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Exploring Port City Development through the Lens of Boundaries and Flows

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Editorial

Port City Porosity: Boundaries, Flows, and Territories

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Abstract
The introduction to this thematic issue on port city porosity sets the stage for the study of port city territories as a particular type of space, located at the edge of land and sea, built, often over centuries, to facilitate the transfer of goods, people, and ideas. It argues that the concept of porosity can help conceptualize the ways in which the spaces and institutions of ports, cities, and neighboring areas intersect. It expands on the well-established notion of the interface and more recent reflections on the port city threshold by arguing for a conceptualization of the port cityscape as a continuous network of port-related spaces and practices. The introduction places this reflection in time, exploring the ways in which boundaries have shifted and opened up; it also provides a brief overview of the 14 contributions to the thematic issue. The contributions are organized in three groups: (1) exploring long-term approaches to porosity in port city territories; (2) mapping and conceptualizing port city porosity on the sea side and on the land side; and (3) measuring, designing, and rethinking porosity in port city territories. The thematic issue opens questions for further research such as: Does the degree of porosity between port and city areas and the presence of maritime pockets in the city and the territory lead to greater resilience of port city activities? Does the existence of porous borders between port and city allow for easier transitions?

Keywords
borders; porosity; port cities; port cityscape; territories

Issue
This editorial is part of the issue “Planning for Porosity: Exploring Port City Development through the Lens of Boundaries and Flows” edited by Carola Hein (Delft University of Technology, The Netherlands).

1. Introduction

Port city territories have been built and administrated to facilitate flows of goods, people, and ideas between a maritime foreland and what is often a transnational hinterland. These flows depend on carefully curated tangible and intangible borders to guide the formation of spaces and social patterns that enable specific kinds of movement. These borders are often multilayered, as they permit passage of some elements while excluding others. Port city territories also serve as hubs for maritime activities, retaining port-related functions, knowledge, and imaginaries. They function like a porous sponge, selectively retaining, excluding, and dispensing. Planners delineate coasts and riversides to separate the spaces between water and land. Their interventions determine whether areas are dedicated to port, urban, or rural functions. Governance, policy-making, and planning create and depend on tangible borders like security fences, and intangible boundaries, like legal systems, and land use patterns. The porosity of port city territories, the degree to which they facilitate flows and retain maritime activities, is thus at least partly the result of planning.

Port city territories have long attracted people and businesses that benefit from access to both sea and hinterland. These parties have accepted the negative externalities of port cities, such as the pollution of air, water, and land. Port functions are not limited to areas dedicated to port functions: ports rely on nearby cities and territories for their labor force, for the location of port-related companies and institutions, and for the social and cultural spaces needed for employees and their families. The maritime capital rankings that measure soft and hard infrastructure, but also components, such as access to the talent and services that are key

to maritime businesses, give a sense of the importance of cities for ports (Menon, 2020). Contemporary urgencies open new possibilities for planning in port and city areas, for example, through the (re)creation of multifunctional spaces where port and city can mix, through the exploration of port influence throughout the territory—the port cityscape (Hein, 2019)—and by understanding how historical transformations have shaped current form and function. At a time of climate change, sea-level rise, and shifting coastlines, it is especially important to understand how porosity or its absence affects port city functioning over time.

This thematic issue's contributions conceptualize the role of borders in port cities through concrete case studies. The issue brings together diverse approaches to port, city, and territory through the lens of porosity. It explores the role of physical spaces and urban morphology from the waterfront to the region, with a focus on flows and borders and the institutional ways in which flows of goods, people, and ideas cross and populate port city territories. It examines the role of institutional settings and legal tools, exploring how new technologies, political and economic frameworks, and new safety regulations have reshaped the ways that port city territories guide flows and attract maritime activities. This introduction sets the stage by briefly exploring the concept of porosity, emphasizing the need for a spatial approach to understanding port city territories. It presents those territories as an interconnected port cityscape with particular spatial, institutional, social, and cultural challenges, before providing an overview and drawing connections between the contributions.

2. Conceptualizing Porosity

Porosity is a scientific term; it is also one that has been used in the context of urban planning. Encyclopedia Britannica states that "porosity reflects the capacity of soil to hold air and water" (Sposito, n.d.). This is directly linked to permeability, which describes the "ease of transport of fluids and their dissolved components" (Sposito, n.d.). The idea of porosity as openings in a solid space has appealed to urban scholars and planners. The concept of urban porosity was first used by Walter Benjamin in an essay with Asja Lacis in 1925 on Naples as a labyrinthic city with an underground filled with voids, a city where all the spaces are open to new interpretations and unexpected constellations, and where private activities are constantly intertwined with public ones (Benjamin & Lacis, 1991).

Several scholars of the built environment have built on Benjamin and Lacis's impression of the porosity of Naples. The Greek architectural theorist Stavros Stavrides (2007, p. 174) has reflected on heterotopias and porosity, stating:

> Urban porosity may be the result of such practices that perforate a secluding perimeter, providing us with an alternative model to the modern city of urban enclaves. A city of thresholds could thus represent the spatiality of a public culture of mutually aware, interdependent, and involved identities.

He underscores the importance in discussions of porosity of both space and time. The American sociologist Richard Sennett, in academic texts and popular press articles, has argued for open and porous cities (Sennett, 2010, 2015). Other authors have also reflected on porosity as a foundation for design (e.g., Wolfrum, 2018; Wolfrum & Janson, 2019).

Many urban designers share the same viewpoint as the academics. For nearly two decades, Paola Viganò has been reflecting on the concept as a tool for both the analysis of urban space and its design (Viganò, 2018). Dutch urban planning scholars Igor Moreno Pessoa, Tuna Tasan-Kok, and Willem Korthals Altes and colleagues summarize the multiple approaches to porosity, inquiring into its usefulness in terms of urban resilience in the context of Brazil, and they have created a porosity index (Pessoa et al., 2015). They propose that porous areas/voids such as "disconnected neighborhoods, brownfield areas and leftover places… can be captured by the metaphor of urban porosity" and "that these areas can provide capacity for flexibility, fluidity and absorption in major cities, but that they can also be a source of fragmentation, disconnection and isolation between different social groups….Porosity may thus have both positive and negative influences on the resilience of urban systems" (Pessoa et al., 2015, p. 47). Designers have followed up on these approaches: for example, a team around Winy Maas investigates porosity in architectural design (Maas et al., 2018). Cristian Moreno, architect of the city-port of Valparaíso, inspired by planning in Palermo, has applied the concept of the water edge (Figure 1).

The focus on porosity in urban studies can be seen as a way to overcome the modernist separation of functions and the introduction of hard boundaries between specific spaces that have led to the increase of traffic and socio-economic segregation. Yet, so far, the existing literature does not explore the theme of porosity in light of big industrial entities such as ports or evolving port city territories. This thematic issue argues that the concept of porosity can aid understanding of how sea and land, and port, city, and hinterland have interconnected over time. It asks whether the size, tightness, and durability of maritime pores and their permeability in a port city territory can predict adaptability in times of transition. Does the degree of porosity, the number of openings in dykes, the presence of maritime pockets in the city, and the territory lead to greater resilience of port city activities? Does the existence of porous borders allow for easier transitions?

Port investments often occur over long periods of time, leading to lock-in effects, to use path dependence terminology (Hein & Schubert, 2021). Understanding

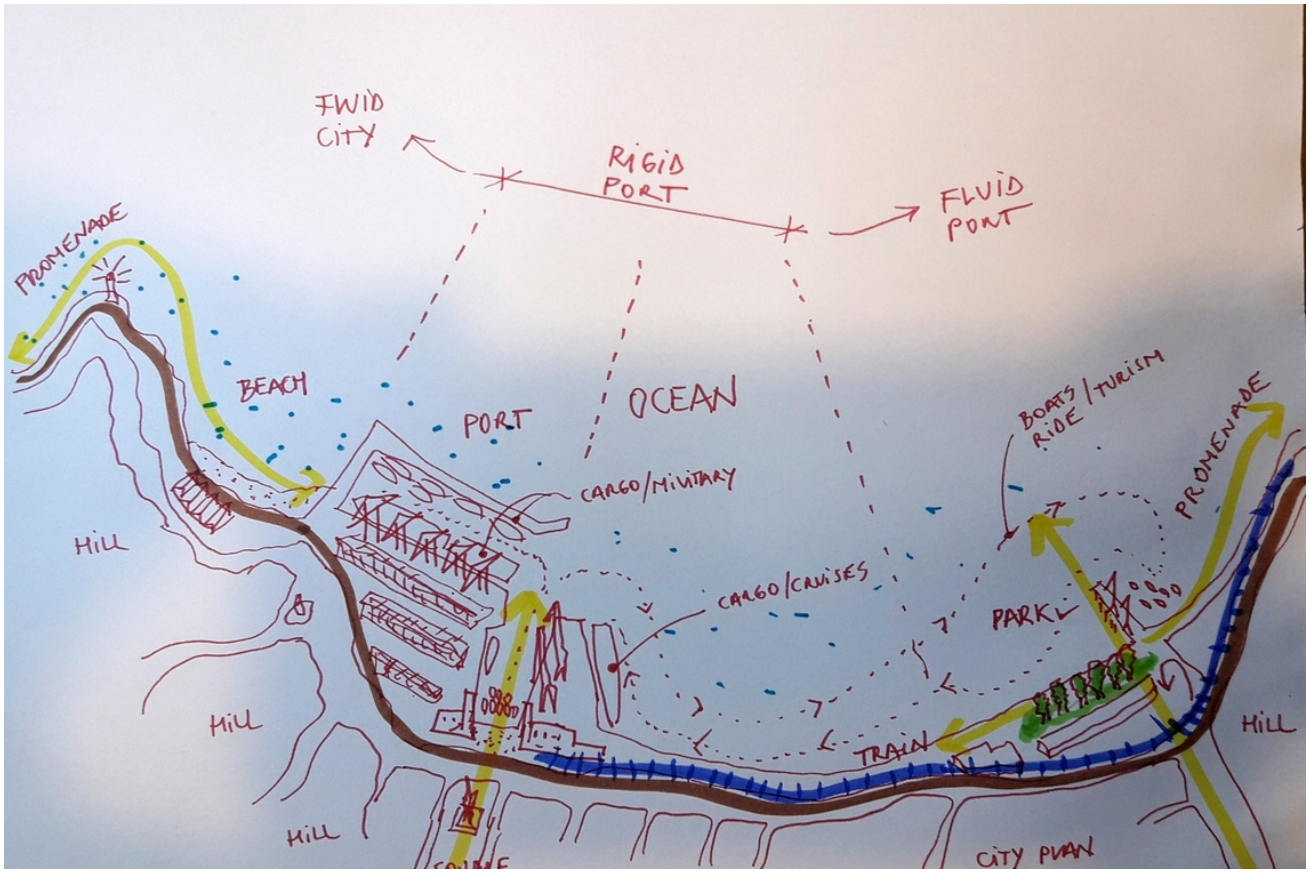

Figure 1. Mental map of the port city of Valparaíso by Cristian Moreno, made for the online course "(Re)Imagining Port Cities." Source: Courtesy of Cristian Moreno.

long-term developments and histories is key to transforming spaces and institutions and ultimately designing future port city territories. As specific areas have become dedicated to port functions, they are locked in and hard to change. Large warehousing, petroleum storage, and industrial areas do not allow easy integration with other functions. Designing and planning smaller spaces for the intermingling of maritime functions can improve the interconnectedness of port and city, and facilitate much needed transitions in line with energy and other concerns. In fact, smaller port cities may be places where change occurs first. Are smaller port cities also smarter port cities?

3. Porosity and Conceptions of Port City Territory: Interface, Threshold, and Port Cityscape

The concept of porosity can help conceptualize the ways in which port, city, and territory interact. It can also help expand on the well-established notion of the interface. The notion of the port-city interface has been helpful in understanding spaces such as urban waterfronts, where port and city interests overlap and often conflict (Daamen & Louw, 2016; Daamen & Vries, 2013; Hayuth, 1982; Hein & van Mil, 2020; Hesse, 2018; Hoyle, 1989; Hoyle et al., 1988). It has been less helpful in understanding the spatial, social, and cultural implications of port city territories in their complexity. Literature on porosity also relates to the topic of thresholds, a key element in the contributions of Beatrice Moretti (2019, 2020) This threshold character is closely linked to the concept of porosity and requires rethinking the boundaries between and the planning of ports and cities.

In port city territories, port and city engage in multiple ways, not just along a single thin line, a clearly visible fence. In fact, the border between port and city has openings, and many elements cut across air and water. Port city functions form networks in space, interlinked by physical infrastructures and administrative, financial, and other chains of power. These networks change over time in scale and size and even usage. We need a clearer understanding of how these networks evolve, how boundaries are pushed and porosity is transformed over time and through intangible tools such as those of planning, polity, and law, but also as a result of cultural transformations and imaginaries.

The port cityscape is discontinuous and not clearly bounded. Most of the current literature, however, considers the port a clearly bounded entity. This perception tends to ignore the many ways ports use spaces on sea and land. Many contemporary ports are surrounded by high fences and controlled by special institutions, but their spatial footprint—through infrastructure, warehousing, and logistics networks—as well as their

environmental impact—for example, air, water, soil, and noise pollution—extends far beyond the port's demarcated borders and into neighboring cities and regions. The result is a port cityscape, a networked space that extends from land to sea, including ships and pipelines, port facilities and warehouses, industrial and logistic structures, headquarters and retail buildings, but also housing and leisure facilities. This port cityscape is administrated, planned, imagined, and represented by multiple institutions and rarely as part of a shared vision. The separate consideration and planning of all these entities leads to a segregated planning approach to waterfront revitalization or river and coastline development, even though water connects all of these spaces. The segregation of planning is reflected in how these sites are represented: Port authorities will write and depict the port city and the water in a different way than a city or regional institution (Hein, 2016; Figure 2).

Port city territories consist of a global foreland and a deep hinterland. The collective governance of these extensive landscapes and the logistics of the multiple flows and the multi-layered use of space in these regions require careful analysis and development. The spaces of port functions—and spaces related to port functions—are thus entangled with and sometimes shared with those the city uses. This new territorial and institutional scale must be theorized and studied in a methodological manner with a focus on governance systems that can contribute to a redefinition of port-city-region relationships. Such a reconceptualization is urgently needed at a time when port city regions around the world face a number of complex problems that require integrated spatial and social planning and design measures for use of this limited space. Port and city (and territory) must be able to evolve jointly. Buy-in from local stakeholders is necessary to facilitate the construction of hard infrastructures necessary for the functioning of the port, for acceptance of the side effects of ports (noise, security, emissions), but also to develop the skillsets and technologies needed for the port and port city of the future. Each city is different in terms of geography, spatial form and function, history and culture; the way a city's government responds will be linked to long-term path dependencies that impact future development.

4. Porosity in Time: Pushing Boundaries, Opening Boundaries

Historically, port and city have been intimately intertwined in many cities around the world. Medieval cities such as Amsterdam, Venice, and Hamburg stand as examples. Images by Braun and Hogenberg from *Civitates Orbis Terrarum* (1572–1612) show the number of ships in the heart of cities at the time and the unique typology of buildings that are accessible on one side by water and the other by land (Figure 3). Ships could unload directly into the warehouses on the waterside, administration is located close to the street side of the house, and living took place above and between these maritime functions. The house itself has historically been a porous border for port-related activities. The surrounding city hosted numerous spaces where maritime activities occurred and where people from different trades mingled. Among these urban cells were also spaces of migration and temporary use—Chinatowns, red light districts, sailor towns—that allowed for rapid transitions. Stock exchanges, but also coffee shops where traders discussed the fate of ships and shipping and where workers had their breaks are part of such a porous space. Market places provided room for the exchange and landing of goods.

With industrialization, the size of the maritime pores changed. Ports emerged as separate, ever larger units, with fewer and more select openings toward their

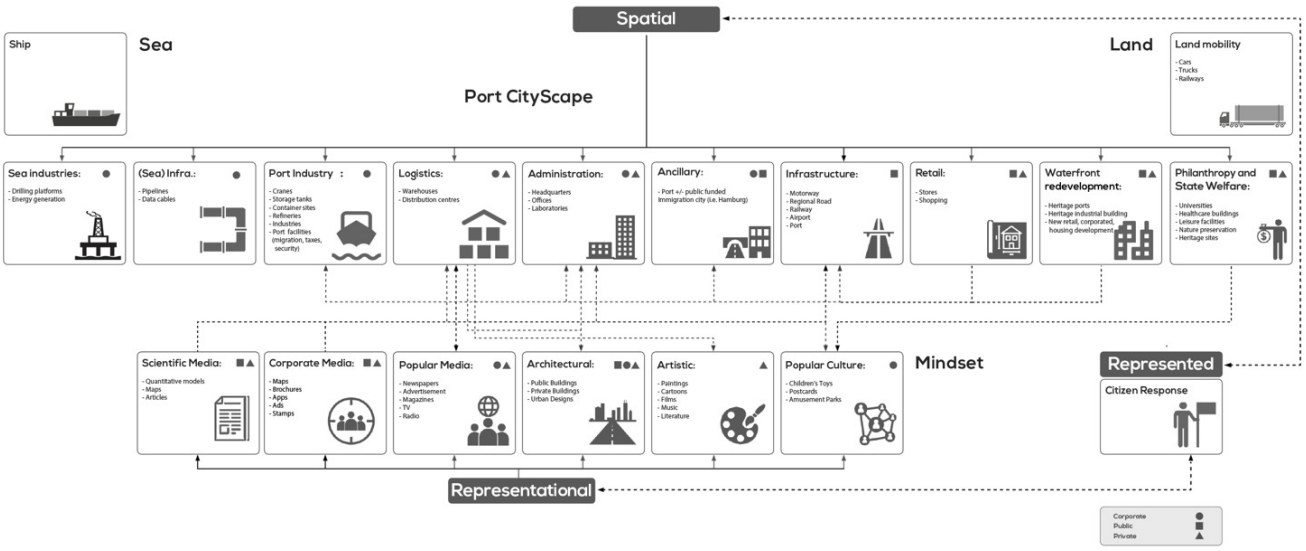

Figure 2. Port cityscape. Source: Carola Hein.

Figure 3. Map of Venice, 1572, by Georg Braun and Frans Hogenberg. Source: Hogenberg (1572).

environment. Safeguarded spaces of transshipment and warehousing facilitated the throughput of goods, rather than the port's integration into the nearby territory. First warehouse districts, then office districts, and occasionally dedicated housing areas became homes for maritime-related functions. Administrative districts such as the Kontorhaus district in Hamburg are icons of these growing mono-functional pores in the tissue of the city. Gates to port districts and some other multifunctional public places have continued to serve as sites of exchange.

With containerization, this maritime intermingling in public spaces disappeared; in fact, the spaces themselves often disappeared. Ports became largely independent entities built for the speedy transmission and refining of goods, and for the transport of people. Cities transformed abandoned and formerly fenced-off port areas into urban waterfronts, creating new openings. Meanwhile, cities focused on addressing local economic, social, and other issues, often paying little attention to the needs and interests of the modern port nearby. As ports battled to rise in the rankings of better and faster, urban maritime activities largely disappeared, or became very specialized and largely invisible. Yet, the attention to the role and ranking of leading maritime capitals (Menon, 2020) suggests a growing need for port city intersection and collaboration. To create more permeability for transmission to the hinterland, we have created larger cells and higher flows in the port area, while limiting the permeability and exchange with the surrounding city and territory. This has meant the port has less value for the city and decreased resilience.

At a time of sea-level rise, designers and politicians are arguing for sponge cities (e.g., Zevenbergen et al., 2018)—cities and territories that can store water in the soil to avoid flooding. Cities around the world are developing new architectural structures that respond to rising sea levels. In the HafenCity Hamburg for example, the ground floor of the new buildings erected behind the dyke can be shut off with flood gates, while people can escape the area via pedestrian bridges. Meanwhile, ever higher dykes, such as along the Elbbrücken area, have been transformed on both sides into stepped terraces that allow strolling, outdoor activities, and sitting on the edge of the city overlooking the port. We wonder: Could we borrow sponge-thinking to imagine port cities as sponges for maritime activities, places where we can create a new water awareness among politicians and citizens and where the ports of the future are designed as places that benefit all stakeholders involved (and not only a few select decision makers)?

5. Overview of the Thematic Issue Contributions

This thematic issue on porosity in port city territories brings together a broad range of scholars, both young and established, to explore a wide range of time periods, spaces, scales, and conceptualizations, discussed in case studies from Europe, America, Asia, and Africa. The contributions raise numerous questions about the object of study: Do we focus on a specific zone between sea and land, port and city, an interface, or does the concept of porosity allow us to look beyond the waterfront to explore the presence of maritime pockets throughout the city and region, in line with the concept of the port cityscape? The texts are organized in three groups, respectively engaging with: (1) histories of porosity in port city territories; (2) mapping and conceptualizing port city porosity on the sea side and on the land side; and (3) measuring, designing, and rethinking porosity in port city territories.

5.1. Porosity in Port City Territories Through Time and Space

Porosity in port city territories has changed over the centuries as spaces of transshipment, warehousing, urban form, and transportation evolved; as political, institutional, and economic frameworks have changed; and as new technologies have emerged. Relationships among diverse port city stakeholders—governments, corporations, maritime companies, and citizens—change over time in ways that are visible in spatial, social, and cultural transformations.

Using mapping-based research and examining population shifts around the North Sea since the medieval period, Yvonne van Mil and Reinout Rutte (2021) describe port cities as entrance nodes to large hinterlands. In a series of demographic maps, they show how social and spatial shifts around the North Sea were heavily influenced by sea-based developments.

How flows of goods shape a port city territory is the focus of the exploration of the Gdańsk region by Karolina A. Krośnicka, Piotr Lorens, and Eliza Michałowska (2021). Starting with the 11th century, the authors examine the influence of politics, economic investments, and infrastructure developments on the evolving forms and the changing borders of diverse types of port cities in the larger region.

Keren Ben Hilell and Yael Allweil (2021) explore questions of infrastructure and waterfront transformation in Haifa since the mid-18th century. They focus on the role that changing commodities have had on port transformations and the way these have been pushing the borders of ports. They trace the changes in the port city as a history of "porosity and intangibility," shifting away from a focus on histories of empire, colonialism, nationalism, and globalization to one exploring the role of transported goods, directions of flows, and technological transformations.

Stephan Hauser, Penglin Zhu, and Asma Mehan (2021) explore port city porosity through the historic development of a single commodity: oil in the port city of Dunkirk since the 19th century. They focus on safety threats emanating from petroleum sites through fires and pollution, and they reflect on the necessary distancing of industrial sites and housing areas as one expression of porosity in industrial cities with shifting boundaries between residential and industrial areas.

The regional dimension of ports is also emphasized by Hernán Cuevas Valenzuela, Jorge Budrovich Sáez, and Claudia Cerda Becker (2021). With the case of Valparaíso, they explore the political process behind neoliberal restructuring and the controversies it has generated. Using an ethnographic approach, the chapter explores labor relationships, social conflicts, and representations of the port city relationship.

5.2. Mapping Porosity on the Sea Side and on the Land Side of Port and City

Understanding the spaces of porosity in port city territories requires appropriate tools and methodologies to study the physical structure of the waterfront, the shape of the quay walls, and other access points between sea and land in light of changes over time and to design them. This group of articles demonstrates how port city porosity evolves as borders are constructed, broken down, and rebuilt, continuously creating new patterns of engagement between port, city, and territory.

Justyna Breś and Karolina A. Krośnicka (2021) explore water-land porosity by tracing the water edge of the Motława River over 1000 years. Assessing the height difference between water and land, the type of slope, and the form of man-made structures and overhangs, they establish categories for assessing porosity that can be more widely used to understand multiple forms and functions of water-land relationships. These categories are particularly important for understanding the complexity of this edge space and opportunities for urban design at a time of climate change.

María J. Andrade, João Pedro Costa, Eduardo Jiménez-Morales, and Jonathan Ruiz-Jaramillo (2021) take a long-term morphological view of Malaga and explore the city's evolution from the 8th century to the present through a spatial analysis of port-related spaces and nodes, emphasizing spaces of physical, functional, and social porosity over time. The authors show how barriers are broken over time and rebuilt, creating new balances and patterns including in regard to contemporary challenges such as cruise ship tourism. They point both to spatial and social porosity, arguing for the opening up of spaces between port and city.

Khalil Bachir Aouissi, Said Madani, and Vincent Baptist (2021) similarly take a long-term and spatial approach, but they do so through the study of Algiers from the 16th century until today. Using a morphological analysis of the port-city interface, they identify a

changing albeit persistent divide between port and city territories. Examining the evolving focus of port activities and their impact on the threshold area through four periods, they explore shifting spatial adaptations.

Lucija Ažman Momirski, Yvonne van Mil, and Carola Hein (2021) add another perspective to the exploration of spatial patterns in and around port cities, focusing on land use patterns in Hamburg, Rotterdam, and Koper over the last 500 years. Although ports may appear to have a clear border with high fences, environmental impacts, for example, shape land use decisions on both the city side and the port side. As the functions of the port and the city change, land use porosity can provide opportunities for innovative design ideas to arise in areas where port and city coexist.

5.3. Measuring, Rethinking, and Designing Porosity

Introducing the concept of porosity to the study of port city territories requires careful reflection on conceptualization, appropriate tools, and methodologies. These case studies can help in the development of a toolbox that allows mixed-methods research to be combined with design interventions and the development of adaptation strategies for future urban planning. The third group of articles explores port city porosity through interviews, company data, design, and the impact of the energy transition.

Yueyue Zhang and Peter Martin Ache (2021) take a conceptual approach to porosity arguing that port cities are capable of pushing their tangible and intangible boundaries. They use the concept of 'penumbral' to examine the case of the Shanghai Baoshan port-city interface. Through first-hand interviews, they study perceptions of local stakeholders, port-related values, and concepts. They argue that such a nuanced approach to tangible and intangible boundaries can advance planning practice for the integration of port and city.

Working at the scale of the waterfront, Maurice Jansen, Amanda Brandellero, and Rosanne van Houwelingen (2021) examine how former port districts in Rotterdam—Merwe Vierhavens and RDM Shipyards—have adapted to the departure of some port functions and have been reused for urban and mixed-use activities. They study flows of users in and out of the area and analyze the companies and institutions currently located in these transformed port city spaces. They offer insights into the district's emerging uses and imaginaries, showing the resilience and adaptation of port legacies.

A better understanding of porosity can also facilitate citizen engagement and design. Drawing on research projects and design studios with students from Tongji University, Harry den Hartog (2021) explores the role of urban labs in the urban regeneration of Shanghai's former industrial waterfronts. Using questionnaires and interviews to understand the use and appreciation of the new public space and buildings, the article explores the role of densification and the reuse of urban elements in the context of high-density investment and development projects.

Lukas Höller (2021) highlights both positive and negative potential effects of exchanges between port and city and focuses on the role of "design fiction" as a tool for improving port-city relationships. Through the case of a design project for the town of Kirkenes in northern Norway, destined to become a seaport on the Arctic route, he explores a floating port, a reindeer-energy port, an urban port, and a wetland port as typologies for future port cityscapes.

To round out the thematic issue, Stephen Ramos (2021) uses the concept of porosity in a speculative proposal for a transitional dome district in what he calls the "seam space" between port and city. As part of the global energy transition, wood pellets are increasingly used for heating. Pellet volatility requires appropriate warehousing, which has led to new building typologies. The article considers the emergence of new energy spaces and the transforming of port city space as it invites politicians and planners to acknowledge material changes in the development of new urban concepts.

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Conflict of Interests

The author declares no conflict of interests.

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Article

Urbanization Patterns around the North Sea: Long-Term Population Dynamics, 1300–2015

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Abstract
Around the North Sea, how have port cities and cities in the hinterlands of port cities influenced one another in the past? What possible links are there between population trends in various urban areas and time periods? Is it possible to identify the origin of the urbanization patterns around the North Sea? To understand the current era of urbanization, we need to analyze historical trends and urbanization patterns in the long term. By mapping the population figures for eight moments in history and combining this with data on political boundaries and large infrastructures that facilitate flows of goods and people, this article aims to contribute to an improved understanding of contemporary and historical urbanization trends around the North Sea. It also presents the first spatial dataset on urban settlements around the North Sea by means of a series of demographic maps, from 1300 to 2015. It provides a detailed explanation of the method used for mapping and handling demographical data. Each map is accompanied by a brief explanation of the urbanization pattern, with special attention to identifying demographic and economic developments and possible clarifications for centers of gravity and shifts. The maps lay the foundation for further research on social patterns and spatial developments in urban (port) regions around the North Sea and for understanding urban culture through space and time. Port cities must be analyzed from the perspective of the sea, which requires a rethinking of data sets and data borders, to understand the ways in which these port cities have served as porous distribution hubs and as transit nodes for boundary-crossing flows.

Keywords
demography; geo-spatial mapping; infrastructure; North Sea region; political boundaries; population numbers; port cities; urbanization patterns

Issue
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1. Introduction

Viewed from land and from various countries with their boundaries, the North Sea is often perceived as a barrier. In *The Edge of the World: How the North Sea Made Us Who We Are*, Pye (2014) argues that the world looks different when the sea is perceived as facilitating movement: Land becomes a barrier and the sea the bearer of trade and prosperity. The North Sea is an important link in shipping routes and connects Europe with the rest of the world. For centuries, people and goods have flowed through and around the North Sea. Areas near the sea are linked by shipping, trade, and the exchange of products and people passing through port cities. These port cities facilitate flows of goods and people between a maritime foreland and cities in the hinterland. Ports are porous, so to speak, because they facilitate flows that pass boundaries. This porosity generates urbanization around the port and in an often-transnational hinterland connected to the port city

through infrastructure (see the editorial of this thematic issue of *Urban Planning*).

Around the North Sea, port cities and the cities in their hinterlands have been influencing one another throughout history (Couling & Hein, 2020). Academic research on urbanization is often nationally oriented, focused on a specific country, and often attention is paid only to developments that took place either up to the Industrial Revolution or from the Industrial Revolution onwards (De Vries, 1984; Lawton & Lee, 2002). By looking at urbanization from the perspective of the sea, we can overcome the limitations of national thinking. To understand the current urbanization pattern of cities around the North Sea, it is also helpful to consider a longer time frame, starting with city formation in the 11th–14th centuries up to the present. But how it is possible to get a grip on developments over such a long-term and across such a large area? In this exploratory article we use population numbers of cities around the North Sea, not dictated by national borders, as an indicator. We limit ourselves to: 1) explaining how to classify, unify, and map the data; and 2) describing the urbanization patterns and shifts that become visible on the maps and exploring the possible causes of these shifts.

2. Method for Mapping and Ranking Data

Geographically, the North Sea is shaped by the coastlines of Norway, Denmark, Germany, the Netherlands, Belgium, France, and the United Kingdom. In the south it borders the Strait of Dover near Calais; in the north, the Atlantic Ocean. But what does the area around the North Sea consist of? One may argue about that. Throughout history, the North Sea has been described from multiple perspectives by travelers, researchers, and scientists (Blass, 2016; Couling & Hein, 2020; Pye, 2014). It has also been mapped countless times and for many purposes, from navigation to propaganda. In this study we focus on the urbanization patterns around the North Sea, with the sea as a shared body of water and foundation for our research. We pragmatically chose a rectangular map cutout, on which population numbers were charted for eight survey years from 1300 to 2015. The maps in this article have been compiled on the basis of datasets that were produced as part of the research project "Ranking cities around the North Sea," and that were made possible in part with grants from *DANS* and *4TU* (van Mil & Rutte, 2020a, 2020b). In addition to including a series of maps (1300, 1500, 1700, 1850, 1900, 1950, 1990, 2015) that allowed us to rank cities based on population size, we include a series of three maps in which the population numbers are combined with flows (infrastructures) and boundaries (political borders) in 1500, 1900, and 2015. These maps give us a better understanding of the porosity of port cities—the movements of people and goods around the North Sea and political forces behind them.

2.1. Working with Population Data from 1300 to 2015

Since the introduction of geographic information systems (GIS), online mapping interfaces, and available digital data, it has become easier to create detailed maps from a huge number of statistical datasets. Although creating and interpreting maps requires some technical spatial knowledge, more people than ever can produce them, relying on a series of well-established cartographic and statistical principles (O'Brien & Cheshire, 2016). This is especially the case when the maps concern contemporary social, political, or demographic data from a single national state. Finding—or building—a reliable dataset and mapping long-term urbanization patterns in a region that includes multiple political boundaries, however, requires more specialized knowledge and labor to process datasets to obtain meaningful and reliable results. We will explain some of the important decisions we needed to make concerning definitions and criteria when we were selecting and interpreting data and data sources, as well as when we were classifying and unifying data in the context of porosity.

In recent decades, several extensive and valuable global demographic studies that take a long-term perspective have been published by Chandler (1987) and Modelski (2003). Concerning Europe, the demographical studies of De Vries (1984), Bairoch et al. (1988), Terlouw (1996), Pinol (2003), and Rutte and Abrahamse (2016) should be mentioned. The two global studies, as well as the European studies by De Vries (1984) and Bairoch et al. (1988) provided demographic data in tabular form with an extensive account of the sources, definitions, and interpretations used, but these studies are limited in terms of time frame: Chandler's (1987) study stops at 1975, and is the only one to make it to the twentieth century. A disadvantage of the other three studies is that they provided only a series of demographical maps without the underlying data itself being visible or accessible as spatial datasets. Until recently, the only spatially explicit data on urban populations with global coverage was the *United Nations World Urbanization Prospects* (Desa, 2014). This free available dataset is considered the most authoritative source of global urban population data and provides information on urban populations for major urban agglomerations around the world. However, these data are only available starting in 1950 (Reba, et al., 2016). In 2015, the Yale School of Forestry & Environmental Studies published the first spatially explicit dataset of urban settlements from a long-term perspective, 3700 BC to AD 2000, by digitizing, transcribing, and geocoding the historical, archaeological, and census-based urban population data of Chandler and Modelski (Reba et al., 2016).

With these primary sources as a starting point, we have developed and refined a dataset for the North Sea region (the Netherlands, Belgium, and parts of the United Kingdom, Norway, Denmark, Germany, and France) for eight moments in history, starting in 1300,

and we use steps of 200 years to capture major social, geo-political, and economic changes. We add more detailed information through smaller steps of 25 to 50 years; these are represented through the years 1850, 1900, 1950, 1990, and 2015. Identifying the appropriate time period to represent in a map in relation to space allows us to capture key changes and patterns, but a particular time period may mean one thing for one continent or country, and something else entirely for another. Selecting time periods for a region that crosses several national borders, is therefore difficult. We tried to overcome restraints in the availability of data to allow a view from the sea. Based on the selected scale and time periods, we framed the data and added missing numbers of cities and reference years on the basis of available data from national or regional publications and open access databases including results of national censuses and the *Eurostat Regional Yearbook* by the European Commission (Kotzeva, 2019). For each reference year we selected only the largest cities in terms of population, each with its own minimum threshold: In 1300 the minimum is 3,000 inhabitants; in 1500 it is 5,000; in 1700 it is 7,000; and so on, with a maximum of about 100 cities per reference year. Chandler (1987), De Vries (1984), and Bairoch et al. (1988) relate the threshold to urbanity or the number of urban inhabitants, but as argued below, definitions of each differ widely. By using a maximum of the 100 largest cities per reference year it is possible to provide insight into shifts in the urbanization patterns around the North Sea. After collecting and processing the population numbers, we have harmonized the data and where necessary spatialized the dataset by providing latitude and longitude values.

In selecting data, before establishing municipal administrative boundaries, it is important to define 'city' and 'city population,' especially in the periods up to 1850. There is a wide variation in definitions of urbanity and it is well established that 'urban' is a multi-dimensional concept, and that the city is defined in myriad ways by different disciplines and research communities (Reba et al., 2016). Chandler for example, defines a city as "urban area including suburbs lying outside of the municipal area, and omitting farmland lying within the municipality" (Chandler, 1987, p. 1). Bairoch et al. (1988) aimed to improve Chandler's population estimates by also taking into consideration the land type within city walls (commercial, residential, gardens, or grazing), uninhabitable space within buildings, and the density of occupations, and suggests increasing Chandler's estimate of European city values by 15 percent (Bairoch et al., 1988; Reba, et al., 2016). In modern times, most scientists and disciplines define an urban area using administrative or political boundaries, but there are national differences in how municipal boundaries are determined. For instance, the boundaries of German urban municipalities are much wider than those of Dutch municipalities. Moreover, cities and their boundaries are constantly changing. Between 1900 and 1950, for example, the population of Hamburg increased significantly, not only because of urban growth but because Altona was incorporated by Hamburg in 1938. Another example of a change in the pattern, which is not necessarily related to urbanization, is Wuppertal. This German city was created in 1929 through the merger of several villages and towns, including Elberfeld and Barmen, which until 1900 were among the cities with more than 50,000 inhabitants. Most municipal border changes were made in the second half of the 20th century. In the Netherlands, the number of municipalities fell from over 1,000 in 1950 to just over 500 in 2000. In England, the Local Government Act of 1972 revised all administrative boundaries. The reclassification of cities and municipal boundaries complicates the comparison of census results between 1950, 1990, and 2015.

Another critical issue concerning selecting and interpreting data is availability. The further back in time, the more limited the available data. The data that do exist are often not comparable from one city to another. Given that historical sources are often incomplete, the quality of the data is uneven and often does not permit full understanding or comparison. Translating historical developments into maps involves numerous questions about which dates to choose. A date that is meaningful in one country may have less relevance for another, making the choice of a date for comparative research particularly difficult (Hein & van Mil, 2019). Population censuses and other methods of measuring populations record numbers in intervals. These intervals do not always run parallel to the chosen reference years; circumstances such as war, natural disaster, and political agitation can disrupt the interval. For reference year, 1850 for example, the results of the census from 1851 are the most accurate for French and English cities; in Belgium the most accurate would be the results of 1846; for Germany, 1849, and for Denmark, 1845 or 1855. Estimates are therefore inevitable. To avoid a semblance of precision and yet show a reliable pattern, the population numbers are rounded to thousands. Additionally, we attempt to cross-check these demographic factors, definitions, and methods when possible. Undoubtedly, errors remain, and a more rigorous process would strengthen the values in the dataset. Unlike some other demographic data, such as Chandler's digital dataset (Reba et al., 2016), we did not add a reliability rating by including a number for certainty to the dataset.

To classify data for mapping, it is crucial to decide both the number of classes and the method for breaking data into ranges. In classifying the population numbers, we chose to distinguish six classes, which reduces the chance of data generalization and increases readability. Generalized data is easy to read and remember but may gloss over some important aspects of data and create artificial geographic patterns by lumping together many places that are in fact quite different. Too many classes would increase the risk of map reading errors because more variation in size means a smaller distinction in classes, which is more difficult to identify. GIS allows

you to choose from a variety of preset classification methods, including Equal Interval, Quantile (equal numbers), and the Jenks (1967) natural breaks. These classification methods did not adequately differentiate the required spatial patterns, mainly because the outliers—in this case the large cities with high population numbers such as London, Hamburg, and Brussels—occupied the three highest categories, while the majority of the cities—with low population numbers such as Cambridge, Oslo, and The Hague—were combined into the lowest class. Therefore, a manual method was developed, based on a modified Jenks classification. Jenks natural breaks is a commonly used method and a kind of optimal classification that finds class breaks that (for a given number of categories) will minimize within-class variance and maximize between-class differences (Jenks, 1967). A disadvantage of this approach is that each dataset generates a unique classification solution. Since we make a series of maps that show developments and changes within the population pattern over time, it is important that the classification can be applied to all maps and that reference years match. The Jenks classification system was modified to include more categories for cities with a lower population and fewer categories for high populations and to align the categories of the reference years from 1300 to 2015. Between 1300 and 1500, for example, the population remains almost the same: Only the minimum threshold and the highest population differ. With the Jenks classification method, the breaks would be unequal, but are kept the same. To visualize the increase in population over time, the size of the symbols has also been manually adjusted. However, the differences in population from 1300 to 2015 are too big for a true continuous series. Moreover, the aim of this study is to show shifts in urbanization patterns and not the development of population over time (see Figure 1).

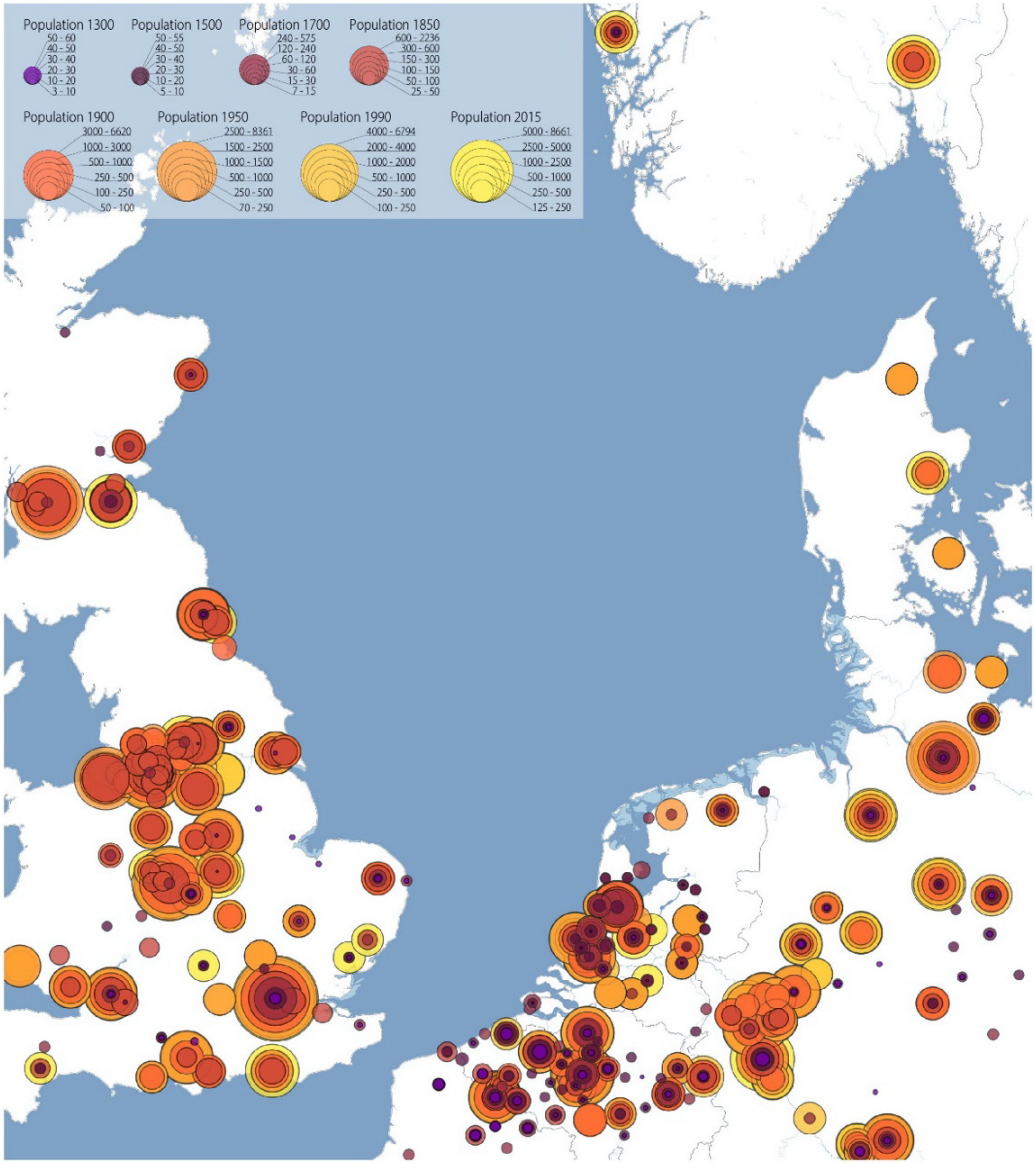

Figure 1. The result of mapping and ranking population numbers in eight survey years. Map by Yvonne van Mil. Source: van Mil and Rutte (2020a, 2020b).

2.2. Working with Historical Maps and Digital Datasets about Infrastructure and Political Boundaries

Finding—or building—reliable data sets is one of the biggest challenges in research. It requires the necessary knowledge and labor to process datasets to obtain meaningful and reliable results. Historical maps and existing datasets imply definitions and decisions; they reflect local particularities and historical choices that may already shape answers. In addition, the effectiveness of a map is a result of selectivity, but before selecting or determining data, it is important to acknowledge the purpose and the historical and social context of the maps in order to select the necessary information (Hein & van Mil, 2019). To estimate the reliability of a map, it is important to know the function: Who is the cartographer or client and what was the purpose of the map? A map is first and foremost a tool of communication, and to understand a map we need to know both the supply side (the maker) and the demand side (the client). We can only understand maps if we know what the cartographer wanted to show, to whom, and why. The purpose of the map determines the scale, the reliability, implementation, and content (Renes, 2016). As Segal (2020) shows in his article "Flow Mapping through the Times," infrastructures—especially canals and railways—were used to display a country's sophistication and prosperity: "Movement and flows became [from the mid-19th century] the signifiers of cultural and scientific progress, while a lack of movement was a sign of retardation" (Segal, 2020, p. 92). Topographical and thematic maps from the 19th to mid-20th century support this assumption; railways and canals are the most or sometimes the only indicated infrastructures on maps, and are represented as the drivers of flows of people and goods. This complicates the mapping of important infrastructures in history. For the reference years 1500, 1900, and 2015, a first attempt was made to map the main infrastructures over water, land, and rail for the North Sea region, and combine them with political boundaries. In this section some difficulties and decisions are explained in more detail.

Infrastructure usually refers to the total of facilities such as railways, airports, ports, cabling, sewerage, and road networks. In this article, by 'infrastructure' we mean physical connections over land, water, and rail, as connections facilitating flows of goods and people. Roads enable flows, but they also restrict them in the sense that they define the routes flows can follow and thus where it is possible to go (Edwards, 2003). Flows of goods can mean economic prosperity and urban growth. Infrastructure, especially the construction of new canals, land, and railroads, has therefore been the cause of conflict between cities and regions for ages (De Pater, 2009). In 1500, waterways were the main transport routes. River access was one of the main reasons for the emergence of urban centers. For centuries waterways have been dammed and deepened, and new waterways have been constructed (canals). After 1800, country roads and railways increasingly took over the transport of people and goods. However, water transport remained important, especially the newly constructed and modernized canals. For the reference year 1500, we only show waterways and possible routes—flows over land. For the other two reference years, we show roads, waterways, and railways.

The roads and railways shown on the map are primary routes, meaning transport connections on land between major cities and industrial areas of (inter)national importance. On the map of 1500 and 1900, the land roads are not by definition the primary, or most important routes or flows: Formal hierarchy in roads has only existed since the 19th century. The French government was the first to introduce a road network that distinguished between different road types serving different purposes. At the top of the hierarchy were the *Grandes Routes*, which started in Paris and continued to a major city or seaport or to an international border (Blond, 2013). At the beginning of the 19th century, Napoleon Bonaparte continued the French hierarchical system of roads (*Routes Impériales*) throughout the French Empire, including Belgium and the Netherlands (Schipper, 2008). Since the introduction of motorized transport, a hierarchy in roads was standardized at a national level and after 1950 on a European level (E-road and TEN-T network).

The first step in the map-making process is finding reliable sources that accurately reflect the most recent reference year. Because we are examining different geographical regions around the North Sea, it has been important to find global or continental GIS datasets that cover several national states with sufficient spatial resolution to analyze and compare the regions in a consistent and systematic way. National and regional data may be more detailed and accurate, but is often not freely accessible and each dataset has its own definitions and criteria, which makes combining and comparing difficult (Hein & van Mil, 2019). As a starting point for the dataset on infrastructure we used the EuroGlobalMap from Eurogeographics (2017). After selecting, adjusting, and preparing the GIS datasets to obtain the required maps for reference year 2015, new data must be generated for the years 1900 and 1500. For this, we have relied on national sources and historical maps. For 1900, changes in the infrastructure and landscape can be mapped on the basis of regularly updated national topographic maps, such as Ordnance Survey maps, supplemented with thematic maps. For 1500, we used two studies on land routes in the Netherlands, one by Horsten (2005) and one by Kosian et al. (2016), supplemented with indications and assumptions based on literature, national topographical maps, and logic. For the waterways in 1500, we used the *Stedenatlas Jacob van Deventer* (Rutte & Vannieuwenhuyze, 2018) and *London: The Illustrated History* (Ross & Clark, 2008, p. 68). The political boundaries are obtained from Euratlas (n.d.).

3. Description and Exploration of Urbanization Patterns and Shifts

3.1. 1300: Foundations

The largest concentration of cities and the center of economic gravity was found in the principalities of the Southern Netherlands: Flanders, Brabant, Artois, Hainaut, and Liège (see Figure 2). This is also where seven of the ten largest cities in 1300 were located: Ghent, Bruges, Ypres, Saint-Omer, Lille, Arras, and Douai. In addition, London, Cologne, and Lübeck were among the largest ten. Both the largest cities and the other cities in the Southern Netherlands were connected to the North Sea by navigable water: The rivers Scheldt, Lys, IJzer, Aa, Meuse, and tributaries. In the Northern Netherlands, cities such as Dordrecht, Nijmegen, and Deventer that were situated on the major rivers Rhine, Meuse, and IJssel, also flowed into the North Sea. Delft and Leiden lay along a trade route through Holland, a crucial north-south water link for northwest European trade. The cities in the German countries, apart from Cologne and Lübeck, for example Mainz and Bremen, were more dispersed and were spread across several principalities. Here we find a good example of porosity in the Middle Ages: The sea with the flows was important, the boundaries were not. As in the Low Countries, rivers flowing into the North Sea were of great importance: In addition to the Rhine, there were the Elbe and the Weser. In England, the orientation of many towns towards the North Sea is also striking. Great Yarmouth is the only one close to the coast, the others are connected to the North Sea by rivers and include London and Oxford via the Thames, Norwich like Great Yarmouth via the Yare, Boston and Lincoln via the Witham, and Hull and York via the Humber-Ouse. In Scandinavia only Bergen is on the map.

During the time of city formation—the 11th–14th centuries—hundreds of cities sprang up around the North Sea (Verhulst, 1999). Only a limited number were important and appeared on the map: These were the cities with a favorable location and a good water

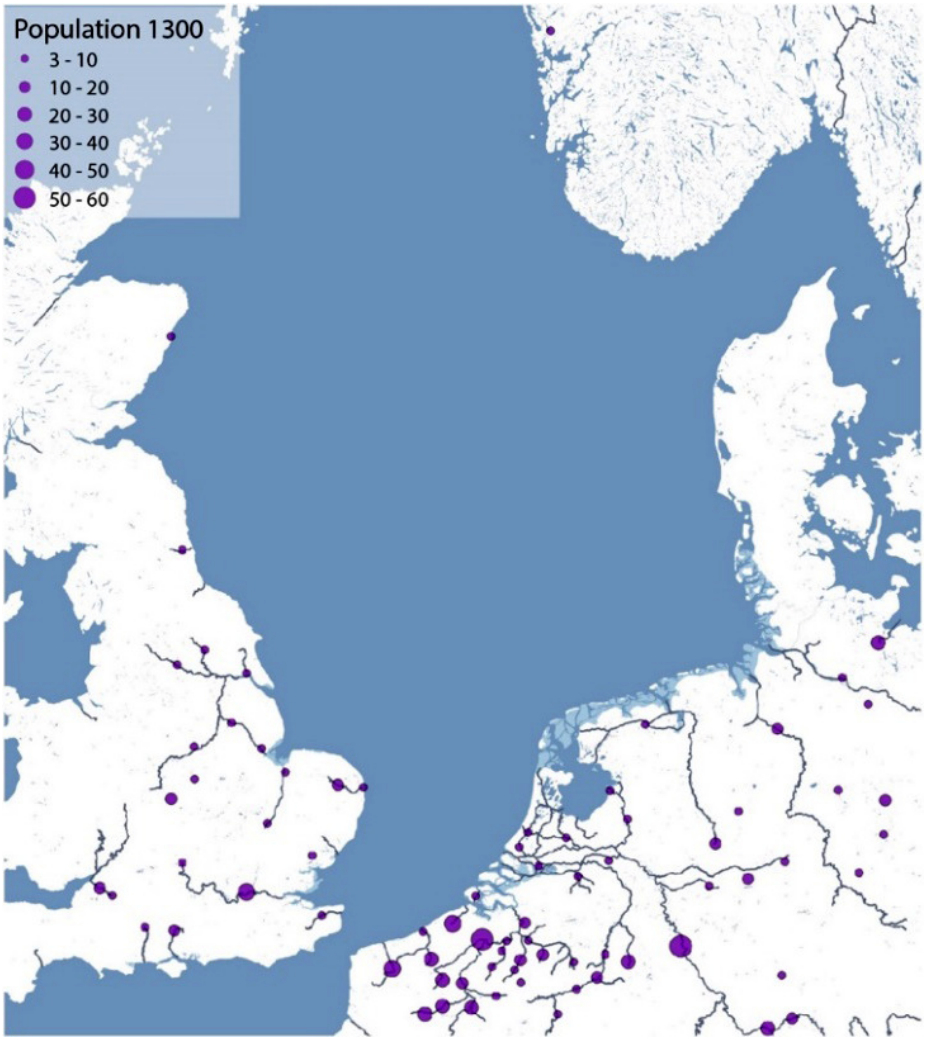

Figure 2. Cities around the North Sea area with the largest population in 1300, combined with main water courses. Map by Yvonne van Mil. Source: van Mil and Rutte (2020a, 2020b).

connection to the North Sea. Intensive contacts existed between these port cities (Ayers, 2016, pp. 33–70). Moreover, these cities, especially the larger ones, were hubs between the cities in the hinterland and trade flows across the North Sea. The high concentration of cities in the Southern Netherlands is probably due to their central location in relation to the German and French hinterland as well as the North Sea and England and, furthermore, to the fertile agricultural land that was easily accessible from the rivers. This was an area where a large group of cities could flourish, together forming a solid economic system (Boone, 2013). The pattern formed by the cities in the Southern Netherlands also had to do with the fact that, in addition to waterways, there were land-based trade routes, via Cologne, between the Rhineland and the Flemish coastal area on the North Sea (Verhulst, 1996). It is striking that the largest concentration of cities in the Southern Netherlands and the cities in the German lands, in contrast to the kingdom of England, are situated in a fragmented area with many political boundaries, governed by many lords, dukes, counts, and bishops, who did not always seem able to exercise much power. This phenomenon is characteristic of the Low Countries and the German countries, especially during the 12th–13th centuries: the German emperor, who was officially in charge, had little authority. Some lords, such as the Counts of Flanders, the archbishops of Cologne, the bishops of Munster, the Dukes of Brabant, and the Counts of Holland knew how to take advantage of this, but it was mainly the inhabitants of the cities who knew how to benefit: Burghers, merchants, and skippers became powerful (Blockmans, 2010, pp. 23–161).

3.2. 1500: Crossroads

Compared to 1300, four striking trends can be observed in 1500 (see Figure 3): 1) An increased concentration of cities in the Southern Netherlands, but also some shifts, such as Antwerp, Mechelen, and Brussels emerging at the expense of Saint-Omer, Ypres, and Douai; 2) An increase in the number of cities in the Northern Netherlands, especially in the principality of Holland and along the river IJssel, for example Haarlem, Amsterdam, and Kampen; 3) A decrease in the number of cities in England as well as a contraction of those remaining; and 4) Little change in the German countries, where Cologne remained the largest city.

In 1500, the historical sources and available data make it possible to represent land trade flows on the map (see Figure 4). For example, the connection between the distribution pattern of the cities in the Southern Netherlands and the important routes to Cologne and the Rhineland come into focus. It also becomes clear that in the Low Countries along the North Sea, waterways were the primary infrastructure, while the German countries depended on overland routes for east-west connections. In England, on the other hand, the rivers to the North Sea were decisive for east-west trade. The north–south connections were overland. Ostensibly, these land routes run partly from nowhere to nowhere, but that is because cities smaller than the largest 100 in 1500 are missing from the map. Proportionally, cities in England were hardest hit by the plague, which claimed many victims in Europe in the mid-14th century (Pounds, 1990, pp. 187–209). The Northern Netherlands

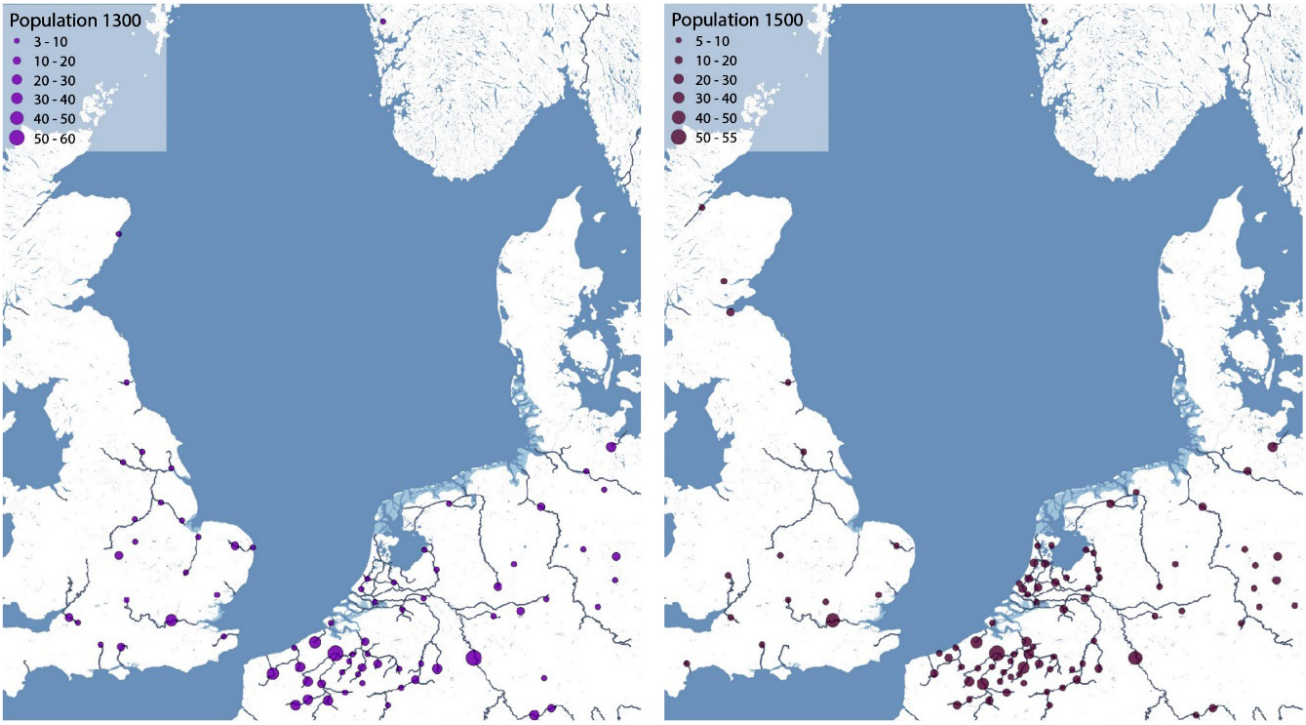

Figure 3. Cities around the North Sea area with the largest populations in 1300 and 1500, combined with the main water courses. Map by Yvonne van Mil. Source: van Mil and Rutte (2020a, 2020b).

