elements Classified in Land Mosaic Model (Ahern, 2007)

<table>
<thead>
<tr>
<th>Patches</th>
<th>Corridors</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parks</td>
<td>Canals</td>
<td>Residential</td>
</tr>
<tr>
<td>Wetlands</td>
<td>Drainages</td>
<td>Neighbourhoods</td>
</tr>
<tr>
<td>Gardens</td>
<td>Riverways</td>
<td>Industrial Districts</td>
</tr>
<tr>
<td>Campuses</td>
<td>Roads</td>
<td>Waste Deposition Areas</td>
</tr>
<tr>
<td>Parking Lots</td>
<td>Powerlines</td>
<td>Commercial Areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mixed-Use Districts</td>
</tr>
</tbody>
</table>

"Networks" and "Locations"

Urban ecosystems are also a combination of networks and locations through scales and hierarchies. (Nijhuis and Jauslin, 2015) Networks can understand as ‘space of flows’, which provide physical structure for connections, interactions and communications. Similarly, locations can be regarded as the ‘space of places’, which is the result synthesis of interactions. (Castells, 2011) Therefore, towards the design approach for shifting urbanization logic, I will introduce this section in two parts for the networks and locations. In relatively larger scale, urban landscape infrastructure design, as a kind of ‘space of flows’, can be a territorial strategy. In relatively smaller scale, as a significant component of urban landscape infrastructure, the urban programmes based on carrying capacity of the landscape structure can be introduced as the ‘space of places’.

Locations: Urban Programmes based on Carrying Capacity

‘Locations’ are also involved in ‘networks’, that is urban landscape infrastructure also organises the space of places. (Nijhuis and Jauslin, 2015) Therefore, this part will briefly review 2 examples to introduce some classic principle for urban programmes based on carrying capacity.

The first classic example is The Valley Section from Patrick Geddes, which implies taking the whole region to make the city. The valley section, as a complex model, combines physical conditions with natural/basic occupations and human settlements considering the geological and geomorphological context. Secondly, another classic example comes from the book Design with Nature by Ian McHarg about the systematic layer approach. A basic methodology for overlapping layers to conclude the geomorphological characteristics of the context as tool to evaluate whether the urban programme is appropriate in its geographical context considering the carrying capacity. This book also provided some classic criteria to evaluate the constraints from the natural system and also the potential impact and synergy from urban landscape development. These systematic criteria consist of layers of climate, geology, physiography, hydrology, pedology, vegetation, wildlife and land use, and then evaluate the potential value of the land use, that is, evaluate urban programmes based on carrying capacity. (McHarg, 1969)
1.5 THEORETICAL FRAMEWORK

SuDS: Source-Pathway-Receptor Conceptual Model

In the context of climate-change-related hydrological threats, the design focus of this field will be flood control systems and the urban drainage system. In the UK, a good example is SuDS-sustainable drainage systems—which has several stages to achieve storm water management. Firstly, it is the source control and infiltration, which help to decrease the volume of water flowing into the river or drainage network, such as the forest patches/corridors in the upstream to soak the source. The second stage is the pre-treatment and conveyance, which mean the drainage and bioswale system to purify the water and quickly discharge to water courses and aquifers. The last stage is storage, which means the stormwater detention and retention, such as parking lots and ponds providing storage. This case well implies how the design of urban landscape infrastructure performs across scales as a territorial strategy. (Bacchin, 2015)

The Source-Pathway-Receptor Conceptual Model is the key idea of Sustainable Drainage System. This model describes the conceptual mechanism of flooding. There are three parts in the flood event; the source of the flood, the receptor to flood, and the pathways linking the source and the receptor. Possible flood alleviation measures are different in different parts, the focus on the source is to reduce flows, the focus of pathways is to manage overland, and the focus of receptor is to improve the flood resilience.

Specifically, source measures aim to reduce the rate and volume of surface water runoff through infiltration or storage, so as to reduce the impact on the local drainage network. As for the pathway, its measures intend to manage the water runoff through infiltration or storage, so as to reduce the impact on the environment. And the receptor measures seek to reduce the impact of flooding to those that are affected (people, properties, and the environment.) (See Fig. 1-16)

Compact City and Sprawl as Strategy

Compact city theory and the open system are two different understandings about the urbanization area. The compact city is an urban planning or design concept, promoting relatively high residential density with mixed land uses (Dempsey, 2010). And the compact city has three main principles, high-density development, mixed land uses, and priority of public transport development.

Sprawl as strategy is based on the Howard T. Odum’s concept of open systems ecologies. Odum helped to redefine the urbanization area as an open and fluid system—more complex, more nuanced and more flexible—in which decentralization operates as a response to the predominant challenges like migration, climate change, energy economies, and resource flows (Belanger, 2013). As we discuss above about the new understanding of landscape as infrastructure, and infrastructure as landscape. The sprawl strategy could also apply on the landscape system, which also contributes to the more complex and flexible urban areas. (See Fig 1-17)

Time-Based Approach

The time-based approach is concluded from the case study of Freshkill Park by Yames Corner. The brilliance of time-based approach is that it offers the way to manage the intensive difficulties of size, scope and complexity and timing which the project presents. Time is required for the existing sealed artificial ground to become sustainable and porous for natural processes to occur. The time-based approach is the only way to get anything done. (Corner, 2014) Time is necessary for the site to evolve, for plants to grow, the soil to build up, for the site to become more diverse through time and elaborate in terms of recreation and social cohesion. Also, the long process also makes it possible to have sufficient funding to undertake the transformation to complete the project. The transformation as a patchwork series of programmes that could be completed through periods of intermittent funding but as a whole project. (Corner, 2014) Therefore, the final product maybe a master plan that is less a completed vision for the project than a plan to manage the complexity of the task through a long timeframe. Therefore, I make a summary diagram as Fig.1-18 shows. The process of time-based approach has four stages, seeding and infrastructuring, programming and adaptation. Seeding means the analysis of potential functions in the landscape and also means imbedding the micro-ecosystems in the built-up areas. The next stage is to infrastructure, to explore the urban infrastructure as territorial strategy to build up the networks for the flow of natural and human system. Then, there are a series of urban programmes based on carrying capacity as well as the process of adjusting and systematization. Finally, the aim is to achieve the adaptation and preparation for the future.
1.5 THEORETICAL FRAMEWORK

Conclusion

According to the theoretical review and discussion above, the logic of urbanization has been shifting since cities should be understood as complex economic, ecological and social systems. The old urbanization paradigm, which is social-economic target oriented, is not valid anymore, considering the upcoming challenge of human and natural development in the context of climate change. Urban ecosystems, as complex systems, should be analysed through time and across scales to understand the dynamics and patterns in such systems. The theory of urban ecology and landscape ecology specifically elaborates the theoretical tools, like POM model and Land Mosaic model to decode the information in urban ecosystems and understand the interactions and dynamics between the built environment and landscape. In this stage, it also points out that the key of successful design for urban ecosystems is to combine the essential ecological functions and cultural functions through time and across scales. (Ahern, 2007) The concept of urban landscape infrastructure is a practical example to apply design in urban ecosystems to enhance the ecological services and provide social cohesion at the same time. Besides, the design of urban landscape infrastructure emphasizes the ‘space of flows’ and the ‘space of places’, which means the integration of the transport, green, blue landscape infrastructure and urban programmes based on carrying capacity of the landscape structure. The practical deployment of urban landscape infrastructure also implies that the single purpose/discipline constructions and projects cannot fit the shifting urbanization logic anymore, a more flexible and interdisciplinary spatial intervention for interrelating systems is increasingly essential in this shift. (Nijhuis and Jauslin, 2015) This concept also brings difficulties and challenges to policy making, since the fixed policy and strategy are doomed to fail in this condition. The practical deployment of urban landscape infrastructure also implies that the single purpose/discipline constructions and projects cannot fit the shifting urbanization logic anymore, a more flexible and interdisciplinary spatial intervention for interrelating systems is increasingly essential in this shift. (Nijhuis and Jauslin, 2015) This concept also brings difficulties and challenges to policy making, since the fixed policy and strategy are doomed to fail in this context of dynamics. It is time for human to embrace the uncertainty and unpredictability, and enjoys the dynamics in such complex urban ecosystem.

1.6 METHODOLOGY FRAMEWORK

The methodology framework diagram below illustrates the research process as well as a methodology framework of this project. Each section and unit have its specific method, and respond to specific sub research questions.

The project will start with the North Sea as the geographical context, we have group research on this scale. In this part, the sea-level-rise projection and precipitation projection is analysed by using GIS. Then I will zoom into the Thames Estuary, as the macro scale, to define the flood situation, degree of soil sealing and population density distribution, the main method is mapping, policy reading and GIS. Based on the analysis above, I address my motivation and scale definition of the project. This part mainly answers the operational questions-N,R.

Still in the macro scale, Thames Estuary, 3x3x3 approach will be used to illustrate the urbanization process of Southend in the context of Thames Estuary, from the policy document and mapping, I define the social-economic pressure and hydrological threats of Southend in the macro scale context. The green grid project is also explained as opportunities and action. This part will address the whole project field, including problem statement, research question, hypothesis and theoretical framework, which will contribute to answer the operational questions-N,R. The main method of this part is mapping, 3x3x3 approach, policy reading, and literature review.

Then the project will zoom into the meso scale, Southend. The analytical framework and the definition of the carrying capacity of the landscape structure are the focus of this part. To achieve that, the first step is to define what is the carrying capacity of the landscape structure. Based on Design with Nature by Ian McHarg, the evaluation of carrying capacity is separated into 6 aspects-topography, geology, hydrology, vegetation, wildlife and land use. This is the process of understanding and learning from the landscape, making decisions based on characteristics of the landscape. Then to design the urban landscape infrastructure matrix, reserving the structure for natural process. And this matrix is a composite of a green graph and a blue graph, according to the soil unit typologies and contour analysis. As further exploration of soil units, we will discuss how to regulate the urban programmes based on the landscape carrying capacity. The first part is a general principle for urbanization gradients, which is the parameters of density to control the form. The next step to regulate the urban programmes is to decide which functions can be added into urban form according to the land use suitability. This part will answer sub-research questions-S1, S2, S3.

The design process is based on the comparison between the principles and guidance from the carrying capacity and the existing conditions of the urban structure. To achieve synergy of territorial urban landscape infrastructure and local urban programmes, the main approach is to integrate the input of the research and the strategic interventions, to decompose systems and evaluate the performance, to express the stories through the images of stages. This is the way to explain the synergy of systems, and to elaborate the relation between the research and design in my project. Finally, my image collections show a short journey traveling from the inland to the coastal areas and spatial experience across five stages according to different stage settings of landscape and urbanization gradients, to express the concept of interweaving the lives of citizens and wildlife. This part will answer the sub-research question S4.

The last part is the conclusion and reflection of the whole project, which will conclude the new urbanization logic based on the carrying capacity of the landscape structure, and explore the possibility of extension, which is to answer the sub research question S5.
1.6 METHODOLOGY FRAMEWORK

Fig. 1-20 Methodology Framework

Source: Made by author.
1.7 RELEVANCE

1.7.1 Societal Relevance

Climate Change and Hydrological Hazard

Climate change has become the an increasingly urgent issue during the last several decades, and most of the specific climate-change related phenomenon is hydrological issue, like sea level rise and flood. Among them, urban pluvial flooding is one of the principal hazards in modern towns and cities. This type of flooding often leads to major economic losses and devastating social and environmental impacts. Take UK for example, pluvial flood risk accounts for about 1/3 of flood risk in UK, approximately 2 million people in UK urban areas are exposed to an annual pluvial flood risk of 0.5 percent or greater (1-in-200 year event). Furthermore, there will be another 1.2 million people in urban areas who could be affected by 2050 due to a combination of climate-change and population growth (Houston, 2011). As for the economic impact, in 2014, overall estimated damages of floods in UK were £1.3 billion, which includes both damages incurred by flooding and water-related erosion. (DEFRA, 2016) To be worse, there is obvious uncertainty about projected changes to rainfall and of course flood hazard, especially for pluvial flood, because it is usually caused by short but very intense precipitation which is difficult to capture in climate models, and these kinds of extreme events will increase and become frequent due to the climate change. The research and design related to the pluvial flood and climate change becomes more and more urgent (Houston 2011). In this context, this project aims at introducing the hybrid infrastructure to enhance the performance before the pluvial flood and also provide a possible preparation for sea level rise. This project will contribute to an interdisciplinary approach incorporating engineering, natural sciences and social sciences, and also help to have a deeper understanding of social vulnerability to flood risk. Besides, explorations and conclusions in this project could introduce a combination of avoiding the highest risk locations, better landscape and urban area, and also maintenance of ecology service. This project will contribute to further understanding and approach to the regeneration in high-density areas, where demand for residential and commercial property is high and also where the enhancement of ecology service is urgent.

Sustainable Development in High-Density Areas

Limited land has become a common issue in high-density, because the further urban development means the higher degree of soil sealing, that means the depletion of ecology service. Therefore, a compact but sustainable city can be an option. Urbanist must aim at developing land more compactly to create sustainable living environments for the future. On the one hand, the land use mix is important for a sustainable compact city. A King County, Washington, study found that areas with low land use mix generate 14 percent more carbon dioxide per person than do areas with high land use mix (Miller, 2011). The compact structure also could free some land for protection of limited green space and also maintenance of ecology service. This project will contribute to further understanding and approach to the regeneration in high-density areas, where demand for residential and commercial property is high and also where the enhancement of ecology service is urgent.

1.7.2 Scientific Relevance

The Practical Attemptation of Urban Landscape Infrastructure Theory

From the theoretical framework above, we know that, although the concept of landscape infrastructure has begun to transit the understanding of relation between urban infrastructure and landscape, and also has been applying in the planning and design in reality. However, there is still little research and approach to explain and guide how to apply in high-density area where is lack of resource of landscape, especially for though urban areas where is over-constructed and has limited space to the structure of landscape infrastructure system in the city. Thus, this project is kind of initial exploration of this academic area. Besides, this project also discusses about the integration of urban landscape infrastructure and urban regeneration programmes based on carrying capacity, which is a relatively new challenge to explore the systematic approach to reverse the sealed ground into sustainable porous surface with social functions. The extension value of this project is to explore the possibility of applying this systematic approach to other cities and area.

The motivation of Graduation Studio Choice

The Delta Intervention research group states: “research programme...investigates the possibilities to combine flood protection and water management strategies with urban design, landscape design and spatial planning, aiming at improving spatial forms and structures in urban and metropolitan delta regions...to make urban delta landscapes more sustainable, attractive and adaptive.” This nearly sums my intention of working with resilient design approach that can preserve the balance between the landscape and urbanized area, and enhance the system when facing the extreme climate change. From this group, I can deepen my understanding of the relation between the landscape and urban area.

The delta area is one of the most dynamic hybrid area (with natural and artificial characteristics and processes). However, one the one hand, the climate change and uncertainty of natural disaster poses the risk on the delta (especially in the transition area between the land and water), on the other hand, the requirements from economic and social development also need to be materialized in the spatial environment. Uncertainty always be there on the two sides, to make full use of an extreme situation and scenarios and to customize flexible and resilient design is the aim of this possible thesis. Therefore, I believe this studio fits perfectly with the original purpose of my research.

1.8 TIME-WORKING SCHEDULE

The motivation of Graduation Studio Choice

The Delta Intervention research group states: “research programme...investigates the possibilities to combine flood protection and water management strategies with urban design, landscape design and spatial planning, aiming at improving spatial forms and structures in urban and metropolitan delta regions...to make urban delta landscapes more sustainable, attractive and adaptive.” This nearly sums my intention of working with resilient design approach that can preserve the balance between the landscape and urbanized area, and enhance the system when facing the extreme climate change. From this group, I can deepen my understanding of the relation between the landscape and urban area.

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MESO SCALE ANALYSIS: SOUTHEND

2.1 URBAN GROWTH OF SOUTHEND
2.2 3X3X3 ANALYSIS
2.3 TOPOGRAPHIC CHARACTERISTICS
2.4 GEOLOGICAL CONDITIONS
2.5 HYDROLOGICAL THREATS
2.6 VEGETATION CONDITIONS
2.7 LIMITS FROM ECOSYSTEM AND HERITAGES
2.8 SOCIAL-ECONOMIC CHARACTERISTICS
2.9 SYNTHESIS OF DIAGNOSE
2.1 URBAN GROWTH OF SOUTHEND

Overall, the rapid expansion of Southend comes from the two railways connections and the London Road (A13) and the A127. The development of infrastructure not only has stimulated the urban growth, but also greatly changed the urban functions of Southend. We can see, from the collage, that Southend originally was a small village if Prittlewell, where people make a living from fishing and agriculture. In the 1790s, when the landowner sold off the land, and the Grand Hotel and Grove Terrace were built, at that time, the development of Southend was slow because the connection between the Southend and London depends on the stage-coaches. Until the 19th century, the railways connected to Southend, the process of soil and land sealing was accelerating to support the construction projects in Southend, which turned Southend into a tourist attraction and a dormitory town for city workers ever since. From the 1960s onwards, due to the single residential function and tourism, Southend started to decline. However, around 6.5 million tourists still come to Southend each year. In the recent decade, the new round of opportunities for development and transformation is coming. Southend faces challenges at the crossroads of transformation. The single function and limited space and the fragile ecosystem performance have become the major obstacles. (Fig. 2-1)

In the meso scale, Southend, I choose the time of 1900, 1990 and 2017 to analyse the temporal-spatial process and dynamics of Southend’s development because the urban expansion during this period is the most fast. The Fig.2-2 shows the matrix of the layers of the landscape, infrastructure and occupation in three different time. Generally, from the layers of the landscape, we can see how the landscape was eroded by the urban growth. In 1900, the landscape around the Southend was quite continuous as a whole, the surface was dominated by natural vegetation like grassland and forest, among them, the most surface is grassland, followed by forests and arable land. By 1990, the landscape layer had become clearly fragmented, in this process, the area of natural vegetation, especially the grassland, has dropped dramatically, and was transformed into infrastructure and occupation layers. By 2017, the landscape layer has been further eroded, even has affected the room for the River Roach system on the northeast Southend. The only expansion of the landscape system occurred in marshland to the south.

