SHRINKAGE-RESILIENCE

Shrinking cities in the longer term
Changing urbanisation patterns and resilience following climate catastrophes

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Shrinking cities in the longer term: Changing urbanisation patterns and resilience following climate catastrophes

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"Globally, future shrinkage will be more substantial because every country will experience some level of shrinking due to demographic changes. The issue of shrinkage cannot be resolved by cities, towns, or rural areas on their own; additional research into practical solutions and major legislative incentives are needed. Even in stable or growing areas, they should make preparations for probable future shrinkage. ***Shrinkage can be an opportunity to reshape urban spaces to be more sustainable and inclusive"***

(European Union 2022:1)

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I would like to express my heartfelt appreciation to my parents, Riefaat and Zarina Samsodien, for their unwavering support and for providing me with the opportunity to pursue an education and become the best version of myself.

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Lastly, I would like to dedicate this dissertation to my mother, who gave me the chance to start a new life and pursue my dreams. This work is a part of her legacy, and I hope that it reflects the resilience that she instilled in me.

Dedicated to my Guardian Angels

ABSTRACT

Coastal port-industrial areas are becoming increasingly significant due to urban shrinkage, population decline, and climate change. To address social and economic issues and enhance climate resilience, it is crucial to anticipate urban shrinkage in both stable and growing coastal areas that are undergoing economic transformation. Urban planning can better understand the dynamics of planning for urban shrinkage and climate resilience, as port-industrial areas have a large economic impact on nearby coastal communities.

This dissertation examines the long-term implications of urban shrinkage in coastal port-industrial areas in the context of climate change and sea level rise in England. The research problem is that current urban policy does not adequately address the challenges of urban shrinkage and climate resilience in these areas. The research questions are: What are the population changes in local areas in England? What effect does population decline have on changing urbanisation patterns in older industrial areas? What type of adaptation efforts were made in North East Lincolnshire, England, and Bremerhaven, Germany, in response to the 2013 tidal surge, and how did this affect urban shrinkage?

The dissertation applies an integrated concept of Shrinkage-Resilience as a framework for analysis. The methodology includes a review of existing models and frameworks, as well as case studies of international and local contexts. The findings suggest that between 2013-2019, 68% of older industrial areas (including coastal ports) in England are undergoing changing urbanisation patterns relative to population, land use, and green belt areas, and are key areas for urban policy, such as the Levelling Up agenda. One of the areas, North East Lincolnshire is discussed and compared to Bremerhaven. These examples demonstrate the link between Shrinkage-Resilience approaches and their practical implementation in coastal port-industrial areas affected by urban shrinkage.

This research advances the scientific practice of urban planning and policy-making for shrinking cities by introducing the approach of Shrinkage-Resilience, which emphasises the importance of considering long-term social, economic, and environmental impacts in urban shrinkage contexts. This approach is crucial in the transition to a more sustainable and inclusive society, where the welfare of present and future generations, the environment, and economic development are taken into account. The dissertation provides recommendations for urban planning to incorporate policy changes for shrinking cities and coastal port-industrial areas worldwide, to include disaster risk reduction and climate change adaptation approaches.

CONTENTS

CHAPTER 1: Introduction

1.1 Urban shrinkage in coastal port-industrial areas

The greatest pressing concern of the twenty-first century is considered as climate change. Numerous cities across the globe have committed to reducing their greenhouse gas emissions. National, regional, and local adaptation and mitigation efforts are prioritised by government policy. According to the Intergovernmental Panel on Climate Change, rising global temperatures will cause sea levels to rise, necessitating infrastructural adjustments and increased resilience in coastal areas (IPCC 2012; 2022).

Cities must amend their fundamental circumstances to accommodate climate risk, which is a consequence of hazards and susceptibility. Population loss, demographic shifts, and structural changes can all have an effect on a nation's capacity to deal with crises such as climate change (Pallagst and Alet al 2009). The Rhineland Palatinate floods of 2021, which resulted in a large number of fatalities and incurred substantial long-term expenses, serve as evidence of a horrible calamity that highlights the urgent need for effective measures to address the impacts of climate change.

Urban shrinkage, which is understood as an expression of uneven development (Turok and Mykhnenko 2007; Wolff 2018), is visible in England through the north-south divide. The unequal distribution of resources, lack of transformation and investment, particularly in the post-industrial north where deindustrialisation and a decline in traditional industries have led to job losses and population decline, highlight the urgent need for targeted policies and interventions to address these challenges. This has contributed to a decline in local economies and physical infrastructure, and has created limited resources to improve sustainability of these areas, as documented in the deprivation report (Ministry of Housing, Communities and Local Government 2019).

The relevance of coastal port-industrial areas will increase in the future as a result of shifting demographics and a decline in population, as well as climate change and rising sea levels. Current global research indicates that eventual urban shrinkage must be anticipated (Aurambout et al. 2021). Ports are dependent on the interaction between port-town regions and broader urbanisation patterns, in which the labour market, infrastructure, and environmental effects are susceptible to local vulnerabilities and policy concerns. What can be done to alleviate any negative repercussions and ensure the advantages of port expansion are distributed equitably, so ensuring climate adaption, community well-being, and economic growth?

As of 2019, there are 63 older industrial areas in England containing 6.8 million people, or 26% of the population of Great Britain (Beatty and Fothergill 2021). According to research, older industrial areas in the northern regions of England will face unprecedented social limitations in the future (Beatty and Fothergill 2021). Creating long-term integrated solutions for England's industrial areas is a key focus in the UK'S Industrial Strategy (HM Government 2021a).

As part of its current "Levelling Up" policy, the British government has implemented a number of initiatives to counteract urban decline and promote the regeneration of port-industrial areas. They are important to the British economy because they serve as important international economic hubs. They provide job possibilities for tens of thousands of individuals and support for businesses associated with recreation and tourism. Moreover, they can have secondary consequences and necessitate substantial investments in infrastructure and services, which can have severe effects on the surrounding population and environment, such as air and water pollution and the disruption of species and ecosystems. These issues underscore the significance of balancing environmental considerations in cities that are shrinking (Mulligan 2014). Nonetheless, are these regions "keeping up" with national economic growth and sea-level rise adaptability?

Resilience can also be understood as an expression of uneven development, influenced by the spheres of transformation, namely practical, political, and personal spheres (O'Brien 2018). This means that the ability of communities, cities, and regions to adapt to and withstand shocks and stresses, such as natural disasters, economic downturns, or pandemics, is influenced by these spheres. Areas with greater access to resources, investment, and economic opportunities are often better able to build resilience and recover from shocks, while areas with fewer resources and limited economic prospects may be more vulnerable to disruptions and face greater inequalities in building resilience.

The research advances the scientific understanding of urban shrinkage as an expression of uneven development by (Turok and Mykhenko 2007; Wolff et al. 2016) by relating this to resilience in the context of England. The benefits of Shrinkage-Resilience expression as part of this dynamic transformation towards a more sustainable and inclusive society that considers the well-being of current and future generations, the environment, and economic growth.

This research offers a deeper comprehension of urban shrinkage It aims to add to an understanding of the many spatial scales at which it occurs in the built environment (Part One) and how it links to

other ideas pertinent concepts such as resilience (parts two and three) from a cross-country viewpoint.

It is based and supported by the following two theoretical underpinnings: The uneven development of urban shrinkage; and the interrelation between the concepts of urban shrinkage and resilience as processes of transformation. These two perspectives collectively introduce *Shrinkage-Resilience* as a new novel concept for shrinking city discourses.

The effects of urban shrinkage and population decline, which are conceptualised in policies but distorted in reality (Ivanov 2021), make it challenging to develop and put into action solutions for shrinking cities.

The major theme of this dissertation concerns urban shrinkage and its connected concept of resilience. By exploring the concepts of urban shrinkage and resilience, and their interconnection as processes of transformation, this dissertation offers a new and innovative approach to understanding the dynamics of shrinking cities. The theoretical underpinnings of uneven development and the interrelation between shrinkage and resilience provide a comprehensive framework for investigating the impacts of climate catastrophes on urban areas. Through this research, we can gain a deeper understanding of the mechanisms and drivers of urban shrinkage, and the ways in which cities can adapt and become more resilient in the face of these challenges. Therefore, this dissertation contributes new knowledge to the field of spatial planning, offering insights and practical applications that can inform urban policies and strategies for sustainable development in the longer term.

1. Uneven urban development of urban shrinkage

Recent typology of urban decline in England indicates that 24 out of 74 areas experienced uneven growth between 1951 and 2011 (Pike et al. 2016), thereby potentially aggravating inequality (Pike et al. 2016), exacerbating inequalities. Additionally, structural shifts have created disparate growth within English cities (Tyler et al. 2017).

Social structural dependencies, urban expansion, and political contexts all have some influence on how land develops or shrinks in the context of the larger debate on shrinking cities (Reckien and Martinez-Fernandez 2011) Other effects, like socioeconomic development and urban environment, were also cited (Guo et al. 2021).

Land use as a concept for sustainable development continues to be emphasised in the context of urban shrinkage and resilience discourses. For instance, the ability to build urban greenspaces that provide enhanced ecosystem services (Haase et al. 2014). Land management plans (Ko-Wan et al. 2016) require an understanding of land use in order to direct urban expansion, development, and environmental protection. Could land use be a factor that affects urban decline and resilience?

As more research has been conducted on land use, research on the land-use change patterns of shrinking cities is scarce, especially in England. The notion is inherently complicated and interdisciplinary, therefore there may be a dearth of current, exhaustive data. This analysis provides a methodology for analysing these interconnected aspects. Based on the relationship between density changes and population growth (Wang et al. 2020; Wolff et al. 2016), this dissertation adapts a density change model to examine how population and density vary over time (Wolff et al. 2017).

The model is modified to include population, land use diversity and greenspace changes. Understanding the interactions between these indicators can assist policymakers and urban planners in developing effective ways to solve difficulties associated with urban shrinkage and resilience, which are the central themes of this dissertation. Using annual population surveys and data on land use change, the study demonstrates a correlation between land use diversity, population growth, and greenbelt expansion in local authority regions. The findings indicate that demonstrating land usage as a critical indicator is essential for comprehending the effects of urban shrinkage and resilience in policy and planning, and for addressing challenges related to inequality and climate change, such as sea-level rise.

2. Linking urban shrinkage and resilience concepts

Resilience is the capacity of a system to adapt to and recover from adverse events or changes. These publications demonstrate that city resilience is multifaceted and that the disaster resilience of urban systems may be measured. Chen (2019) highlighted that social resilience, economic resilience, community capital, institutional resilience, infrastructural resilience, and environmental resilience are the elements of city resilience. According to Bozza, the proposed paradigm can be utilised to evaluate the catastrophic resilience of urban systems while retaining an adequate level of sustainability (2015). According to Li (2017), both New York City and New Orleans plan with resilience in mind. Rus (2018) presented a preliminary concept that might be used to evaluate the seismic resilience of complex urban systems, taking into consideration all urban components that have a significant effect on the latter. These articles are utilised to assess the resilience of urban areas.

While academics are uncertain as to whether resilience measures at the policy level have an impact on population decrease or growth, or vice versa (Bănică et al. 2020), resilience measures at the policy level continue to be implemented. They concur that it allows us to examine shrinking cities and their adaptability (Bănică et al. 2020), Understanding these components may result in a deeper comprehension of urban shrinkage.

In England, the Resilience Strategy[1] is specifically relevant to urban shrinkage. The plan aims to redevelop brownfield sites; land use diversification into creating new job opportunities, empowering communities through participatory planning processes; investment in sustainable transportation systems, such as public transportation and active transportation options and the promotion of green infrastructure in urban development.

Limited empirical evidence exists in shrinking city discourses, despite the incorporation of resilience measurement in numerous frameworks and models. To address this gap, this investigation selected two coastal port-industrial areas, North East Lincolnshire and Bremerhaven, as case studies to explore the dimensions and potential pathways of urban shrinkage and resilience in practice.

Part One: Urban Shrinkage in North East Lincolnshire

The first part of the investigation revealed that North East Lincolnshire experienced urban shrinkage between 1991 and 2019.

Part Two: Projects and Programs in Coastal Areas

The second part of the investigation examined projects and programs implemented in coastal areas between 2011 and 2022 and their corresponding land use changes. The analysis used keyword research and the analysis highlights the *dimensions* (context) and *potential pathways* (transformation) of urban shrinkage and resilience to identify the relationship between urban shrinkage and resilience in practice (IPCC 2012; ARUP 2019).

Part Three: International Comparisons

The third part compared North East Lincolnshire to Bremerhaven, both of which are undergoing economic transformation and experiencing population decline, but are implementing measures to improve their resilience in the face of future sea-level rise. In terms of spatial planning, the selection of North East Lincolnshire and Bremerhaven as case studies offers valuable insights into strategic

[1] The Resilient Cities Strategy: This policy, launched in 2019 by the UK government, aims to promote resilience in cities and to reduce the risks associated with natural and man-made disasters. The strategy focuses on four key areas: urban planning, infrastructure, community engagement, and climate change adaptation.

planning, land use change, economic transformation plans, environmental protection, adaptation planning, and disaster risk management for shrinking cities.

This dissertation contends, based on these two perspectives, that the concept of resilience is intimately related to urban shrinkage because it provides a framework for addressing the limitations and opportunities associated with declining urban populations. In the context of urban decline, resilience can be utilised to assist cities in adapting to population decrease and demographic shifts, as well as preserving their short- and long-term viability and livability. For shrinking city discourses, a novel concept of *Shrinkage-Resilience* is provided.

The research is guided by specific research questions. The research logic includes two types: deductive and inductive. Inductive thinking starts from the ground up, while deductive thinking is top-down. In order to attain urban approaches, this dissertation applies both deductive and inductive logic under the presumption that both ideas—urban shrinkage and resilience—are used.
The primary characteristic of analysis is deductive reasoning since it establishes the groundwork for figuring out how the ideas of urban shrinkage and resilience relate to one another. This reinforces the foundation for identifying the factors driving both concepts' multifaceted processes. On the other hand, inductive reasoning is used to assess the level of dynamics influencing the combined approaches occurring in practice within the specified time.
The empirical evidence is given using a case study methodology and data analysis to find patterns of changing urbanisation trends and a case study method to understand the local societal conditions impacting the local areas. As a result, it is possible to compare the connections between the dynamics that have received the most attention and the introduction of new dynamics in the case studies, presented in Chapter 3.3.

1.2 Research questions

Urban shrinkage is particularly evident in older industrial areas where the decline has been more pronounced. In England, urban shrinkage is part of a larger trend of population decline, and this raises questions about how this decline is affecting urbanisation patterns in these areas. There is a need to understand the causes of population decline and how it impacts the local community, including the economic, social and environmental aspects of the decline.

To explore these issues, this framework proposes three research questions and hypotheses. The first question examines the population changes in local areas in England, to understand the current status

of population decline and its impact on urbanisation patterns. The second question investigates the factors impacting urbanisation trends, with a focus on older industrial areas. Finally, the third question seeks to demonstrate the synergies between the dynamics of urban shrinkage and resilience in the face of climate change. Through these research questions, this framework aims to contribute to the understanding of urban shrinkage and the development of appropriate policies and strategies to address its impacts.

FRAMEWORK
1. Urban shrinkage as part of a larger trend of population decline and changes in urban development in England Question 1 What are the population changes in local areas in England? ● Aim: To get a recent status of population changes in local authority areas up-to-date status 1991 and 2020. ● Hypothesis: Increasing national population change will have a negative effect on local population changes Question 2 What effect does population decline have on changing urbanisation patterns in older industrial areas? ● Aim: To examine factors impacting urbanisation trends in relation to question 1, with a focus on older industrial locations in England ● Hypothesis: There is a loss between land use and greenbelt land in older industrial areas.
2. Resilience efforts in response to a climate catastrophe in North East Lincolnshire, England, and Bremerhaven, Germany Question 3 What type of adaptation efforts were made in North East Lincolnshire, England, and Bremerhaven, Germany, in the following of the 2013 tidal surge, and how did this affect urban shrinkage? ● Aim: To demonstrate the synergies between the dynamics of urban shrinkage, in relation to question 1 and 2, and a focus on international cross-comparison of resilience in practices following the climate catastrophe. ● Hypothesis: In urban planning practice, there is a trend towards incorporating approaches to address both urban shrinkage and resilience, with a focus on adapting and mitigating the impacts of sea-level rise.

1.3 Research design

The investigation is separated into three components. The development of a new integrated notion of *Shrinkage-Resilience* is presented.

Part One identifies and categorises the evolving urbanisation tendencies of local authority areas (LAUSs) in England. The time span is from 1991 to 2019. This permits a current assessment of population change in local authority regions (as of 2019). The association between population and land use change is seen using the Density Change model developed by Wolff et al. (2016). Using data from the Land Use Change Statistics from the Department of Levelling Up, Housing, and Communities, this study expands the Density Change model by categorising land use consuming activities and residential density in greenbelt land and evaluating the changes that result. The Levelling Up agenda has identified key trends in the land use changes of older industrial regions in England, which are of significant policy relevance.

Part Two examines urban planning strategies for places affected by urban shrinkage and sea-level rise. The time frame is from 2011 to 2022. Literature reviews and case study analyses from rich and developing economies will illustrate the dynamic dynamics of urban contraction. Adaptive management, learning, creativity, and leadership were witnessed in practice, consistent with the International Panel on Climate Change's integrated approach.

Following the 2013 tide surge, Part Three covers the adaptation efforts of North East Lincolnshire in England and Bremerhaven in Germany. City Water Resilience (2019) by ARUP is utilised to find approaches in health and well-being, planning and finance, infrastructure and ecosystems, and leadership and strategy. Through mixed-method research, the study expands on the existing paradigm by including techniques to address urban shrinkage-specific vulnerabilities. Between 2013 and 2021, the data reveal synergies between urban shrinkage and resilience.

This research improves the scientific practice of shrinking cities, in methods as part of the transition to a more sustainable and inclusive society that takes into account the welfare of present and future generations, the environment, and economic development. Using the suggested conceptual-methodological framework, recommendations for urban planning to incorporate policy changes in port-industrial areas to include disaster risk reduction and climate change adaptation measures in urban shrinkage contexts are described.

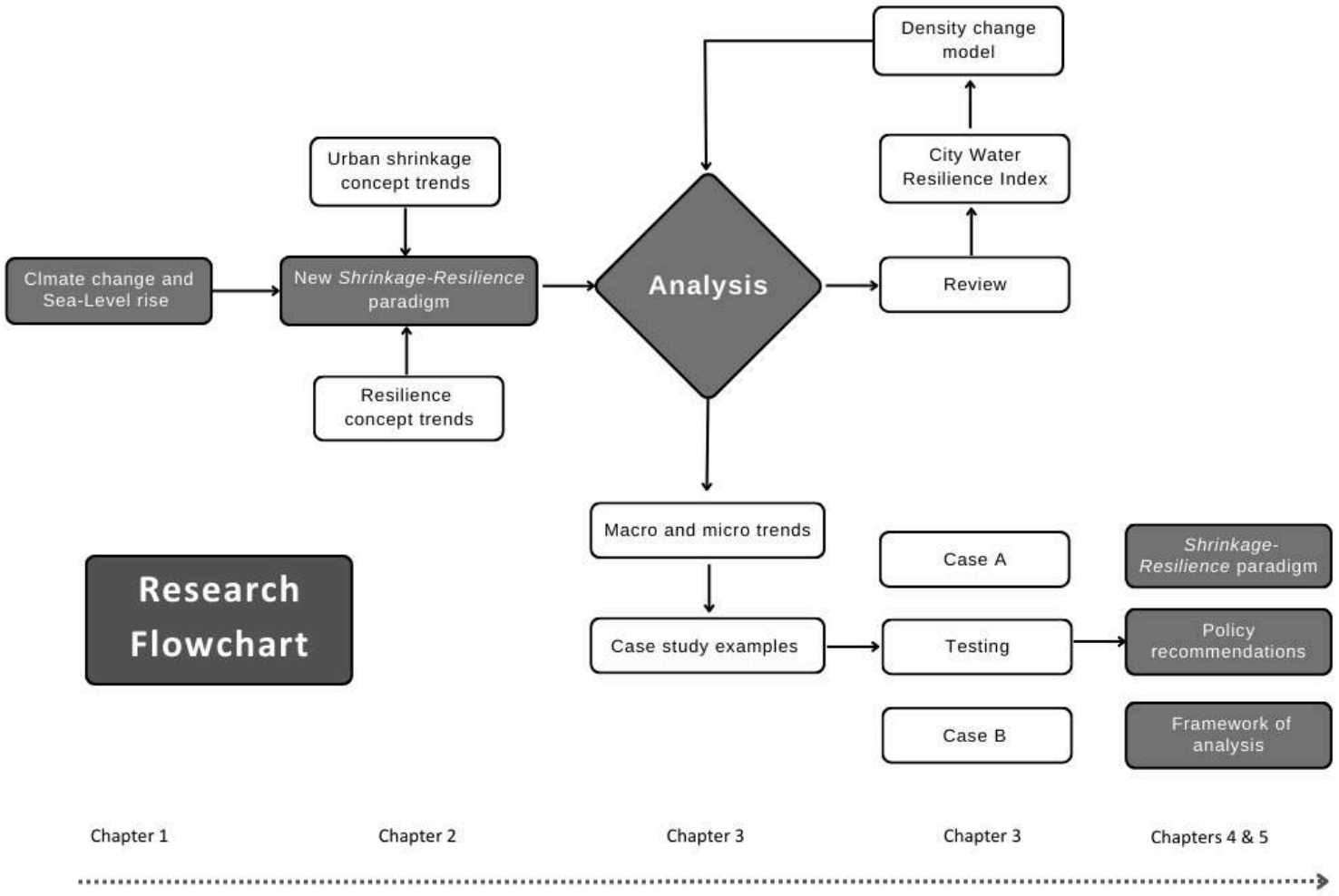

Figure 1: Research Flowchart to demonstrate the Shrinkage-Resilience link: Changing Urbanisation Patterns; Case Studies; and Comparative Local Case Study Areas. Source: Own work

CHAPTER 2: Research Context - Introducing the concepts of urban shrinkage and resilience

This chapter offers an overview of the current state of knowledge on urban shrinking and resilience. To provide a comprehensive understanding of each concept and its underlying theoretical meanings, the section is divided into different parts, as both concepts are multifaceted processes.

The first section of the discussion introduces the concept of urban shrinkage, as well as present trends on the situation of declining cities, discussions, and research gaps. In the second section of this chapter, the concept of resilience as well as contemporary trends, opinions, and research gaps are introduced. This review concludes the chapter by demonstrating that there is a relationship between the concepts of urban shrinkage and resilience, and how this might improve research in the field of Shrinking Cities. However, this new issue on shrinking cities presents both limitations and opportunities. Critical stages for presenting this new paradigm are outlined. This fundamental work provides the basis for Chapter 3's empirical investigation.

2.1 Urban shrinkage concept

2.1.1 Introduction to shrinking cities

A shrinking city refers to a phenomenon where urban areas experience a decline in population due to various factors such as migration, declining birth rates, and economic restructuring. Over the last two decades, numerous scholars and experts have studied the issue of shrinking cities and have proposed various solutions to address the challenges faced by these urban areas.

Key contributors in this field include Karina Pallagst, Annegret Haase, Emmanuel Cunningham-Sabot, Marco Bontje, Thorsten Wiechmann (Pallagst, Bontje and Cunningham-Sabot, eds. 2022). These experts have emphasised the importance of economic diversification, innovation, and investment in human capital as crucial strategies for revitalising shrinking cities.

Pallagst and colleagues provides a definition of "shrinking city" as "a city, part of a city, or an entire metropolitan area that has experienced a dramatic decline in its economic and social base" (2009a). The term "shrinking city" is often used in academia to identify shrinking cities, but it is not used in policy debate. The phrase "urban shrinkage" was used to characterise the phenomena of declining populations in cities, which can result in a variety of problems, such as urban degradation, a decline

in economic activity, and social inequality. This phenomenon is frequently the outcome of long-term economic and demographic shifts, such as falling birth rates, suburbanisation, and deindustrialisation. Since its introduction in the early 2000s as a way to highlight the detrimental effects of these changes in areas, the concept has gained widespread use in academic and policy circles.

The *Handbook on Shrinking Cities* (2022) is a comprehensive analysis of the causes, implications, and possible solutions to the decline of cities worldwide. The book includes contributions from leading scholars in the fields of urban and regional development, offering diverse perspectives on the multidimensional aspects of shrinkage, which refers to the economic and social decline of cities. The book proposes four strategies for addressing shrinkage, namely Shrinking Smart, Governance, Greening/Rightsizing, and Regrowth, which are relevant in the current context of COVID-19 and beyond. The authors argue that addressing shrinkage requires a paradigm shift from traditional growth-centred planning to 'shrinking sustainably.' This shift recognises the complex nature of shrinking cities and the need to consider factors such as economic prosperity, liveability, social stability, and innovation. The authors emphasise the need to reverse the trend of decline and generate more sustainable, robust development in shrinking cities. The book examines governance structures and policies that shape the development of shrinking cities. The authors highlight the need for a coordinated, collaborative approach to address the challenges of shrinkage, which involves engaging with local communities, stakeholders, and policymakers to develop context-specific solutions that reflect the unique challenges and opportunities of each shrinking city. The Handbook's proposals for revitalising shrinking cities are particularly relevant in the current context COVID-19 pandemic, which has exacerbated the challenges faced by cities worldwide, which has led to further shrinkage or new dynamics of shrinkage (Pallagst, Bontje and Cunningham-Sabot, eds. 2022).

Cunningham-Sabot and Ročak's paper examines the terminology and translation used to describe the phenomenon of shrinking cities, which is a complex urban system that is continuously evolving (2022). In Germany, the term used is "peripheralisation," which refers to the process of economic decline, out-migration, and political dependency (Sabot and Ročak, pg 16 2022). In the US, the term "legacy cities" is used, which focuses on growth and obsolescence. In France and the Netherlands, terms such as "urban contraction," "shrinking," and "demographic transition" are used to describe shrinking cities (Cunningham-Sabot and Ročak, pg 17 2022). The authors argue that the language used to describe shrinking cities can be problematic, as it shapes expectations and assumptions about the future of these areas. They question the use of the term "shrinking cities" and how it can be replaced with alternative metaphors that better reflect the reality of these areas.

According to the European Commission's 'EU Policy Brief 2022', one in six of the world's urban areas, in both developed and developing economies, experienced urban shrinkage between 2000-2015 (Aurambout et al. 2021). This idea was mirrored by the present European Commission in its Policy Brief for The Future of Cities Series: Every European nation will face some degree of city decline as a result of population changes therefore future shrinkage will be more pronounced. Cities cannot tackle the problem of population decline on their own; additional research into successful solutions and substantial legislative incentives are required. Even cities that are currently stable or expanding should plan for probable future shrinkage. As a result of shrinkage, urban environments can be modified to be more sustainable and inclusive. In contrast to past studies, which concentrated mostly on Eastern European cities and American Rust Belt regions, this study focuses primarily on Western European cities (Pallagst et al 2009; 2014; 2022). Since 2006, it has been recognised that urban decline has grown increasingly frequent. "In the twenty-first century, unique population expansion will cease, and population growth and decrease will be in equilibrium, supporting the polarisation of cities. Population ageing, particularly in the United States, Europe, Japan, and other developing countries, and the numerous patterns of migration, suburbanisation, metropolitanisation, and deindustrialisation have been studied extensively (Oswalt 2006).

2.1.2 The state of shrinking cities

Shrinking cities have become a global phenomenon, although the causes and extent of population decline may vary from place to place. In developed countries, shrinking cities are often the result of deindustrialisation, economic restructuring, changing patterns of migration, and demographic shifts. For example, in the United States and Europe, a decrease in population has been observed due to the loss of manufacturing jobs and the movement of residents to suburban and rural areas. Conversely, in developing economies, declining cities may be attributed to rural-urban migration, where people leave rural regions for better economic prospects in urban centres. In other cases, people may leave shrinking cities in search of better living conditions and employment opportunities elsewhere. In certain parts of the world, such as Eastern Europe, shrinking cities are common due to the collapse of the Soviet Union and the transition to market economies, which resulted in population loss and decreased economic activity in many cities (Döringer et al. 2020).

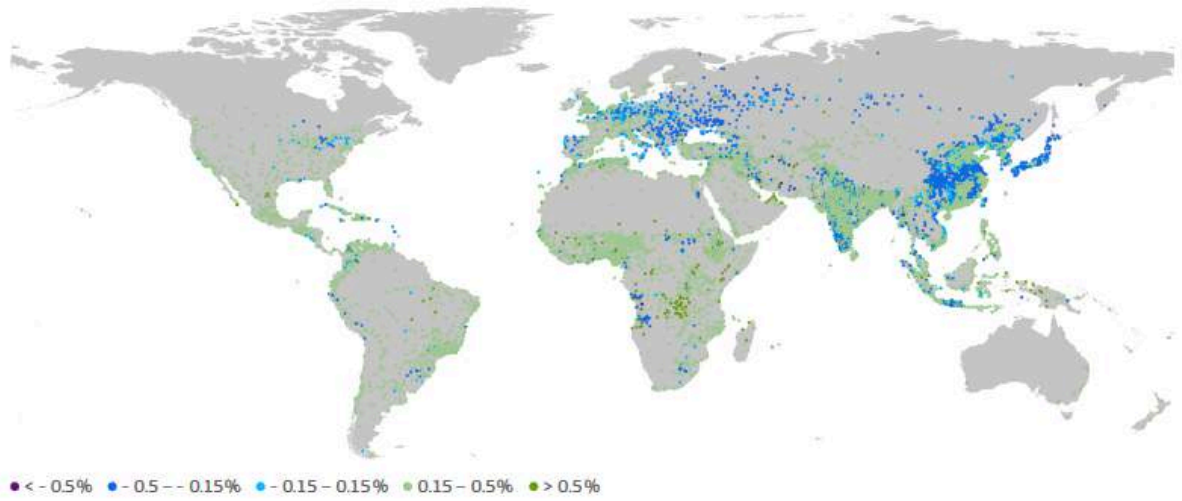

Figure 2: World map of shrinking cities between 2000-2015. Source: Aurambout et al. 2021

The most current research revealed indicators of population decline.

Between 2001 and 2011, it was estimated that more than a quarter of the 610 FUAs in the EU saw a population decline, particularly in Eastern Europe, the Balkans, and southern Italy, affecting over 48 million people (18% of the 2011 EU-27 population). This population decline continued between 2011 and 2018, affecting almost 23% of FUAs, particularly in Spain and eastern Europe (Wolff and Wiechmann 2017)

Other studies on the state of shrinking found 281 shrinking cities in China between 1990 and 2000 (Li and Mykhnenko 2018); 1 out of 5 shrinking cities in Europe between 1990 and 2000 (Wolff and Wiechnauer 2017); 24 out of 74 UK cities between 1951 and 2011 (Pike et al. 2016); 50 large U.S. cities experience population decline every ten years (Beauregard 2013); 13 shrinking cities in Canada; and 70 shrinking cities in (Cunningham-Sabot et al. 2013). Globally, the condition of decreasing cities varies, and the causes and effects of population decline might vary based on the specific environment of each city.

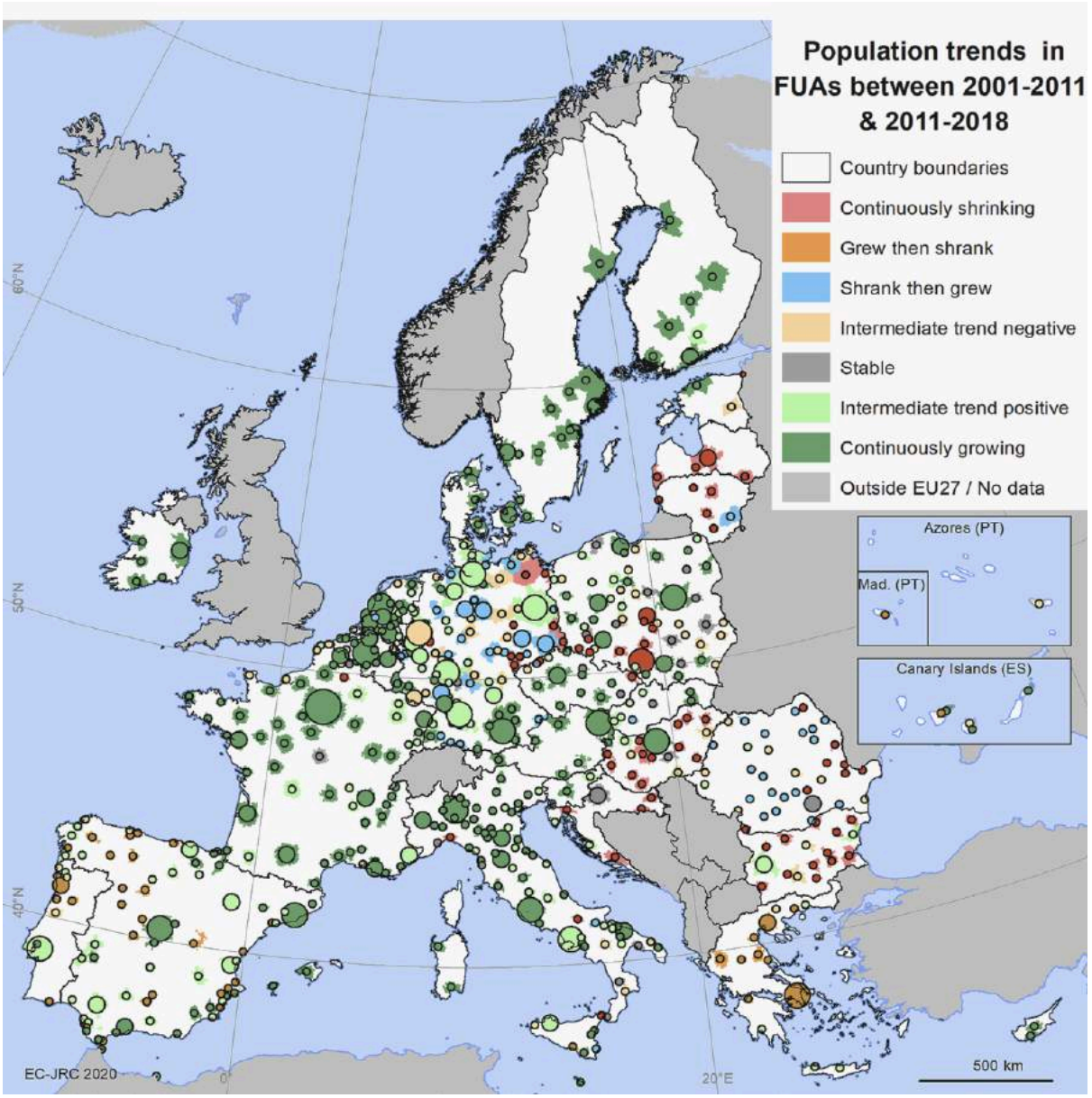

Figure 3: Map of shrinking cities in Europe between 2011-2018. Source: Wolff and Wiechmann 2017

2.1.3 The concept of urban shrinkage

Urban shrinkage is generally understood as the decline in population in urban areas, often accompanied by physical and economic decline. The definition is problematic for several reasons. Firstly, it is often difficult to accurately measure population decline in cities, as there can be significant discrepancies between official population statistics and actual levels of residency (Besana 2021). Secondly, the causes of urban shrinkage are complex and multidimensional, and can vary significantly from city to city (Liu et al. 2020). Thirdly, the impacts of urban shrinkage are often unevenly distributed, with marginalised communities and neighbourhoods often being most affected (Pike et al. 2016). As a result, it can be challenging to develop a comprehensive and accurate definition of urban shrinkage that captures its many facets and complexities.

Over time the concept of urban shrinkage has evolved (Ivanov 2021). A scholar who has made significant contributions to the field is Annegret Haase. Her approach to the conceptualisation of urban shrinkage is widely recognised for its comprehensiveness and nuance, as well as its numerous advantages. Firstly, it goes beyond simple population decline and recognizes the multiple dimensions of shrinkage, including physical, economic, social, and environmental dimensions. Secondly, it highlights the dynamic and relational nature of shrinkage. Rather than viewing shrinkage as a static phenomenon, Haase recognizes that it is a complex and ongoing process that is shaped by multiple factors, including urban development, economic change, and social dynamics. It provides a useful and insightful framework for understanding and addressing the challenges faced by shrinking cities, see figure 3 (Haase et al. 2014).

Additionally, urban shrinkage can also provide opportunities. Later work by scholars point to accepting shrinkage and relying on citizen engagement, and not looking at the negative aspects (Hospers 2014). This positive perspective was later cited (Haase et al. 2018; Haase et al. 2020).

Haase's conceptualization of urban shrinkage is considered especially valuable, as it offers a more comprehensive understanding of the complexities and impacts of shrinkage, as well as the interrelationships between its various aspects. It demonstrates the importance of understanding and responding to the different experiences and perspectives of different groups and communities within shrinking cities. This focus on social justice and equity is crucial for developing effective and sustainable strategies for addressing urban shrinkage and its impacts.

According to various sources, the concept of a shrinking city is linked to phrases: urban decline; degrowth; blight; abandonment; disurbanisation; demographic shift; population loss; housing vacancy; and under-utilised infrastructure (Haase et al. 2014; Du et al. 2020; Wang et al. 2020b; Lupton and Power 2004; Wolff and Wiechmann 2017; Pike et al. 2016). There are various perspectives on shrinking cities which is a trend with spatially observable social, economic, and environmental effects (Cunningham-Sabot et al. 2013).

All these concepts are interconnected and play different roles in the process of urban shrinkage and its management. Understanding their interplay and how they can be leveraged to address the limitations of urban shrinkage is crucial for the development of shrinking cities.

The majority of the literature provides an overview of urban shrinkage and potential strategies for measuring it conceptually (Haase et al. 2014), with spatial metrics (Reis et al. 2014), and with agent-based models Schwarz et al. (2010), Hospers (2014) on the other hand suggests that the most

appropriate strategy for measuring urban shrinkage is to focus on improving the quality of life for the city's existing residents. However, none of the articles demonstrate how to directly combine its measurement with the related idea of resilience. Therefore, additional research is required on this subject. The global perspective as introduced has become more important, as many areas around the world are facing an increased inequality, and there is a growing recognition of the need for international exchange of knowledge and best practices.

The following provides a summary of several concepts are linked to urban shrinkage, including:

1. Demographic change: The changes in the size, age structure, and composition of a population that can lead to urban shrinkage (Wiechmann and Wolff 2013; Wolff and Wiechmann 2013); with a relation to demographic change to land use change (Kroll and Haase 2010).
2. Economic restructuring: The changes in the composition and structure of an economy that can lead to job loss, population decline, and urban shrinkage - driving regrowth in shrinking cities (Haase et al. 2021).
3. Suburbanization: The process of population and economic growth in suburban areas at the expense of urban areas, leading to urban shrinkage (Di Pietro 2021a).
4. Redevelopment: The process of revitalising and regenerating urban areas that are experiencing shrinkage, often through the construction of new buildings, infrastructure, and public spaces (Wolff et al 2016).
5. Adaptive reuse: The process of repurposing or restructuring the existing buildings and infrastructure in shrinking cities, often to address changing population and economic conditions (Edgington 2013).
6. Shrinking Smart/Smart decline: A strategic approach to managing shrinkage that prioritises the well-being of remaining residents and the preservation of valuable resources, rather than trying to reverse population decline (Ivanov 2022).
7. Densification: The process of increasing the population density of urban areas to make better use of existing infrastructure and resources, with pop-up interim uses (Schwarz 2022).
8. Urban design: The process of shaping the physical form of cities, including the design of buildings, streets, and public spaces, to address the limitations of shrinkage through smart cities approaches (Schackmar et al. 2021; 2022).
9. Green infrastructure: The use of natural systems, such as parks and green spaces, to provide ecological and social benefits in shrinking cities (Lewis 2022).

2.1.4 Continued relevance of urban shrinkage in the 21st century

The phenomenon of urban shrinkage is essential for urban planners in the future, as it identifies the particular limitations and opportunities that these cities face. Compared to expanding cities, shrinking cities frequently face a different set of problems, such as a declining population, abandoned properties, and a lack of economic activity.

When designing plans and strategies for these areas, urban planners must take this into account. In addition, urban planners must acknowledge that declining cities are undergoing a transformation in addition to a population decline, and that the city's structure and infrastructure may no longer be suitable for the remaining population. Therefore, urban planners must concentrate on developing sustainable, resilient, and liveable communities for the remaining residents. In addition, shrinking cities offer chances for revival and sustainable development, such as the reuse of abandoned assets, the establishment of green areas, and the promotion of sustainable mobility. Urban planners may play a vital role in recognising these opportunities and collaborating with the community to execute them.

Shrinking cities are the subject of research by various institutions and organisations worldwide. Examples include the Shrinking Cities International Research Network (SCiRN), based at the Technical University of Berlin; the Shrinking Cities Institute (SCI) at the University of Michigan, USA; the Urban Institute in Washington, D.C., USA; the Lincoln Institute of Land Policy in Cambridge, Massachusetts, USA; the Centre for Urban Research (CURB) at RMIT University, Melbourne, Australia; the Centre for Cities in the UK; and the Shrinking Cities in Japan Research Group at the University of Tokyo. These groups conduct multidisciplinary research on the causes, consequences, and potential solutions for population decline and urban decay in cities around the world.

Shrinkage is a feedback loop that is similar to the impacts of the pandemic, where changes in lifestyle choices and behaviour reinforce each other. The pandemic has caused shifts in people's working habits, mobility, travel, leisure activities, and consumption patterns, as well as changes in the location of workplaces. Behavioural patterns have also shifted, with more people working from home, practising social distancing, and home-schooling. These changes have led to shorter workweeks, hybrid working, and changes in employment over the short term. The pandemic has also caused many businesses to close, leading to an increase in city vacancy rates. Furthermore, the pandemic has led to budget cuts in health welfare, which have impacted services such as transport and social services, increasing uncertainty regarding population decline and vacancy rates. Demographically older, non-white, and deprived communities are less likely to work from home and may become the

new frontier of post-shrinkage cities. The pandemic and climate crisis call for new urban approaches, and the countryside, coastal towns, and smaller areas are becoming more attractive, with an increase in demand for larger housing and green spaces. This could present an opportunity for shrinking cities to reinvent themselves (Pallagst and Hammer 2022).