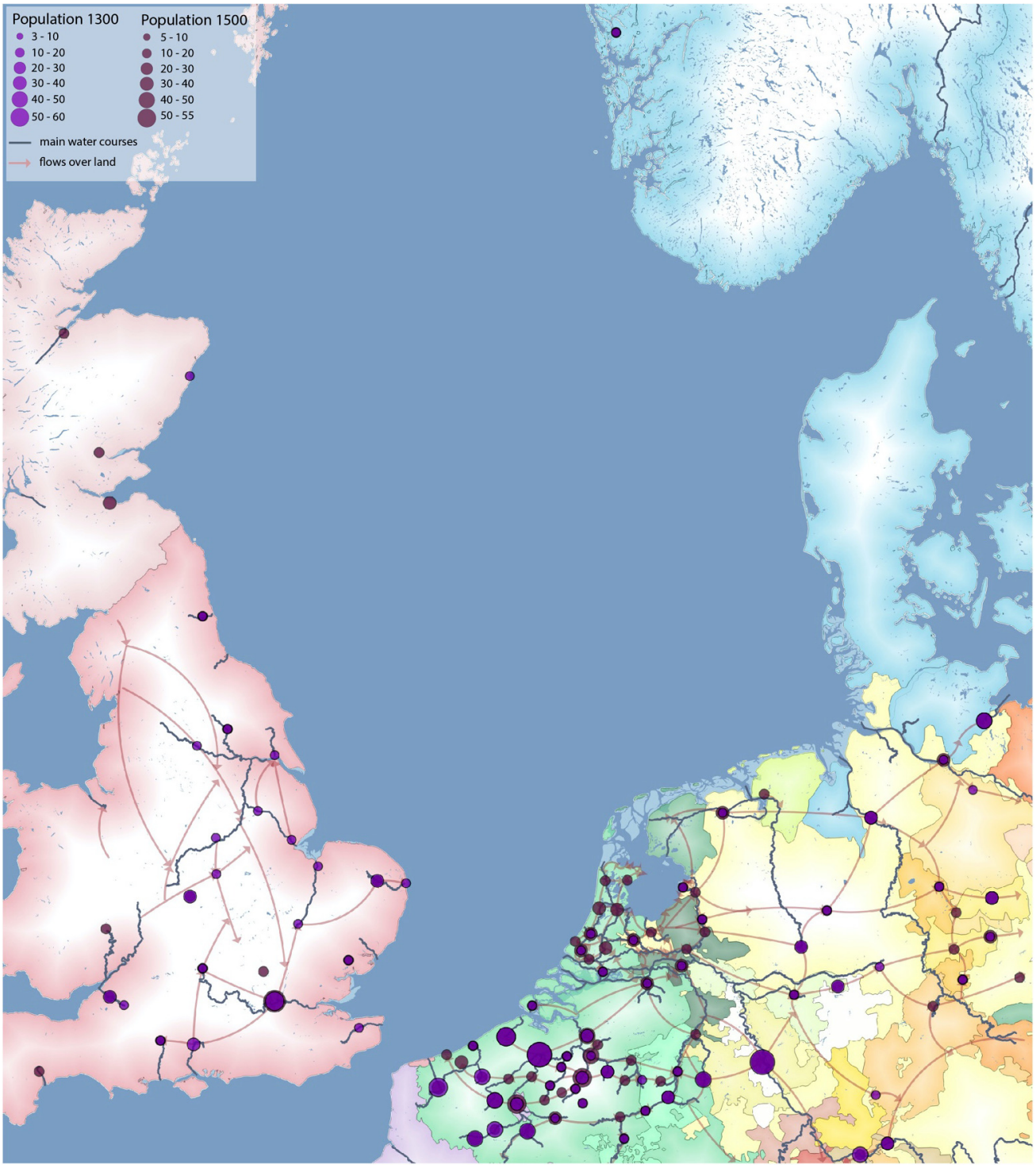

Figure 4. Cities around the North Sea area with the largest populations in 1300 and 1500, combined with political boundaries and flows of goods and people over land and water in 1500. Map by Yvonne van Mil. Source: van Mil and Rutte (2020a, 2020b).

in particular seems to have suffered less from the plague: The number of towns increased between 1300 and 1500, perhaps even thanks to the demographic and economic decline in England. In a broader perspective, the developments in the Northern Netherlands during the 14th–15th centuries were exceptional, because in large parts of Western Europe this was an era of decline or contraction. In this period, the transit function of the port cities in Holland became more important (Brand, 2011). Its location at the junction of the trade flows by water from the Rhineland to the North Sea and from the Baltic to the south was particularly favorable. By 1500, much of the Low Countries was in the hands of the Burgundian princes, but it will be shown below that the remarkable

fragmented political geography benefiting cities and citizens did not end there.

3.3. 1700: Shifts

Comparing the map of 1700 with that of 1500, four striking trends can be identified (see Figure 5): 1) The concentration of largest cities shifted from the Southern Netherlands to the Northern Netherlands, with the center of economic gravity becoming the province of Holland, with Amsterdam as its largest city, accompanied by a group of other large cities including Leiden, Haarlem, Delft, Rotterdam, Gouda, and Dordrecht; 2) There was a decline in the number of cities in the Southern Netherlands and a contraction of the remaining ones, particularly of Ghent, apart from Brussels, which grew; 3) While Bremen and Emden emerged during this period, there was a decline in the number of cities in the German countries, apart from Cologne, which remained important, and Hamburg, which grew strongly; and 4) The number of cities in England increased and London and Edinburgh became much larger.

The shift from the Southern Netherlands to the Northern Netherlands is inextricably linked to political boundaries and the Eighty Years' War (see Figure 6). The cities and provinces of the young Dutch Republic fought to free themselves from Spanish rule and gain political independence, but above all economic freedom, which brought about an enormous flow of people and trade. In 1585, the Scheldt was blocked by the Dutch rebels and Antwerp fell into Spanish hands, as did the rest of the Southern Netherlands, which were under the yoke of the Spanish rulers. Many people from Flanders, Brabant, Artois, and Hainaut fled north, particularly to cities in Holland, such as Rotterdam, Delft, Leiden, and Haarlem. These cities formed a tight economic system together with the most important city, Amsterdam, which took over the role of world seaport from Antwerp (Lesger, 1993). The Republic experienced a Golden Age as a seafaring nation. This attracted many immigrants from the German countries too, both from the cities and the countryside (De Vries, 1984, pp. 151–172; Terlouw, 2009). Cities in the hinterland stagnated, but a limited number of port cities favorably situated in relation to the North Sea, experienced golden times during the 17th century: Hamburg, Bremen, Emden, Edinburgh, and London, because these were sea-minded, porous port cities, entrance gates to the hinterland, like Amsterdam and Rotterdam. In the late 16th century and during the 17th century, Holland became the economic heart of Europe largely because of a number of economic and political-administrative shifts in the center of gravity, not only from the Southern to the Northern Netherlands but also a shift from lords to burghers. We saw earlier that in the late Middle Ages the burghers in the towns gained in influence at the expense of rulers like the Counts of Flanders or the Dukes of Brabant. In the 15th century, the Dukes of Burgundy took over in the Low Countries, which subsequently, in the 16th century, under Emperor Charles V and his son and successor Philip II, were absorbed into the Spanish-Habsburg Empire. However, during the Eighty Years' War, the urban

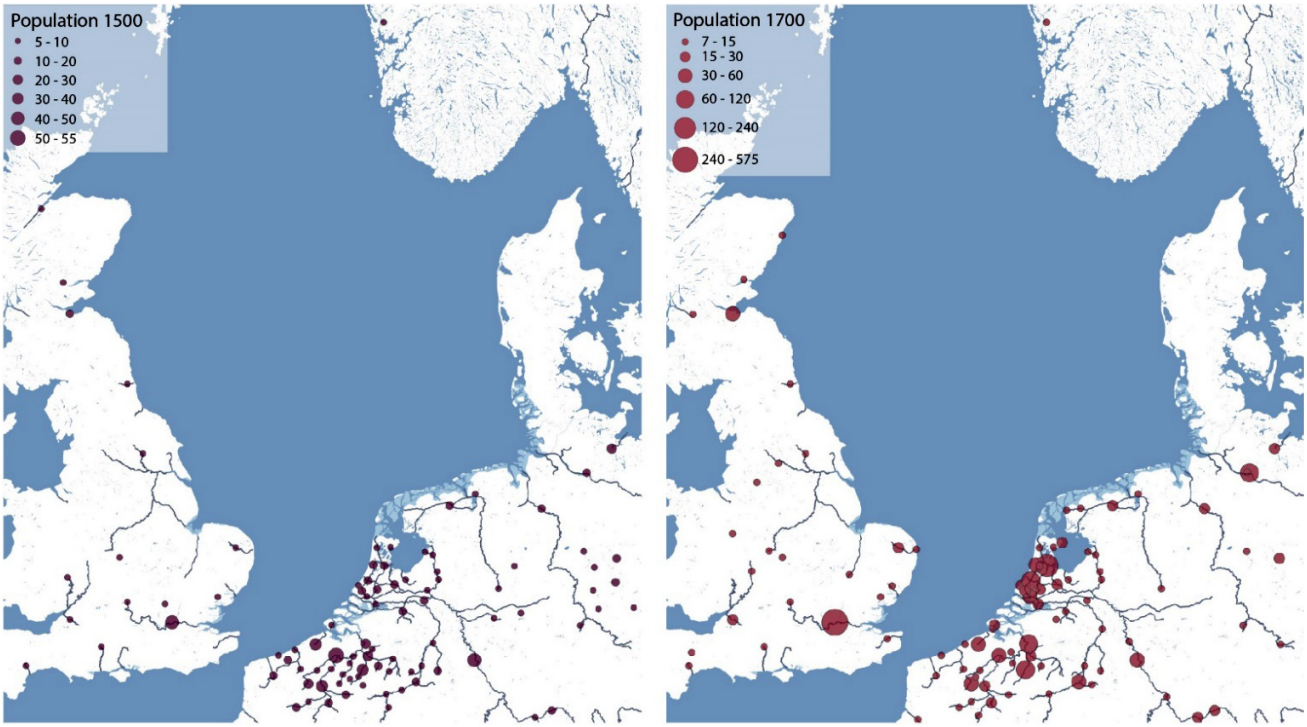

Figure 5. Cities around the North Sea area with the largest populations in 1500 and 1700, combined with main water courses. Map by Yvonne van Mil. Source: van Mil and Rutte (2020a, 2020b).

Figure 6. Political and administrative boundaries in the Netherlands, ca. 1650. Source: Rutte and Abrahamse (2016).

citizenry in the fragmented area of the seven provinces of the Dutch Republic began to act with increasing independence while the economies of the cities in Holland flourished (Rutte & Abrahamse, 2016, pp. 188–197).

3.4. 1850: Changes

In the 150 years between 1700 and 1850, six striking trends occurred (see Figure 7): 1) The concentration of the largest cities shifted from the Northern Netherlands to England, with a new center of economic activity blossoming in the Midlands, where there were rapidly growing industrial cities, the largest being Manchester, Birmingham, Leeds, and Sheffield; 2) London and Edinburgh continued to grow; 3) The North Sea ports in the United Kingdom declined in relation to the Atlantic ports of Glasgow, Liverpool, and Bristol, although Newcastle, Hull and, as said, London, also experienced strong growth; 4) Cities in the former Dutch Republic (since 1815, the Kingdom of the Netherlands) sharply declined and cities in the provinces of North-Holland and South-Holland, including Leiden, Delft, and Gouda, also contracted; 5) The number of cities increased in northern France, the south of the young kingdom of Belgium,

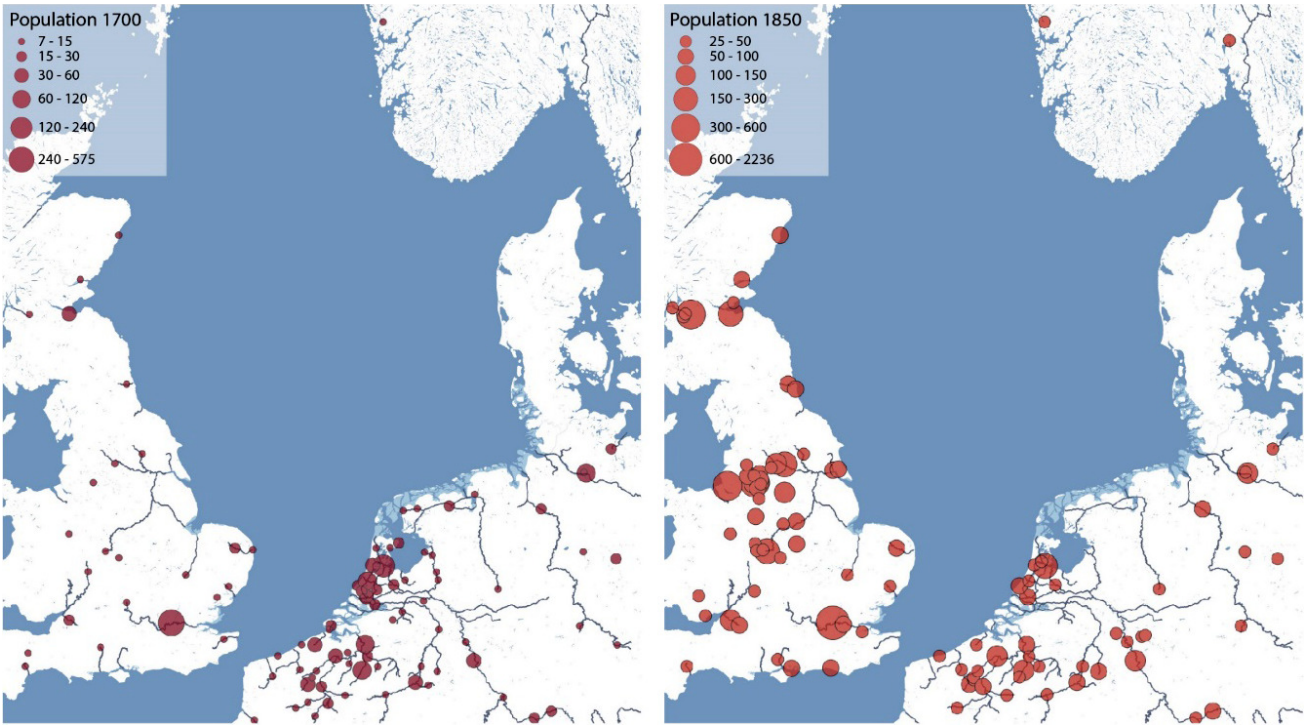

Figure 7. Cities around the North Sea area with the largest populations in 1700 and 1850, combined with main water courses. Map by Yvonne van Mil. Source: van Mil and Rutte (2020a, 2020b).

and around Liège; and 6) The Ruhrgebiet also saw new cities emerge.

During the Dutch Golden Age, the administration of the Republic was characterized by a combination of seven united provinces, a group of powerful cities, stadholders, and so-called *raadspensionarissen*, and during the 18th and 19th centuries the British Empire developed into a world power (see Figure 8). London was both the capital of the empire and a major port. In addition to a British hegemony at sea and overseas territories, the Industrial Revolution during the second half of the 18th century was decisive. Raw materials including coal and ores, equipment like steam engines and blast furnaces, and a new infrastructure of canals and railroads brought about major changes (Hohenberg & Lees, 1995, pp. 179–214). Industrialization led to an unprecedented increase in scale, especially in the Midlands, where necessary raw materials were mined. Consequently, the seaports on the west coast of the United Kingdom experienced great growth. On the continent, too, industrialization took off in the vicinity of coal basins, to which the new infrastructure of canals and railroads was adapted. This transformation took place during the early 19th century in the border region of France and Belgium, around Liège, and in the Ruhrgebiet. For the Ruhrgebiet, the Rhine was the main transport artery. Rotterdam became an important transhipment port. Industrialization enhanced the importance of North Sea ports as links in the transport chains of raw materials and other products. At the same time, the significance of the North Sea as a link between the surrounding countries and as a guiding factor for the patterns of cities seems to have diminished during this time, not only because of the new infrastructure of railroads, but also because industrialization was largely determined by the presence of raw materials. Undoubtedly, the large sphere of influence of world powers such as the British Empire and the formation of nation-states also played a role in this.

3.5. 1900–2015: Consolidation

In 1900, the trends that came into view in 1850 continued (see Figure 9). After a long period of stagnation, in the late 19th century cities in the Netherlands became industrialized and began to grow. This happened much later than in the Midlands, northern France, Belgium, and the Ruhrgebiet. The seaports of Hamburg, Antwerp, Rotterdam, Newcastle, Glasgow, and Liverpool also grew rapidly. Between 1900 and 1950, the population of the cities that were already large in 1900 rose sharply. And finally, some cities in Denmark appear on the map, in addition to Bergen and Oslo in Norway. These developments result in a more even distribution pattern of cities and not one but several centers of economic gravity. However, by 1990, many cities saw their population numbers stagnate or decline, as compared to 1950. This is particularly the case with the most industrial cities, such as Manchester, Leeds, and Sheffield. Many seaports in the United Kingdom also saw a decrease in population in 1990, particularly Liverpool. In 2015, a modest recovery in population numbers appears to have begun.

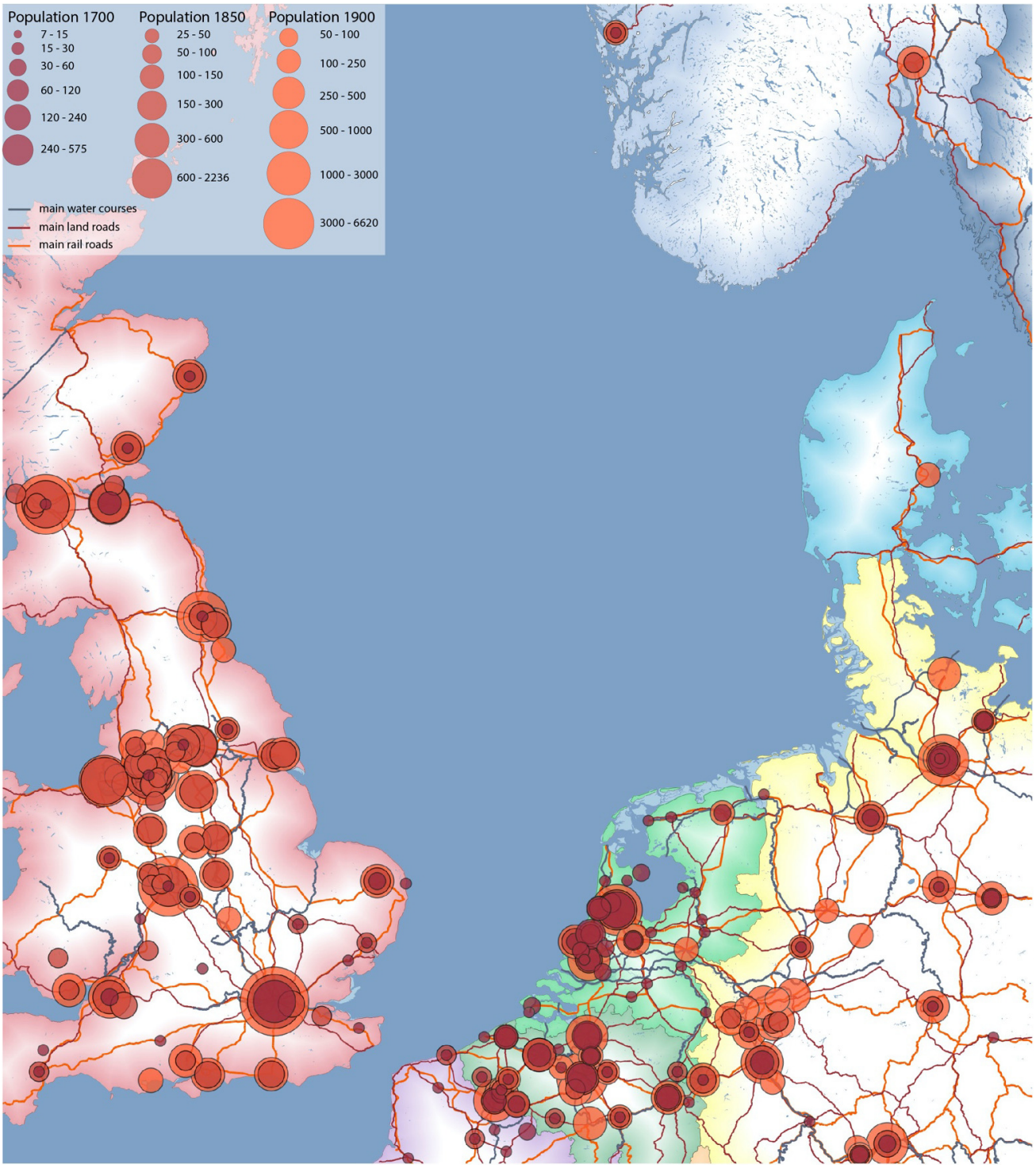

Figure 8. Cities around the North Sea area with the largest populations in 1700, 1850, and 1900, combined with political boundaries and infrastructure over land, rail, and water in 1900. Map by Yvonne van Mil. Source: van Mil and Rutte (2020a, 2020b).

During the 19th century, a major renewal of infrastructure took place with the construction of canals and railways, which connected both existing cities and new industrial cities (Lees & Lees, 2013). Country roads were improved and renewed, and during the 20th century networks of highways were built. Looking at the maps from 1900–2015 (see Figure 10), it is striking that these infrastructural innovations did not lead to major changes in the distribution pattern of cities during the 20th century. The question is why. Of course, the effects of de-industrialization during the second half of the 20th century should not be underestimated—think of the stagnating or declining populations in many cities, the enormous change in function in industrial cities and port cities, or the differentiation that has occurred. For example, London is no longer an important seaport,

Figure 9. Cities around the North Sea area with the largest populations in 1900, 1950, 1990, and 2015 in thousands. Map by Yvonne van Mil. Source: van Mil and Rutte (2020a, 2020b).

whereas Hamburg, Rotterdam, and Antwerp remain as such, but compared to the shifts we saw in the previous centuries, since 1900 these have been less significant. It is tempting to look for the answer in the rise of national states with strong governments in the 19th and 20th centuries, eventually cooperating in the European Union, but that requires further research. In any case, for the last 100 years or so, national governments have been intensely concerned with the development of their countries, the well-being of their citizens, and with the demographic and economic development of their cities, an unprecedented phenomenon, into which sweeping shifts such as those during the late 16th-early 17th or during the 18th century do not fit, since they caused dramatic decline for a long period of time in many cities.

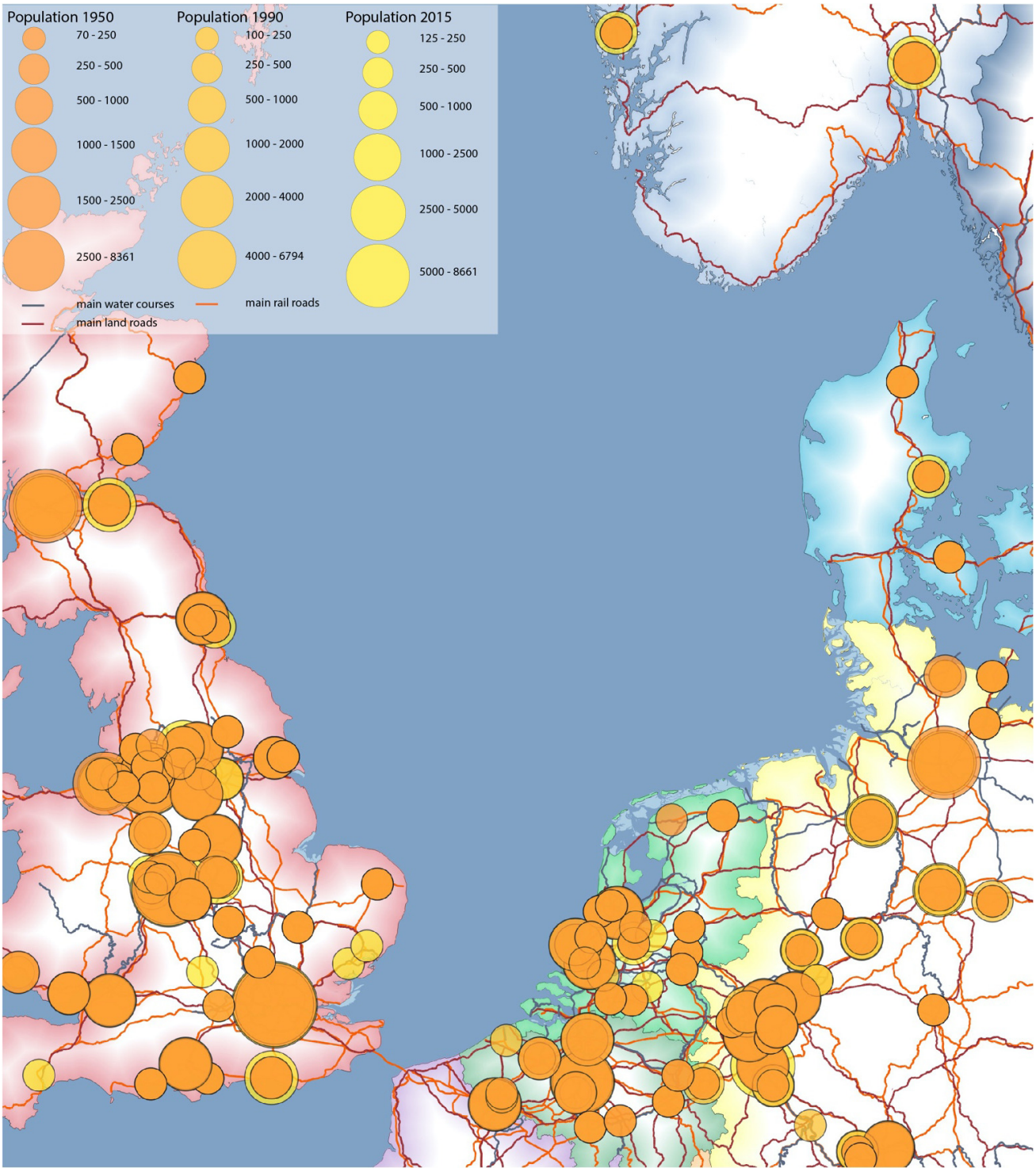

Figure 10. Cities around the North Sea area with the largest populations in 1950, 1990, and 2015, combined with political boundaries and infrastructure over land, rail, and water in 2015. Map: Yvonne van Mil. Source: van Mil and Rutte (2020a, 2020b).

4. Conclusions

Taking a bird's eye view of long-term development from 1300 to the present day, the areas around the North Sea seem to have worked like communicating vessels: The Southern Netherlands fall back, the Northern Netherlands rise, Holland falls into decline, England rises. The porous seaports serve as distribution valves; they connect to the hinterland through canals, rivers, railroads, and motorways, sometimes blocked by national borders. But from the moment industrialization reached the continent, not one, but several centers of economic gravity emerged. The role of the North Sea in the flows between the surrounding areas diminished from that

point on. Remarkably, until the shift to England, the center of gravity was in politically fragmented areas, where cities and citizens had much influence, while later on, nation-states with national boundaries and influential governments emerged. In addition to the centers of gravity, there are cities like Cologne and Hamburg that have developed steadily from 1300 to the present. It also appears that dynamics vary from area to area. England experienced the most numerous and significant changes over the course of 700 years: It hosted a considerable number of North Sea ports in 1300, then underwent a prolonged decline due to the plague. It saw renewed prosperity in the 18th century, followed by major growth during industrialization, a new center of gravity in the Midlands, and the increasing importance of the ports on the west coast, eventually followed again by decline.

Contrary to what is often assumed, the current urbanization pattern around the North Sea can best be understood by looking at the long-term development, by examining how this pattern arose and developed over the centuries. Looking no further back than the Industrial Revolution creates a distorted picture. After all, the distribution pattern of cities was largely determined before that time. The basis for today's important port cities, including Hamburg, Amsterdam, Rotterdam, and Antwerp, was laid during the late Middle Ages. Figure 1 shows that many other cities that matter today also go back to that time. Only for two groups of cities was the Industrial Revolution decisive: those in the Midlands and in the Ruhrgebiet, not port cities. To understand the urbanization pattern and the position, function, and meaning of today's important ports and cities around the North Sea, the developments and shifts through time are also crucial. These can be broadly characterized as follows. The foundations for the urbanization pattern around the North Sea were laid before 1500. The center of economic gravity, with the most important port cities, can be found in a fragmented area, where powerful citizens ensured an intensive exchange of goods beyond the borders; the ports thus served as porous transit centers. Subsequently, the center of economic gravity shifts from the Southern Netherlands to the Northern Netherlands. The Southern Netherlands lost their fragmented freedom and the free Dutch Republic port cities flourished as transit centers. During the 18th century, there were major changes: the center of gravity shifted to the other side of the North Sea, to England, and the character of the economy changed dramatically with the Industrial Revolution. The main port cities were then part of a kingdom, which became the British Empire. From the moment industrialization began in northern France, Belgium, and the Ruhrgebiet at the beginning of the 19th century, the North Sea region has been characterized by different economic centers of gravity, which have persisted despite profound economic changes in the 20th century. Thus, consolidation of the urbanization pattern occurs, to all appearances, due to the intensive involvement of national governments in the development of the cities.

We hope that with this exploratory article we have made it clear that combining, classifying, unifying, and mapping data offers many possibilities for making long-term spatial and social-cultural developments transparent, and useable for different goals. We are aware of the limitations of (historical) maps as a source, as well as maps as scientific evidence. In this study, the maps provide insight into large amounts of spatial data, which make it possible to study and understand urbanization patterns in a Western European context, and a means to communicate by presenting the data in a series of maps. By not only publishing the outcome—the written as well as the mapped results—of our study, but also the 'blackbox' (Harley, 1989), the underlying decisions, definitions, and sources, we hope to contribute to a better understanding of long-term urbanization patterns in the North Sea region.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Port Cities within Port Regions: Shaping Complex Urban Environments in Gdańsk Bay, Poland

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Abstract
Port cities located within various metropolitan or functional regions face very different development scenarios. This applies not only to entire municipalities but also to particular areas that play important roles in urban development—including ports as well as their specialized parts. This refers also to the various types of maritime industries, including the processing of goods, logistics operations, shipbuilding, or ship repairing, to name just a few. Since each of these activities is associated with a different location, any transformation process that creates changes in geographic borders or flows will dynamically affect the port cityscape. Municipalities may evolve in different directions, becoming 'major maritime hubs,' 'secondary service centers,' 'specialized waterfront cities,' or just distressed urban areas. Within each metropolitan area, one can find several cities evolving in one of the above-mentioned directions, which results in the creation of a specific regional mosaic of various types of port cities. These create specific 'port regions' with specific roles assigned to each of these and shape the new (regional) dimension of the geography of borders and flows. As a result, these port regions are created as porous structures where space is discontinuous. To further develop the issue of the creation and evolution of port regions, the authors present the case study of the Gdańsk Bay port region. This study in particular allowed for the development of both the theoretical background of this phenomenon and the presentation of a real-life example.

Keywords
Gdańsk; Gdynia; Kaliningrad; Poland; port city; port regions

Issue
This article is part of the issue "Planning for Porosity: Exploring Port City Development through the Lens of Boundaries and Flows" edited by Carola Hein (Delft University of Technology, The Netherlands).

1. Introduction

Exploration of port city development calls not only for an analysis of the evolution of internal and external boundaries and flows of goods and passengers but also for studies on the consequences of regional transformation processes. This translates into planning decisions, which can also deal with the entire conglomerates of port cities. Therefore, one should note that ports and port cities exist not only as 'stand-alone entities,' but also as nodes within their 'catchment areas' or centers within their 'functional regions.' These port-city areas are shaped by factors similar to ones influencing the development of metropolitan areas (e.g., Faludi, 2009). Due to the duality of their function, to fulfill city functions and also provide for diverse port activities that shape development processes of these entities, these 'port functional areas' may be identified as 'port regions,' which accumulate port cities of a different role, size, and location.

The effects of port activities on the regional economy are quite widely studied in the literature (Ferrari et al., 2012; Munim & Schramm, 2018; Park & Seo, 2016). Some authors noticed, however, that within the last decades, due to changes occurring in the shipping market, including the process of containerization, the effect of port activity on the region decreased, and often the

economic benefits moved from the port region to more distant regions (Brooks & Cullinane, 2007; Krośnicka, 2018; Musso et al., 2000). The social costs however are still mostly paid by inhabitants of the port region (Hoyle & Hilling, 1984). This process, known as 'de-maritimization' (Ferrari et al., 2012), having measurable spatial consequences, is paradoxically being enabled by the infrastructural and technological improvements in port accessibility (via new roads, railways, new transport, and logistic systems). On the other hand, historically in port regions, it was often the lack of new infrastructural investments that led to the loss of the port's significance within the regional structure and even to its fall. The geographies of these port regions are thus shaped by several exogenous and endogenous factors that contribute to dynamic changes in their boundaries (Lorens, 2014). The scope of factors shaping port regions may include several elements such as:

- Technological: Changes in maritime transport and cargo-handling technologies, which may favor some port cities over others;
- Infrastructural: Development of a certain infrastructure type, which may be located only in some port cities that constitute a certain functional area;
- Economic: Differences in economic realities, which may contribute to unequal development in particular parts of the theoretically conceptualized port region;
- Political: Establishment of new political entities or politically-driven decision-making regarding the location of some infrastructure type, which may result in changing the development course of the port region;
- Social: Change in trends and emergence of new tendencies, which may result in the abandonment of certain development concepts in some parts of port regions;
- Environmental: Conditions and existing resources, which may be deemed unsuitable for the location of new port infrastructure sites.

These factors may be explored to a much larger extent than within this short description and can be discussed according to their endogenous or exogenous nature. Factors contributing to the process of redirecting flows of people and cargo that influence the structure of port regions refer to issues described in the fields of economics and human geography (Ducruet, 2009; Ducruet et al., 2015; Notteboom et al., 2009; Notteboom & Rodrigue, 2005; Stavroulakis & Papadimitriou, 2016; Wiegmans & Louw, 2010), social sciences (Hein, 2014; Hein & van Mil, 2019; Schubert, 2018), politics (Daamen & Vries, 2013; Ng et al., 2014; Ressano Garcia, 2008), and technical and technological sciences (Bird, 1963; Ferrari et al., 2012; Hoyle, 1993; Munim & Schramm, 2018).

The authors selected the Gdańsk Bay port region as the case study. This region is formed by several port cities, located within the present-day borders of northern Poland and the Kaliningrad Region of the Russian Federation (see Figure 3). Due to the complex interrelations between these particular port cities and the rich history associated with their evolution, this case may be regarded as a representative example of a port region phenomenon and serve as the basis for further research regarding its nature. At the same time, the study aims to outline the evolution of changes in the functional structure of the Gdańsk Bay port region and to indicate the impact of selected technological and infrastructural, economic, and political factors on the shaping of port cities and port regions. Neither the social nor environmental aspects of this phenomenon were discussed, as the authors believe these played a less important role in the process of shaping the Gdańsk Bay port region.

Firstly, it seems especially important to discuss the historical relation a port has had to its regional hinterland. This relation has changed throughout the ages, having been influenced by the development of new transport technology and the evolution of ports themselves. Consequently, the borders of the areas served and the regional relations between particular ports were changing as well. This also related to the definition and nature of the port itself, which was once defined as a place of changing the means of transport from inland to water-based. One should note, however, that although nowadays the economic significance of many historic ports has been diminished, they are still considered important centers for economic and cultural exchange. Nevertheless, the development and transformation of these ports—whether in history or nowadays—depends on their geographic location and is strongly related to both the inland background (region) and other port centers (Hoyle & Pinder, 1981).

The regionalization process in port cities has been widely examined in terms of transport connections and cargo flow through their hinterland (Notteboom et al., 2009; Notteboom & Rodrigue, 2005). The authors, however, examine the surrounding area of a port city (with a diameter of about 200 km) in terms of its dynamically changing functional borders due to technological, economic, and political reasons, as well as processes of transformation (caused by these emerging conditions) affecting the network of nearby towns and cities such as changing the hierarchy of their interconnections and their role in the settlement system. The aim of the article is therefore to visualize the importance of the influence of global decisions of various characters on port regions and their local context, and at the same time to present the evolution of porosity in the Gdańsk Bay port region.

2. Theoretical Framework

The emergence and evolution of the port region may result in the creation of a diverse network of centers of different spatial and functional importance (Sassen,

2010), which are interconnected by diverse types of infrastructures (Haynes, 2010) and social as well as business connections. In this process, due to complex causes, some centers gain importance in the structure of the given region, while others lose it. Bird (1963) first described this process of emergence and how the port region takes shape by distinguishing the phases of setting, expansion, and specialization. Later on, Notteboom and Rodrigue (2005) further developed this concept by adding the phase of regionalization in connection with intensification of transport and logistics between the port's hinterland and foreland. On this basis, Notteboom and Rodrigue (2005) proposed a model of the spatial development of a port system. The model indicated certain phases of interrelation appear among ports located in a port region as scattered ports, penetration and hinterland capture, interconnections and concentration, centralization, decentralization, and regionalization.

This history of the development of port cities cannot be separated from the evolution of sea transport technologies. This evolution was of great influence over the shape, development, and, finally, degradation of various port structures (Hall, 1993). Such changes in the interrelation between the port and cities can be described in different ways. One model study of this issue that is widely discussed and quoted in literature was prepared by Hoyle (1998).

Based on the above-mentioned models, it was possible to analyze the major similarities and differences in the evolution of port regions in the case study of the Gdańsk Bay port region (Table 1).

The set of evolutionary stages presented above could be further expanded to include potential—probable in the near future—changes in port-city development patterns resulting from the policy of 'greening' maritime trade and port-related operations (see European Sea Ports Organisation, 2020). However, since the scope and nature of these changes are not yet clear, the authors decided not to include speculations on the future transformations within this article.

Among the changes defined in Table 1, the increase in maritime transport significance during the industrial revolution seems to be the most important. This is because water transport has proved the most convenient and the cheapest of means for the transport of goods, as the railway system was insufficiently developed at that stage. However, the port structures developed in the late 19th century could no longer meet the requirements of developing demand and the subsequent evolution of maritime transportation technologies. This is especially related to the development of such technologies as container transport, ro-ro cargo handling, and new technologies for dealing with bulk cargo (Hoyle, 1996).

The development of contemporary ports (Phases 5 and 6 of Notteboom and Rodrigue's, 2005, classification, often referred to as third-generation ports) also resulted in the development of a new phenomenon trespassing the boundaries of a single city: the appearance of 'port regions.' In the time of the earlier generations of ports, a given city/town with its direct background constituted its own 'port region'. Only in a few cases were catchment areas—including civic and industrial centers located within them—related to a given seaport, which resulted in the development of the 'port region.' However, the appearance of contemporary specialized terminals located within ports has radically changed the situation. This means that contrary to the previous generations, in which terminals were prevalently built within the existing port cities, the contemporary specialized terminals have appeared in the structure of only a few of the old ports and, at the same time, these have been created in areas previously unused for cargo shipment purposes. Thus, multiple cities can be found within a single 'port region,' including ports of the earlier generations, although there is usually only a single third-generation port while different cities may be hosts to separate terminals of various specialization. The appearance of third-generation ports along with the emergence of 'port regions' contributed to the abandonment or diminishing of the role of many old port structures, now not compatible with new technologies of reloading and transport. As a result, the above-mentioned port-city structures may evolve in different directions to become: 1) 'major maritime hubs' providing the location of third-generation port structures as well as of other types of transportation and industrial infrastructure; 2) 'secondary service centers' (or cities) that are still developing but have no prospects for the development of modern cargo-handling infrastructure; or 3) 'specialized waterfront cities' providing places where non-cargo handling maritime economy sectors may develop, including water-based recreation, specialized fishing industries, or other maritime-related services.

The authors decided to present this evolution using the example of the City of Rotterdam (Figure 1). Developed by Meyer (1999), the city was facing numerous phases of development, which led to the creation of a diversified regional structure. Of course, there are also many other cases illustrating the port city and port region development phenomena—including those of urban and/or regional scales. It is anticipated that other authors may use such cases for further research and to build more complex typologies of possible interrelations.

According to Meyer (1991), stages of development of the port city of Rotterdam include:

- Original settlement: Development of the port within an enclosed city (the Middle Ages until the mid-19th century);
- Port growth in the industrial era: Port structures develop along the river, and the division of the port and city has begun (mid-19th century until the early 20th century);
- Development of the industrial port along with a functional city: Both port and city become autonomous structures (mid-20th century);

Table 1. Comparison of evolutionary stages of the port-city interrelation.

Period	Stage of development of the port cities according to Hoyle (1998) and Meyer (1991)	Consequences for the creation of port regions	Spatial development of a port system according to Notteboom and Rodrigue (2005)	Period	Stage of development of Gdańsk Bay harbor region	Consequences for the creation of Gdańsk Bay port region
Until the 19th century	I. Simple urban and port structures—the creation of the so-called first generation of ports.	Close spatial and functional inter-relation of the port and city. No close cooperation between port cities and ports despite some exceptional Europe-wide political and commercial structures, e.g., Hansa.	Phase 1: Scattered ports. Phase 2: Penetration and hinterland capture.	Until the 19th century	Water transport domination.	The privileged position had ports located at the river mouth. The hierarchy was however dependent on the surface of the river basin—the larger the river basin, the bigger the cargo flow passing through the port city (the case of Gdańsk). Thus, watersheds formed the borders of ports' hinterlands, even more than the country's borders.
19th—early 20th century	II. Developing the port city—the creation of the so-called second generation of ports.	The rapid development of industrial and commercial functions separates the port from the city spatially, which permits the development of modern wharves, along with industrial and storage areas. Modern port structures are developed only at selected locations, not in the case of each existing port city.	Phase 3: Interconnections and concentration of a port system.	19th—early 20th century	Railway transport domination.	With the introduction of the railway system (in the Gdańsk Bay port region as early as 1860), the port's hinterland expanded towards the biggest cities (Toruń, Poznań, Wrocław, Szczecin, Berlin), almost independent of environmental conditions. The privileged ports were those having multidirectional railway access or forming railway hubs. The country's railway transport policy shaped the hierarchy of cities and ports. In the case of ports, the issue was also the depths of waterways.

Table 1. (Cont.) Comparison of evolutionary stages of the port-city interrelation.

Period	Stage of development of the port cities according to Hoyle (1998) and Meyer (1991)	Consequences for the creation of port regions	Spatial development of a port system according to Notteboom and Rodrigue (2005)	Period	Stage of development of Gdańsk Bay harbor region	Consequences for the creation of Gdańsk Bay port region
Mid-20th century	III. Modern port city.	Industrial and commercial development, (including the oil industry) along with the introduction of container and ro-ro technologies entirely separates the port from the urban area. Differences between modernized and stagnating port cities are contributing towards changes in regional economic and infrastructural structures.	Phase 4: Centralization of a port system.	Interwar period (1918–1945)	Political decisions of the Treaty of Versailles (1919).	The Gdańsk Bay port region is an unusual case due to the political decision to create the Free City of Gdańsk. This act separated the port from its natural hinterland and caused the building of a competitive seaport in Gdynia and the fishing port of Władysławowo within the borders of this greater region. Although cargo transport was concentrated mostly in the port of Gdańsk, the emergence of the port of Gdynia impacted the centralization process of the port system so that this case is not fully in line with the theoretical model.
1960–1980	IV. The abandonment of historic waterfronts—due to the creation of the so-called third generation of ports V. Revitalization of waterfronts (although these two periods in Hoyle's, 1998, original classification were treated as separate; in the subsequent works by Meyer, 1999, they were treated as one. This also corresponds to the situation of post-socialist cities).	Technological changes in maritime transport compel the development of post-industrial structures independent of the city. Developed at the same time, large-sized maritime terminals have consumed vast areas of land; parallel to this is the completed re-development of the waterfront for urban purposes.	Phase 5: Decentralization of a port system (spatial distribution of transport and logistic objects within the port region).	Socialistic port-city (1945–1989)	Iron curtain period.	The reorganization of the political structure of Europe and the introduction of the iron curtain changed the country's borders and the range of the Gdańsk Bay port region hinterland. The strong emphasis on industrialization by countries within the socialistic block caused the development of coal, ore, and oil ports in Gdańsk (north port). Still based on railway transportation, the port region was concentrated on bulk cargo and the shipyard industry.

Table 1. (Cont.) Comparison of evolutionary stages of the port-city interrelation.

Period	Stage of development of the port cities according to Hoyle (1998) and Meyer (1991)	Consequences for the creation of port regions	Spatial development of a port system according to Notteboom and Rodrigue (2005)	Period	Stage of development of Gdańsk Bay harbor region	Consequences for the creation of Gdańsk Bay port region
1980—Today	VI. Reconstruction of city-port interrelation.	Globalization requires changes in the modal functioning of the port and the re-establishment of its links with the city.	Phase 6: Regionalization (investments of a port system located in the further hinterland and foreland).	After 1990—A post-socialist port city	Car transport domination, containerization, and entering the EU.	The three factors (development of car transport, global containerization processes, and entering the EU) caused the development of the transport and logistic sectors and their facilities within the main ports of Gdańsk and Gdynia (the emergence of new deep-water ports and logistic zones along main access roads) and reshaped the structure of the region.

Source: Developed by the authors based on the classification proposed by Hoyle (1998) and Meyer (1991); spatial development of the port system based on Notteboom and Rodrigue (2005); and authors' analysis of Gdańsk Bay port region.

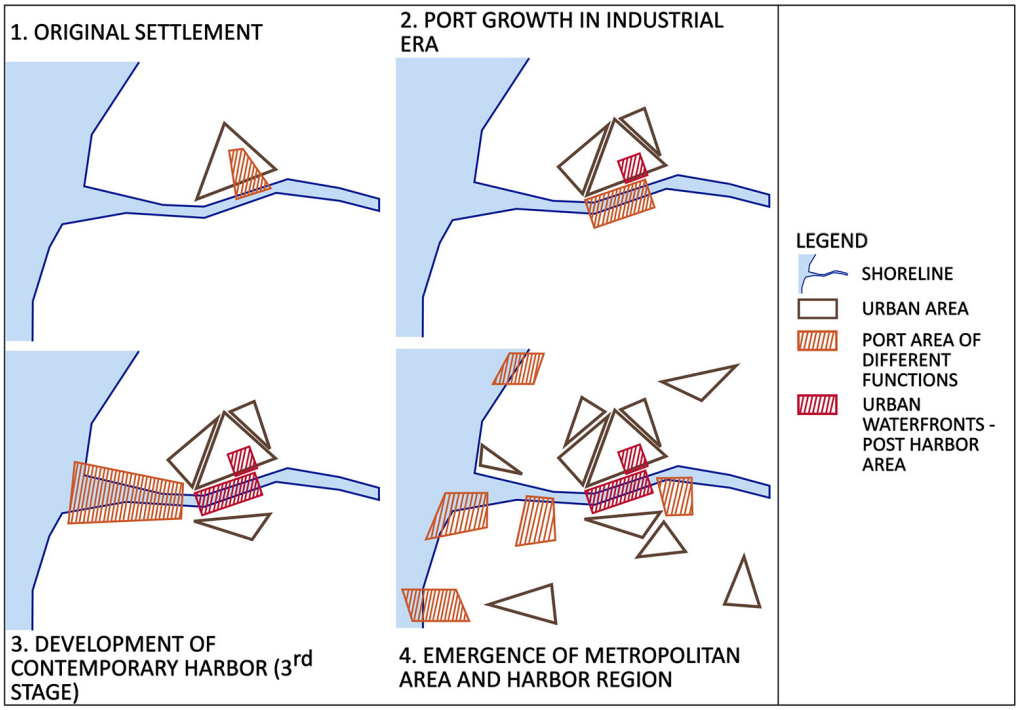

Figure 1. Rotterdam: The evolution of the port-city area. Source: Based on Meyer (1991), reinterpreted by the authors.

- Creation of specialized terminals and port structures along with the network of cities and creation of the port region (since the end of the 20th century).

This example shows the evolution of a port city into a port region, which also created opportunities for the diversification of roles and functions of particular cities within its porous structure. On that basis, it is possible to speculate on the evolving roles of its particular parts (Figure 2).

As indicated in Figure 2, the structure of the contemporary port-city structure may become more complicated than just the development of the network of port terminals and service centers. Within it, one can identify three groups of entities, and each of them may be composed of at least three types of structures (i.e., urban port and waterfront structures). These may include:

- City areas:
  - Historic urban centers;
  - Declining districts, including working-class areas;
  - Developing middle-class suburbs.

- Port areas:
  - Contemporary deep-water port terminals;
  - Declining historic port areas;
  - Specialized non-industrial port areas.

- Waterfront areas:
  - Regenerated urban waterfronts;
  - Developing waterfront sites;
  - Possible future sites of urban waterfront development.

It should be underlined that the roles of these cities and their parts may rapidly change due to currently unforeseen political, economic, or environmental changes. Also, one should note that the current spatial re-arrangement of port cities results—among others—from processes of decreasing significance of mass production as well as from the fact that new types of industrial production areas are rarely linked to the historic locations of industrial activities (Jałowiecki, 1999). As a result, a phenomenon of progressing competition between cities and regions may be observed. Also, there is still some competition inside such a module, which poses a deadly threat to the unity of the whole structure and its position on the world market (van den Berg et al., 1997).

3. Evolution of the Port Region Geography in the Gdańsk Bay Area

Gdańsk Bay is located on the southern coast of the Baltic Sea (Figure 3). Most of its waters are within the Polish economic zone, although the eastern shore belongs nowadays to the Russian Federation. Historically, the group of main port cities constituting the contemporary Gdańsk Bay port region included Gdańsk, Elbląg, and Kaliningrad. Also, several small-scale port cities—located both within the analyzed area (Braniewo, Frombork, and Puck) as well as within its catchment area (Łeba and Ustka)—were identified within its boundaries. A network of these cities was established in the Middle Ages under the rule of Order of the Teutonic Knights. This

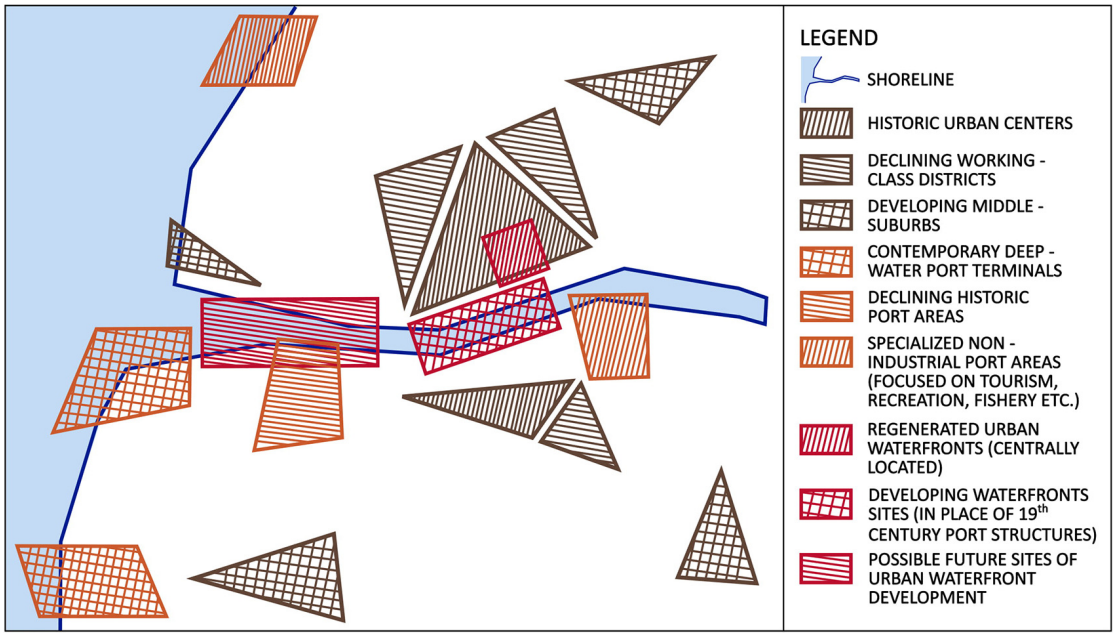

Figure 2. Rotterdam: The hypothetical diversification of port-city area within the porous port region. Source: Based on the interpretation of a drawing by Meyer (1999).

network was complemented by port cities—including Gdynia and Władysławowo that developed within the interwar period.

The port region of the Gdańsk Bay has changed its shape many times in its history, and the cities and ports in its area have assumed different positions in the hierarchy of the settlement structure. This phenomenon was caused by the frequently changing state and administrative borders, but also by the changing range of the economic hinterland of ports (understood as the area of gravity for cargo to the port). In the first case, the changes were driven by political decisions. The changes in the shape of the economic hinterland were, in turn, caused primarily by the technological evolution of transport infrastructure and the transition from the use of inland water transport to rail and then road transport.

Figure 3. Location of the Gdańsk Bay port region.

In the history of the Gdańsk Bay port region, five successive phases have been described, referring to the stages of the port-city interrelation and its evolution (Table 1) as well as the transformations of its borders and cargo flows within it:

- From the mid-11th to the mid-19th century, when the functional and spatial structure of the Gdańsk Bay port region was based on the natural hydrological system. At the time when rivers were the main means of transporting people and goods, the period of crystallization of the settlement structure in the Teutonic State and the functioning of the Hanseatic League stood out (Figure 4);
- At the turn of the 19th and 20th centuries, when the geography of the Gdańsk Bay port region was based on the railroad system (Figure 5);
- During the interwar period (1919–1939), when the Free City of Gdańsk was established under the Versailles Treaty of 1919, as a result of which a competitive port in Gdynia and a modern fishing port in Władysławowo were built in the vicinity of Gdańsk (Figure 6);
- As the People's Republic of Poland (1945–1989), when the port region of the Gdańsk Bay was based on the development of the shipbuilding industry and handling of bulk cargo (coal, ore, and oil). The administrative reform of the country also had a significant impact on the structure of the region, introducing a two-tier administrative division into a province and a commune (Figure 7);
- Currently, since the post-socialistic period of 1990, in which the structure of the Gdańsk Bay port region is primarily defined by Poland's entry to the EU and the road system and the global container system based on it (Figure 8).

These stages also reflect the evolution of porosity in the Gdańsk Bay port region. Political and technological changes, contributing to the shape and range of port region borders, result in the porous character of the geography of both port cities and their hinterland.

3.1. Water Transport Domination

The Hanseatic League was a community of traders whose interests were based on maritime trade and using political and military means to secure trade privileges (Dollinger, 1975). Gdańsk was an important stop on the main Hanseatic trade route, which connected the following cities: Novgorod–Tallinn–Riga–Visby–Gdańsk–Stralsund–Lübeck, Hamburg–Bruges, and London (North, 2018). From 1308 to 1454, the port region of Gdańsk was entirely in the hands of the Teutonic Order, bordering the Holy Roman Empire of the German Nation in the west, Poland in the south, and Lithuania and Livonia in the east. In the area of Teutonic Prussia, the most important centers were the port cities of Gdańsk, Elblag, Königsberg (now Kaliningrad), and Toruń, located on the border with Poland (North, 2018).

Gdańsk was located at the mouth of the Vistula River, which at that time was the main transport corridor in this area of Europe and had extensive economic facilities covering Poland and Hungary (the area of today's Slovakia), with trade contacts reaching through Lviv to the Black Sea (North, 2018). Hanseatic ships (cogs), having a relatively low draft, sailed with luxury goods, amber, and linen to Toruń and further to Kraków. On their way, these ships collected cargo from port cities on the Vistula River, usually located at the mouths of smaller rivers to the Vistula (Świecie, Grudziądz, Kwidzyn, and Gniew). Since these rivers were the main communication routes in the region (Figure 4), the Vistula ports

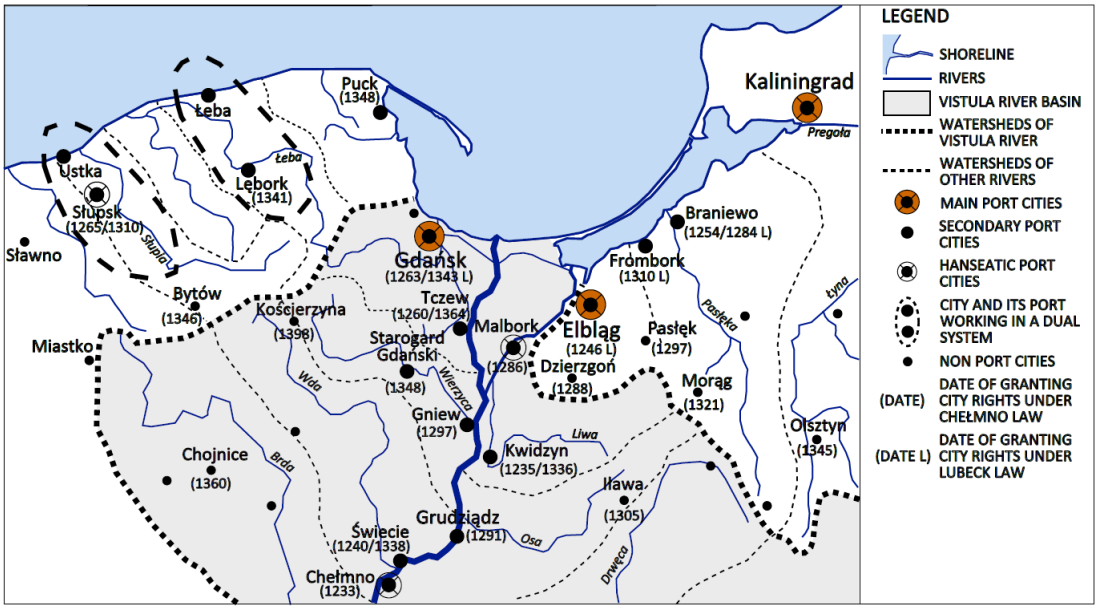

Figure 4. Gdańsk Bay port region geography in Hansa times (around the year 1400). The hinterland is defined by the accessibility of water transport. The lines of watersheds are shown approximately.

collected loads from their entire river basin (e.g., Wda, Osa, Liwa, and Wierzyca). Usually, in the upper reaches of each river, there was at least one larger center organizing the flow of goods and people (e.g., Czersk, Iława, and Starogard Gdański).