As for the evolution of Infrastructure and occupation layer, the former section already has a detailed explanation. Here will not repeat it. But in general, the coastal area has almost completely occupied by these two layers. Continuous landscape changes from inland to the coast have been completely broken. The erosion of landscape in the northwest also directly led to the lack of room for river, the crowded built-up area around the seafront made the city exposed to the sea without buffer area, and the soil sealing in the occupation layer caused more frequent surface water flood.
2.2 3X3X3 ANALYSIS

Source: Made by author, based on the information from Digimap, online maps and spatial data of Great Britain.
2.3 TOPOGRAPHIC CHARACTERISTICS
2.3.1 TPI: Topographic Position Index

From the TPI and land use analysis, we can see that most of urbanized areas are located in the ridge, upper slope and middle slope area where with firm soil condition and less hydrological threats. However, in the lower slope and the flat slope with low elevation height, the land use basically is for green land, woodland or arable and horticultural use, usually these places work as flood plains to adapt to the flood risk. From the perspective of the relation between topography, soil conditions and current land use, the current urbanization is largely adapted to the characteristics of the landscape structure in general. However, the comprehensive conclusion of urbanization logic based on landscape structure still needs to combine several factors from other aspects which will be discussed in the following sessions. (Fig. 2-3, 4)

2.3.2 Current Land Use and TPI

The meso scale, Southend-On-Sea is located in the watershed between Roach River system in the north and Thames River system in the south, the high contour analysis comes from the GIS data, shows elevation conditions from high to low (from dark, 50m to light, 0m), and also the relation of the terrain as well as the river system, which will contribute the Blue Gragh in the next chapter. From the ridge line we can also tell the topographic characteristic of Southend is high in northwest while low in southeast, high in the middle while low in the south and north. (Fig. 2-5)

2.3.3 High Contour Analysis
2.4 GEOLOGICAL CONDITIONS
2.4.1 Geological Layers and Sections

Before the analysis of flood risk locations, it is necessary to understand the geological conditions of Southend first. The geological conditions map shows the locations of different superficial and bedrock deposits in Southend. Firstly, it is noteworthy that there are 5 locations with tidal flat deposits as superficial geology, Two Tree Island, the corner of Ridgeway, Southchurch Park, Gunners Park and the land near the Pig’s Bay, which mean these four places may suffer from tidal flood. Besides, affected by the tide, the surface soil of these 5 places have a high degree of salinity, which will influence the plantation plan, and surface water management in the strategic design. Secondly, the middle and east of Southend have river terrace deposits because these parts are located in the middle stream and downstream, and the deposits come from the river erosion in the upstream, which is located in the west Southend. The uncovered bedrock, London clay, in the west Southend, also can explain it. (Fig. 2-6)

In order to understand the basic terrain, a set of geological cross sections is shown above. These sections show the elevation based on Ordnance Datum as well as the groundwater level. We can see that, the elevation of Southend is high in the west and low in the east. From north to south Southend, it is high in the middle part, while lower in the north and south. As for the groundwater level, the water level is usually between the London Clay layer and river terrace deposits (sand and grave) layer, which means the place where have uncovered bedrock may have risk from high level of ground water, such as Marine Estate in the west of Southend. (Fig. 2-7)
2.4 GEOLOGICAL CONDITIONS
2.4.2 Permeability Capacity

Then the second part of hydrological threats is permeability capacity. Based on three layers of geological characteristics, the permeability capacity is integrated from the permeability of mass movement and artificial ground, superficial deposits, and the bedrock. The Fig. 2-8 shows the layer systems.

Based on the layer analysis on the left, the Fig. 2-9 shows the conclusion of permeability capacity in Southend. It is clear that the northwest, north and east part of Southend has really low permeability. According to green patches analysis above, we can see that the green patches in Southend is mainly located in areas where the geological layers have low capacity of permeability, which will alleviate the negative impact of permeability. Although the permeability in the middle of Southend is good, the surfaces are sealed by artificial ground, which will also exacerbate the risk of surface water flood. Therefore, for the highlight areas, the landscape infrastructure should be applied to connect the green patches to enhance the performance of the infiltration process. In the middle area, the sealed land should be transformed into the porous surface and the conveyance of surface water should be guaranteed.
2.4 GEOLOGICAL CONDITIONS

2.4.3 Summary of Soil Types

Based on the analysis of geological conditions, there are six typologies of soil units in Southend. (Fig. 2-10)

1. London Clay (Bed Rock)
2. Head (Clay, Silt, Sand) + River Terrace (Sand, Gravel) + London Clay (Bed Rock)
3. River Terrace (Sand, Gravel) + London Clay (Bed Rock)
4. River Terrace (Silt, Clay) + River Terrace (Sand, Gravel) + London Clay (Bed Rock)
5. Tidal Flat Deposits (Clay, Silt) + London Clay (Bed Rock)
6. Beach Sand + Tidal Flat Deposits (Clay, Silt) + London Clay (Bed Rock)

Based on the former analysis, the following aspects will be assessed for each typology of soil units to define the characteristics of soil units. Each Aspects are divided into five levels from low to high. (Fig. 2-11)

**Soil Strength:** the characteristic of firmness and capacity of carrying

**Capacity of Permeability:** the characteristic of infiltration capacity

**Nutrition for Biodiversity:** the nutrition that can sustain the amount of biodiversity

**Continuity:** the continuous form or the patchy form
2.5 HYDROLOGICAL THREATS
2.5.1 Coastal Flood

Tide Pattern Study

Coastal flood occurs in areas that lie on the coast of a sea, ocean, or other large body of open water. It is the result of extreme tidal conditions caused by severe weather. To define the risk of coastal flood, it is necessary to study the tide pattern, Fig. 2-9. I collected all the high and low tide data, and adjust the data to the Ordance datun chart, which makes it easy to analyze the high and low water on the map, from the tide pattern diagram, we know that, despite the small number of appearances, there are three or four times per year when the high water is higher than 3 m. And the high water is between 1.5m and 3.2m, and the average high water is 2.29m. Although the esplanade of Southend works as sea wall, but there are still several places in the coastal area whose elevation is lower than 3m, once the saltwater flow across the sea wall, sea water will stay inland. (Fig 2-12)

Coastal Flood Locations

To define the locations of coastal flood, I project the mean high and low water line in the map. Combining contour data and the tide data, I find out there are four locations may suffer coastal flood, the corner of Ridgeway, Southchurch Park, Gunners Park and the land near the Pig’s Bay. Among them, area B, the Gunners park benefits from the flood bund, and the area D is totally a buffer area for coastal flood storage. The risk of coastal flood is a little higher in the area A and C. (See Fig. 2-13)
2.5 HYDROLOGICAL THREATS
2.5.1 Coastal Flood

To define the risk level of coastal flood risk, I zoom into four locations which may suffer coastal flood. The area A is Southchurch Park, because of the esplanade as sea wall, the mean high water is overlapping with the shape of esplanade, the elevation of the sea wall is about 4 m, and the record of the high water is 3.2 m. Therefore, the sea water invasion will not happen under normal circumstances. However, considering the sea level rise, in the long term, the highlight area, whose elevation is 2-3 m, should prepare the treatment and management of salt water.

Area B is the corner of Ridgeway. In this location, the topography of the coast is relatively high. The impact from the tide is relatively small.

Area C is the Gunners Park, which is protected by the flood bund. However, the whole park works as the buffer area for the sea water. Recently, the residential construction project will be built in the locations with black texture on the map. According to the analysis of coastal flood risk, this project will not recommend to continue. The size and the function of the buffer area should be guaranteed.

Area D itself is a buffer area, and works well, besides, since the place is a military site, just keep the status quo.

In general, the impact of coastal flood is not urgent in the short term, but in long term, the transformation of the esplanade and the reservation of the buffer area is necessary. We should transform the hard sea wall into soft barrier with social functions and also consider the plants plan for the salty wetland, and the relatively independent seawater treatment sewer system in this four locations.

Zoom into the Coastal flood locations

To define the risk level of coastal flood risk, I zoom into four locations which may suffer coastal flood. The area A is Southchurch Park, because of the esplanade as sea wall, the mean high water is overlapping with the shape of esplanade, the elevation of the sea wall is about 4 m, and the record of the high water is 3.2 m. Therefore, the sea water invasion will not happen under normal circumstances. However, considering the sea level rise, in the long term, the highlight area, whose elevation is 2-3 m, should prepare the treatment and management of salt water.

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2.5 HYDROLOGICAL THREATS
2.5.2 Fluvial Flood

Fluvial occurs when excessive rainfall or heavy snow melt or ice jams over an extended period of time causes a river to exceed its capacity. In Southend, the type of fluvial flood is the over hand flood, which occurs when water rises overflows over the edges of the brooks. The comparative analysis of hydrological and fluvial flood locations, see Fig. 2-15,16, reveals the reason behind the fluvial flood. From the map 2-17 we can see that, only the area around the Eastwood Brook has high risk of fluvial flood, the reason is the limited room for the river in the upstream. We can see, in the Fig 2-16, that inside the Southend, the brook flows across the built-up area, there is not space for the river store the overflowing water body, the the land in the upstream is almost sealed, the infiltration capacity of the land is limited. When the heavy rain events come, the additional water will pose pressure on the brook. From the map we can see that, the north part to the Southend has relative large land of forest and arable or horticultural land, which help to alleviate the fluvial flood in this area, and in the southwest part of Southend, the Prittle Brook flood relief culvert helps to decrease the water volume in the Prittle Brook. Therefore, the strategy for the fluvial flood in Southend should focus on the porous land in upstream and the fluvial corridor which will connect to the flood relief culvert to alleviate the risk of fluvial flood.
2.5 HYDROLOGICAL THREATS
2.5.3 Pluvial Flood

Pluvial flood locations

Pluvial flood, also known as surface water flooding, occurs when high intensity rainfall causes runoff which flows over the surface of the ground and accumulates in low lying areas. The presence of impermeable surfaces, saturated soil and insufficient capacity within the drainage network can further exacerbate surface water flooding. From the Fig. 2-18, we can see the locations and risk level of surface water flood in Southend. The fluvial flood in Southend usually happens in the area around the brooks. There are four levels of risk flood. The first level is high risk, which means the circumstance at risk of flooding for a rainfall event with a 3.3% (or greater) probability of occurrence in any given year (>3.3% AEP). The medium risk level is the risk of flooding for a rainfall event between a 3.3% and 1% probability of occurrence in any given year (3.3%-1% AEP). The low risk level is between a 1%-0.1% AEP, while the very low risk is less than a 0.1% AEP. (See Fig. 2-17)

2.5 HYDROLOGICAL THREATS
2.5.4 Summary: Define the Catchment Units

Identification of CDA, the sub-catchment unit

The Fig. 2-18 shows the synthesis of flood analysis, also define catchment units, CDAs. The CDA means the Critical Drainage Area, which is a discrete geographic area, usually a hydrological catchment, where multiple or interlinked sources of flood risk cause flooding during a severe rainfall event thereby affecting people, property or local infrastructure. In each CDA, has its upstream, middle stream and downstream areas as well as the influencing drainage system. The map also shows the directions of water flow in each catchments, which will help to build up the flood corridors and define the next scale of this project.
2.6 VEGETATION CONDITIONS

After the long process of urban expansion, the land cover pattern has formed as the Fig. 2-19 shows. In the administrative boundary of Southend, nearly 90% of the land use is urban and suburban area. In Southend, there are only sporadic green patches, which are grassland. The upstream of Roach River is also occupied by built-up areas. There are sporadic forest patches to the northwest of Southend, where is also the upstream of Roach River. In the middle stream and downstream, there are large arable and horticulture, land. The coastal deposits are mainly at the south and west coastal line. And there is also a large growing saltmarsh in the southern coastal area.
The Fig. 2-20 shows the nature reserves and the historical sites and heritages in Southend. Firstly, as for the nature reserves, all the nature reserves are almost located in the salt marsh in the coastal area, the foreshore of Southend is protected for nature conservation and includes the Foreshore Local Nature Reserve, which is the largest in England, and the Leigh National Nature Reserve at its western end. The foreshore has enormous international importance for wildlife, especially during the winter months when thousands of birds come to feed in the foreshore of Southend. Due to the special location at the mouth of the Thames Estuary, the foreshore is at the heart of the coastal area for wildlife stretching around the Essex coast and even the upstream in London. The area between the coastline and boundary of the local nature reserve, is the best site to build the attractive intertidal ecological corridors. Besides, there are also several scheduled ancient monument projects, and the ancient forests to the west Southend are also important sources for the history and social corridors which will contribute the reboot of local tourism and social cohesion.

2.7 LIMITS FROM ECOSYSTEM AND HERITAGES
2.7.1 Nature Reserves and Historic Values

To understand the negative impact of the occupation on the ecosystem, I analyse the habitat distribution of locally dominant species in land, the main key mammal species are hedgehog, fox and grey squirrel. From the Fig. 2-22, we can see that there a huge gap between the west and east wildlife habitats, which is located in the middle Stouthend, to the east of Southend city center. It is necessary to create the path to connect habitats by applying corridors between the habitats. (See Fig. 2-21)
The residential development is the predominant land use in Southend. The residential occupation has expanded as far as possible until constrained by the physical barriers, like seafront and greenbelt. The main public space and retail function are located at the seaward edge of the Borough, especially around the Southend and Leigh-on-Sea, and the London Road (A13). The significant area of industrial development is located at the Shoeburyness. The railways and main roads are well connected here. Recently, the new industrial site is located to the north of Southend with the connection from A127 (Arterial Road). And famous leisure functions are along the seafront. (Fig.2-22)

2.8 SOCIAL-ECONOMIC CHARACTERISTICS

2.8.1 Current Land Use

The Fig. 2-24 Shows the upcoming regeneration projects in Southend, the regeneration projects here have five aspects, the first one is the improvement of beach tourist attractions, including the urban renewal of the commercial seafront near to the city center, and the Shoebury common beach. The second aspect is the commercial/retail center renewal in the center and the shopping street along the London Road (A13), the local commercial centers in the Shoebury, Torpe Bay. The third one is the education center improvement in South Essex College, University of Essex, which are located in the city center, and also the Southend University Hospital located in the Prattleswell Chase. The next aspects are the transport improvements which focus on the A127, A13 and the whole coastal esplanade. The last one is the Airport Business Park around the London Southend Airport, the new attractions for office functions and tourism services. (Fig.2-23)
Based on the former analysis, the synthesis of diagnose shows 5 aspects and 11 maps. These 11 analysis maps, as important input, will include 15 evaluation elements in 5 aspects, to further help to define the carrying capacity of the landscape structure, and further support the following research and design in the next sections.
MESO SCALE OUTCOMES: SOUTHEND

3.1 RELATION BETWEEN MESO DIAGNOSE AND MESO-SCALE OUTCOMES
3.2 OUTCOME #1: LAND USE SUITABILITY
3.3 OUTCOME #2: GENERAL PRINCIPLES FOR URBANIZATION GRADIENTS
3.4 OUTCOME #3: LANDSCAPE INFRASTRUCTURE MATRIX
3.1 RELATION BETWEEN MESO DIAGNOSE AND MESO-SCALE OUTCOMES

There are 16 elements in total. The carrying capacity of the landscape will be defined by this analytical framework. Based on this framework, there are three key conclusions or outcomes in meso scale, the land use suitability comes from the synthesis of all the elements. The general principle for urbanization gradients is concluded from soil unit typologies. And the Landscape Infrastructure Matrix comes from the synthesis of soil unit typologies, contour and terrain analysis. The land use suitability is the guidance for land use, the general principle for urbanization gradient is the parameter of density, and the urban landscape infrastructure matrix is the meso scale structural design.