Defining urban shrinkage

Several entries in this study table display significant definitions, such as the Shrinking Cities International Research Network (SCiRN) term. This term has been widely utilised and embraced in each country as appropriate. Studies have centred on the observation of data on population and economic activity, with the degree of these changes assigned a nominal value of -0.15% per year and a duration of at least five years of decline.

Comparing patterns in various shrinking cities in an international context can be a challenging task, but there are several ways to approach it. Operationalising the concept of a shrinking city involves putting into practice the understanding and knowledge of the limitations and opportunities that these communities face. Understanding the criteria and indicators to understand the causes, effects and variations have advanced over the years. However, population decline is regarded as the main indicator of shrinkage. Therefore, collecting and analysing comparable data is critical. Data collection and analysis on data such as population, land use, economic activity and other relevant factors can help identify trends and patterns in shrinking cities. This information can be used to compare the different limitations and opportunities to inform planning and policy decisions. Secondly, developing a common framework that defines the key characteristics of shrinking cities can help to ensure that data collected and analysed is consistent across different countries.

Shrinking Cities International Research Network (SCiRN) definition

> *"Shrinking city is an urbanised area that has recently faced a population loss of more than 0.15% annually for at least **5 years** or in some former period"*

Adapted SCiRN definition: Jaroszewska, E. (2019). Urban Shrinkage and Regeneration of an Old Industrial City: The Case of Wałbrzych in Poland. Quaestiones Geographicae, 38(2), 75–90.

> *"a densely populated urban area that has on the one hand faced a population loss in large parts of it (for at least **5 years,** more than **0.15 % annually**), and is on the other hand undergoing economic transformation with some symptoms of a structural crisis* **(2019)"**

Adapted SCiRN definition: Wolff, M. and T. Wiechmann (2017), 'Urban growth and decline: Europe's shrinking cities in a comparative perspective 1990–2010', *European Urban and Regional Studies*, 25, 09697764176946

> *"A shrinking city is an urbanised area that has recently faced a population loss of more than 0.15% annually for at least **5 years** or in some former period* **(2017)**"

Adapted SCiRN definition: Stryjakiewicz, T. and E. Jaroszewska (2016), 'The Process of Shrinkage as a Challenge to Urban Governance', *Quaestiones Geographicae*, 35

> *"A shrinking city is a densely populated urban area that has on the one hand faced a population loss in large parts of it (for at least **5 years**, more than 0.15% annually), and is on the other hand under- going economic transformation with some symptoms of a structural crisis"* **(2016)**"

When compared to other definitions in studies, respectively not able to be applied on a comparative basis, however adds value in the studies context of analysis (Hartt 2021; Martinez-Fernandez et al. 2016; Pike et al. 2016).

2.1.5 Key debates of urban shrinkage as a concept

There are several key debates related to urban shrinkage, including:

Economic development is no longer the driver: The primary approach to dealing with shrinkage or urban shrinkage has been to seek economic development, by planning for economic growth through private investment (Rink et al. 2014). The objective is to encourage population growth. Debates on how population growth affects economic development and how economic development affects population growth have already been subject of intensive debate and controversy since the late 18th century, and this debate is still ongoing (Bontje and Musterd 2012). New evidence suggests that shrinking cities are being driven by 'growth machine politics' (Wiechmann and Pallagst 2012) and that modern interventions are growth agendas driven by the state. These are difficult issues, which call for the collaboration of a wide range of interest groups.

Planning for urban shrinkage should be proactive. Cities affected by demographic change require a separate research agenda. They are demographically selective, dynamically nonlinear, informally decentralised and conservative (Galster 2019). This leads to new planning processes, to "Shrink Smart" (Döringer et al. 2020). "Shrink Smart" is a term used in the context of shrinking city discourse as a strategy to manage the process of shrinkage in a proactive and strategic way, rather than simply allowing it to happen haphazardly (Pallagst 2005). This approach focuses on maintaining the quality of life for remaining residents, improving public spaces, and promoting economic development that can help to revitalise the city.

Urban shrinkage as multidimensional process: Some say that urban shrinkage might lead to more effective use of resources, while others argue that it can lead to social and economic inequity (Zaninetti and Colten 2012). Others contend that the urbanisation process must consider urban functions such as land use and infrastructure (Zhang 2016). For instance, Haase examined how the urbanisation process, including how land is consumed for housing and transportation, affects a city's water resources (Haase 2009). The limits of being exposed to a flood risk in conjunction with urban shrinking may result in an unsustainable land usage. (Haase et al., 2014; 2018); densification and land consumption (Wolff et al. 2017). The effects of urbanisation cannot be viewed as an isolated urban phenomenon; rather, it affects a system of spatial limitations that must be understood and analysed in order to respond with appropriate measures, including economic, population, and land dimensions (Du et al. 2020), reurbanisation (Dembski et al. 2019), centralisation and decentralisation (Wolff et al. 2018).

In conclusion, urban shrinkage is a complex spatial planning issue that can be influenced by various factors, including proximity to economic opportunities and the location of neighbouring towns, cities, or regions. The University of Sheffield's research, led by Professor Andy Pike and colleagues (2016), has identified different manifestations of urban shrinkage based on the function of areas in the UK context. Their research categorised urban shrinkage into core cities, overshadowed cities, and freestanding cities, each with its own set of characteristics. Core cities tend to have high-level service industries, major anchor institutions, and net in-migration, while overshadowed cities may have larger neighbouring cities and reduced consumer services. Additionally, urban shrinkage can occur at different geographical scales, ranging from large cities to small villages (Tong et al. 2021). As cities continue to evolve and change over time, it will be important for urban planners and policymakers to consider the specific context and characteristics of each urban area in addressing issues of urban shrinkage.

Covid-19's consequences on urban shrinkage-affected regions can be variable and complicated, and have a considerable impact on the global economy and national government expenditures, which typically influence future urban shrinkage. Residents, businesses, and real estate demand have reportedly shifted from crowded central business districts to less dense suburbs in key U.S. cities, according to a study (Ramani and Bloom 2021). In addition, future demographic changes have been documented in older industrial areas in England (Beatty and Fothergill 2021). The impacts of Covid-19 on shrinking cities are likely to be significant and long-lasting, and will require careful planning and collaboration to address the limitations and opportunities that these communities are facing (Pallagst and Hammer 2022).

2.1.6 Limitations associated with urban shrinkage in practice

The urban decay that frequently takes place in areas experiencing urban shrinkage can frequently bring a variety of development pathways. One of the leading discussions by researchers is found on a local level, that when there is a decrease in population, communities face greater vacancy rates and lower tax revenue owing to property abandonment (Mulligan 2022), impacting the capacity of local municipalities to maintain services and infrastructure. This results in an increase in pressure on the expense of maintaining infrastructure and delivering public services, both of which may become more difficult to maintain as a result. This was found to be the case of New England in the USA (Hollander and Hartt 2019).

When it comes to new urban development, one of the main obstacles that may arise during the planning and development stages is urban regeneration. In spite of the fact that alternative industries were established as a result of the discovery of new development pathways in these regions, the question of whether or not they promote sustainable development is contingent on who stands to benefit from the development (Schackmar et al. 2021).

The topic of socioeconomic inequality is raised based on the relation between population decline and wages. These papers suggest that population decline in a city may lead to a decrease in wages. Echeverri-Carroll (2011) found that every additional 100 000 inhabitants in the local labour market raises individual hourly wages by 0.12 per cent; Di Addario and Patacchini (2007) found that every additional 100,000 inhabitants in the local labour market raises earnings by 0.1 percent, and Gould (2007) found that workers earn more in larger cities for white-collar work, but not for blue-collar work. This suggests that the loss of new economic development and subsequent population loss, may lead to a decrease in wages, particularly for blue-collar workers. This highlights the potential for socioeconomic inequality to arise in shrinking cities, as those who are most vulnerable to economic shocks may be disproportionately affected. These findings suggest that urban planners and policymakers must carefully consider the potential impacts of population decline on the local labour market and take steps to mitigate any negative effects on wages and employment opportunities.

The following provides a summary of key limitations associated with urban shrinkage:

1. Ageing infrastructure: According to Robert and Josephina (2017) ageing infrastructure in shrinking cities is becoming increasingly difficult to maintain and upgrade.
2. Socioeconomic inequality: High levels of socioeconomic inequality can make it difficult to revitalise and redevelop shrinking cities in a way that benefits all residents (Hartt 2019).
3. Urban sprawl: According to Nuissl and Rink (2005) sprawling and peripheralisation of urban

areas, which can make it difficult to densify shrinking cities and make better use of existing infrastructure and resources.

4. Political resistance: Political resistance to managed retreat and other strategies for addressing shrinkage, which can make it difficult to implement effective policies (Bănică et al. 2017).
5. Lack of infrastructure: Limited infrastructure and resources, which makes it difficult to revitalise and redevelop shrinking cities (Haase et al. 2021).
6. Poverty: High levels of poverty can make it difficult for individuals and communities to revitalise shrinking cities and address the social and economic impacts of shrinkage (Pike et al. 2016).
7. Limited governance: Weak governance and limited capacity to implement effective policies for addressing shrinkage (Rink et al. 2014, Stryjakiewicz and Jaroszewska 2016).
8. Urbanisation: Rapid urbanisation and changing urbanisation, which can make it difficult to manage shrinkage in the context of overall population change (Dembski et al. 2019).
9. Climate change: Areas such as coastal areas that are disproportionately affected by the impacts of climate change, such as sea level rise, droughts, and floods, which can make it difficult to revitalise shrinking cities and make them more resilient (Khavarian-Garmsir et al. 2019).

Countries will most likely confront considerable constraints in tackling urban shrinkage, although the particular constraints will differ depending on the country's level of social and economic development. Cities with a more stable economic system may have more resources and capacity to deal with shrinkage, but they also face more complicated and interconnected constraints, whereas other countries may suffer more fundamental constraints relating to poverty, inequality, governance, political stability and infrastructure.

2.1.7 Opportunities associated with urban shrinkage

Over the last decade, opportunities have been associated to improve adaptation efforts in areas affected by urban shrinkage. Environmental issues are unavoidable in future agenda and policy towards shrinking cities.

These publications demonstrate that urban decline can be controlled in a way that improves a region's ability to adapt to the effects of climate change. According to the findings of Haase 2014, there is a link between shrinkage and the providing of environmental services, and this nexus can be exploited to increase cities' ability to adapt to the effects of climate change. The research conducted

by (Antonić and Djukić 2020) determined that environmental concerns are significant for the phenomena of urban shrinkage and that they have the potential to contribute to the success of related activities. According to research done by Hospers (2014), the most effective and long-term method for coping with urban shrinkage is to simply accept it and work toward improving the quality of life for the citizens of the city who are already there. For example, green infrastructure is seen as an opportunity to enhance social justice and regional inequalities (Shi 2020).

Additionally, there is an ever-increasing demand for land, particularly in areas close to ports, which is driving this trend. For example, China has experienced a surge in the percentage of coastline land that has been reclaimed in 16 of its main cities (Sengupta et al. 2018). In addition, between 2014 and 2014, there was a 28% growth in the size of metropolitan areas in Latin America, while wetland regions shrank (Rojas et al. 2019). If particular locations are destined to experience unavoidable economic growth, then planning for adaptation activities should begin immediately.

Certain regions are investing in nature-based solutions in order to adapt to the consequences of climate change while also delivering ecological services. This is being done in order to achieve a win-win situation. Because of this, further policy modifications need to be made across all development activities in order to reduce the number of resources that are lost as a result of being located in vulnerable water bodies (Booth and Jackson 1997). For example, many aspects of urban shrinkage match with national and regional economic developments, such as the rehabilitation of ports to stimulate the construction of resilient communities. This is just one example of how urban shrinkage can be related to economic shifts. It is generally acknowledged that ports are an essential part of a nation's overall economic infrastructure since they serve as focal points for the conduct of business and trade on both the national and international levels. The opportunity to create jobs that will last for an extended period of time, in addition to employment opportunities inside the community Contraction of metropolitan areas can have a negative effect on the competitiveness and economic infrastructure of ports, as well as their standing in the global marketplace (Jonas et al. 2017).

Enhancing environmentally responsible modes of transportation in regions with restricted access in the study that was prepared in 2012 for the Organization for Economic Co-operation and Development (OECD), the concept of the Filigree city is presented as the model that is provided in order to meet this difficulty (Mulligan 2014).

Therefore, the findings of these studies suggest that cities can improve their capacity to adapt to the effects of climate change by managing urban shrinkage in a way that improves the provisioning of ecosystem services; by taking into consideration environmental issues when planning for climate change adaptation.

The following provides a summary of urban shrinkage in the context of adaptation efforts, having environmental opportunities.

1. Green infrastructure: According to Schilling (2009) Floods and sea level rise can be mitigated through the use of green infrastructure such as rain gardens, green roofs, and permeable pavements, which can help to reduce stormwater runoff and protect against flooding, as well as sponge city concept (Daisy 2020).
2. Coastal protection: As sea levels rise, shrinking cities can use natural coastal protection measures such as dunes and wetlands to protect against coastal erosion and storm surges (McGranahan et al. 2007).
3. Habitat restoration: Abandoned properties and underutilised land in shrinking cities can be repurposed as green spaces and habitats, which can help to improve air and water quality, reduce urban heat islands and provide habitats for wildlife. (Antonić and Djukić 2020).
4. Sustainable transportation: Shrinking cities can take advantage of the opportunity to reduce their reliance on cars and promote sustainable transportation options such as walking, cycling and public transport (Schwarz and Hoornbeek 2009).
5. Energy efficiency and renewable energy: As a shrinking city has fewer residents and less economic activity, there may be opportunities to improve energy efficiency and increase the use of renewable energy sources (Di Pietro 2021; Mulligan 2014; 2022).
6. Adaptive reuse: As cities shrink, there may be opportunities for adaptive reuse of buildings and infrastructure, such as repurposing abandoned buildings for new uses or converting underutilised land for regeneration and emergency issues (Takumi et al. 2019; Asano et al. 2018; Di Giovanni and Chelleri 2019).
7. Building resilience: By addressing the limitations of sea level rise, flooding and other environmental limitations, shrinking cities can also become more resilient to future natural disasters and climate change through policy and governance reform. Dressler et al.2016; Eraydin and Özatağan 2021).
8. Economic restructuring: According to Jonas et al. (2017), transforming the economy of shrinking cities to a green economy, creates opportunities to address sustainability in shrinking cities.

Shrinking cities can leverage the limits imposed by flooding and sea level rise to develop more sustainable, resilient, and liveable communities for their remaining citizens.

2.2 Resilience concept

2.2.1 Introduction to resilience

Peter Timmerman, an earlier theorist, is credited with being the one who first utilised the term "resilience" in relation to urban planning in the field of engineering in 1981. Resilience is a technical engineering term that can be defined as "the attribute of being able to store and strain energy and deflect elasticity in a structure without inflicting lasting damage." (1981). It also refers to a person who, in the words of Bernard Manyena, director of the International Disaster Management, Humanitarian and Conflict Response Institute at the University of Manchester, possesses the "ability to recover from external environment stresses with methods and measures to manage with the linked risk" (2006). It is believed that their behaviour is "bouncing back" to a previous state or to another desirable level, such as "survival." Theorists, on the other hand, are of the opinion that "bouncing back" is an objective that is difficult to achieve due to the complexity of growth tendencies and the growing uncertainty around climate change, such as urbanisation, (Manyena 2006).

Resilience in the general sense refers to an area's ability to absorb shocks, stressors and to transform to a better state. (ARUP 2019; IPCC 2012). In recent years, there has been a shift toward placing a greater emphasis on the need for government and industry to understand the dynamics of strengthening resilience to examine how, to whom, to what, when, where, and why (Meerow et al. 2016), specifically in regard to its connection to sustainability.

Both academic circles and the policy world make use of the phrase "urban resilience" (Coaffee and Lee 2016). Nevertheless, as a cross-disciplinary idea that has a mutable and ever-changing character. as a result of the participation of governance and institutional frameworks on a variety of levels. In this particular setting, the phenomenon in question is usually invoked as an answer to the challenges and stresses posed by the climate. Recently, addressing social inequities and ensuring environmental justice have been major themes of discussion.

The concept of urban resilience is constantly evolving and has become increasingly important in the face of challenges such as climate change, social inequalities, and pandemics.

In the paper "City Models and Preventive Planning Strategies for Resilient Cities in Germany," authored by Detlef Kurth, the importance of preventive strategies in urban development planning is

highlighted, particularly in the context of the Covid-19 crisis (Kurth 2022). Kurth emphasises that while the existing urban development model of a mixed and compact city is effective in preventing the spread of Covid-19, the pandemic has highlighted the need for green space and recreation areas in inner city residential areas. Furthermore, green space plays a crucial role in climate adaptation measures by providing cooler air and ventilation.

In May 2021, the German ministry for building adopted the memorandum on Urban Resilience, which emphasises the need for cities to not only repair the damage caused by disasters but also to adapt to future crises and become more resilient and sustainable. To achieve this, preventive strategies in urban development planning must be strengthened and connected with urban renewal approaches. This requires an interdisciplinary approach to prepare for future change, anticipate and prevent danger, protect and expand infrastructure, and serve the common good (Kurth 2022). Kurth's paper highlights the importance of extending integrated urban development concepts with aspects of urban resilience and identifies the city models that are important for the future. As cities continue to face complex and evolving challenges, the concept of urban resilience will continue to evolve and shape the way we plan and develop our cities.

2.2.2 The state of resilience research

The topic of research on resilience is one that is expanding at a quick rate, and there is a growing interest in it from the academic community, the government, and the corporate sector. Understanding the resilience of many systems, such as ecosystems, infrastructure, communities, and humans, has been the primary focus of research in recent years.

Within the realm of academia, one of the most notable current trends is a concentration on governance and policy frameworks that can improve urban resilience. In addition, the scholarly discussion on the definition of resilience and the investigation of its relationship to fundamental terminology and ideas like vulnerability and sustainability is still ongoing. There is a growing movement, within the area of development, to build quantitative methods, indices, and international standards to quantify urban resilience at a larger scale.

At the moment, researchers are concentrating their efforts on a select few primary areas, such as determining how to measure resilience, developing methods for fostering resilience in a variety of different systems, and determining how to evaluate the efficacy of various strategies for fostering resilience (United Nations Human Settlements Programme 2017).

In addition, researchers are attempting to comprehend the relationship that exists between resilience and a variety of other ideas, including adaptation, vulnerability, risk, and sustainability. When it comes to quantifying resilience, academics are hard at work devising methodologies for evaluating the robustness of a variety of diverse systems.

Quantitative and qualitative approaches are also included in these methodologies, and they frequently make use of a mix of different indicators.
In order to build resilience, the primary focus has been on determining the variables that are most important for building resilience and then adopting strategies and policies to improve those factors (Stockholm Resilience Centre 2015).

In addition, research should be conducted into the role that social capital (Ročak 2022), adaptive capacity, and transformative capacity play in the process of building resilience (Ziervogel et al. 2022).

Finally, academics are focused on analysing the efficacy of various policies and methods aimed at strengthening resilience (Raška et al. 2019; Bănică et al. 2021; Eraydin and Özatağan 2021). This entails determining the most effective methods for enhancing resilience and comprehending the costs and benefits that are linked with the various strategies (Raymond et al. 2017).

2.2.3 The concept of resilience

The capacity of a system, community, or individual to adapt and recover after being subjected to constraints or shocks is what is meant by the concept of resilience. It is the capacity to prepare for, endure, and recover from adverse events, such as natural catastrophes, economic downturns, or political instability. Resilience can be defined as the capacity to prepare for, endure, and recover from unfavourable occurrences. The concept of resilience can be applied to many different kinds of systems, including ecosystems, communities, infrastructure, and even individual people. The capacity of a system to recover from an assault in a prompt and efficient manner is one definition of resilience (Seeliger and Turok 2013).

In the context of ecosystems, the capacity of an ecosystem to withstand or recover from disruption, such as by preserving its structural and functional integrity, is referred to as its resilience. In the context of the built environment, this term refers to the capacity of essential systems, such as transportation, communication, and energy, to continue functioning normally both during and after the occurrence of disruptions. In the context of communities, it refers to the capacity of individuals,

organisations, and institutions to collaborate in order to respond to disruptions and recover once they have occurred.

Increases in resilience are possible through the implementation of a number of different strategies, including risk reduction and management, diversification, and the development of adaptive ability. A comprehensive approach that goes beyond risk management and looks at the social, economic, and environmental elements that contribute to a system's ability to adapt and recover from shocks is another component of resilience thinking. This method is also known as "resilience thinking." Planners are seeing an increased need to include resilience theory into their work (Seeliger and Turok 2013; Chelleri et al. 2015; Meerow et al. 2016).

The following provides a summary of concepts associated with resilience, including:

1. Adaptation: The ability of a system, community, or individual to adjust to changing conditions in order to reduce vulnerability and enhance resilience (Nelson et al. 2007).
2. Vulnerability: Vulnerability is the degree to which a system is unable to cope with disaster, including the adverse effects of climate change (IPCC 2012; Pelling 2011) and is a function of the costs and benefits of inhabiting areas at risk (Alexander 1997).
3. Risk: Risk is the potential for loss (Birkmann et al. 2013). With persons or structures, they define risk as the product of the severity of hazard and their vulnerability (Alexander 1997).
4. Sustainability: The ability of a system, community, or individual to meet present needs without compromising the ability of future generations to meet their own needs (Adger 2006).
5. Robustness: The ability of a system, community, or individual to withstand disturbances or stressors without losing function or integrity (ARUP and The Rockefeller Foundation 2014; Stockholm Resilience Centre 2015).
6. Flexibility: The ability of a system, community, or individual to change and adapt in response to disturbances or stressors (Folke 2016).
7. Diversity: The presence of a variety of options, alternatives, and redundancies in a system, community, or individual that can enhance resilience (ARUP and The Rockefeller Foundation 2014).
8. Transformative capacity: According to the IPCC (2012), transformative capacity is the ability of a system, community, or individual to fundamentally change in response to disturbances or stressors, in order to adapt and improve resilience
9. Social capital: The networks and norms that enable individuals and organisations to cooperate and coordinate their actions (Zhou et al. 2016).

10. Adaptive capacity: The ability of a system, community, or individual to learn, change, and adapt in response to disturbances or stressors (IPCC 2012).

All these concepts are interconnected and play different roles in enhancing resilience. Understanding their interplay and how they can be leveraged to enhance resilience is crucial for building more resilient systems and communities. The general consensus from an urban planning theory views Resilience as the ability of a city to absorb climate shocks and stressors, build its capacity and to transform it to a fitter state (United Nations Human Settlements Programme 2017).

Resilience has been recently characterised as being more about the process than the results, which involves a system's capacity to "self-organise, learn, and adapt over a longer period" (IPCC 2012). The ability of a system to anticipate, absorb, accommodate, and recover from the effects of a potentially hazardous event in a timely and efficient manner, including through preservation, restoration, or improvement of its essential basic structures and functions, is defined as resilience by the IPCC (IPCC 2012 pg. 46). In accordance with this concept, urban planning also refers to a strategy that is more incremental, pragmatic, and transformative. Although some authors believe that there’s no Resilience theory, in fact it has a complex systems theory.

2.2.4 Continued relevance of the resilience concept in the 21st century

In the area of development and vulnerability reduction, the concept of resilience continues to gain ground, notably in fields such as social protection, disaster risk reduction, and the adaptation to climate change (Béné et al. 2012). Additionally, it is identified as a significant metric for Environmental Social and Governance (ESG) for monitoring sustainability disclosures and reporting for business and industries (Rodin and Madsbjerg 2021).

A few examples of urban models that fall into this category include the Disaster Resilience Framework that was established by USAID, the Urban Resilience Framework that was created by 100 Resilient Cities, and the Resilience Matrix Framework that was developed by the UK Cabinet Office. The 'Making Cities Resilient' model, which was designed by Arup and the Rockefeller Foundation, is one example of another concept that has been discontinued. This strategy first determines a city's vulnerabilities on a local scale and then develops action plans to address those determinations (ARUP and The Rockefeller Foundation 2014). The Cities Water Resilience Index is another approach that takes into account the challenge of rising sea levels and flooding as a prior condition (ARUP 2019). The fact that there are many various levels of analysis available, depending on the circumstances, helps to foster innovation within the conversation around resilience in urban areas.

Resilience can be beneficial in the following three ways, according to researchers Leanne Seeliger and Ivan Turok of the Human Sciences Research Council in South Africa (2013). In the first place, settlements and the hazards associated with them are examined from a holistic perspective which means that the social, economic, and environmental difficulties associated with the settlement are taken into consideration (Seeliger and Turok, 2013). Understanding the dynamics of settlements on a larger spatial scale and over a longer period of time is the second step. This is because informal regions are frequently "moulded" by other complex systems (Seeliger and Turok, 2013). Thirdly, it emphasises "preparedness" as a vital adaptive response to "feedback effects, or vicious cycles," which have the potential to impede the ability of an urban system to function. This is a key adaptive response. According to the authors' train of thought, we are able to presume that adaptive reuse should take into account other qualities that are related to it and should be considered in a holistic manner. As a result of this, it is abundantly evident that some kind of framework is required to provide direction in practice.

According to Manyena (2016), natural disasters can induce conflict, and conflict can exacerbate vulnerability, a concept that is gaining increasing recognition in the scientific community. Christine Wamsler, an esteemed urban planning professional, has also acknowledged the importance of this relationship, as demonstrated in her City-Nexus model, which illustrates the interplay between a city's urban fabric and disasters (Wamsler 2014). The model involves an analysis of a system's physical features, including population density, land coverage and vegetation, architectural details, infrastructure, organisation of structures, and their relationship with topographic aspects. Wamsler's work highlights the need for integrated planning approaches that address underlying risks, going beyond traditional development considerations. Wamsler suggests an analysis of "subsystems," including ecosystem, society and culture, economy, and governance (2014). Addressing these factors is crucial for achieving resilience, an increasingly important concept in the face of the multiple and interconnected limitations of the 21st century and beyond.

To achieve resilience, a comprehensive plan is required that addresses social, economic, and environmental factors contributing to a system's ability to adapt and recover from disturbances. This should include the development of a risk reduction and management strategy, as well as diversification and adaptive capacity building (ARUP 2019). Building resilience is not a one-time effort but a continuous process of learning, adaptation, and improvement, enabling communities, economies, and societies to be better equipped to face future limitations. The Intergovernmental Panel on Climate Change (IPCC) also recognises the importance of an integrated approach to address

the risks of natural disasters and climate change, as highlighted in their reports on adaptation and mitigation (IPCC 2012; 2022).

Operationalising resilience

Resilience is more about the process than the results. This entails the capability of a system to "self-organise, learn, and adapt over a longer period" (IPCC 2012). According to the IPCC (2012), the ability of a system to anticipate, absorb, accommodate, and recover from the effects of a potentially hazardous event in a timely and efficient manner, including through the preservation, restoration, or improvement of its essential basic structures and functions, is the definition of resilience. Resilience also includes the ability of a system to anticipate, absorb, accommodate, and recover from the effects of a potentially hazardous event (IPCC 2012 pg. 46). Similarly, the Stockholm Resilience Centre emphasises the need of increasing capacities: These are guided by: diversity and redundancy; connectivity; managing slow variables and feedbacks; adaptive systems thinking; learning; participation and polycentric governance systems (Stockholm Resilience Centre 2015).

Urban planning, in accordance with this idea, also refers to a strategy that is more gradual, pragmatic, and transformative in nature. investigating the workings of different kinds of transformations and systems.

In conclusion, resilience research is a dynamic and fast-growing interdisciplinary field that draws on a wide range of disciplines, including engineering, urban planning, disaster risk management, ecology, economics, sociology, and psychology. As new insights and discoveries are made, the field continues to evolve rapidly, and it is an exciting time to be involved in resilience research. The current state of the field is one of continuous learning and development, and it is likely that the insights gained from this dissertation will play an increasingly important role in shaping our approach to addressing complex challenges of shrinking cities in the longer term.

2.2.5 Key debates on resilience efforts

The definition and assessment of resilience are two of the most prevalent points of contention in discussions around this concept. Because there is a lack of data, the validation of resilience metrics has not been achieved (Sun et al. 2020). There is not a widespread agreement on how to define or quantify resilience, which is particularly problematic given its integrated application (Serfilippi and Ramnath 2018).

In terms of whether it is a bottom-up or top-down strategy to urban resilience, research has offered mixed evidence. According to Rogov 2018, there is a necessity for a multi-level perspective that incorporates both top-down and bottom-up dynamic processes (Rogov and Rozenblat 2018). This is the argument that the author presents. While Caputo et.al (2015) suggests that methods to urban resilience that start from the bottom up are not effective. There is no consensus on which approach is preferred.

Another key facet is that it is an ongoing process, and that in order for cities to be really resilient, efforts must be made in both the short term and the long term simultaneously. An emphasis on both short-term and long-term resilience can help to guarantee that cities are better prepared for future disruptions and can recover from them more quickly and effectively when they do occur. Although some may improve infrastructure in the minimum amount of time, such as low-regret solutions that are cost effective even when dangers are unknown, there are also others (Jha et al. 2013).

The concept of "managing resilience as trade-offs" relates to the process of striking a balance between the goal of achieving resilience (defined as the capacity to withstand, recover from, and adapt to adversity) and the necessity of making concessions in order to do so. This requires determining which trade-offs are acceptable in order to construct a more robust system by balancing the costs, benefits, and risks associated with alternative solutions for resilience and making an informed decision about which of those trade-offs to accept. It challenges the normal functioning of government administration (Coaffee et al. 2018). This may require making concessions between various resiliency goals, such as giving reaction and recovery higher priority than preparedness, or between resilience and other aims, such as cost, efficiency, or social equality. In order to effectively manage resilience as a set of trade-offs, comprehensive assessment of all relevant elements and a holistic approach to decision-making are required (Chelleri et al. 2015).

Both adaptation and mitigation are significant techniques for responding to the effects of climate change, and it is possible for these two approaches to be combined. According to Adger's argument from 2005, there are two fundamental ways to respond to climate change: adaptation and mitigation. However, adaptation has received significantly less attention than mitigation has. Pielke's argument from 1998 states that adaptation ought to play a more significant part in climate policy than it does at the moment. In his article from 2003, Adger addresses the difficulties of adapting to climate change and makes the argument that all cultures need to improve their ability for adaptation. The relationship adaptation and mitigation in the context of managing the risks associated with climate change is of current discourse for policy and planning (IPCC 2022a).

These debates highlight the complexity and multi-disciplinary nature of resilience, and the need for a holistic approach that takes into account the social, economic, and environmental factors that contribute to resilience. Additionally, the ongoing conversation around resilience will continue to evolve as new research, evidence and context change over time.

2.2.6 Limitations associated with resilience efforts in practice

The concept of vulnerability has been used in urban planning to understand highly complex systems. In Zaninetti and Colten's research, the flooding caused by Hurricane Katrina, acted as a driver to the changes to the demographic landscape. Five years after the storm shows limited signs of resilience due to population loss and access to service and infrastructure, created a new onset of limitations (Zaninetti and Colten 2012).

The quality of life can be negatively impacted by climate change. The fall in population was caused by outmigration affected by environmental variables. The environmental repercussions exacerbated economic decline, unemployment, addiction, corruption, violence, and crime, as well as infrastructure degradation. In both instances, climate change caused a dramatic population decline, and the remaining population affected the area's resilience (Khavarian-Garmsir et al. 2019).

The governance of managing critical infrastructure can be expensive and challenging, especially in areas that are exposed to climate catastrophes. Local infrastructure must be able to cope with future shocks and stressors. This includes roads, and buildings that have a direct economic impact. In addition, it must consider social and political contexts and the actions that will shape the environments.

The following provides a summary of key limitations associated with resilience:

1. Ageing infrastructure: Ageing infrastructure that is increasingly vulnerable to natural disasters and other disturbances, making it difficult to maintain resilience (Capacci et al 2022).
2. Socioeconomic inequality: High levels of socioeconomic inequality (Wamsler 2014); vulnerability (Kabisch et al. 2012), which can make it difficult to build resilience in vulnerable communities.
3. Urbanisation: The concentration of population and infrastructure in urban areas can make them more vulnerable to disturbances, and more difficult to evacuate in case of emergency (Kuhliche et al 2012).

4. Climate change: According to the IPCC (2022) the impacts of climate change, such as sea level rise and increased frequency and severity of extreme weather events, which can make it difficult to maintain resilience due to governance challenges:
   Time uncertainty and horizon; Cross-scale and cross-domain coordination; Equity and Social vulnerability; Social conflict; and Complexity.
5. Lack of infrastructure: Limited infrastructure and resources, which makes it difficult to build resilience in the face of disturbances (Di Giovanni and Chelleri 2019)
6. Poverty: High levels of poverty can make it difficult for individuals and communities to prepare for and recover from disturbances, and can be both a cause and consequence of disaster risk (UNDRR 2022).
7. Limited governance: Weak governance and limited capacity to implement effective resilience-building strategies (ARUP and The Rockefeller Foundation 2014).
8. Lack of awareness and education: According to Platt (2020) lack awareness and education about the risks and impacts of natural hazards and the importance of building resilience.

Countries will likely face significant limitations in building resilience, but the specific limitations can vary depending on the country's level of social and economic development. More economically established countries may have more resources and capacity to build resilience, and similarly face complex and interrelated dynamics, while developing economies may face limitations related to poverty, corruption in governance systems, and lack of national infrastructure. A rise in inequality is seen in both contexts, which may include issues around social equity and environmental justice.

2.2.7 Opportunities associated with improving resilience efforts for shrinking cities

In another view, coastal areas are viewed as being vulnerable to climate change risks (McGranahan et al. 2007). The opportunity to position environmental issues in the process of shrinkage can foster short-term and long-term approaches (Larondelle et al. 2016), depending on the hazard or disaster being experienced. Unlike growing areas, they have more certainty in dealing with the risk, because they are assured from their prosperity in the past (Schlappa 2016). This can be a leverage in accessing financial support for improving urban development (Slach et al. 2019).

With this respect, the main research gaps in the application of resilience in shrinking cities are highlighted. Firstly, Szpakowska-Loranc, E. and A. Matusik demonstrate the idea of building policies for resilient cities for areas affected by shrinkage. Building the resilience was dependent on its relationship with a more competitive state capital, in this case, Warsaw. Thus, the shrinkage was

stabilised through smart shrinkage. Some of the qualities they mention are using a duopolis development between Warsaw-Lodz, enhancing blue-green networks such as stormwater management and re-naturalisation of the rivers, new city branding policy to enhance the historical industrial context and increasing community awareness (Szpakowska-Loranc and Matusik 2020).

Secondly, Eraydin and Özatağan point out that policies and policy making for areas affected by shrinkage should set directions for the long-term objectives These long-term objectives should create a diversity of strategies. In their review, they found that urban policies in shrinking cities lack diversity. For example, strategies often aimed at retaining the industrial legacy. The authors argue that governance and key actors in engaging the response to shrinkage is important to understand. Although no time frame is given, long term projects in urban planning can be anything between 10-15 years, as well as to 20 to 25 years (Eraydin and Özatağan 2021).

The following provides a summary of the opportunities for improving resilience in communities, systems and infrastructure, including:

1. Risk reduction and management: Developing strategies and policies to reduce exposure to hazards, and to manage the risks associated with hazards, can help to improve resilience (Raška et al. 2019).
2. Diversification: According to Brunckhorst and Trammell, building a diverse range of options, alternatives, and redundancies can help to improve resilience by increasing the ability to cope with disturbances (2023).
3. Adaptive capacity building: Building the ability to learn, change, and adapt can help to improve resilience by increasing the ability to cope with disturbances (Folke 2010).
4. Green infrastructure: Utilising natural systems, such as parks and green spaces, can provide ecological and social benefits, as well as reducing the impacts of hazards (Fields 2009; Vargas-Hernández and Hammer 2022).
5. Social capital: Building networks and norms that enable individuals and organisations to cooperate and coordinate their actions can help to improve resilience (Ročak 2022; Wolf et al 2010).
6. Transformative pathways: Building the ability to fundamentally change in response to disturbances or stressors can help to improve resilience by enabling adaptation and improvement (IPCC 2012).
7. Densification: increasing the population density of urban areas to make better use of existing infrastructure and resources can help to improve resilience (Di Giovanni and Chelleri 2019).

8. Managed retreat: A strategic approach to moving development away from flood-prone areas over time, which can be used to reduce flood risk and improve resilience. According to the online publication of Zurich Insurance (2022), "Due to rising sea levels and threat of storm surge, the coastal village of Fairbourne in west Wales, UK, will need to adopt a policy of 'managed realignment' between 2025 and 2055 – requiring the relocation of property owners and businesses (including 850 residents). The site will then be turned back into a tidal salt marsh. The villagers could be the UK's first climate refugees."
9. Urban design: The design of buildings, streets, and public spaces to improve ecosystem services address the limitations of urban shrinkage and hazards can help to improve resilience (Haase et al. 2014).
10. Community engagement: Involving the community in the process of planning and decision-making can help to improve resilience by ensuring that solutions are tailored to local needs and are more likely to be supported and implemented (Kunath 2012).

All these opportunities can be leveraged to enhance resilience, but it is important to understand that building resilience is not a one-time effort, but a continuous process of learning, adaptation, and improvement, that will help communities, economies and societies to be more prepared and better equipped to face future sea-level rise.

In conclusion, resilience research is a dynamic and fast-growing interdisciplinary field that draws on a wide range of disciplines, including engineering, urban planning, disaster risk management, ecology, economics, sociology, and psychology. As new insights and discoveries are made, the field continues to evolve rapidly, and it is an exciting time to be involved in resilience research. The current state of the field is one of continuous learning and development, and it is likely that the insights gained from this dissertation will play an increasingly important role in shaping our approach to addressing complex challenges of shrinking cities in the longer term.

2.3 The integrated concept of *Shrinkage-Resilience* for urban planning in shrinking cities

This section introduces how urban planners can benefit from the concepts of urban shrinkage and resilience by understanding and addressing their limitations and opportunities in a holistic and integrated way.

Limitations

Despite the potential benefits of going "green", a study by Bănică, Istrate, and Muntele (2020) shows that greener cities do not necessarily improve flood resilience in Eastern Europe. The authors compare new cities with new green infrastructure, natural areas, and older and denser cities where "green" is being used up to build. According to Antonić and Djukić (2020), while projects such as rain proof cities in the Netherlands and Sponge City in China can provide long-term sustainable effects, their costs can often be borne by local taxpayers. As a result, it is important to ensure that such projects are sustainable not only in their environmental impact, but also in their affordability for local residents. Failure to do so could result in increased taxes, housing costs, and a loss of residents, ultimately undermining the resilience of the shrinking city (Antonić and Djukić 2020). Therefore, the distribution of these features varies between areas, and a more integrated approach is needed (Antonić and Djukić 2020).

Moreover, Jonas et al. (2019) found that urban policies at a national and international scale can provide opportunities for shrinking cities to attract "green jobs" and transform their external image. However, Zaninetti and Colten (2012) argue that in the context of post-disaster management, shrinking cities may show limited signs of resilience, as was the case with Hurricane Katrina's impact on New Orleans due to displaced communities and lack of economic opportunities.

Subjective values attached to the link between shrinkage and resilience can influence urban approaches positively or negatively. For example, Kunath (2012) defines resilience more as "capacities rather than outcomes" and highlights the importance of local residents' ability to influence urban approaches. In the German context, emergency response organisations and networks are dependent on volunteers and organisations, and poor coordination of responsible authorities can lead to negative impacts during flood events. This relevance was shown in the devastating flood event in the Rhineland- Palatinate in 2021.

Opportunities

Evidence suggests that repurposing existing buildings and infrastructure and creating new green spaces and natural systems can provide ecological and social benefits. Urban shrinkage offers great potential to enhance green infrastructure (Haase et al. 2014). Other types of infrastructure, however, have shown a willingness of residents to pay the increased costs. More than 70% of residents are willing to pay increased rates for improved services that may be accomplished through retooling alternatives (Faust et al. 2016).

Resilience is a fruitful approach to identify shrinking cities' strength and capacities in order to formulate appropriate policies (Bănică et al. 2017) Secondly, resilience applied as a transformation, but also as a process of creative change and adaptation to support long term positive dynamics (Bănică et al. 2017). Similar relations can be found in "smart decline" that incorporates accepting the current shrinkage (whether it is directly or indirectly) while imagining intelligent adaptive strategies of growing smaller in a more sustainable way, going against the growth paradigm in urban planning (Bănică et al. 2017). This aligns with the wider debate on areas affected by shrinkage in that their future is based on their capabilities and assets (Schlappa 2016).

Urban shrinkage can enhance green infrastructure. Resilience can help identify shrinking cities' strengths and capacities and support long-term positive dynamics, including through "smart decline" strategies that imagine intelligent adaptive strategies of growing smaller in a more sustainable way. The future regeneration of areas affected by shrinkage is likely dependent on their capabilities and assets.

It is important to conclude that *Shrinkage-Resilience* in a context does exist in an urban context, and that each urban approach should be understood in terms of its context. The value of urban planning, as an interdisciplinary field, is a key instrument in joining these two concepts into practice through master planning, planning decision making, local climate action plans, and policy agendas, particularly in the context of port-industrial areas that have a significant economic impact on nearby coastal communities. The dynamics of planning for both urban shrinkage and climate resilience must be better understood, as these areas are subject to local vulnerabilities and policy concerns related to the labour market, infrastructure, and environmental impacts.

A diagram illustrating the relationship between the concepts of urban shrinkage and resilience, as well as the key components evaluated in this study - adapted from (Haase 2014; Wolff 2016) and (IPCC 2012; ARUP 2019).

2.3.1 The proposed framework of *Shrinkage-Resilience*

Climate change and governance changes have significant impacts on the built environment and contribute to changing urbanisation patterns and vulnerability. This, in turn, affects the resilience of coastal older industrial areas. Vulnerability is a crucial aspect of the relationship between urban shrinkage and resilience, as it can both limit and enhance the potential for improving urban approaches.