Port cities located on the Vistula River conducted deep-sea trade, and some of them belonged to the Hanseatic League (Chełmno and Malbork). Similarly, the ports located at the mouths of rivers directly flowing into the sea (not belonging to the Vistula basin) pursued an independent maritime policy (the Hanseatic cities of Braniewo and Słupsk as well as Frombork and Lębork), additionally playing the role of feeder ports for Gdańsk or Elbląg. At this stage, the port region was quite homogenous, although the diversity of the size and importance of port cities and their hinterlands gave the canvas for further differentiation and the porosity of its structure.

At the end of the 14th century, the mainstream of the Vistula, which until then had led through Nogat to Elbląg, changed its direction towards the Gdańsk section due to hydrographic changes. This resulted in a gradual decline in the importance of the port in Elbląg (the depths available to ships in the port decreased significantly), but strengthened the position of the port in Gdańsk (Zbierski, 1964, p. 175). Around 1560, the inhabitants of Malbork and Elbląg made a ditch on the Vistula (Szopowski, 1959, p. 35), which again directed the waters towards Elbląg. However, with the decree of the king of Poland from 1612 (Cieślak et al., 1982, p. 501), the waters of the Vistula were redirected mostly to Gdańsk, weakening again the importance of the port in Elbląg. This single political decision shaped the further history of the region.

The decision that weakened the position of the Braniewo and Frombork ports was the building of the city of Pilau (Bałtijsk), which, thanks to its location at the entrance to the Vistula Lagoon, could control the movement of units within the entire Vistula Lagoon. The district of New Port in Gdańsk was built for similar reasons. Its location at the mouth of the Vistula River allowed for the control of all traffic on the river (including the old port in Gdańsk) while allowing the handling of larger and more modern ships (Cieślak & Biernat, 1969, p. 275).

3.2. At the Turn of the 19th and 20th Centuries

In 1825, the provinces of Ostpreussen and Westpreussen were connected and Königsberg became the capital of the newly joined provinces. Gdańsk became a provincial garrison city and its economic development slowed down (Stankiewicz & Szermer, 1959, p. 172), even though in the years 1854–1865 it was the main operational base of the Prussian navy. The situation changed with the industrial revolution and the introduction of railways to Gdańsk.

With the increasing drafts of ships, the introduction of steam engines, and the connection of the railway line to the ports of Gdańsk, Elbląg, and Königsberg in the 1860s (and then also to Słupsk and Lębork), the economic base of the Gdańsk Bay port region changed completely. The development of the railroad system meant the extension of the port region's hinterland to the area served by the rail network. This phenomenon completely rebuilt the hierarchy of city importance in the region, giving preference to those located at the railway hubs or at least having access to the railway network (Figure 5). The process contributed to the increasing porosity of the hinterland, which in some areas had become discontinuous.

At that time, the cities of Tczew, Malbork, Grudziądz, Olsztyn, Szczecinek, and Nowy Dwór Gdański developed

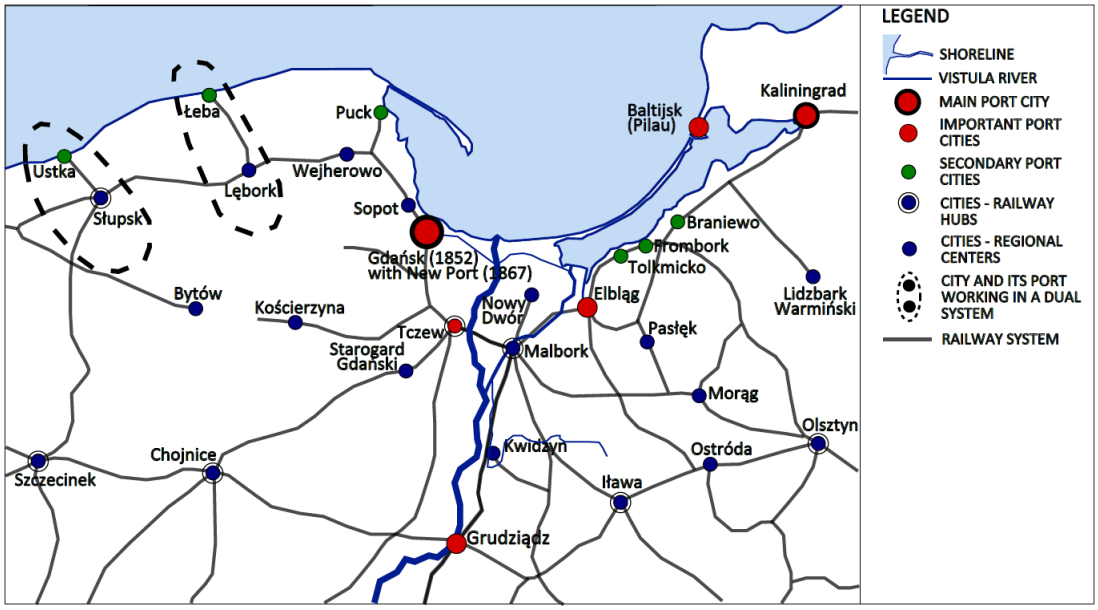

Figure 5. Gdańsk Bay port region geography at the end of the 19th century (around the year 1900). Source: Authors based on Lijewski and Koziarski (1995).

significantly. The development of industry and bringing the rail network to the main ports resulted in the construction of a new deep-water port infrastructure outside the old areas of the port cities of Gdańsk, Elbląg, and Königsberg. The shipbuilding and machine industry also developed in these ports (Cieślak et al., 1972, pp. 240–256). At the same time, the position of small ports (Ustka, Łeba, Puck, Tolkmicko, Frombork, Braniewo), despite large investments carried out in their area, decreased in comparison to the dominant port cities. Inland ports with an economy based on smaller rivers ceased to be important as transshipment centers unless they developed based on rail transport. During this period, the health and spa functions also developed (based on new railway connections), which led to the development of such port cities as Svetlogorsk (connecting to the railway in 1906), Sopot (in 1870), Łeba, Ustka, as well as the districts of Gdańsk Brzeźno and Stogi (based on a tram connection).

3.3. Interwar Period (1919–1938)

As a result of the provisions of the Treaty of Versailles (1919), state borders were changed within the Gdańsk Bay port region and the area was divided among three states: Poland, the Free City of Gdańsk, and Germany (including East Prussia located east of Gdańsk). Thus, three cities became new centers for independent states: Gdynia for the northern part of Poland, Gdańsk for the Free City, and Königsberg for East Prussia.

The Free City of Gdańsk had a small direct hinterland (including a source of food supply in the form of Żuławy area) and the port of Gdańsk was largely cut off from the economic base by the state border. Poland's access to the sea, in turn, resulted in the construction of a port in Gdynia (Sołtysik, 1993), as competition for Gdańsk, and a modern city connected with it (Figure 6). The port in Gdynia has been equipped with a railway line independent of Gdańsk, passing through Kościerzyna and Kartuzy, and activating these areas economically (Stankiewicz & Szermer, 1959). Another Polish investment in the port region of the Gdańsk Bay was the construction of a modern fishing port in Władysławowo, which also serves as a small transshipment port. As a result, the already porous port region was subdivided into four politically independent systems, which due to complicated international relations did not create any economic unity. At the same time, each of those sub-regions became more coherent in terms of logistics and economic ties.

The ports of Lębork and Łeba, located in Germany, continued to operate in a double system, together with the much larger cities of Słupsk and Lębork. In the described period, the tourist and curative functions of centers such as Krynica Morska, Jurata, Jastarnia, and Jastrzębia Góra developed. Svetlogorsk, Sopot, Łeba, and Ustka also developed in terms of health resorts. The ports in Tolkmicko, Frombork, and Braniewo served as agricultural support centers.

3.4. Period of the People's Republic of Poland (1945–1989)

After the end of World War II, the Gdańsk Bay port region was divided into a Polish part with the centers in Gdańsk and Gdynia, and a Soviet Union part with its center in Kaliningrad (Figure 7). The port region of the Gdańsk Bay was seriously damaged as a result of hostilities during World War II. Until the 1960s, the port and shipyard infrastructure underwent reconstruction in this area.

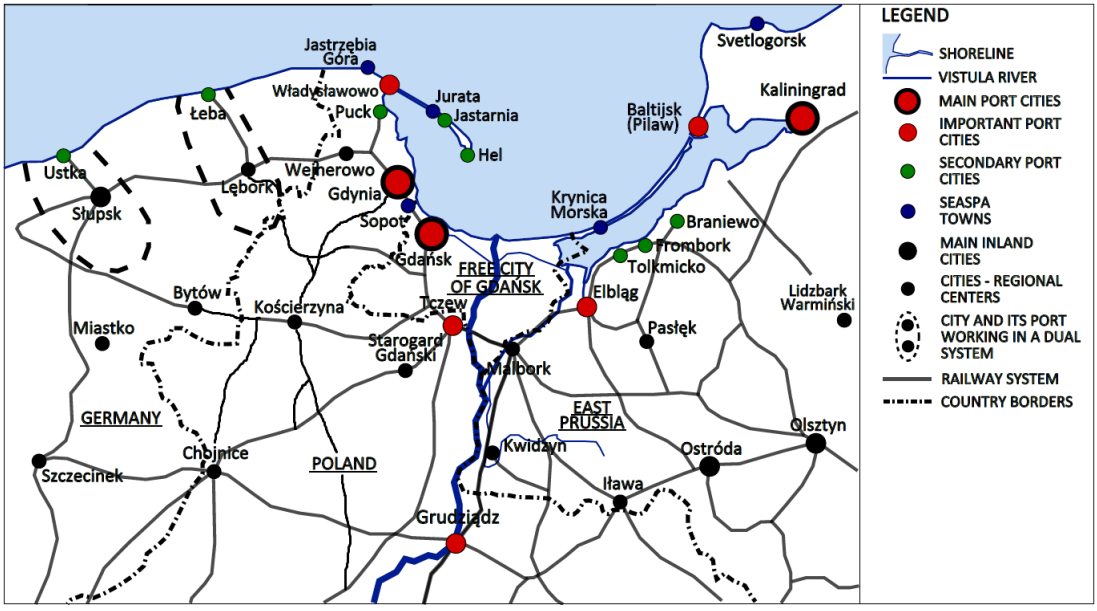

Figure 6. Gdańsk Bay port region geography during the interwar period. Source: Authors based on Lijewski and Koziarski (1995).

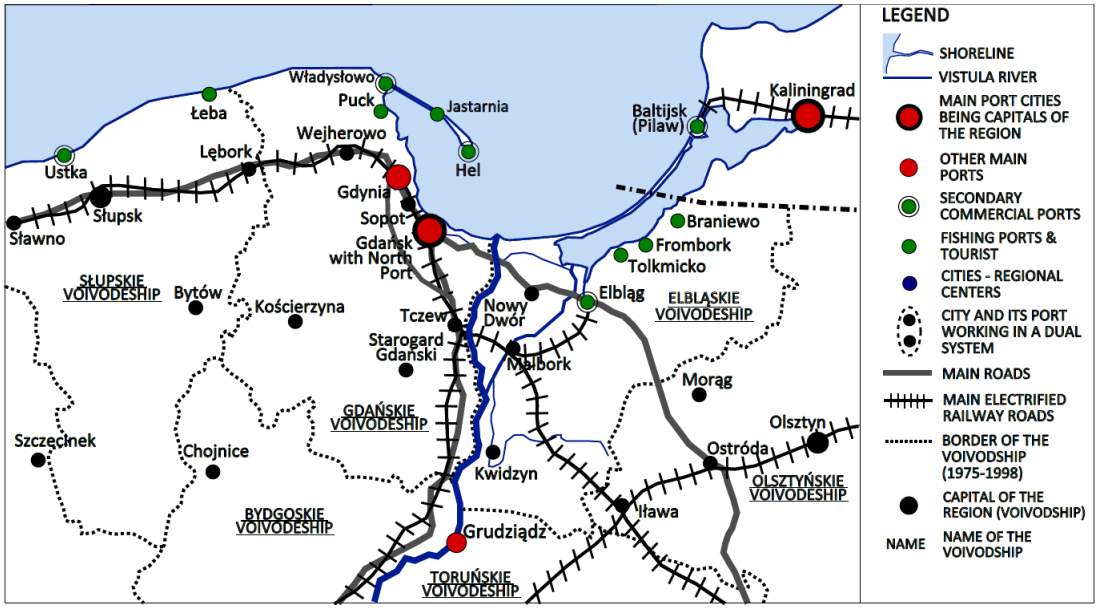

Figure 7. Gdańsk Bay port region geography during the period of 1945–1989.

During this period, tankers and bulk carriers with a draft of about 15m and a carrying capacity of up to 150,000 DWT, called Baltimax, began to enter the Baltic Sea (Piskozub, 1986). However, the Baltic ports were not fully adapted to handle such large vessels. In the years 1970–1975, a modern, deep-water northern port was built in Gdańsk, which ensured Gdańsk's competitive advantage over other areas of the region (Piskozub, 1986, p. 190). Kaliningrad, as the capital of the region (*oblasti*), was still a very important port center. The Port of Gdynia was thoroughly modernized and, by political decision (centrally controlled economy), dedicated mainly to general cargo handling (from 1969 also containers). The significance of the port in Elbląg, which could not serve seagoing vessels due to depth deficits, decreased significantly. The remaining ports in the region (except Ustka and Władysławowo) gradually lost their reloading functions and became fishing ports with a tourist service.

The northern port in Gdańsk handled mainly Polish coal for export and liquid fuels for import and transit. Based on the liquid fuel terminal in Gdańsk, a refinery was built, connected by the 'Przyjaźni' pipeline with the transmission system of other socialist countries (Piskozub, 1986, p. 190). At the same time, the shipbuilding and industrial potential were significantly developed in Gdańsk. Bulk cargo handling, just like most general cargo, was mainly based on the railway system, in which electrified main railway lines became the most important (the remaining railway system did not change much). The electrification of the Wejherowo-Gdańsk section resulted in the linear development of the cities along the railway line and the formation of a three-center urban complex called the Tri-City (Gdańsk–Gdynia–Sopot). This situation led to the restoration of the porous port region. Its structure includes main transportations spines, as well as economically and logistically excluded parts.

A very important factor that influenced the settlement system of the port region of the Gdańsk Bay was the reform carried out in 1975, which introduced a two-tier administrative division into provinces (*voivodships*) and communes (municipalities). Gdańsk, Słupsk, Elbląg, and Olsztyn became the capitals of voivodeships, thus strengthening their position as regional centers.

3.5. Post-Socialist Period (from 1990)

The development of the global container network has contributed to the strengthened position of the port in Gdynia and the development of its close logistics facilities. In 2006, a modern deep-water container and reloading terminal was built in Gdańsk, which resulted in part of the cargo stream being moved from Gdynia (with its greater depth limitations) to Gdańsk. Currently, however, both ports plan to build external ports dedicated to container handling (Krośnicka, 2019).

An extremely important factor in the development of the Gdańsk Bay port region was Poland's accession to the EU in 2005, which enabled the opening of new markets and expansion of the facilities in the ports of Gdańsk and Gdynia. The Kaliningrad port, cut off from its economic hinterland, has more difficult conditions for development in this context. However, still, some cross-border economic relations are taking place (Palmowski & Fedorov, 2020).

The development of car transport and the expansion of road infrastructure (especially expressways and highways) made it possible to carry out cargo delivery in a 'door-to-door' relationship. This strengthened the share of car transport in port turnover and created the need of vast zones for logistics activities. These zones, with a specific large-volume landscape, extend mainly along the main road routes (Figure 8). This contributed to a

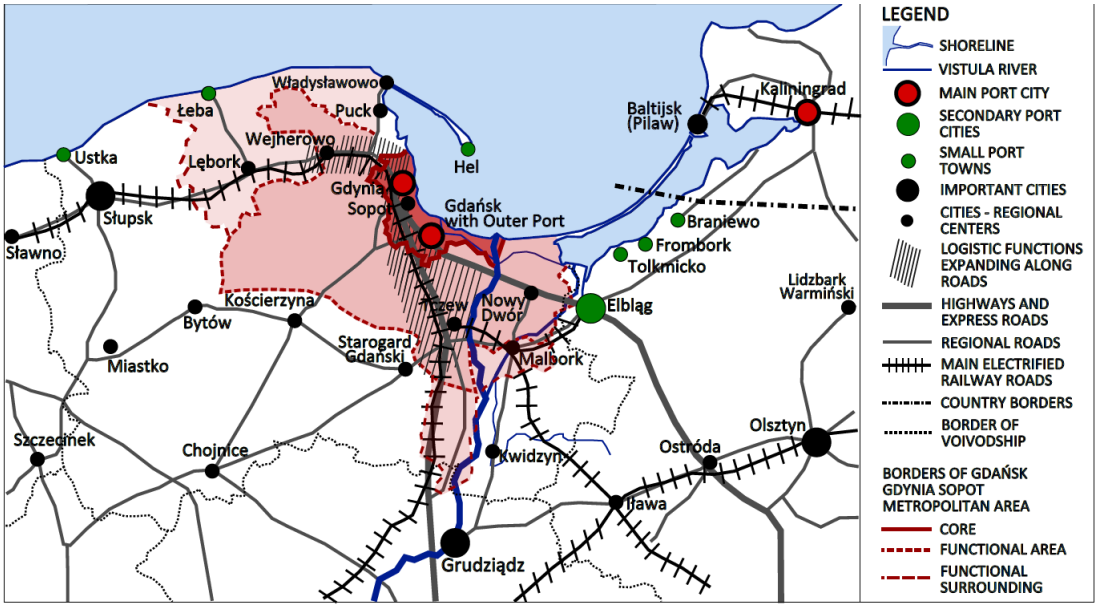

Figure 8. Contemporary Gdańsk Bay port region geography.

redefinition of the porous structure of the Gdańsk Bay port region and its dual character based on differences between deep-water cargo-handling infrastructure and leisure-oriented seaside towns.

Currently, apart from the port of Elbląg, for which investment has been made to improve the port's accessibility from the water (a ditch through the Vistula Spit), other ports are small centers of low demographic importance in the settlement structure of the region. Although they basically do not carry out any reloading activities, they are extremely important tourist centers supporting the economy of the region.

4. Discussion

The analyzed evolution of spatial changes in the Gdańsk Bay port region generally fits the theoretical models of the port-city relationship defined by Hoyle (1998) and Meyer (1991), as well as the model of the port system developed by Notteboom and Rodrigue (2005). In the case of Gdańsk Bay area, however, there is a periodic distortion in the standard course of the port region evolution caused by political factors, including, above all, the very frequent changes of territorial borders in the 1000-year history of this region (including borders of countries and voivodships). It can be assumed that if the entire area of the Gdańsk Bay had remained within one country, the concentration of cargo in one city and the centralization of the port system would have taken place under the model of Notteboom and Rodrigue (2005).

Considering such an alternative scenario for the development of the Gdańsk Bay port region elaborated according to the subsequent phases of the Notteboom and Rodrigue (2005) model, it could be supposed that Gdańsk would have ultimately become the central city of the region. In the first phase (dominance of inland transport), the port cities of Gdańsk and Elbląg would have had the greatest chance of fulfilling such a central function, due to their location in the estuary section of the Vistula, which made it possible to control the cargo flow of the entire Vistula river basin. Königsberg would have been slightly less important as a port city collecting loads from the Pregoła river basin—smaller in area than the Vistula basin. Further fate related to the construction of the railway system and bringing it to these three major port cities would probably have led to fairly even development in the importance of these three centers. In the interwar period, the port and the city of Gdynia would not have been created as competition for Gdańsk, under the conditions of the port region functioning within the same political and economic borders. In the post-war period (if a decision had been made to rebuild the port in Gdańsk at all), it can be assumed that due to the most favorable depth conditions of the port of Gdańsk (the depth of the port of Gdańsk reaches 15–16.5 m, the port of Kaliningrad is approximately 9–10m, the port of Elbląg approximately 4–5m) infrastructure investments, and with them the cargo mass, would have been concentrated in the port of Gdańsk. Thus, it can be presumed that given a situation of political continuity, the port city of Gdańsk would currently be the main center of the port region, within which port functions would be distributed among individual centers of minor importance. In the absence of a border with Russia, the port city of Kaliningrad would probably not have been as important as it is today, but it would have been included in the port region complex as a feeder port. In turn, the cities of Elbląg or Tolkmicko and Frombork, as located in the interior of the port region, would have been more important and not on the edge of the system as it is today.

This alternative development scenario for the Gdańsk Bay port region was presented here as a kind

of discussion on the port region's evolution process. It shows how both the changes made to the national borders and the historical geopolitical situation in which the region is embedded have profoundly influenced the current economic situation and the hierarchy of urban centers. From the point of view of this alternative scenario, we would observe a very different level of porosity within the port region than we see today.

5. Conclusions

Currently, there are three strong port centers in the Gdańsk Bay port region: Gdańsk, Gdynia, and Kaliningrad. The first two, due to their geographic proximity, rely on the common potential of transport and logistics infrastructure and human capital. At present, mainly as a result of the containerization process, the hinterland of the ports of Gdańsk and Gdynia is dynamically deepening. In a way, this serves as an analogy to the situation observed in the Middle Ages, when there were port centers located along the Vistula River to support the transfer of cargo from slightly smaller areas (equivalents of today's intermodal terminals or dry ports located in a distant hinterland). However, the close hinterland of the ports of Gdynia and Gdańsk has shrunk significantly. Most of the nearby areas and small ports of the Gdańsk Bay region do not currently cooperate with the ports of Gdańsk and Gdynia, but focus on functions related to the development of tourism or fishing as they gradually undergo the process of 'de-maritimization' (Merk, 2018). The ports of Władysławowo and Hel may have a chance to assume niche functions related to the maritime economy (servicing wind farms). However, it is currently difficult to determine to what extent these opportunities will be used.

In addition to environmental (the hydrological network of the hinterland of the port region) and technological factors (water, rail, and road transport infrastructure), the range and structure of the functional areas of port city regions are the result of political and economic decisions, such as changes in borders or economic and political investments. Examples given include: the redirection of waters from Nogat to the Gdańsk Vistula by decree of the King of Poland in 1612 (Cieślak et al., 1982, p. 501); the construction of the new port in Gdańsk to control cargo heading to and from the old port of Gdańsk (Cieślak & Biernat, 1969, p. 275); the construction of the port in Gdynia in the 1930s to compete with the port of Gdańsk (Sołtysik, 1993); and currently plans to build deep-water ports in Gdańsk and Gdynia or the ditch across the Vistula Spit. As a result of such decisions, the geography of the port region is a dynamically changing mosaic of cities with different opportunities, hierarchies, and stages of development. Thus, the porosity of a port region evolves along with changing borders and can be strongly influenced by politics and developments in infrastructure, among other factors.

Conflict of Interests

The authors declare no conflict of interests.

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Article

Infrastructure Development and Waterfront Transformations: Physical and Intangible Borders in Haifa Port City

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Abstract
Constructed on its natural bay as a fortified Muslim town in the late 18th century, Haifa's port city transformed into a modern cosmopolitan port city in the second half of the 19th century. Significant technological, administrative, and social changes made Haifa into the transportation and economic hub of northern Palestine: Its harbor, the first in the region, became a gate to the east for commodities, pilgrimages, and ideas. British imperialism enlarged it with landfill areas and added an industrial function, constructing refineries and a connecting pipeline with Iraq. Haifa port served as the main entry port for immigration and goods for the newly founded Israeli state. Privatization and neo-liberalization transformed it from national port to international corporate hub, reshaping both port and city. Individual entrepreneurs, local governments, and imperial actions shaped and reshaped the landscape; perforating new access points, creating porous borders, and a new socioeconomic sphere. This process persisted through the Late Ottoman era, the British Mandate, and the Israeli state. From the first Ottoman landfills to the sizeable British harbor of 1933, the market economy led urban planning of Haifa's waterfront and its adjacent railroad to the current Chinese petrol-harbor project. What were the city's tangible and intangible borders? How did these changes, influenced by local and foreign agendas, unfold? Tapping into built-environment evidence; archival documents (architectural drawings, plans, maps, and photographs); and multidisciplinary academic literature to examine Haifa's urban landscape transformation, this article studies the history of Haifa's planned urban landscape—focusing on transformations to the port and waterfront to adjust to new technologies, capital markets, and political needs. We thus explore Haifa port history as a history of porosity and intangibility—rather than the accepted history of European modernization—building upon theoretical literature on global networks and urban form, regional dynamics of port cities, and tangible and intangible border landscapes.

Keywords
Haifa; infrastructure development; Israel; modernity; porosity; port city

Issue
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1. Introduction

Ports and port cities present a history of spatial situations defined by flexible borders, as porous access points connecting distant places and facilitating movement of goods and people worldwide. Natural harbors, developed into ports, gave rise to numerous cities on rivers and seas, fundamental infrastructure for economic development and cultural interconnection. Ports provided the necessary facilities to connect land and water transport, including the development of docks and breakwaters, redesigned coastlines, and landed infrastructure at the intersection of water and land. These spatial elements enable the porosity of tangible borders. Therefore, the

elaborate infrastructure of piers, wharves, docks, and warehouses—produced for transhipment of goods and people—constitutes a porous border demarcating tangible borders as intangible borders. Around the world, these intangible borders attracted markets and trade, significant brokerage and exchange, and the formation of permanent settlements: the port cities (Hein, 2014).

Port infrastructure and landed structures were crucial for port survival, an issue of imperial and national importance involving commercial and cultural interest groups. As the nature of goods changes, ships' nature and docking infrastructure change accordingly. This has accelerated with industrialization in the 19th and 20th centuries (Miller, 2012). More extensive and more specialized ships—sail ships to steamships, to container ships and oil tankers—demanded deeper docking pools and larger cranes, railways, warehouses, administrative areas, and worker housing. They changed the waterfront and urban fabric of port cities, and the grain of porosity required of port landscapes. Transformations to London, New York, and Rotterdam's well-researched ports portray the tremendous impact of port infrastructure development on the port city and its bordering geography (Meyer, 2003; Smith & Ferrari, 2012).

Because of geographical, political, economic, historical, climatic, and other attributes, port cities differ in their specific landscapes of intangible borders. This article studies Haifa's port and port city's history as a sphere of intangible global and local borders since the mid-18th century. It depicts a specific history of porosity transcending Haifa's accepted, bracketed history in the context of Empire, colonialism, nationalism, and globalization. Our findings indicate that Haifa's water and landed infrastructure constantly transformed the water and landed borders of its port responding to changes in transported goods (cotton, crude oil, immigrants, etc.), movement direction (in or out), and the technological challenges these changes posed to the port's survival. Further, our findings indicate that a diversity of actors were involved in constructing Haifa's port infrastructure and the city, with significant implications for the nature and location of border spheres. Haifa started as a local-dominated port, exporting cotton to Europe as an alternative to Acre's Ottoman-dominated port. In the second half of the 19th century, the Ottomans transformed it into a modern cosmopolitan port city. The British Mandate of Palestine designated it as the Empire's main port in the Eastern Mediterranean for crude oil from Iraq. Haifa port served as the main gateway for Israel since statehood. Run by global corporations, Haifa port has transformed again into a global container port. To explore this history as a history of porosity and intangibility—rather than the accepted history of European modernization—this article builds upon three spheres of theoretical literature: global networks and urban form; regional dynamics of port cities; and tangible and intangible border landscapes.

2. Theoretical Framework

2.1. Global Networks and Urban Form

Port cities are unique in the built environment for providing a water-land transition space (Hein, 2011, 2016; Hoyle, 1989; Hoyle et al., 1988). Ports constitute the spatial infrastructure for the transmission and exchange of people, materials, and ideas in a network system that connects the nodes of the global geography of commerce (Castells, 2000). The design and development of port facilities and land connections to the port determined port survival over time and constituted an issue of social, political, and economic importance: "In the process, they added layer upon layer to social and cultural networks and inscribed wealth into the built environment, building and rebuilding port infrastructure and urban structures" (Hein, 2014, p. 342). Understanding the landscape of ports and port cities as instruments for forming and sustaining the port as a global node is vital for studying this phenomenon.

Port landscapes were reshaped by new infrastructure technologies as maritime steam engines increased marine trade in quantity and speed (Carmel, 2010; Kitsikopoulos, 2013; Kozlovsky & Grobman, 2017). Railroads and steam-powered trains spread goods and peoples inland (Amit, 2007; Christensen, 2017; Hein, 2014; Simonowitz, 2014). The oil industry facilitated the new Petroleumscape of refineries and gas stations (Barrett & Worden, 2014; Hein, 2018; Szeman, 2012; Watts, 2009), while containerization separated cities from ports, creating industrial zones (Hein, 2016; Hoyle, 1989; McGovern, 2008). Adaptation of the ports, urban structures, and their natural environment following new technologies, shipping needs, and ideas required planning and collaboration between public and private actors (Hein, 2014).

In the last thirty years, planning theory and practice has changed from traditionally precise bounded scales (national, regional, local) to the study of transgeographical landscapes, focusing on networks, hubs, webs, corridors, flows, zones, and soft spaces (Castells, 2000; Graham & Healey, 1999; Heley, 2013; Paasi & Zimmerbauer, 2016). While much of contemporary scholarship on globalization focuses on fast modes of transportation (planes, trains, and cars) arguably globalization is more effectively enacted through ports. There, regional and global networks connect, transforming and developing the built environment and urban form. The global shipping market transports most commodities globally (90%), in line with their historical role as global nodes (Hein, 2016). The disciplines involved in the study of port cities include history, economics, transportation, and ecology, requiring further inquiry into the history of architecture and urban planning, focusing on the longue durée of transforming port landscapes (Hein, 2016).

2.2. Geographic Dynamics of Port Cities: Politics, People, and Built Environment

Port cities attract people, power, social and cultural capital. Empires, states, and regional authorities struggle to control and annex them to their territory and operate through them (Driessen, 2005; Hein, 2010, 2014). Commercial companies and individual entrepreneurs participate in political struggles representing their countries and communities, often waged via the port's development and infrastructure (Dündar et al., 2014; Hein, 2016). Space is a social product resulting from constant ongoing struggle between diverse political agendas, ideologies, narratives, and motivations (Lefebvre, 1991). Port cities represent a rich history of such social productions of space, where struggles over territorial control changed the borders of regions, states, and empires in the course of history.

In the Eastern Mediterranean, borders have changed dramatically in the 19th and 20th centuries as Empires, European powers, and the Ottomans have raced for economic and religious power, shifting regional borders through governmental reforms and war (Kark & Frantzman, 2010; King, 2015). With the rise of nationalism in the MENA and particularly the Israeli-Palestinian conflict over Palestine's territory, borders were rapidly drawn and redrawn, determining spheres of affiliation, identity, and recognition (Allweil, 2016, 2017; AlSayyad, 1995; Said, 1979). In the age of capitalism and global markets, spatial conflicts shifted again from national-religious to civil society, with diverse social groups struggling for the right to space (Jabareen, 2015; Yiftachel, 2006). Due to climate crises, new civil demands are rising, opposing the petroleum industry, and calling for sustainable planning (Hein, 2018; Wilson et al., 2017). Through the last three centuries, authorities, economic actors, and inhabitants created and recreated physical and intangible borders via the port, thereby reshaping port and port cities (Fenster, 2019; Schumpeter, 2013).

2.3. Port Cities: Tangible and Intangible Landscapes

Port cities connect to their hinterlands and a network of other port cities. They produce flow and exchange through these intangible borders both in the physical aspect of infrastructure for water-land transport and in the imaginary aspect of the flow of ideas (Castells, 2000; Hein, 2016). Intangible borders are often discussed in the context of conflict-zone case studies, either religious, ethnic, national, or economic (Piquard & Swenarton, 2011). Likewise, the study of ports and port cities in the fields of transportation, tourism, and immigration often discuss ports as spaces of conflict, examining attacks on port facilities and transit systems as well as conflicts revolving illegal travel, tourist misconduct, or tourist exploitation (Khosravi, 2010; Prentice, 2008).

Studies in architecture and urban history examine the design and development of port landscapes as spheres of conflict over domination, capital accumulation, identity, and heritage. These studies highlight the potency of the intangible elements of architecture and urban space in mediating and negotiating socio-spatial borders in the cityscape, in ethnic conflict areas like Cyprus or Israel–Palestine (AlSayyad, 2013; LeVine, 2001). These studies point to port landscapes as abstract boundaries, a phenomenological spatial experience that is primarily conceptual. In addition to tangible physical components in the landscape, ports include place-making boundaries that are time-contingent and shaped by human performance, with overlapping governance systems and flexible coalitions of actors, making them hard to decipher using mainstream categories (Hein, 2019).

Foucault conceptualizes the ship as the ultimate 'other space' (Foucault, 1985). A well-bounded physical space with clear tangible boundaries that, nonetheless, bears the inherent capacity to transcend the tangible borders of land and water, foreign and domestic, port and ship, making it an intangible instrument of border crossing and contamination (Dehaene & De Cauter, 2008). Ports and port cities echo this design. However, the intangible border between land and waterways has not been appropriately historicized. This article explores Haifa's port and port city's history as a history of tangible and intangible landscapes designed for border crossing.

3. Haifa Port City: Border Transformations

This study involves archival research of the history of Haifa's porous urban landscape and port infrastructure. It focuses on primary sources documenting changes to the landscape—historical maps, land surveys, historical photographs, construction documents, and drawings produced by architects and engineers. Our findings point to a porous historiography, transgressing clearly demarcated time periods and geo-political frameworks.

3.1. Haifa al-Jadida, A New Port City in the Eastern Mediterranean (1761–1850)

At a time of weakness for the Ottoman empire, the local Muslim ruler of Galilee Ẓāhir al-'Umar al-Zaydānī (1761–1775) gained power over almost all of Palestine and today's southern Lebanon up to Sidon, controlling cotton-growing and manufacture around Acre and the Jezreel Valley (Philipp, 2001). The declining Acre Crusades port urged al-Umar to seek a new port and establish a new port city for commercial purposes. Old Haifa—Haifa al 'Atiqa—was a small town on the west coast of the Mediterranean Sea, on the southern entrance to Acre's Bay. With its two protecting forts, Haifa's mooring, the best in the eastern Mediterranean between Egypt and Turkey at the time, had safer docking conditions for ships. However, it needed more protection against pirates and weather conditions (Yazbak, 2013). In 1761 al-'Umar decided to build a new city

three kilometres east into the bay by reusing stones of old Haifa to build the new fortified city and jetty (Figure 1; Oliphant, 1886). Seeking new markets for agricultural produce, al-'Umar strengthened connections with French commercial companies convincing them to embark at Haifa on their way to Tyre and Sidon (Carmel, 1985, 2010; Joudah, 2015; Philipp, 2001; Yazbak, 1998). Initiating the commercial relationship between cities overseas, shipping companies started anchoring at Acre's Bay regularly, creating an access point to northern Palestine by perforating Ottoman territorial borders and juxtaposing hierarchies of international trade.

The new fortified city of 20 dunam included souks and a mosque at its central public space by the shoreline, surrounded by residential quarters. Fortifications included a trapezoid-shaped longwall of 630 meters, a 270-meter base along the shoreline, and two castles, one on the hill above the city and another in Wādi Rushmiya. Old Haifa inhabitants, primarily Muslim, moved to the east quarter, above the administrative centre. The harbor attracted migrants to Haifa, including Christians of different sects who settled on the western side of the city (Yazbak, 1998). The city's administrative area managed its economic, religious, and cultural functions, including the *Saray* (government house), A-Za'ir mosque, and a customs house. The grain Bazar and other markets spread along the shoreline and dock, adjacent to Al-Jarina Mosque, opposite two churches. As in other traditional Muslim cities, residential quarters included narrow streets descending, down the hill, between blocks of gated courtyard family houses (Abu-Lughod, 1987; AlSayyad, 1995, 2013; Ben Hilell, 2020; Çelik, 1993; Jayyusi et al., 2008). Perpendicular streets parallel to the main road and shoreline followed the topography to create the city's grid. Residents built one-story Liwan houses and maintained small gardens in their walled plots. Some families also cultivated orchards on an agricultural plot for growing vegetables on the mountain's sloped terraces (Ben Hilell, 2020).

Al-'Umar's goal was to build a new secured port to attract more European shipping companies, gain tax profit on maritime trade, and protect the Haifa-Acre path from both pirates and Ottoman rulers (Yazbak, 1998). Despite his efforts, the town remained a closed community whose porosity remained small-scale.

3.2. Hybrid Local-Cosmopolitan City (1850–1917)

Half a century later, the porous nature of Haifa's port landscape intensified. Unharmed by Napoleon's conquest of Palestine in 1799 and the Egyptian conquest of Haifa in the 1830s, it was the only remaining harbour in the Eastern Mediterranean until the 1850s. As all ancient ports sank or piled with rubble and shipwrecks—the cases of Acre and Jaffa, where ships anchored in the sea, unloading goods into small boats to navigate between the rocky water (Gordon, 2006; Kark, 1984). The Crimean War led to the Paris agreement of 1856 which increased European presence in the region and established significant administrative and governmental changes that permitted non-Muslim religious freedom and equality (Çelik, 1993).

The Ottoman administration and residents aimed to transform Haifa into the modern centre of northern Palestine (Yazbak, 1998). At Haifa's quiet bay, several European shipping companies loaded agricultural

Figure 1. Haifa, looking towards Mount Carmel, April 1839. Source: Roberts (1839).

products from Galilee, Hauran, and the Jezreel Valley. In 1854, a hydraulic press was installed on the dock to package cotton before loading. In 1855–1859 a 30-meter walled pier was built by the Russian Trading and Shipping Company, perpendicular to al-'Umar's dock to serve Christian pilgrims. A decade later, in 1866, the port's platform needed an extension due to sand flow blocking the ships' way. The city's Ottoman administrators appointed Gottlieb Schumacher, a local German-Templer architect, as district engineer to extend this pier by wooden and iron piles enabling the sand to flow rather than pile up (Ben-Artzi, 1994). Port infrastructure therefore positioned Haifa as the site where imperial and local borders turned porous.

Soon, this modest dock infrastructure no longer supported growth in agricultural export, served by new steam engine ships (Kitsikopoulos, 2013). In response, multiple modernization initiatives contributed to adjust port and city to the growing movement of people and goods; further puncturing its borders and increasing its porosity. Diverse initiative groups—a mix of Ottoman government, local entrepreneurs, bourgeoisie, urban migrants, European commercial companies, professional engineers, and pilgrims—generated a complex plethora of environmental developments with differing levels of porosity.

Modern developments included the harbor and breakwater, landed infrastructure to the port by train, roads, and bridges (Amit, 2007; Christensen, 2017; Simonowitz, 2014), as well as the city's waterfront, new neighbourhoods, and commercial facilities (Yazbak, 1998). In the 1880s, a new seafront was constructed upon 16,500 square meters of landfill designed for tying steam ships. It included a trapezoidal seafront wall protruding 5.5 meters above the wharf line. The new dock was served by a new 10-meter-wide road along the shore for camel caravans transporting the goods to Jaffa in the south, Acre in the north, and the Israel Valley to the east. Diverse entrepreneurs constructed massive warehouses of 50 × 10 meters on landfilled area for safe storage of imported goods (Figure 2). The plethora of infrastructure served the many actors involved. For example, during the 1890s a small breakwater was built in front of the Templar's colony for embarking passengers, in anticipation of the German Emperor's visit in 1989, while on the other side of the harbor a new breakwater connected to the railway. Each dock, breakwater and warehouse puncturing the tangible land-sea divide at a difference scale and for a different purpose.

One of these initiatives demonstrating how Haifa port infrastructure transformed demarcated affiliations and hierarchies of power, and ultimately its border landscape, was the construction of the Haifa-Damascus railway. Initiated in the 1880s by Laurence Oliphant and the local Sursock family, construction started but halted after 3 kilometres due to financial problems. In 1892, two railway companies resumed laying the railway line from Haifa to Damascus: the British Peeling and the Ottoman Syrian railway company. The railway's section between Haifa and Bisān (today's Beit She'an), connecting Damascus to Daraa, was planned by Schumacher. Dealing with competition from the Beirut-Damascus line, diverting agriculture export from Haifa to Beirut, as well as financial difficulties, stopped construction short with

Figure 2. Postcard, unknown photographer, unknown issue date, Eli Roman Collection.

only a 10-kilometre line completed (Ben Hilell, 2020; Goren & Sahfran, 2006). In 1905, now promoted by Sultan Abdülhamid II as a tourism-pilgrimage Muslim project, the railroad connecting Haifa to Damascus was completed and connected to the Hijaz Railroad between the Empire's centre and holy city of Mecca (Christensen, 2017; Landau, 1979; Simonowitz, 2014). A total of 286 kilometres, Haifa's railway to Damascus included construction of 442 bridges, six viaducts, and seven tunnels and excavated passages (Amit, 2007; Ben Hilell, 2020; Kushner, 2018). The Haifa–Damascus section of the Hijaz Railway linked the Mediterranean Sea to the Empire's central railway line, transporting 16,000 tons of materials per year between 1903–1905 and establishing the 1400-kilometer Damascus–Medina railway.

Port development fostered three migration waves changing the city's human landscape and creating both tangible and intangible borders between the different groups. Between 1850–1870 immigrants included peasants of northern villages, entrepreneurs from Greater Syria, and first European settlers and consuls, each group settling in distinct areas of the city. The second migration wave of 1871–1904 brought primarily foreign communities including Maronites from Beirut and European communities who gathered around their consulates from Britain, France, Austria, Denmark, and Sardinia, and new consulates from Russia, Prussia, the United States, Greece, and the Netherlands, producing connections between Haifa and important port cities. The Templers' rural colony west of the city, and Bahá'íans colony marked the city's religious connection with distant communities (Carmel, 1985; Yazbak, 1998). The third wave of 1905–1912 included worker-migrants and changed the city's class landscape. Migration waves transformed Haifa from a small port station to the cosmopolitical transportation and economic centre of the region. New connections between individuals and organizations enabled navigation in a growing sphere spanning the MENA and Europe.

Urban migration needs led to new neighbourhoods outside the city walls, pushing the town's reconstruction: City walls were demolished, their blocks used to construct the first new neighbourhoods, spreading to east, west, and up the mountain's slopes (Figures 3 and 4; Ben Hilell, 2020; Yazbak, 1998). Growing revenues from the port contributed to changes to the local vernacular Liwan house by additions of second and third floors forming a new hybrid local-Mediterranean model (Ben Hilell, 2020). Housing needs changed housing culture from gated family houses to villas and apartment houses that opened to the streets, rented for landless dwellers (Ben Hilell, 2020). Local stonemasonry techniques matched with imported architectural elements and materials created a new house model, the Centre Hall House, with red-tiled roof (Fuchs, 1998). Modern public facilities including schools, hospitals, and banks served the cosmopolitan community of Haifa as meeting points for its diverse population as porous intersections in the tangible and intangible borders between them.

3.3. Colonial Port City in British Mandate of Palestine (1917–1948)

At the end of the First World War and the Ottoman Empire's collapse, the southern territory of 'Greater Syria,' which included the vilayets of Beirut, Aleppo, Damascus, and Jerusalem Mutasarrifiya, was divided by the victorious allies disregarding previous regional divisions: The British got the Mandate on Palestine and Iraq, France the Mandate on Syria and Lebanon (Fildis,

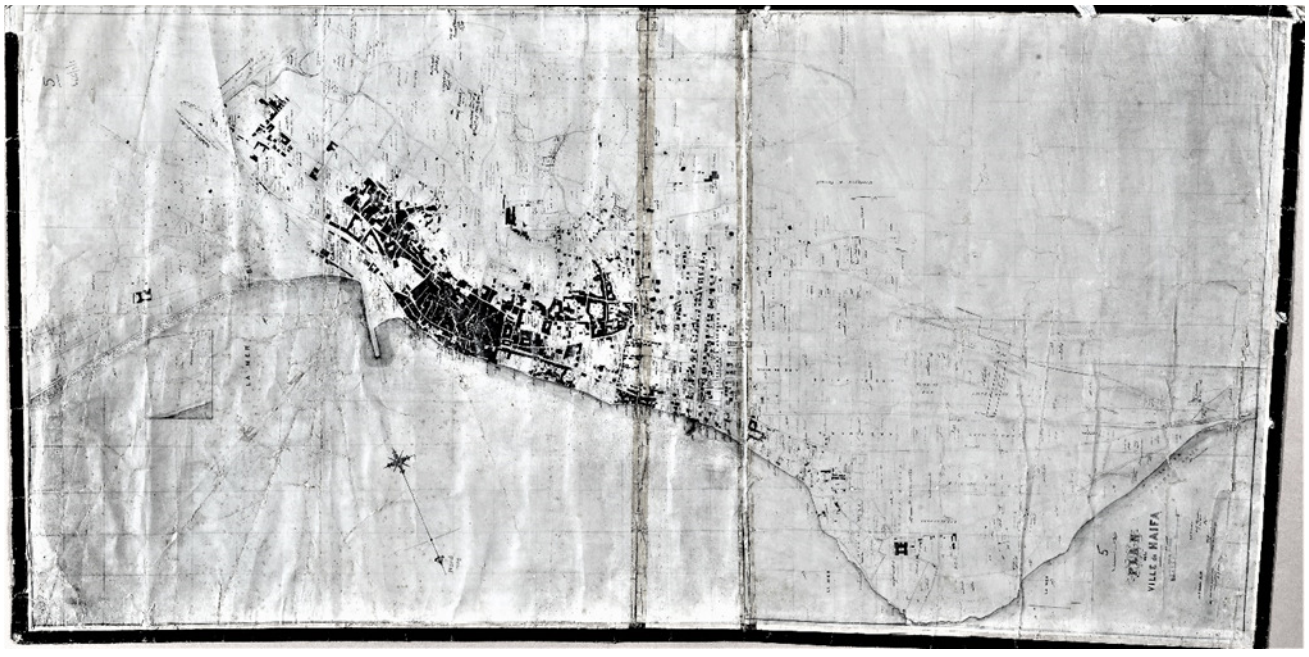

Figure 3. Haifa, 1911. Source: Schumacher (1911).

Figure 4. Aerial photographs of the Australian Air Force photographed on June 8, 1918. Source: Australian Air Force (1918).

2018; Yazbak, 2000). Haifa transformed from a regional Ottoman port city to a British economic and strategic colonial entry port to the oil-rich Middle East and India reflected on Haifa as part of the British empire (Mitchell, 2003), evident in the map of 1934 (Figure 5).

In 1925, the British-owned company Turkish Petroleum (later Iraq Petroleum Company) was granted sole rights for exploiting oil in Bagdad and Mosul requiring a deep-water port for exporting petroleum products (Kolodney & Kallus, 2008). As a strategic imperial decision, the location of this new deep-water port was decided by Winston Churchill, Secretary of State for the Colonies, who appointed engineer Frederick Palmer to survey the region (Fine, 1998; Stern, 1981). Palmer's report rejected old ports in Jaffa, Gaza, Beirut, and Tripoli for their deteriorated state, or utilizing Port Fuad in Egypt. Haifa was selected for its natural bay, existing infrastructure connecting to the hinterland, and better defence, economic, and engineering aspects (Palmer, 1923). Local and international commercial companies played an important role in developing the new territories, promoting diverse initiatives to the High Commissioner of Palestine Herbert Samuel and local colonial authorities. The harbor was built between 1927–1933 with limestone from Atlit's quarry and 360 dunam landfill. Two breakwaters, the western one 2,210 meters long beginning at Bat Galim, and the eastern, 765 meters long, started near the Kishon river's estuary, created a vast docking pool. Two piers extended the east landfills creating separate loading areas for oil products and general commodities. In 1928, the fuel terminal was separated from the commodities terminal by adding another small cooling mooring near the Kishon estuary (Figure 6).

New land connections with neighbouring countries—Lebanon, Trans-Jordan, Egypt, and Iraq—require new land infrastructure. Therefore, new railway lines and pipelines to Iraq were constructed. British planner Clifford Holliday divided the vast landfilled area into three land use sections: the north strip for the port, the middle for the railroad, and the third for urban mix-use of offices and stores. An oil storage area built in front of the Ottoman rail station on the landfill, and additional 20 acres of oil storage facilities was added north to the breakwater in 1932 for Shell, Socony-Vacuum, and Iraq Petroleum Company use (Herbert, 1989). In 1934 the refineries were built connecting to the 998-kilometer pipeline from Kirkuk. The Iraq Petroleum Company constructed oil docks, submarine loading lines, and other terminal installations. In 1938 the first international airport was built near the Kishon to use 'Imperial Airways' amphibian aircrafts that maintained the line between Europe and Asia.

Figure 5. Haifa, 1934. Note: The bright yellow part is the filled era of the new deep-water harbor. Source: Ciffring and Loewy (1934).

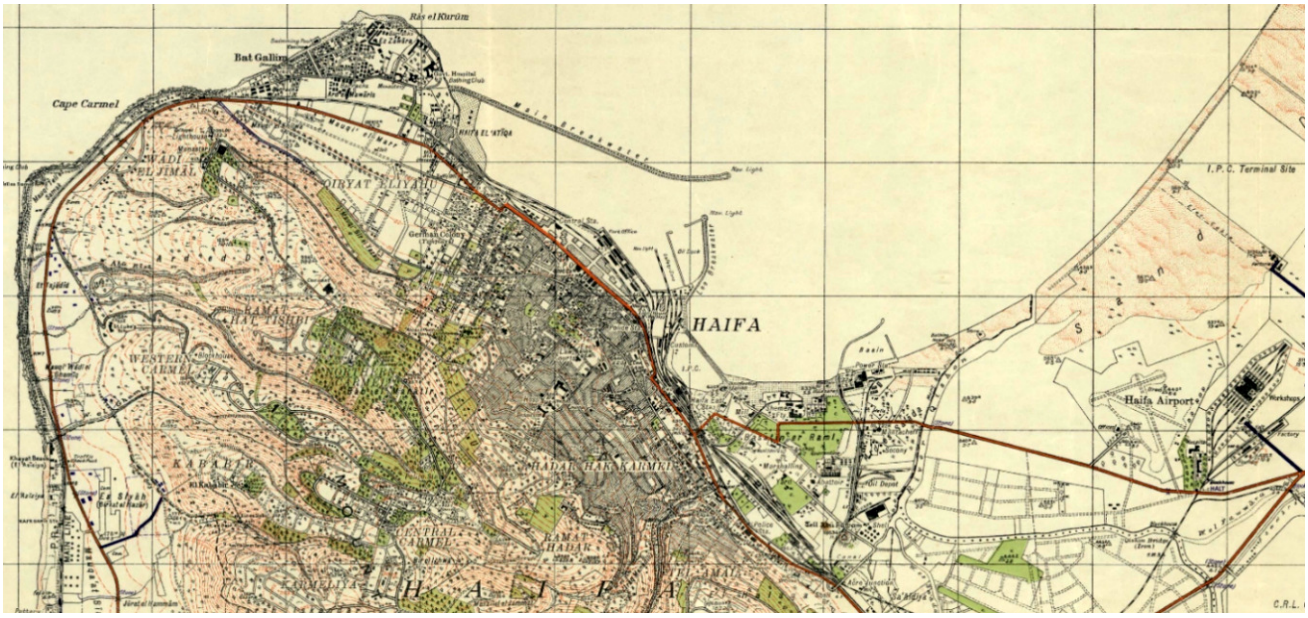

Figure 6. Haifa, 1942. Source: Haifa Municipal Archive (1942).

Haifa city planning was extensive during the British Mandate. The British employed noted planners Patrick Geddes, Patrick Abercrombie, and Clifford Holliday to attach the port to the city, reflecting the empire's needs. The British financed and built local and national infrastructures and demolished areas they characterized as slums. Throughout the British colonies, 'cleaning' slum quarters by demolition and reconstruction legitimized modern planning and enforced new land-use zoning, public health, and hygienic standards (Abercrombie, 1935). As soon as the Patrick Geddes' survey and New City Plan of 1920 were completed, the demolition of Ottoman Haifa began. The first phase cleared space for George V Avenue crossing in the middle of the old town, followed by the Skeleton Zoning Scheme of 1934 and detailed plan for the Old City of 1938 for demolition of 335 dunams, only partly completed due to the 1936–1939 Arab Revolt and the 1948 war (Kolodney & Kallus, 2008).

As a transit hub, many Mecca-bound Muslim pilgrims came through the port. Increasing numbers of Jewish immigrants entered Palestine through Haifa port, many stayed in the city due to diverse working opportunities in the port or one of the new factories. The city's population grew from 20,000 at the end of WWI (with 17,000 Arabs and 3,000 Jews) to about 145,140 inhabitants in 1946 (Yazbak, 1998). As a 'mixed city' with 70,910 Arabs and 74,230 Jews, the city developed new neighbourhoods that spread up mount Carmel. Most of the Arab population stayed downtown, while Jewish immigrants settled in new neighbourhoods uphill (see Figure 7). Out of seven mixed cities in Palestine, Haifa remained mixed until the British left on May 18, 1948. Since its first council election in 1927, the city elected a mixed municipality, cooperation that continued even as the Jewish-Arab conflict intensified at the national level (Goren, 2004; Kidron, 2020) and reflected civil society's prosperity with multiple joint businesses and culture (Goren, 2004; Sharfman & Nachmias, 2006).

3.4. National Port of Entry (1948–2000)

With decolonization processes at the close of WWII, Haifa's borders changed again. The struggle over Palestine led to the 1948 war that divided the land and established new physical and political borders that eliminated Haifa's porous landscape by disconnecting its infrastructure to neighbouring countries and Iraq.

As a city, Haifa suffered traumatic demographical change between the United Nations 1947 declaration and close of the 1948 war. Half of its inhabitants, most of the Arab population, fled or were expelled through its port, leaving only 3,566 Christians and Muslims transferred to the Wadi Nisnas neighbourhood (Goren, 1999). Immediately after the war, the Haganah Jewish paramilitary organization demolished downtown Haifa (Goren, 1994), executing British plans for urban renewal while erasing the historical cityscape (Kolodney & Kallus, 2008). This solidification of border landscapes in the context of national struggle involved the nationalization of 93% of lands as state property under a national-collectivist land regime (Jabareen, 2015; Yiftachel, 2006), displacing 780,000 Palestinians, and demolishing around 400 villages, towns, and cities, known as the Palestinian Nakba (Morris, 1987).

As the main port for the regionally isolated Israeli state, Haifa's became the main national port for entry

Figure 7. Haifa, 1958. Source: Junction of four maps of Haifa by Perry-Castaneda Library Map Collection (1958).

and export, and main industrial centre. Haifa's economy transformed from commerce to industry, including chemical and fertilizer plants, oil refinery, foundries and steel mill, glassworks, motor-car assembly plants, electronic industry and power stations, textile mills, a shipyard, a cement plant, and so on (Rahav, 1976). Haifa became Israel's 'red city,' its inhabitants working in city factories, enlarging the city's population to 160,000 inhabitants for whom new worker housing was constructed.

The harbor was soon extended with new infrastructure to reflect the country's needs as main gateway for people and goods. Enlarged to serve as main immigration gate for Holocaust survivors and Jewish communities worldwide and a key port for exporting national products, with two deep-water wharves one for large passenger liners and the other for cargo vessels, amounting to 98% of trade and human transport. The Palmer gate on the middle section of the port was the country's main entrance for more than 900,000 immigrants during Israel's first decade. As main entry point for immigrants, the port's supporting infrastructure included Sha'ar Aliyah, an immigrant's temporal camp of 200 dunams, established on the former British Sent Lucas military camp. As main entry point for goods, the port included extensive storage area of 59,748 square meters in 18 sheds, one of them for potash in bulk, and open dumps counted 71,415 square meters and six-level luffing portal cranes (Rahav, 1976), most noted the Dagon granary a 65-meter-high building supplying bulk grain contains 200 storage cells for 20,000-ton grains. In addition, the civilian port, the Israeli Navy established a strong military port dominating the harbor's western part, including a United States navy port. Haifa's landscape thus gradually became more and more porous, serving civilian and military, national and international, commercial, and ideological flows of people, goods, and ideas.

During the 1950s, larger infrastructure was developed expanding porosity through Haifa port. A 110-ton floating crane and a fleet of modern mechanical handling equipment, tractors, trolleys, forklifts, mobile cranes, and conveyors were introduced. Between 1952–1954 the port was extended with a new auxiliary harbor on the Kishon estuary with a 70-meter-wide entrance and two breakwaters of 600 and 350 meters to serve smaller ships and free the main port for larger ships. The main breakwater extended by 450 meters. The 765 meters long Lee breakwater created a basin of 1,038 square meters, leaving 138 meters wide open to the port facing northeast and 12 meters deep, suitable for a maximum 10.5 meters long vessels. The overall main wharf of 1,541 meters long suitable for several vessels at the same time. Landfill of 200 dunams began in 1971, preparing for containerization on Carmel terminal, in three stages: The first enlarged the British terminal, adjacent to the Lee breakwater, completed in 1973 (Rahav, 1976), the second constructed in the 1980s, is the longest in Israel, 960 meters long for regular and cooling containers and hazardous materials, and the last one completed in 2010 (see Figure 8). Israel's dependency on Haifa's port was elevated in 1961 with the decision to build two additional harbors, in Ashdod and Eilat, each managed autonomously, consequently gradually diminishing state investment in the port.