Source: Made by author.
### 3.2 OUTCOME #1: LAND USE SUITABILITY

#### 3.2.1 Diagnose: Criteria Form Of Landuse Suitability

<table>
<thead>
<tr>
<th>Factor</th>
<th>Ranking Criteria</th>
<th>Phenomena Rank</th>
<th>Value for Land Use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Topography</strong></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Slope/TPi</td>
<td></td>
<td>Ridge</td>
<td>Valley</td>
</tr>
<tr>
<td>Gradient: High&gt;Low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Geology</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Strength</td>
<td>High&gt;Min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>London Clay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Permeability Capacity</strong></td>
<td>High&gt;Min</td>
<td></td>
<td></td>
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<tr>
<td>Beach Tidal Flat Deposits</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Hydrology</strong></td>
<td>High&gt;Low</td>
<td></td>
<td></td>
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<tr>
<td>Coastal Flood Risk</td>
<td>High&gt;Low</td>
<td></td>
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<tr>
<td>Vulnerability</td>
<td></td>
<td></td>
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<tr>
<td>FLuvial Flood Risk</td>
<td>High&gt;Low</td>
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<tr>
<td>Vulnerability</td>
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<tr>
<td>Pluvial Flood Risk</td>
<td>High&gt;Low</td>
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<tr>
<td>Vulnerability</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Water Features of Scenic Value</td>
<td>High&gt;Low</td>
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<tr>
<td>Distinctive: High&gt;Low</td>
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<tr>
<td>Active Recreation</td>
<td>High&gt;Low</td>
<td></td>
<td></td>
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<tr>
<td>Expansive of Water: Large&gt;Small</td>
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<td>Sea</td>
<td>Southend Beach</td>
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<td>Shoebury Beach</td>
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<tr>
<td>Roach River</td>
<td>Pond</td>
<td></td>
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<tr>
<td>Brooks</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Vegetation</strong></td>
<td>High&gt;Low</td>
<td></td>
<td></td>
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<tr>
<td>Typologies of Green Patches</td>
<td>High&gt;Low</td>
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<td>Environmental Quality</td>
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<tr>
<td>Forest</td>
<td>Grassland</td>
<td></td>
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<tr>
<td>Arable and Horticultural Land</td>
<td>Urban Park</td>
<td></td>
<td></td>
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<tr>
<td>Golf Complex</td>
<td>Allotment</td>
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<tr>
<td>School Playing Field</td>
<td></td>
<td></td>
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<tr>
<td><strong>Wildlife</strong></td>
<td>High&gt;Low</td>
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<tr>
<td>Existing Habitats</td>
<td>High&gt;Low</td>
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<tr>
<td>Disconnectivity</td>
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<tr>
<td>Intertidal Zone</td>
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<tr>
<td>Ancient Forest</td>
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<tr>
<td>Grassland River/Brooks</td>
<td>Urban Park</td>
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<tr>
<td>Arable and Horticultural Land</td>
<td>Allotment</td>
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<td></td>
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<tr>
<td>School Playing Field</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Land Use</strong></td>
<td>High&gt;Low</td>
<td></td>
<td></td>
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<tr>
<td>Historical/Education Values</td>
<td>High&gt;Low</td>
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<td></td>
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<tr>
<td>Importance: Most=Least</td>
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<td></td>
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<tr>
<td>Ancient Forest</td>
<td>Scheduled Monument</td>
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<td>Scheduled Monument</td>
<td>Listed Buildings</td>
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<tr>
<td>Listed Buildings</td>
<td>Campus</td>
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<tr>
<td><strong>Potential Recreation Resources</strong></td>
<td>High&gt;Low</td>
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<tr>
<td>from Urban Regeneration Program</td>
<td>High&gt;Low</td>
<td></td>
<td></td>
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<tr>
<td>Availability: Most=Least</td>
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<td>Beach Tourist Attractions</td>
<td>Commercial/Retail Center</td>
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<tr>
<td>Commercial/Retail Center</td>
<td>Education/Cultural Center</td>
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<tr>
<td>Education/Cultural Center</td>
<td>Airport Business Park</td>
<td></td>
<td></td>
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<tr>
<td>Airport Business Park</td>
<td>Transport improvements</td>
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</tbody>
</table>

The criteria form of land use suitability draws on the criteria system from Process as Values in the book named Design with Nature by Ian McHarg. The main purpose of this evaluation form is to define the suitability of land use based on the landscape structure and characteristics. Due to the limitations of the data, the evaluation system has been slightly simplified on the basis of the original one. In this project, I choose six aspects to outline the landscape features, which are, topography, geology, hydrology, vegetation, wildlife, and land use.
3.2 OUTCOME #1: LAND USE SUITABILITY

3.2.2 Conservation Suitability

Based on the criteria of land use suitability, the basic five land use suitability maps for conservation, commercial/industrial development, residential development, active/passive recreation, are made by overlapping the multi-layers from the analytical framework. These five maps illustrate that the recommended location for each kind of land use functions, in general, the flood plain and the intertidal area in the northeast and south is suitable for conservation area, besides, several ancient forests in the west part of Soutend are also suitable for conservation zones. As for the urbanization development, the distribution of commercial/industrial/residential development is similar, almost located in the southwest inland, the same as the active recreation functions. As for the passive recreation land use has the similar distribution of conservation suitability. Overall, we can see that the southeast coastal areas are not suitable for intensive urbanization development, and the main high density of urbanization development should focus on the southwest inland. In fact, the next step is to take complementary pairs and reduce these maps to single maps, for examples, commercial-industrial and residential use can be incorporated into a single map of urban suitability, while active and passive recreation can also be combined into a single recreational suitability. Then three maps-conservation, recreation and urbanization, will be the basic elements to create the land use composite map as a final conclusion of land use suitability.

3.2.3 Commercial/Industrial Development Suitability

3.2.4 Residential Development Suitability

Conservation Suitability

Residential Development Suitability

Fig. 3-2

Source: Made by author, based on analysis above.

Fig. 3-3

Commercial/Industrial Development Suitability

Fig. 3-4

Source: Made by author, based on analysis above.
3.2 OUTCOME #1: LAND USE SUITABILITY

3.2.5 Passive Recreation Suitability

Passive Recreation Suitability
Fig. 3-5
Source: Made by author, based on analysis above.

3.2.6 Active Recreation Suitability

Active Recreation Suitability
Fig. 3-6
Source: Made by author, based on analysis above.

On the left, there are also some typical examples of passive and active recreation in Southend. As we know, a passive recreation area is generally an undeveloped space or environmentally sensitive area that requires minimal development. Emphasis is placed on preservation of wildlife and the environment. Take park as an example, passive park use refers to less structured recreational activities which require little or no specialized parkland development and management, and therefore can be provided at a low cost to communities. Generally, no motorized activity is allowed and trails are typically dirt or gravel. Typical passive recreation in Southend are like jogging, hiking, wildlife viewing, photography, fishing, rustic picnic and kite flying, etc.

On the other hand, the active recreation is generally any recreational activity that requires significant infrastructure for the purpose of active sports or organized events. It is about engaging in adventure sports or outdoor games. An active park refers to structured recreational activities which require specialized parkland development and management which may restrict general use of the parkland or facility. These kinds of recreation, such as team sports, typically involve intensive management, maintenance, and therefore higher costs, due to the need to provide substantial space to congregate. In Southend, the typical active recreations are sports fields, wonderlands, marinas, golf playing, skating, waterfront, meeting space, swimming and outdoor theater, etc. Besides, it is worth noting that the horse riding and the bicycling can belong to both passive or active recreation depending on the conditions.
3.2 OUTCOME #1: LAND USE SUITABILITY
3.2.6 Conclusion: Land Use Suitability Composite

Conclusion: Land Use Suitability Composite

Based on the former five basic map and their combination, the map of land use suitability composite is shown on the left. The map of land use suitability composite shows that the high-density urbanization development should be in the middle and western part of Southend, and the east part of town and the southeast coastal area should have low density development and also are suitable for conservation area. And this map also gives guidance of different levels for deferent kind of land uses. From the legend, we can see all kinds of suitability have four levels, from I (very suitable) to IV (totally not suitable). The conservation, urbanization and recreation suitability are the three basic pillars come from the analytical framework, then we can see the possible combination of conservation and passive recreation, the possible combination of urbanization and active recreation. Finally, when we overlap all the layer, we can see the grey color is for the urbanization land use, the dark blue color for the combination of urbanization and active recreation, the green means the combination of conservation and passive recreation land use, and the yellow means the conservation area.

Therefore, the map and the legend system show the first conclusion in the meso scale, which is the guidance of the land use suitability based on the landscape and social characteristics.
3.3 OUTCOME #2: GENERAL PRINCIPLES FOR URBANIZATION GRADIENTS
3.3.1 Relation between Soil Unit Typologies and Potential Green Elements

Table 3-2 Relation between Soil Unit Typologies and Potential Green Elements

<table>
<thead>
<tr>
<th>SOIL UNIT TYPOLOGIES</th>
<th>CONDITIONS FOR POTENTIAL GREEN ELEMENTS</th>
<th>ELEMENTS OF URBAN LANDSCAPE INFRASTRUCTURE MATRIX</th>
<th>HIGH DENSITY URBANIZATION DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOIL UNIT CHARACTERISTICS</strong></td>
<td><strong>Open Space Connections</strong></td>
<td><strong>Important Large Patches</strong></td>
<td><strong>Water Related Small Patches</strong></td>
</tr>
<tr>
<td></td>
<td>Regional Corridors</td>
<td>Vegetated Waterfront Corridors</td>
<td>Shopping Streets</td>
</tr>
<tr>
<td></td>
<td>Low Permeability + Close to Patchy Form</td>
<td>High Nutrition for Biodiversity + High Continuity</td>
<td>High Nutrition for Biodiversity</td>
</tr>
<tr>
<td>1 London Clay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Head R. T. D. (Sand, Gravel) London Clay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 R. T. D. (Sand, Gravel) London Clay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 T. F. D. (Clay, Silt) London Clay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Beach Sand T. F. D. (Clay, Silt) London Clay</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Made by author.
Conclusion 2 is mainly based on the characteristics of soil units, the matrix above shows the relation between the soil unit typologies and potential green elements of urban landscape infrastructure. The ranking criteria points out which soil units are suitable for which green elements, and the red texts in the matrix also explain the requirements for each kind of green element.

For example, the requirements of regional corridors are high nutrition for biodiversity and high continuity, the soil units type 3 and 6 are the best choice for a regional corridor. Similarly, type 3,6 is suitable for vegetated waterfront corridors. Type 2,5 is for the stepping stones. Type 2,5 is for regional parks as large patches. As for the water related small patches, type 2,4 is suitable for retention patches while type 2,3,6 is for infiltration patches. And type 1,4 is for high density urbanization development.

**Explanation of 3 Basic Density Variables**

**Building Intensity (FSI)**

FSI reflects the building intensity independently of the programmatic composition and is calculated as follows for all levels of scale. This index uses the unit m²/m². (Berghauser Pont and Haupt, 2010)

\[
FSI_x = \frac{F_x}{A_x} = \frac{\text{gross floor area (m²)}}{\text{area of aggregation x (m²)}} \times \text{aggregation (lot (l), island (i), fabric (f), or district (d))}
\]

**Coverage (GSI)**

GSI, or coverage, demonstrates the relationship between built and non-built space and is calculated as follows for all levels of scale. This index uses the unit m²/m². (Berghauser Pont and Haupt, 2010)

\[
GSI_x = \frac{B_x}{A_x} = \frac{\text{footprint (m²)}}{\text{area of aggregation x (m²)}} \times \text{aggregation (lot (l), island (i), fabric (f), or district (d))}
\]

**Spaciousness (OSR)**

The variable OSR, Spaciousness, is a measure of the amount of non-built space at ground level per square metre of gross floor area. This figure provides an indication of the pressure on non-built space. If more floor area is developed in an area (with the same footprint), the OSR decreases and the number of people who will use the non-built space increases. This index uses the unit m²/m². (Berghauser Pont and Haupt, 2010)

\[
OSR = \frac{1 - GSI_x}{FSI_x} \times \text{aggregation x}
\]
### 3.3 OUTCOME #2: GENERAL PRINCIPLES FOR URBANIZATION GRADIENTS

#### 3.3.2 Relation between Soil Unit Typologies and Urbanization Gradients

<table>
<thead>
<tr>
<th>SOIL UNIT TYPLOGIES AND CHARACTERISTICS</th>
<th>PRINCIPLES FOR URBANIZATION GRADIENTS</th>
<th>ELEMENTS OF URBAN LANDSCAPE INFRASTRUCTURE MATRIX</th>
<th>HIGH DENSITY URBANIZATION DEVELOPMENT</th>
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</thead>
<tbody>
<tr>
<td>London Clay</td>
<td>Soil Strength</td>
<td>Important Large Patches</td>
<td>Residential/Commercial/Industrial Development</td>
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<td></td>
<td>Continuity</td>
<td>Water Related Small Patches</td>
<td>FSI  (↑↑)</td>
</tr>
<tr>
<td></td>
<td>Capacity of Permeability</td>
<td></td>
<td>GSI  (↓↓)</td>
</tr>
<tr>
<td></td>
<td>Maintain for Biodiversity</td>
<td></td>
<td>OSR(↑)</td>
</tr>
<tr>
<td>London Clay</td>
<td>Soil Strength</td>
<td></td>
<td>FSI  (↑)</td>
</tr>
<tr>
<td></td>
<td>Continuity</td>
<td></td>
<td>GSI  (↓↑)</td>
</tr>
<tr>
<td></td>
<td>Capacity of Permeability</td>
<td></td>
<td>OSR(↑↑)</td>
</tr>
<tr>
<td>R. T. D. (Sand, Gravel)</td>
<td>Soil Strength</td>
<td></td>
<td>FSI  (↑)</td>
</tr>
<tr>
<td>London Clay</td>
<td>Continuity</td>
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<td>GSI  (↓)</td>
</tr>
<tr>
<td></td>
<td>Capacity of Permeability</td>
<td></td>
<td>OSR(↑↑↑)</td>
</tr>
<tr>
<td>R. T. D. (Sand, Gravel)</td>
<td>Soil Strength</td>
<td></td>
<td>FSI  (↑)</td>
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<tr>
<td>London Clay</td>
<td>Continuity</td>
<td></td>
<td>GSI  (↓↓↓)</td>
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<tr>
<td></td>
<td>Capacity of Permeability</td>
<td></td>
<td>OSR(↑↑↑↑)</td>
</tr>
<tr>
<td>R. T. D. (Sand, Gravel)</td>
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<td></td>
<td>FSI  (↑)</td>
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<td>London Clay</td>
<td>Continuity</td>
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<td>GSI  (↑↑)</td>
</tr>
<tr>
<td></td>
<td>Capacity of Permeability</td>
<td></td>
<td>OSR(↑↑↑)</td>
</tr>
<tr>
<td>R. T. D. (Sand, Gravel)</td>
<td>Soil Strength</td>
<td></td>
<td>FSI  (↑)</td>
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<td>London Clay</td>
<td>Continuity</td>
<td></td>
<td>GSI  (↓)</td>
</tr>
<tr>
<td></td>
<td>Capacity of Permeability</td>
<td></td>
<td>OSR(↑)</td>
</tr>
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<td>Soil Strength</td>
<td>Regional Corridors</td>
<td>FSI  (↑)</td>
</tr>
<tr>
<td>London Clay</td>
<td>Continuity</td>
<td></td>
<td>GSI  (↓)</td>
</tr>
<tr>
<td></td>
<td>Capacity of Permeability</td>
<td>Regional Parks</td>
<td>OSR(↑)</td>
</tr>
<tr>
<td>R. T. D. (Sand, Gravel)</td>
<td>Soil Strength</td>
<td></td>
<td>FSI  (↑)</td>
</tr>
<tr>
<td>London Clay</td>
<td>Continuity</td>
<td>Patches for Storage/Retention</td>
<td>GSI  (↑)</td>
</tr>
<tr>
<td></td>
<td>Capacity of Permeability</td>
<td></td>
<td>OSR(↑)</td>
</tr>
<tr>
<td>R. T. D. (Sand, Gravel)</td>
<td>Soil Strength</td>
<td></td>
<td>FSI  (↑)</td>
</tr>
<tr>
<td>London Clay</td>
<td>Continuity</td>
<td>Patches for Infiltration</td>
<td>GSI  (↓)</td>
</tr>
<tr>
<td></td>
<td>Capacity of Permeability</td>
<td></td>
<td>OSR(↑)</td>
</tr>
<tr>
<td>R. T. D. (Sand, Gravel)</td>
<td>Soil Strength</td>
<td></td>
<td>FSI  (↑)</td>
</tr>
<tr>
<td>London Clay</td>
<td>Continuity</td>
<td></td>
<td>GSI  (↓)</td>
</tr>
<tr>
<td></td>
<td>Capacity of Permeability</td>
<td></td>
<td>OSR(↑)</td>
</tr>
</tbody>
</table>

Table 3.3: Relation between Soil Unit Typologies and Urbanization Gradients

Source: Made by author.
3.4 OUTCOME #3: LANDSCAPE INFRASTRUCTURE MATRIX
3.4.1 Green Graph

Regional Corridors/ Vegetated Waterfront Corridors

Then based on the distribution of soil unit, regional corridors/ vegetated waterfront corridors should be located in soil type 3 and 6. There are three types of regional corridors, type 1 provide inland habitat connections and surface water infiltration. Type 2 is for coastal habitats connection and surge water infiltration, the type 3 is for inland and coastal habitats connection and provide the synergy of surface and surge water management. There are 4 types of urbanization gradients to guide the density of urban form. And the boundary of the corridor will have different contributions, for example, the straight boundary tends to lead more species movement along it, while the convoluted boundary with loves and coves will provide biodiversity and facilitates boundary crossing between adjacent habitats. (Forman, 2008)
Stepping Stones

The stepping stones should go through soil type 2, 4, 5. There are two types of stepping stones, rest stops for inland wild life movement or for inland to coastal wildlife movement like migrant birds. The main aim of these three urbanization gradients is to decrease the GSI and increase the OSG in the urban island to release the space for several small vegetated patches scattered across a less-suitable matrix, acting as stepping stones and enhancing the movement of some species, providing protection for widely scattered uncommon species, and, if near a large patch, enhancing species richness and movement associated with the large patch. (Forman, 2008)
Regional Parks

According to the capacity of nutrition for biodiversity and patchy form of the soil units, type 2 and 5 is suitable for regional parks, with two types, inland regional habitats and coastal regional habitats. As for the urbanization gradients, the UG-08 and UG-09 will guide the density of urban form in the regional parks, the main idea is to as far as possible to reduce the FSI and GSI, so as to release a large open space for regional parks. Besides, closing spur roads and roads that bisect the interior of a large protected patch, and concentrating recreational opportunities and facilities for people in the edge portion of a protected area are effective ways to protect resources, especially in the interior of a large protected patch. (Forman, 2008)
3.4 OUTCOME #3: LANDSCAPE INFRASTRUCTURE MATRIX
3.4.1 Green Graph

High Density Urbanization Development

Soil type 1 and 4 is great typologies for the high-density urbanization development. According to the ranking criteria, we know that these two types of soil units has high capacity of soil strength but low capacity of permeability, the land here therefore is suitable for high-density urbanization development, as far as possible to increase the coverage of the land and the additional layers of buildings to increase FSI and GSI, then to reduce the OSR of the urban island, so as to use the land resource as efficiently as possible.
3.4 OUTCOME #3: LANDSCAPE INFRASTRUCTURE MATRIX

3.4.1 Green Graph

From the map of existing and potential patches for surface water storage, we know that the potential areas that should have more space for surface water storage should be located in the soil type 1, 4 and 5. And the main guidance from urbanization gradients is to decrease the index of GSI, to release the space for water storage, it can be retention (vegetated surface) or detention area (dry surface like parking lots). As for the height of buildings, it depends on the soil, for example, the type 1, 4 has great soil strength, then buildings here should have additional layers, while in the area with soil type 5, the height of buildings should be lower because of its weak soil strength.
From the map of existing and potential patches for surface water infiltration, we know that the potential areas that should have more space for surface water infiltration should be located in the soil type 2, 3 and 6. And the main guidance from urbanization gradients is to decrease the index of GSI, to release the space for water infiltration, the released space usually has vegetated surface. As for the height of buildings, it depends on the soil, for example, the type 2, 3 has great soil strength, then buildings here should have additional layers, while in the area with soil type 6, the height of buildings should be lower because of its weak soil strength.
3.4 OUTCOME #3: LANDSCAPE INFRASTRUCTURE MATRIX

3.4.2 Green Graph Composite

Therefore, the green graph composite comes from the combination of the potential green elements mentioned before.