Transformative pathways such as adaptive management, learning, innovation, and leadership can be used to identify, measure, and establish which aspects of the *Shrinkage-Resilience* link contribute to making coastal older industrial areas more vulnerable. The interrelation between urban shrinkage effects and resilience is driven by various factors, including social, demographic, economic, environmental, spatial, and governance, which share similar drivers and impacts. The use of urban approaches such as adaptive management, learning, innovation, and leadership can help to link these concepts and create more sustainable and resilient urban environments.

A new integrated concept of *Shrinkage-Resilience* for urban planning is created as a result, driving the formation of a conceptual-methodological framework that is applied in this dissertation, see figure 4

A diagram illustrating the relationship between the concepts of urban shrinkage and resilience, as well as the key components evaluated in this study. Adapted from (Haase et al. 2014; Wolff et al.2016) and (IPCC 2012; ARUP 2019).

How to read:
(From the top) Climate change and Governance changes are drivers of Changing Urbanisation Patterns and Vulnerability, which impacts Urban Shrinkage affects and the Resilience of coastal-port industrial areas.

(Middle) Vulnerability is considered as a significant, interconnected term contained in the relationship between Urban Shrinkage and Resilience, which can limit and enhance the potential to improve urban approaches. Urban approaches characters of Adaptive Management, Learning, Innovation, and Leadership – are part of these transformative pathways to identify, measure, and establish which *Shrinkage-Resilience* linked aspects contribute to make a coastal older industrial areas more vulnerable.

(From the bottom) It is claimed that Urban Shrinkage effects and Resilience are interrelated concepts because of the analysed fundamental parts of Social, Demographic, Economic, Environmental, Spatial and Governance, as well as sharing similar drivers and the impacts they have on the built environment.

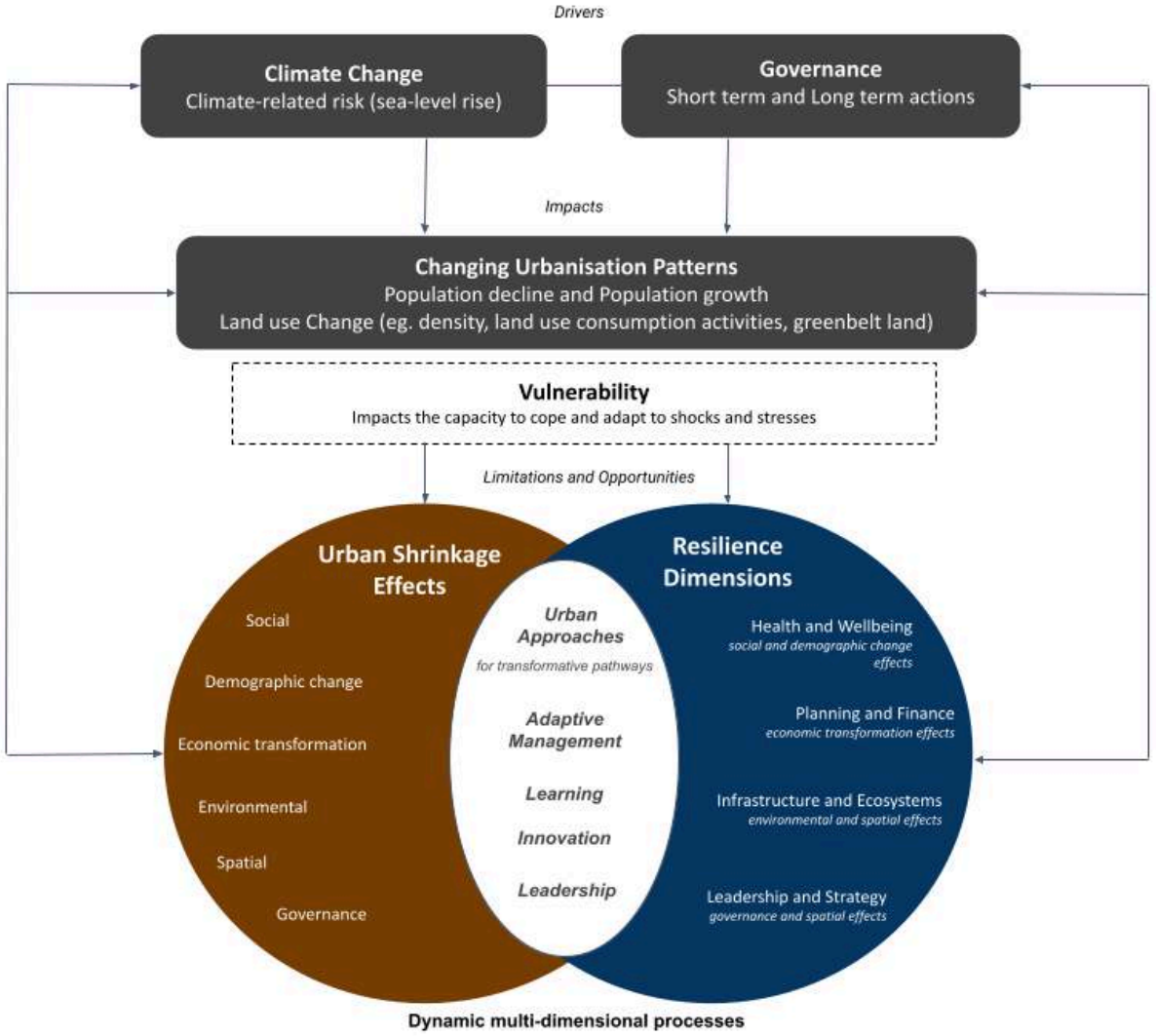

Figure 4: Conceptualisation of urban shrinkage and resilience concepts: *Shrinkage-Resilience* link. Source: Own work

2.3.2 Extended comparison of concept definitions

Following the review in Section 2.1 and 2.2, this dissertation proposes an applied definition that applies both a conceptual and methodological approach in not only identifying what a shrinking city is in features and elements, but also draws on a comparison method between different spatial scales using the formula proposed in the definition below in Table 1.

Potential shrinking city concept	Potential resilience concept
A shrinking city is defined as an urban area that has on the one hand faced a population loss in large parts of it (for at least 5 years, more than 0.15% annually), with a minimum population of 10,000 residents and is on the other hand undergoing economic transformation with some symptoms of a structural crisis.…is a multidimensional process with multidimensional effects having social, demographic, environmental and spatial dimensions Reference: Martinez-Fernandez, C., Ivonne Audirac, Emmanuelle Cunningham-Sabot, and Sylvie. Fol. 2012. "Shrinking Cities: Urban Challenges of Globalization." International Journal of Urban and Regional Research 36 (2): 213–25. doi:10.1111/j.1468-2427.2011.01092.x. Reference: Stryjakiewicz, T. and E. Jaroszewska (2016), 'The Process of Shrinkage as a Challenge to Urban Governance', Quaestiones Geographicae, 35 Reference: Wiechmann, Thorsten. 2006. Coping with City Shrinkage: A Global Issue: Types of shrinking cities: Introductive Notes. Dresden/Germany.	The process of resilience as the ability of a system to anticipate, absorb, accommodate and recover from the effects of a potential hazardous event in a timely and efficient manner including through preservation, restoration or improvement of its essential basic structures and services...and a system's ability to absorb disruption, reorganise, and maintain essentially the same function throughout time. The components involved in producing various functions differ in character, diversity, redundancy, and interactions that result from these interactions. Reference: IPCC (2012), Summary for Policymakers: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation., Cambridge, UK: Cambridge University Press. Stockholm Resilience Centre. (2015). 'Applying Resilience Thinking'. Text. 19 February 2015.

Table 1: Descriptions of the Shrinkage and Resilience concepts

The above definitions could potentially be adapted to other countries to identify shrinking cities

2.3.3 The importance of Adaptive Management, Learning, Innovation and Leadership in the Shrinkage-Resilience link

Taking the above into account, for Urban Systems to be Resilient to the impact of climate extremes, strategies and policies need to move away from rigid sector-based goals to more an integrated approach. In doing this the IPCC advocates a "transformative pathway" to include *Adaptive Management, Learning, Innovation,* and *Leadership*, among other key characters in the process (2012). Can these aspects be the link for urban shrinkage and resilience? The authors emphasise "aspects of adjustment" are ongoing in "socio-cultural and institutional learning processes" which are found in practice (IPCC 2012) and adaptive pathways (Eraydin and Özatağan 2021).

Adaptive Management is defined by the IPCC as "a structured process for improving management policies and practices by taking into account changes in external factors in a proactive manner" (IPCC 2012). Responding to these changes in the climate, Mark Pelling in his book titled 'Adaptation to climate change: from resilience to transformation' describes the need for ancillary organisations to be involved in planning processes (Pelling 2011). For example, this may include an NGO that is not restricted to the fixed agendas or bureaucratic red tape that often hinders the delivery of project goals in a state environment. The authors' further call for the government to reconsider its relationship with local actors because this *flexibility* to operate in a more open market is key for Resilience, especially when uncertainty arises. Arguably the strength of this component is that it may result in more options that make "societies fit to adapt to changing environments" (Pelling et al. 2008).

Another important pathway is *Learning* by increasing the adaptive capacity of society at present rather than focusing on only long-term adaptation (IPCC, 2012). As Fleishhauer and colleagues clearly indicate that "science may become problematic" over time due technical measures that are infrequent (2012). With *Learning* individuals and societies can establish means to deal with this uncertainty and extreme events. Examples of learning highlighted by IPCC can be experiential or transformative in learning by doing; by problem-solving and even by learning cycle activities (2012). For instance, community-based risk assessments. Other adaptation projects foster present adjustments especially in complex societies faced with multiple Vulnerabilities. It is clear that *Learning* adjustment is key to Resilience to foster collaborative governance to allow transformation.

Equally important is *Innovation* in the process. This refers to "non-material changes to be related to knowledge, communication or intelligence" (IPCC 2012 p.468). This relation should involve both

social and technological innovations that are incremental as well as radical (IPCC, 2012). In Europe, an example of *Innovation* is the '*Room for the River Policy'* in the Netherlands that considered the impacts of climate change and the exposure of floods by using technology and integrated systems thinking to bolster community engagement stakeholders. The new integration now looks at how Water Management and Urban Planning can provide landscapes with natural flooding into adaptation (IPCC 2012).

The final pathway is *Leadership.* This refers to processes that are shaped by individuals, societies and communities to take ownership. It implies fostering change and transformation. It focuses on understanding different perspectives of vulnerabilities and how this can be dealt with in motivating others to address social, economic and environmental limitations.

The research advances the scientific practice of the advantages of *Shrinkage-Resilience* in approaches as part of the transition to a more sustainable and inclusive society, where the welfare of present and future generations, the environment, and economic development are taken into account. Recommendations for urban planning to incorporate policy changes in port-industrial areas to include disaster risk reduction and climate change adaptation approaches in urban shrinkage contexts are outlined.

2.3.4 Applying the *Shrinkage-Resilience* framework to coastal port-industrial areas: Case Studies and adaptation efforts

Applying the Framework of *Shrinkage-Resilience* in Practice

This scientific analysis has explored the relationship between two concepts, shrinkage and resilience, and their potential impacts on urban planning in shrinking cities. The literature review suggests that there is a complex relationship between these two concepts, with urban shrinkage potentially limiting or enhancing the opportunities to improve resilience in older industrial areas affected by sea-level rise.

The analysis of *Shrinkage-Resilience* is based on the following observations, as shown in Section 1.3:

- Observation of macro trends on shrinkage and resilience concepts:
    - Part One: Changing Urbanisation Patterns
    - Part Two: Case Study Reviews
- Observation micro trends shrinkage and resilience concepts
    - Part Three: Comparative Local Case Studies

The framework of shrinkage-resilience, which was adapted from various sources, provides a useful tool for analysing this relationship and identifying the various factors that impact both concepts. The framework highlights the importance of considering social, demographic, economic, environmental, spatial, and governance factors in understanding how urban shrinkage affects resilience and vice versa.

Moreover, the newly applied definition of *Shrinkage-Resilience* offers an integrated approach to urban planning in shrinking cities, enabling a comparative analysis between different spatial scales. This approach can be useful in identifying the features and elements of shrinking cities, as well as in developing a conceptual-methodological framework for addressing the challenges of urban shrinkage and building resilience in coastal areas affected by sea-level rise.

The analysis has emphasised the need to consider the complex relationship between urban shrinkage and resilience in the context of changing urbanisation patterns and vulnerability to climate change. The framework of *Shrinkage-Resilience* and the newly applied definition offer valuable tools for urban planners and policymakers to address the challenges of shrinking cities and build resilience in coastal areas affected by sea-level rise.

In this regard, case studies and existing models and frameworks can provide valuable insights into successful adaptation efforts. Specifically, the experiences of North East Lincolnshire in England and Bremerhaven in Germany following the 2013 tidal surge are analysed to highlight best practices and potential areas for improvement.

By examining the challenges and opportunities of these case studies through the lens of the *Shrinkage-Resilience* framework, urban planners can gain a deeper understanding of the complex relationship between these two concepts and develop effective strategies for addressing them in practice.

2.3.5 Recommendations to expand on Shrinkage-Resilience for urban policy and decision making

This chapter presented the framework of *Shrinkage-Resilience*, which provides a comprehensive approach for analysing the complex relationship between urban shrinkage and resilience in the context of changing urbanisation patterns and vulnerability to climate change. The framework highlights the importance of considering various factors, such as social, demographic, economic, environmental, spatial, and governance factors, in understanding how urban shrinkage affects

resilience and vice versa. The newly applied definition of *Shrinkage-Resilience* offers an integrated approach to urban planning in shrinking cities, enabling a comparative analysis between different spatial scales. Additionally, the chapter has emphasised the need to consider the challenges and opportunities of applying the *Shrinkage-Resilience* framework in practice, by examining case studies and existing models and frameworks. By developing effective strategies for addressing the challenges of shrinking cities and building resilience in coastal areas affected by sea-level rise, urban planners and policymakers can enhance the potential for adaptive management, learning, innovation, and leadership in transforming shrinking cities into more sustainable and resilient urban environments.

The *Shrinkage-Resilience* link proposed offers significant implications for policy in the UK's "Levelling Up" agenda for regeneration, which aims to reduce regional disparities, inequalities and promote economic growth across the country. This unique approach, based on empirical evidence using open-source data and literature reviews, integrates spatial planning, climate change adaptation, and disaster risk management into policy agendas.

By considering urban shrinkage and resilience concepts together, policymakers across scales that can address the challenges of limited resources, ageing infrastructure, and climate change in a holistic and integrated way. This approach can lead to long-term sustainable outcomes that benefit both the environment and local communities.

The next section applies the framework covered in Chapter 3 of this dissertation.

CHAPTER 3: Shrinkage-Resilience in comparison perspectives

3.1 ANALYSING CHANGING URBANISATION PATTERNS IN ENGLAND: WIDER URBAN SHRINKAGE TRENDS

PART ONE

Understanding the changing urbanisation trends is a critical first step in developing effective strategies for addressing the inequalities facing existing and future urban shrinkage and promoting their resilience and viability in a rapidly changing world. Additionally, understanding urbanisation trends can help city leaders and residents understand how changes in the urban landscape may affect the physical, social, and economic fabric of the city. The macro trends can inform decisions about how to manage and use land and other resources in ways that enhance the resilience and sustainability of shrinking cities.

Older industrial areas in England continue to experience disproportionate effects of changing urbanisation patterns, and are undergoing corresponding structural changes. These areas are identified in the UK's Industrial Strategy for regeneration and are located throughout England.

In September 2022, the National Government announced a new investment zone as part of its Levelling Up Policy agenda. The investment zone aims to promote long-term economic restructuring and urban regeneration programs in areas that are facing social and economic difficulties. The investment zone will provide support for local areas to plan for growth and address the challenges they are facing.

The investment zone is part of a broader strategy to address regional imbalances and promote growth across the country. The Levelling Up Policy agenda is a key part of this strategy and aims to support areas that have been left behind by previous economic policies. The investment zone is a key tool in achieving this objective, as it will provide funding and support to help local areas invest in their own growth. Local areas will be able to apply for funding from the investment zone to support a range of activities, including infrastructure projects, skills development programs, and business support initiatives. It will be targeted at areas that have the greatest need for support, including those that have experienced high levels of unemployment or are facing other economic challenges. The spatial zones will be managed by a dedicated team within the National Government, which will

work closely with local authorities and other stakeholders to identify opportunities for investment and provide support to local areas. The team will also work to ensure that the investment is aligned with the broader Levelling Up Policy agenda and supports the government's overall objectives for growth and economic development.
In this regard, how can the national government inform policy and decision making to equally distribute future investment opportunities to disadvantaged communities, especially to the current 63 older industrial areas?

This assessment takes into account the multifaceted context of coastal port-industrial areas. These areas can provide insights for policy makers into the underlying causes of population changes, in both growth and decline, which can inform strategies for reversing or mitigating the effects of urban shrinkage. For example, understanding the factors driving migration from shrinking cities to growing cities can help policymakers and urban planners design programs that address the root causes of migration and encourage people to remain in or move back to shrinking cities as explored in this dissertation. By identifying and leveraging opportunities for land use change, such as repurposing former industrial sites for new uses or developing brownfield sites, policymakers and urban planners can create more sustainable and resilient communities.

This method unpacks the relationship between population change and land use change (Kroll and Haase 2010; Wolff et al. 2016) and the potential for improving resilience with densification (Di Giovanni and Chelleri 2019) and green spaces (Fields 2009; Vargas-Hernández and Hammer 2022). For urban shrinkage, densification may potentially increase the population of coastal port-industrial areas to make better use of existing infrastructure and resources to help to improve resilience. On the other hand it can discourage population growth in a particular area (Dembski et al. 2019). This can happen due to a variety of factors such as rising local taxes and housing affordability, having negative consequences such as discouraging population growth and causing migration as studied by Dembski et al (2019).

Resilience on the other hand could also be impacted by climate change (Khavarian-Garmsir et al. 2019), reducing the availability of green space to improve adaptation to hazards or disasters and reducing stormwater runoff, and protection against coastal erosion. These factors contribute to the quality of life of residents and businesses in shrinking cities.

The density change model by Wolff et al. (2016) is applied to study the macro trends of urban shrinkage and resilience concepts between 1991-2019 to assess the changing urbanisation patterns.

The density change model is specifically designed to analyse the relationship between population density and land use changes, which makes it a relevant tool for studying how population decline might impact urbanisation patterns in older industrial areas.

Previous research has shown that population decline can have significant impacts on the built environment and land use in urban areas (for example, see Kabisch et al. 2017). The density change model allows these relationships to be explored in more detail and to assess how they may be changing over time.

The model incorporates a range of factors that are likely to be important for understanding urbanisation patterns in older industrial areas, including land use, densification, and green spaces. By using this model, the impact of these factors on population decline to shape urbanisation patterns can be assessed. The availability of open-source data sources like the Land Use Change Statistics database and the Office of National Statistics makes it possible to apply the density change model at a large scale, enabling an analysis of a wide range of local authority areas and assess broader trends in changing urbanisation patterns.

The adapted Density model approach is focused on local authority areas (Unitary Authority Districts as of 2019). The model's data is aimed to observe the key factors related to shrinkage-resilience: land use (Kroll and Haase, 2010; Wolff et al. 2016); densification (Di Giovanni and Chelleri, 2019); and green spaces (Fields 2009; Vargas-Hernández and Hammer 2022). In addition to the work by Wolff et al. (2016), an approach to consider further factors that impact the built environment of shrinking cities is proposed due to the available databases in England. Factors of population change, multiple density land use types, and green space data are included.

Population changes between 1991 and 2019 for 314 LUAs; land use change statistics between 2013 and 2019 for 326 LUAs; and land use change statistics between 2013 and 2018 for 326 LUAs were calculated using open-source databases by the Land Use Change Statistics database by the Department of Levelling Up, Housing, and Communities and the Office of National Statistics.
The data on population changes between 1991 and 2019 and land use change statistics between 2013 and 2019 and 2013 and 2018 provide a valuable basis for answering the research question of how population decline impacts urbanisation patterns in older industrial areas. By using these data sources to apply the density change model, we can assess the extent to which population decline is

associated with changes in land use and urban density and explore how these changes vary across different local authority areas in England.

3.1.1 Older industrial areas in England: population changes

England's older industrial areas have been a growing topic of investigation for policy makers, governments and researchers since the post-industrialised period. The collapse of industries has left many cities, regions, towns and rural areas with an unwavering circumstance of depopulation and urban decline. There are 63 older industrial areas in England, with 6.8 million people, or 26% of the population of Great Britain, as of 2019 (Beatty and Fothergill 2021), and research shows that older industrial areas located in the North and mid regions of England will, in future, face unprecedented social limitation (Beatty and Fothergill 2021).

Shrinking cities as an urban phenomena is used to describe areas undergoing social, economic and environmental limitation linked to structural changes. What is less clear is whether land use negatively impacts flood risk management (Raška et al. 2014). The American Rust Belt Cities and Germany's Industrial Ruhr region are common places for researchers to investigate shrinkage (Pallagst and Al 2009). UK's older industrial cities have been linked to many shrinking city studies to investigate approaches and solutions to improve the quality of life and the environmental sustainability of these areas (Mulligan 2022).

A study conducted by the Rowntree Foundation highlighted urban decline of 24 local areas between 1951 - 2011 in the United Kingdom (Pike et al. 2016). This decline brings significant effects on labour market trends, particularly for older industrial areas. Recent figures through to 2019, for example, show that in relation to the resident working age population the increase in the number of jobs in older industrial towns since 2010 (2.8%) was five times faster in the main regional cities (14.2%) and nearly six times faster in London (16.3%) (Beatty and Fothergill 2019).

For older industrial areas, they are becoming places where people live, but work elsewhere. In response, those cities need to deal with depopulation because people are migrating to more lucrative cities, for an improved quality of life. The supply of new urban development, particularly in city centres is a direct market response to the number of local residents. From a spatial planning perspective, studies have observed whether cities are centralising or decentralising as a direct consequence for depopulation or increasing population (Wolff et al. 2018). This is an urban phenomenon, very common to older industrial contexts.

National planning has a long history of local growth programmes, such as Enterprise Zones, that have a focus on local economic growth and urban regeneration. These zones, which were initially established in the 1980s, were liberalised under Margaret Thatcher's political career in order to promote development in economically weaker areas. In addition, the related funding was based on long-term investments.

With the most recent initiatives of Investment Zones and Free Port Zones, Enterprise Zones are still used on a similar concept in central government planning to promote growth. City-regions and local areas must undertake competitive bidding to acquire these funds, and are often based on short term programmes.

The Levelling Up Policy, which outlines a 10-year plan to address England's long-term social, economic, and spatial imbalances by 2030, is regarded as the country's most notable policy to date (HM Government 2021b).
The twelve missions that are listed includes:

1. 'Increase pay'
2. 'employment and productivity'
3. 'Domestic public investment in R&D outside south-east to rise by 40%'
4. 'London-style public transport connectivity across the UK'
5. 'Nationwide broadband'
6. 'Fixing the education gap; Skills training'
7. 'Narrowing life expectancy gap, with a UK-wide rise of the five years by 2035'
8. 'Rise in well-being'
9. 'Decreased inequalities'
10. 'Rise in overall number of first-time homebuyers'
11. 'Crime reduction'
12. 'Devolution in England'

The Levelling Up agenda is a strategy proposed by the UK Government to address economic disparities between regions in the UK. In relation to urban shrinkage, the agenda aims to address the issues faced by local areas experiencing population decline and economic stagnation by investing in infrastructure, housing and regeneration projects to promote economic growth and revitalise local communities.

Some of the ways the Levelling Up agenda is addressing urban shrinkage in the UK include:

1. Providing funding for infrastructure projects, such as transportation, broadband and housing, to support economic growth and job creation in areas experiencing population decline. The Coastal Communities Fund, which aims to support economic growth and job creation in coastal communities. The Town Fund, which aims to support the regeneration and revitalisation of towns and cities that have been left behind by economic growth. The Rural Development Programme for England, which aims to support the economic, social and environmental development of rural areas.
2. Investing in regeneration projects, such as renovating and repurposing existing buildings, to revitalise local communities and create new economic opportunities.
3. Supporting local businesses and entrepreneurs by providing access to funding and resources, to create new jobs and boost economic activity.
4. Encouraging people to move to and invest in communities experiencing population decline by providing tax incentives, grants and other financial incentives.
5. Developing policies and initiatives to attract young people and families to move to the declining areas, for example, through education and training opportunities.

It is worth noting that the Levelling Up agenda is still in its early stages and its implementation and effectiveness are yet to be seen. Furthermore, addressing urban shrinkage is a complex issue that requires a multi-faceted approach and coordination across different levels of government and agencies. Since the implementation, the policy has been criticised as a centralised programme creating further displacement of local areas in the Northern regions of England, by attracting urban development that is cost sensitive and low wage businesses. This impacts employment availability in areas, driving population loss further, particularly in older industrial areas. For instance, the Wirral and Blackpool [2] continue to be listed amongst the most deprived areas in England (Mackay et al. 2022).

3.1.2 Population, Land Use and Greenbelt changes: Methodological analysis

Population changes, residential density changes, centralisation processes, land use changes and fragmentation, and population density are metrics to observe changing urbanisation patterns (Reis et al. 2014; Wolff et al. 2017; Wolff and Wiechmann 2017; Wolff et al. 2018; Haase et al. 2018; Sapena et al. 2016; Lauf et al. 2016; Slach et al. 2019). In addition, understanding the relation between one or more metric, land use diversity, spatial distribution, and land use distribution are techniques used

[2] Wirral and Blackpool are two local authority areas in England, with an industrial heritage.

with spatial data (Reis et al. 2014). Using statistical data, studies compare the frequency of changes using absolute change, relative change, and cumulative change methods to extract the correlation between one or more metrics (Centre for Cities 2015; Pike et al. 2016). For example, comparing residential density and population growth and decline revealed how much land is being used when observed over time and space (Wolff et al. 2017). In addition, decentralisation or suburbanisation, known as "doughnut effect" or the "hollowing-out" effect, is a spatial effect symbolising a reduction in urban density (Couch et al. 2005; Nuissl and Rink 2005).

This analysis considers the changing urbanisation patterns of older industrial areas in England offering important insights into what local area factors are impacting the ''Levelling Up'' agenda.

The renowned Density Change model by Wolff et al. (2016) is applied and expanded upon, see figure 1 using the following metrics and planning data:

Applying the density change model developed by Wolff et al. (2016) has the advantage of assisting in the understanding of patterns or characteristics in older industrial cities that are currently the focus of major policy considerations. It closes a gap in previous research by tying theory to the explanation of land use diversity. Shrinking City research emphasises the importance of measures related to sustainability, including population, changes in land use density, and data on greenbelts.

Greenbelt data is used in the analysis because it is a significant factor in shaping land use density patterns and land use diversity in older industrial cities. The presence or absence of greenbelts can influence development patterns and can lead to variations in population density, housing types, and urban form. By including greenbelt data in the analysis, researchers can gain a more comprehensive understanding of the factors that contribute to the complex urban dynamics in these areas and develop more effective policies and strategies for promoting sustainability and resilience. Table 2 shows the data used as part of the framework.

Metrics	Description	Spatial area	Period	Frequency	Source
Population	Registered resident population in accordance to the Annual Population Survey	LAU	1991-2019	Annual	Office of National Statistics
Land Use	Land use consumption activities related to changes of previously developed land to Community Services, Industry and Commercial, Transport and Residential uses	LAU	2013-2019	Annual	Department of Levelling-up, Housing and Communities
Greenbelt	Undeveloped land, Green space availability	LAU	2013-2018	Annual	Department of Levelling-up, Housing and Communities
Older Industrial areas	Post-industrial areas including coal, steel, chemicals, engineering and textiles located in England	LAU	2021	Annual	Beatty and Fothergill (2021)

Table 2: Planning data and selected indicators to analyse Changing Urbanisation Patterns

Research framework

Figure 5 shows the Framework to Analyse Changing Urbanisation Patterns using a three-step process that includes identification of research gaps, data collection and pre-processing using open-source data, and the application of the expanded Density Change Model in accordance with the leading studies identified in Step 1.

To define and identify older industrial areas in England, this analysis uses a combination of methods (Besana 2021; Pike et al. 2016; Stryjakiewicz and Jaroszewska 2016; Wiechmann 2016; Wiechmann and Wolff 2017; Wolff et al. 2016), and a typology (Beatty and Fothergill 2021) is applied as found in the literature review in Step 1.

The Shrinking Cities International Research Network (SCiRN) applied the method to statistical data using quantitative analysis:

> "A shrinking city is a densely populated urban area that has on the one hand faced a population loss in large parts of it (for at least 5 years, more than 0.15% annually), and is on the other hand under- going economic transformation with some symptoms of a structural crisis" (Stryjakiewicz and Jaroszewska 2016 pg 28)

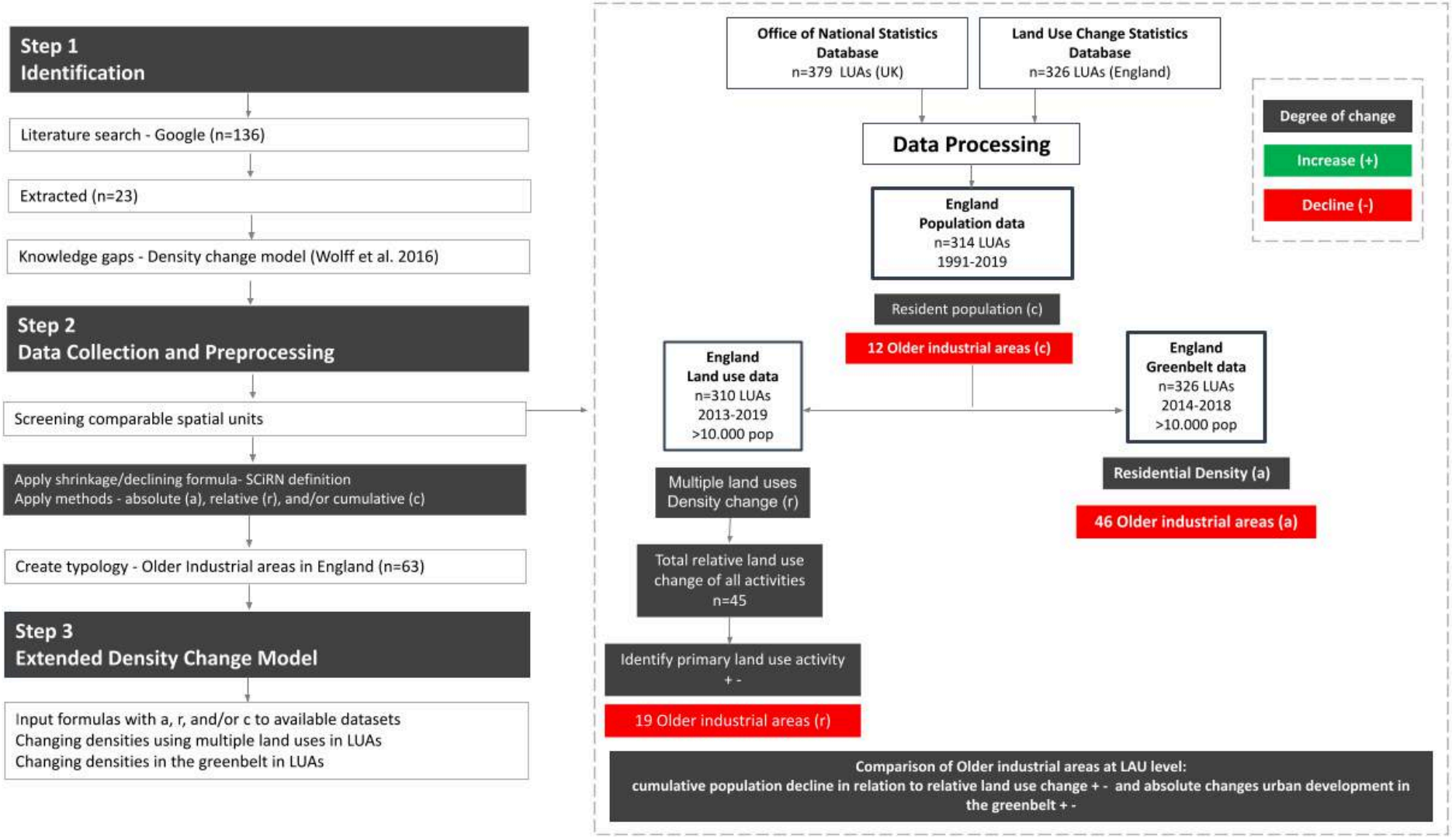

Figure 5: Framework to Analyse Changing Urbanisation Patterns using Population, Land Use and Greenbelt Data. Source: Own work.

There is no definition for statistical comparison on older industrial areas in England. In response, the recent typology developed by Sheffield Hallam University's Centre for Regional Economic and Social Research, uses overlapping criteria of older industrial towns, former coal fields, and major regional cities that can be applied to statistical data to advance quantitative analysis methods. This criterion has the advantage of allowing us to spatially compare local authorities with a minimum of 10,000 residents identified in the Office of National Statistics and Land Use Change Statistics databases. A threshold of 10,000 residents is applied to determine the degree of population loss (Wiechmann 2006) Using a minimum ratio of 10,000 population is suggested by leading studies on this topic (Besana 2021; Stryjakiewicz and Jaroszewska 2016; Wiechmann 2016; Wiechmann and Wolff 2017; Wolff et al. 2016).

Population is the first metric in this research to analyse the cumulative population change in local authority areas (LAUs) with a population loss of 0.15 percent per year over a five-year period and a threshold of 10,000 resident population in order to extract declining areas. (Besana 2021; Stryjakiewicz, and Jaroszewska 2016; Wiechmann and Wolff 2017).

Figure 1 shows the data processing of population and how it relates to relative land use change and absolute greenbelt changes over specified periods. Note that the greenbelt changes could not be measured using relative change because of data availability at the time of the analysis.

The following methods and metrics are explained below for Step 2: Data Collection and Preprocessing:

a) **Population change** - the first step is to determine if the cumulative *population change* for LUAs has experienced population decline or growth, the total population change is taken into account using cumulative frequency (Besana 2021; Pike et al. 2016; Stryjakiewicz and Jaroszewska 2016; Wiechmann and Wolff 2017; Wolff et al. 2016)**.** Using data from the Annual Population Survey for population *(Pop)* between the years 1991 and 2019 for 314 LUAs to determine the cumulative change *(c)* and the SCIRN definition:

cPop = Pop1991:Pop2019 > -0,15%(5y.a)

Own elaboration

b) **Land use change -** the second step is to determine the relative *land use change* of the LUAs undergoing population loss as well as those that are categorised as older industrial areas based on the extracted LUAs from step 1.

An open-source database of land use changes at the national and local levels of government is made available using data from the Department of Levelling Up, Housing, and Communities. Researchers, decision-makers, and business utilise this 2013 tool to assess sustainable development. The database, which was updated in 2019, contained data for 326 local authorities regarding newly constructed homes, density changes in the community services, defence, industry and commerce, mineral and landfill sites, residential, transport and utilities, and other developed uses, as well as vacant sites that had previously been used, and are listed as "developed land"

The ratio of the total building footprint used to compute density determines land use change *(D).* The determination of density *(D)* uses a combination of two processes: combination of Ordnance Survey data and a change of addresses in Address Premium (the national addressing dataset in England) (see full methodology in the Land Use Change Statistics report 2015). The Land Use Change - Hectarage data provides yearly information on the number of hectares that have changed from one land use to another (Tables P350 to P390). Five out of eight land use types were extracted due to data availability, these are: community service *(C)*, industry and commerce *(IC)*, residential (*R)*, transport and utilities (*TU),* other development (*OD*) and vacant *(V)*. Using data from the Land Use change statistics between 2013 and 2019 for 326 LUA's to determine the relative change *(r) of multiple land uses* and the SCiRN definition:

$$rD = 2019(Cha\% + ICha\% + Rha\% + TUha\% + ODha\% + Vha\%) - 2013(Cha\% + ICha\% + Rha\% + TUha\% + ODha\% + Vha\%)5y.a$$

Own elaboration

c) **Urban development in greenbelt areas** - the third step is to determine the rate of *urban development in greenbelt areas,* using density as a metric*.* Greenbelt data from the Land Use Change Statistics is measured using the available residential density. In England, greenbelts are designated by the local government and includes areas such as wetlands, streams, meadows, and forests. Using data from the Land Use change statistics between 2013 and 2018 for 326 LUA's to determine the absolute change *(a) of multiple land uses* (Note the and the SCIRN definition could not be applied due to data availability being less than 5 years.

a*D*= (*D*greenb2019*%)*-(*D*greenb2013*%)*

Own elaboration

3.1.3 Results: Changing urbanisation patterns in older industrial areas

The results of the analysis reveal changing urbanisation patterns, with lagging behind older industrial areas against national growth. Recent data shows a strong relation between density increases and population increases in older industrial areas, as well as the rate of residential density built in greenbelt areas, contributing to the Density Change model by Wolff et al. (2016).

The main findings of the study is summarised and further expanded upon in the sections below:

i. Between 1991 and 2019, a total of 49 older industrial areas experienced cumulative population decline in the Northern and Midlands areas. They are: Allerdale, Amber Valley, Ashfield, Barnsley, Barrow-in-Furness, Blackburn with Darwen, Bolsover, Bradford, Burnley, Bury, Chesterfield, Chorley, Copeland, Corby, County Durham, Darlington, Doncaster, Dudley, Gateshead, Gedling, Halton, Hartlepool, Hyndburn, Kingston upon Hull, Knowsley, Mansfield, Middlesbrough, North East Derbyshire, North East Lincolnshire, Oldham, Pendle, Preston, Redcar and Cleveland, Rossendale, Rotherham, Salford, Sandwell, Sefton, South Tyneside, St. Helens, Stockport, Stoke-on-Trent, Sunderland, Tameside, Trafford, Walsall, Wigan, Wirral and Wolverhampton.
ii. In Northern England, Blackpool is the only older industrial area that has continuously lost residents between 1991 and 2019, lagging behind national trends.
iii. Between 2013 and 2019, there was a reduction in relative land use in 68% of England's older industrial regions.
iv. From 2013 to 2018, the greenbelt areas in England's older industrial areas are seeing a 46% increase in residential density.
v. The main land use activity in older industrial cities experiencing growth and shrinkage between 2013 and 2019 is community services.

Cumulative population change

The total number of 314 LAUs in England were analysed. Figure 6-7 estimates that as of 2019, LAUs with a minimum of 10,000 residents have increased in population, using the SCiRN definition with a cumulative change frequency. This means that for large parts of England the cumulative population is growing. According to estimates, England's national growth rate increased from 1.06% to 3.13% between 1991 and 2019.

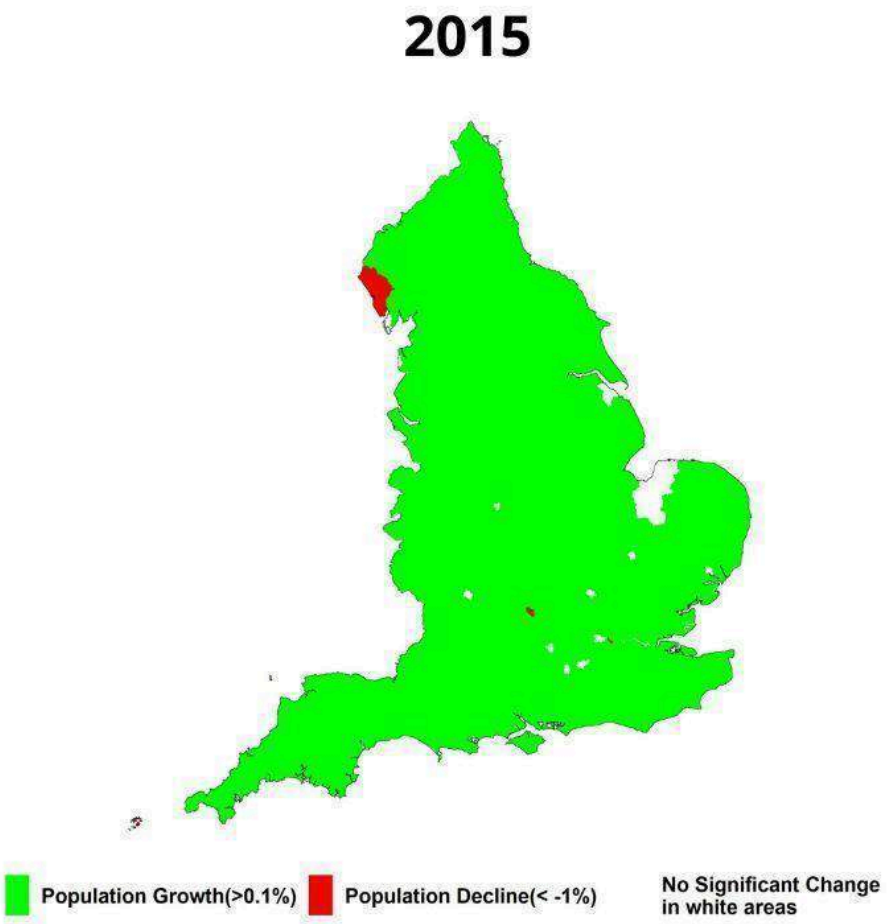

Figure 6: Cumulative Population Growth and Decline trends in England's 314 Local Unitary Authority, 2015-2019

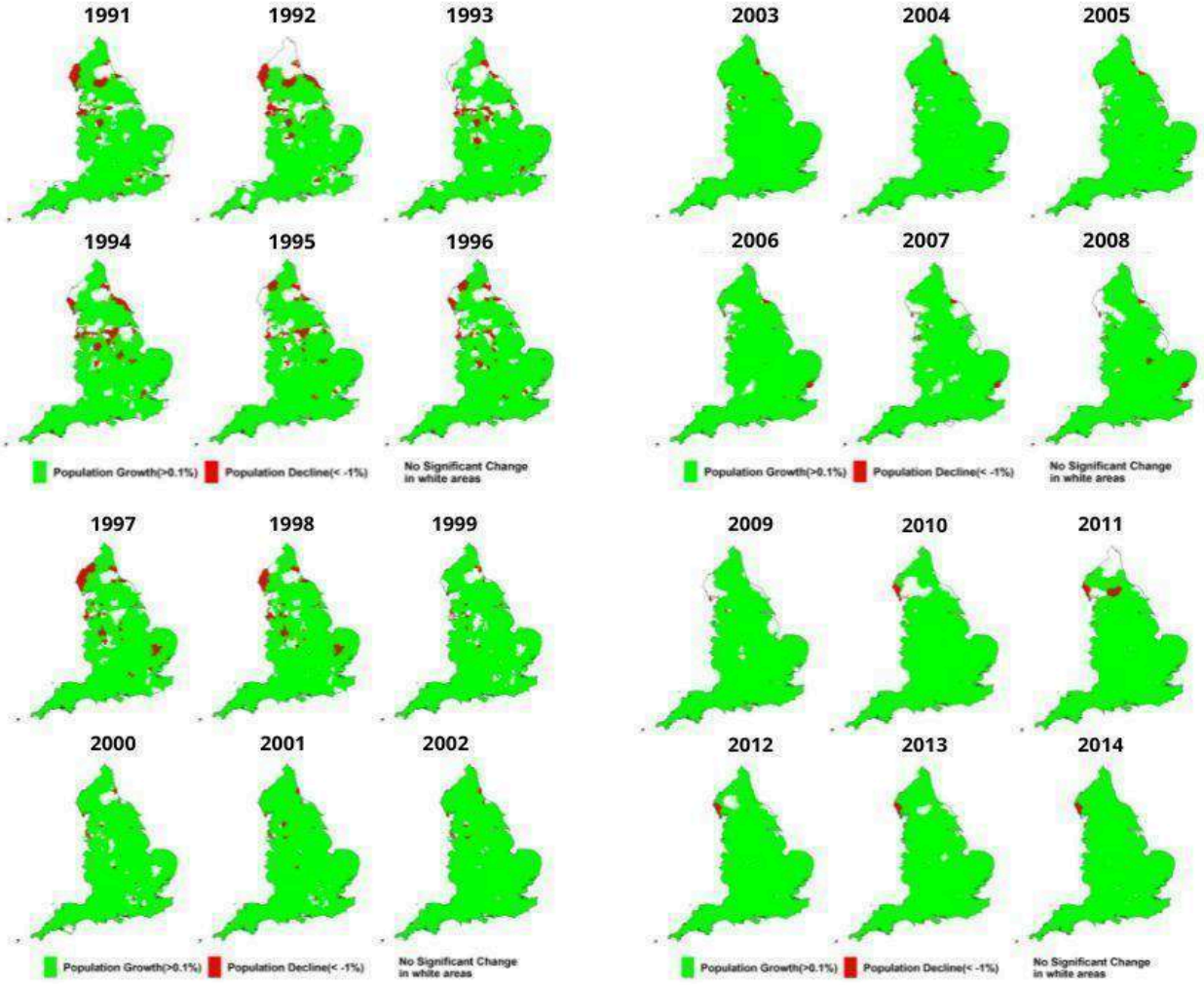

Figure 7: Cumulative Population Growth and Decline trends in England's 314 Local Unitary Authority, 1991-2015. Source: Own work

In the context of older industrial areas, understood as major city-regions (Beatty and Fothergill 2021), figures 6-7 estimates a cumulative population increase between 1991 and 2019. These are: Manchester (-1.61% to 5.33%), Coventry (-0.26% to 8.96%), Kingston Upon Hull (1.08% to 0.45%), Newcastle Upon Tyne (2.28% to 4.38%), and Liverpool (-2.30% to 3.61%). Coventry (-0.26% to 8.96%) interestingly outperformed Manchester in terms of the highest rate of gain between 1991 and 2019.