3.5. Global Node vs. Local Node (1977–Present)

Today, 98% of Israel's foreign trade passes through seaports. International trade constitutes more than 60% of

Figure 8. Haifa, 2021. Note: Chinese-corporate port in grey. Source: OpenStreetMap (2021).

Israel's gross national product. Maritime trade doubles on average every five years (Zaltzman & Armoni, 2020). Over the years, heavy petrochemical industrial factories were established near the refineries, including BAZAN (Oil Refineries Ltd), Haifa Chemicals, Carmel Olefins, and more than 27 risky factories (Raved & Kuriel, 2016). Since the 1977 elections, the political agenda changed from socialist to national liberal capitalism. According to the current neoliberal-capitalistic approach, the government privatized the harbor, selling its seven departments originally managed and operated by the state through national companies to private companies. The 2015 Israeli government's gas agreement (Israeli Government, 2015) expresses the government's aspiration and interests to extend the industrial and petroleum fabrication in the Haifa Bay and establish a national petroleum council, separated from the Haifa civil council. Privatizing the harbor and expanding oil fabrication areas aims to develop natural gas, crude oil, and condensate reservoirs in Israel's territorial water, using local and foreign commercial companies, and expanding international trade by foreign investment. The transfer of responsibility to the market reduces the impact of public opinion and municipal governance and dismantle labour unions' power.

The 2015 gas agreement enabled the entrance of foreign companies to construct and operate Israeli ports. The Shanghai International Port Group Co. won the concession for constructing the new fuel port north of the Kishon (Yellinek, 2019). The new area, a large 728 dunam peninsula, was erected perpendicular to the east bay's shore (see Figure 9). The new deeper water terminal aims to compete and connect with significant harbors worldwide, suitable for mega container cargo ships. The Israel–United Arab Emirates normalization agreement of August 13, 2020, translated to commercial outcomes with the first mega-container ship from the Emirates that came on October 12, 2020 (Raved, 2020), opening the way for a regular commercial line between India, the Emirates, Israel, and the United States. On the other side of the harbor, large cruise ships regularly embark at the passenger's terminal. Again, serving as a node on a global network of maritime trade, in the new millennium, Haifa transformed into a global transportation hub, with its economy tied to the global network.

At the same time, Haifa's porosity to global corporate trade via infrastructure for mega container ships marginalizes local interests and concerns. Increased awareness of the oil industry's impact on the global climate crisis, a growing number of Haifa's citizens and environmental organizations attempted to resist the government's aspiration to expand fossil energy use and construction of the new Chinese port. New research on the connections between the oil industry, air, water, and soil pollution and public health (Nave & Kuperman, 2016; Spector Ben-Ari, 2014; Wolfson et al., 2020), risk of earthquake in the Haifa Bay, and the threat from terrorist

Figure 9. Haifa Port during the construction of the landfilled area for the Chinese petrol-harbor in 2020. Source: Keren Ben Hilell.

attacks or bombings from Lebanon call for reducing risky factories and cleaning the area. As a result, Israel Lands Authority came up with a new plan for the Haifa Bay, 'Bay Gate Project,' also known as 'Bay of Innovation' (Yaar Architects, 2019), calling for the closure of the refineries and the conversion of Haifa Bay refineries to residential neighbourhoods, urban commerce, parks, and green lungs. What will be the result of public debate on the bay's future and how it will change Israel and the world's international connections need further study.

4. Conclusion

Haifa's port has undergone a series of dramatic transformations to its landscape and infrastructure since the mid-18th century, with implications and derivatives extending to decisions taken in Istanbul, London, and Jerusalem, goods sought in Marseille and Damascus, people coming from Europe and the MENA, and oil pumped from Basra. Haifa was inaugurated as a port city in the Eastern Mediterranean by a new local ruler interested in attracting French ships and exporting cotton and other agricultural products to Europe. Nevertheless, Haifa's walled city town planning kept the city at the local level. With the restructuring of the Ottoman Empire, Haifa served as a local-cosmopolitan hub for modernization initiated by a mix of Ottoman government, European commercial companies, local entrepreneurs, urban migrants, and professional engineers, constructing railway connections inland and a deep-water docking pool connecting vaster geographies through land and sea and producing modern grid-based city planning. International borders redrawn after WWI included Haifa in the British Mandate over Palestine, with new landed connections to Iraq, changing the nature of goods and requiring infrastructure for the transport of oil, a military port, extensive landfills, and significant city planning initiatives. With the 1948 war and the establishment of the State of Israel, Haifa became the main port of entry for goods and immigration, with significant immigrant camps and worker housing, grain storage facilities, and navy bases. The privatization of the port in the 2000s and the concession for a new deep-water container port by a Chinese corporation transformed the national port into a global transportation hub, despite labour unions and environmental activist's protests. While scholarly attention has been focusing on Haifa's tangible borders and bracketed historical periods, this article focuses on the ways in which port and city infrastructure engage in constant puncturing of tangible borders between water and land, empire, and colony, local and global.

The constant redrawing of Haifa borders between port and city, population, and commercial concerns, national/local and global, has shaped Haifa port and city. While Haifa's research tends to study well-bracketed historical periods dominated by grand power structures, this study focused on Haifa's port as an intangible, porous border that challenges the accepted literature with findings concerning the role of water and land transportation infrastructure in shaping both port and city.

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Conflict of Interests

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Article

160 Years of Borders Evolution in Dunkirk: Petroleum, Permeability, and Porosity

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Abstract
Since the 1860s, petroleum companies, through their influence on local governments, port authorities, international actors and the general public gradually became more dominant in shaping the urban form of ports and cities. Under their development and pressure, the relationships between industrial and urban areas in port cities hosting oil facilities evolved in time. The borders limiting industrial and housing territories have continuously changed with industrial places moving progressively away from urban areas. Such a changing dynamic influenced the permeability of these borders. Port cities are nodes and logistic points where various flows of commodities, wealth, and knowledge gathered before further re-distribution. These flows affected port cities by changing their spatial organization and the availability of space between borders. The main question here is: How did industrial and urban borders evolve through time in port cities? Through a historical analysis, the article explores the settlements of oil facilities and the influence of oil companies over local, regional, and national governments in creating borders and how it influenced the porosity of port cities. This article, through the petroleum narrative, illustrates the impacts of past borders on the contemporary urban form through the evolution of the French port city of Dunkirk, in the North of France. As a historical study, the article analyzes the changing relationships between petroleum industrial sites and housing areas in the city of Dunkirk, using aerial pictures, archival sources, and regulations of different periods. The importance of this analysis lies in knowing that former oil sites previously located on the periphery of Dunkirk, that were forgotten by the authorities are now located within the current urban tissue. This process demonstrates the importance of historical developments to understand current challenges in the urban planning of industrial port cities.

Keywords
borders; Dunkirk; energy transition; oil industry; port cities; urban history

Issue
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1. Introduction

For more than a decade, scholars have linked ‘porous,’ a term usually used in biology, with the concept of the border to describe all sorts of dynamics between the different urban elements of a city. Richard Sennett (2010), a leading American-based sociologist, compares the neighborhoods in a city with cells since both are resistant as well as permeable. He implies that borders are dangerous areas of interactions, serving as tense, combative zones rather than friendly sites of exchange. In 2015, Sennett elaborated on the concept of porous cities using Nehru Place, an open-air electronic market in Delhi, as an example to advocate nurturing the complexity of the

identity to make more room for diversity. Sennett (2015) describes the place not only as a true mixed use of public and private functions such as schools and clinics, but also as one which includes people coming from different nations and having various religious beliefs.

The creation of permeable borders by different oil-related actors captures the dialectic relations of separation and inclusion taking place. It also shows how the history of flows and actors, particularly linked to petroleum activities, has influenced port city's borders. Intertwined inextricably with global capital, the success of the petroleum economy depended on its continuous expansion (Szeman, 2007), which stimulated urban growth and fostered the demise and birth of borders in port cities. Where oil companies carry out oil trade and activities, environmental risks threaten cities and citizens (Hein, 2011, 2018). Since the mid-19th century, port cities worldwide have evolved together with the development of this oil industry (Tarigan et al., 2017).

To investigate how borders between industrial oil sites and urban areas evolved through time in port cities, one of the main obstacles is the precise use of terms. In the perspective of this article, precision is a challenge considering the debates around the many notions discussed. As such, it seemed particularly important to place the argument within a clear frame before illustrating the spatial importance of these changing borders in Dunkirk, a port city on the North coast of France. The particularities of the oil narrative in this port city make it a representative example to demonstrate the role of history and urban planning in identifying the permeability of borders. The article then discusses the implications of such changing interactions between oil sites, ports, and urban areas in Dunkirk. These changes are then linked to recent concerns regarding security around industrial ports and the ongoing challenges related to the energy transition and the environment. Former industrial areas with their polluting activities and formerly on the periphery are, now, in port cities' urban areas. They have become threats for the security and health of citizens and a challenge for the public authorities managing the spatial organization of industrial port cities. This exemplifies the importance of investigating the evolution of cities' porosity and borders' permeability when discussing petroleum industrial settlements and the health of citizens in port cities.

2. The Use of Terms

2.1. An Understanding of Borders and Porosity in Port Cities

The definition of port cities has always been challenging and changing through time because of their complexity (Ducruet, 2007). The role and significance of port cities tend to be particularly sensitive to changes arising from larger contextual political, economic, and technical transformations unfolding around them, as well as endogenously-initiated changes to their own built environment. It means that any serious analysis of port cities must therefore necessarily take an integrated approach to the complex interactions between a port city's-built environment, metropolitan spatial form, urban planning actors, and economic and commercial land and sea networks (Hein, 2011, p. 285).

The port and the city have long influenced each other (Hall & Jacobs, 2012; Monios et al., 2018). The economic activity of a port city depends on the competitiveness of its port, while port and industrial actors often consider urban areas as an obstacle to the development of their activities (Ducruet, 2007). This dependency also goes together with a form of competition for space, with port authorities fearing urban policies hindering their development, while cities' authorities fear an increase in adverse environmental impacts linked to the growth of port activities (Ažman Momirski, 2015). Because of such a complexity, port and city can no longer be analyzed independently, especially when talking about their economic and spatial developments, and their effects on the surrounding environments and citizens.

The notion of 'borders' in port cities is here understood as the physical and administrative delimitations between industrial and urban activities. On the one hand, the definition of port cities implies that port activities were, at first, located around, if not within the urban fabric of industrial port cities. On the other hand, the explanation of oil through its actors and activities, their importance, scales, and consequences, gives a hint on the threat that they represent for citizens' health and security, as well as on the quality of the surrounding environment. Under such a threat for inhabitants, borders evolved into a powerful tool protecting them against dangerous sites. The infrastructure often played this role, with railways, highways or pipelines creating the physical borders, cutting through cities and dividing them.

Borders are central to the definition of urban districts and industrial areas. In port cities, the changing permeability of borders through times, between industrial sites and housing districts, is another crucial aspect to consider. The influences and effects of borders are not bounded by legal or geographic considerations only. Water and pollution do not stop at borders, natural or human ones. On land or at sea, industrial activities affect citizens, animals, the air, the water, and the soil. This process means that instead of considering borders as a simple two-dimensional line, one needs to understand its three-dimensional implications. This conceptualization is a key element, especially when discussing the contemporary spatial planning of industrial port cities as it affects inhabitants for a long period.

Since the beginning of petroleum developments in the 1860s, entrepreneurs thrived on the territory of port cities like Dunkirk, building numerous storage and transformation sites for the oil coming from the hinterland and beyond. Most of them were located either at the periphery or sometimes within the city. With the growth

of the port-city, parcels hosting the sites formerly located outside the city are now part of the urban tissue. Land uses changed in time, passing from the industrial sites to, in most cases, residential areas, without much concern for the quality of the soil and the future use of the land. Public and private authorities mostly ignored the pollution and its potential effects on health and the environment before the international rise of the environmental concern in the 1970s (Brimblecombe, 1999; Mosley, 2014), while even silencing public debates around the question (Le Roux, 2015).

Jovchelovitch et al. (2020) have already exemplified the current challenges around the definition and explanation of borders and porosity in urban environments. Borders can be both tangible, with concrete walls dividing spaces and restricting movements, and intangible, through cultural or historical processes meant to segregate and configure a territory. These lines can also have dual implications as they can be areas of contact or conflict, gateways or barriers, limiting and allowing exchanges. Jovchelovitch et al. (2020) exemplified through their argument the inherent and multiple porosities of these borders, as well as the extensive factors that can intervene in their definition.

2.2. The Importance of Port Cities, Oil, Borders, and Porosities: The Case of Dunkirk

The port city of Dunkirk is located on the north coast of France, near the Belgian border, and in front of the United Kingdom. In the 1860s, when the oil business started, many investors saw potential in the resource and settled new installations in the French port city. While the area represented an advantageous location for oil actors with connections to both the hinterland and the rest of the world, public authorities considered this new activity an economic opportunity for the development of the port city. Relying on the political support of local and national decision-makers, oil actors participated in the growth of port cities but also shaped them according to their needs for land and workers.

The case of Dunkirk is an excellent illustration of the complexity mentioned above. The relationship between petroleum sites and urban areas in this port city began in the early stages of the oil industry's development. Jean-Baptiste Trystram, for instance, built the first refinery of Dunkirk in 1861 on what was, at the time, the South-West periphery of the port city. Many other sites emerged following the example set by Trystram. Many settled on the periphery of the city before being progressively included in the urban tissue, developing different borders within the city, and different permeabilities, affecting cities' porosity and their consequences on citizens. Regular incidents, combined with a growing need for industrial sites for space, led to creating a port area now 15 kilometers long in Dunkirk. This separate spatial entity, industrial needs, infrastructural, environmental, health, and security rules influenced another understanding of the relation between industrial sites and the city. Nevertheless, past and current practices linked, in the present case, to the spatial definition of borders around oil sites affected and still impact citizens and the efficiency of planning policies in industrial port cities like Dunkirk (Hein, 2018; Hein et al., 2020, 2021; Hein & van de Laar, 2020).

The long oil history of Dunkirk is progressively coming to an end with oil companies closing their refineries in the port and their facilities being transformed and disappearing. Yet, the story of its borders, their permeability and influence on the port city's porosity, as well as their polluting consequences, remain and are transferable to many other places. All the different authorities of port cities in the world experienced similar developments of industries like the oil industry, with first settlements in city centers before moving to detached and dedicated places in ports. It is important to comprehend and analyze this oil history to understand the place and characteristics of borders in port cities, together with the influence of past developments on current urban developments to better plan the future of port cities.

3. Research Question and Methodology

Based on the control that oil companies developed to support the creation of their landscape of influence (Hein, 2018), this article studies the evolution of the oil industry with its various spatial and historical developments and impacts on port cities. Taking Dunkirk as an example, it explores how the incidents around the facilities transforming or storing oil and disasters linked to its transportation influenced the evolution of its borders' permeability. These events led to new investments in planning and security around the industrial areas of port cities hosting them. Such improvements are still visible in contemporary shapes of port cities. The article highlights the link between fires related to oil, economic improvements, and new planning practices aiming at a safer environment for citizens in the French port city through archival study. The article especially explores the settlements of oil sites and the influence of oil actors by asking: How have oil companies influenced the definition of interfaces between the port and urban areas at different times?

A careful identification and analysis of urban developments from different sources will allow a better understanding of the history of spatial planning in port cities linked to oil activities. This analysis aims to highlight the evolution of port cities' borders through the lens of oil activities and demonstrate the importance of past developments on the current and future planning of port cities. The recent scholarship has proved that through the use of historical archives, mainly maps, planning documents, and writings, it is possible to locate former and lost industrial sites in the current shape of port cities and identify the incompatibilities in land uses and changing borders (Hauser, 2020). Recognizing the multiplicity of actors and

factors intervening in the evolution of the oil industry also helps to understand the role of this industry in historical transformations, spatial transformations, and contemporary shapes and challenges of port cities.

The results of this historical research are not applicable to European regions alone, but also transferable to other port cities where the oil industry had and still has a dominant place in the region's economic growth and urban development. Visualizing former oil sites in port cities with the help of historical archives is of primary importance to observe the evolution of borders and efficiently plan for the future use of these polluted sites. The study of maps and aerial pictures confirms the influence of oil industries on the permeability of borders and their consequences on the porosity of the city as they illustrate an absence of enforcement of regulations meant to improve the security of industrial sites for citizens. The creation of maps transcribing these evolutions also allows a better analysis and observation of the historical changes of borders and porosities, and their impact on contemporary shapes of port cities.

To analyze the influence of oil developments, the article uses online archives to support the argument, consisting of aerial pictures, historical reports, literature, archives, policies, and planning documents. Past and contemporary aerial pictures provided by the National institute of Geographic and Forest Information (IGN) help to illustrate the relationship between industrial sites, urban and port areas, and the priority long given to economic interests by public and private authorities in defining borders. Old pictures of Dunkirk are available on the service *Remonter le temps* (literally meaning 'go back in time') of the IGN, however it is limited to specific areas and dates, and starts in 1920 in the case of Dunkirk. Planning rules and policies but also archival maps and documents testify the pressures on public authorities and the growing control of oil actors over the decision-making process. Table 1 sums up the diversity of materials used to uncover past oil influences and their consequences over the definition of borders, and the influence of the porosity over citizens. The cross-analysis of all these resources allows for a better understanding of past developments

Table 1. A summary of the different materials used in this article.

Source	Type	Description	Characteristics
Regulations and policies	Legal texts	Rules affecting industrial activities, urban planning, health, and security	Many different types were considered, ranging from authorizations to decrees, laws, among others
Archives of the region and the Learning Center of Dunkirk	Archival documents and pictures/plans	Archives of the North County of France and of the Learning Center of Dunkirk. Comprises literature, pictures, plans, letters, and minutes from the local chamber of commerce	Many types of documents available but not necessarily online. Sometimes the description of the file in the database does not detail the content of the folder
Literature on the development of industries and environmentalism	Online and offline literature	Literature related to the location of former industrial sites in Dunkirk or in the region, with their stories, pollution issues, and influence on the planning of cities	Online articles and books give precious information on the industry of the North of France
ArcGIS	Software	ArcGIS is the software used to overlap old maps and pictures on the actual shape of Dunkirk	The overlapping of historical maps and pictures on the actual and precise plan of the city highlight the evolution of borders in Dunkirk
IGN	Online database	Online service to visualize maps of France. Through *Remonter le temps*, it gives access to past and present aerial pictures	Excellent quality of images in many places around France. Historical pictures of Dunkirk start in 1920 and are sometimes limited to specific areas
Reports	Reports of institutions or governments	Documents assessing the application of laws or the effects of policies	Reports can provide quantitative data on the effects of regulations while making a comparison to other areas

and the evolution of industrial pressures as well as contemporary challenges and complexity when planning for port cities.

4. The Narrative of Oil Borders and Their Spatial Consequences

4.1. The Early Investments and the Effects of Oil in Dunkirk

The oil venture started early in Dunkirk in 1861 with the above-mentioned Trystram's refinery. But the establishment of numerous oil sites in Dunkirk went together with rising concerns of public and private actors around the risks their activities brought around the port and urban areas. Fires related to the transport and trans-shipment of oil in Jersey and Antwerp in 1866 supported the fears around the new industry, as trans-shipment areas were in the city center and early oil sites surrounded by houses and residential districts. Actors of the port city (local authorities, citizens, and business owners) regularly addressed their concerns over the risks of this resource and its storage to the Chamber of Commerce, already pushing for more control over its trade and handling and for a more apparent separation between industries and urban areas.

By demonstrating the effects of a lack of borders on the water, the consistent fires in various ports exemplified the danger of oil activities. It is only after the authorities of the port cities of Bordeaux in 1867 and 1869 and of Dunkirk in 1868 experienced these similar trans-shipment issues that new management policies emerged. But these fires had dire and direct consequences on ports, cities, citizens, and economies. Multiple ships burnt, traumatizing the population and influencing the future shape of ports as well as their management. Among other reactions of the public authorities, new dedicated places and tools for petroleum trade appeared in Dunkirk. The transshipment docks for oil moved outside the port city centers. This new planning of ports created the first physical distinction between the city and the port.

The new port and its borders progressively led local inhabitants to lose their close relationship with the port. Industrial owners progressively settled their facilities in these areas to benefit from port facilities. Through consecutive transformations, the port of Dunkirk evolved to become one of the most important ports in France, the Freycinet Plan; the name of the public works minister Charles Freycinet triggered a first evolution in 1878 (Figure 1). The aim was not only to improve the port of Dunkirk, but the entire French port infrastructure, with new railways and canals connecting to the hinterland (Gonjo, 1972). The search for economic efficiency drove this first division of ports and cities while indirectly participating in the improvement of citizens' security against explosions and fires through the definition of a strict border represented by the distance between port activities and urban areas.

The improvements in the relation between urban planning of port-cities and the settlements of industrial sites kept, however, on being linked to dreadful events. Public and private authorities did not immediately move industrial sites storing and transforming oil

Figure 1. Maps of the port city of Dunkirk. On the left, Dunkirk in 1875, and on the right in 1910 after the modifications of the Freycinet Plan. The red circle highlights the location of the floating dam and the basin dedicated to oil, the furthest away from the city center. Source: Centre de la Mémoire Urbaine d'Agglomération (n.d.-a, n.d.-b).

into the port's territory. Oil facilities kept on settling nearby if not next to living spaces. The fire and explosion of the refinery Clère-Boilet in Coudekerque-Branche in 1891 (part of contemporary Dunkirk) highlighted, among others, the remnants of the tight and dangerous relationship that the urban fabric had with industrial sites.

The division of spaces between industrial and urban lands promoted by the Freycinet Plan for economic efficiency did not impact the already settled and long-standing oil sites in the city. In 1891, a terrible explosion in the facility followed by a great fire destroyed the site. It spread, burning oil for 500 meters, killed seven people, and destroyed numerous houses located around the facility (Denise, 1988). Inhabitants of the city alerted local authorities again to the danger of this petroleum site and its location within the urban tissue after multiple other fires broke out in this same facility. Yet this incident did not prevent the refinery from being rebuilt in the same place before eventually closing a few years later. Before the first World War, private actors, with the support of public authorities, settled multiple oil facilities nearby houses in Dunkirk, without any considerations for the risks that such activities could have on human lives, health, and the environment. The regular and previous incidents linked to oil storage, transformation, or transportation triggered a reaction from public authorities, with new designs (port areas) and planning rules (distance between industrial sites and houses), but public authorities rarely enforced them or monitored their application.

The long-standing practice of settling facilities near residential areas or sometimes right next to them represented the powerful ties between public and private actors, as well as the danger of porous borders around industrial sites. Considerations for the security and health of workers and citizens were an obstacle in the way of industrial developments and constraining rules for investors. Citizens were also benefiting from this practice. It was convenient both for employees and employers to have this permeability so long as nothing happened. The case of the refinery Clère-Boilet illustrated this problem when a deadly incident occurred. With the following settlements of similar facilities, the competent administration for the authorization required new equipment and planning rules. They became visible in prefectural documents through the authorizations given to industry to settle. These documents created new conditions linked to the settlement of industrial facilities with a two meters high wall around the facility and paved basins for storage units. These new requirements participated in the production of stricter borders between industrial sites and the rest of the city, though these sites remained within the city. This creation transformed borders which became a tool to improve the security of inhabitants against the expanding industrial activities. Industrial actors often opposed the creation and application of these conditions created at the end of the 19th century. The rejection of security rules from industrial actors was not a new thing, as an imperial decree implementing borders through distance rules between industrial sites and living areas in 1810 was similarly never applied due to the pressure of, at the time, the chemical industry (Le Roux, 2009).

This mechanism illustrates not only the difficult rise, if not absence, of borders around oil facilities in Dunkirk or their great permeability, but also the influence of industrial actors on the porosity of the port city, the application of spatial planning strategies, and thus on borders. In the example of the Clère-Boilet refinery, this influence and the reason behind the porous border and the reconstruction on the same site became evident when knowing that Mr. Clère was also the mayor of Coudekerque-Branche. His link with Mr. Trystram, who became a representative in the regional authority before being a member of the parliament and eventually senator, supports this idea of political support towards industrial activities (Denise, 1988).

4.2. A Demonstration of Power

The close proximity between urban areas and oil industrial sites represented the power of oil companies in port cities. It illustrated their lack of consideration for the security and health of citizens, as incidents related to oil activities demonstrated the danger of this planning practice, especially in Dunkirk. Yet, on multiple occasions, industrial and petroleum companies have used this proximity to its fullest, in Europe and beyond, until very recently.

The *Cité des Ingénieurs* or city of engineers in Dunkirk, designed in 1931, performed the use of both strict and permeable borders. This neighborhood, built right next to the refinery in the new port area, was influenced by the Garden City Movement advocated by Ebenezer Howard, with parks and trees surrounding the *cité* and isolating it from the rest of Dunkirk. After the Second World War, the renewal of the port city led to a clearer division between a port area dedicated to industrial activities and the rest of the city (Hauser & Roche, 2020). The destroyed refining complex was rebuilt on the exact location, within the port's territory, and along with its housing district. The 23 houses right next to the refinery had an entire modern comfort with relatively large spaces and various amenities. A railway separated the industrial area as well as the refining complex from the rest of the city of Dunkirk, creating an obvious and almost impermeable border between the urban tissue and the facility, or with the port area (Figure 2). The oil companies behind the reconstruction of this site (the French branch of British Petroleum and Petrofina) created a city within the city for the facility's executives, playing with the notion of borders in the port city.

At the time of its construction, it was a desirable place to live despite the regular incidents. The hazard linked to oil activities remained, but clearer and more impermeable borders increased the porosity of

Figure 2. Aerial picture of the refinery Petrofina France, in 1936, later called refinery BP for British Petroleum, the company owning the facility. The *Cité des Ingénieurs* is on the southwest territory of the refining complex. Source: IGN (n.d.).

industrial port cities with the creation of spaces between port and city territories that served as buffer zones. None of the previous disasters linked to oil pushed public and private actors to prevent its construction. Similar developments happened in other parts of the world, like in Iran with the oil city of Abadan (Hein & Sedighi, 2016). In Abadan, the oil-led developments and industrial borders went beyond the obvious spatial division to incorporate social ranks and status in the design of cities' districts. For instance, Abadan's oil refinery—located in Abadan near the coast of the Persian Gulf—was completed in 1912 and, until it was bombed and destroyed in 1980 by the Iran–Iraq war, remained one of the world's largest refineries which is part of the current Oil Museum of Abadan (Mehan & Behzadfar, 2018). Borders were not only multiple and discriminating but also porous with the oil facility at the center of the district and the houses of the oil company's employees around it.

The multiple and regular industrial incidents, though not necessarily all connected to oil, did not immediately illustrate the importance of strict borders around industrial sites. It is only during the 1970s, together with the rise of the environmental movement, that the *cité* started to empty. Nonetheless, it was not due to security measures; instead, it had to do with the short distance between the noise and air pollution linked to the development of the industrial activity in the port and the housing district of the refinery (Lecuyer, 2002).

The quality of life and the economic efficiency linked to port infrastructure, more than health and environmental concerns, were the main triggers deepening the division between urban and port areas in Dunkirk. The new scale of industrial facilities, constantly bigger, became increasingly incompatible with any proximity with urban areas. The need for a great amount of space to build such facilities and the pollution (noise and air) associated with industrial activities demonstrated the incompatible proximity used in the past between port and urban areas. The border switched from an absent or permeable one, merged with the urban limits at the beginning of the oil industry, to a distinctive and impermeable one separating the port from urban areas. That is geographically and administratively only, as industrial sites and activities increased the pollution and further revealed the absence of underground, air, and water borders in the port city. This need of industries for great space and the

important change in the scale of facilities created a norm, standard planning where port areas moved as far as possible from their cities into dedicated spaces.

4.3. The Forced Transition of Dunkirk

Many European port cities are now trying to deal with the legacy of oil activities and their impacts, and more significant divisions with impermeable borders are gradually being formed as a result of this trend. On the one hand, the refinery of Total in Dunkirk stopped its refining activities in 2010 and the company transformed it into a training school and an oil depot, with a new facility dedicated to the second generation of biofuels nearby. On the other hand, the former refinery of British Petroleum, called Société de la Raffinerie de Dunkerque at the time of its closure, also definitely closed in 2016. The demolition and cleaning of the latter started a few years later and are supposed to end in 2021 to host new activities. These sites being on the port's territory rather than within the urban area facilitated the already complex dismantling operations. The economic purpose of the port authority, reformed in 2008, the distance between the port and the city, as well as the gradual inclusion of local authorities and actors in the decision-making, participated in the swift transformation of the oil refinery.

With this transition, the housing district *Cité des Ingénieurs* together with the former British Petroleum refinery have now disappeared from the landscape of Dunkirk. The future will tell the efficiency of the new practices it applied to demolish and clean the site and to what extent the cleaning, vertically (soil and water) and horizontally (infrastructure), was carried out. In this case, as the site was located on the territory of the port and will receive new industrial activities, the soil does not need a more complete and thorough cleaning procedure than what a housing transformation would require. Yet, this process is a step forward compared to the numerous sites that settled in Dunkirk between the 1860s and the first World War and that were completely forgotten by successive authorities. The lack of early consideration for the protection of health and the environment, as well as the porous borders of the past, led urban activities to take over these former industrial sites. While never cleaned, the land use switched from industrial to housing purposes, creating a new kind of porous borders between remnants of past oil industrial activities and current housing functions (Hauser, 2020). The city's expansion slowly assimilated industrial lands, forgotten and formerly on its periphery (Figure 3).

5. Assessment and Discussion

With investments in other countries and an overcapacity of the refining sector in Europe (British Petroleum, 2019), European oil companies are closing sites. Dunkirk is an excellent example in this perspective because of its long oil history and the multiple permeabilities of borders that were created around its oil sites. If oil activities are slowly coming to an end in Dunkirk, the port city becomes a laboratory for an energy transition and a transformation of petroleum sites that will eventually reach many other places. Such experiments were facilitated by the distance progressively built between the port and urban areas. This distance is the tool public authorities designed to improve the security around oil and industrial sites and represents the current border between port and urban territories. The security

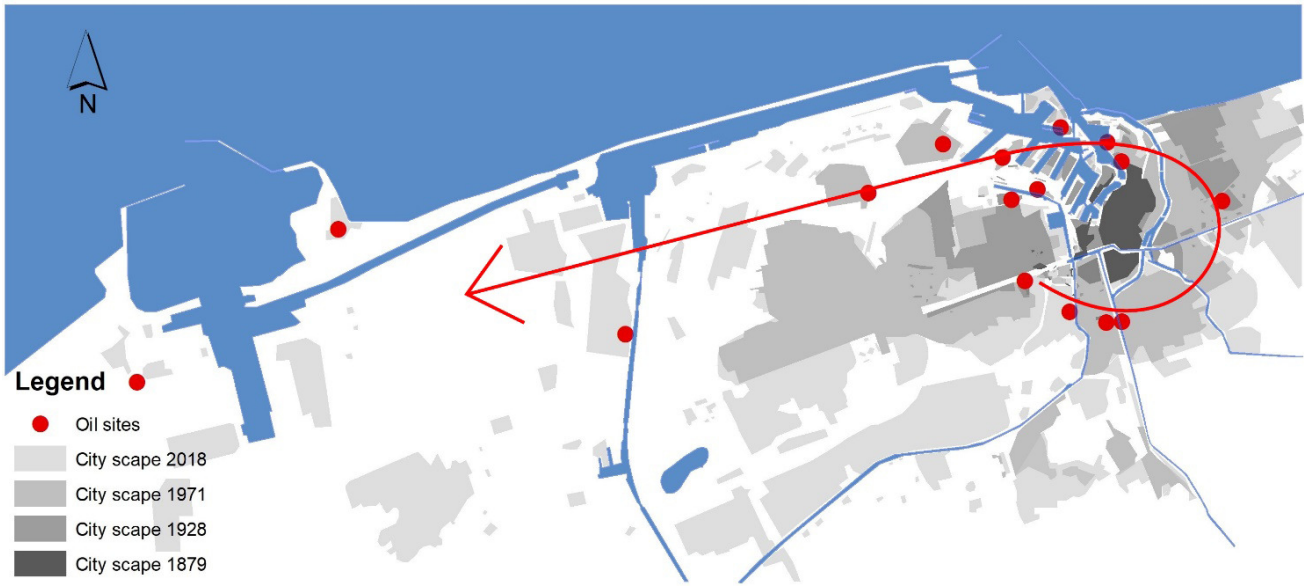

Figure 3. Map of Dunkirk showing the location of oil sites known and discovered during the research in parallel with the urban expansion of the city. The arrow illustrates the settlements through time of oil sites, from the periphery of the city towards a dedicated port area to the west. Source: Stephan Hauser using ArcGIS and archival maps of Dunkirk from Centre de la Mémoire Urbaine d'Agglomération (n.d.-a, n.d.-b).

measures implemented after multiple incidents created an impermeable border, cutting the long ties that citizens of port cities had with industrial activities and risks.

We contend that the permeable ability of the petroleum industry to the borders determines the degree of porosity of a port city. The influence of early oil developments in port cities must, however, be investigated to create safe and coherent planning strategies for the future. Recognizing the multiplicity of actors and factors intervening in the evolution of the oil industry in Dunkirk helps understand the industry's role in the evolution of industrial port cities' porosity. Historical transformations in the permeability of borders influenced contemporary shapes and remain the ongoing challenges in the future planning and development of port cities.

Historical analyses demonstrated that public authorities of port cities ended up including former polluted industrial sites into the urban fabric. This stems from an early lack of consideration for a clear division between industrial and urban activities, which, in the current shape of the city of Dunkirk, created incompatibilities as well as problems for the health of citizens with housing areas built on top of former and polluted industrial sites. The current pledges towards carbon neutrality and renewable energies will lead to additional closures of oil sites in oil-dependent port cities. This movement must trigger anticipative strategies for managing and transforming former and current oil sites together in port cities around the world.

Regular incidents are still demonstrating the impacts that disasters in port areas can have on the life of inhabitants and cities. Thousands of people and entire cities can be affected by a lack of strict borders between the living and industrial areas. The case of Beirut in 2020 also displayed the importance of analyzing the porosity and the permeability of borders rather than implement strict administrative borders in protecting inhabitants against industrial catastrophe. The blast devastating Beirut's port and city shows the latent danger of safe storage of potentially dangerous goods in modern ports, particularly those located close to the city's heart (Mehan & Jansen, 2020). Such a disaster in port-cities shows the interplay of spatial, social, economic, and cultural dimensions. The disconnection between the coordination and controlling of dangerous goods storage on the land side and abandonment of ship and cargo on the seaside seems to be the root cause of the tragedy in Beirut. With so many casualties among citizens, the disaster painfully shows that the proximity of a port to its city requires coordination, transparency, and community dialogue. Disasters' recurrence is a continuous warning to find an appropriate balance in the definition of borders' permeability and port cities' porosity. Unless treated seriously, efficiently, and strictly, port-cities, where most of these calamities happen, will keep on fearing this sword of Damocles. The long list of worldwide industrial incidents similar to Beirut support the need for a debate around the notion of borders in port cities and around industrial sites. These incidents highlight the past and present challenges and remaining industrial threats that authorities of port cities have to consider when planning for the future.

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Conflict of Interests

The authors declare no conflict of interests.

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Penglin Zhu's research focuses on the emergence of port city-region governance in Dalian, which has been triggered by Chinese economic reform. The process has arguably been driven by the Chinese central government in order to coordinate the regional economic development and environmental preservation. The development of the port city-region concept—from the plan of Bohai Economic Rim to the Belt and Road Initiative—essentially reflects new features of urbanization and industrialization policies in China. The research's overarching aim is to explore the particular logics of scale production behind the institutional, conceptual, and methodological borders of the port city-region. It studies whether, how, and to what extent the state has orchestrated the mechanism of institution and administration, the preparation of spatial strategies and urban planning, and the channels of public participation to archive the regional sustainability.

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Article

Neoliberal Economic, Social, and Spatial Restructuring: Valparaíso and Its Agricultural Hinterland

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Abstract
The analysis of the neoliberal restructuring of Chilean port cities and their hinterland suggests there was a functional coupling of neoliberalisation, precarisation, reterritorialisation, extraction, and logistics. To address this process properly, we expanded the boundaries of our analytical scale to include not only the port city, but also its hinterland, and be able to examine the flow of commodities and labour. The analysis demonstrated that the effects of neoliberal restructuring of Valparaíso and its hinterland has had interconnected ambivalent effects. Although social and economic restructuring of agricultural hinterland and port terminals in Chile increased land and port productivity and economic competitiveness, this pattern of capitalist modernisation benefitted neither the increasing masses of temporary precarious workers in the countryside nor port cities such as Valparaíso, marked by territorial inequality, socioecological damage, urban poverty, and a growing sense of closure of the littoral and reduced access to the ocean. These negative externalities and frictions have triggered local political controversies, commercial and economic disputes, labour strikes, and urban and socio-territorial conflicts.

Keywords
agribusiness; Chile; port-city; social and economic restructuring; Valparaíso

Issue
This article is part of the issue “Planning for Porosity: Exploring Port City Development through the Lens of Boundaries and Flows” edited by Carola Hein (Delft University of Technology, The Netherlands).

1. Introduction

Since the late 16th century, port cities have fulfilled essential functions for the rise and development of maritime commerce and the formation of capitalism and the world system. Port cities connected distant territories by channelling flows of commodities, migrants, money, and capital, and contributed to the diffusion of ideas and technologies (Braudel, 1982; Ciccantell & Bunker, 1998; Mah, 2014; Vormann, 2015). During the 19th century, some peripheral port cities, such as Valparaíso in Chile, became cosmopolitan places with vibrant lifestyles and internationalised economies. This romantic representation of port cities is incomplete. Indeed, port cities were also scenarios for the darker aspects of modernity and capitalism’s expansion, such as slavery, forced migration, exploitation, violent forms of appropriation and extraction of natural resources, and ecological and political colonial and postcolonial imperialism (Costa & Gonçalves, 2019; Cuevas & Budrovich, 2020; Mah, 2014).

Similarly, after WWII, there has been a fascination with the restructuring of world production, the expansion of international trade and globalisation, technological improvements, transport, and the logistical revolution. This fascination, which coincides with the expansion of neoliberalism, obliterates some less

acknowledged social harms, inequalities, conflicts, and social and environmental injustices of neoliberal economic and social restructuring. Part of this fascination lies in the incomplete representation of this transformation as the natural development of autonomous economic forces. This article shows that the neoliberal economic and social restructuring of ports and territories was a political process. Section 2 further defines our study problem as part of the wider theme of development and neoliberal restructuring in Chile and identifies our analytical scope to include the port city–hinterland relation. Section 3 addresses the territories and restructuring logics within the wider context of the world system, conceived as a network of global supply chains that are continually reorganising the international division of labour and the global geography of capitalism. Section 4 highlights some of the historical transformation of Valparaíso and its hinterland and justifies its selection as an interesting and paradigmatic case study. Section 5 deals with the transformations of the Chilean economy and port regulations through the workings of these transformative logics, and Section 6 addresses our conclusions. We concluded that the functional and structural coupling of these logics has shown the limitations of neoliberal restructuring, producing social and economic conflicts, increasing spatial and social inequality, logistical frictions and underinvestment in port infrastructure, and a deterioration of the port city.

2. The Problem and Its Context

The international literature on port cities shows that urban coastal areas have been the object of economic, social, and spatial restructuring processes for decades (van de Laar, 2020). These were normally the urban answer to deindustrialisation, the abandonment of port sites, and other significant transformations since the 1960s. The somehow paradigmatic experience of Baltimore fascinated many with the possibilities of waterfront redevelopment projects in London, Barcelona, Liverpool, Bilbao, and Genoa, among others (Jauhiainen, 1995; Porfyriou & Sepe, 2017; Schubert, 2011). Despite some common features, mostly in the physical sense, significant historical, spatial, and cultural differences between cases made them differ in terms of social consequences. Whereas some port cities experienced dereliction, land speculation, destruction of heritage, gentrification, and social expulsions, others had more positive experiences of conservation of architectural heritage, port relocation, and waterfront redevelopment, and even of port expansion (Gastaldi & Camerin, 2017; Guibert et al., 2015; Jauhiainen, 1995; Mah, 2014; Miller, 2012; Porfyriou & Sepe, 2017; Wang et al., 2007).

In Latin America, important port cities have also been the object of neoliberal restructuring. In Buenos Aires (Argentina), neoliberal deregulation and the decentralisation of public ports made it possible for the Puerto Madero Corporation—a public-private partnership—to bring about a large real estate operation in the old port district (Fedele & Domínguez, 2015). Rio de Janeiro, which was a major slave market in the colonial period, became in modern times an industrial hub and the centre of tourism in Brazil. In the last decades, its port did not adapt to new trends in industry and maritime trade, which had a negative impact and led to the decline of the Port district. This ruinous urban area became the object of real estate and financial speculation: the so-called Porto Maravilha Urban Operation, a real estate megaproject that aims at adding value to its historical and architectural heritage, establishing "a new standard of occupation for the waterfront area of Rio de Janeiro" (Urban Sustainability Exchange, n.d.). This recovery of an abandoned urban space has benefited the accumulation of private capital (Costa & Gonçalves, 2019; cf. Rolnik, 2019). The Port of Callao in Lima (Peru) is an interesting and contrasting case that shows how the neoliberal expansion of capitalism can be combined with an active and strategic function of the state to steer private investment in port infrastructure through regulation. The Peruvian Port Authority has been capable of steering port development and enforcing private infrastructure investment to secure compliance with the objectives of the export sector (Guibert et al., 2015). The literature on Valparaíso has mostly focused on the historical role of the port as an urban agent and the current controversies between different agents around the uses given to the coast: tourism, the heritage sector, port, sport, leisure, among others (Budrovich & Cuevas, 2018; Pizzi, 2017; cf. Aravena, 2020).

In our perspective, the most interesting research in the field highlights the ambivalences and difficult articulation between urban and port interests (Jauhiainen, 1995; Mah, 2014). The tensions between urban and port functions and the inherent contradictions of unequal development are present, for instance, in the defence of heritage and the recovery of urban areas that, in the long run, tend to turn into gentrification and heritagisation processes that create opportunities for investors at the expense of local dwellers. Previously abandoned spaces, such as industrial ruins and out-dated port facilities, have been reincorporated into new chains of value production within capitalism (Aravena, 2020; Costa & Gonçalves, 2019; Mah, 2014). More recently, some interesting research has been conducted on the role of logistical, financial, and informational infrastructures for production, circulation, and consumption in global capitalism (Arboleda, 2020; Martner, 2020).

Our approach aims at understanding the complex global connections that constitute port cities and their hinterland. We conceive port cities as complex urban socio-technical systems that function as nodes in global networks within the world system that contribute to the mobility of materials, goods, ideas, and people, thus connecting hinterland and foreland territories. From this network/relational perspective, port cities and regions such as Valparaíso and its agricultural hinterland in Central

Chile are "co-constituted by the global flows" of capitalism (Hesse & McDonough, 2018, p. 354).

Different from other theoretically laden studies, our ethnographic approach to the social and economic restructuring of the port city starts from the situation under study. Based on our previous research, we have carefully selected the case of Valparaíso and its hinterland due to its paradigmatic character. For one part, Valparaíso is the most relevant port connecting Chile's agribusiness to its main consumer destinations in Asia, the Americas, and Europe. Together with this, it condenses some typical problems and tensions of port city development, embodying many of the complexities of neoliberal social and economic restructuring. This case-oriented fieldwork strategy allowed us to produce a more holistic understanding of the restructuring process. We started by using the categories of port city, territory, and economic and social restructuring as 'sensitising concepts' to define the situation and develop a referential research framework to plan and conduct our fieldwork with a basic sense of guidance (cf. Mah, 2014). We observed and talked to people in their natural settings in the port city; travelled and observed inland key places, such as dry ports, monoculture plantations and highways; and collected accounts of more than 50 interviewees of different backgrounds (city dwellers, local activists, local representatives and community leaders, casual and permanent dockworkers, professionals and managers of port, logistics and commercial companies, local officials and authorities, and academics). We talked to participants in their own environments, addressing their experiences and views on neoliberal restructuring, their work, daily practices, everyday life, and social worlds in Valparaíso and its agricultural hinterland. We also conducted three focus groups (one with dockworker representatives and two with city dwellers) and one participatory workshop with city dwellers and local leaders to discuss the different problems and positive experiences in Valparaíso.

These analyses made us realise the need to, first, widen our analytical scope to include the port city-hinterland relation and, second, to reconstruct, through an inferential process of retroductive reasoning (Glynos & Howarth, 2007), the complex configuration of transformative logics restructuring the port city and its hinterland. These logics are neoliberalisation, precarisation, reterritorialisation, extraction, and logistics. These analytical elements offer a justified heuristic to understand the restructuring of territories and a first step in the process of theory building (cf. Burawoy, 2009).

From what has been said until now, the reader should retain that, first, port cities function as hubs of global supply chains and networks of production and circulation in the unequal geography of capitalism. Second, rather than theoretically posited or deduced, the logics restructuring Valparaíso and its hinterland were empirically determined. We inferred them through observation and analysis of empirical evidence. This process involved a back-and-forth movement between microscopic and macroscopic observation and analysis. In what follows, we present Chile's neoliberal transformation as the immediate historical context of Valparaíso's economic and social restructuring (a first macroscopic move).

3. Chile's Economic and Social Restructuring

Since the late 19th century, Chile's international economic insertion has been characterised by the relevance of a few extractive sectors, such as saltpetre and copper mining and, more recently, agribusiness, aquaculture of salmonids, and forestry (Ffrench-Davis, 2018). In the early 1980s, Pinochet's dictatorship implemented a revolutionary project to transform the Chilean economy and society through a series of neoliberal policies to restructure the country's productive base. The aim was to achieve market-oriented capitalist modernisation through the commodification and marketisation of vast spheres of society, including labour, land, and natural resources. After 17 years of authoritarian rule, Pinochet's dictatorship was electorally defeated. However, structural transformations favouring free market and competition, a limited state, and the culture of possessive individualism and consumption were deeply installed. In this context, the new democratic elite decided to keep the pillars of Pinochet's neoliberal capitalist modernisation intact. For years this seemed a sound development strategy: Chile experienced an unprecedented period of economic bonanza accompanied by social peace and democratic stability (Sehnbruch & Siavelis, 2014). Between 1990 and 2017, Chile's economic growth was significantly higher than the world's economic growth. During that period, the poverty rate dropped drastically, and per capita gross national income using purchasing power parity rates more than quadrupled, increasing from roughly US$4.000 in the early 1990s to more than US$20.000 in 2020. However, after the 2008–2009 global economic crisis, different indicators showed that the cycle of economic growth was slowing down (Figure 1).

The self-proclaimed successful development strategy was based on the benefits of an open economy and the export capacity of a handful of competitive economic sectors that extract value from natural resources or produce primary, intermediate, or finished products with little added value such as copper, pulp and wood products, salmon, and fresh fruits (Landerretche, 2014). Thus, the increase of Chilean exports to Europe, the Americas, and Asia has made the country recognisable for its relevance in a few global commodity chains, among these, fresh fruit production (cf. Cuevas & Budrovich, 2020; Goldfrank, 1994). In 2018, Chile was the ninth producer of table grapes, the tenth producer of apples, and the sixth largest producer of kiwis in the world.

This export-based development strategy requires low port tariffs and efficient logistical services to keep up the competitiveness of export sectors. We will come back to

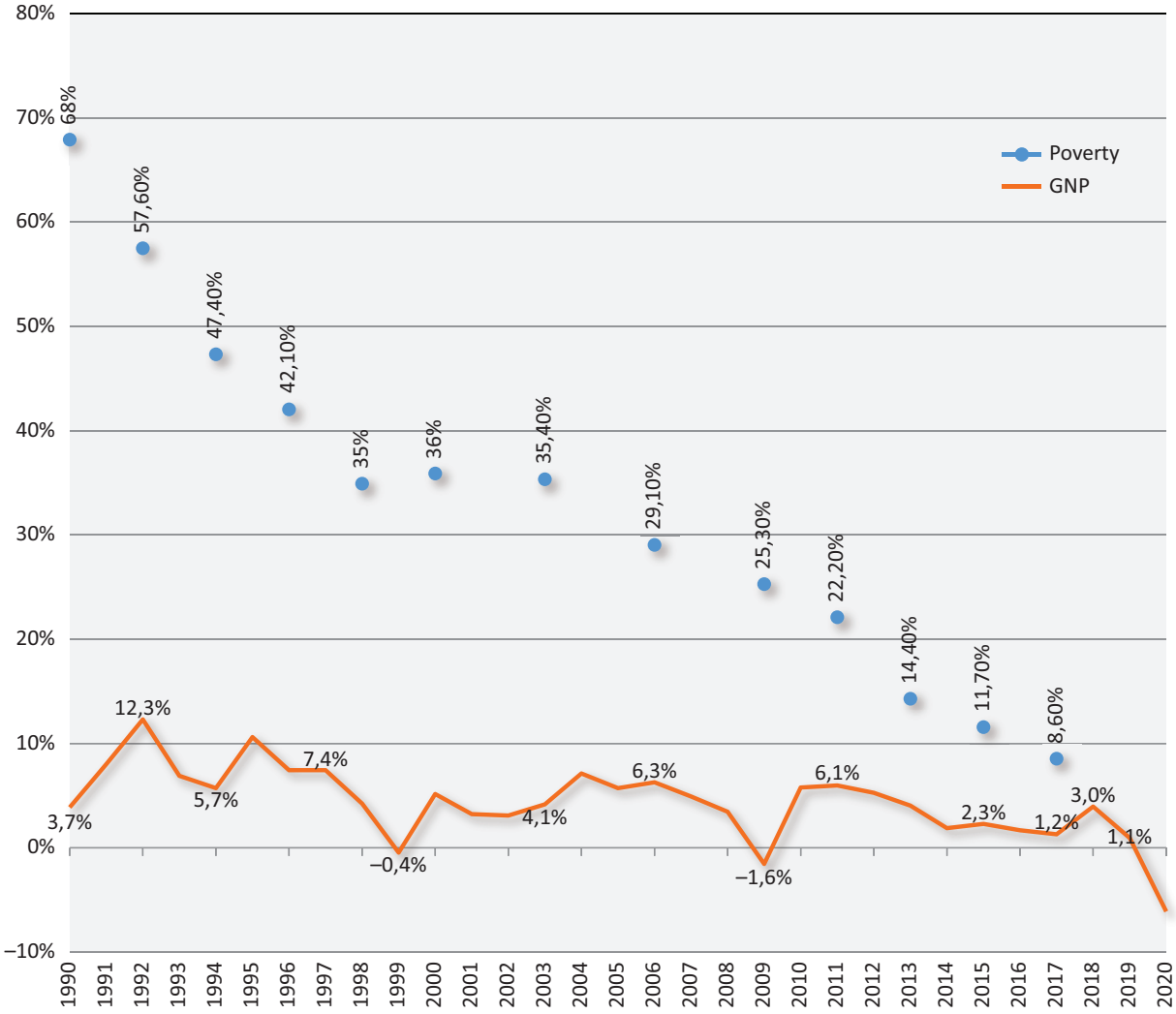

Figure 1. Evolution of poverty and Gross National Product (GNP) in Chile (%), 1990–2020. Source: Own elaboration with data from Ministerio de Desarrollo Social (2017) and World Bank (2021).

this later in more detail, but now we need to turn to some of the flip sides of this development strategy.

Chile's economic growth has been heavily dependent on international trade and the demand of a few trade partners, most notably China and East Asia, the US and the Americas, and Europe. This makes the Chilean economy very vulnerable to international crises. Chile's decelerating economic growth of the last decades has made social inequality and structural unemployment more visible. While economic growth was able to lift many Chileans out of poverty, it became clear that income inequality remained high, especially when compared to OECD countries. In this respect, the most telling indicator is wealth concentration: The top 1% of the Chilean population captures 33% of the country's Gross National Income (Flores et al., 2020; United Nations Development Programme, 2017).

The Chilean experience disconfirms, against many expectations, that economic growth necessarily creates quality new jobs and reduces unemployment. Unemployment and precarious jobs have been relatively high, especially after the so-called Asian Crisis (1998). During the last decade, the unemployment rate oscillated between 6 and 10%, and in the three regions of Central Chile that constitute the hinterland of the port of Valparaíso, it was systematically higher than the national rate (Central Bank of Chile). Entrenched inequality and high and persistent unemployment are two of the most relevant structural problems of Chile's neoliberal modernisation. These seem to be constitutive features and, to some extent, necessary conditions of this development strategy.

These ambivalences of neoliberal development are also evident in port cities and their hinterland. Whereas ports enhanced their competitiveness favouring investment in infrastructure and have modernised their operations, the cities and related territories that surround them suffer negative externalities and environmental and social injustices resulting from this development strategy. Given the critical role of seaports in Chile's open economy and export-oriented development, it is relevant to study its most paradigmatic case—Valparaíso—considering this wider context of national development.

4. Case Study: History and Transformation of Valparaíso and Its Hinterland

Valparaíso is a port city located on the Pacific coast of Central Chile, 116km northwest of the capital Santiago. It was established in 1544 as the Official Port of Santiago. Between 1850 and 1914, Valparaíso became one of the most important ports in the Southern Pacific, as vessels moving goods between Europe and the west coast of the US were forced by the long journey around the southern tip of South America to stop off in Valparaíso. During this Golden Era, Valparaíso became a thriving and progressive city, a commercial hub, a financial node, an immigrant attractor, and home to some artistic movements. During the Golden Era of Valparaíso, there was a close spatial and functional relation between port and city and porosity between interlocking spaces used for leisure, sports, fishing, and local commerce circa 1900 as shown in Figure 2.

This Golden Era came to an end when the Panama Canal opened in 1914. Ships no longer needed to undertake the long transoceanic journey, causing the slow but steady decline of Valparaíso. Somehow paradoxically, these events coincided with the construction of the most ambitious investment project—a massive breakwater and new berths—and the rise of the port as an active urban agent. Around the 1920s, the new port works were renewing the city in a deep process of reterritorialisation of the coastline. The old wooden houses located on the waterfront disappeared. Numerous businesses that sold tea, coffee, food, and alcohol to the numerous seafarers, dockworkers, and other port workers that came to wash up and have fun vanished under the modern port facilities.

For most of the 20th century, the free flow between urban and port spaces favoured harmonious, organic, and symbiotic relationships between port, city, and local community. During this period, port activity was labour intensive, which also coincided with the rise of a powerful dockworkers' movement that gained labour control for the workers (Aravena, 2020; Ortega, 2014). However, by the end of the 20th century, Valparaíso became a city in decadence, a living myth about the expansion of global capitalism in the periphery.

4.1. Valparaíso in the Context of the Reconfiguration of the Chilean Port System

During Pinochet's dictatorship (1973–1990), neoliberal policies fostered private investment in port infrastructure and administration. The immediate effect was the rise in the number and relevance of private ports. Of the total of 73 ports in Chile, 63 are private and operate based on public coastline concessions with little regulation. Private ports currently transfer almost 50% of cargo (estimation based on data provided by the Cámara Marítima y Portuaria de Chile, n.d.). The ten former Chilean Port Enterprise facilities are still among the most important ports in the country. These are managed by autonomous public port companies that form part of the Public Companies System (SEP). Of these, seven operate based on private concessions of terminals, which were transferred to private operators for 20 or more years based on competitive public bidding processes. In these ports, each public port company functions as a port maritime authority and manages the contracts with private port terminal concessionaires. Valparaíso is one of the first public ports subjected to this neoliberalised scheme of private-public partnership.

Additionally, Chilean ports lack an institutional planning and coordination agency that would incorporate them under a broader strategic gaze. The relation between Chilean ports can be better understood as a

Figure 2. Valparaíso: Paseo en el Malecón, 2 [Valparaíso: Promenade on the Waterfront, 2]. Carlos Kirsinger and Cía. Source: Chilecollector (n.d.).

dynamic of coordination in competition to favour logistical and economic efficiency and exporters' global competitiveness (Cuevas & Budrovich, 2020). These principles have organised the neoliberal modernisation of the port sector since the 1980s. Specifically, more competition was introduced between private operating companies through public bidding processes, competition for shipping line contracts and port tariffs, and also competition among workers through the liberalisation of the labour market (SEP, 2006).

This economic regime has been constituted as a hybrid that has been installed in a sociocultural and economic context that facilitated active intervention on the part of the state to promote, through active regulation, private investment, the creation of a logistics services market or quasi-market, and a public-private alliance in the port sector. In short, the state policy has favoured a process of neoliberalisation of the ports, applying measures that are less aligned with neoclassical orthodoxy, but that certainly continue to be coherent with market fundamentalism and with the principle of competition as the best mechanism for introducing economic efficiency and promoting the country's competitiveness.

4.2. Valparaíso and the Restructuring of Space

Historically, Valparaíso has been influenced by changes in port activity, technologies and infrastructure, and by its global connectivity and hinterland. The network of maritime routes and logistical circuits connecting Valparaíso to its agribusiness hinterland and the consumption centres in Asia, the Americas, and Europe is a materialisation of reterritorialisation on a global scale. This is a large-scale restructuring of capitalism's global geography and its international division of labour. Valparaíso's handling of containers is based on its efficient logistical model comprising a logistical forum of stakeholders (FOLOVAP), efficient transport infrastructure, a specialised dry port (ZEAL), and a port community system (the software and digital platform SILOGPORT) connecting port terminals with clients, such as fruit packaging plants, distribution centres, and shipping lines (Empresa Portuaria Valparaíso, 2012, 2020).