The system consists of three types of regional corridors, two types of stepping stones, and 2 types of regional parks and 2 types of local green patches.

As the legend shows that, there are three types of regional corridors, type 1 provide inland habitat connections and surface water infiltration. Type 2 is for coastal habitats connection and surge water infiltration, the type 3 is for inland and coastal habitats connection and provide the synergy of surface and surge water management.

There are two types of stepping stones, rest stops for inland wild life movement or for inland to coastal wildlife movement like migrant birds.

The corridors and stepping stones reconnect two types of important habitats, inland regional habitats and coastal regional habitats.

Besides, there will be new small green patches located in the correspondingly suitable soil types, providing water storage and infiltration. These small patches also have other benefits, small natural-vegetation patches scattered across a less-suitable matrix act as stepping stones enhancing the movement of some species, provide some protection for widely scattered uncommon species, and, if near a large patch, may enhance species richness and movement associated with the large patch. (Forman, 2008)
Then the blue graph simply comes from the elevation and contour analysis, there are four hierarchies of blue conveyors in the whole river basin, and the Southend is belong to two river systems, the Thames River and the Roach River. And I will choose the south church sub river basin which belongs to the Thames river basin, as my micro scale, as the map on the left illustrates.

Zooming into the Southend, we can see there are also 4 hierarchies of blue conveyors in the blue graph, expect the 4 kinds of conveyors, the local potential conveyors are also highlighted according to the run-off directions coming from the contour lines. And Southend is separated into 6 sub-catchments. As mentioned above, the next scale is located in the South Church Sub River Basin.
3.4 OUTCOME #3: LANDSCAPE INFRASTRUCTURE MATRIX

3.4.5 Green-Blue Infrastructure Matrix

Conclusion: Green-Blue Infrastructure Matrix

The urban landscape infrastructure matrix based on carrying capacity comes from the combination of the green graph and blue graph. It is also the structural design in meso scale.

The system consists of three types of regional corridors, two types of blue corridors, and a set of potential local conveyors, two types of stepping stones, and 2 types of regional parks and 2 types of local green patches.

As the legend shows that, there are three types of regional corridors, type 1 provide inland habitat connections and surface water infiltration. Type 2 is for coastal habitats connection and surge water infiltration, the type 3 is for inland and coastal habitats connection and provide the synergy of surface and surge water management.

There are two types of stepping stones, rest stops for inland wild life movement or for inland to coastal wildlife movement like migrant birds.

The corridors and stepping stones reconnect two types of important habitats, inland regional habitats and coastal regional habitats.

The Blue Corridors of type 1 are the conveyors with bioswales transformed from the street and road. The Blue Corridors of type 2 are the natural streams, which are also the vegetated waterfront corridors.

Besides, there will be new small green patches located in the correspondingly suitable soil types, providing water storage and infiltration. These small patches also have other benefits, small natural-vegetation patches scattered across a less-suitable matrix act as stepping stones enhancing the movement of some species; provide some protection for widely scattered uncommon species, and, if near a large patch, may enhance species richness and movement associated with the large patch. (Forman, 2008)

The matrix coming from the green graph and blue graph provides the structural system for ecosystem services and potential ecological system interweaving in the urbanized areas.
4 MICRO/NANO SCALE DESIGN AND TEST

4.1 CONTEXTUAL INFORMATION
4.2 MESO SCALE INPUTS
4.3 MICRO SCALE STRUCTURAL PLAN
4.4 STRATEGIC INTERVENTIONS
4.5 TEST AND DESIGN IN THE AREA 1
As mentioned before, the micro scale is the South Church Sub Catchment which belongs to the Thames River Basin. Considering some of the land conditions in the sub catchment are really similar, I chose to focus on a smaller area for test and design. And this smaller focused area is 3.3km², and mainly located in the town center of Southend.
4.1 CONTEXTUAL INFORMATION
4.1.2 3x3x3 Analysis of Focused Area

From this analysis, we can see this sub catchment has been almost fully occupied by the urban and sub urban development since 1990. Green space which is improved green land, is limited in the highlight area.

Source: Made by author, based on the information from Digimap, online maps and spatial data of Great Britain.

LEGEND
Background
- Sea Water
- Saltmarsh
- Fresh Water

Landscape
- Grassland & Artificial Greenland
- Arable/Horticultural Land
- Beach Sand

Infrastructure
- Main Roads (1900)
- Roads (1900)
- Railways
- Motorway
- Primary Road
- A Roads
- B Roads

Occupation
- Urban Areas
- Suburban Areas

3x3x3 Analysis (Southchurch Scale)
4.1 CONTEXTUAL INFORMATION
4.1.3 Current Urban Characteristics of Focused Area

As for the current land use, the red and orange area are the town center and a major commercial center, which are the main tourism attractions in Southend, and light purple area in the northeast is the local commercial area. The north purple part of south is the local industrial area. The rest area is a residential area. The main green space is the South Church Park in the southeast corner. The design area also has the highest density of roads in the entire town, and the main bus/train terminal is in the town center.
4.2 Meso Scale Inputs

4.2.1 Input of Land Use Suitability

Compared with the guidance from meso scale, the current land use almost meets the requirements of land use suitability, except for the southeast corner, the area which should be the conservation area and regional park, are occupied as low density residential areas, and the north part of south church, where should develop high-density urbanization development, are also low density residential areas.

Fig. 4-6
Input of Land Use Suitability
Source: Made by author, based on analysis above.

4.2.2 Input of Urban Landscape Infrastructure Matrix

As for the input from landscape infrastructure matrix, the biggest challenges come from the matrix input, there should be a regional corridor for inland-coastal habitat connection near to the town center. Besides, a coastal corridor along the seafront in the south and an inland corridor in the north.

Fig. 4-7
Input of Urban Landscape Infrastructure Matrix
Source: Made by author, based on analysis above.
4.2 Meso Scale Inputs
4.2.3 Input of Urbanization Gradients

As for the principles of urbanization gradients, the similar conclusion with land use suitability, the area 2, 3, 4 should have high density development, while the area 5, 6 should avoid urbanization development or should have few buildings as possible. And three corridors mentioned before go through the type 3 and 6 areas.
4.3 MICRO SCALE STRUCTURAL PLAN

4.3.1 Structural Plan of Interventions

According to the comparison of current situation and meso input, I made this micro scale structural plan, the map highlights the linear elements and patchy elements which do not meet the guidance and principles from meso scale, and also mark the location of linear interventions and patchy interventions to design the landscape infrastructure and urban program in the structural plan of interventions. The main aim and concept of the interventions are to interweave the life of citizens and wildlife through the interventions. There are 3 main intervention areas with different characteristics and design aims. The Area 1 is located in the city center, the main aim is to create a inland-coastal corridors as back yard of city center to enhance the ecological services as well as to transform the commercial center to make public green space for tourists, college students and local residents. Area 2 is the coastal area, with the aim of intertidal conservation and commercial/educational edge development. Area 3 is located in the upstream in the north with the aim of creating the linear playground for the local high-density community.
4.4 STRATEGIC INTERVENTIONS
4.4.1 The Main Concept of the Area 1

From the profile of Area 1, we know that it is located in the upstream, with soil type 1.3.4 and 7 urbanization gradients to guide the spatial intervention to create potential space for surge and fresh water storage and infiltration. This area is suitable for high density urbanization with active recreation functions, especially for commercial and educational center, the parking lots, industrial area in the north and several mix use buildings, the shopping street, Chichester road, and A1160 should be redesigned to create the corridor type 3 for inland-coastal habitats connections.

This area is the city center of Southend, with some important commercial streets, commercial complexes, universities and public and transport facilities like city library, railways station and bus terminal. The main concept is to create a backyard of the city center and to interweave the green-blue networks in the city center to reconnect the public space. The main aim is to intensify the commercial and educational center for regeneration of city center, and also to adjust the density of the eastern edge area of city center so as to create an inland-coastal corridors, minimizing the flood risk by reducing the surface water source in the up stream, but also enhancing the wildlife movement between the inland and coast.
4.4 STRATEGIC INTERVENTIONS

4.4.2 Strategic Interventions in Area 1

Strategic Intervention 1
INTENSIFY THE COMMERCIAL/EDUCATIONAL CENTER
REARRANGE THE INEFFICIENT LAND USE NEAR THE CITY CENTER
RELEASE SPACE TO GENERATE A GREEN CORRIDOR

The first strategy is to intensify the commercial and educational center by demolishing the low-rise commercial building along the shopping street, making the public green space in front of the public facilities, such as library, station, university, reconnect to the shopping street through the green-blue networks. The demolition will release the space for high-rise complex buildings with business and commercial functions. On the one hand, the transformation of commercial buildings brings more high quality mix-use space for future commercial/educational center. On the other hand, the small green patches, if near an ecological corridor or reconnecting to the corridor/ large patches, will enhance the species richness and movement associated with the corridors or the large patches.

Strategic Intervention 2
REARRANGE THE INEFFICIENT LAND USE NEAR THE CITY CENTER
RELEASE SPACE TO GENERATE A GREEN CORRIDOR

The second strategy aims at changing the existing inefficient land use. The east edge area of the city center is used for large parking lots and low-rise residential and commercial buildings. The high GSI index and low FSI index cause the lack of open space for ecological services like wildlife movement, and surface water management. Therefore, this strategy aims at transforming the surface parking space into parking buildings in the city center like the city Rotterdam, and also proposing several mix-use buildings for housing and commercial functions to release the space to generate a green corridor near the city center for better ecological services mentioned above.

Strategic Intervention 3
REDUCE THE SURFACE WATER IN THE UPSTREAM
ENHANCE THE WILDLIFE MOVEMENT BETWEEN INLAND & COAST

The third strategy is to reconnect the ecological network so as to reduce the water source in the upstream, and to enhance the wildlife movement between the inland and coastal area. The green-blue networks reconnect the green patches to the corridor to enhance the species richness and movement associated with the corridors, the western area, several stepping stones also make a contribution to wildlife movement. Besides, the conveyor network is redesigned according to the terrain and contour line. Retention green patches in the ridge area and infiltration green patches in the upstream ensure the reduction of surface water source.

Strategic Intervention 4
ADD VARIOUS PROGRAMMES AROUND THE GREEN CORRIDOR

The last strategy is to program the green corridor, various functions are added in different locations of the green corridor according to carrying capacity and surrounding conditions, aiming at making this green corridor an open space shared by humans and wildlife. From the south to north, the programmes are beach, cliff/intertidal park and bicycle lane, outdoor theater and seafront exhibition, meeting place for commercial and educational center, sport fields and rest place for tourists.
4.4 STRATEGIC INTERVENTIONS
4.4.3 The Main Concept of the Area 2

**Intertidal Conservation + The Seafort Edge Development**

Playable And Educational Buffer Zone And Recreational Edge

This area is the commercial seafort of Southend, with some commercial buildings and seafort recreational facilities like hotel, casino, aquarium, as well as seafort housing. The main concept is to create intertidal conservation and propose seafort edge development. The main aim is to plan a playable and educational buffer zone around the South Church Park and demolish the seafort housing to expand the conservation zone as a retention area in the downstream, and closing the interior road and concentrate the recreational opportunities and facilities for people in the edge portion of conservation, which are effective ways to protect resources, and the seasonal exhibition and intertidal protection festivals can also rise the awareness of the protection of wetland conservation and promoting the knowledge of the flora and fauna in the intertidal ecosystem.

Area 2 is in the south part. From the matrix profile and structural plan we can see that, this matrix zone has type 2,5,6 soil unit, and the east part is suitable for conservation and passive recreation land use, therefore, the residential block in the southeast corner should be demolished as an expansion of conservation area, while the low density development in the west part should be the low density of commercial seafort, where the commercial buildings and parking lot are also need to be transformed, and the Marina Avenue and the beach should also be transformed into the corridor for coastal habitats connection. All the transformation will follow the corresponding urbanization gradients shown in the bottom of the profile to create storage and retention space for both surge water and surface water, since this matrix zone located in the downstream.
4.4 STRATEGIC INTERVENTIONS

4.4.4 Strategic Interventions in Area 2

Demolition of the Occupation in High-risk/Low-suitability Land

Expansion of Conservation as Intertidal Park

The first strategy is to demolish the southeast coastal residential buildings around the South Church Park according to the land use suitability as well as the evaluation of flood risk and soil unit capacity, and also to expand the South Church Park as intertidal conservation that connects to the beach and sea to enhance the species diversity and coastal wildlife movement in the intertidal ecosystem. Besides, the expansion of conservation is also important for the beach nourishment and stability, which are an important action for Southend with beach resources as the main tourist attractions. In addition, considering the location of downstream, the conservation zone also serves as a large retention zone for surface water and the surge water. With the natural process, this conservation area will eventually become a large wetland.

Concentrate Recreational/ Educational Edge Development

Reboot the Seafort Tourism

The second strategy is to concentrate on recreational/educational edge development in the edge position of the conservation area. The main aim is to protect the natural resource in an effective way, and also to provide the recreation opportunities and facilities for local people as well as tourists in the edge. The edge development not only focuses on the transformation of the commercial seafort, but also focuses on transforming this place into a more educational place with intertidal ecosystem museum, seasonal exhibition and annual wetland festival to educate the residents as well as the tourists, and rise the awareness of the protection of wetland conservation and promoting the knowledge of the flora and fauna in the intertidal ecosystem.

Close Spur Roads That Bisect the Interior of Protected Patch

Rearrange the Transport Connections on the Edge

The third strategy is to rearrange the transport connection on the edge of a conservation area. The existing marina avenue blocks the connection between the South Church Park and beach/sea. Therefore, as an efficient protective strategy, closing spur roads inside the conservation park and roads that bisect the interior of this protected patch is a great way to reduce the human impacts in the conservation zone, and the step back of the marina avenue will contribute the reconnection of the wetland park, beach and sea, which will enhance the intertidal ecosystem. Inside the conservation zone, it is also possible to design trekking paths and bicycle paths which have low human impacts to the protected area.

Redesign the Seafort

Transform the Hard Edge into Soft Edge

The last strategy is a follow-up strategy after the redesign of the marina avenue, is about transforming the existing hard coastal edge into a soft edge. Since the partial marina avenue is demolished, main strategy is to improve the surface and change the straight boundary between the inland conservation and the beach near the sea. The proposed curvilinear boundary, with tiny-natural-vegetated patches, will provide a number of ecological benefits, including less soil and beach erosion and greater wildlife use. (Dramstae, et al., 1996)
4.4 STRATEGIC INTERVENTIONS
4.4.5 The Main Concept of the Area 3

The Area 3 is located in the upstream, the soil types 3/4 have 4 urban gradients to guide the design to create potential space for surface water storage and infiltration, this matrix zone is suitable for medium and high density residential development, the light red areas around the zones should be transformed into the relative high density residential area, also as a compensation of demolition mentioned in zone 1. The corridor here is type 1 corridor for inland habitats connection. The Road A13 and the highlight black mixture building should be transformed to support the corridors also create public space and local commercial space for the local community.

HOUSING+COMMUNITY RECREATION SPACE
Linear Play Ground Of High-Density Community For Better Life Quality

This area is mainly residential function, with few sports play grounds and scattered shops. The main concept here is to intensify the high-density housing due to the rapid development pressure from the regional regeneration, and create a linear play ground along the road A13 to activate the residential community, providing the multi-functional services like sports space, local shops, bike routes, inland wildlife movement, and upstream water infiltration.
Strategic Intervention 1

PROPOSE HIGH-DENSITY COMMUNITY IN HIGH-SUITABILITY LAND
PREPARE FOR THE DEMOLITION OF STREETSIDE BUILDINGS

The first strategy is to concentrate on the efficient land use of high-suitability and low-risk land. The proposal is mainly about the high-density community development in the north highlight area to meet the requirement from the regional regeneration about increasing the houses and apartments in Southend, and the high-density community is also a compensation for demolition projects in other areas like area 2. This strategy also prepares for the demolition of street side buildings around the A13 Road, and prepares to generate the green corridor for inland wildlife movement.

Strategic Intervention 2

REDESIGN THE STREETSIDE BUILDINGS FOR COMMUNITY CENTER
REARRANGE THE URBAN FUNCTIONAL TRANSFORMATION

The second strategy is about the regeneration of the street side buildings for community service and recreation, and also about the rearrangement of the urban functional transformation in this high-density community. The strategy map shows the new layout of the occupation and the new buildings for the community cultural center, local commercial shops, as well as local recreation facilities. The new layout increases the distance from the street side buildings to the edge of the road, and releases the space for the linear public space as well as a corridor.

Strategic Intervention 3

EXPAND THE STREETSIDE GREEN PATCHES TO GENERATE CORRIDOR
INTERWEAVE THE CORRIDOR AND BLUE NETWORKS

The third strategy is to re-link the new green patches as well as the existing green space to generate the corridor and also interweave the corridor and blue networks for the surface water management. The continuous green space, on the one hand, enhance the inland wildlife movement; on the other hand, the green-blue networks ensure the retention and infiltration of surface water in the upstream area, so as to reduce the water source flowing to the middle and downstream.