Whereas small- to medium-sized industrial cities and towns (Beatty and Fothergill 2021), have seen cumulative population increase. These are: Blackburn and Darwin (1.57% to 1.35%), Wigan (-0.61% to 2.10%), Doncaster (-0.35% to 2.19%), and Sheffield (-0.65% to 3.01%) show an improvement in the relative population increase.

Our estimates show that Blackpool has persistently lagged behind other older industrial areas in the national population trend throughout 1991 through 2019, with the years 1996 to 1998 seeing the largest rates of population loss, as highlighted in red in figure 8.

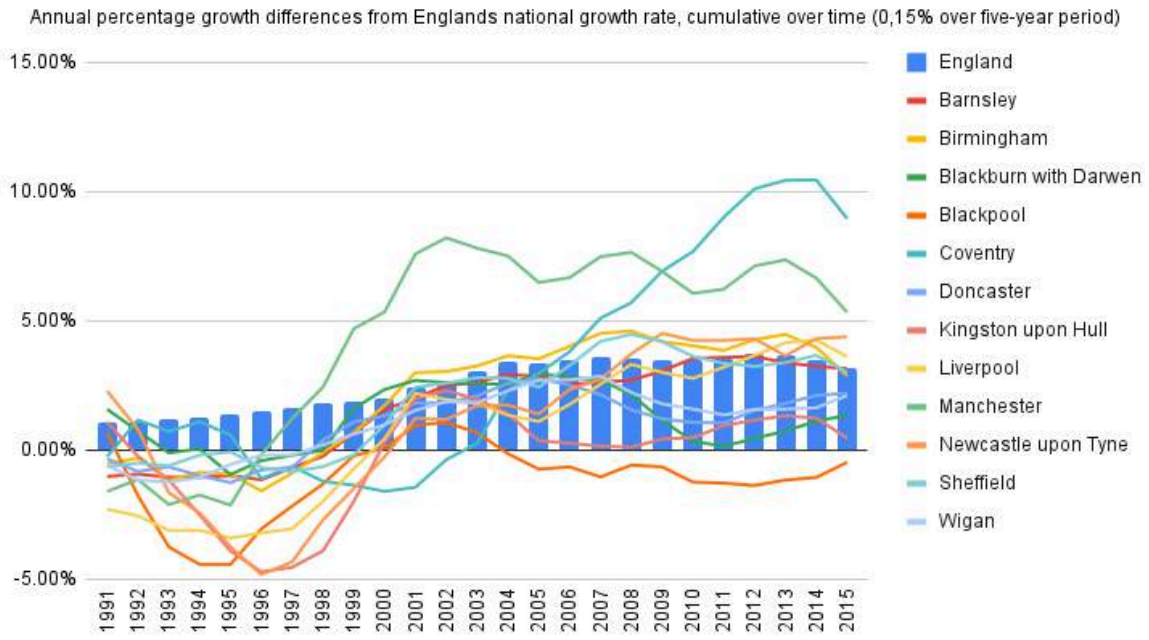

Figure 8: Pathways of Population Growth and Decline trends in older industrial areas in relation to national growth trends, 1991-2015. Source: Own work

Land use change

The estimates concerning the relative land use change in LUAs and out of that dataset, older industrial areas were extracted and are covered in this section.

A total number of 376 LUA's, only 326 had complete land use data over the period of 2013-2019, using the SCiRN definition, with a minimum 10,000 resident population assessed with the Land Use Change Statistics dataset.

Between 2013-2019, out of the 326 LUAs assessed, a total of 144 LAUs experienced relative land use decline, a total 176 LAUs experienced relative land use increase and around 6 LAUs had no land use change. Figure 9 shows LUAS facing relative depopulation compared to land use changes

In the context of the observed older industrial areas, the estimate illustrates that relative land use decline conservatively occurred in 68% (43 older industrial areas) between the periods of 2013 till 2019 experienced a degree decline in their land use. The analysis extended the Density Change Model by Wolff et al. (2016), by exploring what type of land use activity was in decline between 2013 and 2019. The estimates show the top three declining land uses:

1. 23% (10 older industrial areas) had a relative decline in community services and a relative decline in population. Doncaster, an old mining town, experienced the highest degree of decline of Community Services.
2. 18% (8 older industrial areas) had a relative decline in transport and utilities and a relative decline in population. Bradford, a textile and wool industry town, experienced the highest degree of decline in Transport and Utilities.
3. 16% (7 older industrial areas) had a relative decline in industry and commercial activity and a relative decline in population. Walsall, a coal and metal industry, experienced the highest degree of decline in Industry and Commercial.

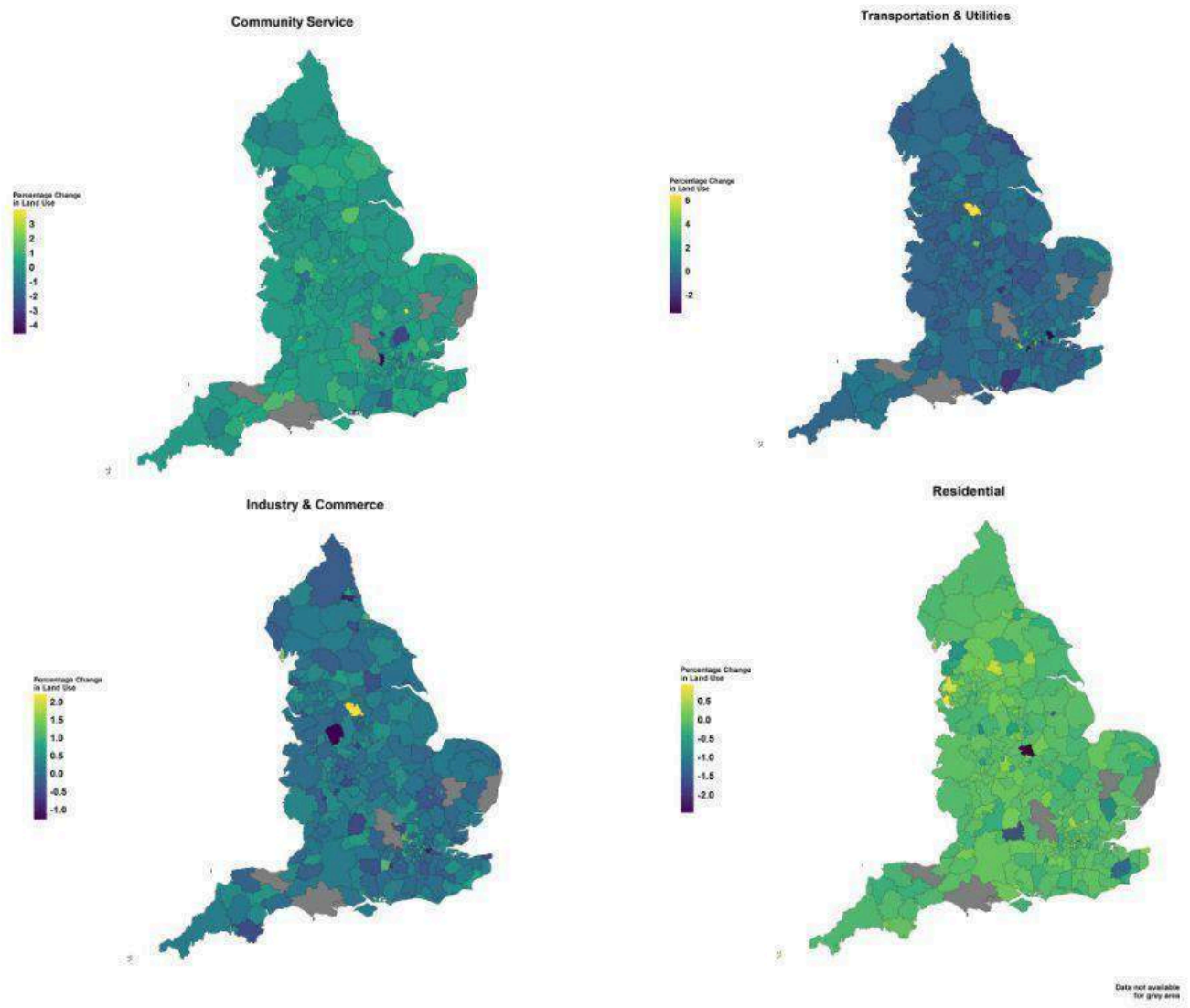

Figure 9: Patterns of Land Use Change in Community Studies; Transportation & Utilities; Industry & Commerce; and Residential in England's 326 LUAs in 2013-2019. Source: Own work

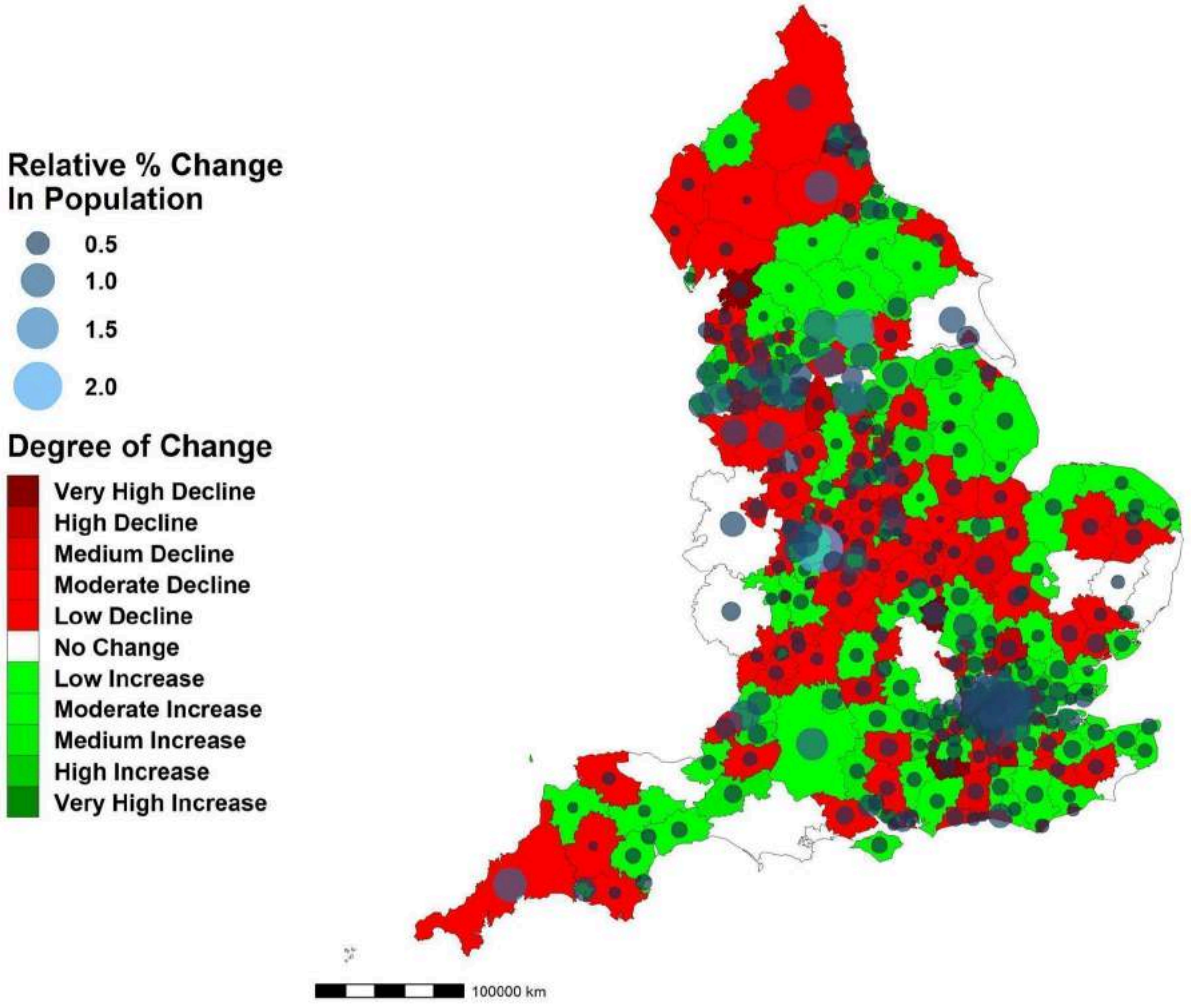

Figure 10: Patterns of Land Use Change and Population in England's 326 LUAs in 2013-2019. Source: Own work

The degree of decline of the land use changes in 144 LAUs from very high to low (at rate of 0,15%):

Very high decline (100-75%): Lancaster, Milton Keynes, Hillingdon, Waverley, Hounslow, Greenwich, Gateshead and Havering

High decline (75-50%): Worcester, Charnwood, Kingston upon Thames, High Peak, Tandridge and East Hertfordshire

Medium decline (50-25%): Portsmouth, Merton, Lincoln, Camden, Fylde, Lewisham, South Ribble, Dacorum, Redditch, Horsham, Huntingdonshire, Rushmoor, North East Derbyshire, Worthing, Vale of White Horse and Corby

Moderate decline (25-10%): Eden, Ashford, Stoke-on-Trent, North Dorset, Kingston upon Hull, City of Warwick, Wellingborough, Gosport, Darlington, Bassetlaw, Runnymede, New Forest, Basingstoke and Deane, Cornwall, Wyre Forest, South Norfolk, Weymouth and Portland, Cheshire East, Allerdale, South Staffordshire, Cherwell, North West Leicestershire, Burnley, Rushcliffe, Cheltenham, Blackburn with Darwen, Rugby, Croydon, Dartford, Braintree, Blackpool, Brighton and Hove, Eastbourne, South Holland, Ashfield, Stratford-on-Avon, South Lakeland, Stroud, Forest of Dean, Leicester, Wandsworth, Lichfield, South Tyneside, Bolton, Wolverhampton, Tamworth, Halton, Sutton, Rutland, Waltham Forest, Stafford, Purbeck, Wycombe, Tunbridge Wells and Scarborough

Low decline (10-1%): Welwyn Hatfield, Tonbridge and Malling, Nottingham, Waveney, Gedling, West Devon, South Cambridgeshire, West Dorset, Cheshire West and Chester, Staffordshire Moorlands, Mansfield, Solihull, St Edmundsbury, Adur, East Northamptonshire, Warrington, Tameside, Babergh, North Tyneside, Hinckley and Bosworth, South Kesteven, Northumberland, South Derbyshire, Wyre, South Hams, St. Helens, Harborough, Mendip, Hastings, Ealing, North East Lincolnshire, North Somerset, Amber Valley, Copeland, Havant, Christchurch, Daventry, Newcastle-under-Lyme, Telford and Wrekin, North Warwickshire, Reigate and Banstead, County Durham, Kettering, Colchester, Nuneaton and Bedworth, Preston, Chorley, Arun, Luton, Surrey Heath, Breckland, Winchester, Fenland, Kirklees, North Devon, Cotswold, Selby, Tewkesbury and Mole Valley

Greenbelt areas

The estimates concerning the absolute change of residential density in the designated greenbelt areas (as of 2019) within the 63 older industrial areas. These results are:

1. 17 out of 63 LUAs have no changes to the greenbelt;
2. 29 out of 63 older industrial areas are potentially losing biodiversity resources by building in the green belt areas;
3. 26% older industrial areas in England have no changes to the greenbelt and 46% of older industrial areas in England are building in greenbelt areas, potentially impacting biodiversity and future availability of greenbelt land.

Comparative analysis: Population changes, land use and urban development in the greenbelt in older industrial areas

	Cumulative population change 1991-2019	Relative land use change 2013-2019	Primary land use activity 2013-2019	Absolute change of residential use in greenbelt area 2013-2018	Total hectarage change (ha)
1	Allerdale	-19%	Residential	no data	-
2	Ashfield	-14%	Transport and Utilities	no data	-
3	Barnsley	no change	not applicable	no data	-
4	Barrow-in-Furness	38%	Industry and Commerce	no data	-
5	Blackburn with Darwen	-17%	Vacant	no data	-
6	Bolsover	9%	Transport & Utilities	yes	0.465
7	Bradford	23%	Transport & Utilities	yes	2.477
8	Burnley	-17%	Community Services	no data	-
9	Bury	8%	Industry and Commerce	no data	-
10	Chesterfield	12%	Community Service	yes	0.014
11	Copeland	-5%	Industry and commerce	no data	-
12	County Durham	-4%	Transport and Utilities	yes	5.069
13	Darlington	-21%	Vacant	yes	-
14	Doncaster	11%	Community services	yes	25.787
15	Dudley	25%	Community services	yes	0.881
16	Gateshead	-76%	Vacant	yes	5.081
17	Gedling	-10%	Community services	yes	52.879
18	Halton	-12%	Other development	yes	2.487
19	Hartlepool	25%	Industry and Commerce	no data	-
20	Hyndburn	18%	Community services	no data	-
21	Kingston upon Hull	-23%	Community services	no data	-
22	Knowsley	12%	Industry and Commerce	yes	1.294
23	Mansfield	-9%	Other development	no data	-
24	Middlesbrough	7%	Industry and Commerce	no data	-
25	North East Derbyshire	-27%	Vacant	yes	4.522
26	North East Lincolnshire	-5%	Transport and Utilities	no data	-
27	Oldham	no change	not applicable	no data	-
28	Pendle	15%	Vacant	yes	0.587
29	Preston	-3%	Other development	no data	-
30	Redcar and Cleveland	4%	Community services	no data	-
31	Rossendale	1%	Transport and Utilities	yes	1.451
32	Rotherham	41%	Vacant	yes	0.769
33	Salford	10%	Community services	yes	3.235
34	Sandwell	2%	Community services	no data	-
35	Sefton	2%	Community services	yes	10.190
36	South Tyneside	-12%	Community services	yes	18.418
37	St. Helens	-6%	Other development	yes	10.765
38	Stockport	11%	Vacant	yes	1.545
	Stoke-on-Trent	no data	no data	no data	-
39	Sunderland	7%	Vacant	yes	3.435
40	Tameside	-8%	Vacant	no data	-
41	Trafford	12%	Community services	yes	1.867
42	Walsall	2%	Transport and Utilities	yes	7.014
43	Wigan	1%	Transport and Utilities	yes	5.604
44	Wirral	10%	Vacant	yes	9.625
45	Wolverhampton	-12%	Residential	no data	-

Table 3: Changing Urbanisation Patterns: Population Changes, Land Use Changes and Greenbelt Areas between 1991 -2019. Source: Own work

Table 3 compares population, land use and greenbelt data in England with the changing urbanisation patterns. The estimation shows 29 older industrial areas to be facing depopulation, a decline in land use and to some degree an increase of residential density in the greenbelt area. The result is interesting because it shows the strong relation between population and urban development, see Table 3 below. This type of urbanisation pattern of demand and supply is typical to English older industrial towns due to the degree of net-migration, as suggested in their study of labour demand and supply in older industrial areas (Beatty 2020).

3.1.4 Discussions

The objective of this analysis was to explore the state of uneven development, by analysing the land use in local areas.

The Levelling Up policy is an opportunity to improve the quality of life of residents in older industrial areas. The framework provides an analysis to understand changing urbanisation patterns, using metrics of population, land use consumption, and the urban development in the greenbelt areas - as metrics of sustainability.

Population decline is recognized as a challenge in some parts of the UK. The population of the UK has been growing overall, but there are certain regions and localities that have experienced population decline, particularly in rural and coastal areas, as well as in some post-industrial cities (interpreted as older industrial areas).

Population decline can have a variety of negative impacts on these areas, such as:

1. Economic decline as a result of fewer people buying goods and services, leading to closure of local businesses and loss of jobs.
2. Social isolation, as the number of people living in an area decrease, it can make it harder for people to connect and form social networks.
3. Reduced demand for services and infrastructure, leading to underutilization of public services and closure of schools, hospitals, and other facilities.
4. Lack of young people and working age population in certain areas, which can lead to an ageing population and difficulties in funding pensions and healthcare.

Government response

The findings emphasise important ideas and themes to take into account for Levelling Up areas and agendas:

Main city-regional differences against older industrial areas- to date, the spatial imbalances between main city-regional areas and older industrial areas are still present in England, this is visible in the increasing polarisation of local areas located in the North and Midlands driven by changes in urban development and population as shown in Table 2. Between 1991 and 2019 areas like Coventry, Manchester, and Liverpool, are seeing a significant increase in cumulative population growth, followed by positive labour market trends as shown in studies (Beatty and Fothergill 2019). The orientation of urban development has been to increase density in the cities focused on attracting new talent and population in the bigger city areas, promoting long term investment.

In Blackpool, the difference is obvious with its closest counterparts of Liverpool (45.1 km / 28 miles) and Manchester (65.5 km / 40.7 miles). Levelling Up in Blackpool's regeneration projects should encounter more long-term investment in community services, improving the quality housing supply to promote compact development as well as environmental protection to avoid urban sprawl.

Land use management and planning - land faces increasing demands for economic restructuring particularly in older industrial areas, the first pattern observed in England, showed depopulation may be influenced by variations in land use changes (see figure 4), as well as an expansion of industrial and economic zones to boost the economy of the area. Enterprise and investment zones that strive to level up may produce rising economic areas by increasing density, but at the same time drive the process of population decline with negative effects on employment opportunities for residents, and the quality of life.

Primary land use perspective of Community services- In England, the topic of land use in older industrial regions is still substantially underdeveloped, especially in terms of the implications of what kinds of land consuming activities are required to enhance the quality of life for the area's current people and to plan for future demographic shifts. The second pattern demonstrates community services as the primary land use activity in older industrial areas that are benefiting from the increase in residential density and population growth – it also demonstrates the opposite urban and spatial effect.

Stoke-on-Trent's successful urban redevelopment with positive effects on the industrial identity of arts and culture of the area by building a unique university experience with Stafford University, Stoke-on-Trent College; the City of Stoke on Trent Sixth Form College, and the Royal Stoke University Hospital. Additionally, to promote Stoke-on-Trent as a growing hub for learning has also included a £26m City of Stoke-on-Trent Sixth Form College redevelopment, Staffordshire University's investment in a £30m science centre, and £270m Building Schools for the Future central government programme to improve the secondary school provision across the city (Mykhnenko and Badyina 2020).

Impacts of 'compact shrinkage' - 'Compact shrinkage,' according to Wolff et al. (2016), is an urban phenomenon in declining areas and is understood as urban development providing opportunities for densification and compact development based on a more stable population trajectory, with a reduced housing demand, which promotes inward growth. These are visible in the 43 older industrial areas (LUA's) facing relative decline in land use. Central economic policies aiming for more compact development targeting industrial areas with 'Transport and Utilities' land uses for production of clean energy such as harnessing hydrogen, wind and solar industries through the Industrial Strategy as of 2021.

To date, many of these older industrial areas are listed as some of the most socially and economically deprived areas in England (Ministry of Housing, Communities and Local Government 2019). For instance, Kingston Upon Hull has benefited from the Enterprise Zone, which is geared toward the private sector and offers tax cuts and government support to encourage density, mixed-use development, and industrial growth. They are important hubs for the energy, offshore, and renewable industries thanks to their status as port cities, which primarily generate green jobs. The negative effects of this spatial instrument are shared across older industrial cities, experiencing an increased cost of living and access to social infrastructure.

Greenbelt land transformation - the spatial consequences of population and land use change was estimated. The rate of residential urban growth in the greenbelt areas is correlated with the present land use change trends in older industrial areas. The process of greenbelt land transformation creates further effects on ecological services, climate change adaptation, and health inequalities. From an urban development perspective, older industrial areas should consider measures to control trade-offs, and to maintain and monitor the sustainable development of land for economic opportunity and the environment protection.

In North East Lincolnshire, meeting environmental objectives to realign existing flood embankments by creating 175 hectares of mudflat and saltmarsh ecosystems is the goal of projects like the Outstrays to Skeffling Managed Realignment Scheme, a joint effort between the Environmental Agency and the Association of British Ports (Bullen 2021). This is indicative of this relation between economic development and environmental sustainability.

Future opportunities for policy makers

The findings of the analysis and the discussions above, describe the potential opportunities for older industrial areas in England. The framework reveals important areas for the Levelling Up Policy to concentrate future resources and the areas potential for submitting bids such as the Levelling Up Funds to improve urban development.

The analysis uses LAU data on population, land use and urban development in the greenbelt areas. The outlook on population changes have influenced the decline of land use activity and development in greenbelt areas. The data portrayed the distinction of older industrial areas against other LAU areas in England.

For instance, private developers are attracted to market demand as well as economic incentives provided by spatial planning such as the Enterprise Zones and Investment Zones in England that are aimed at addressing key social and economic limitations. However, the type of land uses needed to sustain the long-term urban development for local areas ambitions are not fully explored. For areas experiencing depopulation, retaining and attracting more economically active residents is a key aspect to encourage urban development.

Stoke-on-Trent has developed new plans to address the issue of compact shrinkage, which is likely a problem related to urbanisation or population decline. The city is approaching the issue by utilising the knowledge and experiences of local stakeholders, and integrating that information with infrastructure planning. The city is taking a collaborative approach to problem-solving, involving local residents and organisations in the planning process to ensure that the solutions are appropriate and effective for the local context.

To improve sustainable development in older industrial cities, a unique urban regeneration strategy focusing on regional planning to plan for the future population changes, This depends on the city size, location and available transport connectivity in the local area and its relation to other main city

regions (such as Blackpool to Liverpool). Due to their economic power and job availability, larger city-regions will continue to play a role in increasing spatial segregation with their smaller counterparts.

Coventry, regarded as the fastest-growing city in the UK, has witnessed investment in the city centre, new enterprises, and infrastructural improvements. Higher education and research are also drawing many students and young professionals to the region. In a related manner, Liverpool and Manchester have seen an increase in employment creation, and their expanding economies are attracting expansive development. luring more youthful, economically engaged locals to accessible housing options.

Traditional market mechanisms such as enterprise zones and investment zones, are not the sole solution to improve the quality of life of older industrial areas, instead an integration of long-term social, economic and environmental objectives is needed.

Many countries have different approaches to investment allocations and managing land uses with policies on national, regional, and local planning. In England, the National Planning Framework sets mandatory laws on managing and regulating urban development. While local area plans set detailed specific land uses on a local level. Local area plans are particularly focused on planning for economic growth, especially in the demarcated Enterprise Zones, and the recent Investment zones but shortfall in managing the existing urban context of older industrial areas, as our analysis has pointed to. Can the value of understanding land use pressures and using data analysis better support the Levelling Up agenda?

Recommendations for further research

To expand on research in older industrial areas in England, here are some recommendations for further research:

1. To better understand the land use pressures of older industrial areas, it is recommended to conduct empirical data analysis to examine the consequences of population changes and environmental spatial objectives. This will facilitate productive dialogues between government, industries, and local communities. While the study framework provided a conceptual analysis foundation, more research is necessary to determine the actual impact of land use pressures on these areas.

2. It is recommended to allocate resources for the long-term improvement of residents' quality of life in older industrial areas. To achieve this, planning for these areas must take into account the local environment and consider the types of land uses proposed by local governments while being weighed and considered by national bodies distributing Levelling Up funds.
3. Research should be conducted to understand the impact of constrained urban development on the price of housing in older industrial regions. Additionally, it is important to quantify the impacts of expected changes in land use between 2035 and 2050. This will help identify strategies to address housing affordability issues in these areas.
4. Given the needs of an ageing population in shrinking older industrial areas, upgrading will become increasingly important to infrastructure development. Research should be conducted to identify the specific needs of these communities and how to best address them.
5. Climate change adaptation should be adopted as a core requirement for Levelling Up to improve biodiversity and ecosystem services in older industrial zones. Research is necessary to identify the most effective ways to achieve this.
6. Assistance with funding applications is necessary to foster inter industry ties between those that have recovered and those that have lagged behind in older industrial areas. This will help to build sustainable, resilient communities in these areas.
7. Sharing interrelation citizenship actions is required to provide individualised solutions for the type of land supply that may prevent difficulties between older industrial areas. Further research should be conducted to identify effective strategies to achieve this goal.

3.2 CONTEXTUAL ELEMENTS FOR DEVELOPING INTEGRATED URBAN APPROACHES FOR SHRINKAGE-RESILIENCE PLANNING

PART TWO

In light of adaptation efforts in the context of coastal areas affected by urban shrinkage and sea-level rise, the second section analyses the various urban planning approaches. The findings indicate that these transformative pathways are either shaped by or accelerated by resilience in the shrinkage-affected areas. To accomplish each ambition, climate change serves as the primary motivator. In other instances, feedback loops between urban shrinkage and resilience are visible.

The topic of resilience in shrinking city discourses is not very well explored. The aim of this section is to establish to what extent the existing research has progressed towards understanding this relation resilience and urban shrinkage. The methodology is expected to disentangle the relationship between urban shrinkage and resilience. A review of the literature and case studies from developed and developing economies are reviewed as an indicator of structural changes in shrinking cities. The period span is from 2011 until 2022.

To demonstrate the pathways, the approaches are classified as follows: adaptive management, learning, innovation, and leadership (IPCC 2012). The results demonstrated where potential *Shrinkage-Resilience* approaches may potentially be integrated. Interestingly, land use change as a key concept has been found in each approach. The study highlights the potential for an integrated approach to urban shrinkage and resilience planning, including initiatives to address sea-level rise.
Based on Chapters 1 and 2, the potential limitations and opportunities of urban shrinkage and resilience are found to be linked across national and local levels, see Figure 11.

Figure 11: Potential Limitations and Opportunities of urban shrinkage and resilience. Source: Own work

3.2.1 Transformative pathways

Structural changes can make a significant influence in this case. Based on the above the literature summaries in 2.3 and the *Shrinkage-Resilience* link as demonstrated by figure 4 are categorised using the dimensions by the IPCC resilience approaches that may be taken at local or regional scales to improve sea-level rise impacts**:**

1. *Adaptive management is defined as an organised approach for enhancing management policies and practices by anticipating changes in external conditions*
2. *Learning is defined as increasing society's adaptive potential in the present rather than focusing solely on long-term adaptation*
3. *Innovation is described as the non-material changes related to knowledge, communication, or intellect, this relationship should include both incremental and revolutionary social and technological advances.*
4. *Leadership is described as a process that are shaped by individuals, societies and communities to take ownership to foster change and transformation*

While existing literature provides a general understanding of these dimensions, it could benefit from additional details and examples to illustrate how they could be applied in practice. For instance, specific adaptive management policies or practices could be implemented to anticipate changes in external conditions related to sea-level rise, such as developing early warning systems or zoning regulations for flood-prone areas. Similarly, learning and innovation could be used to develop new technologies or processes that can help communities adapt to sea-level rise, such as building sea walls or using green infrastructure. Moreover, leadership can be used to mobilise community support for such initiatives, such as encouraging citizen participation or creating public-private partnerships. It is also important to consider potential challenges or trade-offs that may arise when implementing these approaches, such as limited resources or conflicting priorities. These challenges could be addressed through stakeholder engagement, innovative financing mechanisms, or prioritisation frameworks to ensure that the overall goal of improving resilience to sea-level rise is achieved.

3.2.2 Urban planning approaches for areas affected by urban shrinkage and sea-level rise

The analysis identified coastal areas, and their respective land use change.

In order to identify potential components for the proposed *Shrinkage-Resilience* planning and to further our understanding of this relationship in practice, the urban approaches mentioned in the case studies are grouped according to each country's example. Additionally, special focus was placed on countries that have been listed as experiencing shrinkage as defined in this dissertation, and

which had an impact on the standard of living of locals and their ability to adapt to floods, increasing their resilience to future climate events.

The following are the considerations that led to the selection of the review:

- The selected approach experienced population decline (for at least five years, more than 0.15 percent annually)
- The areas are vulnerable to future sea-level rise due to their unique coastal location, and showed evidence of changing their land use and their efforts towards improving their resilience, as conceptualised in 3.2.3.

Flood Resilience Community Pathfinder, England

After the 2007 floods, Hull experienced a shrinkage. Hull concentrated on combining a number of activities, including economic reform, integrated spatial designs, public-private partnership leverage, investment in coastal infrastructure, and pumping stations (Mackay et al. 2022). North East Lincolnshire followed a similar pattern of redevelopment with denser urbanisation along the port-area urban core. Due to the inability to address the 'flood footprint,' the physical damages in the area imposed indirect costs on services and infrastructure, which local citizens had to pay for through taxes (Mendoza-Tinoco et al. 2017).

To address the potential indirect costs of flooding, Yorkshire Flood Resilience will release a community toolkit in 2020 to assist home and business owners in Yorkshire in making their properties more resistant to flooding. A website that provides users with access to an abundance of information and counsel. City of York Council is in charge of Yorkshire Flood Resilience, with assistance from several partners, including The Environment Agency, The Yorkshire Integrated Catchment Solutions Programme (iCASP), Living With Water, and JBA Consulting. Yorkshire Flood Resilience is one of three nationally funded Flood Resilience Community Pathfinder Projects by the Department for Environment, Food and Rural Affairs (DEFRA). It aims to improve awareness of property flood resilience measures, a phrase used to describe methods that lower the danger of flood damage to properties, expedite recovery, and allow people to return to their homes more rapidly following floods. The measures are put in residences and businesses to reduce their susceptibility to flooding. Some work by blocking, delaying, or restricting the quantity of water entering your property, giving you additional time to relocate your valuables and family to safety. Other examples include materials, technologies, and building techniques to modify the interior of your home or business to minimise the damage caused if flood water does enter, hence reducing the probability of permanent damage and accelerating recovery after a flood. In addition, it includes case

studies and films highlighting home and business owners who have placed flood-resilient measures on their properties, as well as articles and blogs supplied by top experts on flood resilience, links to helpful websites and resources, and much more.

Sustainable Water Drainage systems, England

The National Planning Policy Framework (NPPF) in the United Kingdom controls every new development to implement sustainable water drainage systems. This regulation applies to all new developments. In contrast to Germany, where the obligation is with the national government, flood risk management is a local concern in England. In Germany, this issue is dealt with at the federal level. The Sequential and Exceptions Tests are a planning guideline that is implemented by the National Flood Protection Program (NFPP). This planning guideline is intended to lessen the danger of flooding and to spatially target development in areas that are in need. An applicant, such as a property developer, is the one who is responsible for conducting this evaluation in support of a planning application (or appeal), however it is strongly recommended that you also engage the Local Planning Authority (LPA) at various points along the process. Someone who is knowledgeable about the planning concerns in a local area, such as a planning consultant but maybe even an architect for smaller projects, is required in order to finish the Sequential Test. This someone must have this level of expertise. Since the Exceptions Test is the more technically challenging of the two, you will need the assistance of a flood risk specialist in order to finish it. Correspondence with the Local Planning Authority to establish the search parameters for the Sequential Test is the first step, and this can take anywhere from a few days to a few weeks depending on response times from the Council as well as whether you agree or disagree on the parameters. Once the search parameters have been established, the next step is to perform the Sequential Test. The actual process of looking for potential locations can take several days, depending on the size of the search region and the quantity of data that is readily available. For instance, if you have to search an entire authority area but the council does not have an up-to-date list of potential development sites (which is typically published within a Strategic Housing Land Availability Assessment, or SHLAA), this can be a time-consuming process. This is in contrast to searching a smaller Housing Market Area (HMA) where there is a wealth of information at your disposal. Evaluation of each of the websites that you've located that are comparable to your own is the following phase in the process. The Exceptions Test does not take up a lot of time since, in most cases, the consultant team has already determined that the site will not be subject to floods for the entirety of its lifetime and that it will not make the risk of flooding in other areas worse. The benefits of carrying out the Sequential and Exceptions tests include the fact that it places an emphasis on the contribution of local planners to the process of development, and

that the results of the tests have the potential to be used to identify opportunity areas with the goals of renewing and upgrading vacant and underutilised buildings and enhancing flood risk management.

Lafitte Greenway Project, United States of America

In the United States, the rate of population decreases accelerated five years after the devastating hurricane Katrina struck in 2005, significantly aggravating existing inequality and leading to a shift in the ethnic minority population (Zaninetti and Colten 2012). In order to plan for strategies on targeted investment and consolidation; alternatives for underused areas; mechanisms to reintegrate abandoned parcels of land; and provision for services and infrastructure provision, among other things (Ehrenfeucht and Nelson 2011).

Specific areas of intervention, such as the Lafitte Greenway Project, were put into place in order to address the demographic shift that has taken place. This project is an excellent illustration of a green infrastructure project with various applications, and it is intended to alleviate the social and environmental inequities that exist in an extremely impoverished area. The Lafitte Greenway is a bicycle and pedestrian trail as well as a green corridor that stretches for 2.6 miles and connects the historic French Quarter to Bayou St. John. The project's partners, which include the Lake Pontchartrain Urban Waters Partnership, worked together to develop the Lafitte Greenway. The project repurposed an old shipping canal and railway into a public park that now features a variety of different opportunities for leisure activity. At the present time, the greenway features an asphalt route that is 12 feet wide, brand new leisure fields, basketball courts, outdoor workout parks, green space, and enhancements to the landscaping.

Safe Place project, Italy

In the case of a flood happening, the Safe Place concept advocated a new urban approach by having streamlined operational instruction materials. Everyone will be prepared for the flood catastrophe and will know what to do and how to react because of this. As a result, the capacity of its citizens to adjust to the risk has been increased. When it comes to contingency planning, the national project on 'Safe Plans' is a collaborative effort between the national, provincial, and local levels of planning with the goal of reorganising the way in which municipalities respond to disasters. 109 different local municipalities were involved in the event in some capacity. In Italy, preparation for unexpected events falls under the purview of the local municipalities. In response to a flood, conventional urban planning typically involves the construction of a new physical space, the clustering of populations,

and finally the rebuilding of a site (as experienced in the Honduras disaster event) (Earth Polis-Cluster 2021).

Zorrotzaurre Island, Spain

Since the 1980s up till the present day, Bilbao, Spain has been experiencing population loss, which is primarily attributable to the city's ongoing economic restructuring (Ivanov, 2022a). The strategy plan known as Bilbao Metropoli-30 places an emphasis on the development of large-scale projects that are led at the regional, provincial, and local levels. These projects are made possible through national money as well as investments from the EU. The island of Zorrotzaurre, which is safe and its buildings, roads, parks, and neighbours are sheltered from the possibility of floods, is a good illustration of shrinkage resistance. As a result, in addition to the measures that have already been planned in case of an overflow of the Estuary, such as opening the canal, the construction of two deposits in the Ribera de Deusto has now been added in order to prevent flooding of the roads and conditions to the rain network during episodes of high tides in the buildings that have already been constructed previously and that will comprise the Old Town of the Island.

Portland Climate Action Plan, Columbia

The Portland Climate Action Plan establishes a neighbourhood plan for the year 2050 that prioritises underprivileged communities and calls for 80 percent of the city's people to have access to a combination of different modes of transportation. A 30-minute city strategy and the Barrios Vitales ('vital neighbourhood') approach will be integrated into the draft land management plan (Plan de Ordenamiento Territorial (POT)) for Bagota in 2021 (C40 Cities Climate Leadership Group, C40 Knowledge Hub 2020).