Valparaíso—Chile's second most important port in terms of freight transfer—is a small but efficient multipurpose hub. Together with San Antonio, which is the most important port in the country, Valparaíso handles the trade generated by Santiago and the macro-zone of Central Chile and its nine million consumers that represent 60% of Chile's GNP. Valparaíso's two terminals transfer approximately 10,000,000 tons a year, of which 14% is general cargo and 86% is container cargo. Its small bay is protected by a 1,000-metre-long breakwater that reduces the risk of heavy storms that would otherwise disrupt transhipment services during the year. Terminal Pacífico Sur (TPS), its biggest operating company, specialises in container transhipment. Due to recent investment, its 740-meter-long quay can simultaneously berth two Post-Panamax vessels. Its Quay 2 adds 266 meters for smaller vessels. Its terminal yard of 14.6 footprint hectares is just enough to efficiently mobilise up to 1,000,000 Twenty-foot Equivalent Units a year. Terminal Cerros de Valparaíso (TCVAL) is a much smaller operator. Its facilities count with a terminal yard of only 6.4 hectares and three quays for vessels between 125m and 235m long, mostly transporting break-bulk cargo.

Valparaíso is specialised in the export of fresh fruit. This is a seasonal activity that takes place between November and April which requires handling refrigerated containers (reefers), large areas of reefer racks, and massive energy consumption. The TPS terminal yard includes a refrigerated container stacking capacity of 3,000 units. This infrastructure forced the demolition of ten out-dated warehouse buildings, with only three of the original warehouses remaining due to their historical value. Valparaíso´s small transhipment supporting areas in terminals led the state to steer private investment in inland ports to efficiently handle the increasing cargo. To facilitate this private endeavour, the Chilean state built a massively expensive logistical corridor, including tunnels and bridges, to connect the terminals to the inland port area, and from there to the main highway and railway transportation networks (Figure 3).

Similar to other industrial and post-industrial ports that have increasingly become more capital intensive through mechanisation, automatisation, and digitalisation, Valparaíso has reduced its direct employees and become a specialised logistical hub separated from the city (cf. Hoyle, 1989; Schubert, 2011). As a consequence, the port-city relation has been controversial (Aravena, 2020).

4.3. Representations of the Port and Port-City Relations

During our research, we identified two schematic representations of the heterogeneous meanings that people attach to the port and its relationship to the city (these are summarised in Table 1 at the end of this section). These representations organise, articulate, and condense those meanings, either as a positive or as a negative evaluation of the port impacts on the city. According to the positive representation, the port is a symbol of development, modernity, and constructiveness. It fosters economic activity, economic growth, and creates many direct and indirect jobs for the locals. From this perspective, the port is also an entity that builds and spills positive effects over the urban fabric through its development plans, its best practices, and socially responsible interventions. The port is represented as a modern economic sector and an enclave of efficiency. In summary, the port enhances the life quality of the local *porteños* in what otherwise would be a rather nostalgic, dark, and declining city. The fluidity of exchanges between tourism, commerce, transhipment, and leisure co-exists through the porosity of spaces in the Prat Pier area (Figures 4, 5, and 6). As is shown in the figures below,

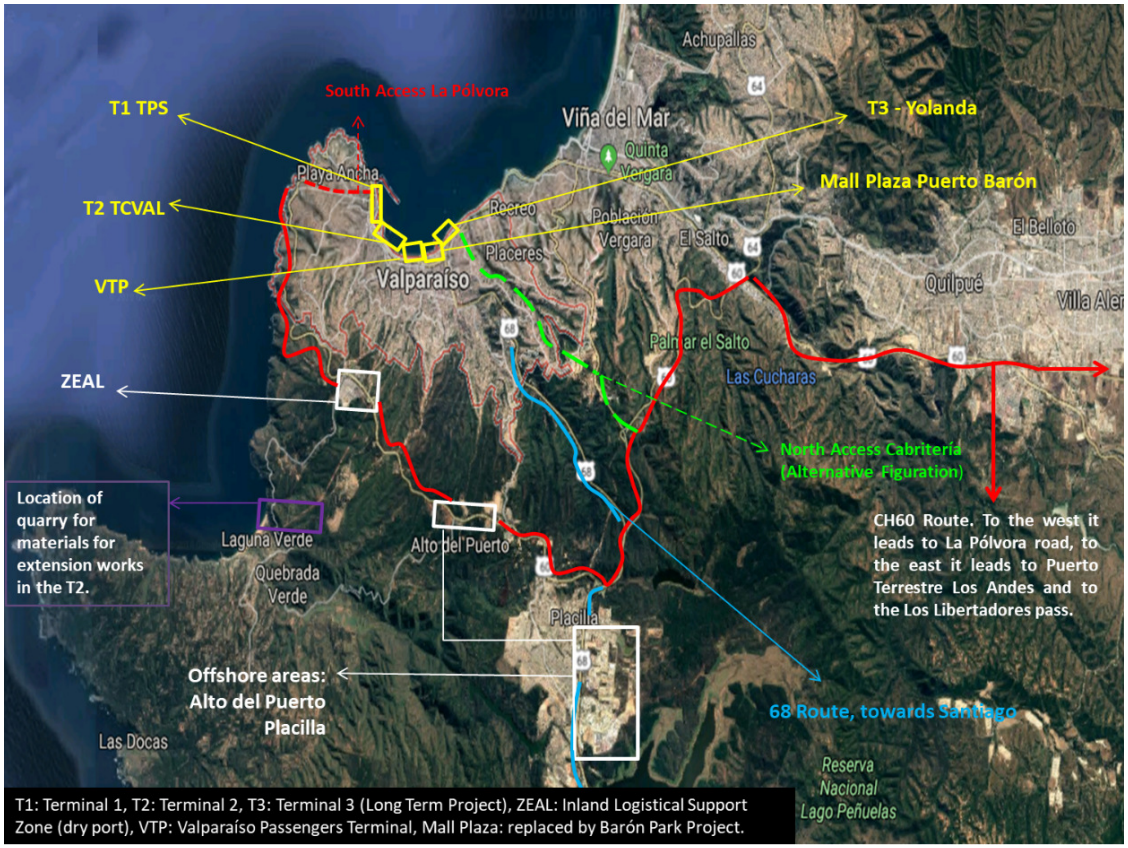

Figure 3. Logistical map of Valparaíso and its hinterland. Source: Own elaboration using Google Earth.

visual porosity and functional porosity are very much present in this section of the port separating the two terminals (Carta, 2012; Ellin, 2006).

This positive view of the port somehow hides the deeply controversial character of the city-port relation. Indeed, modern ports require space, and they prefer coastline-enclosed spaces. Hence, the use of the small bay and littoral of Valparaíso is a controversial issue that has not been definitively resolved, nor can it be, since its character is structural. While the coastline, according to Chilean law, is public property, conflicting powerful private interests aim to commodify it for their benefit: real estate investors; private port concessionaries; tourism agencies and cruise tourism operators; historical heritage

Figure 4. Prat Pier (Muelle Prat). Source: Own elaboration using Google Earth.

Figure 5. Muelle Prat (Prat Pier): A window to the sea. Source: Empresa Portuaria Valparaíso (2020).

Figure 6. Dockworkers and visitors in front of the TPS Gate and pedestrian crossing near the Prat Pier. Source: Hernán Cuevas (photograph taken circa 2016).

defenders; local fishermen, and local commerce, to name but a few. These conflicting lines of interests became visible when local activists and social organisations sued a real estate and commercial project to halt the construction of the so-called Barón Shopping Mall in a traditional place of Valparaíso, the so-called Barón Park. Over the last three decades, this 12-hectare piece of land went through several phases of appropriation, abandonment, and reterritorialisation. Currently, the area harbours the ruins of the old Simón Bolívar Warehouses, and a few

small enterprises and activities, of which the most notorious is the almost inoperative VTP Passengers Terminal, a US $9,000,000 underused modern facility recently built for receiving cruise tourists. It is expected that this urban space will soon become a park with a promenade; a place granting access and visual porosity for people's enjoyment (Figure 7). However, particular interests still lobby to reconfigure it as a cargo handling area.

The negative representation of the port constructs it as incomplete or underdeveloped. The so-called modern port deteriorates the littoral and the port cityscape, generating a noisy environment and a logistical enclave separated from the city by walls and pilled containers, thus making the ocean inaccessible to city dweller (Figure 8). According to this representation, the port destroys old buildings, extinguishes traditional ways of life, and impacts forms of using and inhabiting the coastal border, such as fishery. In this perspective, the modern port destroyed the past organic relationship between city-dwellers, the old port, and the ocean, thus ruining the natural fluid exchanges between port and city spaces. A remainder of this previous organic interconnection between port, city, local community, and visitors is still vivid in the complex porosity of the Prat Pier area (Figures 5 and 6 above).

Each representation of the port constitutes a patterned cluster organised around pairs of categories that articulate meanings by linking them to longer sequences of argument. In the polarised political culture of Valparaíso, people attribute meanings to the port city and position themselves in the local controversies based on these binary oppositions: the port constructs/the port destroys; modern/backwards; developed/underdeveloped; positive/negative. We reconstructed these representations that distil people's common ideas about the port-city relationship (Table 1). As with any analytical device, our stylised table misses some of the specificities of participants' accounts and meanings, their ambiguities, and contradictions.

Somehow paradoxically, as in Valparaíso, in many other Chilean port cities, efficient terminals coexist with precarious and impoverished urban areas. This creates social tensions and negatively affects the sustainability of the territory and the quality of life of local communities. Thus, port cities cannot be considered unquestionable factors of local, regional, and national development. Moreover, unexpected urban and socio-territorial conflicts have been emerging between port, city, and hinterland (Budrovich & Cuevas, 2018; Cuevas & Budrovich, 2020). Among these, we have identified the following types:

- Labour-capital conflicts in terminals (choke points, strikes);
- Logistical and commercial controversies between private companies (including logistical controversies);
- Disputes over the use of land in the littoral and port area;
- Socio-territorial conflicts in the hinterland.

Additionally, most Chilean port cities, such as Valparaíso, experience tensions between port and city governance. The lack of institutions of collaborative governance to promote joint master planning inhibits the formulation of a joint vision of port-city development.

1. VTP (pasengers termnal and events) – Link) , 2.Puerto Deportivo (sports centre)(Link), 3. Escuela Prodiver (Diving school) (Link), 4. Barón Pier (Muelle Barón, association of tourism operators – Link), 5. Club House (Link), 6. Kayakea Chile (kayaking centre) (Link) , 7. Simón Bolívar Warehouses (Bodega Simón Bolívar, old warehouses - heritage site) – Link), 8. Mirador Barón (real estate project– Link) , 9. Tsunami Early Warnings System – Nautic Exploration Centre, Universidad de Valparaíso (Link 1, Link 2), 10. Metro de Valparaíso – Link).

Figure 7. Barón Park (Parque Barón). Source: Own elaboration using Google Earth.

Table 1. Cultural representations of the port-city relations.

POSITIVE REPRESENTATION OF THE PORT			NEGATIVE REPRESENTATION OF THE PORT	
More CONCRETE IDEAS (free codes)	More ABSTRACT categories		More ABSTRACT categories	More CONCRETE IDEAS (free codes)
	MODERNISATION/ DEVELOPMENT/ PORT CONSTRUCTS		UNDERDEVELOPMENT/ BACKWARDNESS/ PORT DESTROYS	
Port as economic and development agent Port as a driver of local economic development	Port as a symbol of development		Lack of coordination Underdeveloped institutions and regulations	There is no coordinating institution Institutional chaos Too many procedures and disorganised services
Advantages of regional infrastructure (breakwater, calm waters in Valparaíso Bay)	High productivity High competitiveness		Inefficiencies	Inefficient use of time and space by the logistical sector
Efficient cargo transfer, efficient logistics model (FOLOVAP, SILOGPORT, ZEAL)	Transport efficiency and efficacy/ Cargo throughput		Lack of long-term strategic planning	Inefficient coordination of logistical activities (in the chain or logistical line) Lack of strategic view of the sector and the economy Short term planning
Perspectives of the steady growth of international commerce Sound port logistics and infrastructure investment plans	Projection of port logistics activity Increase of export Public and private investment		Slow investment in infrastructure Backwards infrastructure	Backwards technologies Backwards machinery Dodgy designs of motorways, tunnels, and bridges Backwards connectivity and infrastructures Lack of railroad, over-dependency on truck transport
Automation and technology as an opportunity for better, qualified jobs Cargo operators are the most stable employers, even in a time of crisis (during the pandemic) Port companies are good employers Port activity has a positive impact on direct and indirect employment (20,000 jobs)	Employment		Precarisation	Job destruction through technological innovation and automation Labour precarity, flexible labour regime Labour deregulation to minimise costs Informality (*pincheros*) Uncertain lives Social precarity, social insecurity
Specialised zones, areas, circuits Security, protection Trade security	Reterritorialisation		Reterritorialisation	ZEAL is almost empty Port as a closed enclave Port enclave: walled, closed area, port-city separation Port enclave: dramatic reduction of public access to the ocean Precarious urban infrastructure

Economic Dimension and instrumental Rationality

Table 1. (Cont.) Cultural representations of the port-city relations.

POSITIVE REPRESENTATION OF THE PORT			NEGATIVE REPRESENTATION OF THE PORT	
More CONCRETE IDEAS (free codes)	More ABSTRACT categories		More ABSTRACT categories	More CONCRETE IDEAS (free codes)
	MODERNISATION/ DEVELOPMENT/ PORT CONSTRUCTS		UNDERDEVELOPMENT/ BACKWARDNESS/ PORT DESTROYS	
Port companies are locally prestigious	Positive image of port logistics business (including historical heritage)	— Culture, forms of life —	Negative interaction between port and city	Port expansion plans increase pressure on the city and territories
Port companies have clean production agreements	Shared value, Corporate Social Responsibility		Risks	Wildfires (city and forestry wild fines). Pollution, floods, accidents
Budget for communitarian projects/ interventions	Best practices			Toxic and/or dangerous cargo
Narrative on Valparaíso's cultural uniqueness	Cultural identity		Cultural Identity	Abandoned cultural sites/buildings
Cruise Tourism Industry				The decline of traditional port culture
Strong port-city identity				Individualism
Peñas, local festivities, local culture, local history				Consumerism
Common culture and collective values				
Workers' solidarity				

Figure 8. Walled port of Valparaíso. Source: Hernán Cuevas (photograph taken circa 2016).

4.4. Dock Work and Job Precarity

Historically, causal labour has been a characteristic of dock work worldwide (Davies et al., 2000; Philips & Whiteside, 1985). To guarantee some employment for each worker, Chile trade unions struggled to install a closed shop protection scheme and work regulations to stabilise the number of jobs, hours, and shifts for union members. The effect of this was an inefficient port and expensive transhipment tariffs due to an inflated workforce beyond the size that was needed at any one time.

These changes implied the modification of industrial relations and the role of trade unions and employers to the state, weakening the influence of trade unions and diminishing official welfare measures, manpower, and increasing subcontracting in the port. In sum, labour, the main traditional mechanism of port and city integration, has been weakened and its impact on the local economy reduced (Aravena, 2020; Budrovich & Cuevas, 2018).

Neoliberal labour reforms destroyed the closed-shop and social benefits scheme and implemented a heterogeneous labour regime that established a reserve army of unemployed and multiplied labour positions. Expanding the port labour pool further shifts the balance of power from labour to capital, reducing labour costs and favouring workers mobility and flexibility in the benefit of capital. Different from other countries where dock work modernisation guaranteed minimum wage in return for greater regularity and discipline at work, in Chile, and in particular in Valparaíso, the majority of the workforce is still covered by a *sui generis* casual work scheme that institutionalises multiple labour positions and precarity (Figure 9).

The implementation of neoliberal policies in Chile between the 1970s and 1990s roughly coincided with containerisation, gigantism in container shipping, enhancement of crane technology, mechanisation, and computerisation. These advances in logistics increased port productivity, but also reduced and rationalised dock employment. Whereas in the 1970s Valparaíso employed roughly 3,000 dock workers, nowadays the two terminals together employ less than 700 workers (Budrovich & Cuevas, 2018).

4.5. Valparaíso and Its Agricultural Hinterland

During the military dictatorship, a selective neoliberal modernisation of rural territories was implemented to deepen the international insertion of Chilean agriculture in the world market according to its comparative advantages. Agribusiness have expanded in Chile since the 1980s under the promotion of a neoliberalisation process of unorthodox state-led policies that favoured the concentration of land property, large-scale monocrop production, and intensive use of energy, water, soil, and agrochemicals. This implied the reterritorialisation

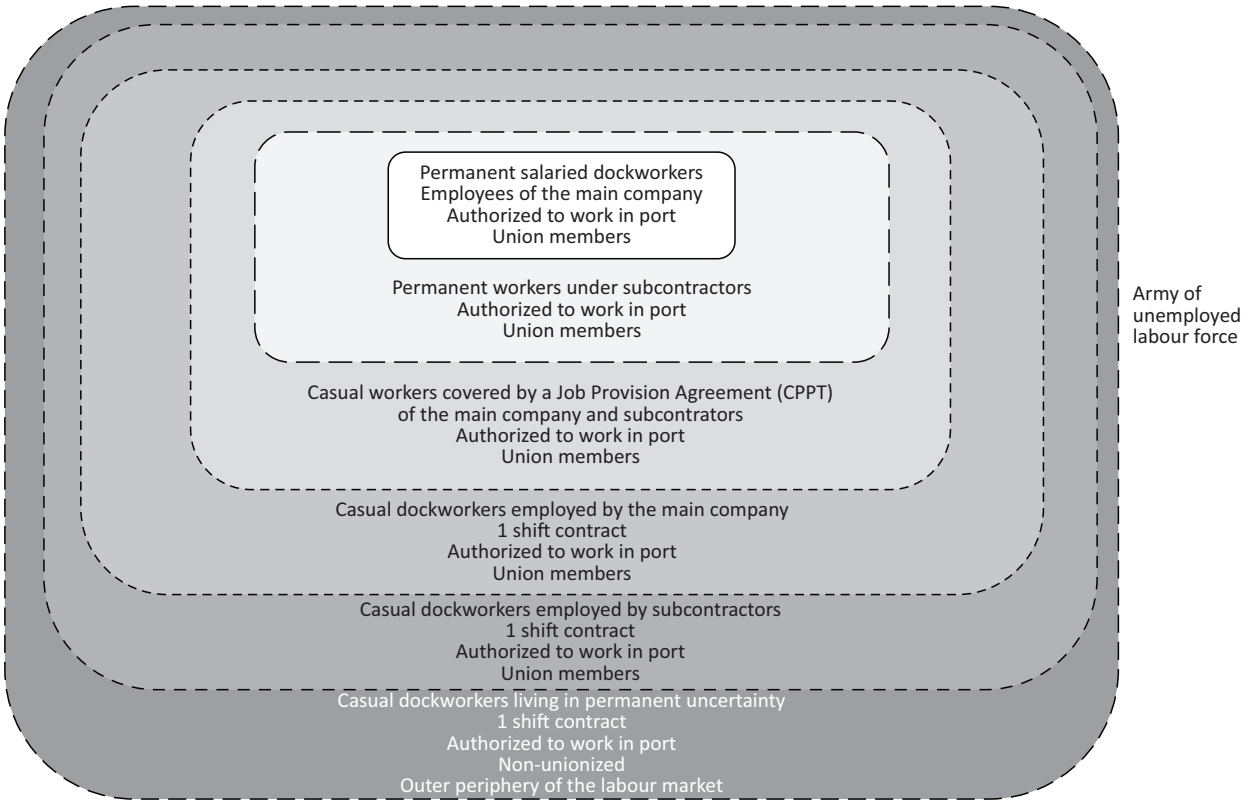

Figure 9. Multiple labour positions in Chilean ports. Source: Own elaboration.

of the countryside and the conversion of traditional local production to the monoculture of fruits for large-scale export. This was fostered by an increasing technification and use of chemical and biotechnological industries. This mode of production has initially favoured a new class of local entrepreneurs and lately to agribusiness transnationals dedicated to the export of fresh fruits. These new globalised producers displaced the local ones and replaced traditional crops and horticulture with fruits such as table grapes (Cavalcanti et al., 2018; Cerda, 2018; Pengue, 2006). This process of reterritorialisation expanded the agricultural frontier to include unproductive land beyond the normal irrigation level of canals and changed land use. The production of table grapes for export, especially in the Elqui and Limarí valleys, is illustrative of all these processes (Murray, 2011; Rovira, 1993; Venegas, 1992).

This authoritarian neoliberal restructuring of agriculture also included the precarisation of rural jobs, initially, through repressive means. In a subsequent phase of labour restructuring, private companies implemented a variety of contract modalities and other flexible and informal patterns of labour relation that segmented the labour force, thus multiplying labour positions. These different categories of workers have different income levels and differentiated access to labour and socioeconomic rights. This heterogeneous and cheap labour regime was functional for the extractive and export-oriented mode of production and the neoliberal regime of accumulation (Cerda, 2018).

Currently, the Chilean Ministry of Agriculture promotes a new development paradigm: transforming Chile into a worldwide agricultural and food power. Exporters associations together with the Chilean Ministry of Agriculture normally collaborate in applied research to improve fruits' features and carry out international marketing and advertising campaigns, like the famous '5 a Day' Programme to promote fresh fruit consumption (WHO, n.d.). Furthermore, Chilean elites backed by the state have successfully disseminated an ideological image of the agro-export sector as a sustainable industry. Hence, the monoculture of fruits cannot be reduced to a simple operation of extraction of raw materials. Instead, it is a sophisticated and technologised productive sector that produces final goods for human consumption, such as fresh seedless table grape. These varieties of grape have been modified to satisfy the global North consumer's insatiable desire for quality and freshness all year long. To match this opulent demand, fruits have to be produced on a large scale, consuming enormous amounts of water and minerals in the valleys of Central Chile (Figure 10), to be later harvested and selected, washed, weighed, stored, and refrigerated for export by some permanent qualified workers and a majority of temporary unqualified workers, most of whom are women and foreign immigrants.

In Chilean valleys, fruit production has a sequence of labour demand organised according to the different harvesting seasons and their respective windows of demand in the global market. A significant number of

Figure 10. Fruit plantations in the Central Valley, Region of Valparaíso, Chile. Source: Courtesy of Francisco Báez (photograph taken circa 2019).

these temporary workers follow this sequence, beginning with cherry, nectarines, plums, and finishing with table grapes. This labour force is made up of precarious workers subjected to a labour regime of induced mobility, flexible contracts, and piece-rate payment. This heterogeneous labour market constitutes many precarious labour positions functional to the expansion agribusiness and the reterritorialisation of non-productive land. This precarious and heterogeneous labour regime institutionalised workers' instability, making them more prone to accept extreme flexibility, mobility, and low payment (Figure 11).

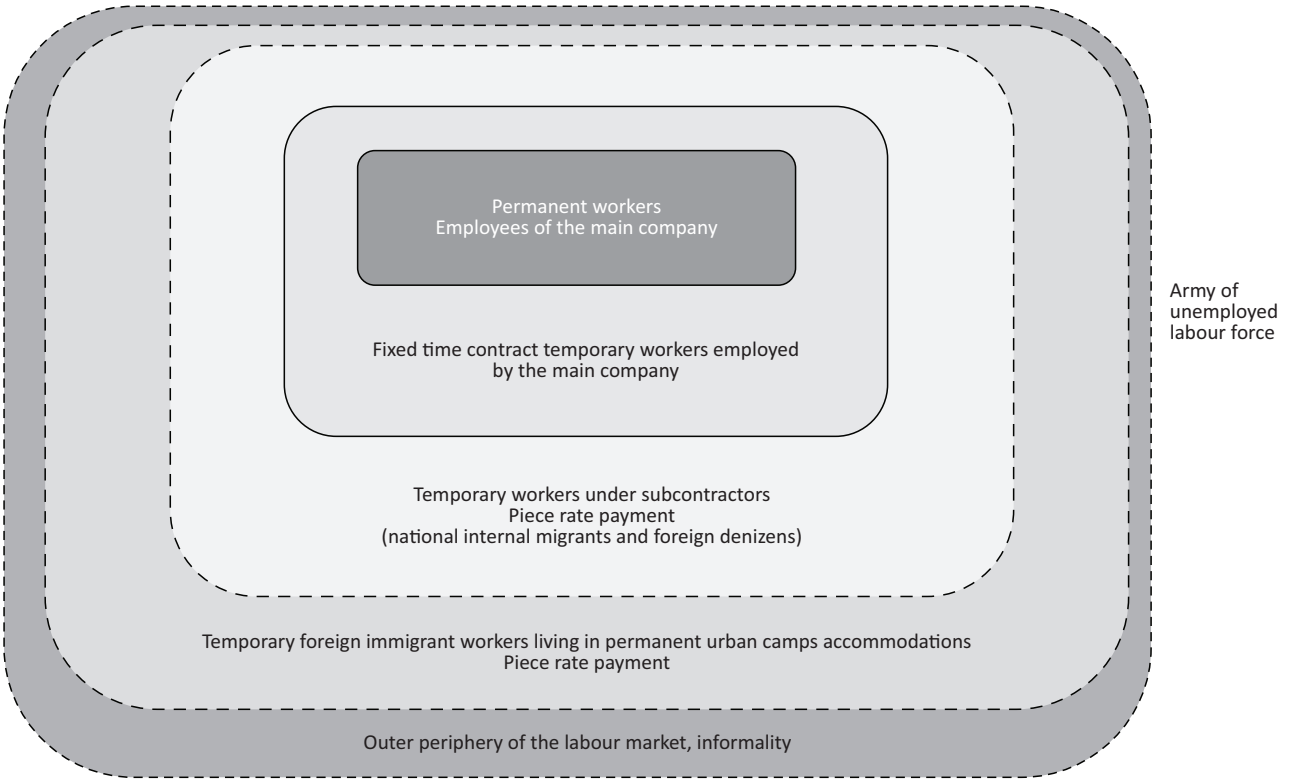

Figure 11. Multiplicity of labour positions in Chilean agribusiness. Source: Own elaboration.

Fruit commercialisation is usually carried out by transnational companies, such as Dole and Unifruti, which also take care of its packaging and labelling for dispatch. Grapes circulate in a logistical chain: they are loaded at origin in plastic unit packages (500g), organised together in cardboard boxes and pallets, or refrigerated containers to later be transported on trucks to one of Central Chile's ports, very likely Valparaíso, from where almost half of the fruit export is dispatched. When embarked, fruits are boarded and organised either in pallets on a reefer vessel (Figure 12) or in container reefers in a container ship by longshoremen and gantry crane operators. In either case, a small crew of seafarers is responsible for the vessel operation.

Finally, depending on the destination, fruit arrives after approximately 12 days of travel to North America and in around 21 if the destination is Asia. This fresh fruit global commodity chain is a network of labour, production, and circulation processes whose result is the fruit as a finished commodity, ready to be commercialised and consumed (Figure 13).

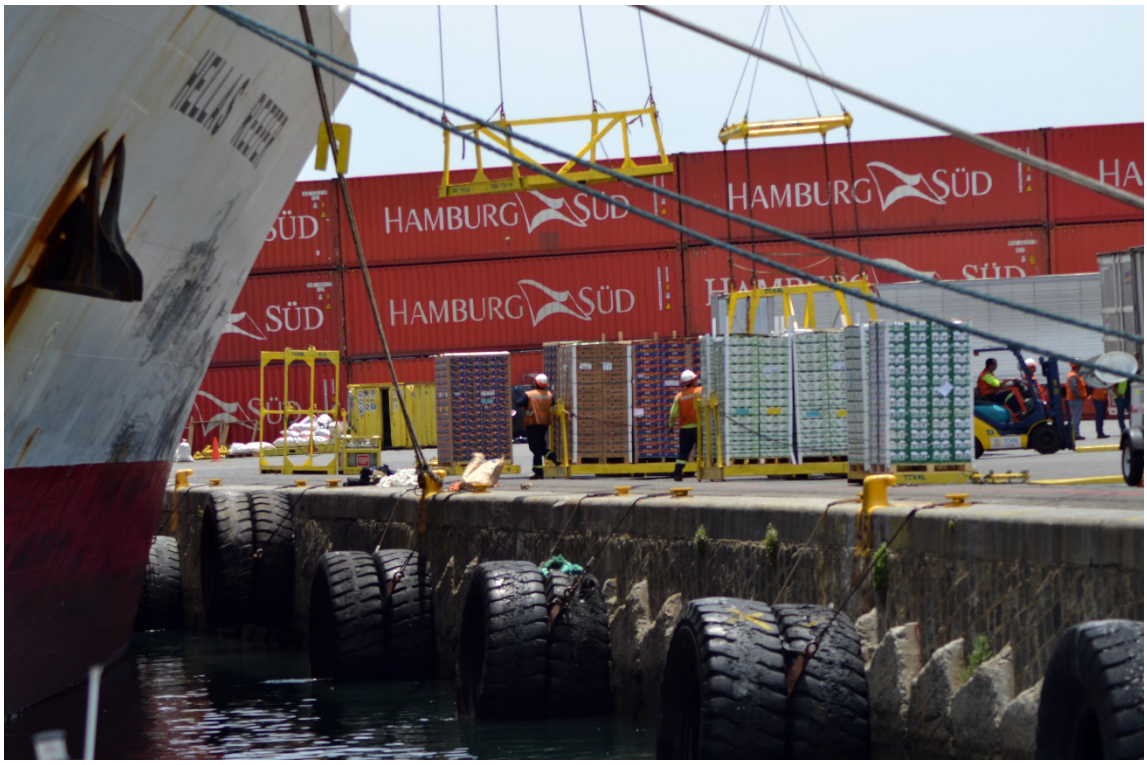

Figure 12. Dockworkers embarking a reefer vessel in Valparaíso's Terminal 2 (TCVAL). Source: Hernán Cuevas (photograph taken circa 2016).

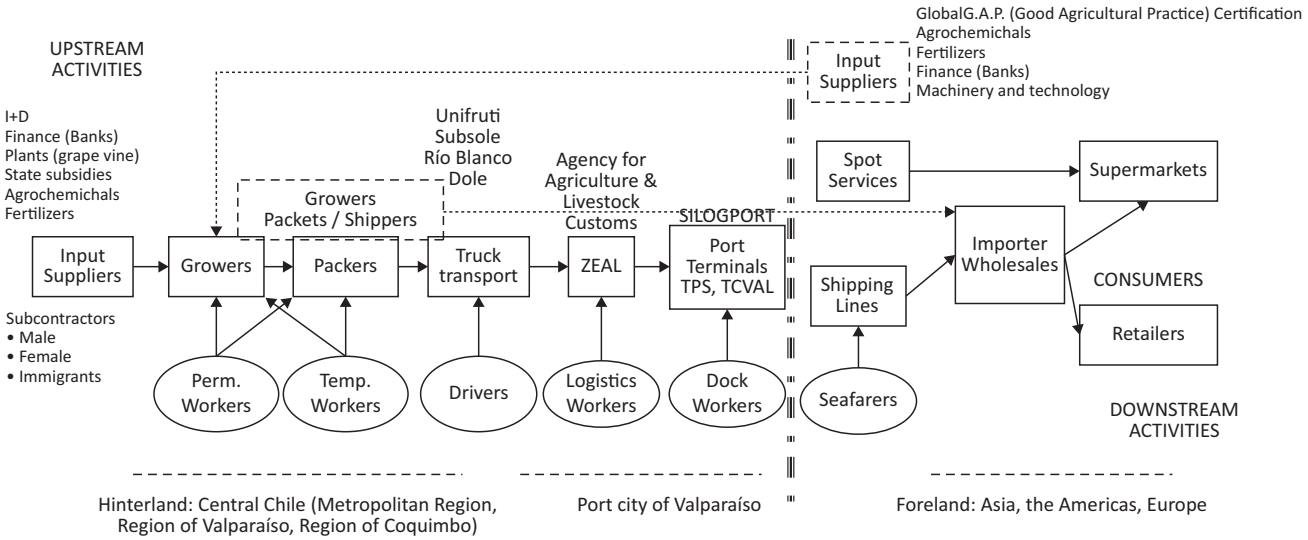

Figure 13. Global commodity chain of table grape. Source: Own elaboration based on Goldfrank (1994).

5. Distilling the Logics of Economic and Social Restructuring in Chilean Port Cities and their Hinterland

Our previous descriptions and analysis of this commodity chain reveal the workings of the interdependent logics of neoliberalisation, precarisation, reterritorialisation, extraction, and logistics. These are materialised in the geographically dispersed operations of capital that are part of the production, circulation, and consumption of fresh fruit. This process, represented as a successful development strategy by the Chilean elite, can also be interpreted as yet another instantiation of a historical asymmetrical exchange pattern involving material and ecological flows with consequences of degradation of natural resources and unsustainable exchanges between city and country, and between the core and the periphery (Clark & Foster, 2009). Through fresh fruit export, agribusiness directs water and minerals from the Chilean countryside, mountains, and basins to subsidise mass consumption in the core. Therefore, together with agricultural extraction, job creation, and wealth accumulation in origin, the Chilean countryside and its logistical hubs such as Valparaíso locally support and suffer the negative effects of this development strategy, namely environmental degradation, soil overexploitation, hydric stress, and social and labour precarisation (Cuevas & Budrovich, 2020). This extractive development strategy produces some less evident but equally related negative effects on urban inequality and port-city uneven development. This ensemble of transformative logics—neoliberalisation, precarisation, reterritorialisation, extraction, and logistics—provide a configurative explanation of the restructuring of the port city and its hinterland.

Such logics evoke an already existing concept. Our contribution has been to rework them based on, first, our empirical findings and, second, their inherent ambivalence. More importantly, these logics are not only analytical categories; they are also real abstractions (cf. Toscano, 2008) organising economic and social restructuring through their functional coupling. Again, this means that they are not isolated. Rather, they are a configuration or ensemble of multiple forces working together. In what follows, we briefly define these reworked logics (Figure 14). Although we cannot claim that our list is exhaustive, based on our research we can at least conjecture that they seem relevant and, therefore, have significant explanatory power.

5.1. Neoliberalisation

Neoliberalisation is a complex of processes, rationalities, and practices which intensify the commodification and mercantilisation of society and nature. Contrary to common knowledge on neoliberalism, we have found that state interventions play a key role in producing its characteristic unequal regulation of the economy (cf. Brenner et al., 2010). State interventions are pragmatic and always functional to the interests of the business sector. Indeed, Chilean neoliberal capitalism should be defined as hierarchical due to the determining influence of the

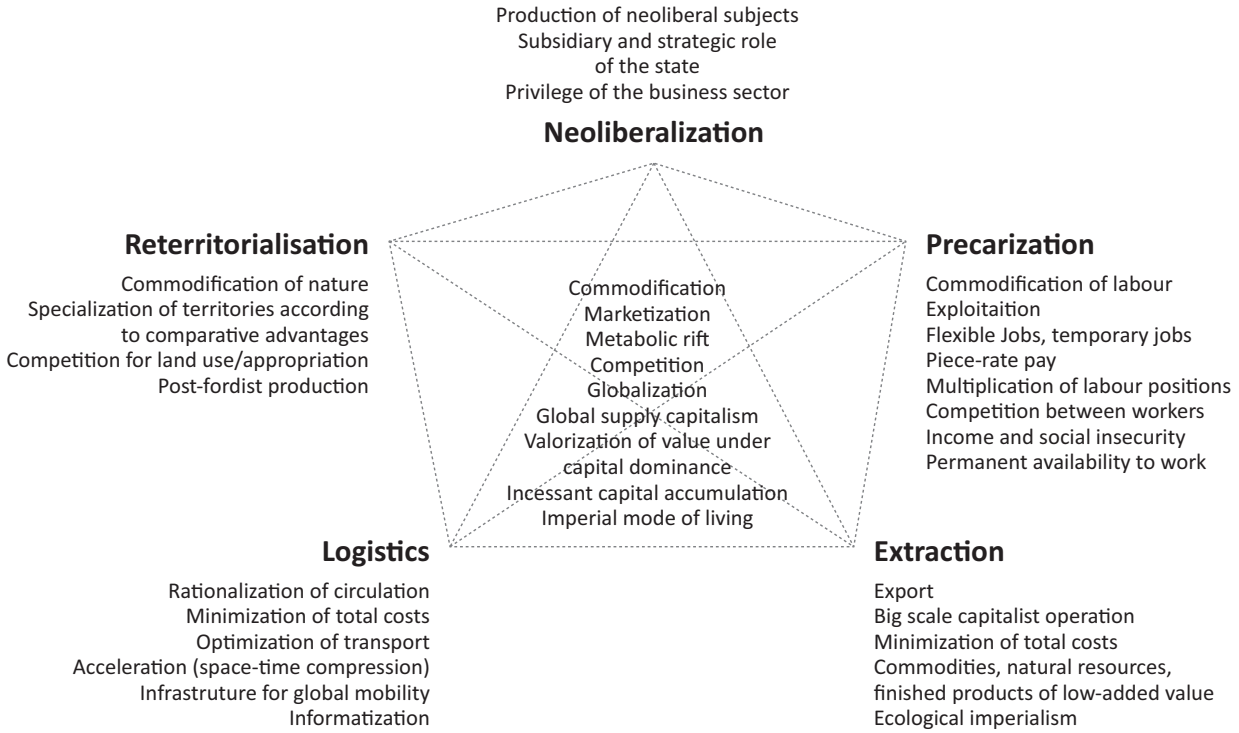

Figure 14. Logics of economic and social restructuring in Chilean port cities–hinterland territories. Source: Own elaboration based on Cuevas and Budrovich (2020).

national oligarchy's holdings and related multinationals (cf. Schneider, 2009). Port investment policies are a fine example of this existing and unorthodox neoliberalism: Whereas the majority of port activities and the construction of infrastructure have been privatised through public bidding, port and littoral property remains public. Somehow differently, (de)regulation of dock work increased its endemic flexibility, following the logic of mercantilisation and state rollback, but allowing a high degree of trade union control of the labour force through particular legislation. The deregulation of labour and the property of land and water in rural areas exacerbated marketisation in favour of agribusiness. Despite the particularities of each sector, a common feature is the expansion of competition as the economistic rationality introducing efficiency in all economic processes. This strategy falls within the 1990s dominant discourse on global competitiveness, entrepreneurship, export-driven economy, market-oriented policies, and economic growth as instruments to secure socioeconomic development. This pragmatic neoliberalisation favoured the functional coupling of economic competitiveness with labour flexibility and adaptability, and the focus on natural resources' exploitation as Chile's comparative advantage.

5.2. Precarisation

Precarisation is the process of deterioration, erosion, or worsening of working and living conditions. It can be characterised by the diffusion of insecure low-quality jobs, labour flexibility schemes, multiplication of labour positions in the market, and availability of cheap labour (Dörre, 2009). In agribusiness and ports, precarious work is frequently based on productivity and piece-pay schemes with the effect of accelerating and intensifying work, and inducing competition among workers for payment and scarce jobs. Social inequality and competition work together as motivational engines of social mobility, individualisation, and worker self-reliance, thus promoting a culture of resilience and adaptability to face uncertainty and social change. These effects of labour precarisation go well beyond job quality, impacting negatively on the living conditions of workers and their families. Precarisation also fosters the mobility and flexibility of labour and the production of labour subjectivity that experiences life as rootless and vitally displaced.

5.3. Reterritorialisation

Reterritorialisation refers to the "reconfiguration and rescaling of forms of territorial organisation" such as cities, productive enclaves, plantations, and logistical infrastructure, among others (Brenner, 1999, p. 432). Against the fascination with the disembedding dimension of globalisation and flow, our approach balances this by also paying attention to some relatively fixed forms of territorial reorganisation of local, regional, and national economies within global capitalism.

Reterritorialisation also takes place as a consequence of capitalist expansion in the form of appropriation of territories that were in the periphery or outside of capitalism, such as natural environments, or through the reincorporation of previously abandoned capitalist space, such as out-dated infrastructure and industrial ruins. Hence, reterritorialisation frequently involves the spatial transformation of operations of capital through successive reappropriations of territories. Port terminals expansion, highways and rail track construction, and land grabbing for intensive and extensive farming in the hinterland are all instances of territorial reorganisation lead by the state, agribusiness, and by port and logistical industries. This reterritorialization has involved a networked articulation of relatively immobile elements, such as infrastructure, land, and littoral through logistical planning and mobile elements, such as transport means. Together with this, the waterfront regeneration and port outdated infrastructures have been reappropriated for tourism, commerce, and leisure, redefining urban spaces and creating a porous waterfront, as the cases of Prat and Barón Piers show (see Figures 4, 5, 6, and 7 above).

5.4. Extraction

Extractive activities can be characterised by their exploitation of large volumes or high-intensity exploitation of primary materials or natural resources that depend on enclave economies and are exported as commodities (Gudynas, 2012). The most dynamic sectors of the Chilean economy, such as mining, agro-industry, fishing, aquaculture, and forestry, are representative of extractive activities that, although anchored locally, are connected globally as part of the global commodity chains that constitute the world geography of capitalism. The social logic underlying these extractive activities often involve the violent appropriation or procurement of the value of raw materials and forms of life that exist in the biosphere, including the surface and depths of the land and ocean (Mezzadra & Neilson, 2015). Although fresh fruit is a final product and not a raw material, the fruit growing sector should be considered an extractive activity under its general orientation towards production for large-scale export, characterised by its intensive and indiscriminate use of natural resources such as water and land (and minerals) at environmentally unsustainable levels (Cuevas & Julián, 2016; Gudynas 2012; Svampa, 2015).

5.5. Logistics

In managerial common language, logistics refers to the part of the supply chain that deals with the planning, implementation, and control of efficient circulation and storage of goods, services, and information from the point of origin to the point of consumption. In this strict sense, logistics refers to the economic sector of cargo transport aiming at the optimisation of freight

transference, and the related services and information. Chile faces important logistical challenges due to its complicated geography and distance from major consumption centres. Extractive activities in Chile are geared towards large-scale production for export, for which ports serve some crucial logistical functions: to ensure that maritime transport can be provided efficiently, securely, continuously, and cheaply to keep export operation costs and the prices of commodities competitive. Together with extraction, logistical operations assume a central position in articulating the intensive and extensive dimensions of global capitalism and how capital continually expands through them. From this wider perspective, logistics is a systemic logic based on calculative rationality aiming at the instrumental organisation and efficient circulation in space and time of materials, information, people, etc., to favour the acceleration of the capitalist operations of the global supply chain (cf. Chua et al., 2018; Cowen, 2014). Logistics can also be seen as a spatial practice that rationalises, organises, and articulates operations of capital in territories to maximise the benefits and minimise the total costs of capital. Logistics allows productive operations to be fragmented, externalised, and scheduled in a deterritorialised manner according to the competitive advantages of each local economy so that the parts and processes can then be articulated for the benefit of capital (Cowen, 2014).

6. Conclusion

We have described and explained the workings of the social processes and forces that gave form to the neoliberal restructuring of the port city of Valparaíso and its hinterland. We identified these as the logics of neoliberalisation, reterritorialisation, precarisation, extraction, and logistics. The functional coupling between these logics has shown positive effects in terms of logistical modernisation, but also some limitations, frictions, and ambivalent effects. Whereas on the positive side neoliberal social and economic restructuring of port terminals in Chile increased their productivity and economic competitiveness, on the negative side this pattern of capitalist modernisation did not benefit port cities such as Valparaíso, marked by territorial inequality, socioecological damage, urban poverty, and a growing sense of closure of the littoral and reduced access to the ocean. These negative externalities and frictions have triggered local political controversies, commercial and economic disputes, labour strikes, and urban and socioterritorial conflicts.

Interestingly, we have found that the driving force behind this logistical modernisation of the port was in the countryside. The productive restructuring of Chilean agriculture that favoured an internationalised and export-oriented agribusiness based on fruit production and the explosive increase of production for export demanded that port and logistical modernisation handle the cargo.

Similar to the ambivalences of neoliberal modernisation and its economic and social restructuring detected in the urban space, in the countryside, some collateral damage was provoked in the form of a high concentration of land property and the institutionalisation of a heterogeneous labour market and masses of precarious temporary workers. These interrelated processes run in parallel to more general privatisation and marketisation of society, land, and nature. The modernisation of the port increased the capacities and accelerated the operations of extraction, production, transportation, and circulation, thus facilitating the global consumption of fruits. These operations impacted urban and agricultural territories, redefining space and the uses of land in the countryside as well as in the littoral, intensifying work and social precarisation, and increasing the command of capital over natural resources, especially over land and water. Our exploratory analysis calls for further research to be conducted on port cities and their hinterlands to better understand how these territories function as integral parts of global supply networks and their relations within the world system.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Evolution of Edges and Porosity of Urban Blue Spaces: A Case Study of Gdańsk

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Abstract
Current waterfront studies focus mainly on a land-based perspective, failing to include the water side. Water is, however, not just a resource for port and industrial purposes and an edge to the waterfront; it is also a feature of the waterfront and the complex relation between water and city. Thus, the article suggests that water-land edges need to be re-contextualised, taking into consideration also their shape, functionality, and evolution over time. This article therefore introduces the concept of urban blue spaces, that is, spaces that include at least one land-water edge, such as a shoreline or river edge. The types and character of these edges define the porosity of urban blue spaces: Spaces with easy connections, such as boulevards or parks, are highly porous, while fenced areas have low porosity. The research first analyses the existing literature on the spatial and functional characteristics of the land-water edge in port cities, and explores existing typologies of urban blue spaces. The results of this investigation are used to examine the most iconic urban blue space of Gdańsk, the Motława river, over the last 1000 years. The case study shows that the porosity of the Gdańsk urban blue space has been increasing over time, in line with its spatial and functional development from an undeveloped riverbank to a 'gated' port and industry area, to urban living spaces today. The article thus presents the whole breadth of urban blue spaces through the case study of the Motława river urban blue space. The spatial evolution of the urban blue space is depicted through the transformation of its land-water edge—from a natural sloping edge to the dominance of vertical edged structures or ones overhanging the surface of the water, to the emergence of spatially 'blurred' sloping, slanted, terraced, and floating structures, partially independent of the riverbank. The transformation of the structure of the Motława urban blue space edges increased its complexity over time, from a single-edge structure to a double and multiple-edged one.

Keywords
Gdańsk; land-water edge; port city; urban blue space; waterfront

Issue
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1. Introduction

Water has been present within public spaces since ancient times. However, aquatic space became the subject of spatial planning only at the end of the 20th century (Zaucha, 2009). In the second half of the 20th century research has given thorough attention to the influence of water on the development of urban public spaces and notably the waterfront (Breen & Rigby, 1996; Bruttomesso, 1993; Hall, 1993; Hoyle, 1989; Meyer, 2001; Vallega, 2001). The aquatic space, however, has not been recognised as a spatial resource that should be planned along with the adjacent land, as the concept of waterfronts refers more to the land area, rarely including the body of water. Currently, we observe the progressive occupation of water spaces in cities,

by functions that have so far been the domain of land areas (Couling & Hein, 2020; Hein, 2016; Jerzak et al., 2019). In the 21st century, politicians, planners, and scholars have rediscovered water areas in cities as a spatial resource and a platform for public activity. The concept of urban blue space has taken shape in the academic field in the last decade (Brand, 2007; Breś, 2018; Gledhill & James, 2008; Haeffner et al., 2017; Taufen-Wessells, 2014; Völker et al., 2016). Due to the intensification of the use of aquatic spaces, the level of their complexity as well as the number of spatial conflicts between their stakeholders is rising. Thus, water should be thoroughly planned together with the surrounding land to increase the multifunctionality and efficiency of both environments.

The authors use the case of the historic city centre of Gdańsk, Poland, to illustrate the theoretical considerations on the function and shape of blue urbanised spaces. This iconic public space of Gdańsk, stretching along the Motława river, was not built from a single projection. It has been shaped over hundreds of years as the main port of Gdańsk. It was transformed according to the rhythm of technological leaps and changes in the organisation and lifestyle of the city's inhabitants. These changes, recorded in the physical space of the port and the city, and in the archaeological evidence; drawings and cartographic materials illustrate the dynamics of the functional and spatial transformations of this main water space of the city in subsequent historical epochs. This article explores the urban blue space of Gdańsk in terms of changes in space and time. The observed specific functional life cycle of the area of the Motława river, interrupted from time to time by massive war damage (1308, 1454, 1734, 1945), is reflected in the changes of the waterfront through the following phases: natural landscape with ecological and agricultural functions; landscape of a working waterfront (port and shipyard); a post-port landscape related to commercial and housing functions; and finally an intensely built-up water square, fulfilling cultural functions. A long-term perspective, taking into account the life cycle of urban spaces and its planning, further confirms the need to consider water areas in the spatial planning process.

2. Spatial Characteristic of Urban Blue Space

Urban blue space is understood as an area consisting of both water and land and therefore including at least one land-water edge (e. g. shoreline, riverbank), usually separated from the surroundings by at least one physical edge (e.g., line of hills, buildings, wall, forest). A determinant of urban blue space is its tangible and intangible relation with water, which largely influences the character of the space. The boundaries (edges) of urban blue space, defining it as an urban interior, may vary according to topographic conditions, functional layout, and surrounding urban structures. The structure of urban blue spaces edges (or any other urban spaces) is not uniform—it has voids (pores) of a different size, distribution, and character, through which the human flows might pass, allowing them to pass from sea to land and land to sea. The feature of existence of voids within the volume of urban blue space edge the authors call porosity. The more pores the edge contains, the higher its porosity and at the same time the permeability for human flows.

The porosity of urban blue space depends mostly on the type of its edge (Figure 1). The urban blue space edge might be a solid wall, fence, or line of buildings not accessible for people, such as for example a port basin with surroundings quays detached from the surrounding area by industrial buildings. It might take the form of a row of buildings cut by streets, passages, and view openings, for example, a boulevard along the river limited on one side by a row of trees and on the other by building frontages with the views opened to the water. The urban blue space can have an undefined edge, where no physical boundaries detach the urban blue space from the neighbouring area, such as a bathing area covering

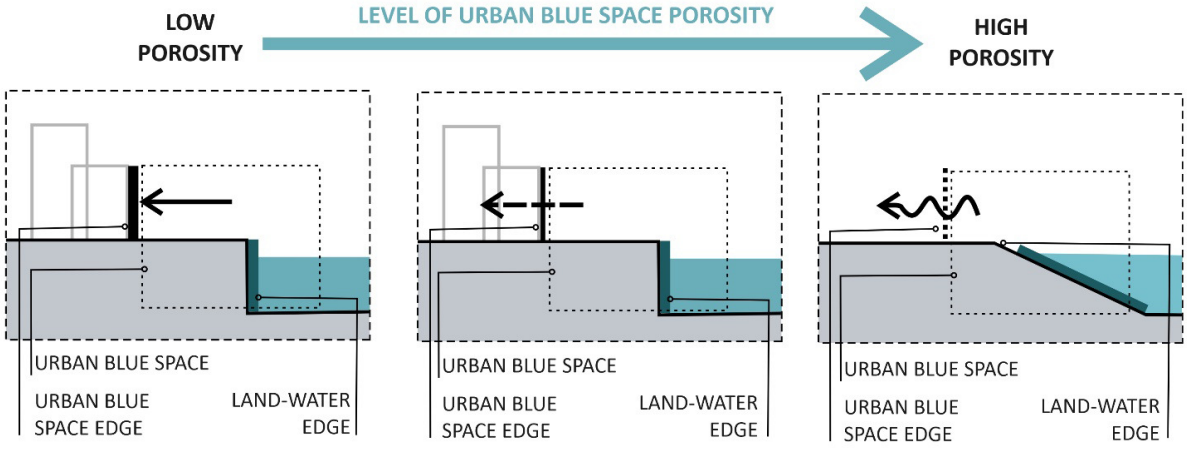

Figure 1. Types of urban blue space edge in terms of their porosity. From left to right, the images show increased accessibility from land to water, and thus increased porosity.

both the beach and swimming area with no 'solid' edges delimiting the space.

The urban blue space might have one or more spatial edges (Figure 2). It may be limited from the land side by a single edge of buildings, infrastructure, or greenery, while on the other side there can be an uninterrupted view to the open waters or the other bank of the river. The space might be limited from two sides (double edge) and encompass water in the middle, forming a 'water street.' Finally, urban blue space might be surrounded by walls from many sides, taking the form of a 'water square.' The layout of urban blue space may constitute a network of all types mentioned above, creating a complex spatial system. The number of edges and their character determine the level of compactness of the interior of the urban blue space and its landscape porosity.

Water, which changes its function, shape, physical state, and colour, interferes with the adjacent territory and affects the multidimensionality of the water-land relation. The physical embodiment of this relation is the edge between the water and land areas. The edges of urban blue spaces may vary in their spatial layout and their section (Januchta-Szostak, 2011; Prominski et al., 2012). The land-water edge, in terms of its section, might be described as 'fixed' or 'flexible' (Figure 3). A fixed land-water edge does not change its position in time (except for emergencies). It is typical for transport, industrial, and infrastructural functions of urban blue spaces, such as a sheet pile wall in a port. Usually, the fixed edge does not provide users with direct access to the water, only enabling access to the water transportation units moored to the wharf and providing only a view to the water. A flexible edge changes its position in time according to fluctuations of the water level. This kind of edge is characteristic for waterfronts fulfilling residential, recreational, and commercial functions—most often, they appear in parks, and along boulevards and pedestrian streets. This water-land connection provides users with greater contact with the aquatic environment and often direct access to the water. There are various types of flexible edges within urban blue space, such as a sloping edge gently leaning into the water, a slanted edge with a steeper slope, a terraced edge with a multilevel floor, and a floating one, adapting to the changing water level.

A land-water edge might be also characterised by its layout (Burda, 2015; Meyer, 1999; Moughtin, 2003; Niemann & Pramel, 2017; Yang, 2006). An urban blue space might have a connection with the existing waterline or be separated from it (Figure 4). The first type of land-water edges might have no physical connection to the existing water line and be located further into the aquatic space (an island) or territory (land area having intangible connections with the water). The second type of land-water edge is physically connected to the original shoreline and might run longitudinally, perpendicularly, or independently from it. In the case of a narrow strip of water, the land-water edge might be connecting two water lines with a bridge.

An important factor in the case of the land-water edge is the impact of time, which plays a much greater role in the case of urban blue space than in the case of

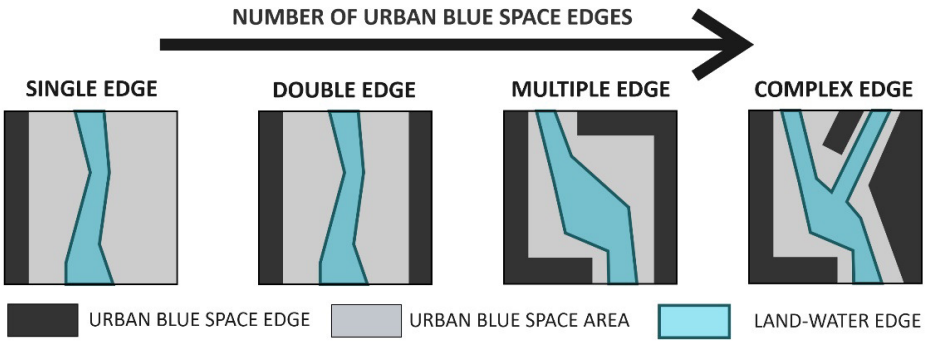

Figure 2. Urban blue space type in terms of number of edges.

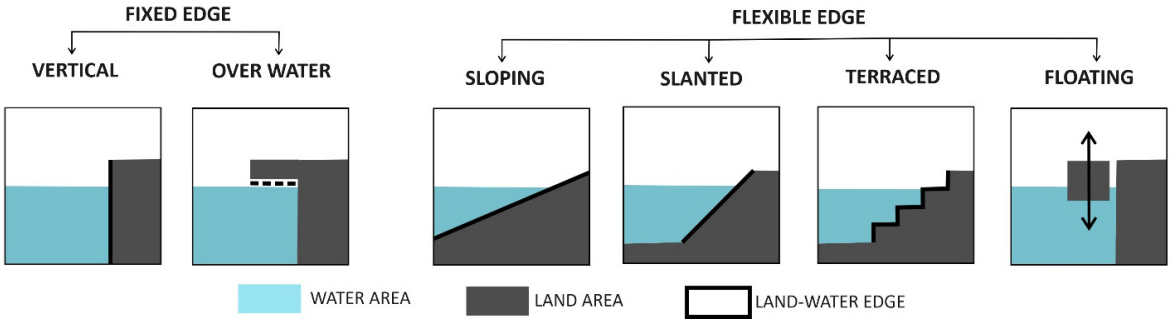

Figure 3. Types of water-land edges according to their relation to the waterline (shore or riverbank).

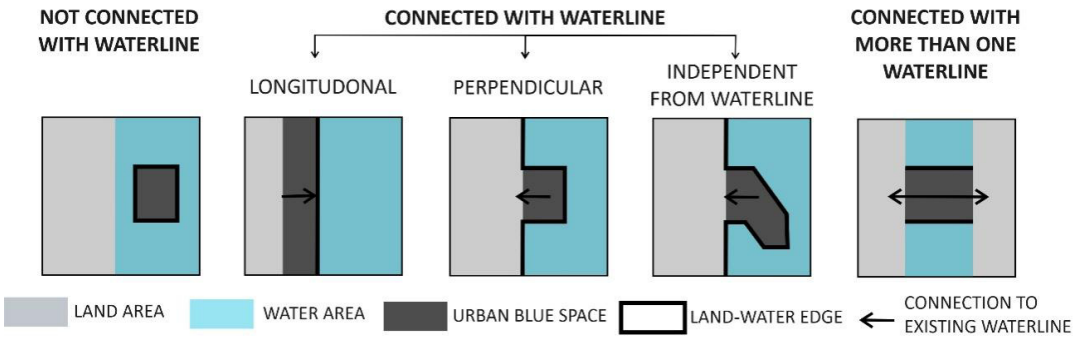

Figure 4. Types of land-water edge spatial layout in terms of the relation between water and land.

land area. Transformation of a land-water edge occurs on various time scales: it might be the matter of occasional changes due to some extraordinary weather conditions affecting the water level, periodic processes such as tides, or hydrological evolution happening over hundreds of years (Schwarzer et al., 2003; Sherman & Bauer, 1993). The 'mixture' of different temporal and spatial scales require more complex knowledge on the ongoing processes at the edge of the water and land to be obtained while planning the urban blue space (Finkl, 2004). The dynamic character of aquatic space and changes of the land-water edge in time affect the spatial management and functioning of urban blue space, which is essential for development of port cities and may play a number of roles within an urban environment.