Strategic Intervention 4

ENHANCE THE INLAND-HABITAT CONNECTIONS
RE-PROGRAMMING THE CORRIDOR

The last strategy is to re-program the corridor to create a multi-functional linear playground for the community. A new bicycle lane is going through the corridor, besides, the corridor is separated into two part, the west part will concentrate on creating sports fields and the common room for the community to provides space for the recreation activities in the community, in the east part will focus on improving the local commercial squares to improve the spatial quality of the local commercial street.
4.5 TEST AND DESIGN IN THE AREA 1
4.5.1 Reviews of Contextual Information and Main Strategies

AREA 1

COMMERCIAL+EDUCATION+RECREATION
Back Yard Of City Center
Interweaving The Green-Blue Networks In The City Center

New Structure of Area 1

Strategic Intervention 1
- Intensify The Commercial /Educational Center
- Reconnect Small Green Patches To The Corridor

Strategic Intervention 2
- Rearrange The Inefficient Land Use Near The City Center
- Release Space To Generate A Green Corridor

Strategic Intervention 3
- Reduce The Surface Water In The Upstream
- Enhance The Wildlife Movement Between Inland & Coast

Strategic Intervention 4
- Add Various Programmes Around The Green Corridor

Reviews of Information in Area 1
Fig. 4-29

4.5 TEST AND DESIGN IN THE AREA 1
4.5.2 Reviews of Contextual Information and Main Strategies

Intervention Library of Engineering and Technical Guidance (See Appendix A4- Explanation of Intervention Library)

Based on the strategies mentioned above, the intervention library will be separated into two parts, linear interventions and patchy intervention to guide the design process of Area 1. In each layer of intervention, there will be more specific spatial pattern in the design process with technical guidance, which will be specifically explained in the Appendix part: A4 Explanation of Intervention Library.

Fig. 4-30
Systems of Intervention Library
Fig. 4-30
4.5 TEST AND DESIGN IN THE AREA 1
4.5.3 Master Plan

**Master Plan before Interventions**
Fig. 4-31

**Master Plan after Interventions**
Fig. 4-32
4.5 TEST AND DESIGN IN THE AREA 1
4.5.4 Performance: Decomposing the Layers and Evaluation

Evaluation #1 Ecosystem Services (Habitats Connections)

BEFORE

The existing habitat connections, on the one hand, is limited by the sparse number of small green patches. Although the network of the green space provides a set of stepping stones on the east edge of city center, the average distance between stepping stones is 213.9m, which is too long for some species, especially for highly-visually-oriented species, the effective distance for movement between stepping stones is determined by the ability to see each successive stepping stone. On the other hand, the railway becomes the main barrier of the habitat connection, making it difficult for the terrestrial animals.

Evaluation #1 Ecosystem Services (Habitats Connections)

AFTER

In the proposal, the gross area of green open space is increased to 0.232km², which is almost 4 times the existing open green space. And the average distance between stepping stones is decreased to 102.9m, which is half distance in the existing situation, contributing to the wildlife habitats’ connection. From the proposal, we can also see the transformation of railway alleviate the barrier from transport infrastructure, besides, we can see the new system of habitats connections, the new structure, consists of continuous corridors and attached stepping stones, and the networks expand and link to other habitats in the larger context.
The performance of reducing the hydrological risk is also an important aspect in the evaluation of the ecosystem services. In the existing situation, the green patches for infiltration and storage are limited, the gross area is only 0.059km². The conveyor network works as a weak system, there is only 1.75km conveyors in total length. The limited hydrological-related open space and unsystematic conveyance system, are the main reasons for the high incidence of hydrological hazards. (*See Appendix A 3.3 Calculation of Surface Water)

In the proposal, according to the former analysis of the soil characteristics, the open green space are rearranged to create the patches for storage or infiltration, and the conveyors are redesigned to build up as a network to reconnect the water-related green patches, so as to generate a more efficient system to reduce the source of surface water and hydrological risk. (*See Appendix A 3.3 Calculation of Surface Water)
The second aspect of the evaluation is to evaluate the impact of the urban functional transformation. Before the transformation, the main coverage of land uses in Area 1 is commercial, residential, industrial land use, and surface parking lots. Therefore, the main adjustment happens in the commercial, residential and industrial land use and the surface parking lots. The urban blocks which will be transformed are also highlighted on the top in the explosive diagram below.

**AVG HEIGHT AND GROSS AREA IN THE INTERVENTION AREA**

- **Commercial**: 32.66ha (x2.3), 14.01ha (x1.3), 8.96ha (x2.5), 6.22ha (x2), 6.52ha (x1.9), 2.77ha (x1.6), 1.3ha (x1.3), 0.7ha (x1), 0.9ha (x1), 1.5ha (x1.9), 0.9ha (x2.1)
- **Residential**: 20.62ha (x2.3), 6.92ha (x2.5), 6.22ha (x2), 4.05ha (x2.1)
- **Industrial**: 6.22ha (x2), 4.05ha (x2.1)
- **Education**: 0.7ha, 0.9ha, 1.5ha
- **Transport Facilities**: 6.52ha
- **Surface Parking Lots**: 2.77ha, 1.3ha, 0.7ha, 0.9ha, 1.5ha, 0.9ha, 1.3ha

**SIZE OF AREA 1**

- **Commercial**: 32.66ha
- **Residential**: 20.62ha
- **Industrial**: 6.22ha
- **Education**: 6.22ha
- **Transport Facilities**: 6.52ha
- **Surface Parking Lots**: 2.77ha
- **Other**: 107ha

**COVERAGE AREA OF DIFFERENT LAND USE**

Source: Made by author.
Evaluation #2 Urban Functional Transformation

After the intervention, we can see the main improvement of urban functional transformation is the increasing space for the conference and office use in the new high rise buildings in the city center, which also provide conditions and space for the transformation of Southend-On-Sea, from a seaside resort to a future education and cultural center in the lower estuary area. Besides, the data of average height and gross area in the intervention area, we can see that the coverage of commercial/residential and industrial buildings will be decreased and the height of buildings will be slightly increased for more space. In addition, most of surface parking lots are transformed into parking buildings, which provide extra 500 parking places in the city center in the future.

Source: Made by author.

Urban Functional Transformation: After

Fig. 4-38
The last part of evaluation is about the land use efficiency related to the carrying capacity of the landscape structure. The first part is the evaluation before the interventions. Although, from the data we know that, the GSI index is not very high in the existing situation, the degree of soil sealing is quite high because of the large area of surface parking lots. In addition, in the area of project 1, 2 and 4, the forms of buildings are basically flat and with high coverage rate and low height. These two reasons cause the limited green space in the city center of Southend-on-Sea. That is why the green space is still limited when the FSI and GSI index is relatively low, and OSR is relatively high (which means low pressure on the non-built space and large open space per person.) We can tell that the inefficiency of land use in Southend is coming from the flat and low height building form as well as large area of surface parking lots.
After the intervention, we can tell the improvement of land use efficiency related to the density. From the general data of the whole area 1, we can see the GSI index is decreasing in the proposal, and FSI, AVG L is increasing, and the OSR index is slightly decreasing. In addition, the coverage of green open space is significantly improved, no matter in the whole area 1 or in each project (especially in the project 1, 2, 3, 4). In the projects mentioned above, due to the transformation of the building form and the parking space (from the surface parking lots to the parking buildings), the land use efficiency is improved. In the project five, the main improvement is coming from the rearrange of the coastal avenue (rearrangement of transport infrastructure).
4.5 TEST AND DESIGN IN THE AREA

4.5.5 Operational Sections

BEFORE

Overview of Project 5

Before the intervention, the coastal avenue blocks the connection between the cliff park and the beach. Because of the wide coastal avenue, the beach in the Southend has limited space, which limits the biodiversity of the intertidal system, and weakens the wildlife connection like migrant birds’ movement. Besides, the project 5 is located in the downstream with steep slope, and the soil type in the cliff park has low capacity of permeability, therefore coastal avenue also blocks the conveyance of the surface water.

Overview of Project 4

The Project 4 is located in the middle stream with a gentle slope. The main existing function in this area is the coastal commercial use, with hotel, commercial complex, casino and so on. This area has soil type 3 with great capacity of permeability and soil strength. From the research, this place should intensify the coastal commercial use with the public facilities like museum, outdoor theatre, and also replace the surface parking space with parking buildings to decrease the high coverage of soil sealing.

Overview of Project 3

The Project 3 is located in the upstream with a flat slope. The main existing land use of this area is mainly residential use, and the most of the sealing surface is used as community parking space. The elevated railway is built on the concrete levee, which blocks the wildlife movements and other natural processes. The soil unit here is type 3, which has great capacity of permeability and soil strength. The high-rise community, with community parking buildings and the community common space, is an appropriate proposal here.

Overview of Project 2

The Project 2 is located in the upstream with a flat slope. This area is the city center and commercial, educational center of Southend-on-Sea. The main challenge here is the limited space for open green space in the crowded city center. The lack of green space also causes the lack of space for surface water storage. The surface water flow from the upstream also causes the surface water flood in the downstream of the sub-basin. Therefore, the main action here is the transformation of the shopping street and the mix-use commercial buildings.

Overview of Project 1

The Project 1 is located in the upstream with a flat slope, which is close to the forest and the regional park in the north. The existing land use here is industrial development and a few residential buildings. The industry here is the logistic service and the furniture shop, with large surface parking space. The built-up environment blocks the connection between the inland forest and intertidal cliff park. The main action here is to redesign the form of industrial buildings and the layout of transport facility.
After the intervention, the coastal avenue is moved to the inner city, the rearrangement of coastal avenue makes it possible to reconnect the beach/wetland and the cliff park, the new space released from the old avenue can be redesign as the intertidal park in the coastal area, where is the first rest stop for the wildlife movement from sea to inland. The intertidal park is also serving as the retention space for the surface water coming from the upstream and the surge water from storm events. Simple programmes like bike lane will be introduced here.

The Project 4 is to redesign coastal commercial area and its surface parking lots. The soil type here allow the design of underground parking space, and the original surface will be transformed into a large stepping stone for the habitats connection and the space for water storage, besides, the space can also be the outdoor theatre and open space for exhibition and festival events. As for the commercial building transformation, the soil allows the high-rise building here, with mix use of hotel, casino, residential development, shops, exhibition and the museum.

Project 3 aims at creating a continuous corridor, which provides the habitat connection and the infiltration surface, crossing along the high-density community. The proposal is to demolish the single-family house and design the apartment buildings to create a community for local people as well as the youth entrepreneur. There will be more space for community activities like community education and community common room for collective recreation. Besides, the new elevated railway alleviates the barrier between habitats.

Project 2 aims at transforming the city center into a cultural and commercial center with considerable amount of office, conference space, meeting space for the tourists, local residents, and college students. The squares in front of the city library and college will be reconnected to the green corridor in the project 3, so as to enhance the species diversity and the wildlife movement. Greening squares will also be the small detention space to store the surface water, then to reduce the amount of surface water flowing to the middle stream and downstream.

The Project 1 is mainly about the transformation of the industrial area and the community in the north. The main action is to build up the parking buildings replacing the surface parking lots, which serve the logistics and the furniture factory and store. The low-rise industrial buildings are transformed into the relative middle-rise buildings with mix use of both industrial and office space for furniture and logistics companies. The released space will be vegetated again as a large inland forest habitat, which has great capacity of infiltration and wildlife movement.
4.5 TEST AND DESIGN IN THE AREA 1

4.5.6 Graients of Stage Setting of Stage #1

Story of Stage #1

THE INDUSTRIAL AREA WITH CAREFULLY-BALANCED MIX OF USES AT THE EDGE OF THE FOREST

Stage #1 is set in the north edge of city center. We would see the transformation of the industrial area from a flat, high-land coverage urban form into a middle-rise layout with carefully-balanced mix of uses such as industrial space, office for the industrial company as well as the centralized industrial parking buildings. The released space is transformed into a wonderful green corridor connecting the inland forest, increasing the adaptability and flexibility of both built-up environment and the natural landscape. The beautiful forest becomes the sharing space for both animals living and passive recreation activity of human, like hiking and picnic.

Fig. 4-43

Graients of Stage Setting of Stage #1

Source: Made by author
4.5 TEST AND DESIGN IN THE AREA 1

4.5.7 Stage #1: Images of Interweaving the Life of Citizens and Wildlifes

STAGE SETTING

STAGE SETTING OF LANDSCAPE

* INLAND FOREST
* GREEN CORRIDOR

STAGE SETTING OF URBANIZATION

* FURNITURE INDUSTRY
* PARKING BUILDING
* COMMUNITY

STARRING LIST

CAST

* WORKER
* LOCAL RESIDENT
* TOURIST

EVENTS AND PROGRAMMES

* FURNITURE PRODUCTION
* SPORTS
* HIKING
* HOME LIFE
* HOME OFFICE

FLORA

* INLAND FLORA

* INLAND TREE: POPLUS
* UMBRELLA TREE
* HIKING
* LILY-OF-THE-VALLEY
* MONSTERA
* AGALONEMA

FAUNA

* RACCOON
* SQUIRREL
* RABBIT
* MIGRANT BIRDS
* FOX
* ROE DEER

Source: Made by author.
4.5 TEST AND DESIGN IN THE AREA 1

4.5.8 Gradient of Stage Setting of Stage #2

The stage #2 is set in the city center, we would see the transformation from a single shopping street into an entertaining, vibrant and well-connected city center – a varied center for civic life for people from different places, local citizens, tourists, businessmen/women, college students, also for the animals which adapts to the city life, like domestic cat, dog and hedgehog and migrant birds. Stage 2 will incorporate the widest possible range of uses: from workspace to experiential retail, and from culture, leisure to education. The small green patches connected by the bioswales in the city center became the important playground and rest stops for migrant birds, and also became the meeting places for people from all over the world, making the city center a safe, entertaining and vibrant and well-connected area.

Gradient of Stage Setting of Stage #2
Fig. 4-45

Source: Made by author.
4.5 TEST AND DESIGN IN THE AREA 1
4.5.9 Stage #2: Images of Interweaving the Life of Citizens and Wildlifes

**STAGE SETTING**

<table>
<thead>
<tr>
<th>STAGE SETTING OF LANDSCAPE</th>
<th>STAGE SETTING OF URBANIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMALL STEPPING STONE WITH BIOSWALES</td>
<td>COMMERCIAL USE</td>
</tr>
</tbody>
</table>

**STARRING LIST**

**CAST**
- TOURIST
- LOCAL RESIDENT
- BUSINESSWOMAN
- STREET ARTIST

**EVENTS AND PROGRAMMES**
- TOURISM
- STREET SHOW
- GATHERING
- HOME LIFE
- CONFERENCE ACTIVITY
- COMMERCIAL ACTIVITY

**FLORA**
- INLAND FLORA
  - INLAND TREE: POPULUS
  - UMBRELLA TREE
  - HIKING
  - LILY-OF-THE-VALLEY
  - MONSTERA
  - AGALONEMA

**FAUNA**
- DOG
- CAT
- HEDGEHOG
- MIGRANT BIRDS

Fig. 4.46 Stage #2: Images of Interweaving the Life of Citizens and Wildlifes
Source: Made by author
4.5 TEST AND DESIGN IN THE AREA 1
4.5.10 Gradients of Stage Setting of Stage #3

**Story of Stage #3**

**A GREEN CORRIDOR GOING THROUGH THE CREATIVE COMMUNITY**

In the stage #3, the health and wellbeing will be prioritised in the brand new community, where has the widest possibility of uses from home working to community education, and leisure to home life. The high-rise apartment makes it possible to create a continuous green corridor going through the edge of the city center, enhancing the connection between coastal habitats and inland habitats. The SOHO community for youth entrepreneurs creates the possibility of transforming the Southend into the educational and cultural center in the lower Thames Estuary. The design of the green corridor provides clear routes between the city center and outskirt of the town, between the coastal and inland landscape.

**Gradients of Stage Setting of Stage #3**

<table>
<thead>
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<th>Density Gradients</th>
<th>Value</th>
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<tbody>
<tr>
<td>A</td>
<td>1.11ha</td>
</tr>
<tr>
<td>FSI</td>
<td>0.896</td>
</tr>
<tr>
<td>GSI</td>
<td>0.196</td>
</tr>
<tr>
<td>OSR</td>
<td>0.897</td>
</tr>
<tr>
<td>L</td>
<td>4.56</td>
</tr>
<tr>
<td>Green Space</td>
<td>37.5%</td>
</tr>
</tbody>
</table>

**Soil Typologies**

- **R. T. D. (Sand, Gravel)**
- **London Clay**

**TPI**

**GENTLE SLOPE**

**UPSTREAM**

**Fig. 4-47**

Source: Made by author.
4.5 TEST AND DESIGN IN THE AREA

4.5.11 Stage #3: Images of Interweaving the Life of Citizens and Wildlifes

**STAGE SETTING**

**STAGE SETTING OF LANDSCAPE**

- Green Corridor

**STAGE SETTING OF URBANIZATION**

- Soho Community
- Parking Building
- Common Space
- Elevated Railways

**STARRING LIST**

**CAST**

- Local Resident
- Youth Entrepreneur
- Family

**EVENTS AND PROGRAMMES**

- Friends Gathering
- Community Recreation
- Sports Fields
- Home Office
- Community Education

**FLORA**

- Inland Flora

- Inland Tree: Populus
- Umbrella Tree
- Hiking
- Lily-of-the-Valley
- Monstera
- Alocasia

**FAUNA**

- Hedgehog
- Squirrel
- Weasel
- Cat
- Dog
- Migrant Birds

- Fox
- Roe Deer

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Stage #3: Images of Interweaving the Life of Citizens and Wildlifes

Fig. 4.48

Source: Made by author.
4.5 TEST AND DESIGN IN THE AREA 1
4.5.12 Graients of Stage Setting of Stage #4

**Story of Stage #4**

**THE ATTRACTIVE COASTAL COMMERCE NEAR THE STEPPING STONE**

The stage #4 is set in the city center, we would see the transformation from a single coastal commercial area to an attractive coastal commercial complex, providing new opportunities for entertainment, culture and productivity, such as casino, club, hotel and high-fashion design workshop and educational museum, all the activities in the coastal commercial complex will continue throughout the night, expands the appeal of the destination for a new range of visitors to Southend-on-Sea. Besides, the aim of urban design is not only improving the spatial quality and stimulating the social-economic development, but also creating conditions for educating people to raise the awareness of landscape protection and sustainable development. Therefore, the new coastal park with underground parking space transformed from the surface parking lots, will provide space for outdoor theater and exhibition space for the annual Intertidal Festival.