This will be accomplished by integrating a network of green corridors, improving a 218 km network of pedestrian routes, and delivering 18 Barrios Vitales. In addition to these requirements, it increases protection for green space and wetland areas, as well as making allowances for denser buildings to fulfil the anticipated housing demand inside the city. In order to lessen the amount of traffic caused by commuters, the local government in Houston, Texas, has enacted the Walkable Places Act and revised the Transit Oriented Development plan. This will result in the creation of six business areas.

The 15-minute city is an approach to urban planning that aims to create self-sufficient and sustainable neighbourhoods where residents can access all essential services and amenities within a 15-minute walk or bike ride. This includes everything from healthcare and education facilities to

grocery stores and green spaces. By reducing the need for car-dependent transportation and promoting active mobility, the 15-minute city can also reduce traffic congestion and air pollution, which can have significant health benefits for residents. In the context of urban shrinkage in Colombia, the 15-minute city concept could be particularly useful. As cities experience population decline or spatial contraction, it becomes increasingly important to optimise the use of available resources and infrastructure. By creating more self-sufficient neighbourhoods, the 15-minute city approach can help to ensure that essential services and amenities remain accessible to residents, even in areas with a smaller population.

Additionally, the 15-minute city approach can also enhance resilience in Colombia by promoting more sustainable and equitable development. By prioritising active transportation and reducing car dependence, the 15-minute city can help to mitigate the impact of climate change by reducing greenhouse gas emissions. Furthermore, by promoting equitable access to services and amenities, the 15-minute city can help to reduce social inequalities and enhance the overall well-being of residents.

Disaster Danger Zones and countermeasures, Japan

In Japan, rural communities have been hit particularly hard by population decreases. Japan is currently going through a period of demographic decline as a result of its ageing population and its consistently low birth rates (URBIPROOF 2015). Agriculture is the primary industry that thrives in Miyazaki, Japan's low-lying lowlands and plains. Recent years have seen a rise in the amount of urbanisation in low-lying areas. The frequency of flooding and the overflow of inland waterways has increased as a direct result of poorly constructed banks and drainage systems. High-risk areas are referred to as "disaster danger zones" under the City Planning Act and the Building Standards Act, and they are not allowed to be used as residential zones under either of these laws (URBIPROOF 2015). In accordance with the requirements of Article 39 of the Buildings Standards Act, the local council came up with a regulation for land use that mandates all newly constructed residential buildings must be constructed at a height that is greater than the highest level reached during any previous floods. Due to the fact that the regulatory area contains residential uses, this is done in an effort to reduce the negative impact by placing stringent restrictions on how the land can be used. Given that the region has been subjected to a great deal of devastation in the past. The inhabitants were not opposed to this control and supported the combination of the designated disaster hazard regions and the construction of drainage pumps. The bulk of the local homeowners had already been encouraged to have their homes rebuilt by increasing the floor height. The results revealed that as a

result of having personal experience with the threat posed by flooding, locals were more willing to accept the risk management control of a "disaster danger zone." In addition, the countermeasures of "building to the flood risk" were cooperatively adjusted and disseminated among the governance structures in locations where there are several competent authorities.

Re-blocking, South Africa

Re-blocking is a community-led urban upgrading technique in informal communities (ARUP and the Rockefeller Foundation, 2014) Re-blocking is "a community-led process of reconfiguring the current layout of informal settlements by grouping shacks into clusters and reorganising the spatial layout to optimally utilise space to promote the health, safety, well-being of households, with a particular focus on promoting accelerated service delivery to informal settlements. In 2006, the local municipality (CoCT) joined SA SDI, CORC, and Ikhayalami, Cape Town's top re-blocking NGOs, to address marginalised poor vulnerabilities. In 2013, CoCT adopted a strategy to promote upgrading and servicing. Re-blocking is advertised as resilient to risk and inequality, unlike other service upgrade methods (ARUP and the Rockefeller Foundation, 2014). This technique helps community members own their Settlement and promotes urban transparency. "Inclusive engagements between stakeholders; its design-led initiative and the increased community cohesion" are the benefits of being in the "Making Cities Resilient Framework" and a World Design Capital project. In 2013, the CoCT Municipality and the allocated NGOs signed a Memorandum of Understanding to implement 22 projects as part of the Cities Five Year Integrated Human Settlements Plan. The 2013 City of Cape Town Proactive Re-blocking of Informal Settlements Policy has made re-blocking a key policy in Cape Town and Durban settlements.

Land Drainage Master Plan, Mauritius

In the 1960s, the government initiated a stringent birth control programme with the goal of controlling the island's population increase to 3 million people by the year 2000. This was done in order to prevent the country's resources from being depleted. In addition to this, the displacement of people caused a decrease in population in other parts of Mauritius. During the 1970s, the inhabitants of Chagos Island were forcibly displaced and replaced by colonial authorities (Reply 2019).

In more recent times, the government has brought up the topic of relative decrease as a matter of concern for the government. The decline in the average number of children born to women, which in 2018 was 1.4 (Reply 2019). Mauritius, like many other islands that are classed as small island developing states (SIDS), is characterised by its small size, its remoteness, and its dispersion

(Chacowry et al. 2018), and are faced with limited resources to deal with emergencies (Sobah 2022). Additionally, as a result of climate change, the country is experiencing increasingly heavy rains. The island is also plagued by deteriorating infrastructure as well as a lack of preventative maintenance on its drains (Sobah 2022). The Land Drainage Authority, which is in charge of managing floods, has begun implementing the Land Drainage Master Plan, which includes allocating a budget for the implementation of the national flood management programme (Sobah 2022).

The capacity to recover from the effects of the flood in Port-Louis, the capital of Mauritius, was based on a number of factors, including income level, literacy level, household size, and the presence of children and elderly people. Other evidence suggested that issues of social inequality and environmental justice were standing in the way of low-income households' ability to recover. Therefore, "how to deal" was an essential topic for discussion on the resilience building tactics of local residents. (Chacowry et al 2018).

Flood dykes, Mozambique

Due to a surge in emigration, the population of Mozambique decreased from 12,700,780 (1.29%) in 1985 to 12,897,366 (0.090%) in 1990. Even if it is anticipated that the population will reach its steady state by the year 2100, the degree to which communities will recover and be resilient in the future will be determined by the social and economic conditions, as well as the health and happiness of their citizens (UNEP 2019). Factors relating to low literacy levels, weak infrastructure, and a high dependency ratio, Mozambique is regarded to be an economy that is more susceptible to flood damage than other industrialised nations. Flooding was prevalent as a result of the effects of Cyclones Idai and Kenneth in 2019, which also led to the destruction of agricultural harvests. When it comes to urban planning, urban policy is faced with particular limits that preclude transformations comparable to shrinking cities, which are impeded by a lack of finances for building dykes and reaching isolated communities. This prevents transformations similar to shrinking cities.

It took substantial international cooperation from the Government of Mozambique, the United Nations Environmental/Office for the Coordination of Humanitarian Affairs (OCHA) Joint Unit, and the United Nations Disaster Assessment Coordination Team in order to get technical experts to advise governments. The Dutch Surge Support (DSS Water) ensured remote support for data collecting from the field, and the Joint Research Centre of the European Commission provided modelling scenarios on the impact of floods on dams. Both of these organisations are part of the Dutch Surge Support. The Dutch hydrologist Jeroen Helder says that the development of

flood-resistant infrastructure that is capable of withstanding floods would assist in the dissemination of information regarding the management and prevention of floods (UNEP 2019). In the same vein, he emphasises the importance of taking preventative measures for those living in flood-prone areas as well as investing in early warning systems in order to dramatically increase capacity.

Nature based solutions, Morocco

Morocco has been experiencing a demographic transition characterised by a decline in both birth and death rates (Population Reference Bureau 2023). This has led to a significant increase in life expectancy and a decrease in infant mortality, which has contributed to an ageing population.

Moroccan cities contribute more than 75% of the country's GDP but are becoming increasingly vulnerable to natural and climate hazards such as floods, heatwaves, droughts, sea level rise, and earthquakes (World Bank 2022). These hazards are expected to worsen in the next few decades, costing Morocco over $575 million each year and disproportionately affecting vulnerable people in urban areas such as women, youth, migrants, and minorities. This demographic shift could also have implications for the country's urban shrinkage-resilience. As the population ages and the birth rate declines, the workforce may shrink leading to a decrease in economic activity and potentially exacerbating urban shrinkage. On the other hand, an ageing population may also bring about changes in demand for services and infrastructure due to this demographic change.
To address these limitations, the Moroccan government has taken action to strengthen disaster risk management (DRM) and climate change adaptation at the national and local levels. The World Bank has partnered with the Moroccan government to support two pilot cities, Fez and Mohammedia, in developing urban resilience strategies and action plans to become safer, greener, more resilient, and inclusive.

These strategies were developed using a participatory approach that involved multiple stakeholders and rapid diagnostics, considering the socio-economic impacts of the COVID-19 pandemic. The Urban Resilience Handbook for Moroccan Cities was created to provide guidance to decision-makers and technical staff at the city level to develop robust urban resilience strategies and action plans. The government envisions that many more cities will follow Fez and Mohammedia examples to develop urban resilience strategies to strengthen disaster risk management at the local level, with priority measures benefiting from the pilot exercise.

Climate Resilience Pilot Program, Central America

The Honduran government made preparations in 2015 to participate in the Climate Resilience Pilot Program. The PPCR group recommended to the Climate Investment Fund (CIF) that Honduras be nominated as a country that is eligible to receive up to US$1.5 million for the formulation of a Strategic Program for Climate Resilience. First PPCR-Honduras Joint Pilot Mission for Climate Resilience was carried out in 2016 by the Honduras Government, the World Bank Group, and the Inter-American Development Bank (IDB) (PPCR).

The purpose of this broad consultation is to begin the process of formulating the Strategic Program for Climate Resilience (SPCR), which will involve participation from a variety of people and will be open to all ideas. Building consensus and engaging in inter-institutional reflection on the most important transformational and strategic actions Key priorities include strengthening the management of knowledge, water resources, and climate data in order to inform decision making; strengthening governance; developing climate-resilient agricultural practises and ensuring sustainable food security; and strengthening institutions and building the capacity of human resources to adapt to climate change. Additionally, the PCCR Honduras Implementing Technical Unit was established. Members of this technical team have contributed to the preparation of studies that have been expanded upon and discussed with all of the project's major actors.

3.2.3 Findings of integrated Shrinkage-Resilience approaches in practice

The investigation has shown that there is a connection between urban shrinkage and resilience as prospective urban approaches that are connected. This section analysed the potential constraints and opportunities and categorised the concepts through pathways, including adaptive management, learning, innovation, and leadership. The literature and case study reviews were used to compile this section's findings. How can existing inequities in society and the environment be addressed while simultaneously improving the climate resilience of urban areas? Examining the concept of climate resilience from the perspective of multiple disciplines. Investigating what variables have been incorporated as urban techniques that have led to societal change is one of the goals of this research.

The information that was examined suggests that coastal communities that are declining may be more likely to address environmental issues for a number of reasons, including the following:

- Shrinking cities have a smaller population and, as a result, a reduced demand for resources like energy and water. This results in the shrinking cities' ability to consume fewer resources.

This has the potential to lead to reduced demands on the environment and create chances for more sustainable practices relating to the management of resources.

- **Land reallocation:** The abandoning of residential and industrial areas in cities that are experiencing population loss can give chances for the land in such regions to be reallocated to green spaces and other environmentally friendly uses. Using the Lafitte Gateway Project as an example, this can contribute to the reduction of the effect of urban heat islands, the improvement of air and water quality, and the enhancement of biodiversity (USA). After Hurricane Katrina, the project successfully established a green infrastructure project on land that was not being used to its full potential. It also provided opportunities for underrepresented ethnic groups, improved the health and well-being of the city's residents, and connected them to economic opportunities.
- **Focus on revitalization:** In many instances, cities that are losing population are actively working to revitalise their economies and communities, and environmental sustainability can be an important component of this plan. Because of this, there may be a greater emphasis placed on enhancing the environmental performance of buildings, infrastructure, and transportation systems, as well as on supporting behaviours that contribute to sustainable development.
- **Engagement in the community:** Shrinking cities frequently confront major social and economic limitations; resolving environmental challenges can assist to improve community resilience and strengthen social cohesion; these are two benefits that can result from community engagement. A sense of shared responsibility for environmental results can also be created by community engagement and involvement in environmental activities, which can lead to solutions that are both more successful and more sustainable.

Even though there are constraints that need to be addressed in shrinking cities, such as the requirement to maintain and improve existing infrastructure and to find new uses for abandoned lands, the one-of-a-kind conditions of these cities can provide opportunities to address environmental issues in innovative and effective ways.

Table 4: Elements of urban approaches influencing *Shrinkage-Resilience* through local land use. Source: Own work

		Adaptive Management	*Learning*	*Innovation*	*Leadership*
1.	**Flood Resilience Community Pathfinder** **England**	Climate change, Frequent occurrence of floods Increase in local taxes Integrated spatial plans Investment into coastal infrastructure and pumping station National-local funding	Community toolkit for local businesses, creating the Yorkshire flood resilience website to foster education and best practices	Low-cost alternatives in materials, products construction techniques	Public-private partnership City of York Council, the Environment Agency, The Yorkshire Integrated Catchment Solutions Programme (iCASP), Living With Water and JBA Consulting
2.	**Lafitte Greenway Project** **United States of America**	Influencing climate catastrophe, Hurricane Katrina Relocation Accelerated Socioeconomic inequality Regeneration of old shipping canal and railway		Environmental justice and social equity principles Green infrastructure Transport Outdoor Fitness parks	Public-private partnership , community engagement, technical experts
3.	**Safe Place project**	Addressing environmental risks	Increasing knowledge on emergency planning	Integrated approximately 109	National, provincial and local level

	Italy	Improved emergency planning Integrating urban planning in risk management	Building community awareness Building new sites	local municipalities in active participation	
4.	**Zorrotzaurre Island** **Spain**	Population decline Large Scale Development on strategic plans: decontamination of rivers and engineering solutions	Building flood awareness and safety	New buildings elevate ground level to decrease future risk of flooding Energy efficient measures	Local planners outlining sites that are flood prone
5.	**Disaster Danger Zones and countermeasures** **Japan**	Demographic change, stagnant growth, low fertility rates Urban sprawl - rural-urban Inadequate drainage systems Disaster hazard zone	Community awareness - countermeasures rebuilding homes with raised floor	Regulated the height of the floor surface, instead of relating the residents	Stakeholder accepted the risk management after experiencing the disaster Coordination between local authority and the community

		Adaptive Management	*Learning*	*Innovation*	*Leadership*
1.	**Re-blocking approach** **South Africa**	Socioeconomic inequality Urban sprawl Lack of infrastructure, Poverty Limited governance Urbanisation Climate change	Community based risk assessments Improved spaces: roads, parks, community gardens	Social justice International recognition: World Design Capital 2014 Further retrofitting the residential structures	Public private partnership Local municipality (CoCT) aligned with SA SDI, CORC and Ikhayalami, community engagement
2.	**Land Drainage Master Plan** **Mauritius**	Socioeconomic inequality Urban sprawl Ageing/lack of infrastructure Climate change	Implementation of the National flood management programme Education and knowledge sharing	Improving drainage systems and monitoring drainage systems	Coordination with the Land Drainage authority and local residents
3.	**Flood dykes** **Mozambique**	Socioeconomic inequality Poverty Ageing/lack of infrastructure Lack of finance Climate change	Raise awareness on flood management and protection Early warning systems for residents in flood prone areas	Modelling scenarios on flood impact on dams Building flood resilient infrastructure backed by climate science	Public-private partnership and Government of Mozambique, the United Nations Environmental/Office for the Coordination of Humanitarian Affairs

					(OCHA) Joint Unit, and the United Nations Disaster Assessment Coordination Team
4.	**Nature based solutions** **Morocco**	Migration and fertility rates Fez 2022–2027 Action Plan Lack of infrastructure Climate change	Creation of Steering committees, held stakeholder engagement workshops, and thought about the socio-economic consequences of COVID-19 by using a participatory approach	Modelling land use and projected sea level rise scenarios	Participatory approach with the civil society, academia, national ministries, and technical agencies
5.	**Climate Resilience Pilot Program** **Central America**	Climate change Strategic Program for Climate Resilience	Strengthening the management of knowledge, water resources and climate data to inform decision making		Honduras Government, the World Bank Group and the Inter-American Development Bank (IDB) held the First PPCR-Honduras Joint Pilot Mission for Climate Resilience, technical teams

3.2.4 Discussions

Urban shrinkage and resilience are closely related and interdependent concepts that are influenced by changes in land use. As highlighted earlier, alterations in land use can have social, economic, and environmental repercussions, which can lead to urban shrinkage.

This can cause a vicious cycle of disinvestment, degradation, and further shrinkage if not addressed. However, policymakers can assist in developing resilience against multiple threats, such as urban shrinkage and rising sea levels, by taking an all-encompassing and integrated approach. Such policies can promote urban resilience by generating new economic opportunities and improving the quality of life for inhabitants. Additionally, policies that mitigate the effects of sea-level rise can also help address shrinkage by increasing the attractiveness of coastal cities as locations for enterprises, investors, and inhabitants.

Figure 12 shows that the relationship between land use, urban shrinkage, and resilience, and how they are interrelated, would be appropriate for demonstrating the significance of addressing both urban shrinkage and resilience to sea-level rise for the long-term viability and sustainability of coastal cities and communities.

Figure 12: Interrelation between Land Use, Urban Shrinkage and Resilience to Rising Sea Levels. Source: Own work

In addition, the approach to changing how land is used can open up possibilities for urban contraction and increased resilience. Changes in land use can have social and economic

repercussions, such as the displacement of people, an increase in inequality, and changes in the sorts of jobs and economic possibilities that are available in an area. This is one of the factors that contributes to urban shrinkage. In terms of robustness, it is possible for it to have substantial repercussions on the environment, such as the loss of biodiversity, an increase in the emissions of carbon, and an increase in the pressure on natural resources. The dynamics of the economy play a significant part in the way in which cities adjust. Take, for example, the various institutions. In the circumstances of economies that were still in the process of developing, international collaborations were established in order to provide assistance in the areas of technology and technology.

According to the opinions of various experts, the influence of alterations in land use can be analysed to provide vital insights into the types of spatial and urban planning that are essential for the development of urban policies (Banzhaf et al. 2017 In this section, we talk about urban techniques, and then we apply those ways to the theoretical and conceptual understandings of shrinkage and resilience.

Resilience in the face of urban decline is considered as an example of a dynamic process. Because urban shrinkage and resilience to rising sea levels are closely related and interdependent limitations that many coastal cities must contend with, addressing both of these issues simultaneously is crucial. The loss in population, the reorganisation of the economy, and the shifting of societal values are among the causes that contribute to the contraction of urban areas. It is possible for it to lead to the demise of cities and communities if it is not addressed, generating a vicious cycle of disinvestment, degradation, and further shrinkage if it is allowed to continue. On the other hand, the rise in sea level is a consequence of global climate change. This phenomenon is responsible for the increasing flooding and erosion that coastal communities are experiencing. Especially in low-lying locations, this can provide a serious risk to the towns and infrastructure that are located along the coast.

Policymakers have the ability to assist coastal cities in developing resilience against multiple threats, thereby ensuring the cities' long-term viability and sustainability, if they take an all-encompassing and integrated approach to addressing issues such as urban shrinkage and resilience to rising sea levels. For instance, policies that aim to promote urban resilience can also assist in addressing shrinkage by generating new economic opportunities and increasing inhabitants' quality of life. At the same time, policies that aim to mitigate the effects of sea-level rise can also help address shrinkage by increasing the attractiveness of coastal cities as locations for enterprises, investors, and inhabitants.

In conclusion, focusing on urban shrinkage as well as resilience to sea-level rise is important for ensuring the long-term viability and sustainability of coastal cities and communities, as well as for building resilience against the multiple and interrelated limitations that will be faced by these areas in a rapidly changing environment

3.3 A COMPARATIVE REVIEW OF SHRINKAGE-RESILIENCE IN NORTH EAST LINCOLNSHIRE IN ENGLAND AND BREMERHAVEN IN GERMANY BETWEEN 2013-2020

PART THREE

In 2013, a devastating tidal surge struck a number of locations in England, including North East Lincolnshire. This event also affected other parts of England. The devastation is referred to as the floods in the North Sea. Other countries including Germany, Belgium, and the Netherlands were also affected.

This section looks at the efforts that North East Lincolnshire in England and Bremerhaven in Germany have made to adjust to changing conditions in their respective port-industrial zones. When it comes to urban planning, both of these regions are taking a strategic approach to addressing the social and economic challenges of the long term and enhancing their capacity to withstand the effects of climate change. Because of their potential to become "Renewable Energy" capitals, they play a significant role in the economy of their respective nations. They have a monetary influence on the coastal communities that are in close proximity, which are in need of resiliency. The relationship between port-town areas and the wider urbanisation trends, in which the consequences of urbanisation on the labour market, infrastructure, and the environment are subject to the local vulnerabilities and concerns of policymakers.

ARUP's City Water Resilience (2019) is used to analyse their efforts in health and well-being, planning and finance, infrastructure and ecosystems, and leadership and strategy in order to study their methods. This is done so in order to better understand their techniques, and thus the previous paradigm is expanded upon in this study by the use of mixed-method research. This allows for the inclusion of strategies that address vulnerabilities that are specific to urban contracting settings. The findings indicate that there will be synergies between urban contraction and resilience between the years 2013 and 2021.

Introduction

There have been significant shifts in flood risk management practises as a direct result of the devastation caused by the tidal floods that occurred off the east coast of England in 1952. After that, in 2013, there was a tidal surge that happened. The floods caused substantial damage to the properties along the coast, as well as the natural ecosystems and the means of subsistence employed by individuals and enterprises in that area.

The recent Paris Agreement and the United Nations COP27 called on governments throughout the world to take action to reduce the negative effects of climate change and established a new goal to reduce emissions of greenhouse gases by the year 2050. As a response, national governments have made legally enforceable commitments to lower their emissions of greenhouse gases. In addition, as a response to mitigating flood risks, urban policies are still altering today to account for flooding and changing circumstances along the shore.

Localities that are susceptible to tidal surges have adapted to new forms of integrated multi-level approaches as a result of the political influences that they are now subjected to in order to achieve a balance between the growth of the emerging market and the green economy sector (the transition towards renewable energy). Examples of this in action may be seen in the rise of public-private partnerships, the diversity of access and means to financial resources, and changes in decision-making between top-down and bottom-up planning techniques (Raška et al. 2019). These modifications are essential for urban planning and determining how to alleviate inequities in regions that are currently experiencing urban shrinkage and regions that may in the future suffer urban shrinkage.

The Climate Change Act of 2008 required some amendments to be made to the National Planning Policy Framework, which had an effect on urban growth in the United Kingdom. In the management of land uses, building projects, and property or land rights, for example, "site-specific flood risk assessments" were required, along with the design of "flood-resilient buildings," providing "sensitivity testing" based on wave and wind speed, and in accordance with the contingency allowances for sea level rise provided by environmental agencies. These laws govern land use and spatial planning. These changes had a huge impact on the development of the surrounding area, which included repercussions for enterprises, industries, and developers (Ministry of Housing, Communities and Local Government 2021; Environment Agency 2022).

In a different context, where land use and spatial planning for floods and coastal change are not developed by the national government (also known as the Federal Government), they set environmental goals that are known as "Concepts and Strategies for Spatial Development in Germany." (Scharmann, 2020). These environmental goals are intended to be met by the year 2050. 2016 are environmental goals that have been established by the Federal state in order to promote the execution of environmental goals that are in keeping with the Climate Action Plan 2050 in Germany. In the areas of agriculture, forestry, business and industry, construction and transportation, energy supply, and business and construction, strategic goals have been created (BMU, 2016). Instead, these responsibilities have been delegated to the country's sixteen federal states, also known as Lander, which include more economically significant urban areas like Berlin, Hamburg, and Bremen (Scharmann, 2020). These states are tasked with setting legal standards and coordinating programme planning efforts in accordance with the principles of "place-based planning."

The various forms of governance at the national level have a direct impact on the institutional structures and the availability of financial resources at the local level (Mehryar and Surminski 2020) This raises the question of how coastal post-industrial towns are coping with dangers and getting ready for the future in light of the structural shifts that have taken place in the economy. Integrated and multi-level urban methods can help to find a middle ground between the competing goals of increasing resiliency and addressing the challenges posed by shrinkage processes.

Examples of areas faced with globalisation and climate change impacts are North East Lincolnshire and Bremerhaven, in coastal port-industrial contexts.

3.3.1 Case study selection

This section provides an explanation of the third component of the empirical study. The systematic review, the field investigation, and the participation of stakeholders have all contributed in some way to the formation of the case study. The following are the considerations that led to the selection of the English case study:

Both port-industrial areas are experiencing population decline (for at least five years, more than 0.15 percent annually) between 1990-2019; and are undergoing economic transformation: transforming the industrial landscape as "Renewable Energy Capitals." The selected coastal port-industrial areas demonstrate urban shrinkage as conceptualised in both case studies are experiencing population decline between 1990-2019.

The analysis of urban loss continues from this vantage point with subsequent features.

Both of the selected coastal port-industrial areas were impacted by the climate catastrophe (the tidal surge in 2013), and they are vulnerable to future sea-level rise due to their unique coastal location. The selected coastal port-industrial areas are enhancing their efforts towards improving their resilience, as conceptualised in 3.2.3. (North East Lincolnshire: Humber Estuary-North Sea and Bremerhaven: River Weser-North Sea), see Figure 13. When it comes to urban planning, they both have a wealth of information on strategic planning, land use change, economic transformation plans, environmental protection, adaptation planning, and disaster risk management. This information can be found in both of their respective databases. The concept of resilience is broken down even more from this vantage point.

The study areas make interesting cases for comparison - they are both regarded as having similar contexts of shrinking cities (both are regarded as “shrunk cities” - recovering from shrinkage) (similar X values), but share different governance and institutional contexts towards land use and spatial planning (Y values) (Gerring 2017).

This primarily supports the IPCC's perspective of policies to implement a 'transformative pathway' in climate adaptation (IPCC 2012); and how to understand the concept of both shrinkage and resilience implementation through urban systems context. (Martinez-Fernandez et al. 2012, Stryjakiewicz and Jaroszewska 2016; Wiechmann 2006, IPCC 2012; Wamsler et al. 2021). In this view, changes in the built environment can inform urban policy.

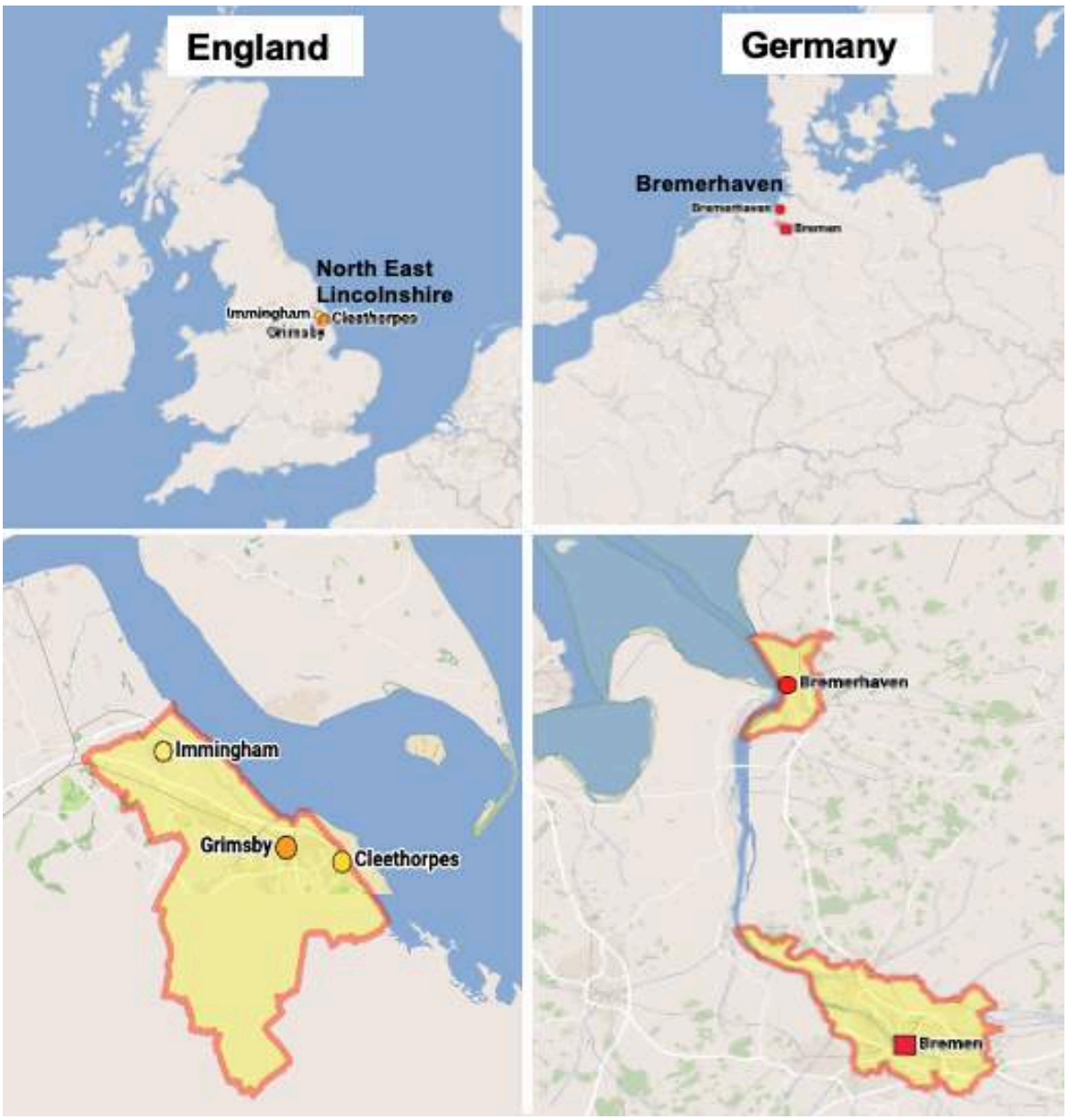

Figure 13: Map of North East Lincolnshire and Bremerhaven. Source: Own work based on Google Maps

3.3.2 Methods of data collection for the case studies

This section presents the finding of six urban approaches (proposed and existing) that occurred following the 2013 tidal surge impact. This event-focused period allows us to understand the environmental challenge (in this case climate change) and consequent wider adaptations undertaken in the selected case study areas. A mixed methodology using quantitative and qualitative data over the time period is shown, see Table.

Data was translated using the DeepL app, a recognised app for scientific research.

These pathways can take shape in different dimensions:

1. Leadership and Strategy: This has to do with the requirement for strong leadership and long-term plans that guide choices regarding water resources and services.
2. Planning and Finance: This relates to the requirement for integrated planning, oversight, and funding processes for projects and programmes that promote water resilience.
3. Infrastructure and Ecosystems: The dimensions have to do with the ecosystems and infrastructure that allow cities to deliver essential water services and safeguard citizens from threats associated with water.
4. Health and Well-Being: The importance of water in ensuring that all urban residents can survive and thrive is related to the health and well-being of people.

Types of planning data	**Main emphasis**	**Source**	**Date of reference**	**Rationale**
Secondary analysis *quantitative data*	*Flood event: 2013 tidal surge* *Population changes*	Flood risk maps Environmental Agency (UK) and Senator for Climate Protection, Environment, Mobility, Urban Development, and Housing (Germany) Office of National Statistics (UK) and the Statistical Office of Bremen (Germany)	2013 (UK and Germany) 1990-2019 (UK) 1990-2018 (Germany)	To understand the impact of the 2013 tidal surge, and the impact and the changing patterns of urbanisation, as well as adaptation measures implemented to mitigate climate change impacts To demonstrate the population trajectory
Literature and document analysis *qualitative data*	*The review of Urban plans and policies to address social and economic issues, and adaptation to future sea-level rise*	Technical literature, Stakeholder consultation, field observation Policy and Planning	2013-2021 2013-2021	To identify approaches that informed the projects as discussed with the stakeholders, and to identify further projects of significance (proposed)

		documents (urban policies), Stakeholder consultation, field observation		
Field observation *qualitative data*	*North East Lincolnshire site visits* *Bremerhaven site visits*	Observational analysis and stakeholder engagements Observational analysis and stakeholder engagements	20 November 2019, November 2021 9-10 October 2020, 22 September 2021	To identify significant projects through stakeholders and to understand the current physical character of the areas. The projects identified are existing projects visited based on the exposure of future floods and sea-level rise.

Table 5: Data collection and techniques used for comparing resilience efforts in North East Lincolnshire in England and Bremerhaven in Germany

3.3.3 North East Lincolnshire

3.3.3.1 Historical development

Similar to Manchester and Liverpool, the post-industrial region of North East Lincolnshire has been affected by structural changes and the decline of trade in its port districts since the collapse of Scandinavian trade in the 12th century. These changes and declines have occurred after the collapse of trade with Scandinavia. The influx of Norwegian timber, Icelandic fishing, and the North Sea caused the dock's importance to decline between the early 15th and early 17th centuries. This decline is attributed to the North Sea.

As a result of political alliances in "Humberside," comprising East Yorkshire, Holderness, Kingston Upon Hull, East Yorkshire, Boothferry, Scunthorpe, Glanford, and Grimsby, the region became a part of a network of port towns in 1974. Cleethorpes and Grimsby were also included in the coalition.

Grimsby's Old Dock, Alexander Dock, Royal Docks, and Fish Docks were all built at the behest of a private business known as the Grimsby Haven Company, see Figure 14. The fishing fleet in Grimsby eventually grew to become the largest in Europe. The downturn in the fishing business that resulted from growing competition from neighbouring port cities and emerging EU markets caused an

increase in the number of residents who moved away from the affected areas. In addition, the events that took place during the Cod Wars and EU quota limits in the 1990s contributed to the reduction in population and the rise in unemployment that occurred as a direct result of a lack of job opportunities in the fishing industry.

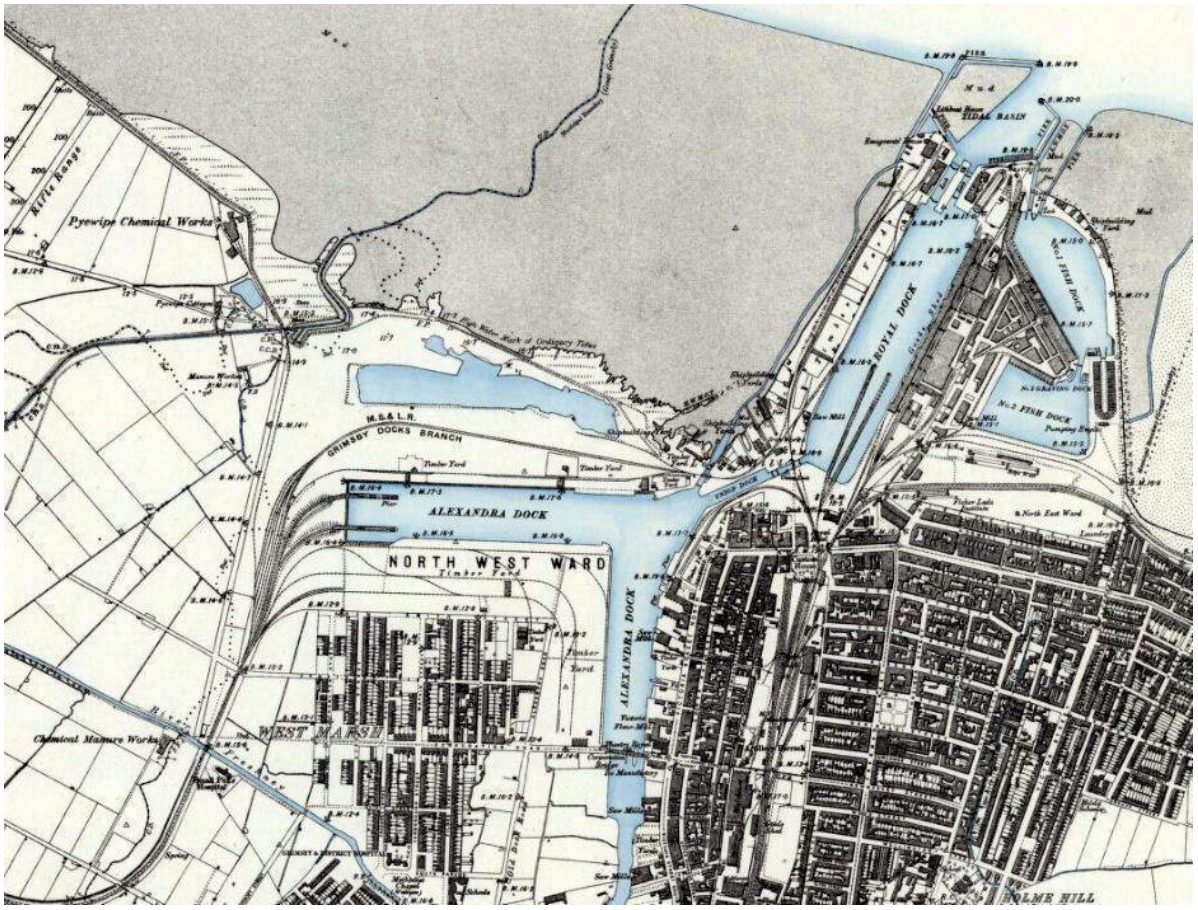

Figure 14: Historical Map of Grimsby Docks. Alexander Dock and the Royal and Fish Docks in Grimsby. Source: Ordnance Survey 2015

Current limitation and opportunities

The decline of the fishing sector has had a lasting impact on North East Lincolnshire's economy, which has left the region with significant challenges. There is a contemporary problem with the availability of skilled personnel across all industries (port and logistics, renewable energy, chemical processing, housing and construction, food processing, health and social care, visitor economy, services and retail). Issues that continue to plague business include a lack of apprentices, which contributes to a skilled labour shortage in the face of shifting demographics and an ageing workforce, as well as a lack of available skilled workers. The challenge of finding high-quality land at a reasonable price is a factor that slows the expansion of businesses. The poor rental and selling value,

as well as the property's continued lack of financial viability, can both be attributed to its position in a flood plain.

The Economic Strategy 2021 identifies the recovery of the COVID-19, environmental preservation, improvements to worker skills, and the development of new skills as its four primary concerns for the future. First and foremost among the goals are the South Humber Industrial Investment Program, the Freeport Zone, and the Town Centre (Grimsby, Cleethorpes, and Immingham) Improvement Program. This paper proposes a five-year action plan for the growth of companies that capitalises on the assets of the sector, leverages a green economy by making the most of efforts to improve industrial health, invests in the development of the workforce's skills, and encourages the creation of places.

NELC has declared a climate emergency and is in the process of developing a road map to a future with zero carbon emissions in order to meet the Sustainable Development Goals established by the United Nations by the year 2030.

The process of decarbonization presents both the greatest opportunity for the community as well as the greatest challenge. The classification of the area as a Freeport makes it possible for investments to be made in the areas that are close to the Humber Port and also speeds up this process. The Freeport Skills Academy, a Green Energy Skills Hub, and an expansion of the existing CATCH site are just a few examples of how STEM fields are creating opportunities for skill development. Other examples include: The Levelling Up Fund, Shared Prosperity Fund, Future High Streets Fund, and Towns Funds all offer initiatives aimed at regional revitalization long-term financial support. Both the Cleethorpes Master Plan and the Grimsby Master Plan include regenerating the waterfront as one of their primary objectives. The Cleethorpes Master Plan's focus is on tourism and hospitality.

3.3.3.2 North Sea Flood 2013

On January 31, 1953, a storm that developed over the North Sea resulted in flooding in a number of coastal regions of the Netherlands, Belgium, Scotland, and England, most notably the Humber. In 1953, a tidal wave caused the destruction of 24,000 homes and 100,000 hectares of land. As a result, 300 individuals lost their lives and 300 other people were forced to abandon their home. According to estimates, there were still 1100 homes and 7,000 hectares of land that were submerged in 2013. The significant consequences that the tidal surge had on the infrastructure and industries of the estuary had an effect on all aspects of commerce, including transportation and production. Even after the water levels have returned to their normal levels, the tidal surges that occur in the dynamic

environment of the Humber estuary can still have an effect on other natural processes. For instance, since the tidal surge that occurred in 2013, there has been a major shift in the patterns of water flow in this region of the estuary, which has resulted in the progression of coastal erosion at South Ferriby. In 2013, DEFRA made a commitment to capital investments that would last for the following six years (UK Parliament 2014). Other sources include revenue from local levies, funding from partnerships, as well as contributions from water and sewerage corporations (UK Parliament 2014).

The report further identified that 470 properties are at risk of fluvial floods, and further estimated that 33,000 in the tidal floodplain are at risk to coastal flooding (North East Lincolnshire Council 2015 pg 23). potential "tide-locking of over 7 metres between high and low tides contributing to tidal flooding and coastal erosion from the sea (Environment Agency 2016).

According to projections made by the Intergovernmental Panel on Climate Change (IPCC), the anticipated rise in sea level in the North Sea by the year 2030 is anywhere between 0.26 and 0.55 metres (0.85 and 1.80 feet). It is anticipated that the sea level would increase between 0.33 and 1.01 metres by the year 2050. (1.08 and 3.31 feet). These forecasts are based on a variety of emission scenarios and models, and they are susceptible to uncertainty because of this (IPCC 2012). According to the most recent findings, it appears that within the next 100 years, the Humber might see a rise in sea level that ranges from 1.0 to 1.3 metres (Environment Agency 2022a). During this time, it is anticipated that the flows on the tidal rivers will increase by up to fifty percent (Environment Agency 2022a).

As a direct response to the threat of flooding in the Humber Estuary, the Environmental Protection Agency (EPA) is developing plans to reduce the risk of flooding, which will be carried out over the course of the next quarter century. In 2008, the 33-year plan included strategies for managing flood risk, improving flood defences, defining locations for managed realignment, and expanding flood storage in order to sustain flood levels and ecosystems (Environment Agency 2008).

The identification of Flood Zones 2 and 3 in North East Lincolnshire's "Flood risk area" in Figure 15, based on the Technical Guidance outlined in the National Planning Policy Framework (2012), suggests that the region may be at risk for future flooding due to rising sea levels.