3. Functional Characteristic of Urban Blue Space

Urban blue space might have various functions: transportation and industry (Couper, 1983; Sorensen & McCreary, 1990; Vallega, 1992); agriculture and ecological purposes (Gledhill & James, 2008; Taufen-Wessells, 2014; Völker et al., 2016); and housing, services and commercial (Feiler, 2007; Olthuis & Keuning, 2010). The compared classifications of waterfront functions largely comprise industrial, transport, residential, and recreational functions. Hoyle (1989) recognised the port function, comprising the industrial as well as derelict post-industrial use, residential, recreational, commercial, cultural, and transport function of the space, which is quite similar to what was introduced later by Hall (1993). Breen and Rigby (1996), apart from such functions as commercial, cultural and educational, recreational, residential, working, and transportation, also distinguished another type of area at the water frontage—the historic waterfront. Vallega (2001), describing the types of uses that have replaced a relocated port or the industrial function through the process of revitalisation, introduces the following types of successor functions: communication (transport), settlement (residential), recreation and tourism, cultural heritage (historical), and research. Meyer (2001) describes types of waterfront areas and divides them into four functional sections: industrial, transport, recreation, and residential. Moughtin (2003), in his research on public space, distinguishes waterfront as a specific type of public space and introduces its following functions: commercial, industrial, transport, leisure, and residential. Januchta-Szostak (2011) presented an exceptional approach, which shows an attempt to understand the area at the edge of the water and land as both land and aquatic space. In her research, she recognised the following functional types of the area at the edge: defensive, land transportation, water transportation, recreational, and economic.

The currently dominant land-based approach on the functional use of waterfront areas is not enough to thoroughly understand the functioning of urban blue space, which comprises elements of the aquatic environment. Therefore, it is also vital to analyse the subject of functioning of the space at the edge of the water and land from the water perspective. Research on the urban use of aquatic space dates back to the late 1980s and has been conducted mainly within the field of marine spatial management or economy related to urban development. Couper (1983) describes economic activity sectors within the aquatic area, including navigation and communications, strategy and defence, research, recreation, and management, as well as activities connected with natural features of the aquatic environment, such as mineral and energy resources, biological resources, waste disposal, and the environment. The functional division delivered by Sorensen and McCreary (1990) comprises coastal uses based on marine economic sectors (recreation development, tourism development, port development, energy development, industrial siting, agriculture, and mariculture development), activities connected with coastal resource exploitation (fisheries, water supply), and functions referring to the protection of the coastal environment (natural area protection systems, and oil and toxic spill contingency planning). Pido and Chua (1992) distinguish the following purposes of coastal environment use: agriculture, fisheries and aquaculture, infrastructure, mining, ports and harbours, industry, tourism, urban development, forestry, and shipping. In turn, Vallega (1992) presents a detailed functional framework, which includes resources (biological, mineral, energy resources), activity sectors (seaports, various kinds of shipping, air transportation), man-made

structures (underwater infrastructure, defence infrastructure, waterfront structure, recreational infrastructure), and environmental protection (waste disposal, research, archaeology, and environment preservation).

Synthetising the above, three categories, with regard to their environmental impact and therefore the type of landscape, were distinguished: environmental functions, urban living functions, and urban industrial functions (Table 1). The environment-oriented category includes activities such as scientific research on coastal habitats, protection of the cultural and natural environment and pollution prevention, agriculture and mariculture, and exploitation of natural resources such as fauna, flora, and the water itself. Urban living space refers to an inhabited urban environment characterised with more intensive spatial development such as communication space dedicated for individual or public transport, various services including commercial use of space, cultural and educational functions, recreation, greenery, and residential function. The third includes industrial use providing such functions as industry and port activity, technical and hydrotechnical infrastructure, energy production and mining, waste disposal as well as post-industrial brown of grey fields. Among the mentioned urban functions, the ones of public use, such as transport, culture, commerce, and recreation, are of the greatest importance for the city structure.

The transport functions characteristic for such urban blue space are a fairway, ferry terminal, port or yacht marina, or bridge. The main purpose of a fairway is the communication of water vessels. A water transport junction, such as a port or marina, connects collective and individual means of water transport to inland transportation and creates a unique identity of the city. Bridges might come in various forms—from traditional permanent bridges to bascule, swing, or rotational ones. Although their primary function is transport, they often become a city landmark.

An urban blue space connected with the cultural function is a water square or plaza, which performs a representative function for cultural, educational, and recreational activity with the possibility of hosting public events. A water square consists of a basin surrounded by land or a square adjacent to the water. A water boulevard might also play a cultural, representative, or recreational role. It often constitutes an icon of the city. Sometimes, apart from being used for recreational purposes, it serves as a reloading and mooring berth. A boulevard usually provides visual access to the water, sometimes with the possibility for physical contact with the water or access to ships moored to the embankment.

The commercial function is performed by a water market, where the main function is trade and exchange of goods. In the past, port markets played a significant role in port cities, however, in the present times of globalisation, the function of port marketplaces is fading since the trade has moved inland to fish direct sale centres or other service and commercial premises. Fish markets adjacent to the water are currently mainly tourist attractions.

A pier is a unique urban blue space, the main function of which is recreation, sometimes combined with transport. Similarly to the waterfront boulevard, it might become a landmark of the city. It is a public space situated perpendicularly to the coast which stretches towards the water and is surrounded by it from three sides. Recreational blue space might also serve for sports and leisure activities, for example, a beach with a bathing area, surfing, scuba diving spot, or regatta course, where users come into direct physical contact with the water. It can also take the shape of a reservoir or a floating sports facility such as a floating swimming pool or recreational pavilion. A type of urban blue space with a dominant recreational function with significant environmental value may be a park located by or on the water. In this case, urban blue space might be understood as a water surface occasionally traversed by humans or an underwater area rich in flora and fauna constituting a tourist attraction for divers.

As described above, urban blue public spaces can fulfill a large variety of functions, responding different needs of their users. Moreover, the functions of urban blue public spaces have transformed over the centuries. The process of evolution of the form and function of urban blue space takes place in many developing port cities. An interesting example, which depicts

Table 1. Urban blue space functional typology.

Urban blue space functions		
Natural environment	Urban environment Living	Urban environment Industry Infrastructure
Research Environmental protection Agriculture and mariculture Biological resource	Transport Infrastructure Residential Cultural, educational Commercial Recreational	Defence Port Industrial Transport Infrastructure Energy production Waste disposal

the transformation of space at the edge of water from medieval times until the present, is the case of Gdańsk.

4. Gdańsk Case Study: From Medieval Port to Water Plaza and Water Streets

The evolution of the historic port area in the city of Gdańsk is presented in a simplified form in Figure 5. In order to understand the evolution of the urban blue space of the Motława river, it is necessary to describe the successive phases of its thousand-year development reflecting the changes in this area in terms of: porosity of the urban blue space edges; number of edges of the urban blue space; types of land-water edges according to their relation to the waterline; and types of land-water edges according to their spatial layout. The distinguished phases (1050–1308, 1308–1454, 1454–1560, 1560–1630, 1630–1820, 1820–1945, 1945–2010, 2010–present) are briefly characterised below in relation to the historical events which have defined and shaped their spatial character (Figure 6).

The seaport along the Motława River started to emerge in the early Middle Ages at the southern foot of the fortified Slavic stronghold (*castellum*) located on the island, near today's Grodzka street (Śliwiński, 2016, p. 163; Zbierski, 1964, pp. 204–205). The stronghold port, where small-draft boats were handled, was formed as an oblong wooden embankment, probably freely accessible to the inhabitants, but also serving commercial functions (Cieślak et al., 1978, p. 92). The arrival of Lübeck merchants in Gdańsk around the mid-12th century resulted in the establishment of a merchant's kontor (*palatium*), which was a fortified trade settlement with its port (Cieślak et al., 1978, p. 219; Zarębska, 1998, p. 18). In connection with the widespread use of Hanseatic cogs, the depth demands of the port increased and a group

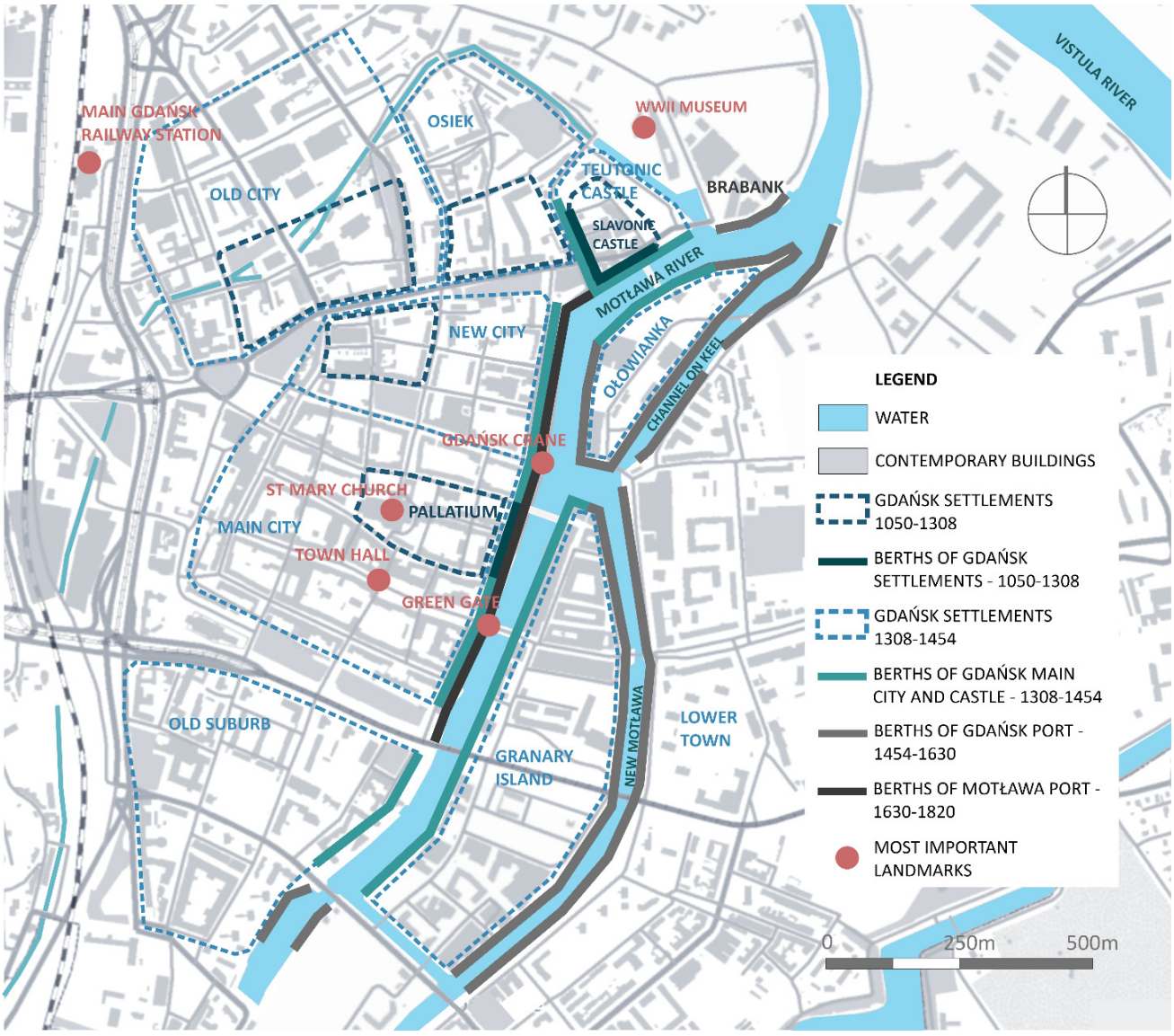

Figure 5. Map of the historic port of Gdańsk on Motława river presenting the phases of the port's development and location of medieval 'cities' and districts. Source: Own elaboration based on Interaktywny Plan Gdańska (n.d.).

of piers was built (Zbierski, 1964, p. 220). Piers in the form of wooden platforms soon also appeared at the Slavonic stronghold port. Most likely, these platforms did not allow access by outsiders.

During the years 1050–1308, within the Motława blue space there were two independently functioning centres (palatium and Slavonic strongholds), both with single-edged spatial land-sea structures. In each of the centres, the city was separated from the port and water area by a solid structure (a wall or a rampart). In both cases, the port infrastructure was placed over water (piers; Figure 6a).

In 1308, the Slavic stronghold and the Lübeck cantor were destroyed and the activity of their ports was suspended for some time (Śliwiński, 2016, p. 201). However, around the year 1340, in the place of the former stronghold, a Teutonic castle was built (Cieślak et al., 1978, p. 345). In the area of the former palatium (approximately the area between Świętego Ducha and Ogarna streets), the new city, the so-called Main Town, was founded (Cieślak et al., 1978, p. 358). The number of wooden piers increased then, as they were built along the frontline of the city walls. Access to the piers from the city was possible only via so-called water gates (Figure 6b).

With the creation of the so-called New Town (Cieślak et al., 1978, p. 366), new water gates and port piers were built between Szeroka street and the Fish Market (Zarębska, 1998, p. 22). A reloading crane was built at the gate of Szeroka street in 1379, which is still a symbol of this place. The Brabank workshops and Lastadia shipyard and the Old Suburb district were erected around 1360, completing the urban layout of the left bank of the Motława River.

The increase in the port's turnover made new storage facilities and mooring berths necessary. The Cog bridge was built (today's Green bridge), heading to the right bank of the Motława River, being at that time a marshy area of meadows with oxbow lakes. The Cog bridge, reliably existing since 1346 (Zarębska, 1998, p. 22), opened up new investment opportunities. On the right bank of the river, in the area of today's Granary island, multi-storey granaries and warehouses were built, as well as ash, tar and wood storage yards. In 1378, another bridge (Cow bridge), located at the mouth of Ogarna street, leading to the right bank of the Motława river, was built (Cieślak et al., 1978, p. 447). Port functions expanded further towards the eastern bank of the river. As a result, on the right bank, a port district which was inaccessible to residents was created together with a quay stretching along the river, called Long Embankment (Podgórski, 1997, p. 26).

The port of the Castle also expanded its storage and technical areas, shifting some of its activity from the right bank to the area of the Szafarnia (now Ołowianka island). There was a bridge leading to the Szafarnia area, running approximately along with the extension of today's Rycerska street (Zbierski, 1964, p. 142).

In this phase of evolution of the Motława urban blue space (1308–1454; Figure 6b), the ports of the Castle and the Main Town worked in a dual system: the left-bank held city functions, the right-bank port warehouses and granaries (Castle—Szafarnia, Main Town—Granary district). The introduction of multi-storey buildings along the bank created the waterfront of the Granary district and visually closed the interior of the port. The original single-edge layout (the left bank of the Motława) turned into a two-edge structure, where both sides of the port interior were connected by bridges (the castle bridge, Cog and Cow bridges). Thus, the west bank of the Motława river was lined with a series of piers located at the city's water gates, while the eastern bank had a linear layout. Despite the fact that the port area was inaccessible to its inhabitants, at that time the Motława river became a part of the urban structure of 14th century Gdańsk, constituting its most important water interior.

In 1454, as a result of warfare, the Teutonic castle was completely destroyed and its area remained undeveloped until the middle of the 17th century (Cieślak et al., 1982, p. 414). Gradually, the building density in the area of the agglomeration of the Gdańsk 'cities' was increasing. From 1457, the area began to be treated as a functional whole (Figure 6c), in which the Main Town became the most important centre (Cieślak et al., 1982, p. 7). The port on the Motława river underwent a significant reorganisation, especially within the framework of the existing structure of the Granary district.

From the moment of digging the moat, called New Motława in the years 1454–1456, Granary island became spatially separated. The island was connected to the eastern shore by a bridge at Stągiewna Gate. At the end of the 15th century, almost the entire island was built up with granaries (Cieślak et al., 1982, p. 21; Podgórski, 1997, p. 26). The channel separating Szafarnia from the mainland on its eastern side was also regulated, creating Channel on Keel and Ołowianka island (Cieślak et al., 1982, p. 419). Gradually, the Ołowianka was built over by port warehouses (Cieślak et al., 1982, p. 500).

At that time (1454–1560), the water space on the Motława river took the shape of the letter H at the intersection of which the Gdańsk crane was located (Figure 6c). Spatially, the port area was divided then into two interiors—two water channels and the most important port's turning basin, resembling by analogy two streets and a square on at their junction. The western edges of the first interior were the city walls, which cut it off from the system of port piers. On the eastern edge of the Motława water space were multi-storey granary buildings located on Granary and Ołowianka islands. The second interior, stretching along New Motława and Channel on Keel, still maintained a single-edge character, and was limited by only one wall of warehouses located on the eastern shore of Ołowianka and Granary islands. Therefore, the H-shaped Motława water space was already quite tightly enclosed within the walls of granaries, warehouses, and city walls. Its interior was,

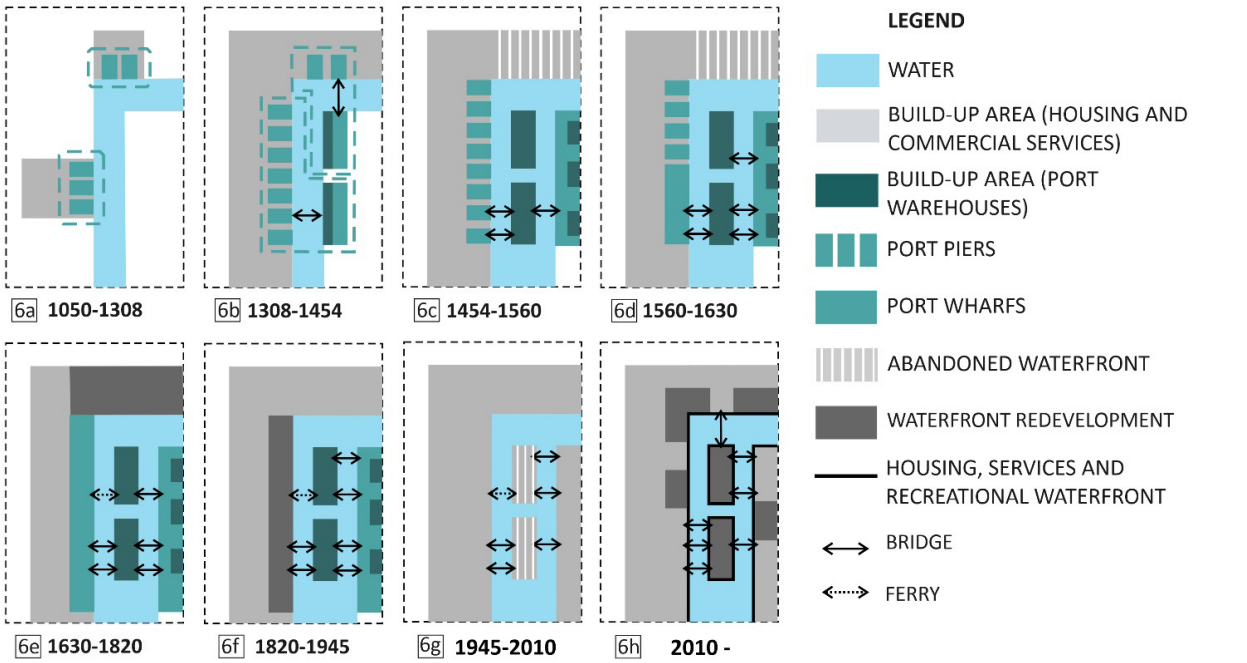

Figure 6. Scheme of spatial and functional development of Motława blue space in Gdańsk from 1050 to 2020.

however, not accessible to inhabitants, except port employees. That made the bridge connections even more important for perceiving this water space as a part of the Gdańsk public space system and for the porosity of the Motława urban blue space.

As a result of depth deficits connected with a change in the hydrological system, from around 1560 (Biernat, 1959, p. 218) the port on the Motława became inaccessible for large ships and it served only smaller ships and barges, which carried cargo between the port and the anchorage area next to Vistula river mouth. In 1570, the piers in front of the city water gates between the Green Gate and Holy Spirit street were merged into one long bridge running along the defensive wall of the Main Town (Cieślak et al., 1982, p. 418). Then the bridge was lengthened towards the Old Suburb district (Krośnicka, 2005, p. 123). In the years 1563–1568, the Green bridge heading to Granary island was rebuilt, and its external spans were enlarged creating vast reloading yards, which Zarębska (1998, p. 47) called the "vestibules of the Long Market." At the turn of the 16th and 17th centuries, bridges connecting Granary and Ołowianka islands with the areas east of New Motława were built. Thanks to the construction of a continuous embankment along the Motława (Figure 6d), the number of mooring places increased. However, more and more cargo was relocated outside of the Motława port. In this phase (1560–1630), the H-shape of the Motława urban blue space was even more enhanced by a new wall of granaries along New Motława. The previous overwater type of land-water edge, dominating on the left bank, was slowly replaced with the vertical structures of wharfs, some of which were publicly accessible. This process, together with the construction of new bridges (Figure 6d), made the Motława water space more 'permeable' for inhabitants and became, at least visually, a part of the city.

In the years 1630–1640 (Stankiewicz & Szermer, 1959, p. 95), fortifications covering the entire urban complex of Gdańsk, including the Old Suburb, former castle, port islands and quite extensive wetlands located east of New Motława were implemented. These last areas were drained and parcelled out (Cieślak et al., 1982, p. 413), and therefore the housing of the so-called Lower Town gradually developed in this area. The medieval walls no longer fulfilled their functions and were 'overgrown' with residential buildings, including on the border between the port and the city (Cieślak et al., 1982, p. 414). A new fortification system allowed for the development of the area of the former Castle and the parcelling of the land adjacent to the Fish Market, which made both areas a part of the Main Town. A comprehensive planning process according to the design from 1648 (Cieślak et al., 1982, p. 414) made the transformation of the area comparable to contemporary waterfront revitalisation projects. Even before 1650, the line of the Main Town's quays was extended to the north, as far as the Fish Market, where short piers for barges were also built (Cieślak et al., 1982, p. 419). Designating the areas of the Lower Town and the former castle for residential purposes led to the surrounding of the port with housing and service buildings (Figure 6e). In order to improve transportation between the right and left banks of the Motława River, at least from 1687, a ferry ran between the crane and Ołowianka island (Litwin, 1998, p. 39).

The siege of the city in 1734 caused the destruction of many buildings in Gdańsk (Cieślak & Biernat, 1969, p. 181). Gradually, the city was rebuilt. However, in 1772, at the mouth of the Vistula river to the sea, a new

port was built, competing with the one on the Motława. The modern district of New Port with its storage areas gradually began to take over the turnover of the old port and weaken its commercial importance. The longest-lasting process of integration of urban blue space into the city structure took place in the years 1630–1820 (Figure 6e). Although the H-shaped water area still fulfilled some minor port functions, it became most of all the vivid city centre of Gdańsk (Figure 7).

In 1863, the Motława riverbed was widened next to Ołowianka island (Ciemnołoński et al., 1998, p. 144). In the years 1885–1902, the quays along New Motława and Channel on Keel were rebuilt, and the adjacent basins were deepened. The remaining technically decapitalised port areas were taken over by the functions of municipal infrastructure. In 1852, a railway terminus was built in the southern part of Granary island (Biskup, 1996, p. 107). In 1853, a gas plant was built next to the railway station, and in 1897 a municipal power plant was built on Ołowianka island (Stankiewicz & Szermer, 1959, p. 196). In 1884, railroad tracks were led to the north part of Granary island in order to service the port (Biskup, 1996, p. 107). However, the inability to handle large ships limited the possibilities of storing bulk cargo, and the fact that the city densely surrounded the port with buildings and fortifications meant that reloading was gradually eliminated from the old port and transferred to New Port. Around 1840, the port area on the left bank of the Motława was made accessible to inhabitants, and commercial and service functions gradually began to enter its area (Krośnicka, 2005, p. 164). Long Embankment and Stągiewna street have become a full part of the public space of the city. In 1853, between the Gdańsk crane and St. John street, the embankment was widened (Litwin, 1998, p. 71) and transformed into the city boulevard. The passenger harbour for tourists' steamboats was located there. From 1861, the quay in the vicinity of the former castle became a floating fish market, where goods were sold directly from boats moored to piers (Litwin, 1998, p. 72). Functionally, the area along the Motława river was divided into the eastern port and the western range with services, trade, and recreational activities (Figure 6f). At that time, the area of Granary island, although still fulfilling port functions, became available to the town inhabitants. During the period 1820–1945, the Motława urban blue space was used more and more for recreation, residential, and small trade purposes (Figure 6f). Its porosity and accessibility significantly increased. In this phase, the level of the water space seems to be fully developed.

In 1945, the city centre of Gdańsk and its port were completely devastated. Gradually, as a part of an extensive program, the buildings on the western bank of the Motława river were rebuilt, opting for a historicising approach and preserving the urban layout of medieval Gdańsk. In turn, the eastern shore of New Motława was partially rebuilt using a modernist approach. In this zone, buildings in the form of tall blocks of flats were proposed. In the Lower Town, a large part of the facilities was implemented according to the plan from 1962. The southern part of Granary island was only partially rebuilt. For many years, the ruins of single granaries standing in the open space of the northern headland of the island constituted a specific war memorial in the structure of the city of Gdańsk, being at the same time a focal point of the blue space of the Motława River. The space on

Figure 7. The view of Motława river from the Cow bridge towards the Green bridge, 1761–1765, by Matthäus Deisch. Source: Gedanopedia (n.d.).

the Motława and New Motława became a large, however not very intensively developed, water plaza, with a strongly marked wall of historicising buildings on the western side and an undefined eastern wall with loose modernist buildings (Figure 6g).

From around 2010, a number of local revitalisation activities were undertaken (Lorens et al., 2018; Szczepański, 2010), and most of them took the form of urban injections within the Motława's blue space. To name a few: Stągiewna street was built-up with historicising tenement houses (the first were built around 1990); residential buildings with service ground floors were erected on the former Brabank in 2016; near the Gdańsk crane, the new facilities of the Central Maritime Museum were built; and several new hotels and apartment quarters were erected along the Motława. Even before 2010, part of the Maritime Museum was moved to old granaries on Ołowianka island (1985), the building of the old power plant on Ołowianka was converted into a philharmonic hall (1997), and a yacht marina was built on the waters of the New Motława (also in 1997). In 2017, the WWII Museum was built, which visually closed the river's interior from the north (Figure 8). In 2017 and 2019, footbridges were built connecting Ołowianka island and Granary island with the western banks of the Motława river to improve its pedestrian accessibility.

The development of Granary island in 2020 can be considered as the completion of the second stage of the reconstruction of Gdańsk after WWII (Figure 8). New buildings, with the intensity of development as well as their heights and shapes, refer to the port warehouses previously existing in this area. Investments implemented in recent years, pedestrian bridges in particular, have significantly activated the water space, increasing pedestrian and water unit movement. The buildings restored the H-shape of the water basins and divided the great water plaza into two parallel 'water streets' (Figure 6h).

The water area of the described urban blue space is currently undergoing the process of marine spatial planning. As this section of the Motława river is legally part of the port of Gdańsk waters, and therefore of Polish marine waters, it is subject to the planning process defined in the Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014, establishing a framework for maritime spatial planning. Marine spatial planning is a relatively new process, which was first introduced in the late 20th century (Carneiro, 2013; Ehler & Douvere, 2009; Hassler et al., 2018; Jay, 2012). It is defined as a public process involving the analysis of the existing human activity in the maritime area and its spatial and temporal location, which enables ecological, economic, and social goals set in the political process to be achieved (Ehler & Douvere, 2009). Directive 2014/89/EU provides a clear indication of the need to take into account the

Figure 8. Axis of Motława river heading north, closed visually by the WWII Museum. On the left, the new residential district on Granary island and the Maritime Museum on Ołowianka island visible in the background. On the right, the Gdańsk crane and tenement houses.

impact and interrelationships between the water and land, although it does not define the tools of this integration (The European Parliament and The Council of the European Union, 2014). According to the Directive, the spatial plan of port waters of Gdańsk must be elaborated up to the year 2023 (The European Parliament and The Council of the European Union, 2014). At the moment, this plan is being developed by the Polish Maritime Office. However, due to parallel planning competencies of the city authorities and the Maritime Office and the novelty of the procedure, this administrative process remains independent from already existing land spatial plans developed by the city authorities.

5. Evolution of Motława Urban Blue Space in Terms of Theoretical Considerations

The research in this case study of Gdańsk has shown the functional life cycle of the Motława river blue space (Figure 9). The function of the area was evolving from the natural space (before the year 1050), through the functions of port and industry (1050–1945), infrastructure and transport (1852–2005), into inhabitant-oriented functions, such as housing, services, and recreation (from 1840). These changes were possible due to the relocation of the main port activities to New Port in Gdańsk, a consequence of technological evolution in maritime transportation (increasing parameters of ships).

During the years 1050–1840, the blue space of the Motława performed mainly port functions, isolated from the area of the city. However, due to the erection of new city fortifications in 1630–1640, the old city wall lost its role and the blue space edge on the left bank of the river became more 'porous,' enabling the flow of people. From around 1840, the left bank was completely overtaken by the city functions and both structures—the port and the city—merged. Thus, paradoxically, again an investment taking place at a distance from the Motława defined its new character.

The port activities were led until 1945 on the right bank of New Motława, and on Granary and Ołowianka islands (Figure 9). However, the port was increasingly replaced by infrastructure facilities and transport connected with servicing the city (e.g., power plant, railway terminus, sewage pumping station).

After the damages caused by WWII, the port functions were not reintroduced to the Motława. The left bank was rebuilt as a vivid, multifunctional city structure. From around 1960, residential functions and offices were built along the right bank of New Motława. Since activating the eastern side of New Motława, as well as Ołowianka island and Stagiewna street, and introducing more services (gastronomy, culture, hotels) and recreation to the area, both sides of the Motława blue space have become a functional unity again. In the last couple of years, together with building the multifunctional complex of Granary island, the Motława blue space is even more intensively used. The last period shows the expansions of city functions onto the water (e.g., bridges, marina).

Table 2 shows the evolution of the water-land edges within the Motława urban blue space. As the case study

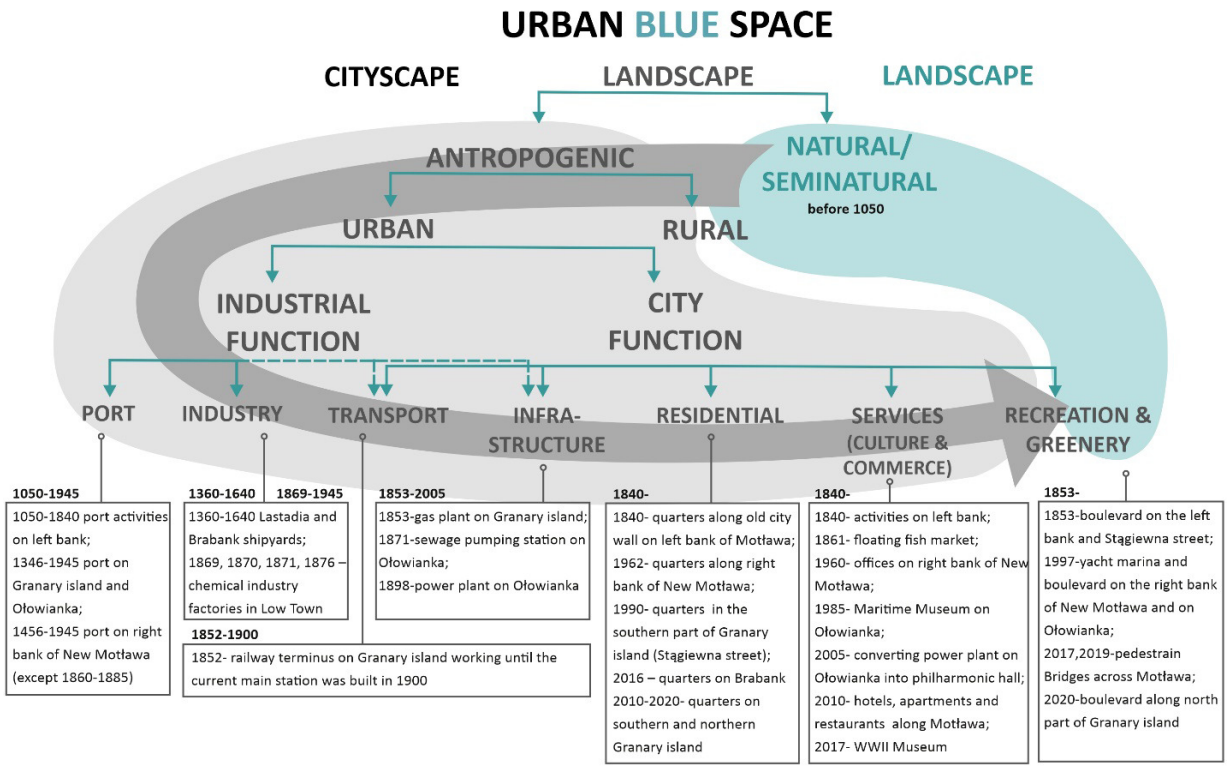

Figure 9. Functional life cycle of the Motława river urban blue space.

proves (Table 2, column 2), the porosity of the Motława urban blue space has increased in time. This process is connected with the evolution of functions (changing from 'gated' port and industry into functions accessible for inhabitants), as well as changes of the city defence system redefining the location of the urban blue space

Table 2. Evolution of water-land edges and urban blue space edges of the Motława river urban blue space.

Phase	Urban blue space edge			Land-water edge				Direction of water-land interaction
	Section		Plan	Section		Plan		
1050–1308 (6a)	solid (l.b.)	undefined (r.b.)	single	over (l.b.)	sloping (r.b.)	longitudinal		L→W
1308–1454 (6b)	solid (l.b.)	porous (r.b.)	double	over (l.b., r.b.)	vertical (G.C.)	perpendicular (l.b.)	longitudinal (r.b.)	L→W W→L (G, O)
1454–1560 (6c) and 1560–1630 (6d)	solid (l.b., G, O)	porous (N.M.)	multiple	over (l.b., r.b.)	vertical (G.C.)	perpendicular (l.b.)	longitudinal (G, O, N.M.)	L→W W→L
1630–1820 (6e)	solid (G, O)	porous (l.b., N.M.)	complex	over (l.b., r.b.)	vertical (G.C.)	longitudinal		No specific direction
1820–1945 (6f)	solid (G, O)	porous (l.b., N.M.)	complex	vertical	floating	longitudinal		W→L
1945–2010 (6g)	porous		multiple	vertical	floating	longitudinal		No specific direction
2010—present (6h)	porous		complex	vertical floating terraced	slanted sloping over	longitudinal	independent	L→W

Notes: r.b.—right bank of Motława; l.b.—left bank of Motława; G—Granary island; O—Ołowianka island; N.M.—right bank of New Motława; G.C.—Gdańsk Crane.

within the structure of the whole city. Therefore, it can be assumed that these two factors—function and water accessibility—define the porosity level of the urban blue space. The level of porosity, in turn, increases the spatial range of the functional connections of the urban blue space.

Considering the evolution of the Motława urban blue space in terms of the structure of its edges (Table 2, column 3), it can be seen that its complexity has increased with time, from a single-edge structure, via double and multiple-edged to a complex network of urban blue spaces. An exception from that rule was the phase 1945–1960 when, due to the damages caused by WWII, the inner part of the blue space was destroyed. That caused the H-shaped blue space network to transform into a simpler but much larger structure of a water plaza. With the construction of a complex on Granary island (2020), this very interesting form of water plaza was again replaced by the historical H-shaped network of water spaces. This change proved how strongly an urban intervention taking place in the inner part of the water blue space might redefine its spatial character and the reception of its space.

Considering the evolution of the plan of the land-water edge (Table 2, column 5), four periods can be delineated: the domination of perpendicular structures between the years 1050 and 1308; the presence of both perpendicular structures (left bank of Motława) and longitudinal structures (right bank) in the years 1308–1630; the domination of oblong structures from the year 1630, as further expansion towards the water was no longer possible due to the limited navigational widths of the river; and finally the introduction of the structures independent from the riverbank, which is a result of the new expansion of recreational functions towards the water.

The evolution of the Motława land-water edges in terms of their section (Table 2, column 4) indicates the increase of their diversity. During the first phases, they usually took the form of wooden overwater piers or shallow vertical structures. From the second phase, stone vertical structures appeared next to the wooden ones (e.g., foundation of the Gdańsk Crane from 1379, and the first concrete wharf from the year 1863 along New Motława). In the last three phases, floating structures appeared (1861—floating fish market, 1985—Sołdek museum ship, 1997—floating jetties of Gdańsk marina). Recently, next to the previously described types, recreational terraced edges appeared along Granary island (Figure 8).

The scheme regarding the development directions of the Motława blue space in time (Table 2, column 6) indicates that both directions (from water to land and vice versa) are possible. Historically, using the water as the area of expansion was considered until the limits of its navigational possibilities (changing in time with the function), while expansion towards land was taking place until the land reserves ended. The postwar periods were usually the turning points in shaping the Motława blue space, when new paths of development were undertaken.

6. Conclusions

The borders and functions of urban blue space dynamically change in time, as shown in the case of Gdańsk. Figure 9 and Table 2, summarising the spatial and functional evolution of the Motława blue space over the almost 1000 years of history of Gdańsk, clearly show that from the long-time perspective, this area should not be considered using the land approach only. The urban blue space is a pulsating space, changing its borders, expanding and contracting along with the economic, demographic, and political events taking place in the city (new investments, population growth or decline, wars), changes in shipping technology (variable size of ships), and defence techniques (city fortifications), where the factor crystallising the urban structure of the area is the water.

The case study shows that the functional borders of urban blue space are flexible due to the life cycle of its functions, and therefore the changing porosity of their edges. The porosity of this space depends on the character of the urban blue space edge as well as on changes in the land-water edge. The water line varies due to changes of water level, dynamic hydrological, as well as investment expansion both towards the water (e.g., piers, jetties, newly built land) and the land (e.g., digging out moats or port channels), thus influencing the water-land spatial relation. The type of edges of urban blue space often depends on their location (e.g., location on the island allowed to get rid of the defence system), but also on the investment activities taking place sometimes away from them—both on land and water. Currently, the water and land areas of urban blue space are administrated by different bodies. The competencies of these bodies, as well as the spatial plans developed by them, stop at the land-water edge instead of covering both elements of the urban blue space. As urban blue space usually consists of both land and water, to manage it effectively and to maintain its functional unity, one common plan should cover both areas.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

A City Profile of Malaga: The Role of the Port-City Border throughout Historical Transformations

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Abstract
The relationships Malaga has established with its port have changed over the centuries, conjuring up a variety of scenarios and circumstances. The past and present are closely linked phenomena in this case study where the porosity of the port-city fabric has marked the city's development and constitutes a key issue in the current and future challenges it faces. Malaga provides a particularly interesting example of a post-industrial city that has reopened its port to its inhabitants' acclaim while maintaining port activity. However, the growth tourism has seen in recent years has come to dominate the local economy. Cruise ships have taken on a significant role and have brought about important changes in the dynamics and flows between the port and the city, unsettling the balance between the two. This profile explores port-city development through the lens of boundaries and flows, demonstrating how their dynamics have determined Malaga's spatial, functional, and social development over time and how they continue to do so to this day. This article reviews the transformations the city has undergone and its future opportunities to achieve a balanced and sustainable port-city relationship.

Keywords
Malaga; porosity; port city; waterfront

Issue
This article is part of the issue "Planning for Porosity: Exploring Port City Development through the Lens of Boundaries and Flows" edited by Carola Hein (Delft University of Technology, The Netherlands).

1. Introduction

Porosity, as described by Walter Benjamin in the chapter dedicated to Naples in his book "In One Way Street and Other Writings" (Benjamin, 1985), provides a reference to understand urban space as a result of processes of appropriation and encounter (Sennett, 1995). It articulates the previously established relations between place and function. In this sense, porosity considers spontaneity as a permanent challenge to the limits between urban spaces and times, simultaneously connecting and separating neighbouring zones and events through time.

The porosity of the port-city fabric has marked the development of the port city of Malaga and constitutes a key issue in the current and future challenges it faces. Exploring port-city development through the lens of boundaries and flows can demonstrate how the dynamics of these over time have been a determining factor in Malaga's spatial, functional, and social development and how they continue to be so to this day. By assessing issues like industrial heritage, the historic city centre's public neighbourhood spaces, new functional interactions and the mix of memories and meanings, along with other topics, it can be seen that this port city's present and future development opportunities are to be found

in the permeability established in a porous dynamic border between the port and the city.

From the viewpoint of urban historiography, which has become increasingly specialised since the 1960s and an academic discipline in its own right, the analysis of the history of urban phenomena has produced a broad range of topics of study that has been approached from a sectoral perspective by a multitude of disciplines, including architecture, geography, sociology, political science, economy, and anthropology. This disciplinary dispersion is a direct result of the physical and social complexity of the urban phenomena (Harvey, 1973), and obstructs any holistic methodological approach to the subject when trying to incorporate its several dimensions. The article combines historiographical methods with spatial analysis and urban morphology, as a technique to address complex urban processes (Guardia, Monclús, & Oyón, 1996) and an indispensable tool to spatial planning applied in planning historiography (Kwak, 2017). According to Izaskun Landa (2020), the first category of analysis addresses the historical process of construction of the city, focusing on its space and morphology. The second refers to the sociocultural processes that take place in the city as a place where economic, cultural, political, and religious events occur without considering its spatial variable. Lastly, the third school of thought associates urban sociocultural processes with the space in which they take place. In other words, it correlates the location of activities in urban spaces and these are in turn correlated with their evolution over time. An association of the sociocultural dimension of the city with the physical and spatial dimensions serves as the methodological basis for this article, based on the use of geo-historical spatial mapping as an analytical tool (Hein & van Mil, 2020), allowing the evaluation of how the levels of porosity in the port-city interface have changed over time (Schubert, 2017).

In this regard, the importance and impact of port activity as a highly significant socio-cultural factor in understanding urban historiography is unquestionable, even more so when we consider that the majority of the great historical cities are port cities. The sea, and by extension rivers, have shaped them over time, acting as a route of cultural exchange, as well as for population and merchandise flows, thereby forging a plural multifaceted place where diverse landscapes and environments from different periods coexist (Braudel, 1980). The nature of the port-city relationship has changed throughout history and has resulted in different scenarios and circumstances. This relationship constitutes one of the most important paradigms for contemporary cities, since it brings together a close spatial association with the utmost functional interdependence, as Hoyle (2000) points out. There is no doubt that ports, as infrastructures of exchange between the sea and land (Grindlay Moreno, 2017), have evolved to adapt to changes in technology and trade and have at the same time transformed their relationship with cities. Hence, there are two key moments in the historiography of port-cities: the industrial and post-industrial periods. These periods also marked a structural change in the society of the era, understood as referring to the territorial change that resulted from an alteration in the logistics of production (Costa, 2007a).

Moreover, authors such as James Bird (1963), Brian Hoyle (2000), or Han Meyer (1999) refer to the preindustrial period as a key one to understanding the subsequent dynamics, proposing interpretative schemes to better explain this complex reality. Bird (1963) describes the observed changes in space and time through the definition of three phases: the initial settlement phase; the development and expansion of activities phase; and the specialisation and port areas reconversion phase (Figure 1a). Hoyle (2000) proposes six stages: the preindustrial period; the industrial period; and the post-industrial period, which comprehends four dynamics, balancing between the expansion of port activity, and the redevelopment of former port areas, reincreasing port-city integration (Figure 1c). Meyer (1999) defines four moments, the first three similar to the Bird's Anyport, adding a fourth period with the complex port's articulation and the advanced dysregulation, particularly evident in the large port-cities (Figure 1b). As such, a synthesis definition of three large periods of port-city can be accepted (the preindustrial, the industrial, and the post-industrial phases), allowing to address the case study, also referring to the 'medium port-city' proposed by Ducruet and Lee (2006; Figure 1d).

As Meyer (1999) affirms, ports had already distanced themselves from cities in the industrial period, forsaking the close relationship of the pre-industrial period as a storage and distribution centre for merchandise within the walled enclosure. At this point, they were converted into industrial or 'transit' ports (Meyer, 1999). Due to the modernisation of ports, the port-city dichotomy would increase until they became two independent and functionally autonomous realities. The city's trade and industrial fabric would be progressively replaced by another fabric based on tourism and real estate, while the port maintained its separate autonomous function. Schubert (2017) also asserts that all seaport cities have structural similarities, being a functional and spatial unit until the beginning of the 19th century, and later they spatially separated and assumed different institutional responsibilities. Meyer (1999) himself describes this period as an 'industrial port—functional city,' lasting until practically the end of the 20th century. Subsequently, in the post-industrial period, cities would rediscover their ports as part of the urban landscape, and in turn, cities would be discovered by ports as a potential asset, first as a logistics and telecommunications centre, and later as a tourist attraction for cruise tourism. This period spans from the end of the 20th century to the present.

In the case study at hand, the first period runs from the 8th century BC to the middle of the 19th century,

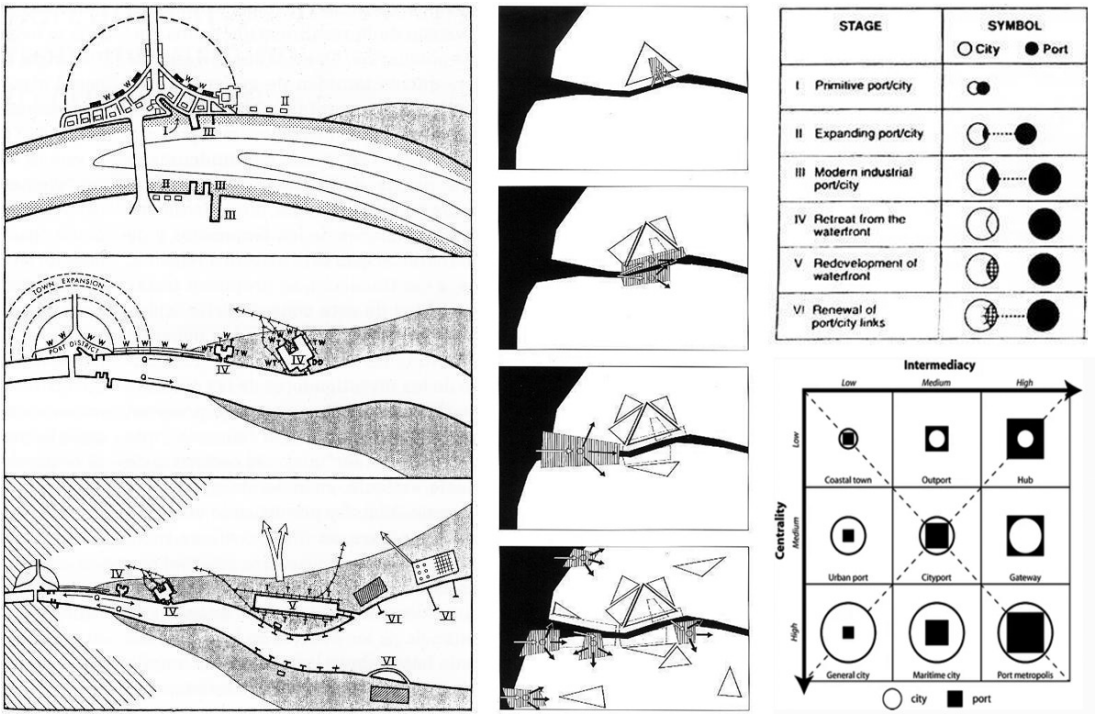

Figure 1. Port-city dynamics. From left to right and from top to bottom: a) Anyport (Bird, 1963, pp. 29, 31, 33); b) Historical port-city evolution (Meyer, 1999, p. 23); c) Development dynamics of the port-city interface (Hoyle, 2000, p. 405); and d) Matrix of port-city relations (Ducruet & Lee, 2006, p.109).

a considerable period that can be divided into two critical periods of the port-city relationship, and which is especially marked by the demolition of the medieval ramparts. The second period revolves around industrialisation, with Malaga being one of the few Spanish examples of significant industrial activity along the coastline, along with Bilbao and Barcelona (Alemany, 1991, 2010). At the beginning of the 20th century, this activity was replaced by another kind of industry: tourism. The Costa del Sol is one of the most important areas in Spain for beach holidays, and Malaga, as its main hub, has been considered a tourist destination since the 1930s (Barke et al., 2010; Pellejero-Martínez, 2005). Lastly, the third period, from the third quarter of the 20th to the present century, has been characterised by the port's modernisation which has seen the development of the container terminal (2004), the cruise ship terminal (2008), and the restoration of the old port docks for the city (2011; Figure 2). The port city has thus managed to shift its offer towards cultural and urban tourism in a clear attempt to differentiate itself from other nearby coastal destinations. Urban improvement plans, the transformation of its waterfront, and the emphasis placed on cruise ship activity have turned Malaga into a point of reference

Figure 2. Images of the port city of Malaga with the huge traffic barrier that separates them. Source: Pedro Marin, edited by María J. Andrade (2012).

for cruise tourism in the Mediterranean, reaching a flow of 476,970 passengers per year (Malaga Port Authority, 2019) in a city with a population of 578,460 inhabitants (Instituto de Estadística y Cartografía de Andalucía, 2020). In the case of Barcelona, the modernisation of the port is carried out with the growth of the port along the industrial coastline, allowing the liberation of Port-Vell and the realisation of a great event such as the 1992 Olympics (Gastaldi & Camerin, 2018) as the main strategy, like other international cities such as Genoa (Gastaldi & Camerin, 2020). In Bilbao, the transfer of port activity downstream freed the old port, allowing the construction of the Guggenheim, an iconic building that transformed the image of the city (García Vázquez, 2008; Ponzini & Akhavan, 2020; Vegara & de las Rivas, 2004), a strategy followed by many other cities. These three cases of industrial port cities have carried out different dynamics for locating port areas (Costa, 2001) as well as different strategies for relaunching the city, with their own particular impacts on tourism (Andrade & Costa, 2020; López-Gay et al., 2021).

Nevertheless, the organisation and functioning of the port city has been, and continues to be, the subject of study for experts in many disciplines (Breen & Rigby, 1994, 1996; Bruttomesso, 1991; Casariego, 1999; Chaline, 1991; Costa et al., 2013; Daamen & Vries, 2013; Ducruet, 2007; Fleming & Hayuth, 1994; Gastaldi & Camerin, 2020; Hall, 1992; Hein, 2011; Hoyle, 2000; Hoyle & Pinder, 1992; Marshall, 2001; Meyer, 1990), who have focused on highlighting the relationship between the city and its port to describe and understand its configuration from an analysis of its various urban transformations; the functional evolution of the activities they host; the intensity and growth of economic and spatial relationships; the balances between centrality and nodality of the port-city relationship matrix over time; the waterfront adaptation to climate change; along with other issues. In this regard, this article aims to understand how the port invigorates the city of Malaga's urban reality over time.

Undoubtedly, ports are usually places of urban centrality, which is why their constant transformation changes not only their own appearance but also that of the city. As such, the main aim of this article is to study the port-city's organisation and functioning in different periods, the close link between port functions and urban trade, and its historical manifestations on Malaga's urban dynamics. We also analyse the porosity of its borders, the nodes, flows, and urban dynamics that have adapted throughout history to the alterations both the port and the city have undergone. To achieve this, a study is conducted of the city and the port as a single reality, structuring the article around three sections that correspond to the three periods mentioned above (pre-industrial, industrial, and post-industrial periods). Given the importance of the global context when considering the history of a port city, each section describes the global context and then focuses on the case study with graphic contributions and findings derived from each period.

2. Origin and Evolution of the Port City in the Pre-Industrial Period (8th Century BC–19th Century)

As Bruttomesso (2010) rightly states, cities have been constructed to establish relationships with the world beyond them. The origin of numerous Mediterranean coastal cities resides precisely in the expansion of trade through the maritime routes across the Mediterranean opened up by the first seafaring peoples (Grindlay-Moreno, 2001). This gave rise to the creation of these spaces as central places of urban areas, around which most of their citizens' activity would be carried out (Grindlay-Moreno, 2001). As Morris (2007) affirms, the agora was not just a simple public space but rather an intense concentration of diverse activities.

Malaga has been a port city from its inception and arose from a settlement built around a natural harbour. The city and the port grew together, and port activities were present in the structure and development of urban planning that constantly adapted to the needs of maritime traffic and trade. The origin of the city of Malaga might lie in a small Phoenician port or factory (García Gómez, 1995). The city grew in tandem with the port activity located at two differentiated sites (see Figure 3). The existence of two ports led to the appearance of two main forums. On the one hand, the commercial port has been linked to the Plaza, the centre of socio-economic activity. On the other hand, the fish-salting factories and salting pools were located in a second port, which was, therefore, more integrated into the life and activities of its inhabitants and has been associated with the religious centre (Andrade Marqués, 2012). Hence, the presence of these two ports had a crucial influence on the urban development of the city, from its Phoenician roots to the Roman Era and beyond.

2.1. Muslim Malaga: 8th to 15th Centuries

When the Arabs settled in the south of the Iberian Peninsula, Malaga played a leading role due to the continued growth of its trading activity through its port. The port was a key element in maritime links, not only with North Africa but also with a wide variety of ports in the Mediterranean, the Far East, and Northern Europe (Rodríguez Alemán, 1984). During the Muslim era, from approximately the 8th to the 15th centuries, the existence of two ports was maintained, though not exactly in the same location. The more commercial port remained next to the river, though somewhat further out into the sea due to constant silting. It was delimited by the shipyards and the Castle of the Genovese, which served as a hinge to the urban port (Figure 4). This second port was located in the central bay and economic activity was concentrated in the surroundings of the Castle of the Genovese, the most important centre of the port-city

Figure 3. Historical evolution of the port-city relationship of Malaga: Muslim Malaga, 8th to 15th centuries; 18th century, demolition of the ramparts; 19th century, Industrialisation. Notes: 1. Commercial Port; 2. Urban Port; 3. Plaza de la Constitución; 4. Shipyards (currently the market); 5. Castle of the Genovese (currently the Plaza de la Marina); 6. Mosque/Cathedral; 7. Fortress/Arab Citadel; 8. Alameda; 9. Customs House (currently the Museum); 10. Park. Source: María J. Andrade (2012).

relationship. The urban reflection of these port activities inside the medina was to be found in the Plaza, which maintained its character as a forum.

The layout of the city is perfectly defined with the Arabs, with such force that subsequent centuries would be unable to erase that layout. Its shape reflects the relations between basic territorial arteries and the important Granada-Africa route since the Port of Malaga was the Kingdom of Granada's main port. The city's economic and religious hubs, like the Plaza and the Mosque, were established at the crossroads of these arteries, with all the city's activities taking place at the gates of these arteries (Figure 4): "Malaga was a great import-export centre capable of creating an entire communications system, to which the city itself was subordinated" (Rodríguez Alemán, 1984, p. 23). Despite the existence of the ramparts as a boundary, the port-city relationship was highly intense and practically all the city's activities took place at the gates which opened up to the sea. In this way, porosity occurs because the existence of the edge itself is questioned. Despite the barrier posed by the rampart, there is a physical porosity marked by the rampart gates and their connections with the two forums of the city (functional porosity), causing urban flows and dynamics around them (social porosity).

Malaga was conquered by the Catholic Monarchs in 1487, sparking changes in its urban structure. Nonetheless, the city continued to maintain its three-pole functionality: a religious centre (the Cathedral), a civic centre (the Plaza), and a mercantile centre (the Port), which still had two different port locations. Each port was linked to an internal forum, the Plaza and the Cathedral, thus creating the city's layout of streets and areas of activity. Such is the case of Calle Nueva, which was created to link the port (Sea Gate) to the Plaza, thus transferring commercial activity from the old *Alcaicería*, or goods market, to this street.

2.2. The 18th Century: Demolition of the Ramparts

The 18th century was a positive era for Malaga. It can be construed as the century of reforms, which began after the War of the Spanish Succession in the reign of Phillip V. Malaga formed part of the important demographic boom that took place across Europe during the 18th century. This had a direct impact on local urban planning since new facilities were required, thus producing a further expansion of the city. As Vilar (1962) suggests, not all cities and regions underwent this change to the same extent. It was essentially the maritime cities at the periphery which consolidated a bourgeoisie that was mainly dedicated to trading and manufacturing, especially in the second half of the century. The rise in economic activities required an increase in transport infrastructures, which led to an improvement in the road network and the facilities of some ports to channel foreign trade through them (Rodríguez Alemán, 1984).