**Graients of Stage Setting of Stage #4**

Fig. 4-49

Source: Made by author
4.5 TEST AND DESIGN IN THE AREA 1
4.5.13 Stage #4: Images of Interweaving the Life of Citizens and Wildlifes

**STAGE SETTING**

**STAGE SETTING OF LANDSCAPE**
- STEPPING STONE

**STAGE SETTING OF URBANIZATION**
- MUSEUM/EDUCATION
- COASTAL COMMERCIAL
- RESIDENTIAL USE
- UNDERGROUND PARKING

**STARING LIST**

**CAST**
- CONSTRUCTION WORKER
- BUSINESSMAN
- TOURIST
- LOCAL RESIDENT
- ARTIST

**EVENTS AND PROGRAMMES**
- INTERTIDAL FESTIVAL
- OUTDOOR THEATRE
- HOME LIFE
- FRIENDS GATHERING
- COASTAL RECREATION
- CONSTRUCTION ACTIVITY

**FLORA**

**COASTAL FLORA**
- QUEEN CALM
- PHOENIX
- COASTAL REED
- SALICORNIA

**INLAND FLORA**
- INLAND TREE: POPULUS
- UMBRELLA TREE
- MANGROVE
- LILY-OF-THE-VALLEY
- MONSTERA
- AGALONEMA

**FAUNA**
- RACCOON
- SQUIRREL
- NIGEL
- RABBIT
- HEDGEHOG
- MIGRANT BIRDS

Stage #4: Images of Interweaving the Life of Citizens and Wildlifes
Fig. 4.50

Source: Made by author
4.5 TEST AND DESIGN IN THE AREA 1

4.5.14 Gradients of Stage Setting of Stage #5: Scenario #1

Story of Stage #5 (MILD SEA-LEVEL-RISE SCENARIO : 0.1-0.4M)

BROADER SANDY BEACH AND INERTIDAL PARK

Stage #1 is a broader stage for citizens and wildlife, the rearrangement of coastal avenue makes it possible to create a larger space for the beach and the intertidal park. The continuous landscape connection, between the beach, intertidal zone and the cliff park, provides the enhancement of species biodiversity and beach nourishment. As the soft edge between the sea and coastal built-up environment, the broader beach and intertidal park create a pleasant seafront environment for citizens and tourists, and coastal flora and fauna, the sensitive intervention like bike routes and intertidal park will encourage a better exploration and connections to the wider lower Thames Estuary.
4.5 TEST AND DESIGN IN THE AREA 1

4.5.15 Stage #5: Images of Interweaving the Life of Citizens and Wildlifes: Scenario #1

STAGE SETTING

STAGE SETTING OF LANDSCAPE

STAGE SETTING OF URBANIZATION

BEACH & INTERTIDAL PARK

COASTAL WONDERLAND

SOUTH END PIER

COASTAL BIKE LANE

STARRING LIST

CAST

LOCAL RESIDENT

TOURIST

FAMILY

EVENTS AND PROGRAMMES

SWIMMING

SURFING

BEACH VOLLEYBALL

BEACH CYCLING TOUR

SUNBATHING

WONDERLAND PROGRAMME

FLORA

COASTAL FLORA

QUEEN CALM

PHOENIX

COASTAL REED

SALICORNIA

FAUNA

MUD SNAILS

STARRYFISH

CRAB

MIGRANT BIRDS

Fig. 4-52

Stage #5: Images of Interweaving the Life of Citizens and Wildlifes (Scenario #1)

Source: Made by author.
4.5 TEST AND DESIGN IN THE AREA 1

4.5.16 Gradients of Stage Setting of Stage #5: Scenario #2

**Story of Stage #5 (HIGH-END SEA-LEVEL-RISE SCENARIO : 1.8-3.5M)**

**COASTAL WETLAND AND INTERTIDAL PARK**

In the second scenario, which is the high-end sea-level-rise scenario, the beach will be flooded and the coastline will get close to the cliff park. With the marsh nourishment, Stage #1 is still a broader stage for citizens and wildlife, the rearrangement of coastal avenue makes it possible to create a larger space for the wetland and the intertidal park, as the buffering zone. The continuous landscape connection, between the wetland, intertidal zone and the cliff park, provides the enhancement of species biodiversity and marsh nourishment. As the soft edge between the sea and coastal built-up environment, the broader beach and intertidal park create a pleasant seafront environment for citizens and tourists, and coastal flora and fauna, the sensitive intervention like walking paths and intertidal park will encourage a better exploration and connections to the wider lower Thames Estuary.
4.5 TEST AND DESIGN IN THE AREA 1
4.5.17 Stage #5: Images of Interweaving the Life of Citizens and Wildlifes: Scenario #2

STAGE SETTING

STAGE SETTING OF LANDSCAPE

- COASTAL WETLAND

STAGE SETTING OF URBANIZATION

- COASTAL WONDERLAND
- SOUTHEND PIER
- WETLAND WALK PATH

STARRING LIST

CAST

- LOCAL RESIDENT
- TOURIST
- FAMILY

EVENTS AND PROGRAMMES

- SWIMMING
- WILDLIFE VIEWING
- WETLAND HIKING
- MARSH LAND FOOTBALL
- SUNBATHING
- WONDERLAND PROGRAMME

FLORA

COASTAL FLORA

- SEA WEEED
- PHOENIX
- COASTAL REED
- SALICORNIA
- CALENDULA

FAUNA

- MUD SNAILS
- STARFISH
- CRAB
- MIGRANT BIRDS
- MIGRANT BIRDS
- MIGRANT BIRDS

Source: Made by author.

Fig. 4-54

Stage #5: Images of Interweaving the Life of Citizens and Wildlifes (Scenario #2)
5 CONCLUSIONS, UPSCALING AND REFLECTION

5.1 CONCLUSIONS
5.2 UPSCALING PROJECTIONS
5.3 REFLECTION
5.1 CONCLUSIONS
5.1.1 Relation between the Sub-Research Questions and the Chapters

As the first part of conclusions, I would like to review the whole framework of this graduation thesis and discuss about the relation between sub-research questions and chapters. As mentioned before, to answer the research question- "How to systematically design urban landscape infrastructure and urban programmes based on the carrying capacity of landscape structure?", five sub-research questions need to be answered.

Chapter 2 is the main analytical framework of the research, mainly based on the Design with Nature by Ian McHarg. This chapter is separated into 6 aspects-topography, geology, hydrology, vegetation, wildlife and land use-to define what is the carrying capacity of landscape structure, which is the first sub-research question. This is the first step of the research framework, which is understanding and learning from the landscape, making decision based on characteristics of the landscape.

Chapter 3 is mainly about how to use the outcomes of analytical framework to support the research and design of urban landscape infrastructure and urban programmes based on the carrying capacity of landscape. Elements of contour/terrain and soil unit typologies determine the structure of the blue graph and green graph, which are the basic structure of the urban landscape infrastructure matrix. The matrix structure reserves the basic networks for natural processes, like the hydrological process, wildlife movement, etc. This part supports to answer the second sub-research question- how to systematically design the urban landscape infrastructure as territorial strategy. In addition, the study of soil unit typologies also supports to regulate the parameters of the density to control the urban form according to the characteristics of soil. Furthermore, all the elements in the analytical framework help to create the guidance for the land use, which is the land use suitability. The land use suitability is the further step of density control, which points out the distribution of urban functions according to the carrying capacity. Sessions of playing with density and functional distribution, answer the third sub-research question- how to regulate the urban programmes imbedded in the urban landscape infrastructure matrix.

And the chapter 4 is answering the forth sub-research question- how to achieve the synergy of territorial urban landscape infrastructure and local urban programmes by integrating the input of the research and the strategic interventions, by decomposing systems to evaluate the performance, by expressing the stories through the images of stages. The main aim of Chapter 4 is to explain the synergy of systems, and also to elaborate the relation between the research and design in this graduation thesis.

The last chapter is the conclusions, upscaling and reflection, which are the final aim of this graduation thesis- to provide a new urbanization logic based on the carrying capacity of the landscape structure. This part will be well explained in detail in the next section.
5.1 CONCLUSIONS
5.1.2 New Urbanization Logic based on Carrying Capacity of Landscape Structure

Old Urbanization Logic

![Diagram of Old Urbanization Logic]

New Urbanization Logic Based On Carrying Capacity Of Landscape Structure

![Diagram of New Urbanization Logic]

THE OLD URBANIZATION IN THE LAST CENTURY

Economic Driver = Land Selling = Land Sealing = Depletion of Landscape

The top of Fig. 5-2 shows the old urbanization paradigm in the rapid development period. The basic logic behind this process is that, the economic driver leads the land selling, and further stimulates the occupation of the land and transport infrastructure, and the improvement of infrastructure will further exacerbate the occupation of the land. The result behind this process is the erosion and fragmentation of the landscape.

NEW MODEL OF THE NEW URBANIZATION LOGIC BASED ON CARRYING CAPACITY OF LANDSCAPE STRUCTURE

Nature Comes First ≠ Denying and Ignoring the Social-Economic Development

The Fig. 5-2 also shows the new urbanization logic based on the carrying capacity of landscape structure, which is the main conclusion of my graduation thesis. “Nature comes first” does not mean denying and ignoring the social-economic development. The process of understanding the landscape and learning from the landscape, makes it possible to understand the characteristics of carrying capacity of the landscape structure, guiding us to reserve space for natural processes, to play with density and control the density of urban forms in different soil conditions, and also to scientifically distribute the urban functions according to the land use suitability. The main aim of this new model is to reduce the risk from the uncertainty of climate change, and reserve safer space for future development, so as to achieve greater social-economic development and benefits. The old urbanization logic starts with the economic driver, ends with the depletion of the landscape, on the contrary, the new urbanization logic mentioned above starts with the process of learning from the landscape, ends with greater social-economic benefits and safer space for future development, that is, the meaning of the title “REVERSE TO REBOOT.”
5.2 UPSCALING PROJECTIONS

5.2.1 Projections of The Thames Estuary

THE THAMES GATEWAY 2.0: THE GATEWAY IMBEDDED IN THE ESTUARY PARKLANDS

Going back to the Thames Gateway context, the new urbanization logic based on the carrying capacity of the landscape structure will reshape the Thames Gateway Project, and create the brand new era of the Thames Estuary: The Gateway imbedded in the estuary parklands. The system of parklands enhances the ecosystem services in the lower Thames Estuary, making it a strong networks for natural processes like hydrological cycle and wildlife movements. Besides, the rearrangement of urban programmes based on carrying capacity of the landscape, also help to reduce the risk from the uncertain climate change, reducing the economic losses from natural disasters.

THE THAMES GATEWAY 2.0: THE GATEWAY IMBEDDED IN THE ESTUARY PARKLANDS

Source: https://farrells.com/zh-hans/project/thames-estuary-parklands

5.2.2 Projections of The North Sea

THE RING OF THE NORTHSCAPE: EDGE DEVELOPMENT IN NORTH SEA CONTEXT

In the North Sea context, the concept is the ring of the North Sea, which emphasizes the edge development in the area between the existing coastline and the projective coastline of the North Sea. The ring will work as a huge stepping stone in the migration pathways for species between Europe and Africa. Besides, the ring itself will be developed as one of the political economic and cultural center in the co-existing Northscape of Europe.

THE RING OF THE NORTHSCAPE: EDGE DEVELOPMENT IN NORTH SEA CONTEXT

Source: Made by author.
5.3 REFLECTION

The characteristics of the North Sea context and the collective impact of precipitation and sea level rise will shape new coastline in the future, making the areas between the current coastline and projected shoreline, an ideal lab for exploring the coexistence between the built-up environment and the landscape. Besides, the urbanization process that emphasizes the social-economic development in the last century, had exacerbated the occupation of the land and the depletion of landscape, especially in the case of Southend On-Sea, a seaside resort located in the lower Thames Estuary. These aspects led to the possibility of new urbanization logic based on carrying capacity of landscape and emphasizes nature comes first, and then framed the research question, “How to systematically design urban landscape infrastructure and urban programmes based on carrying capacity of the landscape structure?”

In order to address my graduation project which explores the possibilities of shifting the social-economic oriented urbanization paradigm to a sustainable one, several research processes were employed to build up the framework of my research. The research processes consist of two aspects, the first aspect is the observation of spatial-temporal context, 3x3x3 analysis, which integrate three physical layers of landscape, infrastructure and built-up environment, in the temporal dimension and in three geographical scales. The second aspect is the investigative process of defining carrying capacity of the landscape structure, which mainly refers to the concept of three physical layers of landscape, infrastructure and built-up environment, in the temporal dimension and in three geographical scales. In this case, the information from the analytical framework is usually very complex and dynamics. Therefore, in the process of designing the projects, I divided the guidance and principles from the precedent research in Process as Values, in the book Design with Nature by Ian McHarg. The core of the research comes from the second aspect, referring to the ranking criteria in Process as Values, the analytical framework in this research process consists of 16 elements in six aspects-topography, geology, hydrology, vegetation, wildlife and land use. There are three key conclusions or outcomes in meso scale, the land use suitability comes from the synthesis of all the elements. The general principle for urbanization gradients is concluded from soil unit typologies. And the Landscape Infrastructure Matrix comes from the synthesis of soil unit typologies, contour and terrain analysis.

As the conclusions of the research, the three outcomes mentioned above define the carrying capacity of landscape in three aspects-urban functions, density control of urban form, ecological network design respectively. More specifically, the land use suitability is the guidance for land use, the general principle for urbanization gradient is the parameter of density, and the urban landscape infrastructure matrix is the meso scale structural design.

So far, I think the research approaches are quite clear, coherent and feasible. However, reviewing my research process, there were still several obstacles. The biggest challenge for me, coming from the general principle, is the division of design urban landscape infrastructure. At first, I was stubborn about designing the landscape infrastructure by choosing and transforming the existing infrastructure, which did not touch the core of my thesis topic. My tutors also had reminded me to temporarily forget the existing urban form and infrastructure, and to locate and design the landscape infrastructure just based on the landscape structure and characteristics. Through the adjustment of research and design methods, the three outcomes mentioned above had been finally sorted out. And I also learnt about that the design of urban landscape infrastructure, in my case, is not only the transformation and greening of the existing infrastructure, but also the adjustment of density index in different urban islands based on carrying capacity of landscape structure, so as to change the urban form, then to release the space systematically to generate the urban landscape infrastructure matrix.

To emphasize the consistency in research and design, the process of design by research is mainly based on the comparison of existing urban form and the outcomes based on carrying capacity. In this case, the information from the analytical framework is usually very complex and dynamics. Therefore, in the process of designing the projects, I divided the guidance and principles from the analytical framework into two parts-patchy interventions and linear interventions, so as to emphasize the coherence between research and design. More importantly, during the design process, another challenge is to eliminate some non-core elements in the analytical framework and highlight my own decision about what kind of city Southend will become, then create the conditions for the new space and new life under the premise of priority that nature comes first. This is the most important part to reflect my own values and positions in this project.
APPENDIX
A1 THEORY PAPER
A2 SELF ORGANIZED WORKSHOP REPORT
A3 DATA SET
A4 EXPLANATION OF INTERVENTION LIBRARY
Abstract

In the old urbanization paradigm, which is socio-economic-target oriented, the inertia of urban development process and the neglect of values of ecological services has caused the high degree of soil sealing not only disrupts a variety of natural processes, but also directly aggravate the threats and damage from hydrological hazards in the context of climate change. Nowadays, the state of the environmental issue has generated a sense of shifting the urbanization paradigm from socio-economic oriented to nature-come-first. The urgency of redesign the built environment (especially urban infrastructure) and landscape system has gradually increased. Recently, the concept of urban landscape infrastructure is being used as an armature for urban development and for facilitating functional, social and ecological interactions. This review paper will explore the possibilities of applying urban landscape infrastructure in high-density urban areas to re-establish the role of design as an integrated practice for reversing the urbanization paradigm. Therefore, this paper will start with the complexity of economic, ecological and social systems, and defines the main theoretical tool to understand urban ecosystems. Then subfield of urban ecosystems- urban ecology and landscape ecology will be discussed and explored to outline theoretical tools for decoding the information in urban ecosystems. This paper will finally shift into the design approach, and review the theory of urban landscape infrastructure to support the possibility of the design process in the context of shifting development paradigm and climate-change-related hydrological threats.

Keywords: urban landscape infrastructure, complexity theory, urban ecology, landscape ecology

1 Introduction:

The Shifting Urbanization Paradigm

From nineteenth century, the natural landscape had been controlled by the human in favour of socio-economic growth. The causal relation among the land consumption, urban sprawl and soil sealing has become clearer, t he rapid urban development process and the neglect of values of ecological services has caused the high degree of soil sealing not only disrupts a variety of natural processes, but also directly aggravate the threats and damage from hydrological hazards in the context of climate change. Nowadays, the state of the environmental issue has generated a sense of shifting the urbanization paradigm from socio-economic oriented to nature-come-first. The urgency of redesign the built environment (especially urban infrastructure) and landscape system has gradually increased. Recently, the concept of urban landscape infrastructure is being used as an armature for urban development and for facilitating functional, social and ecological interactions. This review paper will explore the possibilities of applying urban landscape infrastructure in high-density urban areas to re-establish the role of design as an integrated practice for reversing the urbanization paradigm. Therefore, this paper will start with the complexity of economic, ecological and social systems, and defines the main theoretical tool to understand urban ecosystems. Then subfield of urban ecosystems- urban ecology and landscape ecology will be discussed and explored to outline theoretical tools for decoding the information in urban ecosystems. This paper will finally shift into the design approach, and review the theory of urban landscape infrastructure to support the possibility of the design process in the context of shifting development paradigm and climate-change-related hydrological threats.

Another widely accepted model related to the complexity of human and nature system is the Abiotic, Biotic and Cultural (ABC) resource model. (Ahern, 2007) This resource model has the consistent perspectives with landscape ecology theory, and reveals the process of human needs and interactions with the abiotic and biotic systems. Compared with single purpose policy and planning, this multipurpose and multifunctional resource model supports the key paradigms of sustainable principles, which are easier accepted and supported by the public. Above perspectives also articulate the key of
applying urban landscape infrastructure successfully is to combine the key ecological functions and cultural functions through time and across scales. (Ahern, 2007)

Given the broadness of discussion of complexity theory, I will focus on the more specific field of urban and landscape ecology, to further explore the principles from urban and landscape ecology for urban landscape infrastructure, and to explore the theoretical basis and method of combination of ecological functions and cultural functions through urban landscape infrastructure and urban sustainability programmes.