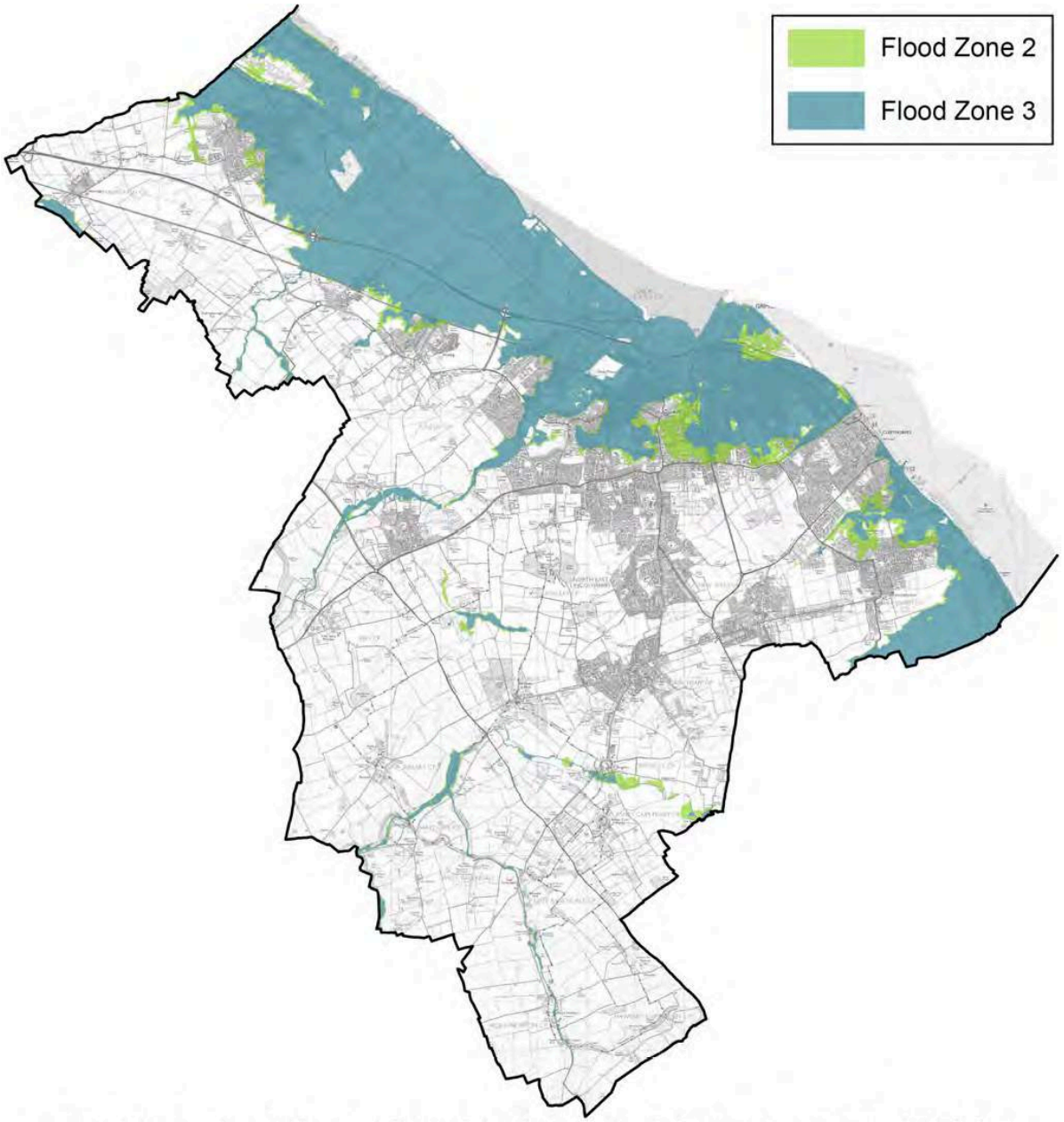

Figure 15: Flood Risk Areas in North East Lincolnshire. Source: North East Lincolnshire Council 2018

3.3.3.3 UK Planning system

The United Kingdom has a comprehensive land-use and development management framework. The system is divided between the national government and the local government, with the national government establishing a broad policy and the local government implementing it. Nationally, the UK government establishes planning policy through the National Planning Policy Framework (NPPF), which outlines the planning system's overarching objectives and principles. The NPPF is supplemented by a number of additional national policies and standards, such as the Planning

Practice Guidance (PPG), which provides extensive guidance on particular planning system components.

Local Plans, which are prepared and maintained by local planning authorities (LPAs) such as district or borough councils, are used to execute planning policy at the local level. Local Plans outline the particular policies and ideas for the use and development of land within the LPA's jurisdiction, including new housing, commercial development, and infrastructure proposals. The planning system also contains a number of additional essential components, including:

- The process of examining and approving individual planning applications is called development management.
- The classification and protection of historic properties, such as listed buildings and conservation areas.
- The environmental evaluation of proposed developments, including an evaluation of the potential implications on biodiversity, air quality, and water resources.

The British planning system is continually developing and under government scrutiny. It seeks to strike a balance between economic development, environmental conservation, affordable housing, and the preservation of cultural resources. In addition, public participation and community engagement are incorporated.

In the United Kingdom, the National Planning Policy Framework (NPPF) and the Flood Risk Management Plans control urban development laws in flood-prone regions. The NPPF stipulates that development in flood-prone areas must be safe, resilient, and sustainable, without increasing the danger of flooding to others. Plans for Flood Risk Management are used to detect and manage flood risk and to guide land use planning decisions. These plans also mandate that developers take efforts to limit the risk of flooding, such as incorporating flood-resilience measures into building design and protecting vital infrastructure. In addition, the Environment Agency offers flood maps and flood warnings to assist local governments in making informed planning decisions.

3.3.3.4 Population trajectory

North East Lincolnshire is a relatively small coastal town located in the east of England. Despite its small size, its population has been growing steadily over the past decades, reaching 159,563 in 2019, see Figure 16. This population growth trend can be observed in the context of wider trends in the UK, where coastal areas have seen significant population growth due to a combination of factors such as improved transportation links and the rise of tourism.

However, this population growth has not been constant, and there have been periods of decline. For example, between 1994 and 1998, many students left North East Lincolnshire to pursue higher education in nearby cities, causing a decline in enrolment. This decline was eventually stabilised, but it highlights the challenges of retaining young people in the area.

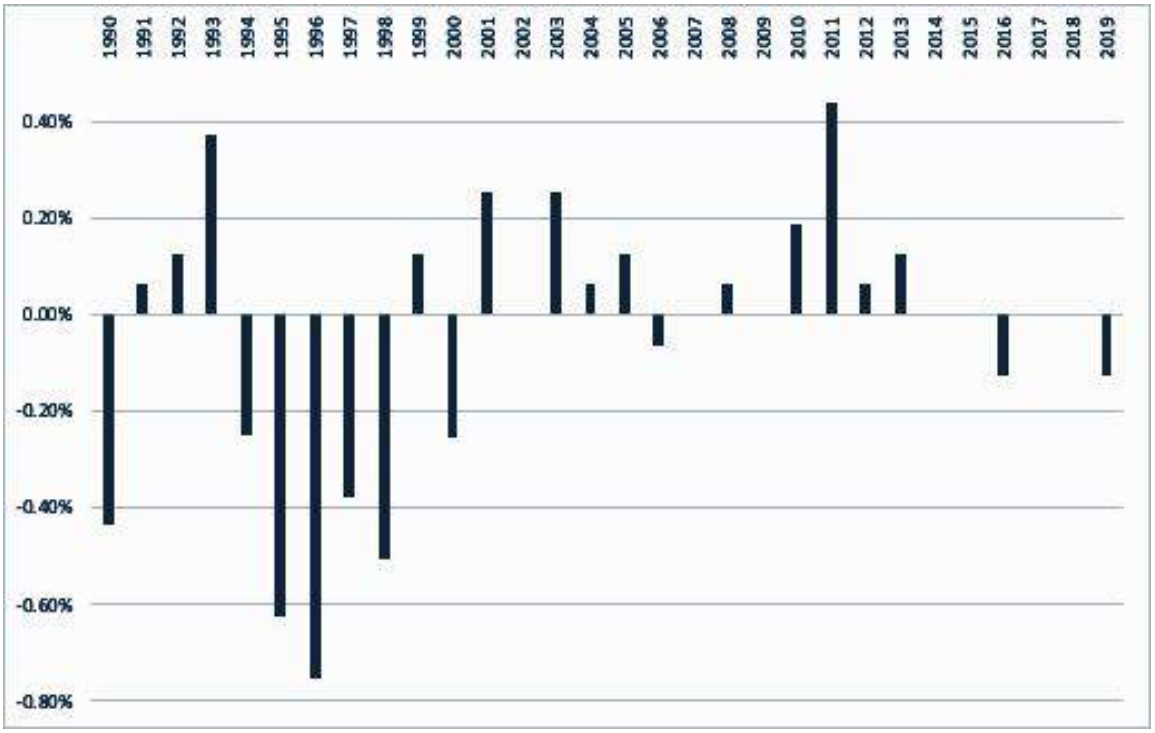

Figure 16: Population trajectory between 1990-2019 in North East Lincolnshire. Source: Own work. Data from the ONS midyear population estimates (2019), Labour Market Profile - Nomis - Official Labour Market Statistics, accessed 12 October 2020 at https://www.nomisweb.co.uk/

Access to healthcare and services for the elderly is also a challenge in North East Lincolnshire, which has an ageing population. This is an issue that is not unique to this area but is becoming increasingly common across the UK. Additionally, the availability of flood-resistant housing is another limitation in flood risk management. Coastal areas are particularly vulnerable to flooding caused by sea-level rise, and ensuring that homes are designed and built to withstand these challenges is an important part of managing flood risk.

The Census has also shown that the share of one-person homes with people under the age of 65 has increased considerably in North East Lincolnshire, from 14% to 18%. This trend is also observed across the UK and highlights the changing demographics of the population. It has implications for how services are provided and the types of housing that are needed in the area.

The next section presents local case studies of urban approaches used to improve *Shrinkage-Resilience* as conceptualised in this dissertation.

3.3.4 *Shrinkage-Resilience* urban approaches in areas located in North East Lincolnshire

Community team: Barton to New Holland project

Forty residential properties, fifteen commercial/recreational sites, and one school were damaged by the 2013 floods in Barton, Barrow Haven, and New Holland. 400 hectares of agricultural land and 200 hectares of wetland; railway and highway infrastructure; and 3.5 kilometres of flood embankments were damaged (Environment Agency 2021). Figure 17 shows the extent of the tidal flooding that occurred.

The Department for Environment, Food and Rural Affairs is responsible for the protection and improvement of England's environment. Due to future tidal flooding disasters, the Barton and New Holland communities convened in 2013 to establish a Community Engagement Forum. A steering group and resilience advisory group will proactively interact with the environmental agency to convey the concerns of local people and businesses.

It is distinctive in that it employs local knowledge and skills to generate long-term solutions that are economical and potentially have minimal environmental impact on the Humber Estuary. The Environment Agency has modelled future flooding scenarios that are significantly more catastrophic than the 2013 tidal surge and anticipated direct damages of £10 billion (Environment Agency 2021a). The communities have elected to stay put. The committee is composed of local government, corporate, landowner, community, and ecological group members.

Figure 17: Aerial view after the North Sea flood in 2013 in North East Lincolnshire: Barton, Barrow Haven, and New Holland. Source: Environment Agency 2021

The community is proactive in its understanding of risk and impact, and ecological surveys are guided. In addition, professional specialists from the Environmental Protection Agency, ARUP, and Jacobs and Jackson Civil Engineering are included on the team (Environment Agency 2021b). The Environmental Agency will submit a request for future financing to the government under the Environmental Agency's Investment Programme and the Humber Strategy in order to reduce the danger of tidal flooding around the Humber Estuary. Any deficits will be covered by local funds. Locally, North East Lincolnshire is a member of the Humber 2100+ partnership, which consists of twelve local authorities and is supported by Natural England and Internal Drainage Boards (Environment Agency 2021b). The alliance establishes a long-term strategy. Due to multiple conservation designations under UK and international law - the Special Protection Areas, RAMSAR, and Site of Special Scientific Interest - the Humber Estuary and parts of the Hull Catchment are Sites of Special Scientific Interest (SSSI) and Areas of Outstanding Natural Beauty (Environment Agency 2022b).

Forward-thinking Grimsby: Digital Master Planning

A local area plan to revitalise the town centre in North East Lincolnshire was produced by the community in accordance with the provisions of the Localism Act.

Photos 1-2 show the main street in Grimsby and Photo 3 the main seafront.
The ten-year plan places a significant emphasis on economic growth as a means of achieving its goals of constructing 13,340 new dwellings and producing 8,800 new employment opportunities. On a national scale, it intends to carry on the goals laid out by the government for the Industrial Strategy by maintaining its function as a coastal port-industrial area that serves operation and maintenance for the offshore wind energy sector. To revitalise the town centre, it further encourages research and innovation in hydrogen technologies by utilising a model of public-private cooperation between the central government, local government, citizens, and enterprises.

There has been an increase in the number of employment available in the service industry, while the number of manufacturing jobs has decreased. Between the years 2002 and 2015, the number of people living in the Grimsby area's East Marsh declined by 2.1%, from 5,712 to 5,592, making it one of the most economically deprived places in the United Kingdom (Department for Communities and Local Government 2015). In 2018, Grimsby was successful in its application to the government for the Town Deal Fund. By recovering places and repurposing land that has been abandoned, neglected, or otherwise underutilised, the spatial vision contributes to the North East Local Area Plan (2018). As part of the Grimsby Town Centre Plan, the North East Lincolnshire Council has been given permission to invest 25 million pounds on the town centre of Grimsby (ARUP 2022).

The blueprint for the project was developed during the pandemic in the year 2020, when face-to-face consultations were not possible, making it a one-of-a-kind undertaking. Participants were able to submit comments online on the council website, social media platforms, and many press releases by using a "virtual room," which gave the idea that participants were in a real venue. This gave the sense that participants were actually present at the event. The findings saw 3,444 unique visitors and received 438 replies, of which 94% came from people and 6% came from businesses (ARUP 2022).

The key principles from the master plans are:

1. 'introduce more diverse uses into the town centre'
2. 'reconnect the town centre with the waterfront'
3. 'celebrate and enhance heritage sites'
4. 'promote and support community ownership and participation'
5. 'improve permeability of the town centre'
6. 'identify development opportunities'

7. 'priorities health and wellbeing'
8. 'enhance opportunities for employment, skills and enterprise'

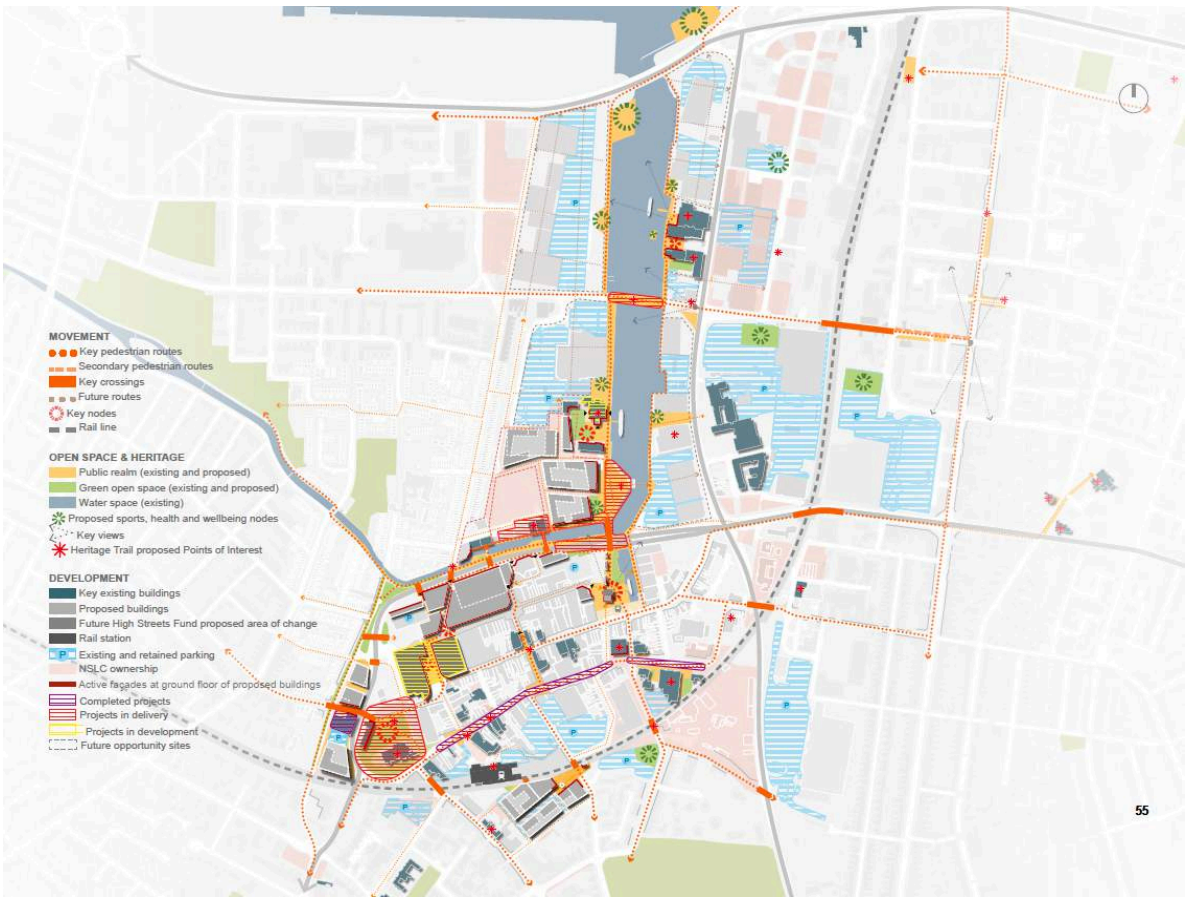

Figure 18: Town Centre Redevelopment Plan in 2022. Source: ARUP 2022

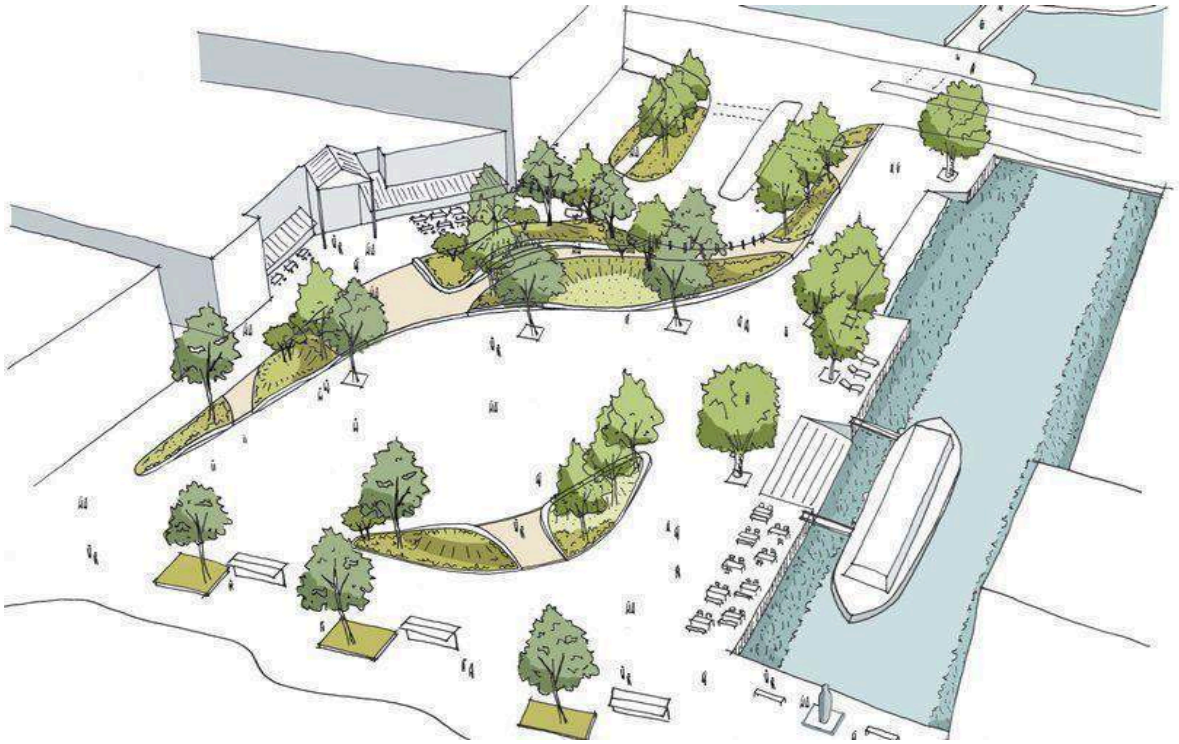

Figure 19: Waterfront development concept: Riverhead square in central Grimsby. Source: Jackson 2022

One of the projects included in the Town Deal, which received funding in 2020 for specific projects, is financing the renovation of the area. Arup Landscape Design has created new designs that integrate input from recent consultations with local people, including children and young adults, to determine what they would like to see in the area (Jackson 2022). These designs reflect the town's industrial and maritime history and the natural environment of the coastline, with the aim of establishing the area as a public square that supports the town centre, see Figures 18-19 (Jackson 2022).

Photo 1: Vacant building on the main street in Grimsby. Source: Author's archive: October 2020

Photo 2: Vacant buildings with residential uses on top floor in the main street in Grimsby. Source: Author's archive: October 2020

Photo 3: The Grimsby seafront facing the North Sea. Source: Author's archive: October 2020

In collaboration with SGL Planning and Urban Design, North South Environmental and NLBC, Thinc design was responsible for the trail design components of the study (Thincdesign 2022). This involved designing a network of trails and a range of on and off-road trail types that link the Waterfront Trail to various destinations along Grimsby's waterfront, see Figure 20. The basis for future decisions concerning the creation of a parkland trails system and planned built form during the lakefront development will be Grimsby's West End Waterfront Master Plan and Trail Design Study (Thincdesign 2022). The study is centred around a West End Waterfront Vision that enhances the area's recreational connections and access to the lake, as well as providing guidance for the development of new neighbourhoods that possess a distinct sense of place and character.

Figure 20: Grimsby West End Master Development Plan published by Thinc Design. Source: Thinc design 2022

Uptake of sustainable flood defences: South Ferriby

According to North East Lincolnshire Council's blog, the flood defence project was concluded in 2021, and its advantages included the creation of embankments and habitats in addition to offsetting a reduction in carbon emissions (2019). These benefits were offset by the fact that less emissions of carbon dioxide were produced.

It was built as a direct response to the tidal surge that took place in 2013, and it has its starting point at South Ferriby. It continues all the way up to Werringhams Ings, which is located in the northern part of the Humber Estuary. It is believed that 129 homes in South Ferriby and 13 homes in Winteringham were impacted by the incident in 2013. These numbers include both private and public housing. In addition, the region had an impact on around 1,000 hectares of agricultural land in 2013, and it took more than 6 years for that land to recover after the impact. It is anticipated that the economy has sustained damages to the tune of almost fifty million pounds. Both the key route known as the A1077 and the cement plant that is owned by CEMEX have been forced to close for the entire year, although the A1077 has been closed for only four days. On a more macro scale, it is anticipated that the risk of damage to 150 residential properties, 3,000 hectares of agricultural land, and transportation infrastructure, such as the A1077 and the railway line, which is responsible for transporting 20% of UK freight, will be reduced. Additionally, it is anticipated that the risk of damage to agricultural land will remain the same (North East Lincolnshire Council 2019).

A press release statement from DEFRA stated that the project was initiated by the Environmental Agencies using the £12 million in defence funding (2021). The part funding fell under the Environmental Agencies *Flood and Coastal Erosion Investment Plans, a* 2.6 billion investment between the 2015 and 2021. It was selected as one of a 25-year strategy to safeguard the region from tidal floods, under the *Humber Flood Risk Management.* A 50% of Grant-in-aid[3] partnership grants were received (DEFRA 2021).

[3] A financial contribution made to an organisation that will be used to support the organisational objectives. A payment made by a government agency, sometimes referred to as the "sponsor department," to cover all or some of the expenses incurred by the organisation receiving the grant in aid.
(https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/654680/2017-09-27_Grant_Definitions.pdf)

Photo 4 (top) and 5 (bottom): Overlooking the Humber Estuary from Sluice Road and completed construction of the South Ferriby Scheme. Source: Author's archive: April 2021

The defensive plan involves the installation of detachable flood defences across the sluice, a floodgate that is 13 metres wide, 2.7 kilometres of flood embankments, 200 metres of sheet piling, 150 metres of reinforced concrete flood walls, and the reinforcement of existing defences. The Environmental Agency, the Department of Environment, Food, and Rural Affairs, the South Ferriby Parish Council, CEMEX Industry, Jacobs, and the North Lincolnshire Council were the project's partners. Other partners included the Environmental Agency (DEFRA 2021).

Photo 6: Completed construction of the South Ferriby Scheme and The Hope & Anchor Pub. Source: Author's archive: April 2021

This flood protection and carbon reduction project was undertaken by the defence department with the primary intention of achieving sustainability. CEMEX, one of the businesses that was impacted by the project, collaborated extensively on it and provided 240 thousand tonnes of clay for the embankments. In order to cut down on the amount of material that was wasted, precise amounts of clay were calculated using 3D modelling and the adjacent quarry (which is located less than two miles from the embankment). As a result, the scheme is expected to reduce carbon emissions by 10,000 metric tonnes CO2 equivalent (JBA Consulting 2023). According to the economic advantage, there will be a reduction of economic losses amounting to 248.1 million pounds (JBA Consulting (2023). As a result of the implementation of a number of mitigation strategies aimed at the protection and preservation of ecosystems and species, the establishment of a community woodland was one of the outcomes (Environment Agency 2021c).

3.3.5 Bremerhaven

3.3.5.1 Historical development

A post-industrial area, Bremerhaven can be found in the state of Bremen (Land), which is situated in the northwest corner of Germany. The history of Bremerhaven is intricately intertwined with the history of the city of Bremen, which may be found around 50 kilometres (or 30 miles) to the southeast of Bremerhaven. It is situated on the eastern side of the Weser estuary, on both the left and right banks of the Geeste River at the point where it joins the Weser and flows into the North Sea. In the early 1800s, the three distinct towns of Bremen, Geestemünde, and Lehen merged together to form what is now known as the municipality of Bremen, see Figure 21.

There is evidence of human habitation in the region that is now known as Bremerhaven dating back to prehistoric times; nevertheless, the city of Bremerhaven was not established until 1827 to serve as Bremen's port city. This was done because Bremen, which was a city-state and a part of the German Confederation, did not have a deep-water port of its own and was therefore unable to take advantage of the expanding trade and emigration of the 19th century. As a result, this led to the city being annexed by Hamburg.

During the 19th century, Bremerhaven experienced significant growth as a port city, and it developed into an important passenger port that served both trade and emigration. Through Bremerhaven, a significant number of Germans settled in the United States as well as other countries. In addition to this, the city developed into a significant centre for the industries of fishing and shipbuilding. Manufacturing became a far more important part of Bremerhaven's economy in the 20th century.

During World War II, the city was subjected to heavy bombing, and the port docks were completely devastated. The city went through a period of rebuilding and modernization after the war. This was marked by the construction of the Columbus Centre in 1971, which revitalised the city centre. Additionally, the port was expanded so that it could accommodate larger ships.

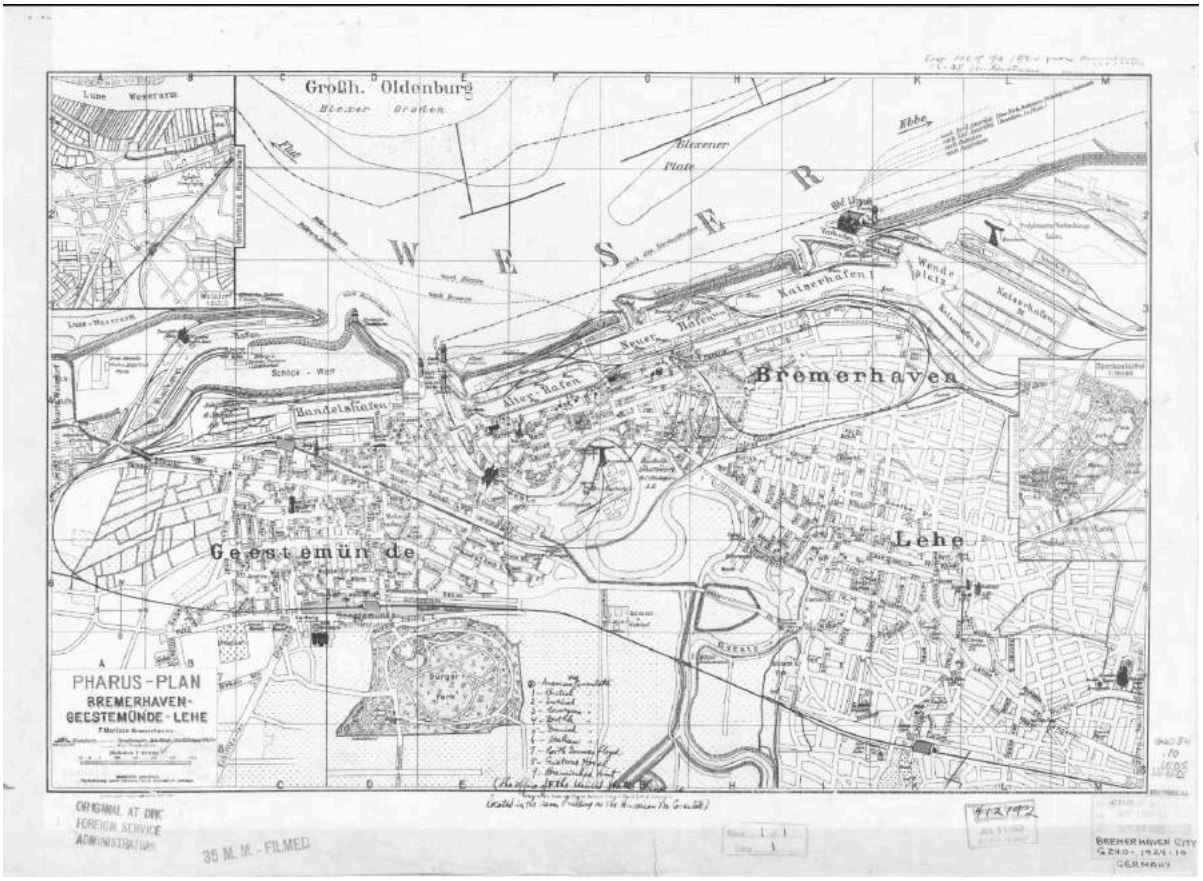

Figure 21: Historical map of the location of Bremerhaven "Old Harbour". Source: UCLA Library 2021

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Current limitation and opportunities

Bremerhaven connected with city- and state-level competences, including those over Bremen and Bremerhaven. There are constraints on Bremerhaven's potential for recovery. Concerns in the city include the following: the consolidation of public finances; the management of increasing social polarisation; the existence of vacant buildings; the assurance of the long-term viability of the innovation strategy; net-migration as a result of a lack of employment opportunities; and poverty. Bremerhaven's attempts to mitigate the effects of climate change include a number of different energy education programmes. These projects engage all segments of the local people to reduce the negative impact of their energy usage (Szolucha 2018)

Sources of funding from national programmes such as Stadtumbau Ost and Stadtumbau West focused on giving financial help to communities that were limited in their resource availability due to a lack of a local tax base (Bernt, 2019).

The Economic Policy Action Plan, also known as Wirtschaftspolitisches Aktionsprogramm (WAP), along with housing renewal plans and the Special Investment Programme, also known as Investitionssonderprogramm (ISP), received €18 billion in funding from the federal government in order to support research, innovation, and technology; the development of new industrial and office parks; transport projects; and tourism projects (Ploger, J. 2007). However, due to financial

constraints, not all of them were able to successfully market their products. According to Ploger, the growing debt and budgets of the precinct had an influence on the rehabilitation of the city. By 2005, the amount of financial debt had reached a record high of €12 billion, having previously been €8 billion (Plöger 2007).

Since 1951, the Federal Ministry of the Interior, Building and Community has supported urban development in areas that have been impacted by urban shrinkage. This ministry also oversees community building. In the 1990s, the "Urban Development Support Programmes" were established as a cooperative effort between the federal government, the federal states, and the municipalities of Germany. This was done in response to the negative consequences of structural change and decline. One of the most important tools for achieving the goals of the present Leipzig Charter on Sustainable European Cities is to combine the cooperation between the federal government, the federal states, and the municipalities. Recent funding initiatives have placed a larger emphasis on social cohesion, living town and city centre revitalization, as well as growth and sustainable regeneration. These are essential for post-industrial cities that are experiencing population decline and need to adapt.

According to the report published by the Federal Ministry of the Interior, Building and Community, since 2002, Bremerhaven has received its allotted portion of 7 billion euros (2020). The Gründerzeit neighbourhood presented this as a way to revitalise 235 hectares of post-war residential neighbourhoods that had been vacant and deserted properties prior to the proposal. A total of €60 million was given by the Federal Government, the Free Hanseatic City of Bremen-Bremerhaven, and the City of Bremerhaven Federal Ministry of the Interior, Building and Community (2020).

3.3.5.2 North Sea Flood 2013

The years 1962, 2002, and 2013 were marked by significant flooding in the state of Bremen/Bremerhaven, where 86 percent of the land is susceptible to flooding and storm surges. Bremerhaven, a 93.8-kilometre-long city situated at the mouth of the River Weser in Germany, faces the highest risk due to its geographical location, see Figure 22. Bremen, on the other hand, has 92% of its land located in the low-lying Weser Marsh, making it the most vulnerable coastal state to the rise in sea level. The state of Schleswig-Holstein follows with 33 percent of its land exposed. In comparison, Hamburg, Lower Saxony, and Mecklenburg-Vorpommern have lower proportions of land (30%, 20%, and 9.5%, respectively) that are susceptible to flooding.

According to the Centre for Climate Change Adaptation (2022), if a catastrophic flood caused by climate change were to occur, the city of Bremen, a significant German port, would suffer total damages of approximately 18.5 billion euros, which includes 6.5 billion euros in direct destruction and 12 billion euros in macroeconomic consequences such as loss of labour, assuming a sea level rise of 55 cm.

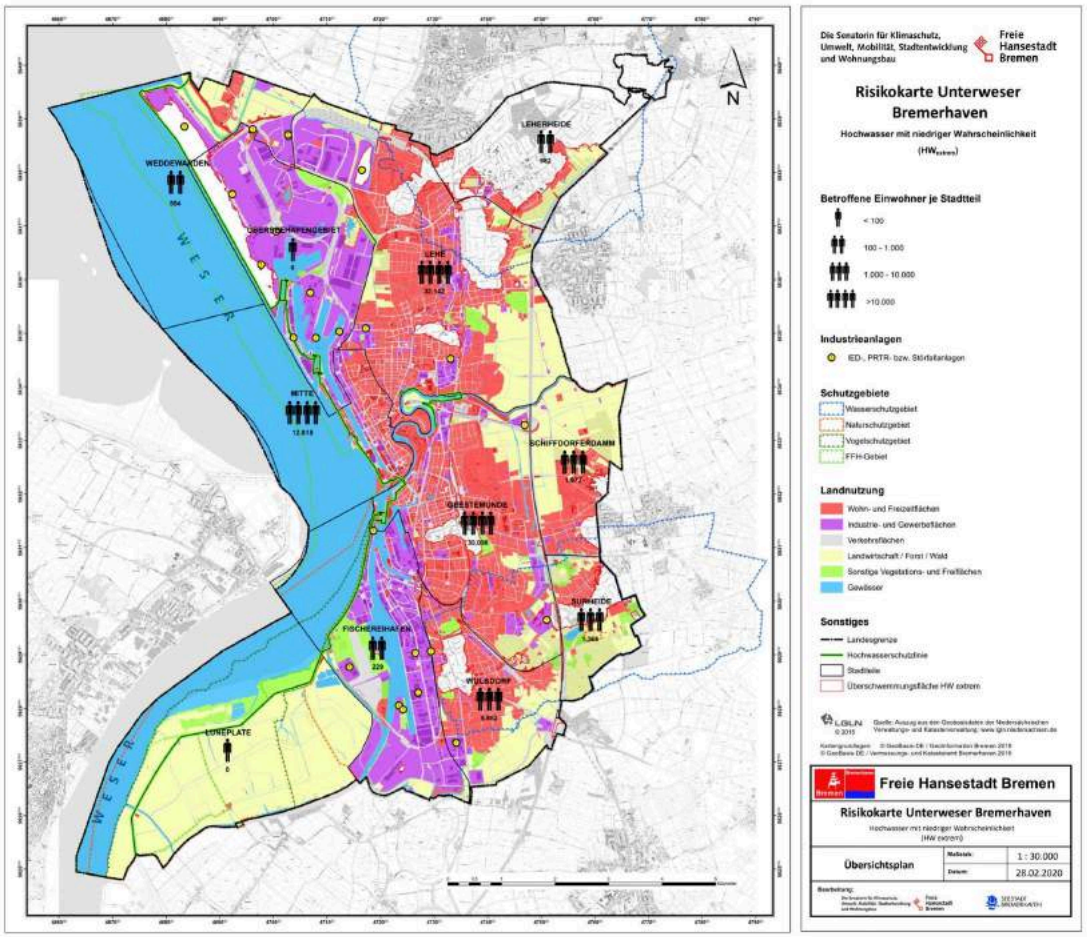

Figure 22: Flood Risk Areas in Bremerhaven and Bremen. Source: Freie Hansestadt Bremen - Die Senatorin für Klimaschutz, Umwelt, Mobilität, Stadtentwicklung und Wohnungsbau 2020

The combination of storms and higher-than-average sea levels will lead to higher storm-surge levels. According to the findings of the North German Climate Office, which forecast that sea levels in the German Bight will rise by approximately 80 centimetres by the end of the century, we are able to anticipate that a changed wind climate will result in North Sea storm surges at a level that is 30 to 110 centimetres higher than they are at this time by the end of the century (The Senator for Environment, Urban Development and Mobility 2018).

The Free and Hanseatic City of Hamburg and Bremen, Lower Saxony, and Schleswig Holstein are the four federal states in charge of the adaptation plans for the German North Sea coast Niemeyer et al. (2016). A total of around 39 million euros was invested in flood protection measures in Bremerhaven in the period 2007 to 2019 inclusive.

3.3.5.3 German Planning System

The planning system in Germany is a federal system, and the duty for determining how land should be used is shared between the federal government and the constituent states (Länder). The national government is responsible for formulating broad policies and general guidelines, but the various states are the ones who must carry out the actual implementation of those policies and regulations inside their own borders. Both the Federal Building Code, also known as the Baugesetzbuch or BauGB, which governs the use and development of land, and the Building Code, also known as the Baurecht, which contains specific regulations related to building construction, are both part of the planning policy that is established at the national level by the German government. In addition, the federal government of Germany has enacted a National Spatial Planning Framework (Raumordnung) that details the overarching goals of land use planning and offers basic direction to the states.

At the state level, planning policy is put into action by means of the State Development Plan (also known as the LEP or Landesentwicklungsplan) and the Regional Plan (also known as the Regional Plan), both of which are prepared and kept up to date by the various states.
In these plans, the precise policies and ideas for the use and development of property within the borders of the states are laid out.

These plans include proposals for new housing, proposals for commercial development, and proposals for infrastructure. In addition to these, the German planning system consists of a number of additional essential components such as: The process of evaluating and granting approval for certain planning applications is referred to as development management. The naming of heritage assets and ensuring their protection, such as the declaration of conservation areas and listed structures.

The environmental assessment of the developments that are being proposed, which includes an analysis of the potential effects on biodiversity, air quality, and water resources. The objective of the planning system in Germany is to strike a balance between economic growth and the conservation of the environment, the provision of affordable housing, and the protection of heritage treasures. In

order to ensure that the planning process takes into account both local and regional viewpoints, it has been designed to encourage public participation and community engagement, and it also has a high level of citizen participation in the planning process. This is accomplished through the participation of local communities, expert groups, and non-governmental organisations (NGOs).

The Federal Building Code and the Water Management Act both provide direction for the planning laws that are followed in Germany for urban growth in areas that are at danger of flooding. The Federal Building Code establishes minimum standards for the construction of buildings in flood risk areas, including requirements for elevated structures, waterproofing, and flood-resistant materials. These standards must be met in order for a building to be considered compliant with the Federal Building Code. The Water Management Act requires local authorities to consider the potential impact of development on water management and flood protection, and it provides for the preparation of flood hazard maps to inform planning decisions. Additionally, the Act mandates that local authorities must consider the potential impact of development on water management and flood protection. Additionally, the German government has implemented a number of programmes and initiatives to promote sustainable and flood-resistant urban development. These programmes and initiatives include the National Flood Protection Program and the National Adaptation Strategy. Both of these programmes can be found on the German government's website. These projects intend to lessen the likelihood that flood damage will occur, encourage improved land use planning, and stimulate the development of novel and environmentally friendly flood prevention strategies.

3.3.5.4 Population trajectory

Bremerhaven's population is getting close to 113,634 (2019), with a population reduction between 1994 and 2001, then additional decline between 2003 and 2011, as illustrated in Figure 23. This decline is attributed to presumed economic difficulties by residents seeking to pursue higher education and job possibilities nearby.

Physical safety and protection have always been the main priorities of flood risk management. These include: Managing coastal drainage systems and emergency management, including flood awareness, methods for addressing concerns associated with residential (flood) risk, and location exposure to floods brought on by sea-level rise.

In 1843, AG Weser, founded a shipbuilding industry that employed around 16,000 workers. When the company closed in 1983, 10,000 jobs were lost. The population declined from 140,455 to 126, 629

between 1970 and 1987 (City population 2020). In 1997 Bremer Vulkan AG, a second ship building company, collapsed causing the second wave of population decline from 126,629 to 108,156 between 1987 and 2011 (City population 2020). In this subsequent crisis of the sector another 8,000 shipbuilding jobs were lost across the company and its supply chain. Despite this Plöger points out that population loss was not caused by migration to more affluent regions, as for example in most East German cities, but by suburbanisation, low birth rates, and the return of contract workers to their home countries (Plöger 2007).