The end of the 18th century and the beginning of the 19th century was an era marked by prosperity in Malaga. This was reflected in a series of significant actions that would change the relationship of three realities, the city, the port, and the sea, and lead to the culmination of this

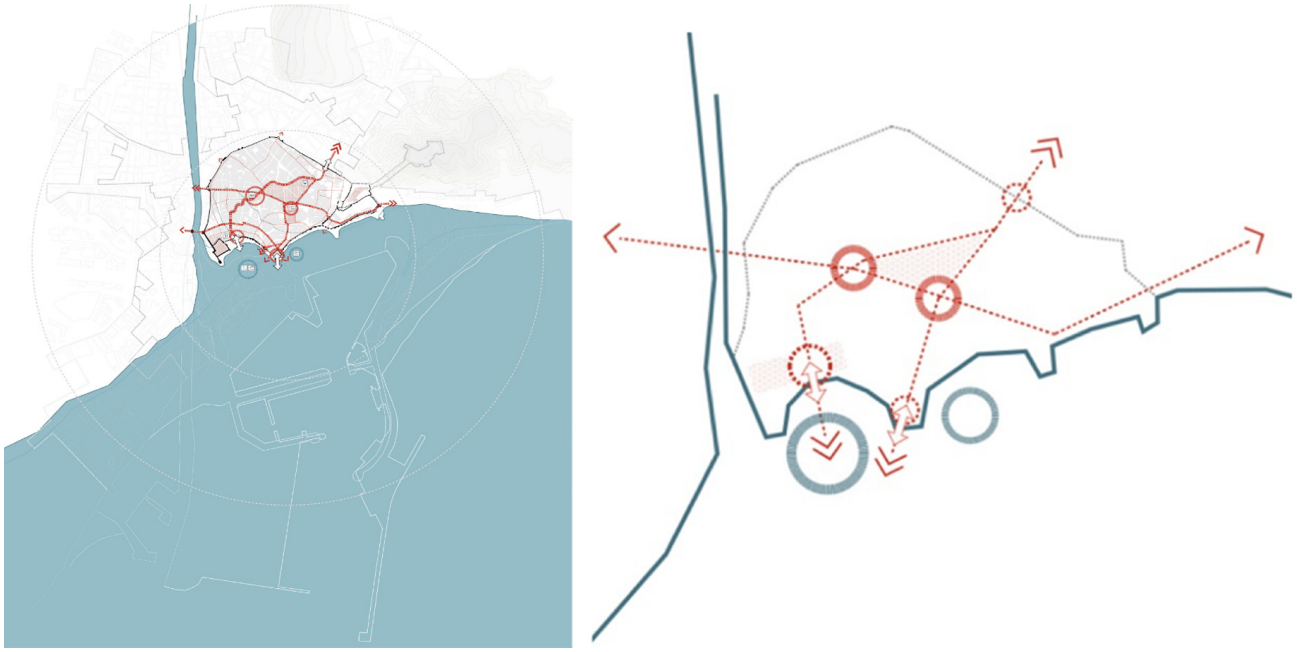

Figure 4. Analysis of the port city of Malaga's configuration: Physical, functional, and social porosity; Two ports–two forums–land and maritime connections (Muslim era). Source: María J. Andrade (2012).

relationship. The first important event was the demolition of the medieval ramparts in 1786, which had separated the port from the city for ten centuries. The city and the sea were thus joined by an open port, and the dock's edge was turned into just another city street. The construction of the Eastern Dock (*Muelle de Levante*) along with the new Customs House led to the definitive transfer of most of the port's activity to this site. This freed up a large part of the coastline and allowed for the creation of the Alameda, the city's main leisure area (García Gómez, 1995). The Alameda and the dock made up the city's waterfront, which had been turned into a continuous promenade next to the sea. For its part, the area around the Castle of the Genovese, located between the Western Dock and the Espartería Gate (*Puerta de Espartería*), would now be the nexus between the port and the city. The Sea Gate (*Puerta del Mar*) maintained its importance from a mercantile perspective. It was then that the city expressed the importance of the communication that would be opened up between the population of the seashore and the rest of the city (Figure 5). This would be the time of greatest porosity, without boundaries between the port and the city and with a huge urban waterfront and a green space, which connects the port and the city as a whole.

3. The Role of Industrialisation in the Port-City Relationship (19th–20th Century)

The demolition of the defensive ramparts in the 19th century, which can be considered a common phenomenon in almost all European cities, created a physical continuity between the port and the city. However, this continuity would soon be eradicated by another kind of wall, an industrial wall. The port-city relationship became increasingly distant as a result of the industrial revolution, which, despite being a great economic boost for the port and the city, brought with it a rupture of said spatial continuity. From then onwards, the port area was seen as an entity that was disconnected from the city's historical shape, although it coexisted with the city both physically and socially (Casariego, 1999). The development and progress of these cities in the new industrial era were reflected in their port frontages.

The transformation of ports in the industrial period was characterised above all by the appearance of steam, which transformed navigation and the techniques for carrying out public works (Alemany Llovera, 1991). Ports were thus modernised, harbour mouths made narrower by lengthening breakwaters, and dock alignments extended, in many cases to gain greater water depth through filling works that had a repercussion on the morphology and layout of cities. The rise and development of railways and their introduction into port areas also revolutionised exchange capacity and sea transport. The impact of these changes is evident in the structure and functioning of cities (Alemany Llovera, 2010). The vacant spaces freed up by the demolition of ramparts were generally taken advantage of for port activities, railway lines that crossed these cities along their waterfronts and even for roadways that would be the origin of future barriers between the port and the city.

The transformation of ports in the industrial period, therefore, had a direct impact on the configuration of the city. This ended up creating both a barrier between the city and the sea, as well as social segmentation along the coastline (Alemany, 1999, 2010). The industrial city containing factories and workers' settlements was devel-

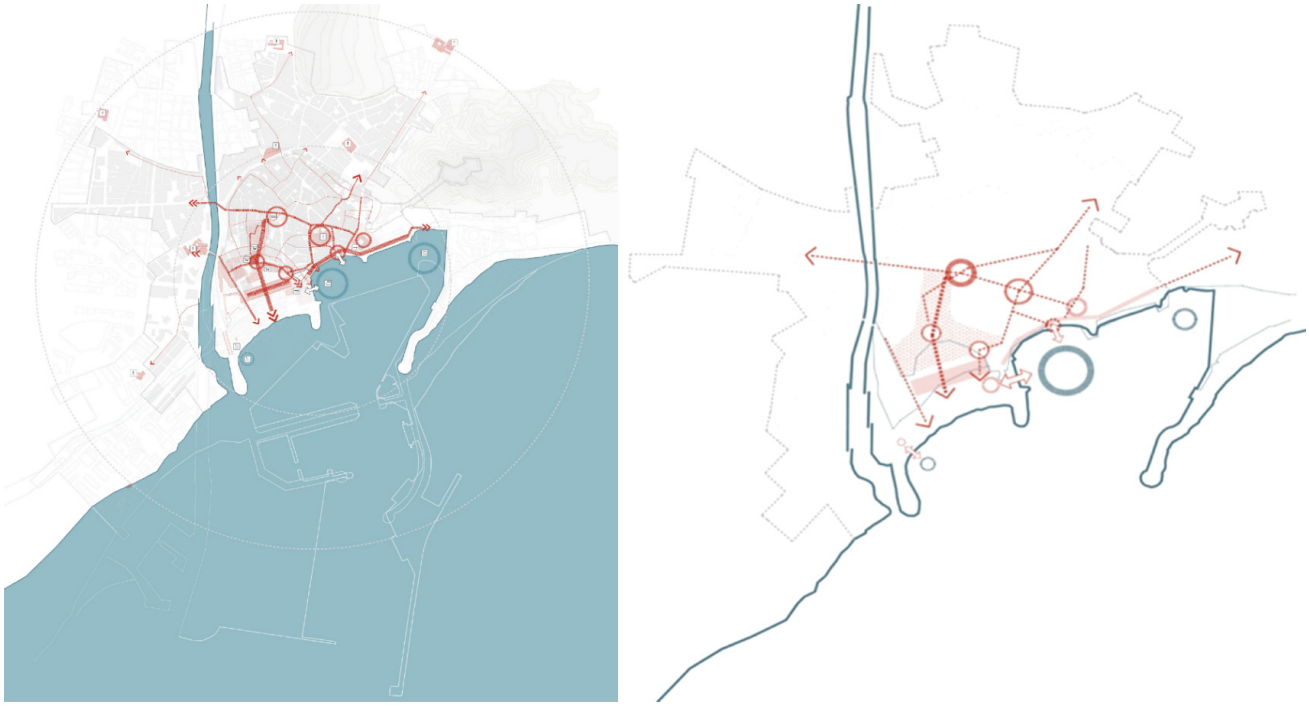

Figure 5. Study of the port city of Malaga's configuration in the 18th century: Physical, functional, and social porosity; Demolition of the ramparts, upon whose imprint a seaside promenade was built. Source: María J. Andrade (2012).

oped on one side of the port, while a spa city containing the bourgeoisie's second homes was found on the other (Reinoso Bellido, 2005).

This social segregation of the coastline around the port was visible in cities like Santander, Barcelona, or Malaga, which underwent extensive development during the industrial period. Malaga's industrial bourgeoisie built high-rise tower blocks on the city's outskirts, promoted factories and workshops, attracted foreign talent, and fostered railways and port improvements. Subsequently, the economic slowdown of the 1950s saw Malaga endeavour to overcome the slowdown by enhancing the port and building railways, although by then industry had already lost its regional weight.

One of the greatest urban contributions of the period was Calle Larios. This street was built to link the Plaza with the port's main gate, the Espartería Gate, a particularly important site due to its location on the Alameda, and which thereby concentrated a great deal of activity. As the city's main shopping artery, the layout of Calle Larios mimics the model set by Calle Nueva, which in the past linked the Plaza to the port's main gate. Both thoroughfares have shaped the city's shopping district since then and continue to do so to this day.

The modernisation of the port, along with the regularisation of its docks on land reclaimed from the sea, allowed for the city's growth. As such, the park—the city's main green area—and the new residential area, the Heredia Enlargement (*Ensanche Heredia*), were both promoted, but at the same time, the borders between the port facilities and the city were precisely set by means of a fence that prevented any physical or visual contact with the sea. The port was not only present in the city's growth to the west with factories and their settlements, but this growth also allowed the port to expand to the east thanks to the railway line, which was subsequently converted into a seaside promenade serving as a central leisure and relaxation area. Hence, while the port spurred industrial manufacturing development along the western coastline, it likewise fostered an incipient tourist industry in the east. Despite the distancing of the port from the city, it is clear that the urban developments of the 19th and 20th centuries were once again closely linked to the port, not only with regards to the opening up of connections to the city and development of the waterfront but also to the widening and development of the eastern and western coastlines. The port was once again the major factor in the city's development (Figure 6). However, as the port becomes a port area, an independent entity, in addition to the barriers posed by railroad tracks and fences, governance and land ownership become real boundaries that hinder the porosity between the port and the city even to this day. This time will be the one with the greatest physical and functional discontinuity between the port and the city.

4. The Transformation of the Port-City Relationship in the Post-Industrial Period (Late 20th Century–Present)

The third quarter of the 20th century was marked by significant port growth. The container traffic phenomenon, which is associated with logistics management, the changes in energy use and shipping routes and networks, are the origin of new facilities being relocated far

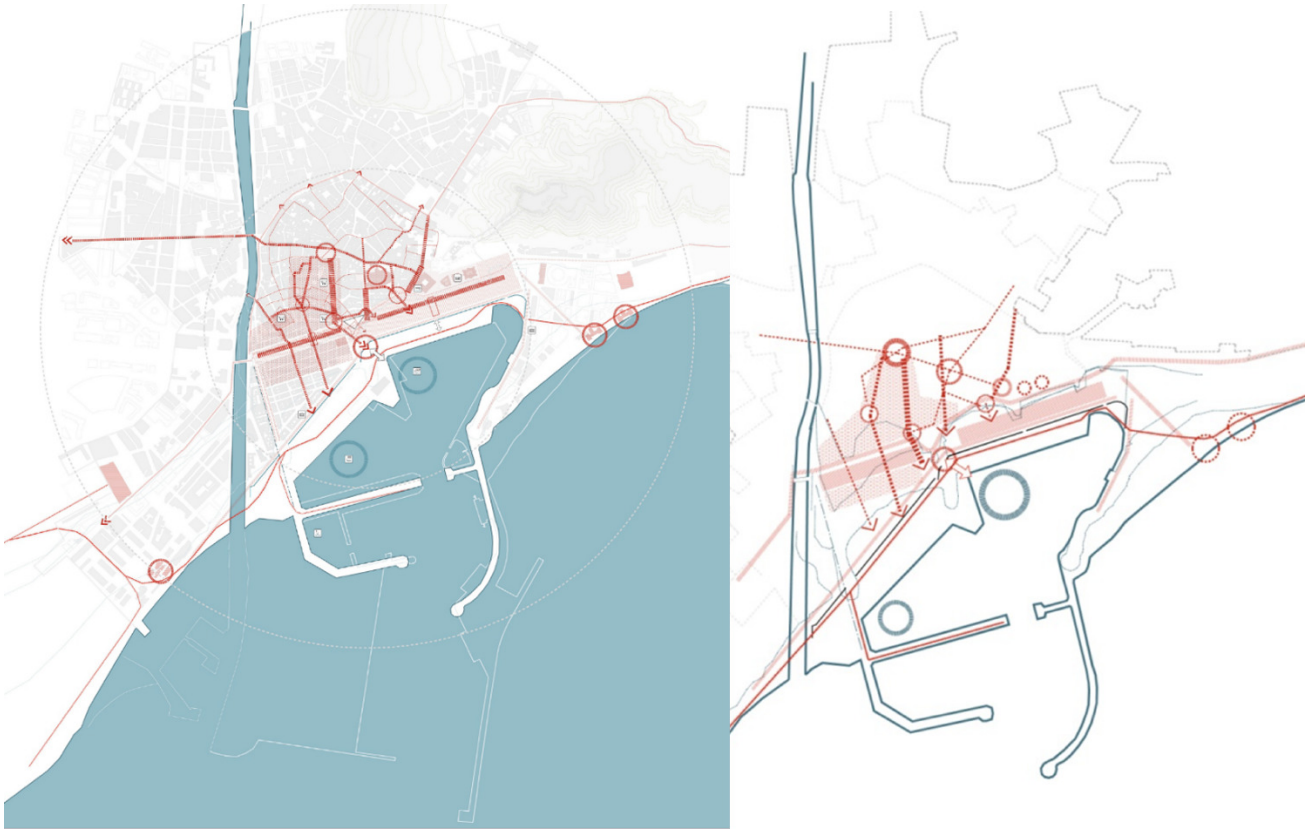

Figure 6. Study of the port city of Malaga's configuration around different physical, functional, and social factors (19th century): The port closes in on itself, separated from the city by fencing, roads, and railway lines, and from the sea by the narrowing of the harbour mouth. Source: María J. Andrade (2012).

from the old port areas (Baudouin & Collin, 1994; Hoyle, 1996; Hoyle & Pinder, 1981; Malone, 1996; Mosso, 1996). The resulting deindustrialised spaces were used as places of opportunity to recover historic city centres that were in decline at the time. This gave rise to the waterfront phenomenon, which became an essential paradigm for post-industrial cities (Bruttomesso, 2001). The academic literature on waterfronts is abundant (Breen & Rigby, 1994, 1996; Bruttomesso, 1991; Carpenter et al., 2018; Hein, 2011; Marshall, 2001; Meyer, 1990, 1999), as is the literature on their classification (Andrade Marqués, 2012; Brownill, 2013; Perea-Medina et al., 2018; Schubert, 2011; Shaw, 2001) ranging from the first American waterfront experiences focused on leisure and shopping, to the ones which take on the role of tourist ports (McCarthy, 2003; Perea-Medina et al., 2018). In a period that seeks to maintain port activities that are compatible with urban life, the cruise industry stands out as one such activity, straddling as it does both tourism and port activities (Capocaccia, 2001). If there has been an effort to get inhabitants closer to their port throughout the different stages of the waterfront phenomenon, this objective is currently in disarray as thousands of tourists make their way along the waterfront to historic city centres daily (Perea-Medina et al., 2018).

Malaga is no exception to this rule. The need for port improvements and the rush to find new areas that could rescue its historic city centre led to a contentious process to plan this space. This process began in 1985 and would last for over 20 years. In the face of the endless negotiations on the port-city interface, both the port and the city continued to move forward and develop as independent spaces. The port grew seaward (Figure 7), freeing up some of the docks near the historic city (Docks 1 and 2), while maintaining port activity at others (Docks 3 and 4, passengers, and ro-ro). When a development agreement was reached on Docks 1 and 2 in 2010, the city centre had already been renovated, the container terminal was in operation (2004) and the eastern breakwater was beginning to receive the first cruise ships (2008; Andrade Marqués, 2012). Despite this, the port-city analysis conducted by Andrade Marqués et al. (2012) placed Malaga within the international context of waterfronts, positively highlighting the quality of its public spaces to deal with the powerful combination of leisure and entertainment which characterises the city. These docks have been mixing uses—urban docks 1 and 2 maintain port activity as a terminal for luxury cruise ships, mega-yachts, boats for sports, and tourist use—and enriching the cultural offering over time with museums like the Pompidou Centre or craft shops and local products. Maintaining port activity so close to the city (both urban docks 1 and 2 and docks 3–9: passengers, cruisers, ro-ro, fishing, containers, and bulk) reinforces its identity and turns

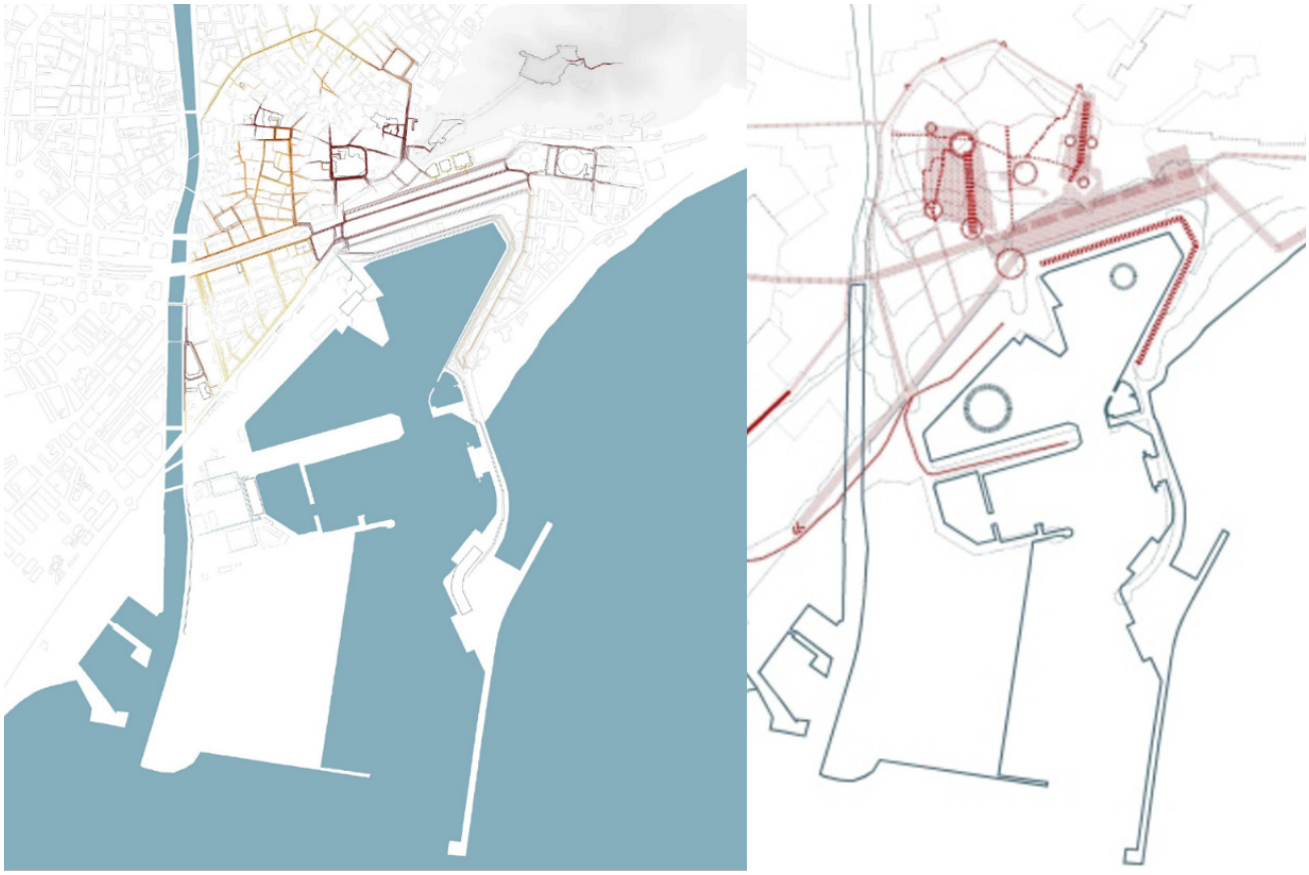

Figure 7. Study of the port city of Malaga's configuration around different physical, functional, and social factors (21st century). Source: María J. Andrade (2012).

Malaga into a highly attractive tourist destination given the cruise terminal's proximity to the renovated historic city centre and a broad cultural offering. Despite physical barriers (Andrade et al., 2020), the governance structure (Daamen & Vries, 2013) and International Ship and Port Facility Security Code, the porosity between the port and the city is a reality not only through the punctual connection between both—which should be improved—but also through the visual relationship with the ships, cranes, and port activity that reinforce the identity of the port city.

The historic city centre is still functionally organised around the same two historic forums: the Plaza de la Constitución on the one hand, which still maintains its commercial nature, and the Cathedral on the other, which acquired this role due to its historical importance, although it still maintains its religious function. Both forums have expanded along linear nodes, the cultural artery is Calle Alcazabilla as a prolongation of the Cathedral, and the commercial artery is Calle Larios as an extension of the Plaza de la Constitución. The latter artery divides the historic city centre into two 'cities.' A more active, community-based city, where most neighbourhood amenities are concentrated, is on one side, and a more touristic and contemplative city containing more museums and monuments is on the other (Andrade Marqués, 2012). At the same time, the transformation of Docks 1 and 2 in the urban port, together with the fact that the port continues to operate in the old city centre, ensure that two ports, which are physically and functionally distinct, coexist in the very heart of the historic city centre of Malaga, as has always been the case throughout history. Each of these ports—one an urban port and the other a commercial port—is linked to one of the two parts of the historic city centre. In other words, the operational port is adjacent to the active city, while the urban and cruise ship port is linked to the more contemplative part of the city. Despite this, and after more than 20 years of urban planning focused on the port-city relationship and ten years of the waterfront redevelopment project's existence, the same historical borders remain to this day, such as the ramparts transformed into 19th century barriers, which were then converted into more than eleven traffic roadways that separate the port from the city (for the analysis of the waterfront see Andrade et al., 2020).

The cruise industry has undoubtedly been one of the most dynamic and fastest-growing sub-sectors of tourism over the last decade (Sun et al., 2011), especially in the Mediterranean basin, where cities offer a wide variety of assets that are easily accessible and attractive for historical and cultural tourism (Castillo-Manzano et al., 2014; Gui & Paolo Russoz, 2011; Rodrigue & Notteboom, 2013; Soriani et al., 2009). Such growth has

led to the beginning of Malaga's touristification, and, although this is not as intense as in the cases of Barcelona or Venice, it has triggered a focus on economic activity and urban planning geared at tourism. This has brought with it a rise in the number of museums, hotels and rental apartments, followed by the historic city centre's gentrification, whereby local inhabitants are forced to abandon the city centre, coupled with the trend to replace local activities with international global companies dedicated to commerce and restoration (Andrade et al., 2020). This search for a global image leads most of those in power to view the future in terms of skyscrapers and the city's growth in terms of its expansion, as opposed to more sustainable proposals advocating for the conservation and reuse of the industrial and port heritage, which would increase the current port-city border's porosity.

5. Conclusions

This brief view over time allows us to show how port-city porosity has been a determining factor in Malaga's development and how it continues to be so concerning the challenges broached today with a view to the future.

One of the most important elements required to understand this city, its morphology and how it functions, is that the city has been built around two ports. The urban reflection of these two ports is to be found in the two main forums which have been preserved throughout history and around which the city is organised (Plaza and Temple). By studying how the city functions around these two forums and the links each of them has to its port, the layout of its streets, the activities which take place at each site, etc., the way the city is assembled can be viewed as a perfect mechanism. This powerful structuring of the city has survived to this day. Although the port's modernisation during the period of industrialisation resulted in both ports merging into a single autonomous and independent structure, those two ports can still be perceived. The two forums still maintain their nodal role in the way the city functions, with one being more commercial and active, while the other is more contemplative and cultural, each in keeping with the rhythm of its distant port.

Despite its borders, the city of Malaga has always faced the sea and its relationship with its port has created very diverse situations (Figure 8). However, even in historical periods when defensive systems made it difficult, these relationships have always sought porosity and openness to the port and the sea. The rampart gates which once faced the sea, the crowded squares and the subsequent promenades built along the port's waterfront at different stages were all places that linked the port directly to the city. These are the spaces the city's inhabitants have most visited and admired, finding in them a changing dynamic landscape where people, wealth, culture and merchandise travelled back and forth from distant lands. Unfortunately, the defensive borders built during the Muslim era still survive today, transformed into barriers comprised of up to eleven traffic roadways. This discontinuity among the historic city, the actions undertaken in the 19th century, and today's interventions have been shifted on to an operational framework since the city lacks a common urban planning scheme to resolve the different projects' links and coordination through an overarching view.

As has been demonstrated, a historical reading allows one to comprehend the reality of the port city in: (i) its physical scope through the communications arteries which define the city; (ii) its functional scope corresponding to the forums around which the city is organised and; and (iii) its social scope through urban dynamics. Nonetheless, this view on the border and flows in the complex port-city relationship also opens up opportunities for Malaga's present and future by weighing opportunities and risks in a world where territorial decisions are increasingly double-edged. Just as they have been in the past, port docks today are the door to the city for cruise tourism flows. However, the negative impacts caused by the touristification process need to be addressed. The industrial waterfront and its heritage are attractions for collective life alongside the water, but their responsible renovation and social utility must also be considered. The densely urbanised historic city centre benefits from the former port area's open spaces, though large infrastructure barriers still divide both spaces. Lastly, if the port city forms part of Malaga's collective memory, a new memory for the future should be built.

Port-city porosity is today a multifaceted and complex topic, in which several perspectives overlap and oblige to construct integrated overviews. As can be seen throughout history, it involves an effort to break barriers (Costa, 2007b) and to seek new balances in keeping with strategic views of the future. But not all the broken barriers are the same, and new research on the contemporary dynamics is needed. Social porosity presents a double perspective when the port territories are opened to the city: as the democratisation of the access to the waterfront brings new opportunities for urban and port development in domains such as public space, leisure, culture and tourism; negative impacts might occur, as segregation finds its expression in phenomena such as the touristification and the gentrification of the surrounding urban areas. The same happens with the functional porosity in the rediscovering of the waterfront areas. On one hand, the functional permeability allows for the location of public facilities and other uses that did not have space to be located in the dense historical city, both in new buildings and the reuse of industrial heritage. On the other hand, port-cities must be addressed the danger of transforming these new waterfronts on thematic parks for leisure and tourism. And the same also occurs in the physical porosity, as the classical conflict between the waterfront longitudinal barriers (walls, structural avenues, train) and the transversal integration of urban tissues continues to be a difficult equation on the regeneration of port-cities. As observed, in

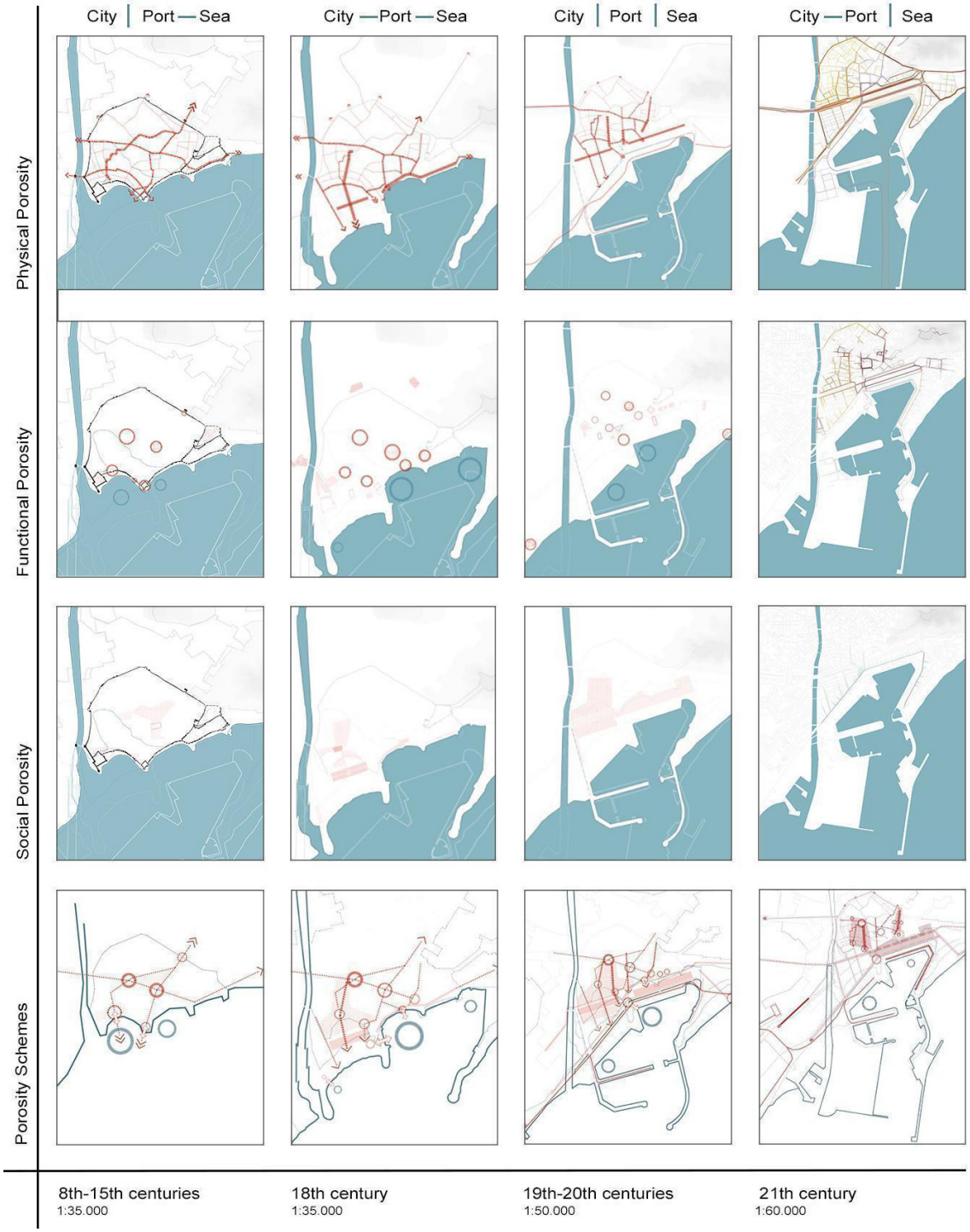

Figure 8. Joint reading of the port and the city throughout history; Physical, functional, and social analysis. Source: María J. Andrade (2012).

Malaga, as well as in several other port-cities, this interface remains a contemporary space of opportunity, a challenge for the city, the port, and the citizens.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Morphological Evolution of the Port-City Interface of Algiers (16th Century to the Present)

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Abstract
This article traces the centuries-long morphological development of Algiers' port-city interface across four historically relevant time periods that together span from the dawn of the 16th century up until today. Through a diachronic and geo-historical approach, we identify and analyse the origins of Algiers' persistent port-city divide. In doing so, the notion of the interface is interpreted as a spatial threshold between city and port, which nevertheless supports the material flows of both entities. As a multi-purpose area, the interface holds the potential to weave the disparate entities of a port city back together. To further complement this conceptual angle, we provide investigations of porosity that determine the differing degrees of connectivity between the city and port of Algiers. This is combined with a spatial-functional analysis of Algiers' current port-city interface, which is ultimately characterised as a non-homogeneous entity composed of four distinct sequences. These results contribute to a better orientation of imminent plans for waterfront revitalisations in Algiers. Whereas the interface was long considered as some kind of no man's land in the past, port and municipal authorities nowadays aim to turn the interface into a tool of reconciliation, and can do so by acting upon its potential porosity. Finally, this article's critical examination of the previously neglected case of Algiers can and should also be considered as an applicable model for the continuing study of southern Mediterranean and African port metropolises in general, which share a particular evolution in the relations between city and port.

Keywords
Algiers; flows; Kasbah; porosity; port-city interface; waterfront

Issue
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1. Introduction

Between land and sea, at the convergence of two different spheres of flows, port cities can be qualified as interfaces between a foreland and a hinterland that generate crossroad connections on an intercontinental scale (Chaline, 1994). Regarded as "centres of exchange where different cultures and different environments meet" (Tan, 2007, p. 852), port cities are themselves composed of an urban entity and a port entity. The buffer space between the two is defined as the port-city interface (Boubacha et al., 1997; Hayuth, 1982; Hoyle, 1989, 2000). As a median space, this interface materialises the legal boundaries between city and port, but also ensures the interlocking of the urban and port system and their overlapping interests, thus becoming an area of simultaneous cooperation and conflict, or convergence and divergence. Any contrast between land and sea, and between city and port, is played out on this median part, hence the importance of studying port-city interfaces

in particular detail and within historical contexts (Hein, 2020). Technological developments of transport can be considered as the main factor in the evolution of maritime flows and global economic transformations, which have resulted in the metamorphosis of port-city interfaces around the world. In this regard, the industrial revolution has been a milestone for changes in the port-city relationship, passing from a clear-cut spatial interconnection to a complex, interwoven system. In the face of this drastic development, the port-city interface has likewise passed from a simple public zone to an intricate and porous space. It emerges as a transformative space, onto which strategies of recomposition and renewal are applied, through confrontation, consultation, or collaboration (Boubacha, 1997). In this sense, the interface does not simply separate, but also has the ability to 'weave together' the various entities that comprise a port city.

In having their own diachronic and synchronic developments, and responding to the social, economic, and environmental contexts that surround them, port cities across the world are not necessarily different from other kinds of cities. However, a set of shared key characteristics does make port cities stand out as a distinct urban category in analyses (Chaline, 1994). The first common element is of course the presence of the port itself, which imposes a particular spatial configuration onto the city and simultaneously connects it to a transnational network of fellow cities. Secondly, the evolutionary chronology of port cities generally distinguishes two major urban phenomena that have propelled these maritime hubs from the pre-industrial to the industrial and post-industrial era. The first phenomenon in this case, the port-city split or divide (Boubacha et al., 1997; Chaline, 1999), is a consequence of the industrial revolution in the 19th century. The second phenomenon, waterfront revitalisations (Hoyle, 1989, 2000; Hoyle & Pinder, 1992), is an antipode to this, serving as a response to the rise of the tertiary sector in cities since the 1950s. Both events have strongly influenced the urban form of port cities through their direct impact on the port-city interface.

In the pre-industrial era, maritime trade flows were ensured by rudimentary means of transportation such as wooden ships, whereby the rotation between different flows of goods would take up days. Back then, the port was mostly an artificial extension of the city into the sea (Aouissi, 2016). Port activity complemented urban activity, and one would therefore talk about 'the city and its port' in unison. This also expresses the significant levels of porosity and permeability that existed between city and port then, as both were not developed enough yet to even be regarded as entirely separate entities. It begs the question to what extent this kind of historical congruence is still traceable in the oldest foundations of port cities and their interfaces nowadays. After all, due to considerable technical advances in terms of the mobility of resources and the mass production of goods, the industrial revolution subsequently engendered global market shifts. The mechanisation of production processes generated excess quantities of products, which helped contribute to the expansion of trade. The new industrial-economic base thus essentially started to depend on the transfer flows of goods, hence the need for new means of transportation such as railways on the land and new steam and motor ships at sea (Bird, 1963).

Faced with this new situation, ports became economic actors of primary importance. The double-sided position of ports proved itself as a real catalyst of exchange: enhanced connections on the land endowed the port with a larger hinterland, while the maritime sphere became faster navigable and started to offer a greater range of actions. Furthermore, with the increasing establishment of factories and warehouses close to the port and its adjacent railway infrastructures, the notion of the port took on an even more industrial meaning. This new status ensured that the port was no longer considered as simply a district of its city, but as a true infrastructural complex in its own right and with a regional scale of direct connectivity. The conceptual understanding of 'the city and its port' changed into that of 'the port and its region'. The physical expansion and distancing of the port became accompanied by a weakening relationship with and accessibility to the city (Hayuth, 1982; Schubert, 2018). Within urban geography, planning, and sociology, this particular development has sometimes been considered as an urban scourge or crisis of sorts. Detailed investigations of port-city interfaces in specific contexts, like the one provided in this article, can help track down to what extent this problematic development still affects the interlinkages between city and port today.

During the 20th century, with the globalisation of trade firmly under the influence of mass production, the situation of the port-city split continued to be accentuated (Hall & Jacobs, 2010). Additionally, the means for maritime transport became more extensive and demanding in terms of the space needed for technical equipment and wider quays. In this way, the port-city interface evolved through an increasingly thick and opaque physical materialisation: next to railways, the development of roads further filled up this buffer zone, in positive correlation with the continued importance of land transport (see Figure 1). Nevertheless, with the rise of containerisation deepening the port-city split in the mid-20th century (Hoyle et al., 1988; Schubert, 2018), the abandonment of port sites most closely located to city centres also resulted in the new urban phenomenon of waterfront revitalisations that profoundly modified the interface areas again (Aouissi, 2016; Porfyriou & Sepe, 2017). Industrial storage terrains, and locations strongly connected to transport infrastructure that fell out of use, became favourable grounds for large urban transformation operations, with cities like Baltimore, Barcelona, or Lisbon offering some of the most illustrative cases in this regard (Aouissi, 2019; Sánchez & Daamen, 2020). Often seen as some sort of panacea for the break-up between cities and ports, the question remains whether

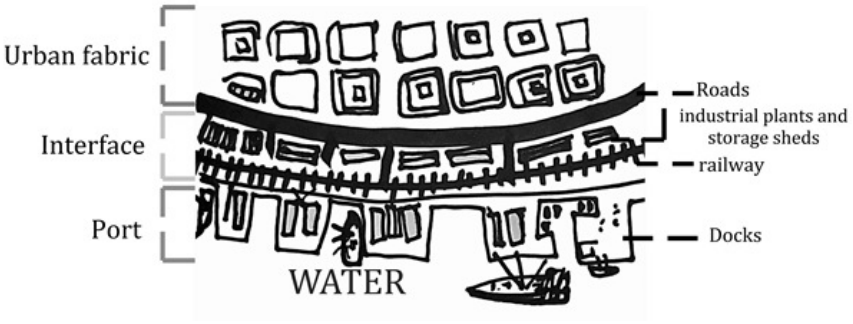


Figure 1. Illustrative diagram of the spatial split between city and port, with the separating interface as buffer zone. Source: Amended by the authors, based on Wrenn (1983).

waterfront revitalisation plans are also able to overthrow the traditional industrial density of the port-city interface in non-Western maritime hubs, which often drag along a different trajectory of urban evolution.

If the origins of the port-city split were directly linked to the industrial revolution for European and American cities, the urban phenomenon also further manifested itself globally and affected non-Western port cities, through the increased colonisation of Africa and Asia that started in the 19th century. Yet, as one might expect, the predominant focus in scholarly literature is put on Western as well as contemporary East Asian port contexts, and thereby often foregoes significant differences and historical nuances that are at play in port cities in other parts of the world (Akhavan, 2020). To help alleviate this persisting imbalance, Algiers has been chosen as a pertinent case study that needs further exploration, since, firstly, very few studies so far have dealt with aspects of port-city relationships, and particularly the interface, in this North-African capital over the course of its history. Secondly, Algiers currently finds itself in a situation with a very pronounced port-city divide, and is blatantly lagging behind on issues related to port-city relations within the larger Mediterranean context that it is part of (Aouissi, 2016). This necessitates further analyses that can contribute to a better orientation of future port reconversion plans. Finally, this article's critical examination of the case of Algiers can and should also be considered as an applicable model for the continuing study of southern Mediterranean and African port metropolises in general, which experienced a period of colonisation and subsequent waves of independence during the last century. As such, port cities in these less developed countries share a particular evolution in the relations between city and port, as well as in the morphology of their port-city interfaces. Especially in the case of Algiers, the port-city interface not merely functions as a physical separator, but is also highly illustrative of a mental dichotomy or value-based clash between urban interests that focus on the comfort of city inhabitants and port interests that concern economic efficiency. The city and the port thus influence each other in paradoxical and negative ways, thereby turning their shared interface into the spatial concretisation of a conflicting situation.

With a focus on these circumstances, the port city of Algiers is specifically considered as an amphibian creature throughout this article, whereby the interface can weave together different types of zones and levels of porosity. This is already due to Algiers' original morphological configuration: With the hills of Bouzaréah forming a shelter to the dominant northwest winds while overlooking the central bay area, and a set of islets connecting to the mainland, everything is favourable for Algiers to be considered as a naturally shaped port (Ravéreau, 2007). Historically, this also motivated the construction, by the Phoenicians in the 4th century BC, of the city of Icosium by the sea (Camps et al., 1986), in the same area that later housed the famous Kasbah of Algiers. While the word 'Kasbah' designates an urban entity that makes up the old city of Algiers, especially as it is assimilated through the population's imagination nowadays, it simultaneously refers to a particular period in the city's history that spans more than three centuries, from its capture by the Ottoman privateer brothers Arudj and Khayr ad-Din Barberousse in 1516 until the start of the French colonisation in 1830. Since then, through its military and geostrategic importance, Algiers experienced a series of changes that have become reflected in the spatial configuration of its port-city interface. In this respect, the purpose of this article is to map, dissect, and understand the material and immaterial evolution of the flows and related porosity characteristics dictating this port-city interface and their varying impacts on Algiers' urban form, from the age of the Kasbah to its contemporary metropolitan context.

2. Methods

This study combines historical and geographical approaches into one axial method that crosses temporal and spatial scales (Braudel, 1949), in order to explain the changing composition of the port city territories under investigation. This procedure allows to reconstruct both the structure and dynamics of Algiers' port-city interface, while providing a diachronic perspective of the landscape (Jacob-Rousseau, 2009). More specifically, our case study describes the evolution of Algiers' urban and port history through events that cross both domains,

notably economic and political events, and their material and immaterial translations at the level of the port-city interface. Our research relies on cartographic archival material, graphic representations, and written testimonies, in particular the historical descriptions of Diego de Haëdo (1612/1998) that predate the French colonisation period and the cartographic reconstructions of Roger Meunier (1961). In addition, the remarkable thesis of René Lespès (1921) is also of primary importance to us, as it originated from a request of the municipality of Algiers to introduce major projects of urban expansion that were to be conducted in semblance with European counterparts (Bernard, 1931).

Based on these historical sources, and together with more contemporary references, this article first constructs an overview of Algiers and its port before the French colonisation. Subsequently, the period of colonisation, commonly known as one with great upheavals and transformations for the port-city interface, is investigated in two parts. Finally, we look at the development of Algiers' port-city relations from the national independence starting in 1962 up to today. The adopted geo-historical approach allows us to focus on key moments in Algiers' urban evolution and their particular impact on the port-city interface. This work adds to the understanding of the interface as a multi-purpose area and a concrete spatial threshold between city and port (Moretti, 2018), while nevertheless providing infrastructural support for the material flows of both entities. To further complement this conceptual angle, we provide accompanying investigations of porosity. By calculating and interpreting the void ratios of the urban walls in relation to the interface, the differing degrees of connectivity between the city and port of Algiers are determined.

In this way, it becomes possible to better identify and analyse the origins of the contemporary dichotomy between city and port, as mentioned above. With a better understanding of the root causes of the port-city interface's shape, we construct a spatial-functional analysis of the current territory. By considering in this way how fluctuating flows and porosity structure and determine the stakes between city and port, we formulate the continuing influence and dynamics between both entities more accurately. Ultimately, this is considered as a necessary step towards a more holistic diagnosis and a better orientation of upcoming action proposals for the inevitable revitalisation processes of the Algiers waterfront (Aouissi, 2019).

3. Findings and Results

The sea has always shaped the city of Algiers. It originally arose from an ancient Phoenician trading post, which found all the assets it needed in the direct natural environment (see Figure 2): shelter against the regular winds, a strategic hilltop from where to dominate the surroundings, and accessible and abundant water sources. "Algiers is nothing less than a natural port" (Bérard, 1837, p. 91; authors' translation): this was the opinion of Lieutenant-Commander Bérard, to whom we

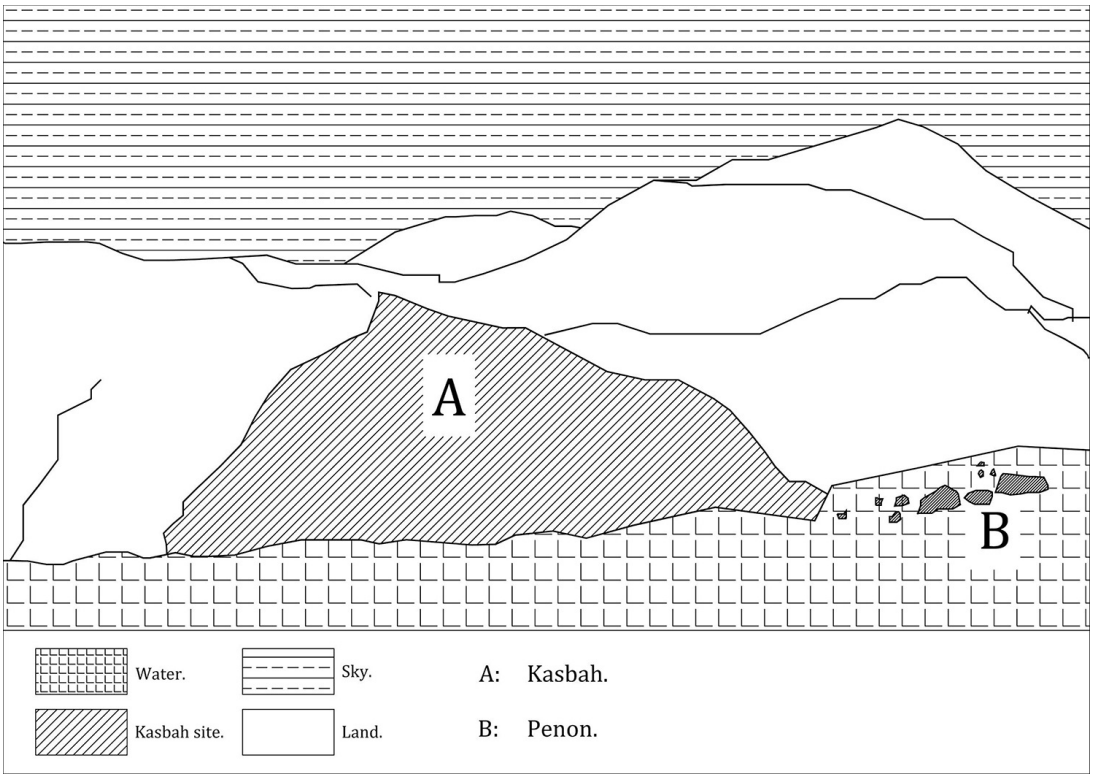


Figure 2. Frontal view of the natural landscape surrounding the original Kasbah site. Source: Produced by the authors, based on Meunier (1961).

owe the first nautical description of the Algerian coasts. Since the birth of the city, a series of events has significantly punctuated its urban history and shaped its form, resulting in a range of dialectical metamorphoses for the port-city interface in particular. From the first formation of the inner Kasbah city until Algiers' coming into being as a modern metropolis half a millennium later, we distinguish four historically relevant time periods, on the basis of notable urban or port-related transformations involving changes in the flows, porosity and morphology of the port-city interface, and which are related to major historical and economic events.

3.1. The Interface during the Kasbah (1529–1830)

The capture of Algiers by the Ottoman brothers Barberousse dates back to 1516. However, Algiers could not be considered a port city at that point in time, as the port simply did not exist yet (Meunier, 1961). Back then, a group of four main islets located very close to the city coast formed the 'Penon of Algiers' (see Figure 2). The Penon was initially under control of a garrison of the Spanish Empire, which settled there by building a fortress in 1510 (Chérif, 2010). In 1529, the Barberousses took over the Penon and launched a series of colossal backfill works to connect all islets to the city's coastline (see Figure 3). A dike was formed that has kept its original name, the 'Khayr ad-Din Barberousse pier,' up until today. As the earliest created form of the port, the newly connected territory provided a surface area of four hectares and a capacity to accommodate 70 small ships, mainly used by privateers to supply larger ships that were berthed offshore and could not yet reach the port due to the insufficient depth offered by the harbour (Meunier, 1961).

In this period, the port was a base for privateers active in the region, who brought Algiers to life under a new regency. This 'golden age' period was characterised

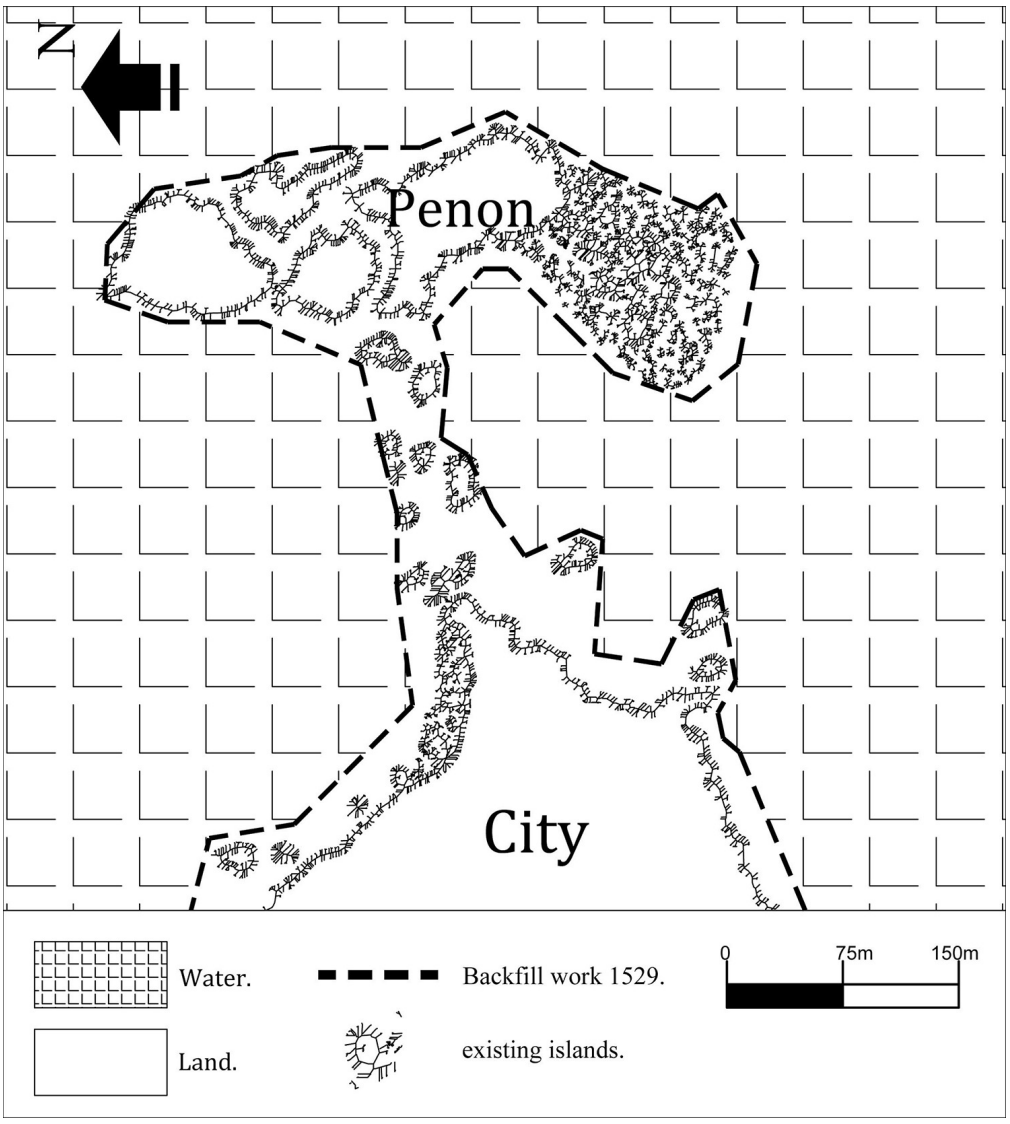


Figure 3. Map of the Penon and the city before 1529, providing an overview of the connecting backfill works that were carried out. Source: Produced by the authors, based on Meunier (1961).

by an electrified atmosphere in the Mediterranean, particularly between Muslims and Christians. Algiers' principal concern at the time was its protection against European rivals. The port sheltered a formidable social class of pirates, known as the 'Taïfa des Raïs.' All representations and written sources related to this time depict the port of Algiers as a fortress and a first line of defense, standing in front of the actual city walls that were endowed with loopholes for cannons. Already in this earliest context, then, a strategic interface materialised as mediating space between city and port.

Apart from the slave trade, for which Algiers became a crucial market (de Haëdo, 1612/1998), trade and commercial exchange were not yet of primary importance to the port. Most commercial exchanges were meagre and limited to the import of exotic and expensive materials, such as Italian marble for the palaces of the Kasbah, for example. Fishing, on the other hand, was a vital source of income for city inhabitants. Consequently, large parts of Algiers' population were characterised as fishermen. This economic function of the city has been kept until today, with the eastern part of the port denoted as the fishery (Aouissi, 2016). Nevertheless, the main role of the port of Algiers was taken up by its supreme naval force back then (Belhamissi, 1986). The port of Algiers became profitable as a maritime base for privateers, by imposing taxes on various fleets entering the Mediterranean in exchange for protection against pirate ships and third-party attacks (Lespès, 1921).

The communication between city and port was ensured by two gates in the front rampart that fortified the pyramid-shaped perimeter of the city. The first gate, called 'Bab el Bhar' or gate of the sea or the fish, was used by local fishermen to access the beach (Missoum, 2003). The second gate, called 'Bab el Djazira' or island gate, was more important and used as a crossing point to control the incoming and outgoing flows of goods to and from the port. Between the two, a transverse street was built, giving birth to the Lower Kasbah. It could best be considered as a space for the exchange of flows, and it thus defined an interface between city and port. In spatial terms, this crossing clearly belonged within the walls of the inner city, but its functioning largely depended on the port. The historical importance of the district that grew around it is exactly due to its location as an interface or median space, as acknowledged by the location of the city's administrative, financial, and commercial centres.

On the basis of traditional descriptions, the entire interface can be divided into two parts (see Figure 4). The first one, the east side of the Lower Kasbah, links the city gate Bab Azoun to Bab el Djazira. Its function is essentially commercial, by providing services intended for the daily lives of city inhabitants, which is also reinforced by the cross-connection to Bab el Bhar where fishermen sell their harvests. The second, western part, approximately going from Bab el Bhar to Bab el Oued, is known as the Navy District or Marine Quarter and overlooks the port (Missoum, 2003). A part of it that still exists, namely the Bastion 23 that is also known as the 'Palais des Raïs,' was classified as universal heritage in 1991. This part of the interface was directly aligned with the interests and activities of the port at the time, sheltering luxurious residences for privateers, places of worship, as well as military and maritime factories. The entire interface was thus made up of two parts that not only reflected the dual vocation of Algiers as a port city, but also the hierarchical division of its population. While the eastern part was dedicated to the more plebeian public, the western part was reserved for more distinctive social classes and the elite. These two parts of the interface were distinct, but they also necessarily complemented each other, thereby ensuring the interconnection between city and port. During this first historical phase, Algiers and its port already formed a homogeneously operating entity, whose role was significantly enhanced by an interface that served the spatial and functional mediations between the port city's two spheres.

3.2. The Interface during the First Period of Colonisation (1830–1848)

As France was seeking to impose its power more in the south of the Mediterranean, which was mostly controlled by Ottoman fleets until then, the capture of Algiers in 1830 proved to be the ultimate strategic opportunity for French domination on these southern shores. The port of Algiers accentuated its military vocation as a desired French naval base, comparable to that of Toulon (Djedouani-Rakem, 2004). The arrival of the French marked the end of the Ottoman-Turkish period, with the Kasbah being the fruit of three centuries of that occupation. The brutal installation of the French colonial regime changed the morphology of Algiers in a spectacular way (Çelik, 1997), especially with the almost complete destruction of the Lower Kasbah. Outside of the ramparts, a purely technical choice was made to extend the southeastern part of the bay (see Figure 5). The city subsequently simply followed, and grew at the same pace as its extended port (Aouissi, 2016).

While the part of the Navy District up to the 'Palais des Raïs' was preserved, the superimposition of a new urban typology on the Lower Kasbah brought about an important metamorphosis to its overall shape as a port-city interface. The realisation of the new dock in the southeast contributed to the increasing physical distancing between the urban fabric and the seaside by offering more space for the interface itself, which consequently became a more dilated entanglement between the port and city boundaries. Previously characterised through the presence of housing that ultimately got destroyed, the interface took on a new shape. As this change resulted in a withdrawal of the interface, the Navy District also started to lose its role in particular port interests. These transformations further materialised in a concrete way, namely through the insertion of a new public space, the government square, which has ensured

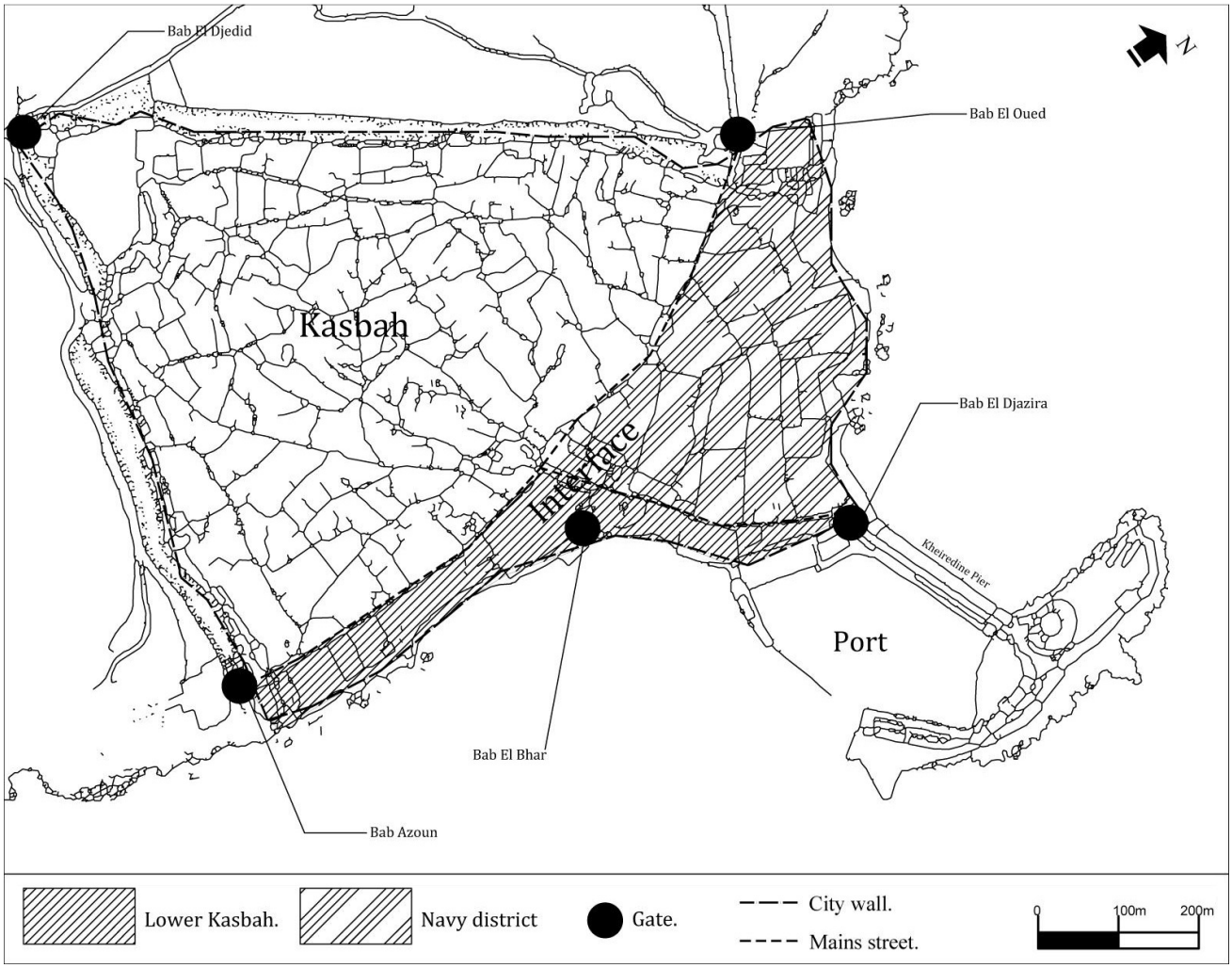


Figure 4. Map (1830) of the divisions of the port-city interface in relation to the principal city gates. Source: Produced by the authors, based on Lespès (1921) and Missoum (2003).

the connections between the newly built dock, the new European extensions of the city, and the rest of the original Kasbah area (see Figure 5).