2.1 Urban Ecology

As mentioned above, to explore the possibility of shifting the urbanization logic, we should zoom into the subfield of ecology-urban ecology and landscape ecology, to review and discuss the models about the human-ecological systems. Cities are hybrid phenomena, which is not a simple combination of human system and ecological system. (Alberti, 2008) The theory of urban ecology is also a hybrid between urban and ecological theory, and explains the mechanisms of behaviours of urban ecosystems. In other words, urban ecology is the study of the interactions between human and ecological processes in urban ecosystems, and explore how these interactions make human and ecological patterns emerge. (Alberti, 2008) The patterns mentioned above means the information of vital underlying processes and structures in urban ecosystems. The integrated model to understand the patterns is the pattern-oriented modelling, POM, which requires to observe patterns through scales and testing the hypothesis of urban ecosystems. (Grimm et al., 2005) Therefore, to analyse the basic patterns like structure and functioning of patches and mosaics through the time and scales is the theoretical tool to understand the interactions between human and ecological systems. In the next section of landscape ecology, I will systematically review and introduce the theoretical tool of decoding the basic element and patterns of urban and landscape ecology, as a supplement.

Besides, in such adaptive and nonlinear systems, the existing landscape patterns can only be explained through the existing changes and driving force. The chance events happening locally and regionally reinforce most of the changes in such adaptive systems. (Alberti, 2008) That is, the analysis of local and regional chance events through time is also important for the explanation and projections of the further impacts and development in these systems. Again, the spatial-temporal approach mentioned above- 3x3x3 layer analysis- is the essential tool to build the connections between the historical or existing events and projective changes/patterns and dynamics in urban ecosystems.

Hydrological threats in Urban Ecology

Urban ecosystems provide vital ecological services for urban residents as well as other creatures. (Ahern, 2014) In this part, I will briefly discuss how urban development influences the ecological services of hydrological performance in the urban ecosystems, and what kinds of elements we should focus on in the research. The urban development modifies the nature water resources like river and streams, which will also change the volume and delivery of surface runoff in the precipitation process. The sealed surfaces, such as parking lots, roads stop the infiltration process, which will increase the amount and speed of run-off. Once the artificial drainage system cannot support the capacity of water conveyance, the flood will happen in the urbanized watersheds. That is why the floods are larger, and the peak flows are more often in the urban ecosystems. Therefore, several elements related to the hydrological threats should be highlighted-the rate of change of hydrologic conditions, frequency and timing of the stream flows, run-off volume. (Alberti, 2008) Furthermore, the size and location of the patterns of urban ecosystems (such as urban patches) as well as the changes of the land cover type through the time, will directly affects the performance of urban ecosystems in different hydrologic regimes.

According to the discussion above, it is essential to explain how to systematically decode the urban and landscape ecology when talking about the shift of the urbanization logic from socio-economic oriented paradigm to ecological first paradigm. In the next section, I will discuss the theoretical models about it.

2.2 Landscape Ecology

To systematically decode the information of urban ecosystems, landscape ecology will be briefly reviewed and discussed, as an essential sub-field to help specifically define the theoretical tools and models.

In the past decades, landscape ecology has become a comprehensive discipline revealing the dynamics and spatial structure of the landscape. A brief review of landscape ecology, as a starting point, will be useful for articulating the principles of landscape ecology for urban landscape infrastructure. From 1950 to 1980, due to the development of aerial photography, the term, landscape ecology was first used to describe the specific spatial pattern of landscape, and in this phase, the landscape ecology was simply the ecology of regions. (Dramstad et al., 1996) Then the “land mosaic” phase arrived since 1980, when landscape ecology began to emerge as integrative discipline, including habitat fragmentation, corridors and connectivity, quantitative methodology, heterogeneity and boundaries and so on. During this phase, one of the typical and universal model of landscape ecology from Richard Forman defined the basic elements of landscape ecology: patch, corridor and matrix. (Forman, 1995)

A patch is a relatively homogeneous area which is not a linear area, and is different from its surroundings. Patches should be analysed according to their size, number and location, which will tell whether the patches are beneficial or harmful to the functioning of landscape. (Ahern, 2007) Patches are connected by corridor, a kind of linear land cover type that differs from its context, like a river, canals. (Forman, 1995) The corridor provides landscape connectivity to alleviate the isolation and fragmentation, especially for species movement. (Dramstad et al., 1996) Besides, river and stream systems are also important corridors in the landscape, and the ecological integrity of this kind of corridor directly determines the ecological performance in the context of climate-change related hydrological threats. Therefore, the corridor should be analysed in term of connectivity, width and typology-such as barrier, stepping stones, corridors. (Forman, 1995) The last basic element is matrix, which is the dominant land type in its context. Matrix has high degree of connectivity and continuity, with high dynamics in its landscape context. (Forman, 1995)

Nowadays, the characteristics of landscape ecology are well defined in three main parts: structure, functioning and change. The structure of landscape ecology means the spatial pattern of landscape element mentioned above. Functioning is happening through the structure, representing the movement of fauna and flora, flows of water, wind, energy and materials. The change means the dynamics of structure and functioning through time. (Dramstad et al., 1996)

2.3 Reflection of Urban Landscape Elements

As a short reflection, Table 1 shows the examples of urban landscape elements classified in Land Mosaic Models, and provides possible analysis elements. Observing through time, we can tell which artificial infrastructures -like railway, road, etc- are barriers to break the landscape continuity, and to block a series of ecological activities, further to cause the fragmentation of landscape. We can also figure out which human activities, for example, land reclamation and soil sealing, will disrupt the biotic and abiotic process. Vice versa, this analysis method and process also help us to determine which land and elements need to be maintained or enhanced for ecological services. Acknowledging these information helps us to evaluate the necessity of urban programmes as well as the landscape protection programmes, and provide proof for changing the occupation patterns.

Table 1 Examples of Urban Landscape Elements Classified in Land Mosaic Model (Ahern, 2007)

<table>
<thead>
<tr>
<th>Patches</th>
<th>Corridors</th>
<th>Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parks</td>
<td>Rivers</td>
<td>Residential Neighbourhoods</td>
</tr>
<tr>
<td>Sports fields</td>
<td>Canals</td>
<td>Industrial Districts</td>
</tr>
<tr>
<td>Wetlands</td>
<td>Drainages</td>
<td>Waste Disposal Areas</td>
</tr>
<tr>
<td>Gardens</td>
<td>Riverways</td>
<td>Commercial Areas</td>
</tr>
<tr>
<td>Campuses</td>
<td>Roads</td>
<td>Mixed-Use Districts</td>
</tr>
<tr>
<td>Parking lots</td>
<td>Powerlines</td>
<td></td>
</tr>
</tbody>
</table>

3 Design Approach for the Shifting Urbanization Paradigm: From ‘Networks’ to ‘Locations’

In last section, I already discuss the perspectives that urban ecosystems as complex systems, have their own dynamics and changes through scales
After the discussion of the concept of urban landscape infrastructure, its possibilities for territorial strategy and local interventions will be explored in the following section. There are three typical potential fields—transport, green and water landscape infrastructures. (Nijhuis and Jauslin, 2015)

The first field consists of diverse modes of facilities related to transportation, energy supply, waste treatment and information communications. When these facilities become multi-functional and integrate technical, aesthetic and social values, these systems, as urban landscape infrastructure, can create conditions for future urban development, and changes for new public space as a transit landscape. (Nijhuis and Jauslin, 2015)

The second field is a set of systematic green space networks which maintain the ecosystem values and create social-economic benefits. The land mosaic concept mentioned above is a great example to guide the design process, and to create an interconnected system formed from green patches, corridors and matrixes. The green landscape infrastructure is important for increasing the run-off capacity in the built environment.

The last type is related to the water, and is about coastal and river management. (Nijhuis and Jauslin, 2015) When it is in the context of climate-change-related hydrological threats, the design focus of this field will be flood control systems and the urban drainage system. In UK, a good example is SuDS-sustainable drainage systems—which has several stages to achieve storm water management. Firstly, it is the source control and infiltration, which helps to decrease the volume of water flowing into the river or drainage network, such as the forest patches/corridors in the upstream to soak the source. The second stage is the pre-treatment and conveyance, which mean the drainage and bioswale system to purify the water and quickly discharge to water courses and aquifers. The last stage is storage, which means the stormwater detention and retention, such as parking lots and ponds providing storage. This case well implies how the design of urban landscape infrastructure performs across scales as a territorial strategy. (Bacchin, 2015)

**Networks: Urban Landscape Infrastructure as Territorial Strategy**

As mentioned above, urban landscape infrastructure is a new approach, as a territorial strategy, to secure the provisioning of ecosystem services in human-dominated landscapes, and performance as structurally system in urban ecosystems towards the future development. (Colding, 2011) This implies that urban landscape infrastructure design is a construction process of landscape itself to create conditions for the future, not a process of adding constructions in landscape. (Nijhuis and Jauslin, 2015) As a kind of spatial design, the design of urban landscape infrastructure emphasizes several characteristics, such as multi-functionality, integration and connectivity, strategies through time, and interdisciplinary design process. (Nijhuis and Jauslin, 2015) And the multi-functionality can be identified and assessed according to the ecosystem services which should be maintained or enhanced in urban landscape infrastructure. Besides, the design of urban landscape infrastructure is also about achieving the purpose of sustainable ecosystem services while respecting societal needs and values. (Ahern et al., 2014) Therefore, urban landscape infrastructure can contribute to a more integrative approach towards a new urbanization paradigm where social, economic and ecological systems are inseparably intertwined. (Bacchin et al., 2014)

Locations: urban programmes based on carrying capacity

In fact, the ‘space of places’ is also an important part in the design of urban landscape infrastructure, since the ‘locations’ are also involved in ‘networks’, that is urban landscape infrastructure also organises the space of places. (Nijhuis and Jauslin, 2015) Therefore, this part, as a supplement, will briefly review several examples to introduce some classic principle for urban programmes based on carrying capacity.

The first classic example is The Valley Section from Patrick Geddes, which implies taking the whole region to make the city. The valley section, as a complex model, combines physical conditions with natural/basic occupations and human settlements considering the geological and geomorphological context. Secondly, another classic example comes from the book Design with Nature by Ian McHarg about the systematic layer approach. A basic methodology about overlapping the layers to conclude the geomorphological characteristics of the context as tool to evaluate whether the urban programme is appropriate in its geographical context considering the carrying capacity. This book also provided some classic criteria to evaluate the constraints from the nature system and also the potential impact and synergy from urban landscape development. These systematic criteria consist of layers from climate, geology, physiography, hydrology, pedology, vegetation, wildlife and land use, and then evaluate the potential value for the land use, that is, evaluate urban programmes based on carrying capacity. (McHarg, 1969)

As a supplement for ‘space of flows’, these two classic examples show the necessity of natural physical characteristics analysis as an important background to support the ‘space of flows and places’. It shows the logic that how urban landscape infrastructure and urban sustainable programmes interconnect with each other based on the synergy of complexity of landscape.

4 Conclusion

According to the theoretical review and discussion above, the logic of urbanization has been shifting since cities should be understood as complex economic, ecological and social systems. The old urbanization paradigm, which is social-economic target oriented, is not valid anymore, considering the upcoming challenge of human and nature development in the context of climate change. Urban ecosystems, as complex systems, should be analysed through time and across scales to understand the dynamics and patterns in such systems. The theory of urban ecology and landscape ecology specifically elaborates the theoretical tools, like POM model and Land Mosaic model to decode the information in urban ecosystems and understand the interactions and dynamics between the built environment and landscape. In this stage, it also points out that the key of successful design for urban ecosystems is to combine the essential ecological functions and cultural functions through time and across scales. (Ahern, 2007) The concept of urban landscape infrastructure is a practical example to apply design in urban ecosystems to enhance the ecological services and provide social cohesions at the same time. Besides, the design of urban landscape infrastructure emphasis the ‘space of places’ and the ‘space of places’, which means the integration of the transport, green, blue landscape infrastructure and urban programmes based on carrying capacity of landscape structure. The practical deployment of urban landscape infrastructure also implies that the single purpose/discipline constructions and projects cannot fit the shifting urbanization logic anymore, a more flexible and interdisciplinary spatial intervention for interrelating systems is increasingly essential in this shift. (Nijhuis and Jauslin, 2015) This concept also brings difficulties and challenges to policy making, since the fixed policy and strategy is doomed to fail in this context of dynamics. It is time for human to embrace the uncertainty and unpredictability, and enjoys the dynamics in such complex urban ecosystem.
References


Colding, J. (2011). The role of ecosystem services in contemporary urban planning.


Self-Organize Workshop Report

Self-Organize Workshop Report
AR3U040 Graduation Orientation

Group part

1. Title: Building with nature

2. Date: 8th, March

3. Main scope:

More than half of the world’s population lives in urban areas located near rivers, deltas or coastal areas. Accommodating this growing population will involve the development of infrastructure, such as harbors, access channels, land reclaims and flood defenses. Additionally, sea level rise and climate change are also enhancing the demand for adaptable designs. Under this condition, if we want to maintain delta environments around the world, and the ecosystem services they provide, we need to make a transition from the present building in nature to building with nature.

Building with nature is a concept where nature is used to cope with climate change risks, such as floods, waves and sea level rise. It utilizes the strengths of the natural system in infrastructural and hydraulic construction, and at the same time considers nature as an integral part of the design from the start of the project development process; this is ‘eco-dynamic design’. With the help of new insights, nature itself is then used as an ‘engine’ for strengthening ecosystems, thus making both the constructions and the natural system more sustainable.

The Netherlands has also adopted this new, proactive approach to developing its extensive coastal and river works. Rather than simply minimizing or mitigating the environmental impact of harbors, navigation channels, land reclaims and flood defenses, the idea is to make use of the dynamics of the natural environment and provide opportunities for natural processes. Existing concepts and ideas have been further developed and tested in several full-scale pilot experiments, including sand engines, oyster reefs, wave-attenuating forests and so on.

This workshop intends to give us an overall introduction of this approach – Building with Nature. To answer the research question: “How can we implement the theory Building with Nature and what design principle shall we use in the development process of a specific project?”, a lecture will be given on a practical project along with the preliminary results and lessons learned. Through this workshop, we claim that building with nature can be a new approach to successfully address the uncertainties that we are going to face in the future.
As the Delta Intervention research group investigates the possibilities to combine flood protection and water management strategies with urban design, landscape design and spatial planning, aiming at improving spatial forms and structures in urban and metropolitan delta regions... to make urban delta landscapes more sustainable, attractive and adaptive. The concept of designing with nature is one of the important branches of research field in this studio.

With the help of this workshop, we hope to support our graduation projects systematically and pertinently, help us to explore how to apply these theories and concepts in different national contexts and landscape contexts (such as UK, NL and etc.) On the other hand, for classmates of other graduation studio and MSc 1/2 students, this workshop is a wonderful opportunity to promote communication between different graduation studios and introduce the main scope of building with nature to these future urbanists.

Specifically, this workshop aims at exploring how to implement the theory Building with Nature and what design principles should be introduced in the development process for a specific project in different territorial contexts and different landscape conditions. Through this workshop, we claim that building with nature can be a new approach and concept to successfully address the uncertainties that we are going to face in the future, and create the new balance between human system and the natural system.

### 5. Students Organizers List

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Yichuan Huang 4622650  
Junzhong Chen 4606779  
Qing Ma 630963  
Wentong Wang 4618572  
Wenxin Jin 4617452

### 6. Participants:

Urbanism and Landscape Architecture Students  
Students from Harbin University  
All the members who are interested in this topic

### 7. Lecturer list:

Name: Steffen Nijhuis

### 8. What specific issues considered at the workshop will clarify specific issues on you OWN research- What are the specific question that will be clarify, reveal or dimensional within.

Junzhong Chen 4606779  
Over 220km² of the UK’s land surface was transformed from farmland, forests or wetlands to urban development in just six years up to 2012. Soil sealing is happening and even accelerating in UK, to enhance transport infrastructure and start numerous construction projects. The cost of this old development paradigm, which emphasizes the significant socio-economic development, is to seal the land, to erode the landscape structure, and to weaken the ecological services. In the context of climate-change, the delta and coastal areas have been exposed to climate-change related hydrological threats. In the long-term, it is necessary to prepare and introduce sea defense interventions. In the short-term, influenced by the extreme rainfall events or record tide events, as well as the insufficient surface-water run-off system, surface water flood should be noticed. It is time to rethink the development paradigm and consider that nature comes first.

Therefore, my project aims at changing the logic of urbanization, and emphasizing nature comes first. On the one hand, urban landscape infrastructure should be implemented in the region as a territorial strategy. On the other hand, urban projects/programs will be introduced in different areas of the region (upstream, middle stream and downstream) based on the carrying capacity of the landscape structure. The brand-new development paradigm is providing for the micro-climate regulations, flood risk management as well as new tourism attractions.

The workshop provides the theoretical and practical logic and approach to explore how to systematically design the urban landscape infrastructure and urban form based on the carrying capacity of landscape structure and reduce the influence of soil sealing and human construction activities on the landscape, and also preserve void space for a sustainable and resilient future. The theoretical and implement exploration mentioned above is the most important input for my graduation process.