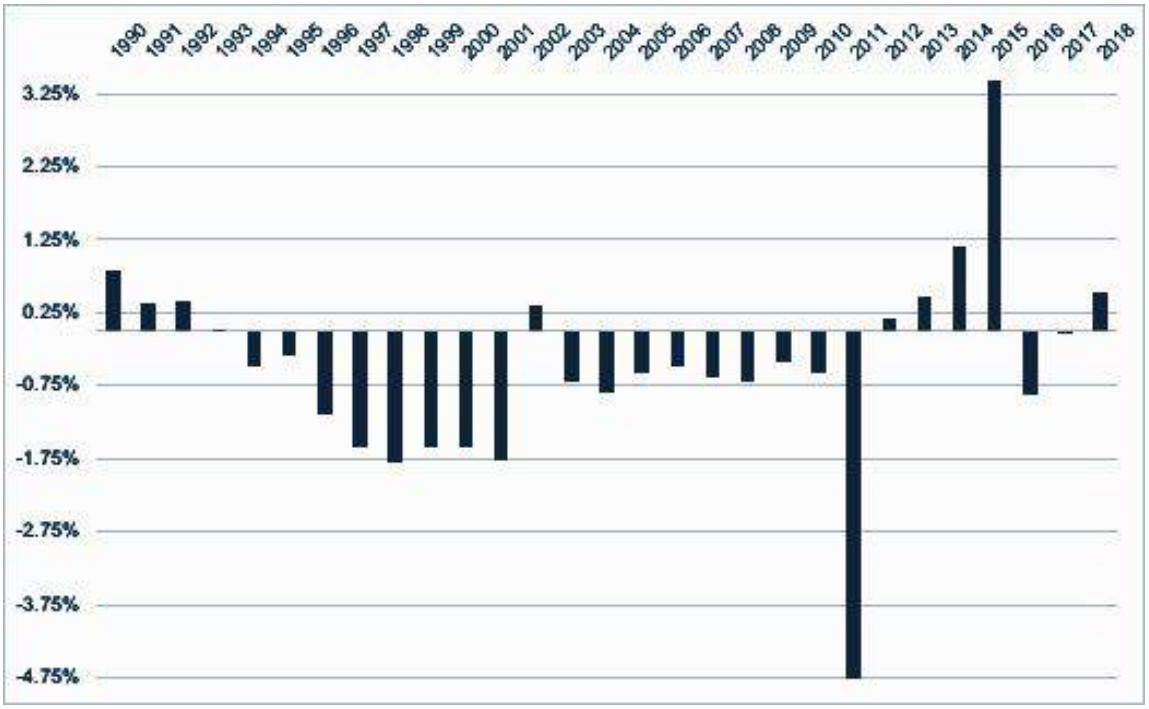

Figure 23: Population trajectory between 1990-2018 in Bremerhaven. Source: Own work. Data from Bremen State Statistical Office, accessed 12 October 2020 https://www.statistik.bremen.de/publikationen/statistisches_jahrbuch-2044.

Bremerhaven is a major centre for the wind energy industry, as well as a port for cruise ships. Overall, the history of Bremerhaven is closely tied to the maritime and commercial history of Germany, as well as its role as a gateway for emigration and a centre of industry and trade. To date it serves as an important research area in the University of applied sciences, featuring the German Maritime Museum, Institute for Polar Research and the renowned Climate Museum/ 'Klimahaus'.

3.3.6 *Shrinkage-Resilience* urban approaches in areas located in Bremerhaven

Shipyard Quarter Framework

Bremerhaven is home to a number of urban development initiatives, but one of the most noteworthy is the revitalization of the former shipbuilding district (known as the former Seebeckwerft). Its history dates back to the building and remodelling of container ships, and in 2008, it employed about 320 people. The company shut operations in 2009.

A map depicting the shared spatial boundary between the coastal port area of Bremerhaven Municipality and Bremen Municipality is presented in Figure 24, sourced from Google Earth.

Figure 24: Bremerhaven Municipality and Bremen Municipality 2022. Source: Google Earth

As early as the beginning of the 17th century, silting made shipping on the Weser difficult. Oceangoing ships no longer headed for the ports in the city centre (Schlachte in Bremen), but for ports downstream, first Vegesack, later Brake (Unterweser) and from 1827 Bremerhaven. Because of

the increasing silting up of the Weser, in 1827 Bremen bought through Mayor Johann Smidt of Hanover the land and dyke foreland of the former, unfinished Swedish fortress town of Carlsburg on the north side of the mouth of the Geeste into the Outer Weser, which was handed over on 1 May 1827 and named Bremerhaven. The overseas port in Bremerhaven has belonged to the city of Bremen since 1 April 1938 and has been steadily expanded. The city of Bremerhaven exercises partial local government for the area by contract. The port area is geographically located in the north-western part of Bremerhaven, to the city of Bremen. It includes the port facilities Container Terminal I-IV, Columbuskaje, Kaiserhafen, Nordhafen, Osthafen and Verbindungshafen. The largest part of the city of Bremen's overseas port area is demarcated by the customs border of the Bremerhaven free port. Photo 7 shows the extent of the current development within the port area.

Photo 7: Bremerhaven Shipyard Quarter, with the Climate Museum and Bremen Port Head Office. Source: Author's archive: September 2021

In the City of Bremen overseas port area, the Hanseatic City of Bremen Port Authority is, in addition to its port-related tasks, the contact point for citizens to the City of Bremen authorities. More extensive tasks (e.g. environmental authority) are performed by the city of Bremen authorities (e.g.

SKUMS). Bremerhaven's urban planning system is extremely distinctive because the proposed renovation is subject to a tendering process. Six national and international offices participated in the competition, and the jury's ultimate decision was delayed over numerous public hearings hosted by the Technical Town Hall (Wikipedia 2023).

The proposed development consists of housing, offices, car park, commercial space, urban space: 30,000 m² office; 24,500 m² owner-occupied flats; 6,700 m² non-profit housing; 8,000 m² commercial space; 7,600 m² car park; total floor space 77,000 m² (Bremerhaven Municipality 2019). Architects, urban planners, investors, and representatives from the government and political parties make up the jury. The Lord Mayor, the Senator for Science and Ports, the Head of City Planning, and regional and worldwide architecture firms were among the participants. Figures 25-29 are the winning concept: Shipyard Quarter Framework Plan presented by COBE Copenhagen.

A a review by the Transsolar Energietechnik GmbH reviewed how residents provided feedback on the suggested ideas presented by the various businesses through working group meetings (such as Octagon, ASTOC Architects and Urban Planners, ADEPT, DeZwarteHond, gruppeOmp Architektengesellsschaft mbHBDA, etc.) (2020). About 190 events were present. On the local planning website, all findings, presentations, and participant input are available. In 2020, COBE's "Living with Water" initiative was named the winner. The project's vision was featured in a renowned online magazine, Design boom magazine, as setting a creation of a district that is carbon-neutral, resource-neutral, and close to the city, water, and greenery. In doing so, transforming the shipyard quarter in a way that is carbon neutral is based on the idea of an efficient energy supply from renewable sources (Designboom 2019). The project will include its own, urban microclimate, seven car-free districts and 500,000 m² urban development, provision of outdoor and interior areas (Designboom 2019).

Figure 25: Shipyard Quarter Framework Plan presented by COBE Copenhagen Concepts of Blue, Green and Urban Infrastructure. Source: Bremerhaven Municipality 2019

Figure 26: Shipyard Quarter Framework Plan presented by COBE Copenhagen. Source: Bremerhaven Municipality 2019

Figure 27: Shipyard Quarter Framework Plan presented by COBE Copenhagen. Source: Bremerhaven Municipality 2019

Figure 28: Shipyard Quarter Framework Plan presented by COBE Copenhagen. Source: Bremerhaven Municipality 2019

Figure 29: Shipyard Quarter Framework Plan presented by COBE Copenhagen. Source: Bremerhaven Municipality 2019; 2021

Green/Blue infrastructure

Bremerhaven/Bremen share a climate change adaptation strategy that was established by the Senator for Environment, Urban Development, and Mobility in 2018. It targets twelve different sectors with its actions. Real estate and construction, mobility and traffic, health, conservation of

nature and species, agriculture and forestry, economy, soil, parks and open spaces, tourism and leisure, energy, water management, and ports are just a few of the industries that are affected. In addition, it identifies cross-cutting industries that can help with climate change adaptation, including urban and landscape planning, disaster relief and civil protection, education, and international cooperation in research and development. Bremerhaven and Bremen are both identified as having preventative measures in the strategy paper by BREsilient - Climate-resilient Zukunftsstadt Bremen (BRESILIENT 2022)

The flood defence schemes are shown in Photos 8 and 9.

Photo 8: Completed Flood defence scheme along the River Weser. Source: Author's archive: September 2021

Photo 9: Completed Flood defence scheme along the River Weser with pedestrian path and access for emergency vehicles. Source: Author's archive: September 2021

During the tidal surge that occurred in 2013, it became apparent that one method for lowering the economic risks that are present in port areas is to put in place long-term preventive policies. Current sea level rise estimations and scenarios are analysed as part of the general strategy for coastal protection. This analysis is based on information obtained by the IPCC and scientific research initiatives. Because there was such a wide range of possible estimations, using the worst-case scenario to determine whether or not the dikes needed to be lifted or reinforced was not an economically efficient way to make the determination. As a consequence of this, the following principles will serve as the basis for the new plan to preserve the shore. These uses were done by changing the dyke extension using a mix between grey/green defence (vegetation and sediment rocks) to adjust the dyke to account for greater sea-level rise. A method that can be easily transferred to regions that are working towards coastal protection and management despite having long-standing infrastructure issues.

The General Plan has designated SKUMS as its primary agency. Along the same lines as the proposal for a cap that was put forth by the German state of Schleswig-Holstein, this one also contained a system for public input and was standardised across the North German Coastal States. The majority of the donations were given by SKUMS as well as Bremen Ports, which is the landowner responsible for coastal maintenance. The maintenance of open lines of communication between Bremen Ports and SKUMS in order to guarantee the implementation of appropriate preventative measures and response protocols for unexpected events is the primary source of concern. Among the key measures that have been specified, a reassessment of the smaller bodies of water (moats), a review of the size of the pumping stations, and an investigation into the vulnerability of smaller river courses to extremely heavy rainfall events with concurrent storm surges are all going to take place. As a component of the long-term strategy for adapting to the effects of climate change, the following are included: interdepartmental working groups, progress reports every five years, and climate experts from research institutes. The sharing of scientific and technological information on a regional scale. A communication strategy is established so that there would be a greater amount of citizen participation.

Increasing Port resilience

In 2014, Bremenports created the *Port Development Concept*, it's a climate adaptation placed on port facilities and infrastructure. The concept is based on a proactive approach by identifying risk from early stages and developing measures on addressing it. It also focuses on raising awareness on the consequences of climate changes. Stakeholder dialogues are also held to integrate knowledge sharing between industries and the affected communities of Bremerhaven.

The German Port Technology Association (HTG) has formed a working group with the purpose of addressing these concerns and sharing information with one another. Members of the group include terminal operators, companies that manage sea and inland ports, national research organisations like the German Meteorological Office (DWD), the Federal Waterways Engineering and Research Institute (BAW), and the Federal Maritime and Hydrographic Agency (BSH), and national research organisations. The working group's purpose is to provide solutions for coping with climate change.

Port-Klima is yet another big construction project. This project, which was concluded in 2021, was in charge of the development of teaching and training modules on the subject of climate adaptation in port regions. It is directed by the Bremen Ports and owns the majority of the port areas in the city of Bremerhaven. The majority of the port's facilities are situated within the area that is protected from flooding by the flood control line.

The Climate Change Adaptation Strategy required the ports of Bremerhaven and Bremen to develop long term adaptation concepts as part of the strategy's requirements.

Photo 10 and 11: View from the parking area Mole overlooking the river Geeste. Source: Author's archive: September 2021

Photo 12: Completed Flood defence scheme along the River Weser. Source: Author's archive: September 2021

Participation in studies on climate change adaptation is done by Bremenports. The "Port Klima" project, which was overseen by the Bremen University of Applied Sciences, resulted in the production of educational and training materials for the purpose of incorporating climate change adaptation into the design, construction, and management of German seaports. In 2021, the project was completed. The Senator for Climate Protection, Environment, Mobility, Urban Development, and Housing launched the "BREsilient" project, which investigates the indirect effects of climate change and the necessity for the maritime economy and logistics sectors to adapt in response to these potential changes, such as the breakdown of supply chains and sales markets, as a basis for developing proposals for more resilient supply chains. BREsilient examines the indirect effects of climate change and the need for the maritime economy and logistics sectors to adapt in response to these potential changes.

The development of the Lune Plate site is one of the most important projects that are now being undertaken in Bremerhaven. The most significant ecological area for a variety of animals and plants. As a mitigation site in the course of the CT 4 port extension project, Bremenports was a pioneer in the field of ecological compensations and provided one of the earliest examples. The location is

significant in that it provides an important example of striking a balance between the conflicting goals of economic development and environmental protection.

3.3.7 Cross comparison of international Shrinkage-Resilience approaches

In this section, a comparative review of the Shrinkage-Resilience approaches used in the two case studies. The analysis is organised according to the categories of approach, transformative pathways, and key activators, as well as the corresponding vulnerabilities.

The purpose of this comparison is to provide an overview of the resilience efforts undertaken in the two shrinking cities vulnerable to sea-level rise and their response post-climate catastrophe. The table format used here could be adapted for other case studies, allowing for a comparative analysis of Shrinkage-Resilience approaches across different contexts.

Table 6: Comparison of Shrinkage-Resilience approaches in North East Lincolnshire and Bremerhaven. Source: Own work

	North East Lincolnshire England			Bremerhaven Germany		
Broad analysis urban approaches for managing sea-level rise	Barton to New Holland Flood dykes (Existing)	Grimsby Master Plan (Proposed)	South Ferriby Flood dykes (Existing)	Shipyard quarter (Proposed)	River Weser Flood dykes (Existing)	Increasing Port resilience (Existing)
Category of approach	Infrastructure	Urban regeneration	Infrastructure	Urban regeneration	Infrastructure	Infrastructure
Transformative pathways	*Adaptive management* *Learning* *Innovation* *Leadership*	*Adaptive management* *Learning* *Innovation* *Leadership*	*Adaptive management* *Learning* *Innovation* *Leadership*	*Adaptive management* *Learning* *Innovation* *Leadership*	*Adaptive management* *Learning* *Innovation*	*Adaptive management* *Learning* *Innovation* *Leadership*
Activator/Lead along coastal management	(Public Sector) Environmental Agency	(Public sector) North East Lincolnshire Council	(Public sector) Environmental Agency	(Public sector) Bremen/Bremerhaven	(Public sector) Bremerhaven Council	(Private sector) Bremenports

	RESILIENCE EFFORTS					
	Health and Wellbeing					
	Active community engagement through community newsletters (published on the Environmental Agency website) - through a citizen space page. *Ongoing community perception conducting environmental surveys and climate modelling (consisting of 'do-nothing and do-minimum' scenarios') up to 100 years.* *GIS Mapping to identify areas that are most vulnerable through*	Active co-creation and design to create several strategic visions through online surveys and interviews with local residents and businesses. *Proposed ongoing engagement in the implementation of future Local Area Planning.* *Building new partnerships of pop-up spaces and arts and cultural programmes and events.* Promoting a positive identity	South Ferriby village scheme received industry recognition, national CECA awards and higher government recognition of community and industry efforts. *Ongoing monitoring through the Humber 2100+ programme.* *Participation in decision making through the Resilience Advisory Group.* *Access to GIS Mapping to identify areas that are most*	Active co-creation across stakeholders, active public participation and design-based competition. *Proposed ongoing mitigation impacts through greening, building retrofit, car free zones to reduce carbons emissions with protection to sea-level rise.* *Access to GIS Mapping to identify areas that are most vulnerable* Build social awareness on accepting climate risk through	Public participation in planning processes. *Ongoing Improved access to shoreline, improving spaces for exercise and recreation for residents.* *Access to GIS Mapping to identify areas that are most vulnerable.* *Monitoring and evaluation of ongoing sea-level adaptation.* Promotes continued building relations with the port owners and	Active training and development of working groups of staff through programmes and projects led by in Bremen ports. *Ongoing climate adaptation training and development plans (Port development concept) alignment, towards Sustainable Development Goals.* *Monitoring and evaluation of ongoing sea-level adaptation.* Integrated and future response to climate adaptation concepts.

	the citizen space page. *Ongoing monitoring through the Humber 2100+ programme.* Promoting social prosperity through active engagement and building trust with the government, adapting to the climate risk. *Participation in decision making through the Resilience Advisory Group.* *Community ownership through finding funding alternatives.*	through planning processes and improving the built environment. Strengthening existing infrastructure and enhancing mix of old and new land use. Promoting equal access to planning and processes.	*vulnerable to sea-level rise impacts.* Promoting social prosperity through active engagement and building trust with government, encouraging protection of ecological designated zones for animal and plant species., Daubenton's bat *Participation in decision making through the Resilience Advisory Group.* *Ongoing monitoring through the Humber 2100+ programme.*	promotion of the concept of "Living with Water". Promoting equal access to planning and processes. Strengthening existing infrastructure and enhancing mix of old and new land use.	government bodies. Monitoring of climate adaptation projects, and readjusting defences. Strengthening of existing infrastructure.	Monitoring of climate adaptation projects. Strengthening existing infrastructure.

	Improved adaptation and protection to future sea-level rise with improved infrastructure Improved nature-based solutions and habitat rehabilitation Access to transport: Funding approved for Barton Train station	Restoring unused buildings and vacant land Improved access healthy green parks and open space, green corridors, reactivation water spaces, promotion of walkability *Ongoing: improved healthier lifestyles through increased mobility and exercise, potential health benefits*	Improved adaptation and protection to future sea-level rise with improved infrastructure Water sensitive design: reduction in carbon emissions during the construction of the flood defences Improved nature-based solutions and habitat rehabilitation	Restoring unused buildings and vacant land Water sensitive design through improved solutions in blue and green infrastructure Improved access healthy green parks and open space, green corridors, reactivation water spaces, promotion of walkability	Improved adaptation and protection to future sea-level rise with improved infrastructure Improved Blue and green infrastructure Creating new pathways and walkways	Improved adaptation and protection to future sea-level rise with improved infrastructure Analysing existing structures, "Future Concept for the Port 2035", encourages sustainable development principles in urban development by supporting future developers in planning processes. Increased efforts in engaging with residents and businesses.
	For an area located outside the urban core, evidence of support by government agencies and	Promotes access to land use diversification to enhance access to social and economic opportunities.	Promotes access to the Humber Estuary with walkways and sightseeing of ecological areas Infrastructure	Promotes active community engagement through public meetings to disseminate feedback and	Promotes active use of the area through walkability corridors.	Promotes active community engagement through public meetings to disseminate feedback and

	businesses. Future project: *'Community-Panel'* programme aimed at demographically disadvantaged groups to contribute to adaptation pathways -DEFRA funded. Promotes improved access to transport services.	Promotes opportunities for employment, skills and enterprise. Promotes equal access to the public proposed waterfront development.	improvement for elderly population on site. Encourages ecological protection of the natural ecosystem and improved biodiversity services.	concerns of residents and businesses. Promotes opportunities for employment, skills and enterprise.		concerns of residents and businesses.

	Infrastructure and Ecosystems					
	As a spatial factor, the Humber influences the feedback of other future impacts causing higher water levels. Balancing affordability of additional flood protection measures insurance. Protection surrounding agricultural land. Protecting ecosystems that are vital for existing animals and plant species. Protecting the Humber Estuary. Monitoring offsetting	Promotes digital infrastructure services to manage physical and mental health. Plans for improved rail services and connectivity "Northern PowerHouse Rail'. Presents promoting access to Town centre infrastructure that is safe for wheelchairs, pushchairs, cyclists and pedestrians	As a spatial factor, the Humber influences the feedback of other future impacts causing higher water levels. Balancing affordability of additional flood protection measures insurance. Protecting ecosystems that are vital for existing animals and plant species. Protecting the Humber Estuary through planning regulations Management of protected environmental areas.	Presents promoting employment. Promoting opportunities for access to housing Strategies to enhance carbon mitigation. Improving quality of life for existing residents and business. Protecting the River Weser catchment through improved coastal measures. Focused development on green infrastructure. Low carbon strategy.	Ongoing maintenance of flood defences and funding by Bremerhaven Council and Bremen Ports. Protecting the River Weser catchment through improved coastal measures with flood dikes. Adaptive and flexible approaches in monitoring climate change allowances. Ongoing maintenance of infrastructure from port authorities.	Ongoing maintenance of flood defences and funding by Bremerhaven Council and Bremen Ports. Protecting the River Weser catchment through improved coastal measures with flood dikes. Increasing adaptive management approaches in port areas. Adaptive and flexible approaches in monitoring climate change allowances. Ongoing maintenance of infrastructure from port authorities.

	environmental impacts, 100-year flood level. Active monitoring and evaluation of the flood schemes. Promotion of flood awareness maps and alerts by the community newsletter issued by the Environmental Agency. Evidence of access to early warning systems (by the Met Office). Creation of natural buffers (green spaces). Build resilient flood defences.	Strategies to enhance safety through Crime Prevention through Environmental Design principles Protecting rural landscape and village areas 'Area of Outstanding Natural Beauty/ Limited proactive action on the preparedness to sea level rise. Enhancing the existing waterfront through conservation and renewal of urban spaces. Focus on green infrastructure Ecological Mitigation Scheme to turn	Active-onsite water management facilities Active monitoring and evaluation of the flood schemes. Evidence of access to early warning systems (by the Met Office). Creation of natural buffers. Build resilient flood defences. Evidence of developing Evidence of backed-up assets individual insurance (Flood RE-scheme) back by government and private insurance companies).	Climate adaptation planning toolkit to encourage resilient buildings. Project has several green infrastructure sites. Creation and maintenance of natural buffers. Measures to improve stormwater management.	Increased coordination with port owners by developing plans and policies. Implementing coastal management practices. Creation and maintenance of natural buffers.	Improving coastal management practices in the port development area. Investment in new research and development of new technologies and approaches to support port development

	Evidence of developing Evidence of backed-up assets individual insurance (Flood RE-scheme) back by government and private insurance companies).	unused land into mitigation sites Promoting connectivity and accessibility to green and coastal areas (Waterfront redevelopment, Alexandra Dock and River Freshney. Encouraging green infrastructure. Creation of natural buffers along the proposed waterfront development. Build resilient flood defences				

	Planning and Finance					
	Regulation and accountability of services are in place. Design standards for flood defences. Planning is interconnected. Opportunity for increased disaster recovery planning. Shows evidence of applying for national government and partnership funding - using 'benefit cost ratios, external funding partners, government agencies - led by the Resilience advisory group.	Regulation and accountability of services are in place. Design standards for flood defences and stormwater management. Planning is interconnected. Opportunity for increased disaster recovery planning. The plan sets a clear objective to obtain funding from the national government: Future High Streets Funds, Stronger Towns Funds, National Lottery Heritage Funds.	Regulation and accountability of services are in place. Design standards for flood defences. Planning is interconnected. Opportunity for increased disaster recovery planning. Shows evidence of applying for national government and partnership funding. The flood defence project provides embankments and habitat creation while offsetting carbon reduction (co-benefit).	Action plans with emergency services, authorities and volunteers - under various scenarios, with demographic change and population decline- by the State of Bremen. Combination of state and municipal funding. Funding from national and EU level. External funders.	Regulation and accountability of services are in place. Design standards for flood defences and pumping stations Urban planning is interconnected across service departments such as spatial planning and environmental and climate change experts. Action plans with emergency services, authorities and volunteers - under various scenarios, with demographic change and population decline- by the State of Bremen.	Regulation and accountability of services are in place. Action plans with emergency services, authorities and volunteers - under various scenarios, with demographic change and population decline - by the State of Bremen and port owners. Combination of state and municipal funding. Funding from national and EU level. External funders.

	Regulations are seen as flood defences and are accountable by the Environmental agency. Not all land has infrastructure and methods are explored on the local level. Provides adaptation through local resilience forums, meetings and the newsletter. Fostering economic assessments under different options for human, economic and ecological benefits.	It further mentions the need to foster new partnerships with investors, co-founders and operators. However, getting private sector investment is needed based on the implementation of the projects. Regulations are seen clear for new development potential to integrate infrastructure related to drainage systems and flood defences. New development subject to building codes and regulations.			Combination of state and municipal funding. Funding from national and EU level. External funders.	Evidence of a compensatory mitigation site of climate change and environmental impact (Lune Plate).

		Design standards for sustainable water drainage systems (new waterfront development).				
	Leadership and Strategy					
	Evidence of community and industry 'accepting the risk", through active planning and community funding. Shift from top down to integrated relations forming partnerships government, private sector, industries and communities : Environmental Agency works in close relation with the Resilience Advisory group, technical experts.	Produced by North East Lincolnshire With collaboration with community led interventions and volunteering, North East Lincolnshire Council, Greater Grimsby board.	Evidence of community and industry 'accepting the risk", through active planning and community funding. Shift from top down to integrated relations forming partnerships government, private sector, industries and communities : Environmental Agency works with close relation with the Resilience Advisory group, technical experts	Driven by port governance models with national and regional states, private industries driving climate adaptation. Federal Government: Bremen state. Emergency responses (local authorities and volunteers.	Evidence of public-private strategic leadership in climate adaptation.	Driven by port governance models with national and regional states, private industries driving climate adaptation. Federal Government: Bremen state Emergency responses (local authorities and volunteers.

	Solutions around adaptation and catchment planning. Demonstrates coordination with the environmental agency inspecting flood and coastal defences through the year (Resilience Advisory Group with technical engineers). Coordination between community, business and the government agencies.	Actors adjacent to the regeneration sites of (Alexandra Dockside, Riverhead and Garthlane and St James Fresney) should define clear vision and leadership. Co-design principles till 2030 with community led interventions and volunteering, North East Lincolnshire Council, Greater Grimsby board.	Solutions around adaptation and catchment planning.			

	Area falls under the Humber2100 project, local authority partnerships and industry. Progress towards a proactive approach across multiple sectors.	The plan identifies strategic vision to reuse vacant and existing sites for redevelopment - Council ownership. Three areas Alexandra Dockside, Riverhead and Garthlane and St James Fresney - with a link to the waterfront. Wider economic vision: Business growth, a green economy, skills and place-making initiatives. Focus on sustainability, Net Zero 2050, Low carbon transportation.	Area falls under the Humber2100 project, local authority partnerships and industry. Progress towards a proactive approach across multiple sectors.	Economic growth (renewable energy sector and cargo and freight) Increasing port capacity and competitiveness in the EU and global trade. Focus on reducing environmental impact and climate adaptation in port operations. Strengthen relation with business and communities.	Economic growth (renewable energy sector and cargo and freight) Increasing port capacity and competitiveness in the EU and global trade. Focus on reducing environmental impact and climate adaptation in port operations. Strengthen relation with business and communities.	Economic growth (renewable energy sector and cargo and freight) Increasing port capacity and competitiveness in the EU and global trade. Focus on reducing environmental impact and climate adaptation in port operations. Strengthen relation with business and communities.

Broad analysis of influencing risk factors (shrinkage-related effects and responses)	URBAN SHRINKAGE DYNAMICS					
	Social-Demographic					
	Barton to New Holland (Existing)	**Grimsby Master Plan (Proposed)**	**South Ferriby (Existing)**	**Shipyard quarter (Proposed)**	**Green/Blue infrastructure (Existing)**	**Increasing Port resilience (Existing)**
Vulnerability	Demographic changes (ageing population), climate disadvantaged communities, high deprivation level	Demographic changes (ageing population), climate disadvantaged communities, high deprivation level	Demographic changes (ageing population), climate disadvantaged communities, high deprivation levels	Demographic changes, climate disadvantaged communities	Demographic changes, climate disadvantaged communities	Demographic changes, climate disadvantaged communities
	Economic					
Vulnerability	**Capacity to cope and adapt to:** Unemployment, Poverty, Crime,	**Capacity to cope and adapt to:** Unemployment, Poverty, Crime,	**Capacity to cope and adapt to:** Unemployment, Poverty, Crime,	**Capacity to cope and adapt to:** Unemployment, Poverty, Crime,	**Capacity to cope and adapt to:** Unemployment, Poverty, Crime,	**Capacity to cope and adapt to:** Unemployment, Poverty, Crime,

	Deprivation Funding for long term infrastructure projects by governments are competitive and allocated through bidding processes.	Deprivation	Deprivation Funding for long term infrastructure projects by governments are competitive and allocated through bidding processes.	Deprivation	Deprivation	Deprivation
	Environmental					
Vulnerability	**Exposure:** **Climate change** Natural variability, Anthropogenic Climate change, North Sea, Glacier shrinkage, Humber Estuary Catchment.	**Exposure:** **Climate change** Natural variability, Anthropogenic Climate change, North Sea, Glacier shrinkage, Humber Estuary Catchment.	**Exposure:** **Climate change** Natural variability, Anthropogenic Climate change, North Sea, Glacier shrinkage, Humber Estuary Catchment.	**Exposure:** **Climate change** Natural variability, Anthropogenic Climate change, North Sea, Glacier shrinkage, River Weser catchment.	**Exposure:** **Climate change** Natural variability, Anthropogenic Climate change, North Sea, Glacier shrinkage, River Weser catchment.	**Exposure:** **Climate change** Natural variability, Anthropogenic Climate change, North Sea, Glacier shrinkage, River Weser catchment.

	Spatial and Governance					
Vulnerability	Changes in Climate Change adaptation responses, Disaster Risk Management responses.	Changes in Climate Change adaptation responses, Disaster Risk Management responses.	Changes in Climate Change adaptation responses, Disaster Risk Management responses.	Changes in Climate Change adaptation responses, Disaster Risk Management responses.	Climate Change adaptation, Disaster Risk Management.	Climate Change adaptation, Disaster Risk Management.

3.3.8 Discussions

This chapter analysed existing projects to examine urban shrinkage and resilience. This relation stems from research studies that focus attention on the impacts on the built environment (Wolff 2017), vulnerabilities (Kuhliche et al. 2012) and the wider context of economic transformation of port cities (Jonas et al. 2017). In addition, the resilience theory offers a good filter for explaining and interpreting shrinkage in direct connection to certain “natural” phases in the process of adaptation (Bănică, et al. 2020). Using mixed method research the results were coded to identify aspects of transformative pathways (IPCC 2012) - of urban shrinkage and resilience. This chapter highlighted the limited relevance of shrinking city discourses integrating these discussions, as examined in Part Two. Among the 136 research papers, 23 papers directly used resilience as a concept to understand urban shrinkage between 2006-2021. Integrating areas of spatial planning, climate change adaptation and disaster risk management is relatively limited. Climate Mitigation and issues around environmental sustainability is a growing topic (Chapter 2). This chapter discusses the limited knowledge around areas affected by shrinkage and are susceptible to floods and climate change (Mackay et al. 2022).

In terms of resilience, the existing policy debate on the role of spatial planning within climate change and disaster management, such as the Sendai Framework for Disaster Reduction 2015-2030, continues to be relevant, especially in port-industrial contexts as described in this chapter. The analysis shows evidence that port-town areas have the capability to absorb the consequences of future sea-level rise and are able to recover without suffering socio-economic catastrophe. This study highlights the importance of considering the port-town relationship when developing both long-term and short-term adaptation strategies that involve citizen participation (Jonas et al. 2017) and address property rights (Ataç & Hartmann, 2022). A potential reason for disengagement in such efforts is the infrequency of storm surges, and the fact that institutional disaster risk management remains outside the scope of climate change governance and spatial planning. According to the latest report by the IPCC, "key governance limitations that will prevent sustainable transformation are: complexity, time horizon and uncertainty, cross-scale and cross domain coordination, equity and social vulnerability and social conflict" (IPCC 2022a). This leads to how it relates to shrinkage.

This research has shed light on the immediate and direct impact of urban shrinkage on coastal port-industrial communities. It is crucial to plan for the anticipated decline in urban development, in both developing and stable coastal areas undergoing economic transformation, as this could lead to significant economic impacts on the nearby villages. The interdependence between ports and port-town regions, as well as wider urbanisation trends, also contributes to local vulnerabilities and

policy challenges that must be addressed. Despite these challenges, coastal port-industrial areas remain attractive investment opportunities, especially if there is high potential for market return and incentives for adaptation development. The COVID-19 pandemic has accelerated economic transformations and highlighted existing inequalities and vulnerabilities, making it more important than ever to incorporate disaster risk management and resilience-building into spatial planning procedures, providing an opportunity for increased resilience in these areas.

Despite the limited uptake of the integrated *Shrinkage-Resilience* approach in urban policy, our study has revealed that this integration is already taking place indirectly and outside of the private sector, as shown in Table 3. The impact of land use change on population growth is evident in the case study of industrial areas in Part Three (3.2).

Additionally, the examples of urban regeneration we examined demonstrate that inclusive and sustainable adaptation efforts are more achievable through diverse land use and community engagement. For instance, in the North East Lincolnshire case, it was recommended that multi-level and multi-sectoral techniques be employed to facilitate information exchange between port businesses and communities, as part of planning for sea-level rise. Similar findings were obtained in the Bremerhaven investigation.

In the early 2003s, the planners in Bremerhaven and North East Lincolnshire focused on developing the port area while anticipating future growth. Both regions focused on compact development, conserving space for commercial and industrial use, and slowing down development to comply with environmental requirements. This included demarcating flood risk zones, implementing nature-based solutions, and expanding the port for more activities. In the case of North East Lincolnshire, the planners also prioritised information exchange between port businesses and communities to plan for sea-level rise.

The study concludes that incorporating urban shrinkage and resilience initiatives to address sea-level rise limitations have a positive link. Urban shrinkage has influenced the type of development that has taken place in coastal port-industrial areas, and resilience can influence approaches. Planning for growth and anticipating urban shrinkage can help reserve space for future development while considering policy changes in disaster risk reduction and climate change adaptation approaches.

Based on the conceptual-methodological framework proposed earlier, the study recommends including disaster risk reduction and climate change adaptation approaches in urban planning in port-industrial areas. This can be achieved by adopting multi-level and multi-sectoral place-based techniques, increasing information exchange between port businesses and communities, and prioritising mixed-use and diverse land use development to engage communities and promote sustainable adaptation efforts.

CHAPTER 4: Results and Findings

The study analyses the connection between wider changing urbanisation patterns of shrinking areas, coastal resilience - and urban approaches, as outlined in the research's title. Previous research was analysed revealing a connection between urban shrinkage and resilience. This connection has implications for addressing climate change and long-term vulnerabilities and inequalities. The dissertation brings together three separate investigations and examines how they can contribute to the broader arguments surrounding these concepts.

During the course of this research investigation, it was shown that climate change poses a significant danger not only to the present levels of poverty in England but also to the coastal port-industrial zones. It portrayed the current status of urbanisation patterns in England, the repercussions of land use change for coastal areas, as well as a study of urban techniques that could potentially inform shrinkage and increase resilience to sea-level rise. An important topic in the discussion focuses on the importance of spatial planning as the essential mechanism in carrying out adaptation efforts. This is accomplished by integrating both notions in practice. This new course of action is based on a different set of processes and routes, all of which will need to be investigated in the years to come. In this chapter, the new shrinkage-resilience idea is integrated, and a connection is made between it and urban planning as the major narrative of the dissertation.

Within the scope of the dissertation was a cross-sectional and longitudinal analysis of population loss in England. This resulted in the creation of a framework that illustrated the relationship between shrinkage and resilience. In light of the lessons learnt from the North Sea Flood event in 2013, it presented decreasing areas as a target for decision-making and policy action. Additionally, it provided a perspective for future urban design to take urban shrinkage and resilience into consideration. It looked at the most important case study, which was North East Lincolnshire, and compared it to other case studies that were similar so that they could assess how it would change over the next few years.

The current trajectory of coastal port-industrial areas

The relative population loss in older industrial areas (a decline of 0.15% with a minimum of 10,000 residents) between 2013 and 2019 corresponded to 68% of the decline in land usage. The Levelling Up agenda, which aims to alleviate social, economic, and spatial inequalities by the year 2030, can benefit from this information. This is in line with the findings of other studies on recent population shifts in relative terms. It is distinct in both its spatial classification and its conceptualization of shrinkage, both of which take into consideration economic and demographic statistics. This research, on the other hand, expands the density change model to monitor changes in the built environment. It also provides a more sophisticated analysis by combining recent data on land use change and classifying it according to activities that consume land use. During this particular time period, the sector of land use activities that saw the greatest increase was the community services sector. The lack of provision of additional information regarding the demand and supply of land for land use diversification is a current shortcoming in local area planning. This information can be used to help inform decisions about how best to manage and utilise land and other resources in ways that promote the resilience and sustainability of shrinking cities.

This revision illustrates the impact of relative change, which represents the progress of urbanisation. For the purposes of formulating public policy, population change relative to macro trends and to other industrial areas is preferred over absolute population change. This is due to the fact that relative population change paints a more accurate picture of the proportionate increase or decrease in the population when taking into account the size of the population. It provides a more meaningful measurement of population growth or decline, allowing policymakers to better understand the significance of changes and to compare population changes across different geographic areas or over time. In addition, it makes it possible to measure population growth or decline over a longer period of time. Furthermore, relative change helps to identify regions that are increasing or dropping at a quicker rate, exposing possible areas of concern as well as chances for intervention. This can be done by comparing the previous state to the current state.

The findings also illustrate the overall progression of demographic change. According to the findings, the cumulative population in the Northern and Midlands regions decreased in 49 out of 63 older industrial locations between 1991 and 2019. This reduction was most pronounced in the Northern region. Providing further evidence that more recent population reduction patterns are indeed taking place in older industrial areas.

In addition to this, due to an increase in the number of homes being built in England's older industrial zones, 46 percent of the country's greenbelt space has been reduced. This indicates both the demand for housing and the relation between that demand and the need to alter their resilience in other areas of policy.

The revised perspective on older industrial zones has revealed that just a limited number of studies and evidence have been incorporated into it. Because of planning practices, economic disinvestment, political contexts such as political gridlock or lack of funding, public attitudes that are resistant to growth ideologies, and a lack of coordination, it is common for shrinking cities to have an imbalance in land use planning and diversity. The causes of this imbalance can be broken down into five categories: To modify land use in a way that will allow for future resilience, one will need to use a multi-disciplinary and integrated approach that is tailored to the particular circumstances of the place in question.

The theoretical framework suggests that a growing debate of this port-town dynamics, in older industrial areas as discussed in Part One, will continue in the National Planning Policy Framework, UK's National Infrastructure Act, and the Climate Change Act that sets policy-related research. This debate was suggested by the theoretical framework. Particular attention has been paid to coastal port-industrial regions that are in the process of experiencing significant economic change as part of the "Renewable Energy Capital" initiative in the United Kingdom. At the national level, it has been recognised as a problem that future urban decline, such as changes in demographics, will occur. However, the concerns on how land use change can adapt to this an opportunity to address both urban shrinkage and boost climate resilience are notably lacking in the current policy debate about the Levelling Up agendas. This is an opportunity to address both urban shrinkage and enhance climate resilience (as discussed in Part One).

Chapter 3 provides empirical evidence that, despite the nation's overall growth trends, changing urbanisation patterns are predominantly occurring in older industrial zones. Such patterns can heighten the risk of natural disasters in densely populated areas with concentrated infrastructure. For example, emergency evacuations may be necessary in such areas. It is noteworthy that Allerdale, Ashfield, Blackburn with Darwen, Burnley, Copeland, County Durham, Darlington, Gateshead, Gedling, Halton, Kingston Upon Hull, Mansfield, North East Derbyshire, North East Lincolnshire, Preston, South Tyneside, St. Helens, Tameside, and Wolverhampton are among the older industrial

areas that represent crucial areas that are potentially vulnerable. To address the specific needs of shrinking cities and support the Levelling Up Policy and the National Planning Policy Framework, tailored interventions are required.

The cases of Kingston upon Hull, North East Lincolnshire, and South Tyneside offer specific recommendations for managing the dynamics of port towns. As highlighted in this section, it is imperative to plan for the potential decline of metropolitan areas located in coastal regions that are either stable or expanding despite economic changes. This finding is consistent with similar conclusions drawn in Europe, which are supported by the demographic projections presented in the 8th EU Cohesion report. The report predicts that by the year 2050, around 50% of the European population will reside in territories that are experiencing shrinkage (Dijkstra et al. 2020).

Using the changing urbanisation patterns in North East Lincolnshire as an illustration of the county's experience with structural shifts in the region, we can examine the impact of these shifts on the local economy and population.

In coastal areas that have either a stable or increasing population, urban shrinkage can have a significant impact on the economy, the environment, and the quality of life of the people living there. It is necessary to plan for the urbanisation of the future. Coastal communities that are undergoing economic transformation frequently confront significant economic changes, such as the loss of established industries and the creation of new economic sectors. Coastal locations that are not undergoing economic transformation do not suffer these types of changes. It's possible that as a result of these developments, people will lose their jobs and the population will decrease.

In coastal port-industrial areas, addressing issues related to urban shrinkage and resilience will be an essential future problem. The effects of climate change, which include the rise in sea level, an increase in the frequency of extreme weather events, and erosion, are especially likely to have a devastating impact on coastal communities. These repercussions can include the destruction of coastal regions and infrastructure, as well as an increase in the cost of living and a reduction in the number of economic opportunities; all of these factors can lead to the decline of metropolitan areas. On the other hand, adaptation efforts can contribute to urban shrinkage by limiting opportunities for new development, which can lead to the abandonment of existing development. This is something that can be seen in the Humber Estuary, which is highly valued for its natural beauty, proximity to water, and recreation opportunities.

The ever-shifting dynamics of port-industrial areas have been influenced, in part, by the dynamics of the surrounding environment. The COVID-19 pandemic has led to an increase in suburbanization, which clearly indicates that there will be future demographic shifts. The United Kingdom is currently anticipating a possible population increase in coastal port industrial areas as a result of the increasing number of retirees and old people moving to these locations. If birth rates continue to drop and migration trends remain the same, we could see a population decline in the future. As a consequence of this, there may be a decrease in the demand for housing, services, and infrastructure, which may lead to the contraction of metropolitan areas and the requirement to modify disaster risk management.