Besides, the concept building with nature is also helping me to rethink how to shift the old development paradigm to a sustainable one and explore the planning and design process considering the idea of nature comes first. The workshop clarifies the catastrophic consequences of predatory exploitation of the landscape and emphasizes the indispensable relationship between human and nature, points out that we should regard human beings as a part of the entire biological world to cope with the interaction between the human and nature. The design and planning should adapt to the natural environment to seek maximum development according to the environmental tolerance and rethink the development of human society as a part of process of natural evolution.
### A3 DATA SET

#### A3.1 Data of Tides

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<tr>
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<td>0.94</td>
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<td>5.66</td>
</tr>
</tbody>
</table>

---

### Standard MSL in Celsius

- AVG: 1.06
- MAX: 1.25
- MIN: 0.89

---

### HW-MHW

- AVG: 0.31
- MAX: 0.45
- MIN: 0.17

---

### MHW

- AVG: 0.33
- MAX: 0.48
- MIN: 0.19

---

### MHW

- AVG: 0.35
- MAX: 0.52
- MIN: 0.21
# A3 DATA SET

## A3.2 Evaluation Data of Urban Functional Transformation

<table>
<thead>
<tr>
<th>Before</th>
<th>Commercial</th>
<th>Education</th>
<th>Residential</th>
<th>Industrial</th>
<th>Coastal Commercial</th>
<th>Transport</th>
<th>Parking Place</th>
<th>Other Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>ha</td>
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<td>0.914432195</td>
<td>6.524171522</td>
<td>4.0527</td>
</tr>
<tr>
<td>AVG L</td>
<td>2.33</td>
<td>4.8</td>
<td>2.3</td>
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<td>1</td>
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<tr>
<td>Gross Area</td>
<td>32.6620863</td>
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<td>20.6244979</td>
<td>6.915734399</td>
<td>0.689216993</td>
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<td>Parking Place</td>
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<table>
<thead>
<tr>
<th>After</th>
<th>Commercial</th>
<th>Education</th>
<th>Residential</th>
<th>Industrial</th>
<th>Coastal Commercial</th>
<th>Transport</th>
<th>Parking Place (Surface)</th>
<th>Conference/Office</th>
<th>Other Function</th>
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<tr>
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<tr>
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<td>Parking Buildings</td>
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## A3.3 Evaluation Data of Density Gradients

<table>
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<th>Before</th>
<th>After</th>
<th>Before</th>
<th>After</th>
<th>Before</th>
<th>After</th>
<th>Before</th>
<th>After</th>
<th>Before</th>
<th>After</th>
<th>Before</th>
<th>After</th>
<th>Before</th>
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</thead>
<tbody>
<tr>
<td>Area of Aggregation (ha)</td>
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<td>Foot Print (ha)</td>
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<td>5.218123</td>
<td>4.768989</td>
<td>2.002057</td>
<td>1.984769</td>
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<td>0.715191</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Gross Floor Area (ha)</td>
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<td>20.34744</td>
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<td>9.478194</td>
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<td>0.715191</td>
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<td>0.091691</td>
<td>0.523565</td>
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<td>9.906181</td>
<td>9.906181</td>
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<td></td>
</tr>
<tr>
<td>Green Space (%)</td>
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<td>0.641821</td>
<td>9.906181</td>
<td>9.906181</td>
<td>0.3984</td>
<td>0.308710</td>
<td>0.091691</td>
<td>0.091691</td>
<td>0.523565</td>
<td>0.641821</td>
<td>9.906181</td>
<td>9.906181</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### A3.4 Calculation of Surface Water (Before)

#### Land cover type:

<table>
<thead>
<tr>
<th>Year area in m²</th>
<th>Dependent variable</th>
<th>infiltration loss</th>
<th>Specific storage</th>
<th>Delay</th>
<th>Your area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface water</td>
<td>0</td>
<td>0</td>
<td>0.5 m³/m²</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rain garden, infiltration field</td>
<td>98000</td>
<td>2940</td>
<td>25</td>
<td>75</td>
<td>0.1 m³/m²</td>
</tr>
<tr>
<td>Lawn, garden, green belt, shrub</td>
<td>128000</td>
<td>3840</td>
<td>15</td>
<td>50</td>
<td>0.1 m³/m²</td>
</tr>
<tr>
<td>Play ground, sports field</td>
<td>4800</td>
<td>150</td>
<td>5</td>
<td>5</td>
<td>0.1 m³/m²</td>
</tr>
<tr>
<td>Vegetated water</td>
<td>875</td>
<td>26.25</td>
<td>10</td>
<td>2.5 m³/m²</td>
<td>160</td>
</tr>
</tbody>
</table>

**Paved**

<table>
<thead>
<tr>
<th>Year area in m²</th>
<th>Dependent variable</th>
<th>infiltration loss</th>
<th>Specific storage</th>
<th>Delay</th>
<th>Your area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof – sloping</td>
<td>149100</td>
<td>100</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof – flat, tar</td>
<td>120800</td>
<td>3624</td>
<td>5</td>
<td>0</td>
<td>0.05 m³/m²</td>
</tr>
<tr>
<td>Green roofs – extensive</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0.1 m³/m²</td>
</tr>
<tr>
<td>Green roofs – intensive</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>0</td>
<td>0.2 m³/m²</td>
</tr>
<tr>
<td>Roads, car parks – asphalt</td>
<td>200400</td>
<td>6012</td>
<td>1</td>
<td>0</td>
<td>0.05 m³/m²</td>
</tr>
<tr>
<td>Roads, car parks – porous asphalt</td>
<td>150300</td>
<td>4509</td>
<td>1</td>
<td>40</td>
<td>0.05 m³/m²</td>
</tr>
<tr>
<td>Roads, car parks – brick</td>
<td>150300</td>
<td>4509</td>
<td>3</td>
<td>10</td>
<td>0.05 m³/m²</td>
</tr>
<tr>
<td>Roads, car parks – porous pavement</td>
<td>50100</td>
<td>1503</td>
<td>3</td>
<td>40</td>
<td>0.05 m³/m²</td>
</tr>
<tr>
<td>Sidewalk, terrace, tiles</td>
<td>19000</td>
<td>570</td>
<td>3</td>
<td>8</td>
<td>0.05 m³/m²</td>
</tr>
</tbody>
</table>

**Total Area**

<table>
<thead>
<tr>
<th>Year area in m²</th>
<th>Dependent variable</th>
<th>infiltration loss</th>
<th>Specific storage</th>
<th>Delay</th>
<th>Your area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1029770</td>
<td>26205.1</td>
<td></td>
<td></td>
<td></td>
<td>-20904</td>
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</tbody>
</table>

### A3.4 Calculation of Surface Water (After)

#### Land cover type:

<table>
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<tr>
<th>Year area in m²</th>
<th>Dependent variable</th>
<th>infiltration loss</th>
<th>Specific storage</th>
<th>Delay</th>
<th>Your area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface water</td>
<td>0</td>
<td>0</td>
<td>0.5 m³/m²</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rain garden, infiltration field</td>
<td>98000</td>
<td>2940</td>
<td>25</td>
<td>75</td>
<td>0.1 m³/m²</td>
</tr>
<tr>
<td>Lawn, garden, green belt, shrub</td>
<td>128000</td>
<td>3840</td>
<td>15</td>
<td>50</td>
<td>0.1 m³/m²</td>
</tr>
<tr>
<td>Play ground, sports field</td>
<td>4800</td>
<td>150</td>
<td>5</td>
<td>5</td>
<td>0.1 m³/m²</td>
</tr>
<tr>
<td>Vegetated water</td>
<td>875</td>
<td>26.25</td>
<td>10</td>
<td>2.5 m³/m²</td>
<td>160</td>
</tr>
</tbody>
</table>

**Paved**

<table>
<thead>
<tr>
<th>Year area in m²</th>
<th>Dependent variable</th>
<th>infiltration loss</th>
<th>Specific storage</th>
<th>Delay</th>
<th>Your area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof – sloping</td>
<td>149100</td>
<td>100</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roof – flat, tar</td>
<td>120800</td>
<td>3624</td>
<td>5</td>
<td>0</td>
<td>0.05 m³/m²</td>
</tr>
<tr>
<td>Green roofs – extensive</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0.1 m³/m²</td>
</tr>
<tr>
<td>Green roofs – intensive</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>0</td>
<td>0.2 m³/m²</td>
</tr>
<tr>
<td>Roads, car parks – asphalt</td>
<td>200400</td>
<td>6012</td>
<td>1</td>
<td>0</td>
<td>0.05 m³/m²</td>
</tr>
<tr>
<td>Roads, car parks – porous asphalt</td>
<td>150300</td>
<td>4509</td>
<td>1</td>
<td>40</td>
<td>0.05 m³/m²</td>
</tr>
<tr>
<td>Roads, car parks – brick</td>
<td>150300</td>
<td>4509</td>
<td>3</td>
<td>10</td>
<td>0.05 m³/m²</td>
</tr>
<tr>
<td>Roads, car parks – porous pavement</td>
<td>50100</td>
<td>1503</td>
<td>3</td>
<td>40</td>
<td>0.05 m³/m²</td>
</tr>
<tr>
<td>Sidewalk, terrace, tiles</td>
<td>19000</td>
<td>570</td>
<td>3</td>
<td>8</td>
<td>0.05 m³/m²</td>
</tr>
</tbody>
</table>

**Total Area**

<table>
<thead>
<tr>
<th>Year area in m²</th>
<th>Dependent variable</th>
<th>infiltration loss</th>
<th>Specific storage</th>
<th>Delay</th>
<th>Your area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1074825</td>
<td>27871.75</td>
<td></td>
<td></td>
<td></td>
<td>-20904</td>
</tr>
</tbody>
</table>

### Calculation of Surface Water

Formula: $A = 0.03 - \text{Depression storage} \times 0.001 - 2 \times \text{Infiltration loss} \times 0.001$ m²

Explanation:

- $A$ is the amount of water per hour
- Infiltration loss needs to be doubled

NB: Calculation is suitable for a flat urban area; sandy topsoil.

Land cover type:

<table>
<thead>
<tr>
<th>Surface in m²</th>
<th>Dep</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 m³/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1 m³/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2 m³/m²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Surface Water in Two Hours = m³**

- **[mm]**
- **[mm/h]**
- **Capacity**
- **[min]**

<table>
<thead>
<tr>
<th>Land cover type</th>
<th>Surface in m²</th>
<th>Depend</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unpaved</td>
<td>0</td>
<td>0</td>
<td>0.5 m³/m²</td>
</tr>
<tr>
<td>Rain garden, infiltration field</td>
<td>98000</td>
<td>2940</td>
<td>25</td>
</tr>
<tr>
<td>Lawn, garden, green belt, shrub</td>
<td>128000</td>
<td>3840</td>
<td>15</td>
</tr>
<tr>
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</tr>
<tr>
<td>Vegetated water</td>
<td>875</td>
<td>26.25</td>
<td>10</td>
</tr>
</tbody>
</table>

**Paved**

<table>
<thead>
<tr>
<th>Land cover type</th>
<th>Surface in m²</th>
<th>Depend</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof – sloping</td>
<td>149100</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
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<td>3624</td>
<td>5</td>
</tr>
<tr>
<td>Green roofs – extensive</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Green roofs – intensive</td>
<td>0</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Roads, car parks – asphalt</td>
<td>200400</td>
<td>6012</td>
<td>1</td>
</tr>
<tr>
<td>Roads, car parks – porous asphalt</td>
<td>150300</td>
<td>4509</td>
<td>1</td>
</tr>
<tr>
<td>Roads, car parks – brick</td>
<td>150300</td>
<td>4509</td>
<td>3</td>
</tr>
<tr>
<td>Roads, car parks – porous pavement</td>
<td>50100</td>
<td>1503</td>
<td>3</td>
</tr>
<tr>
<td>Sidewalk, terrace, tiles</td>
<td>19000</td>
<td>570</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Area**

<table>
<thead>
<tr>
<th>Year area in m²</th>
<th>Dep</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1029770</td>
<td>26205.1</td>
<td>-20904</td>
</tr>
</tbody>
</table>

Total surface of the area: 100%

<table>
<thead>
<tr>
<th>Year area in m²</th>
<th>Dep</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1074825</td>
<td>27871.75</td>
<td>-20904</td>
</tr>
</tbody>
</table>

Total surface of the area: 100%
A4 EXPLANATION OF INTERVENTION LIBRARY

Strategic Information of Area 1

### COMMERCIAL+EDUCATION+RECREATION

- Back Yard Of City Center
- Interweaving The Green-Blue Networks In The City Center

### Strategic Intervention 1
- Intensify The Commercial /Educational Center
- Reconnect Small Green Patches To The Corridor

### Strategic Intervention 2
- Rearrange The Inefficient Land Use Near The City Center
- Release Space To Generate A Green Corridor

### Strategic Intervention 3
- Reduce The Water Source In The Upstream
- Enhance The Wildlife Movement Between Inland & Coast

### Strategic Intervention 4
- Add Various Programmes Along The Green Corridor

Intervention Library of Engineering and Technical Guidance

Based on the strategies mentioned above, the four strategic interventions mentioned above will be decomposed into the intervention library to give more specific spatial pattern for the design process with technical and engineering guidance. The intervention library will be separated into two parts, linear interventions and patchy interventions.
A4 EXPLANATION OF INTERVENTION LIBRARY

Conveyors intervention means to create the linear permeable surface, such as bioswales, in the concrete surface. This intervention layer consists of two parts, the conveyor transformation of roadway and pedestrian path.

The general technical guidance for the roadway transformation is to reduce concrete surface on the road and create the vegetated soil surface in the middle or two sides of the road (depending on the width of roads), and build a water tank beneath the soil surface then linked to the drainage system. The design of road surface design will be slightly inclined, so as to guide the water flow to the bioswales.

The intervention of conveyors in the pedestrian path is similar to the roadway interventions. The difference is to add the urban furniture like benches, sculptures on the new green surface, as a potential space for rest.

The road intervention includes the greening of the roads to improve the continuity of green open space, on the other hand, the greening of the roads is also related to the hydrological risk reducing.

The roads connecting the coastal and inland area need different strategies of water treatment, according to the different soil salinity. In the coastal area, the water tank is needed beneath the green surface to decrease the salinity of water, the surface water will be collected in the urban drainage system after treatment. In the inland area, the surface water will be directly collected into the drainage system.

The first part of the intervention library is linear intervention, which focuses on strategic interventions in the linear structure like conveyors, roads, pedestrian paths, shopping streets and other transport infrastructures.

As for the relatively narrow roads, the edges on the two sides of the road will be transformed into green surface which is connecting to the urban drainage system. And the road surface should be high in the middle and low on two sides in order to convey and collect the surface water.

As for the relatively wide road, the non-stop zones and the dividers can be transformed into green surface which is connecting to the urban drainage system. Unlike the narrow road, the design of wide road surface should be high on two sides and low in the middle in order to convey and collect surface water.
Similarly, the paths connecting the coastal and inland area need different strategies of water treatment, according to the different soil salinity. In the coastal area, the water tank is needed beneath the green surface to decrease the salinity of water. The surface water will be collected in the urban drainage system after treatment. In the inland area, the surface water will be directly collected into the drainage system.

For a better transport connection and better connection between wildlife habitats, some transport infrastructures should be adjusted. This layer of intervention includes the adjustment of layout of the coastal avenue and the Chichester Road. For the coastal avenue, the partial avenue near the cliff park will be cancelled and reconnect to the Clifftown Parade to ensure the landscape connection between the cliff park and the beach.

As for the Chichester Road, the intervention is about the layout rearrangement of central bus terminal and the Chichester Road itself. The decentralized terminal design will be changed into a centralized terminal so as to decrease the road density and the degree of soil sealing, then to set free the space for additional green space.

The first part of the intervention library is linear intervention, which focuses on strategic interventions in the linear structure like conveyors, roads, pedestrian paths, shopping street and other transport infrastructures.
The first situation is about the commercial building which blocks the connection between the existing green patches and the green corridor. The partial commercial building should be demolished to create the reconnections of green elements. Besides, as compensation, the additional floors can be added on the adjacent commercial buildings to create more commercial space.

The second part of the intervention library is patchy intervention, which focuses on strategic interventions in the patchy structure like urban block with different urban function, green space, public space and parking lots and so on.

This intervention layer is about the residential patches intervention in the east edge of the city center. The proposal is to transform the single-family house into the apartment buildings. On the one hand, it is because of the soil type and the location of the site, the edge area of the city center needs a middle density urban block as a transition area between the high density and low density area. Another reason is about the need for new public space of community activities.

The first layer of patchy intervention is the transformation of the industrial buildings, the soil type 3 allows the additional floor of industrial buildings, so as to decrease GSI and create more green open space. The additional floors also provide new mix-use space to combine the industry functions as well as office space for these industrial companies.

The second typology is the complex commercial buildings. For the complex commercial buildings blocking the green-element connection, the intervention is to decompose the complex building into several parts by demolishing the affiliated structures. On the one hand, it is to transform the interior facade as new commercial space, and also creates new green space connection inside. On the other hand, the additional floors can be added on one of the small part to achieve the mix-use of urban functions, such as commercial use, office and conference and so on.

The third typology is the commercial building near to the green corridors, the low height commercial building should be transformed into middle height buildings to create more space for the commercial function. Besides, new large green patches will be attached to the green corridor to enhance the ecosystem services.
A4 EXPLANATION OF INTERVENTION LIBRARY

**PARKING PATCHES INTERVENTION**

For the area with the soil type 4, which has low capacity of permeability, it should develop underground parking space to reduce the degree of soil sealing, the new vegetated surface can serve as water detention space to storage the surface water, and also serve as a stepping stone to enhance the wildlife movement.

The area with the soil type 4, which has low capacity of permeability, the existing green space should be transformed into the sunken green space and connect to the urban drainage system. When facing the record storm, the green space can work as retention space to store the water in the upstream to reduce the surface water.

For the area with the soil type 3, which has high capacity of soil strength and permeability, the surface parking lot should be transformed into the parking buildings to decrease the GSI, so as to create the green patches for infiltration and also serving as a stepping stone to enhance the wildlife movement.

For the area with the soil type 3, which has high capacity of soil strength and permeability, the green surface should be connect with the urban drainage system and other engineering which will enhance the infiltration process, such as infiltration trenches, soakaways, bioways, and so on.

The last aspect is to transform the solid concrete elevated railway structure into the overhead railway structure to release the permeable surface to the continuous green space, and also reshape the surface to improve the efficiency of water collecting. On the other hand, the new structure can also enhance the habitats connection.

**GREENLAND AND SQUARE PATCHES INTERVENTION**

The second part of the intervention library is patchy intervention, which focuses on strategic interventions in the patchy structure like urban block with different urban function, green space, public space and parking lots and so on.

**PATCHY INTERVENTIONS**
The North Sea context


Urban ecology and landscape ecology


Colding, J. (2011). The role of ecosystem services in contemporary urban planning.


Flood risk management study


Complexity theory


Urban landscape infrastructure and urban programme based on carrying capacity


Other websites

https://flood-map-for-planning.service.gov.uk/