In light of this dynamic, major objectives can be seen, such as the Levelling Up Policy, to reflect on this transformation pathway with incremental modifications of activities. The current agenda places an emphasis on the development of skills, the reduction of inequities, and the enhancement of well-being; this could enable further activities to strengthen the resilience of adaptation efforts by adding disaster risk management, such as emergency preparation.

Effective port governance is essential to strengthening climate resilience to sea level rise and to resolving the complex and linked dynamics that ports experience as a result of climate change. This is because ports face a number of different challenges simultaneously. Port governance can play an important role in ensuring that ports are able to adapt to shifting conditions and continue to provide the essential services and infrastructure on which coastal communities and economies depend. This can be accomplished by encouraging cooperation, coordination, and the effective making of decisions. The problem is made worse by the fact that different public and private entities own and administer different aspects of port infrastructure. As a result, it is difficult to coordinate efforts to make ports more resilient to the effects of climate change. Because of the haziness or dispersion of responsibility for the infrastructure in some situations, it can be challenging to obtain finance and to coordinate the efforts of those working to update and maintain the assets in question. When it comes to making towns more resistant to the effects of climate change, these regions serve multiple stakeholders, such as shipping corporations, cargo owners, fishing communities, and local inhabitants. Striking a balance between the various interests of these communities can be difficult. For instance, the implementation of measures to improve resiliency, such as the building of additional breakwaters, may offer increased protection against the rise in sea level; but these measures may also have a negative impact on fishing or shipping operations.

Coastal port-industrial areas are integrated into larger frameworks for coastal and regional development, and strengthening climate resilience to sea level rise may involve coordination with other sectors, such as transportation, housing, and tourism. This is from the standpoint of urban planning. This can be difficult to accomplish due to the fact that various actors may have varying points of view and priorities, and decision-making procedures may be complicated and fragmented.

The inability to finance the adaptation of port infrastructure as a result of a low tax base is a common problem for towns that are experiencing population loss. This is because the costs of these measures may be substantial, and the benefits may not be realised for a significant amount of time. It is possible that public finance is constrained in certain situations, and it is also possible that private actors are reluctant to engage in solutions that are either unproven or have lengthy payback periods.

The role of urban planning as a mechanism for the future

As described in Chapter 3, both urban shrinkage and resilience to rising sea levels can be addressed through the integration of spatial and urban planning into urban approaches to adaptation efforts for climate change mitigation and disaster risk management. A management strategy that strikes a healthy balance for coastal areas - should encompass several approaches. A first step to revitalise communities that are getting smaller could be to promote the reuse of buildings that are vacant or not used to their full potential. In this way, supporting land use that is compact, mixed-use, and sustainable should fulfil the social and economic needs of future population shifts and to build communities that are resilient.

Secondly, the integration of green spaces, such as parks and wetlands, into the urban fabric can help alleviate the consequences of sea-level rise and give other environmental advantages. To make structures and infrastructure in flood-prone locations more resistant to the effects of rising sea levels, preventative measures should be taken, such as floodproofing or flood mitigation. It may be necessary, in certain circumstances, to relocate vulnerable individuals and essential infrastructure to higher ground in order to guarantee their safety. In addition, the encouragement of a progressive retreat from places that are at a high danger of coastal flooding and erosion, as well as the transformation of these areas into green spaces.

Before deciding on whether to include disaster risk management in the integrated strategy, it is important to consider the governance and institutional framework of coastal port-industrial zones. This research suggests several ways to prioritise adaptation actions and inform decision-making,

including conducting comprehensive assessments of the risk of coastal flooding and rising sea levels, incorporating adaptation strategies into municipal and regional land use plans, building regulations, and other relevant legislation.

To limit exposure and susceptibility to climate-related hazards, physical and non-physical measures can be implemented such as elevating buildings, enhancing drainage systems, and improving emergency response capacities. Early warning systems can also be established and maintained to alert communities to potential dangers and assist with evacuations. Mechanisms for risk finance, such as insurance programs and disaster relief funds, can help communities recover from natural disasters more quickly and reduce the economic impact of climate-related hazards. Involving local communities in the planning and implementation of risk management is crucial for ensuring that adaptation strategies meet their needs and that they have the knowledge and skills to prepare for and respond to disasters.

It is possible for communities to become more resilient to the effects of sea-level rise and coastal flooding by incorporating these strategies into disaster risk management. This will reduce the communities' vulnerability to the risks associated with these impacts and ensure a more sustainable future.

In the majority of cases, the questions regarding the cause of urban shrinkage and the function of urban planning and policy in the UK have not been satisfactorily resolved. This uncertainty can be traced back to three different causes that were described in this dissertation. To begin, there are financial limits. Integrated urban systems can be expensive to implement, and finding appropriate funds can be a huge barrier, especially for towns and communities that have little resources. Second, in order to face the future challenges that will be brought by rising sea levels and coastal floods, political will is often required. This is because strong leadership is required to overcome resistance to change and put in place the necessary precautions. Thirdly, the implementation of some of the more technical aspects of the infrastructure, such as elevating the building or floodproofing it, can be technically difficult and calls for the knowledge of trained professionals.

The development and implementation of land use plans and policies, building standards, and other regulations that encourage resilience to sea-level rise and coastal flooding are the responsibility of governments at all levels. The advocacy for adaptation measures, the development of knowledge about the risks of sea-level rise and coastal flooding, and the engagement of communities in risk

management planning are all significant roles that non-governmental organisations and community-based organisations can play. On the other hand, in situations such as port towns, the private sector plays a more significant part in resolving shrinkage-resilience.

The necessity of coordination and collaboration is demonstrated by the proactive coordination of Bremen Ports with local, state, and federal governments, each of which has its own set of obligations and mandates. They were able to successfully demonstrate that balancing the requirement to protect essential infrastructure and continue economic activity with the need to limit exposure to sea-level rise and coastal flooding can be difficult because these goals may sometimes clash with one another.

This broad discussion has led to the development of a conceptual-methodological framework, which is referred to as the *Shrinkage-Resilience* framework in this dissertation. The purpose of this framework is to monitor the dynamic processes of urban shrinkage and resilience to sea-level rise by making use of the potential components that are outlined in Chapter 3. The major indicators included here could include the population density and growth, patterns of land use, housing stock and affordability, economic activity, infrastructure and critical facilities, as well as the extent and frequency of the consequences of coastal flooding and sea-level rise. Participating in the monitoring process could be beneficial for stakeholders such as local, state, and federal governments, as well as community organisations, academic institutions, private sector firms, and any other pertinent organisations. Monitoring could take place at set intervals, such as annually or biennially, while assessments could be carried out at more frequent intervals in reaction to noteworthy occurrences or shifts. The process of data collection and analysis could be carried out with the assistance of a wide variety of instruments and methods, such as statistical analysis, field surveys, and remote sensing. The results of the monitoring process might be reported and communicated to key stakeholders, such as local communities, decision-makers, and the general public, through the use of interactive mapping tools, regular reports, and any other applicable forms.

CHAPTER 5: Conclusions

With the launch of the UK Government's Levelling Up Programme, resolving the inequalities of left-behind towns were emphasised as a significant task. This was a challenge that has been recognised as a crucial challenge. This thesis adds on the background of places in urban decline as described by Pike et al. (2016), with a particular emphasis on older industrial locations as described by the research in the literature (Beatty and Fothergill 2019; 2021; Beatty 2020). This dissertation confirms the continuous relative population changes. This article elaborated more on the shifting patterns of urbanisation and the potential influence that this change may have on the climatic resilience of older industrial areas in England. It is believed that urban decline is something that must be planned for in coastal areas that are both developing and stable while simultaneously undergoing economic development (Aurambout et al. 2021).

Coastal Communities Fund (CCF), Coastal Revival Fund: The Coastal Revival Fund, Port Pilot Scheme, and The Future High Streets Fund are some examples of recent policies and initiatives in the United Kingdom that aim to address the impact of urban shrinkage in coastal port areas. These policies and initiatives have emerged in conjunction with the expanding discussion on Levelling Up in the UK. Of a similar vein, the territorial objectives and cohesion policy in Europe have been in effect since 2021. For coastal port-industrial areas, notably those in the North Sea, challenges of climate change adaptation and catastrophe risk management are crucial to territorial developments. This dissertation contributes to the strengthening of the discourses by expanding on urban shrinkage and resilience as having transformative pathways that are dynamic, that reinforce each other, and that will continue to exist in contexts such as coastal ports. Specifically, the dissertation focuses on how these pathways can be seen as having this transformative potential.

Socio-economic inequality presents a significant obstacle for coastal communities that are experiencing population loss and are at risk from rising sea levels. Low-income communities and communities of colour are typically disproportionately affected by sea-level rise due to their placement in flood-prone locations and lack of resources to plan and adapt. This has the effect of making existing disparities worse, as well as undermining social and economic stability, which in turn leads to increased marginalisation of communities who are already vulnerable. In order to ensure a fair and resilient response to the rising sea level in shrinking cities, addressing socioeconomic disparity is consequently essential. The ageing of the population may result in an increase in the demand for services and resources, but at the same time the tax base and workforce may decrease.

This may place an additional burden on the resources that are available to address socioeconomic disparity and rising sea levels. In addition, if changes in demographics cause variations in the racial or ethnic composition of the population, this may have an effect on the allocation of resources and political power, which could potentially exacerbate disparities that already exist.

Underscoring the necessity for a reasonable and equitable response to the effects of climate change, the problem of socio-economic inequality in declining cities is likely going to be a main focus of discussions at COP 27, which will take place in December 2023. The COVID-19 epidemic has had a tremendous impact on climate change pledges at both the national and international levels. On the one hand, the epidemic has raised attention to the urgent need for collective action to address global dynamics such as climate change. On the other hand, the pandemic has generated economic disruptions that have resulted in a halt in progress towards fulfilling targets for climate change. This is because governments are prioritising immediate economic recovery above long-term sustainability programmes.

Cities that are decreasing in size and adapting to changes in sea level, as well as measures for resolving disparities, can offer a number of helpful lessons to other regions that are experiencing similar connected processes. In order to construct just and resilient responses, collaboration, green infrastructure, community engagement, and innovative thinking are essential.

Governance and institutional context play a significant role in shaping the effectiveness and equity of adaptation efforts in shrinking cities that are exposed to sea-level rise and socio-economic inequality. These factors are expected to have a significant impact on the effectiveness of adaptation efforts.

It is absolutely necessary to have a robust political will in order to address the fundamental factors that contribute to socioeconomic disparity and to put into place efficient adaptation strategies in shrinking cities. Leadership and assistance from the government can be helpful in ensuring that required resources are not only accessible but also that policies are efficiently implemented. Institutions such as government agencies, non-profit organisations, and academic institutions play an important part in the process of formulating responses to socio-economic inequality and rising sea levels. They provide the infrastructure and resources necessary for planning and implementing effective adaptation actions.

It is possible for the regulatory environment to have an effect on the capacity of declining cities to adjust to rising sea levels and socioeconomic disparities. For instance, regulations that prohibit development in flood-prone areas can help decrease the effects of sea-level rise, while policies that encourage the development of green infrastructure can help establish communities that are better able to withstand the effects of climate change. The ability of shrinking cities to adjust to rising sea levels and socioeconomic disparity can be significantly impacted by the distribution of resources, such as funding for adaptation measures and disaster assistance.

Localism and place-based planning provide urban planners with a platform from which they can introduce a scheme for synthesising the connection between shrinkage and resilience, with a focus on building community capacities and identifying specific land use diversities to address future demographic changes. Nature-based solutions, such as renovating the waterfronts to boost health and well-being, for example the tidal floods through flood awareness through sculptural art and exhibitions, gaming competitions, strengthening infrastructure for the ageing population and adapting to new technologies.

The distribution of resources has the potential either to exacerbate existing inequality or to contribute to its reduction. Within this, the degree of public participation in decision-making processes can influence the effectiveness and equality of adaptation efforts in declining cities. When the public is involved in the decision-making process, local perspectives and needs are more likely to be taken into consideration when developing solutions, and communities are more likely to support those solutions and take part in their implementation. It is an opportunity to form cross-collaborative partnerships with institutions in the port regions and the surrounding local communities in order to create jobs and to build on flood risk management operations in areas that are undergoing fast economic upheaval.

The topic of this dissertation, which discusses the importance of resilience theories in policy for shrinking cities, drew attention to the scarcity of study that has been done in this particular field.
The Levelling Up Policy, which aims to address the economic imbalances between regions in the UK, includes missions that are directly relevant to urban shrinkage, such as investing in infrastructure, housing, and regeneration projects. The policy is intended to support economic growth and job creation in areas experiencing population decline and economic stagnation, with a focus on revitalising local communities.

Levelling Up measures include funding for infrastructure projects, supporting local businesses and entrepreneurs, providing tax incentives, grants and other financial incentives, developing policies and initiatives to attract young people and families, and supporting the economic, social and environmental development of rural areas. However, the implementation of the policy is still in its early stages, and it remains to be seen how effective it will be in addressing urban shrinkage. Critics have expressed concerns that the policy could create further displacement of local areas, particularly in older industrial areas, by attracting low-wage businesses and driving population loss.

In this thesis, a connection has been established for understanding the precise nature of future dynamics throughout coastal port-industrial zones, which plays an important role, both economically and otherwise, in the future of the UK.

5.1 Connecting urban shrinkage and resilience: *Shrinkage-Resilience*

The dissertation included two ideas that are widely used in urban literature, and it studied how those ideas may be actually used in practice by making use of strategies, methods, and frameworks to assist in decision making. The discussion centred on coastal port-industrial communities that are challenged by complex social, economic, and environmental dynamics, as well as governance and institutional challenges. This analysis was made possible because of the framework provided by ARUP's Resilience Cities Network. Additionally, the Density Change model and theoretical approaches of the current debates on the ideas contributed to the construction of the *Shrinkage-Resilience* link.

The research question for the dissertation aimed to investigate the wider shrinkage trends by comparing national and local population trends between 1991 and 2019. Additionally, the question sought to investigate the impacts on the built environment by observing changes in land use and the greenbelt areas. The cross-analysis of the results revealed that older industrial areas suffered from a lack of long-term land use diversification, which contributed to an increase in 'inequality.' This was a significant factor that had an effect on the areas' ability to remain resilient. The Covid-19 epidemic has had the greatest impact on older industrial areas and the rehabilitation process will take a significant amount of time. The inherent precariousness brought on by people's states of health and happiness will bring about economic recovery in the long term. The recent shift in national policy that devolved more authority to local governments presents an opportunity to reshape both the Levelling Up Fund and the existing Brownfield Land Release Fund. This is because both funds were previously administered by the federal government (BLRF). Due to the priority that the UK is placing on Covid recovery, the level of discussion regarding coastal resilience and floods is minimal.

5.2 A reflection on the conceptual and methodological framework

This dissertation has addressed two of the most significant difficulties in shrinking city research, namely the inability to carry out comparable case study research.

The lack of standardisation in terminologies, data gathering methods, and analytical frameworks has been cited as the cause of these problems. Therefore, the models and frameworks were expanded. The first thing that needed to be done in order to calculate urban shrinkage was to analyse the different patterns of population growth in England by using cumulative change. After that, it enhanced the Density Change model that had been developed by Wolff et al. (2016) by merging local population data with national growth trends and determining how this connected to land use change on a LAU (local authority unit) against national growth trends. For the purpose of identifying shifting urbanisation trends, it utilised various land use diversification kinds and greenbelt area. This further underlined the importance of older industrial areas, which play a unique role in the economic life of the UK. Two different conceptual frameworks were utilised when discussing resilience. The International Panel on Climate Change's demonstration of adaptive management, learning, Innovation, and leadership was used to demonstrate the components of the process of the concepts of urban shrinkage. Also demonstrated was ARUP's Cities Resilience framework, which demonstrated adaptation efforts of health and well-being, planning and finance, infrastructure and ecosystems, and leadership and strategy. The years 2013-2021 are covered in depth across the entirety of the investigation.

The advantage of the model was that it gave a possible way that may be used to examine the function that urban shrinkage plays in the patterns of urbanisation and to what degree it could potentially connect to resilience. The port-town dynamics are quite complicated, and on a local level, the dynamics of *Shrinkage-Resilience* give a basis for study that can further extend the vulnerabilities across many government levels.

The case studies that were presented barely scratched the surface when discussing the population decrease as a foregone conclusion in older industrial areas. Standardised the definition of urban shrinkage, which is defined as a decline in population of 0.15 % over a period of five years between 1990 and 2019, using primary open data collection methods, such as statistical datasets of population and land use, classification of land use, and grading and scaling climate catastrophes.

By applying the criteria outlined above, it is possible to contribute to better guiding effective policies and interventions, which are typically informed by best practices and evidence-based solutions. It can also be difficult to evaluate the effectiveness of policies and interventions over time when there is a lack of standardisation and data availability. It is important to emphasise that spatial planning cannot be used to address threats that are relevant to specific locations. For the purpose of this dissertation, a region that is prone to storm surges was chosen.

This information can be utilised to observe spatial fragmentation, land use intensity, the spatial variation of green space equity and its relationship to urbanisation processes, suburbanisation trends, reurbanization, ecosystem provision, surface runoff, the relationship between residential development and the development of green space, urban expansion, assessing spatial quality, and mapping climate action areas. The United Nations Sustainable Development Goals are a 25-year environmental strategy, and the data on land utilisation may be important to the achievement of those goals. Keeping track of environmental goals and natural capital metrics is possible with the use of this information. Monitoring and analysing projects can also be made easier for governmental and financial entities thanks to the information provided here. This information can also be used to identify potential regions in which to make investments. This analysis makes use of data derived from open sources, which are not only freely available but also quite inexpensive. Using observational field data is more time-consuming than this method.

5.3 Future recommendations for urban planning policy

Addressing inequalities to target coastal post-industrial areas as mean to address inequalities (Levelling Up Policy)

Inequality in the communities that will be impacted by sea-level rise needs to be addressed as one of the primary concerns in order to make cities more resilient to the effects of climate change and urban decline. The same holds true for other shocks, such as the Covid-19, the conflict in Ukraine, and the growing costs of energy, which have had an effect on long-term economic recovery, directly influencing the capacity to cope with and adjust to future pressures. In order to tackle the issue of inequality, we need an approach that incorporates a number of different strategies, including those of both the public and private sectors. This needs to be incorporated into the planning and policy processes that are already in place for metropolitan areas. A set of guidelines pertaining to this subject that explain how to deal with the impacts over the short, medium, and long term, as well as the uncertainties, and that combine both climate change adaptation and disaster risk management

techniques in relation to sea-level rise. Brownfield sites, abandoned properties, and other underutilised land along the coast in shrinking cities can be prioritised for use by governments as a means to improve climate resilience and create new opportunities for environmentally responsible development. These approaches can be integrated into redevelopment and restructuring strategies, as shown in the case studies and examples. Port towns need to work together with a wide range of stakeholders in order to make certain that their points of view are taken into consideration during the decision-making process and to foster a sense of local ownership of *Shrinkage-Resilience* initiatives. These stakeholders include governments, regional territories, port industries, community organisations, local businesses, emergency services, and environmental and conservationist groups. Indigenous communities with emerging science can also contribute local knowledge to restore and rewild ecosystems, wildlife, and biodiversity. A good example of a long-term institutional interaction is the problem known as the Island-Ocean Connection.

Understanding the assets of a community, such as how local knowledge may help enhance capacities, is essential for the development and implementation of climate adaptation strategies by governments, which should take into account the requirements of underprivileged communities. The Lafitte Greenway project is a comprehensive approach to engaging with disadvantaged communities, to better prepare for and adapt to the impacts through training in disaster preparedness and community-led initiatives. The detailed examples of place-based approaches, Re-blocking, looked at co-creation design in South Africa.

Investing in climate-resilient infrastructure that can survive the effects of sea-level rise and safeguard communities is another way the private sector, and port sectors in particular, may contribute to reducing inequality. This can be accomplished through the use of capital. Communities that are impacted by the negative effects of sea-level rise can benefit from the financial assistance and other resources that port companies can provide. Using Bremerhaven as an example, bremenports has been actively pushing sustainable practices through its Port Development Concept measures to drive adaptation and minimise the impacts of climate change and sea-level rise since the 2013 tidal surge.

Environmental justice as a concern for urban policy

The economic and social discrepancies that exist between the northern and southern parts of England are referred to as the "north-south divide" in England. This term is used to refer to the country as a whole. This gap is reflected in a number of different metrics, including career

possibilities, income levels, and quality of life, among others. In terms of the connection between the divide between the north and the south and environmental justice, it is frequently the case that disadvantaged communities and communities of colour, which are disproportionately impacted by environmental harm, are located in the north of England. This is because the north of England experiences a greater concentration of polluted areas. It is possible that the pollution in these towns will have a more detrimental effect on residents' health, that they will be more susceptible to the effects of climate change, and that they will have fewer resources and less political authority to address these concerns. Investing in environmental justice initiatives can be one way to help address the unequal distribution of environmental risks and benefits between northern and southern England. By promoting greater environmental equity and reducing the north-south divide, environmental justice initiatives can help address this issue.

It is necessary to make fundamental shifts in the process by which environmental laws, policies, and regulations are formulated, put into practise, and policed in order to address the possible problems that could arise from environmental justice. Among these are the following: increasing public participation; increasing transparency and accountability in decision-making processes; addressing and mitigating the disproportionate impacts of environmental hazards on communities of colour and low-income communities; and increasing public access to information about environmental hazards. The benefits of enhancing this relationship within the context of port-town partners include the ability to bring significant local knowledge and skills to the table, as well as the ability to assist in ensuring that adaptation plans are culturally and socially relevant. Port industries have the opportunity to improve their reputation and create trust with the communities and stakeholders they interact with if they adopt a proactive approach to environmental justice. This will ultimately lead to stronger relationships and increased support for future initiatives. In addition, steps should be taken to lessen the likelihood of natural disasters and other climatically-related occurrences. This can ultimately reduce the costs associated with responding to these events and minimise the number of disruptions caused to port operations.

Concerns over the availability of funds for local governments

There are still barriers that prevent local governments from gaining access to future funding for integrated approaches to disaster risk management, climate adaptation, and urban shrinkage. There is typically a lot of competition for money, both on a national and international level. This is because many governments and organisations are trying to secure funds for programmes that are quite

similar to one another. Cities on the decline It is possible that local authorities will have restricted access to funding sources, such as grants or loans, in order to support their initiatives. Additionally, it is possible that local authorities will lack the technical and administrative capacity to prepare competitive proposals for funding, which will result in missed opportunities for funding.
Local authorities have a variety of options available to them in order to address these issues. Some of these options include increasing their capacity, forming partnerships, advocating for increased investment, and maximising the use of resources that are already available in order to secure funding for their initiatives. Public-Private Partnerships (PPPs), Community-Based Funds, Green Bonds, and Crowdfunding are some examples. North East Lincolnshire may wish to explore the possibility of forming a partnership with Bremerhaven in order to gain access to European funds such as the European Regional Development Fund (ERDF) and the European Social Fund (ESF). These funds could be used to support initiatives relating to the management of disaster risks, the adaptation of communities to changing climates, and urban shrinkage. The new offer of land from the Brownfield Fund made by the UK government for the redevelopment of brownfield properties provides an opportunity to "build back better" by establishing boundaries for its grants.

Planning at the local level to improve resilience to the effects of climate change and disaster risk management in the private sector

The need for integrated solutions that take into account urban shrinkage as well as resilience may become even more urgent. Local authorities face challenges in a number of areas: rising levels of inequality, issues of environmental justice and funding for new initiatives. Further research is needed on all these topics. This dissertation however focuses on issues concerning climate change and resilience.

The Localism Act of 2011 can provide a framework for local governments in port regions to be more proactive in disaster risk management and climate adaptation, collaborating with their communities and other stakeholders to improve resilience and produce better results. This would be possible if the local governments had access to the framework. In a similar manner, the concept of decentralised decision-making and the devolution of power to local communities is established in the Constitution of Germany (the "Basic Law").

In a similar manner, the concept of decentralised decision-making and the devolution of power to local communities is established in the Constitution of Germany (the "Basic Law"). The German Federalism Reform Act of 2006 (Föderalismusreformgesetz) was also passed in order to further

decentralised decision-making in Germany and empower local communities to play a more active role in disaster risk management and climate adaptation. Both of these goals were accomplished by further decentralising decision-making in Germany. The act transferred jurisdiction from the federal government to the 16 states (Lander) and their respective municipal administrations, giving these entities an increased amount of responsibility for putting these policies and programmes into action.

The significance of involving the community in the planning and execution of port development, as well as giving local residents the ability to have a voice in the matter. This can help ensure that the requirements of port communities as well as their points of view are taken into account during the process of formulating these strategies. Increased collaboration and partnership building, for example, among port sectors, local governments, communities, and enterprises can lead to more effective and sustainable solutions. In the not too distant future, accurate projections of how the climate will change in coastal areas will become increasingly important.

Port businesses have the opportunity to embark on a transformative journey of incremental changes in adaptive management, learning, innovation, and leadership thanks to networks such as the Resilience Cities Network. These kinds of changes all contribute to the development of more sustainable and resilient coastal port-industrial areas.

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Appendix I: Key concepts

Adaptive management
Adaptive management is an organised strategy to improve management policies and practises by anticipating changes in external situations. It is characterised as "adaptive management."

Environmental Justice
The concept of environmental justice is based on the idea that all individuals and communities have a right to equal protection under environmental laws and regulations, and that these laws and regulations must be enforced in an equal manner.

Social equity
The term "social equality" refers to a situation in which all groups have access to the resources and opportunities necessary to improve the quality of their lives, and in which variations in life outcomes cannot be anticipated based on factors such as race or income.

Changing urbanisation patterns
The term "changing urbanisation patterns" refers to the development of urban areas over the course of time. This development includes shifts in the size, growth, and spatial distribution of cities, in addition to shifts in the socioeconomic and demographic characteristics of urban populations.

Climate catastrophes
Extreme weather occurrences or natural disasters are referred to as climate catastrophes when they are caused or made worse because of climate change.

Climate change adaptation
The term "climate change adaptation" refers to the process of responding to the effects of ongoing or predicted climate change as well as minimising the effects of these changes. It involves reducing the vulnerability of communities, ecosystems, and economies to the impacts of a changing climate and increasing their capacity to cope with and recover from extreme weather events and other climate-related disruptions. Additionally, it involves reducing the vulnerability of communities, ecosystems, and economies to the impacts of a changing climate.

Climate resilience
The capacity of a system, community, or civilization to plan for, endure, and recover from the effects of extreme weather events, climate hazards, or other climate-related disturbances is referred to as climate resilience. It entails making these systems less susceptible to the effects of climate change, strengthening their ability to absorb or adapt to those effects, and improving their capability to quickly recover from disruptions when they do occur.

The use of feedback loops
According to the idea of resilience, feedback loops are the mechanisms through which changes in one element of a system influence other sections of the system, leading to further changes in the system.

Green infrastructure
A network of urban and rural green and blue spaces as well as other natural features that are capable of bringing a wide range of environmental, economic, health, and welfare advantages to nature, the climate, local and larger communities, and prosperity is referred to as a green and blue network. The

use of porous pavements, rain gardens, and green roofs to assist in the absorption of stormwater and its management.

Inequality
The unequal distribution of resources, opportunities, or outcomes among various individuals, groups, or populations is what we mean when we talk about inequality. It can relate to discrepancies in access to healthcare, housing, and other fundamental needs, as well as differences in income and wealth disparity, educational inequality, and wealth inequality.

Innovation
Innovation should involve both gradual and revolutionary social and technological developments. Innovation is defined as the process of making non-material changes relating to knowledge, communication, or intelligence.

Learning
Learning can be seen as strengthening a society's potential for adaptation in the here and now rather than concentrating simply on adaptation in the long term.

Leadership
Leadership can be defined as the processes that are shaped by individuals, societies, and communities to take ownership to encourage change and transformation.

Nature-based solutions
actions to maintain, sustainably manage, and restore natural and modified ecosystems that effectively and adaptively address societal restrictions while simultaneously offering benefits to human wellbeing and biodiversity are referred to as "ecosystem services." For instance, rehabilitating and creating new wetland habitats in order to lessen the occurrence of flooding, enhance the amount of biodiversity, and improve human health.

Resilience
The capacity of a system to anticipate, absorb, accommodate, and recover from the effects of a potentially hazardous event in a timely and efficient manner, including through the preservation, restoration, or improvement of its essential basic structures and services, is referred to as resilience. Resilience can be defined as the ability of a system to recover from the effects of a potential hazardous event in a timely and efficient.

Shrinking city
A city that is shrinking is an urban area that, on the one hand, has experienced a population loss in large parts of it (for at least 5 years, more than 0.15% annually), and, on the other hand, is undergoing economic transformation while exhibiting some symptoms of a structural crisis. This definition describes a city that is shrinking.... is a multifaceted process with multidimensional consequences that have social, demographic, environmental, and spatial aspects to it respectively.

Strategy
A strategy is an organised set of thoughts on a certain issue or topics. It addresses the most important problems and aids with the active stakeholders so that they can concentrate on particular duties and procedures. They provide standards to gain perspective in particular situations, to simplify behaviour, and to encourage consistency. Additionally, they establish priorities and provide explanations for each, where appropriate.

Sea-level rise
The term "sea level rise" refers to the process by which the average level of the world's oceans is gradually rising. This is happening primarily as a result of the seawater's thermal expansion and the melting of ice sheets and glaciers on land. This phenomenon, which is caused by the warming of the planet as a whole, has a number of adverse effects, including the flooding of coastal areas, an increase in erosion, and the destruction of coastal habitats. Especially in low-lying places, the rise in sea level poses substantial dangers to the human communities, ecosystems, and infrastructure that are located there.

Storm surge
A transient rise in sea level induced by a storm that is moving inland and has onshore winds is known as a storm surge. Storm surges, which are caused by an increase in water level as a result of wind surges and strong waves, are more likely to occur in coastal regions during the spring and autumn seasons.

Sustainability
The ability to maintain and conserve natural and human systems over time in such a way that they continue to support human well-being and growth in the here and now as well as in the future is what we mean when we talk about sustainability.

Land use change
Land use change is the process through which natural ecosystems and landscapes are converted into man-made or otherwise altered habitats, such as urban areas, agricultural fields, or forestry plantations.

Urban approaches
An urban approach is a manner of thinking about and going about one's work that places an emphasis on the unique requirements, difficulties, and potential benefits of urban environments.

Vulnerability
The degree to which a system, community, or individual is vulnerable to injury or damage, particularly in the face of stresses or bad events, is referred to as the vulnerability of the system, community, or individual. It comprises the "ability to cope and adapt" to external shocks and stresses, as well as "susceptibility" and "exposure" to those things.

Appendix II: List of Figures, Tables and Photos

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Appendix III: Key Literature operationalising urban shrinkage

Hartt, M. (2021), 'The Elasticity of Shrinking Cities: An Analysis of Indicators', The Professional Geographer, 0 (0), 1–10.	Cities that experience population loss greater than or equal to the threshold value over a given time period are considered to be shrinking (2020)
Martinez-Fernandez, C., T. Weyman, S. Fol, I. Audirac, E. Cunningham-Sabot, T. Wiechmann and H. Yahagi (2016), 'Shrinking cities in Australia, Japan, Europe and the USA: From a global process to local policy responses', Progress in Planning, 105, 1–48.	Urban areas that have experienced Population Loss, economic downturn, employment decline and social problems as symptoms of a structural crisis … is a multidimensional phenomenon that is strongly anchored in the Globalisation process (2016)
Pike, A., D. MacKinnon, M. Coombes, T. Champion, D. Bradley, A. Cumbers, L. Robson and C. Wymer (2016), Uneven Growth - Tackling City Decline, York, UK: Joseph Rowntree Foundation	Primary urban areas are defined as urban areas with at least 125,000 residents in 2001. The definition here extends to capture slightly smaller urban areas by reducing the PU population minimum to 100,000 (2016)
Martinez-Fernandez, C., Ivonne Audirac, Emmanuelle Cunningham-Sabot, and Sylvie. Fol. 2012a. "Shrinking Cities: Urban Challenges of Globalization." International Journal of Urban and Regional Research 36 (2): 213–25. doi:10.1111/j.1468-2427.2011.01092.x.	[Shrinking city is] 'a functional urban area with a minimum population of 5,000 residents in its core city (or a certain district in it) that has faced a remarkable population loss at least for 5 years (in recent years or in some former period) and/or is undergoing a long term or episodic economic, social or cultural transformation that cause symptoms of a structural crisis
Wiechmann, Thorsten. 2006. Coping with City Shrinkage: A Global Issue: Types of shrinking cities: Introductive Notes. Dresden/Germany	A densely populated urban area with a minimum population of 10,000 residents that has faced a population loss in large parts of it for more than two years and is under- going economic transformations with some symptoms of a structural crisis (2006)

Appendix IV: Key Policies identified for Shrinkage-Resilience approaches

International Level	
United Kingdom (England)	**Germany**
UNFCCC	UNFCCC
Paris Agreement	Paris Agreement
Sendai Framework	Sendai Framework
Sustainable Development Goals	Sustainable Development Goals
European Level	
EU Flood Directive	EU Flood Directive
National level/ Federal Level	
United Kingdom (England)	**Germany**
National Planning Policy Framework 2018	National Urban, Development Policy 2000 (*Nationale Stadtentwicklungspolitik*)
National Flood and Coastal Erosion Risk Management Strategy	
Net Zero Strategy 2021	
Localism Act 2011	Federal Water Act
Infrastructure Act 2015	
Water Act 2014	
Climate Change Act 2008	
Regional/ State/ Territorial level (Länder)	
United Kingdom (England)	**Germany**
Humber Flood Risk Management Strategy 2008	**Urban Development Report 2016 *(Bundesregierung*)**
The Yorkshire and Humber Plan: Regional Spatial Strategy to 2026	**Climate Change Adaptation Strategy Bremen Bremerhaven 2018**

	General Plan for Coastal Protection Part 1 (GPK I) ***Generalplan Küstenschutzes Teil 1 (GPK I)***
	Bremen Water Act
Local Level	
United Kingdom (England) Counties and Boroughs	Germany Counties & Municipalities (*Landkreise*)
Economic Strategy 2021	Flächennutzungsplan 2006
Grimsby Town Centre Master Plan Framework 2020	
North East Lincolnshire Local Plan (2013-2032) 2018	
North East Lincolnshire Local Flood Risk Management Strategy 2015	
Infrastructure Development Plan	
North East Lincolnshire Local Area Plan 2003	
Humberstone, New Waltham and Waltham District Plan September 1982	
Grimsby and Ancholme Catchment Flood Management Plan	
Low Carbon Future Road Map by 2023	

Key UK Port Policies	Key Germany Port Policies
Transport Act 1947	Electricity Feed-in-Act (StrEG) (1991)
Transport Act 1962	Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz) or 'RESA' in 2000
Harbours Act 1964	Federal Offshore Wind Strategy 2002
Harbour Revision Orders (HRO)	National Strategy for German Ports 2016
Transport Act 1981	Energiwende or 'energy revolution (ongoing)
Ports Act 1991	Guidelines on State Aid for Environmental Protection and Energy
Modern Ports: A UK Policy 2000	Climate Action Plan 2050
Climate Change Act 2008	Act to Improve Preventive Flood Control 2005
Low Carbon Transition Plan 2009	
UK Offshore Energy Strategic Environmental Assessment 2009	
Flood and Water Management Act 2010	
National Policy Statements for Ports 2012	
Maritime Growth Study 2013	
Offshore Wind Industrial Strategy 2012	
UK National Ports Strategy 2018	
Port Infrastructure Resilience 2018	
National Flood and Coastal Erosion Risk Management Strategy 2020	
Transport Act 1947	
Transport Act 1962	

Strategic objectives in 1982	Strategic objectives in 2003	Strategic objectives in 2018
Housing and Population	Maintain an adequate supply of Housing	Population
Movement	Provision of affordable housing to meet local needs	Climate change
Employment	Maintaining an adequate supply of land for employment and for meeting new trends in employment	Economy
Shopping	Encourage the reuse of of derelict and contaminated sites	Housing
Open Space and Recreation	Reduce the amount of off street car parking and encourage the use of alternative forms of transport	Social and Health inequality
Tourism	Maintain a strong divergent retail market	Built, natural and historical environment
Education and Community Facilities	Maintain a range of recreation facilities to meet local needs	Transport
Environment	Maintain a strong and divergent range of tourist attractions	Town centre and local facilities
Services	Maintain and enhance the condition and vitality of Conservation Areas and Listed Buildings	Design
	Maintain and enhance the areas natural environment, species, scarce and finite resources	Minerals and Waste
	Maintain an adequate and steady supply of aggregates in accordance with national and regional guidance	

Appendix V: Stakeholders

Stakeholders contacted in England

Name of stakeholder	Organisation	Area of focus	Outcome
Dr Vlad Mykhnenko,	University of Oxford Studies	Studies trends of urban decline in the UK, urban resilience	Conceptualisation of shrinkage in the UK
Andy Pike	University of Liverpool	Studies trends urban decline in the UK. Local, regional, and urban development, policy, and governance. Current project: Beyond 'left behind places': understanding demographic and socio-economic change in peripheral regions in France, Germany and the UK	Outcome: Provided source of data on historical growth funding schemes
Anonymous	Savills (UK)	Real estate	Outcome: Provided an overview of land use process to build in a flood risk zone Sequential Test process
Dr Elena Kuvshinova	Flood Innovation Centre	Support small to medium businesses to develop new products and services to support with flood resilience measures	Outcome: case study data on flood risk measures
Lauren Davidson	Yorkshire Flood	Property Flood Resilience -	Outcome: Outline of new strategies -

	Resilience	works with residents, SME's to install flood protection infrastructure	provided text on Yorkshire Flood Resilience
Dr Lewis Evans	Northumberland County Council	Regeneration of older port cities. Expert in Hull in England and Cuxhaven Ports	Outcome: Provided a list of documents/policies related to the historical development of Port Governance system in UK and Germany
Sam Horton	Humberside Fire and Rescue Service	Watch Manager in Grimsby, responsible for the operational practitioner	Outcome: Discussed insights and experiences of the 2013 Flood event. In addition to the 2019 floods. Provided further contact details for strategic planners in the organisation.

Stakeholders contacted in Germany

Name of stakeholder	Organisation	Area of focus	Outcome
Annegret Haase	Helmholtz (UFZ)	Research scientist	Outcome: Conceptualisation of shrinkage processes
Dagmar Haase	Helmholtz (UFZ)	Research scientist	Outcome: Overview on methodologies, and tools used to study/measure shrinkage
Manuel Wolf	Helmholtz (UFZ)	Research scientist	Outcome: Suggested database to retrieve data on local authorities in Germany
Andreas Krause	Senator for Climate Protection, Environment, Mobility, Urban Development, and Housing	Engineer	Outcome: Site visit of flood protection infrastructure, an overview of the complex urban planning processes relating to the environmental risks and current decision making between Bremen-Bremerhaven
Laura Baumann	Magistrate of the City of Bremerhaven City Planning Office	Spatial Planner	Outcome: Gave an overview of projects to revitalise/regrow the area, overview of governance structures in Bremerhaven

Alexander Schulz	Building regulation office	Building control officer	Outcome: Data on the number of building applications decided upon between 2010-2020
Oliver Bretag	Green offshore terminal	Project manager	Outcome: Information on the current plans to protect the port from flood risk

Lebenslauf

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Scientific and Professional Experience

- 04/2023 till present - Consultant at Varsity Town Planning, United Kingdom
- 12/ 2022 till present - Associate at Cambridge Architectural Research, United Kingdom
- 07/2019 - 07/2022 - Early Stage Researcher/ Marie Sklowska- Curie Fellow in the RE-CITY ITN Reviving Shrinking Cities Project; Department of International Planning systems at the University of Kaiserslautern-Landau RPTU, Germany
- 02/2022 - Guest Workshop Facilitator at the University of Cambridge on 'cognitive behaviour in decision making', United Kingdom
- 01/2018 - 03/2019 - Professional Town Planner at City Of Cape Town Municipality, South Africa
- 03/2016 - 09/2017 - Town Planning Consultant, Headland Town Planners, South Africa
- 09/2014 - 11/2016 - Masters in Spatial Planning at the University of Dortmund, Germany
- 01/2011 - 12/2012 - Bachelors Degree in Town and Regional Planning at the Cape Peninsula University of Technology, South Africa
- 01/2007 to 12/2010 - National Diploma in Town and Regional Planning at the Cape Peninsula University of Technology, South Africa

Teaching

- 23/11/2023 and 24/11/2021 - Technical University of Kaiserslautern (Online Guest lecture). International Planning Systems
- 2022 - Technical University of Kaiserslautern (Online MOOC Course). Urban approaches to address shrinkage: An opportunity to improve flood resilience
- 07/2019 to 11/2019 - Cape Peninsula University of Technology (Part Time Guest Lecture). Planning Design Course. Town and Regional Planning, South Africa

Participation in Conferences

- 03/2022 - Shrinking cities in the longer term: Changing patterns of urbanisation and resilience to floods' ,RECITY International Training Network final conference ‘Shrinking Cities Revived!’, Kaiserslautern, Germany, March 16-18. 2022
- 05/2021 - Invited presentation, ‘Approaches to urban shrinkage while improving flood resilience: a dilemma? ’. Cambridge Architectural Research forum, Cambridge, United Kingdom, May 27. 2021
- 09/2019 - Shrinking cities: Changing patterns of urbanisation and resilience following catastrophic events' LAND4FLOOD – PhD Workshop Innovative and Successfully Implemented Strategies for Achieving Resilience in Flood Risk Management with a Special Focus on Private and Public Property Flood Resilience. Germany, 09-11 September 2019
- 09/2019 - 'Changing patterns of urbanisation and resilience - Comparative case study between the UK and Germany'. CITTA 12th Annual Conference on Planning Research, Porto, Portugal, September 19-20. 2019

Publications

- Mackay, F., S. Platt and F. Lopane (2022), ‘Regrowth challenges of English cities in the context of flood risk. A discussion on flood resilience and regrowth in Hull, United Kingdom , in K. Pallagst, M. Bontje, E. Cunningham Sabot and R Fleschurz (eds).Handbook on Shrinking Cities, Edward Elgar Inc

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