3.3. The Interface during the Transition from the Military to the Tertiary Sector (1848–1962)

As a gateway to Africa, filled with agricultural assets and mining sources, Algeria aroused the economic interests of industrial France (Zimmermann, 1896). Algiers became a point of diffusion for the larger colonisation movement and thus also a valuable ground for investments, as witnessed by the realisation of urban planning projects through the pivotal Guiauchain plan from 1846 onwards. Initially however, this plan for the urban development and expansion of Algiers did not yet give any particular importance to the port. It was first simply enlarged through the basin of the old port between 1848 and 1867, primarily for military purposes (Djedouani-Rakem, 2004). After this phase, however, the development of the port gradually started to gain more importance, as commercial interests began to take precedence over military ones. This was firstly due to the disappearance of real military rivals after the gradual dissolution of the Ottoman Empire. Secondly, it was due to the continued progress of French colonisation in the hinterland, and to the exploitation of available raw materials that put France in a position of full industrial and economic bloom. As a rich source for agricultural products, the Mitidja plain on the outskirts of Algiers, and comprising such satellite towns as Blida, Boufarik, Medea, and Miliana, formed the hinterland of the port city to which it mainly was connected through roads and railways.

Because of these rising economic interests, Algiers quickly developed into a true transfer or relay city. This situation was stimulated by a particular series of events, of which the vast destruction of French vineyards by a phylloxera pest in 1878 was one of the most essential. The resulting crisis contributed to increasing exports of Algerian wines from the Mitidja plain via the port of Algiers to the European continent. As a consequence, the development of both port and city accelerated, as

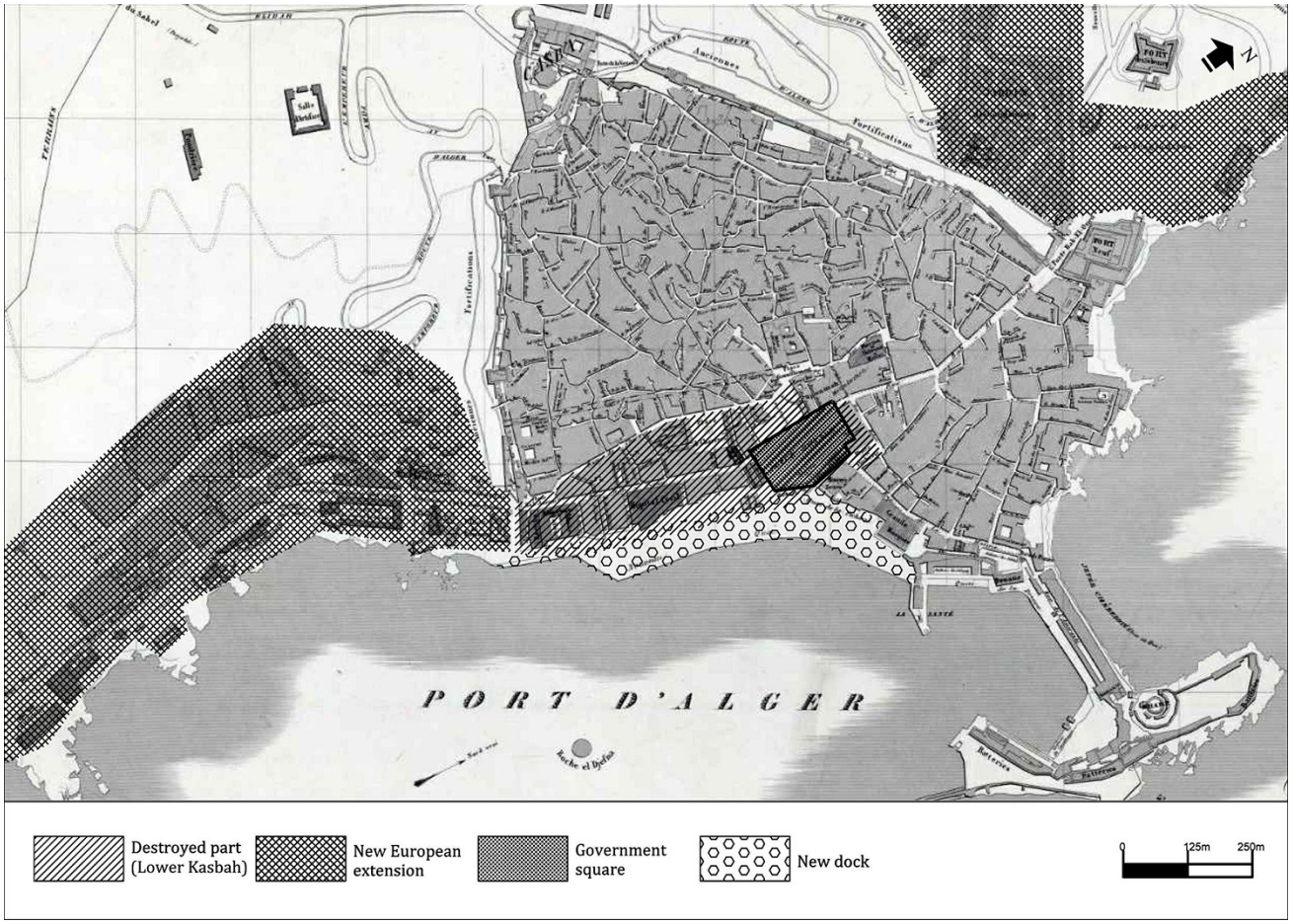


Figure 5. Map of Algiers in 1846. Source: Amended by the authors, based on Berbrugger (1846).

the resulting trade revenues were being invested in the construction industry (Lespès, 1921). This shows that the development of the port continued to simultaneously influence the development of the city. In addition, the opening of the Suez Canal in 1869 made Algiers an unavoidable transfer hub for liners arriving from the North Sea or the Atlantic. The strongly increased traffic became increasingly more difficult for the port to absorb. Therefore, by law of 25 June 1897, the Chamber of Commerce in Algiers was granted the permission to increase the port's capacities through a set of expansion projects (Lespès, 1921).

The aforementioned set of economic events opened up new prospects for the port city of Algiers, thereby changing its predominant vocation from a military into a tertiary hub. Accordingly, the port was significantly enlarged: to the previous basin of the old port (1848–1867), two new ones were created and added, namely the Agha (1898–1905) and Mustapha basins (1927–1940; Djedouani-Rakem, 2004). At the same time, the development of the port continued to stimulate the urban growth of the city (Djedouani-Rakem, 2004). On the other hand, however, Lespès (1921) argues that it is already around 1884 that the transformation of Algiers from a military city into an important tertiary centre must be situated, notably thanks to the major railway developments at the time (new connections between Algiers–Constantine [1887]; Algiers–Tizi-Ouzou–Béjaïa [1890]; Algiers–Blida–Berrouaghia [1892]). A strong connectivity with the hinterland and its flows of goods was indeed developed thanks to these new railway connections. Furthermore, the linear development of the port towards the east stimulated the extension of the city in the same direction, thereby giving rise to a mixed urban fabric of housing and small industries linked to port activities in the neighbourhoods El-Hamma and Hussein-Dey that further concretised the new port-city interface.

Faced with this fundamental change from a military to a transfer city, the port-city interface started to take on a new spatial configuration that was adapted to the new flows that it supported. The interface evolved from a rather open space, ensuring relative reciprocity between port and city, to a denser zone through which spatial limitations between the city and the port materialised. A situation similar to that of the classic port-city split described earlier became increasingly noticeable from this period onwards (Aouissi & Madani, 2017). The rising dichotomy became especially accentuated by the piling up of industrial activities that distanced the new urban extensions, particularly on the side of El-Hamma and Hussein-Dey, from the port and the sea. Within this context, the

interface continued to develop in a two-dimensional way: longitudinally, following the extensions of the port and thus mostly guiding the colonial city's development towards the southeast; and transversally, according to the needs of flows of goods and thereby especially linking the port to the colonial hinterland through an extended railway network. With this new morphological configuration of the port-city interface in mind (see Figure 6), the first steps of a shift between port and urban development could be traced. If the port had guided the urbanisation of Algiers up to that point, the dichotomy created by the interface's rigidity and the growing physical distance between both entities now started to cause a new development rhythm, one characterised by a shrinking sense of porosity in Algiers' overarching evolution. While the port continued its expansion further towards the southeast, the city, on the other hand, started to pursue its path of urbanisation more towards the inland and the adjacent hilltops.

3.4. The Interface of the National Capital (1962–Present)

After gaining independence, Algiers became the national capital due to its geostrategic, economic, and relay location. This status was quickly reinforced, especially after the nationalisation of the hydrocarbon industry in 1971 (Leroux, 2018). Up until today, Algeria's economy is mainly based on the export of hydrocarbons and the import of almost all consumer goods and products, and the port of Algiers is still considered as the nation's principal commercial port (Entreprise Portuaire d'Alger, 2019). In this contemporary context, the port-city interface has become more complex, expressing a superposition of urban and port interests in one conflicting space. Interests related to life quality in the modern metropolis are juxtaposed with concerns over economic efficiency in the face of strong competitiveness on the national and Mediterranean level. In the midst of this duality, the interface has become the autonomous space of a very pronounced port-city divide, physically limiting and separating both city and port, but also providing support for common flows (Aouissi, 2019). Currently, it is possible to identify four spatial sequences of the interface, which connect and correspond to the differing rhythms of the city's and port's evolution that we have investigated. Each of these sequences has a distinct composition, and together they illustrate the significant expansion of the port-city interface over time (see Figures 7 and 8). In correspondence with this historical growth in scale, the interface is nowadays no longer considered as some kind of no man's land, as it often had been in the past, but rather as a true asset for future municipal planning projects. In order to better understand Algiers' multifaceted interface, Table 1 describes its different, present-day states through characteristic cross-sections and porosity-related variables.

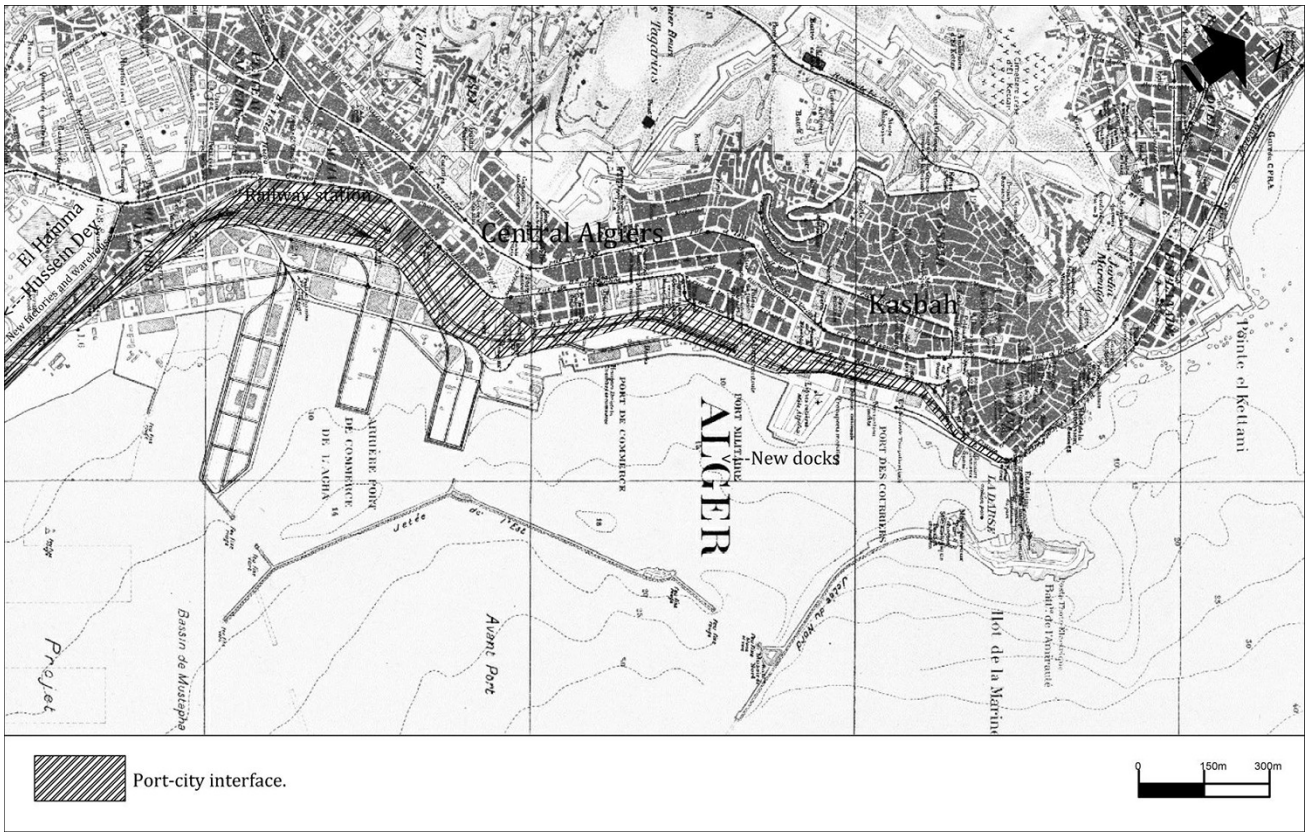


Figure 6. Map of Algiers in 1925, accentuating the structure of the port-city interface. Source: Amended by the authors, based on Farnet (1925).

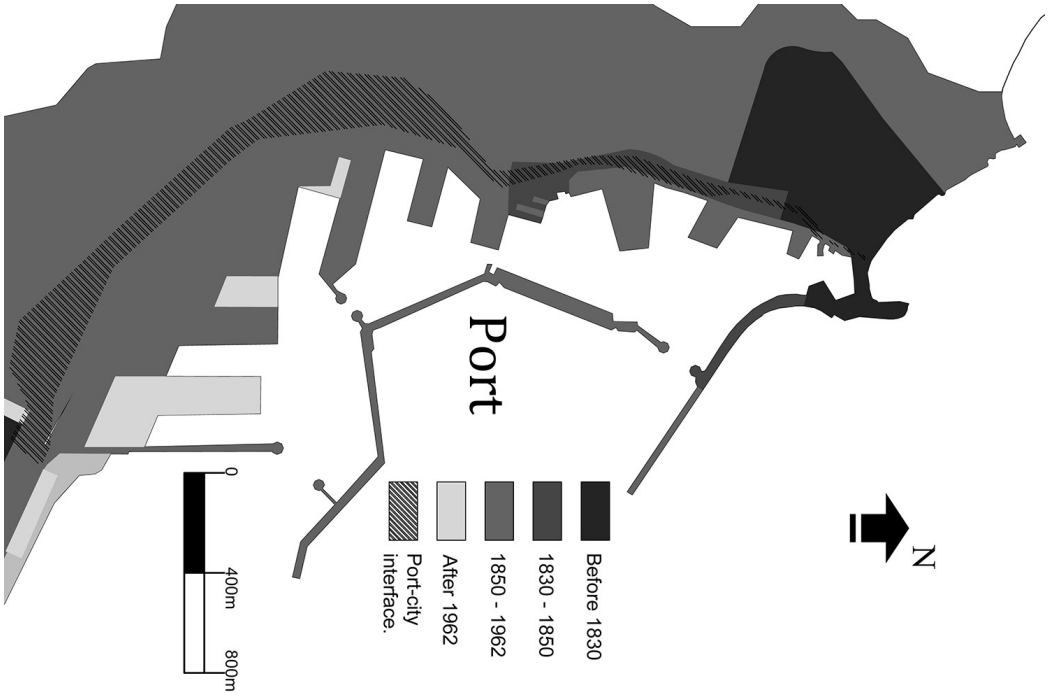


Figure 7. Diagram of Algiers' current port-city interface, divided according to its morphological evolution. Source: Produced by the authors, based on Google Earth with the distinctions of the different periods visualised in accordance with Hammache et al. (2000).

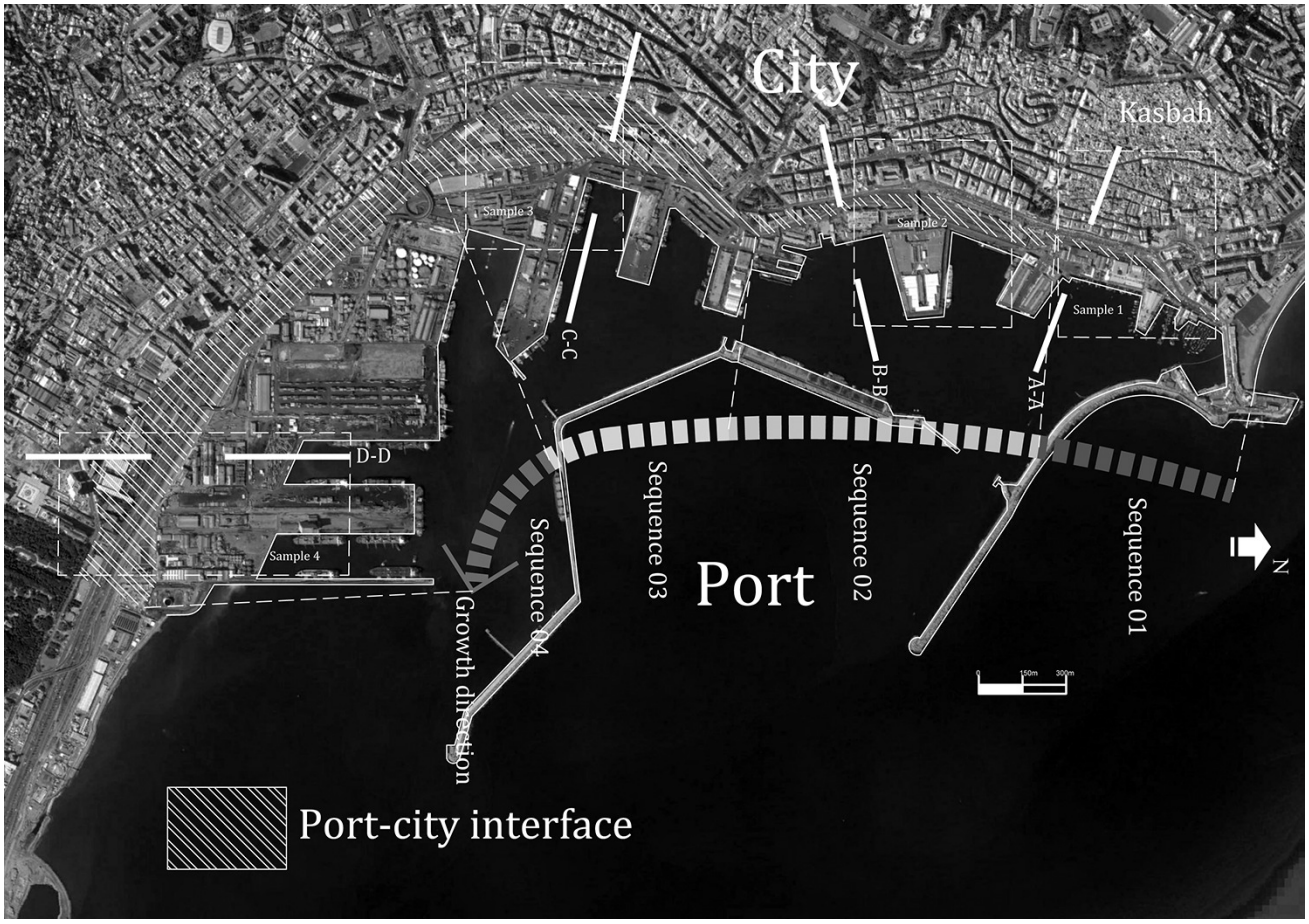


Figure 8. Map of Algiers' current port-city interface, divided in relevant sequences with cross-sections. Source: Google Earth and modified by the authors.

In addition to the information displayed for each interface sequence in Table 1, we can interpret the variations in the ratios of the void spaces to the total linear contact with the urban walls as a consequence of the intentions and perception of the responsible planning actors during each corresponding historical period. In the first sequence, the urban fabric is composed of an alignment of small building blocks, in accordance with the existing pre-colonial fabric of the Kasbah. This expresses a significant potential for porosity and permeability, which would allow further control over the flows between city and port through materialised connections like footbridges. The second sequence expresses an even higher level of porosity, through an opening up of the urban fabric and continuity by means of footbridges from the sloping site of the city. The third and fourth sequences, on the other hand, express very weak levels of porosity. As these sequences are the products of the final colonisation phase and of the post-independence period, their opaque character testifies of the consistent preference of past port authorities regarding the planning of extra port extensions and the corresponding management of flows within an industrial landscape. In this respect, it is no surprise that the port-city interface has long been considered no man's land until now. Therefore, the aim nowadays is to take back the port-city interface, so to speak, and to substantially include it in Algiers' urban planning, in order to reweave the links between city, port, and sea.

Table 1. Different sequences of Algiers' current port-city interface.

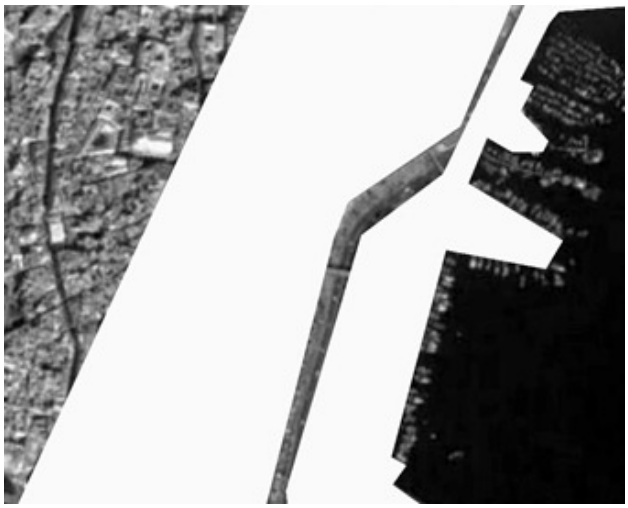
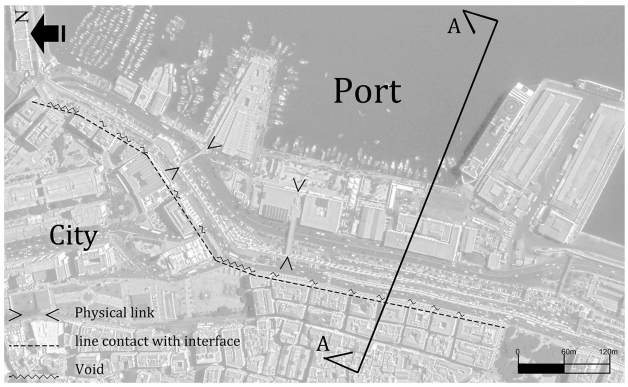
Satellite views with schematic cross-sections and porosity studies	Interface descriptions
Sample 1:  Section A-A:  Porosity study: 	Sequence 1: The first part of the interface is connected to the origin of the port that dates back to the Ottoman period. It is adjacent to the historical part of the Kasbah and was adopted as a fishing port. The sloping site of the city and the reduced thickness of the interface, which is mainly composed of roads here, provides a certain visual transparency in the surrounding landscape. Although the fishing port is fenced and remains difficult to access, the presence of fishing activities and some nearby restaurants maintain the link between city and port in this area. Porosity-related characteristics: Physical links: 2 Line contact with interface ≈ 720m Void ≈ 217m Void ratio = 0,30

Table 1. (Cont.) Different sequences of Algiers' current port-city interface.

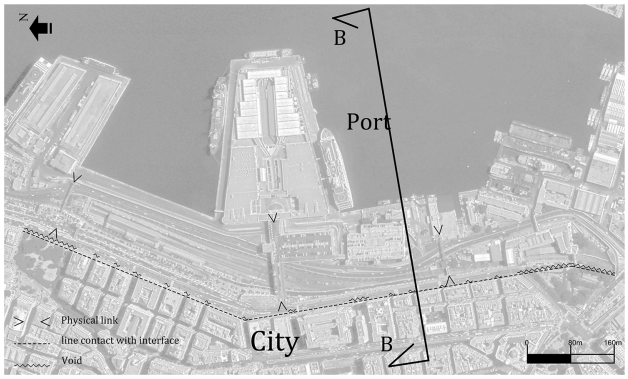
Satellite views with schematic cross-sections and porosity studies	Interface descriptions
Sample 2:  Section B-B:  Porosity study: 	Sequence 2: The second sequence contains the first extramural urban extensions. Here, the port area goes back to the time of the military use of the port. Today, after the creation of several quays at the end of the 19th and beginning of the 20th century, it includes the Algiers Maritime Station. This site has a continuously descending shape. At a lower height, the footbridge of the Maritime Station provides a clear form of connectivity between the city and the port. On the other hand, the thickness of the interface increases here, through the stacking of mechanical and railway tracks. Porosity-related characteristics: Physical links: 3 Line contact with interface ≈ 1300m Void ≈ 520m Void ratio = 0,40

Table 1. (Cont.) Different sequences of Algiers' current port-city interface.

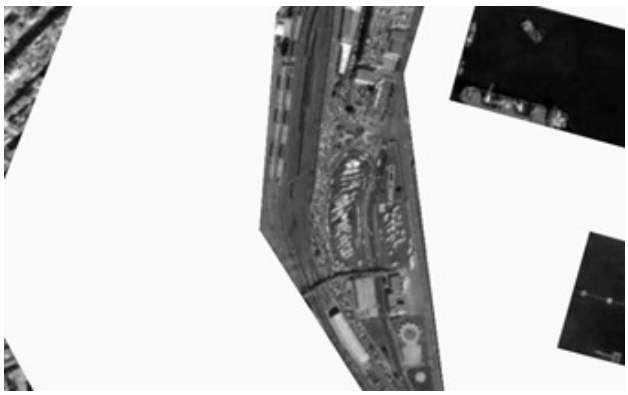
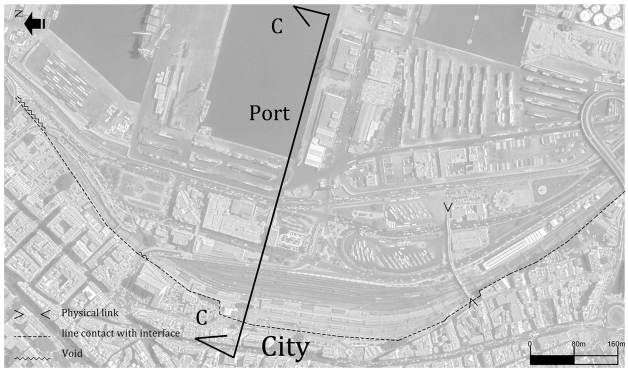
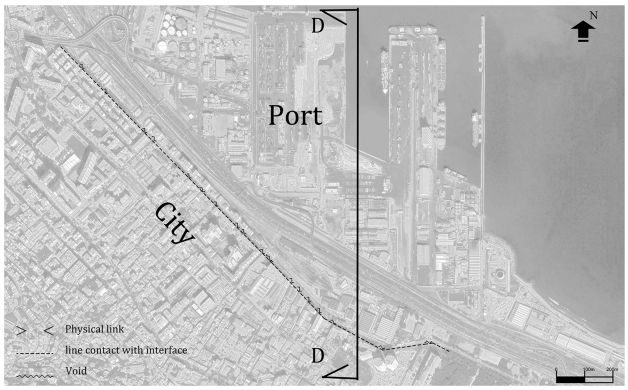
Satellite views with schematic cross-sections and porosity studies	Interface descriptions
Sample 3:  Section C-C:  Porosity study: 	Sequence 3: This sequence includes the most recent extensions of the port, built by the colonial authorities just before Algeria's independence. Here, city and port are at the same height level, and the interface takes up a more significant width. The interface becomes more dynamic at this section, due to the strong presence of mechanical tracks and the railway and land station. However, fewer direct connections between city and port are established here. Porosity-related characteristics: Physical links: 1 Line contact with interface ≈ 1400m Void ≈ 103m Void ratio = 0,07

Table 1. (Cont.) Different sequences of Algiers' current port-city interface.

Satellite views with schematic cross-sections and porosity studies	Interface descriptions
Sample 4:  Section D-D:  Porosity study: 	Sequence 4: After independence, local authorities continued within the same framework of industrialisation that the colonial powers had previously set up. This currently results in the most recent phase of the port's development, which is also the most commercially significant, as it includes a major container terminal, oil terminal and wheat storage silos. Staying at the same height level, the thickness of the interface persists here. The width exceeds 300m in certain places, and its physical dominance is reinforced by the presence of warehouses and industrial wastelands. A close connection with the port and waterfront is absent. In terms of flows of goods, it can nevertheless be considered as the most dynamic part of the interface, since it forges direct access to the contemporary centre of Algiers. Porosity-related characteristics: Physical links: 0 Line contact with interface ≈ 1820m Void ≈ 250m Void ratio = 0,13

Notes: Source of processed satellite images and cross-sections: Aouissi (2019). Porosity studies by the authors.

4. Conclusion

Through an analysis of the long-term evolution of its port-city interface, the case of Algiers shows that this median space is much more than merely a buffer zone that articulates and limits the spatial contours of the port. The often technical evolution of the port city's flows has contributed to the increasing complexity, fluctuating porosity, and dynamic mutation of the interface over time, from a rather strictly amalgamated space between city and port into an intricate support structure for incoming and outgoing flows of goods. Our study of the interface's morphological evolution has made it possible to both understand the synchronic structuring between port and city, and the diachronic development of the interface itself, which ultimately turns out to be a non-homogeneous spatial entity composed of four distinct sequences with differing porosity profiles.

The presented work on Algiers' interface can be decisive for a better and more nuanced understanding of the relationship between city, interface and port. This directly contributes to a better orientation of imminent waterfront revitalisation processes in and around the bay of Algiers, as foreseen in the city's 2016 Master Plan (Aouissi, 2019; Wilaya d'Alger, 2016). Today, the interface is considered as the quintessential spatial concretisation of Algiers' port-city split (Aouissi & Madani, 2017), not only by researchers, but also by local port authorities and municipal actors. The municipal government's 2016 Master Plan aims to turn the interface into a tool of reconciliation, however, as the driving force of envisioned urban planning operations. Through this prism of urban renewal, the planned interventions on the interface will enable the city of Algiers to acquire more than 58 hectares of additional land, both in the heart of the city centre and on the waterfront. This opens up a variety

of new urban development possibilities and porosity-related improvements within the four different interface sequences distinguished in this study, which we briefly want to highlight further.

Interventions in the first interface sequence can allow to more strongly connect the Kasbah's heritage fabric with the port. The second sequence, essentially composed of mechanical and railway tracks, can easily be reconfigured by the municipality to further exploit the descending shape from the city to the port, in particular through the existing pedestrian bridge that currently remains inactive because of safety reasons. The third and fourth sequences take up an extended width between 100 and 300m and thus offer the possibility for new planning projects to break free from the traditional rigidity of the interface (Hayuth, 1982), by acting upon its potential porosity and permeability instead. The initiation of projects in these parts of the interface can make it possible to constitute a more elaborate built environment by the waterfront, in order to enhance the links between city, port, and sea (Yang, 2006).

Port spaces, functions, and interests have shaped the growth and development of many port cities across the world (Hein & Schubert, 2021). This is also confirmed in the previously neglected case of Algiers, especially when considering the four different sequences that we have now identified for its current port-city interface. Born from a tumultuous, centuries-long history, the multifaceted characterisation of Algiers' interface nowadays shows how the city's development has only followed that of the port, even if they were strongly spatially separated over time. It should be emphasised that the findings and results arising from this historical examination can be considered in a more general sense and potentially extrapolated to other port city contexts, especially those on the west side of the southern Mediterranean shore. Port cities like Casablanca, Tangiers, Oran, Béjaïa, Annaba, and Tripoli also did not experience an industrial revolution during the 19th century, but rather a colonisation movement that remains the origin of the port-city divide experienced in these cities today. The case of Algiers shows that within such a context an indirect relation between city and port still persists, which the interface can well help to further weave together and reinforce through new reconversion projects. As these prospects present themselves as necessary interventions for tackling Algiers' port-city split, their future implementation hopefully acknowledges the intricate profile of the port-city interface, in order to put Algiers on a successful course towards sustainable processes of waterfront revitalisations.

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Conflict of Interests

The authors declare no conflict of interests.

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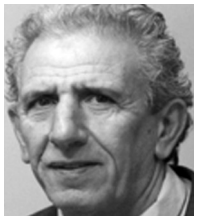

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Article

Straddling the Fence: Land Use Patterns in and around Ports as Hidden Designers

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Abstract
Ports are clearly demarcated structures on land and water. They are fenced in, easily recognizable on satellite and orthophoto images, and they have specific functions. This apparent clarity of ports, their function and outline, in relation to nearby urban and rural areas, becomes more complex when explored through the lens of land use, that is the existing and planned future functional dimension or socio-economic purpose of the land. In contrast to urban and rural areas, where land use has been mapped and defined for centuries, the use and function of land and water in port areas has long been multifunctional and not defined on land use maps. This raises questions about the role and understanding of port territory in relation to neighboring spaces, past, and present. This article first defines land use and describes its historical development. Scholars from various disciplines, including geographers, planners, and economists, have addressed the issue of land use in port areas. Land use patterns have emerged over time and are based on earlier demarcations of port areas and distinctions between port and city. As shown by the historical port city borders in Hamburg, Rotterdam, and Koper, these delimitations can change over time, by location and by function. The land use register has only recently been harmonized at the European level. European and national registers distinguish existing and planned land use in port areas differently. Mixed uses prevail in new port interventions, creating a new kind of permeability or porosity; that is, areas where port, urban and rural functions merge. New land use porosity is a particular state of land use (on both sides of the boundaries of port areas) that goes beyond the physical boundaries marked by fences. Land use porosity effectively creates land use continuity, a functional porosity that serves as a hidden blueprint for future planning. Understanding land use porosity can provide a foundation for novel approaches to the development of transition strategies that are needed to address contemporary challenges, including climate change and sea level rise, digitization, and new work and life practices in port city regions. In conclusion, we note that due to the porosity of land use patterns, the separation between the present port and the city is beginning to crumble. However, this process has yet to be made fully visible and used as a basis for design.

Keywords
boundaries; Hamburg; Koper; land use; planning; porosity; port city; Rotterdam

Issue
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1. Introduction

Port areas are clearly recognizable structures on satellite and orthophoto images of metropolitan areas, similar to airports, traffic systems, and industrial areas. Usually, port areas are surrounded by physical fences, such as walls, wire fences, metal fences, boards, and large infrastructures, that separate the port territory from other urban and rural landscapes. Within the port areas, some functions can be visually identified: water

basins, including berths, storage areas, and industrial production or administrative sites. However, many invisible boundary lines—such as land use borders—remain unseen in situ and in aerial observation and exist only in specific inventories. Although largely invisible, these land use designations can have long-lasting impact on a port's spatial development and on the urban and rural areas in its vicinity. Many ports are industrial hubs, and designation as an industrial site—for example for an oil refinery—will affect neighboring areas—their livability, functional assignment, or land price—because of air, water, or sound pollution (Hein, 2018a, 2018b). Polluted soils will affect the use of the site for decades to come, although this information is not included in land use databases. The land use designations in the port, however, are different from those used in urban and rural areas. In fact, port territories are not as mapped and defined in terms of land, water, use and function; changes in function are not updated, and at times the area is left completely empty in land inventories.

Since containerization in the 1960s, the explosive growth of port areas has led to remarkable changes in land use. Due to the expansion and functional upgrading of these areas that are located at the edge of sea and land and in the vicinity of large city regions, the land use patterns and resulting changes have become even more significant. To achieve an integrated planning that respects the environment and the health of nearby communities, contemporary planning for urban and regional areas is moving away from traditional technocratic statutory planning, that is, away from regulating land use plans, and toward a more collaborative and actor-based approach (Albrechts, 2006). In some cases, port authorities try to adapt their own land use plan to the surrounding areas and support participatory planning approaches to guarantee the sustainability of port city land use. An integrated approach to the multifunctional planning of ports is necessary (Ažman Momirski, 2017).

Planning practices are changing (in port areas as well as outside them), but one of the most important foundations for urban planning still remains land use data, including land use by type (residential, commercial, industrial, recreational, open space, institutional, etc.; Kliment et al., 2014). However, a lack of detailed types of land use undermines planning in and at the borders of ports. The blankness (Kipnis & Maymind, 2013; Unger, 1991) when it comes to land use within port areas poses a challenge for future planning, especially regarding environmental impact, energy transition, and contact with neighboring urban and rural areas. It also raises questions regarding the role and understanding of the port territory. What is needed is a more comprehensive approach to land use, treated as a process by which humans transform land. Subsequently, the process of land use should be studied as a system and important feedback, interrelations, interconnections, and interdependencies should be taken into account (Kostrowicki, 1983):

> At the level of policy, categorisation of areas, uses and covers plays an equally important role. The categorisation of an area as either nature reserve or industrial will have a clear impact on future economic decisions. Thus, the relation between categorisation and decision-making may be invisible but is evidently powerful. (Jansen et al., 2014, p. 320)

To better understand the challenges created by the interrelated development of two areas, one controlled by national, regional, or local urban land use planning and the other usually exclusively in the hand of port authorities, we explore the interconnectedness of land use on both sides of the fences surrounding ports. We stipulate that there is a certain continuity in land use, which we call land use porosity. This permeability of land use on both sides of the fence in some ways mirrors the permeability of functions from land to water (and vice versa), which has led to the construction of docks and other spatially defined objects in the past (i.e., parallel to the perpendicular movement of flows in relation to the coast as well as inland), and these functions still exist today. Land use porosity emerges at the landward border of the port. It is caused by the overflow of land uses from and around the current port's fringe area, even if no gates exist in the fence. The continuity comes about through invisible influences, such as pollution (not shown in land use keys as represented in plan legends) or green systems entering the port area (defined in the land use categories). Pollution effectively expands port (industrial) areas, and green systems seemingly shrink them.

Although the port is surrounded by fences, some land uses appear in both port and urban or rural territories that are close to each other. This process effectively dissolves borders as it creates continuous land use patterns between the surrounding areas and the port and it expands land use porosity by pitting highly defined land uses in urban and rural areas against much less specific land uses in the port. Moretti (2019) similarly observed that the areas dedicated to port activities can be considered functional sectors that are constitutive parts of a developing organism. Land use patterns in and around port areas effectively become a hidden designer of port uses in space. As port fences become invisible, the longevity of these patterns is inscribed in the urban and rural landscapes, but not in those of the port, effectively providing the port with planning powers beyond its boundaries.

Adding to the complexity of the phenomenon of expanding port territories, such situations occur in different topographical settings (e.g., bays, islands, open coasts, inlets), within different morphological structures (e.g., linear, circular), in ports of different functions (e.g., industrial, commercial, traffic), operations (e.g., loading, unloading, transshipment of cargo to and from the vessels, storage), sizes (e.g., very small, small, medium, large, and very large—based on tons of cargo handled during the year, hinterland size, and importance) and

governance models (e.g., public, private, or mixed management entities). While size may influence the form of land use porosity (e.g., monofunctional areas v. mixed uses), the port typologies are not reflected in land use categories and the governance models do not define land use categories in the port areas (e.g., public–private management does not have an influence on land use categorizations, as the land use register is predefined). Port authorities need to adapt their functions, operations, and activities to critical issues at port boundaries (environmental issues, etc.) and negotiate with state, municipal, and other authorities concerning the impact of the border land use (e.g., on water quality, air quality, noise, carbon footprint, marine ecosystems, terrestrial habitats). To better understand the role of port borders in space and through time, this article first explores land use in port areas through time, land use classification in existing land use data sets, and their national and international alignment. We conclude by considering whether port land use categories require defined types of land use data sets, and whether the land use nomenclature should be adjusted according to the differences of ports in size and function (e.g., small or large transit ports), different social systems (e.g., Western, Central, Eastern, Southern European ports) and different parts of a continent or sea (e.g., North Sea ports, Ligurian Sea ports, Adriatic Sea ports). In order to find an answer to these questions, this article examines the characteristics of land use, internal and external port boundaries over time and today in three port cities—Hamburg (Germany), Rotterdam (the Netherlands), and Koper (Slovenia)—selected here as pilot studies because of the authors' advanced knowledge of these three sites.

1.1. On Land Use

Urban and rural territories are defined by land use, which is, according to an INSPIRE directive, a "territory characterised according to its current and future planned functional dimension or socio-economic purpose (e.g., residential, industrial, commercial, agricultural, forestry, recreational)" (European Parliament & Council of the EU, 2007, p. 13). This description is not limited to land areas, but also includes the sea. INSPIRE states: "The inland water bodies as well as coastal waters are considered within the connected piece of land and planning of the use of sea and the use of seabed has been taken into consideration" (INSPIRE Thematic Working Group Land Use, 2013, p. VI). Land use is registered in a database on a national or supranational level, which separates the existing land use ("the use and functions of a territory as it has been and effectively still is in real life" [INSPIRE Thematic Working Group Land Use, 2013, p. VI]) and the planned land use ("which corresponds to spatial plans, defined by spatial planning authorities, depicting the possible utilization of the land in the future" [INSPIRE Thematic Working Group Land Use, 2013, p. VI]).

Land use does not match the existing land cover, that is, the "physical and biological cover of the earth's surface including artificial surfaces, agricultural areas, forests, (semi-)natural areas, wetlands, water bodies" (European Parliament & Council of the EU, 2007, p. 229). With new technologies for surveying land using satellite imagery and with the ability to abstract the earth's surface, land cover, as an abstraction of the surface, has emerged as another mapping category alongside land use. Land cover is mapped and recorded through land cover survey initiatives (EEA CORINE land cover program [Copernicus, 2016]; Urban Atlas by the European Environment Agency [Copernicus, 2018a]; LUCAS survey by Eurostat [Eurostat, 2021]). Land cover data are used to monitor changes in land cover and climate variables and are an analytical tool. Land use cannot be determined using (only) land monitoring techniques and requires direct field observation. Land use is thus both a record of existing functions and a future-oriented planning tool.

1.2. Historic Development of Land Use

Using land use as a planning tool requires careful documentation of existing patterns. Cadastral maps (a long-standing tool around the world) and land registration have evolved over centuries to track land use (the notion of the cadastre has been associated with the Byzantine books, called *katastichon* in Greek, which literally means 'line by line' [Stubkjær, 2008]). Cadastral maps document the partition of territory in parcels; they are linked to ownership and serve as an official land register. The cadastre connects rights in rem—that is, to an object—but in this case to real estate (plots of land listed in the land register) with a location in space; that is, the cadastre locates a property in space, or it connects space with the owner. In the land cadastre, written and graphic data are kept for each parcel. The first, written part of a cadastre defines data such as parcel number, boundary, area, owner, administrator of state or municipal property, actual use, built-up area, and credit rating of the land plot. The graphical display of the land plots is the cadastral representation, which shows the boundaries of parcels, parts of parcels and parcel numbers (Kadaster, 2021; Working Committee of the Surveying Authorities of the Laender of the Federal Republic of Germany, 2020; The Surveying and Mapping Authority of the Republic of Slovenia, 2020). A cadastre provides legal certainty (Kadaster, 2021).

Since antiquity, one of the main aims of the cadastre was to support land taxation policies (Richeson, 1966). Dobner (Dobner, 1973; National Research Council, 1980, p. 6) has argued that almost all European cadastres were established in response to the need for fiscal information. Most properties in medieval and early modern Europe were managed without the aid of maps. Throughout the 15th and 16th century, large-scale maps came to supplement medieval written cadastres as inventories of property. Over centuries the property value of the

land in general, and around port areas in many parts of Europe, increased. Consequently, the manner and style of property mapping became more precise. In Central Europe, the Milan cadastral mapping program, carried out between 1720 and 1723, was the only fully surveyed and mapped cadastre with graphical presentation for more than a century (Kain & Baigent, 1992). The Franciscean or Stable cadastre, from the first half of the 19th century, notably contains, in addition to written records, cadastral maps at a scale of 1:2,880, showing land use (Bičík et al., 2015).

Agricultural cadastral cartography was the basis for the development of new land uses for urban, industrial, and other types of development, and was (most importantly) used to delineate private property and ecclesiastical and aristocratic estates. Land ownership maps were critical for securing rights to real property (whether residential or productive, such as mills and workshops) and land resources (arable land, fields, forests, and pastures). In the 17th century, Europeans developed an understanding and appreciation of the cadastral concept for purposes beyond taxation in the development of the legal or judicial cadastre. Starting at the end of the 18th century, cadastral maps were increasingly related to or based on geodetic triangulations (e.g., the case for the Napoleonic cadastre of France, Belgium, the Netherlands, and the Napoleon-occupied areas in Germany, left of the river Rhine; Kain & Baigent, 1992).

These detailed maps served land ownership and taxation purposes. Port lands were long owned by the state/crown, so goods were taxed rather than land. Consequently, port areas were historically not defined by land use and by the land registry. However, there were other demarcations and separations, but also inclusions between the city and the port, such as physical barriers and functional designations (which we do not treat as land use given the definition provided in Section 1.1).

1.3. Previous Research on Land Use in and Around Port Areas

Land use in port areas differs from that in cities and rural areas. Scholars from various disciplines have addressed this topic. Canadian geographer Charles Nelson Forward (1968, 1969, 1970) has written about land use in waterfronts in the context of metropolitan areas and compared the waterfront land use structure of different port cities. Forward (1969) argues that although each port city is unique in terms of location, setting, and physical characteristics, one would expect similarities in waterfront land use patterns in cities with reasonably uniform culture and economic development, and this is currently not the case. In 1983, the United Nations published the report "Planning Land Use in Port Areas: Getting the Most out of Port Infrastructure" (Takel, 1983), introducing land use categories in port areas with the aim of unifying land use data sets for the EU as well as on a global level.

Selected authors have recognized the complexities of port transformation and the difficulties that issues of land ownership and control can create, especially in a time of transformation. Economist Reginald Loyen from KU Leuven (with Erik Buyst and Greta Devos; Loyen et al., 2003) summarized, in terms of land use and land use policy, the changes that took place in Rotterdam and Antwerp as they developed into modern ports, showing that quay and land use policy in the ports has long been a delicate issue. The port of Antwerp has evolved from a traditional transshipment port to a multifunctional port. The classic cargo-handling function has been complemented by a wide range of logistics services (warehousing, distribution, value-added logistics, semi-industrial activities, etc.) as well as port-related industries. Rotterdam managed to make land available for commercial functions through the construction of new ports prior to 1940 and later. In 1960–65, companies that carried out large cargo transports were given preference in renting port land. In this way, companies that transported, handled, or processed large quantities of goods found their way to the port, and the city made extensive land available to them. The availability of land and flexibility regarding new land uses was a key factor in the growth and transformation of Rotterdam into a world port.

Economist and port and logistics adviser Peter De Langen (2005) emphasizes that mixed land use in ports is a strength in a port's functional organization and at the same time an increasingly attractive basis for port planning. The Canadian planner Peter V. Hall and the German geographer Markus Hesse (2013) addressed the relationship between systems of physical flows and cities, which seem to be increasingly separated from each other (an example of the tensions between the two is the regionalization of ports and the expansion of port-related activities and facilities away from the historic waterfront), even though the management of flows requires spatial capacities and associated land use. In the same compendium, Heike Flämig (2013) argues that transport and land use planning measures are only successful in combination with environmental standards, also when influencing the locations of inland port areas. Canadian planner Clarence Woudsma (2013) stresses that logistics activities and associated flows—which are often linked to ports—have not been well integrated into the urban planning process, despite urban planning's emphasis on intensification, mixed land use developments, and active transport for quality of life and health in the cities. There is no coordinated approach to land use and the principles of 'restrict and regulate' rather than 'understand and adapt' have been applied to logistics land use activities, which is true even in logistics-oriented communities such as large ports, and manifests itself in pressure for port land to be developed as residential and recreational areas rather than for industry or logistics (Hall, 2007).

2. Delimitation of the Port Areas

Port areas are located at the boundary of water and land. On the land side, they control flows of goods and people from port to city and hinterland, and, on the seaside, they control the connection between land and sea. Port areas and "waterfronts are typically places where the movement or flow of people, nature, goods and capital make their entrances to and exits from the city, and where they leave their marks on it" (Desfor & Laidley, 2011, p. 3). Therefore, delimitations in and around port areas have been caused by restrictions and by the implementation of controls over the territory and over the movement of goods and people.

The main reason for delimiting a port territory has always been the desire to control and govern the space in line with maritime interests. In the article "Early Medieval Port Customs, Tolls and Controls on Foreign Trade," Middelton (2005) points out that coasts and river systems in Europe have been divided into toll or customs areas since Roman imperial times, as well as in the Middle Ages and up to the present day. In the medieval urban tradition, towns whose main activity was trade, and which were located either on the banks of a major river or on the sea, were appointed ports (Antunes, 2010). In England, ships were allowed to load and unload only in ports so assigned and designated, at least since the 12th century. This procedure, however, necessarily required that the ports that received this "civil signature" were not only properly designated and appointed as such, but also properly delimited and defined. Even the earliest surviving texts (see Boys, 1792, p. 549) attest to the necessity to delineate assigned ports not only in terms of length along the coast, but also in terms of depth inland (Jarvis, 1959). The word 'port' was used not only to refer to a place, but also in a more precise sense, as a technical term denoting a specific, delineated length of coastline based on a privileged harbor—a fiscal 'collection' (Jarvis, 1959). There were ports that were privileged for foreign trade, and on the other hand, there were places that were restricted to coastal traffic (Jarvis, 1959). The definition of boundaries was important in combating smugglers. The question of a port's seaward boundaries was often a very practical matter of knowing whether a particular smuggler was inside or outside the boundaries of a port for purposes of inspection, forfeiture, and legal proceedings. One purpose of establishing boundaries was to prevent the passage of smugglers.

The definition of a port city is not insensitive to time and the evolution of the relationship that links the two parts and the two territories. In the 20th and 21st century, the dynamics and uncertainty of the commercial world, combined with the impact of the global economy, have profoundly changed the relationship between city and port, causing an irreversible rupture in the evolution of the two poles. Numerous authors from many disciplines have reflected on and theorized the relationship of port and city through the centuries, also providing insights on scales and methods of investigation (e.g., Hein, 2011; Hein & van Mil, 2019; Hoyle, 1989; Lee et al., 2008; Lee & Ducruet, 2009; Schubert, 2011; Van den Berghe, 2016). Close spatial and functional association between the port and the city in most cases until the 19th century enabled the porosity between them. Expanding port areas beyond the city areas and/or perimeter walls diminished the previous permeability of functions. This can be well represented by the case of the port of Trieste, where authorities separated the city and the port by a fence in the late 19th century. In 1891, the free city port status was valid only for the area of the Porto Vecchio and the eastern dock, Punto Franco Nuovo ("New Free Port") or Franz Joseph Hafen (Minca, 1995). In a free port area, goods in transit were exempt from customs duties and commercial and industrial activities remained untaxed to support the upgrading of the port. New regulations formalized the physical and functional separation of the city from the port (Minca, 1995), disrupting the intensive functioning of the port system and requiring many new investments. As can be seen in various maps of Trieste from 1900 on, the port area is already drawn blank (with no definition of land uses) at that time, and in some versions only warehouses are identified along the operational coast and on the piers.

In the 20th century, commercial and industrial growth led to the progressive separation of port cities, as ports became more specialized (e.g., container ports, liquid bulk ports, passenger ports), industrialized (e.g., port-led industrialization through locating manufacturing centers closer to the ports or within the port areas, coastal economic zones), protected (e.g., safety measures, physical security barriers), and controlled (e.g., regulating and monitoring the access, arrival, stay and departure of ships), all with the aim of increasing efficiency. Physical delimitations were clearly defined by fences and controlled entrances and land use supported this division, especially at borders separating the port area from the neighboring city and rural spaces.

2.1. Historical Port City Borders in Hamburg, Rotterdam, and Koper

The study of individual port cities can shed light on the process of delineations and permeabilities of space in and around port spaces. The topographical settings and the historical circumstances which influenced the development of the selected three port cities are quite different. The relation between the city and the port also differed. In Hamburg, port and urban spaces were multifunctional for many centuries. In Rotterdam, port and city were first physically separated by a dike (a barrier which regulates or retains water from a river, lake, or even the sea) and by functions (Hein & Van de Laar, 2020; Meyer, 1999), and only later in the course of the 17th century, the separation of functions between the port and the city blurred, with the areas becoming both multifunctional and representative. A defensive wall separated

the town and the harbors in Koper, which was originally located on an island (Figure 3a).

Both Hamburg and Rotterdam were surrounded by strong walls and canals (Figure 1 and Figure 2a), and they developed a dense spatial pattern, with agricultural land uses outside the city walls (Figure 1a and Figure 2b). The port of Hamburg was located within the city walls on the Elbe River and grew along with the city. The flow of ships up and down the Elbe was constant, with two larger water basins for waiting ships to enter the port within the city (Figure 1a), which enabled the city to control the permeability of ships with cargo. Warehousing, living, and administrating all occurred in the same buildings, and small ships entered the canals that ran through the city. There was neither a clear distinction between dedicated port areas with fixed infrastructures nor a specific labeling of multifunctional spaces. In Rotterdam, the situation was different, as the oldest part of Rotterdam grew behind the dike, but to the south and outside the dike the port was built, and it introduced the distinction between the Landstadt (Polderstad) and the new Waterstad (the new part of the city). Originally, the former represented the city, and the latter the port with harbors, quays, warehouses, and shipyards (Meyer, 1999): "The relationship between the city and port was organized on the *scale of individual land parcel*, with an imposing front side for the home or office, and a rear side for the warehouse or other port-related activity" (Meyer, 1999, p. 293). In contrast to Hamburg and Rotterdam, Koper did not experience multifunctional spaces during the period when it held a monopoly as a salt port in the eastern part of the northern Adriatic (since 1182).

In the 19th century, with industrialization and the arrival of new forms of transport, private actors, and port companies, some municipalities in Hamburg and Rotterdam created their own port areas separate from

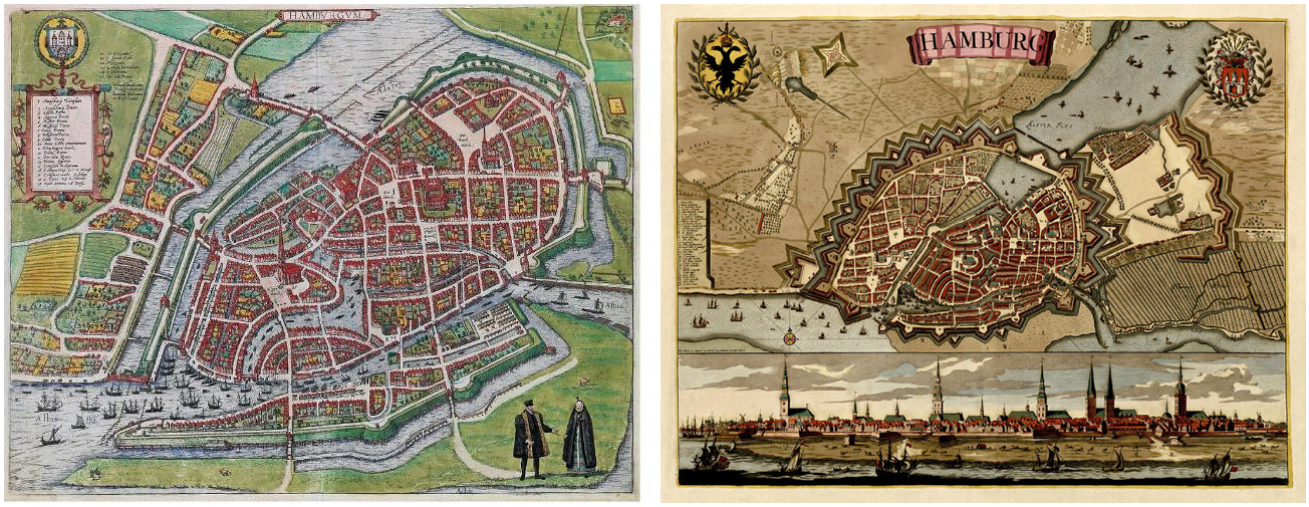

Figure 1. Hamburg in 1589 and 1690. **(a)** Hamburg in 1589, kol. Kupferstich von G. Hufnagel (left); **(b)** Hamburg in 1690, kol. Kupferstich von P. Schenk (right). Source: Hoffmann and Frank (2009).

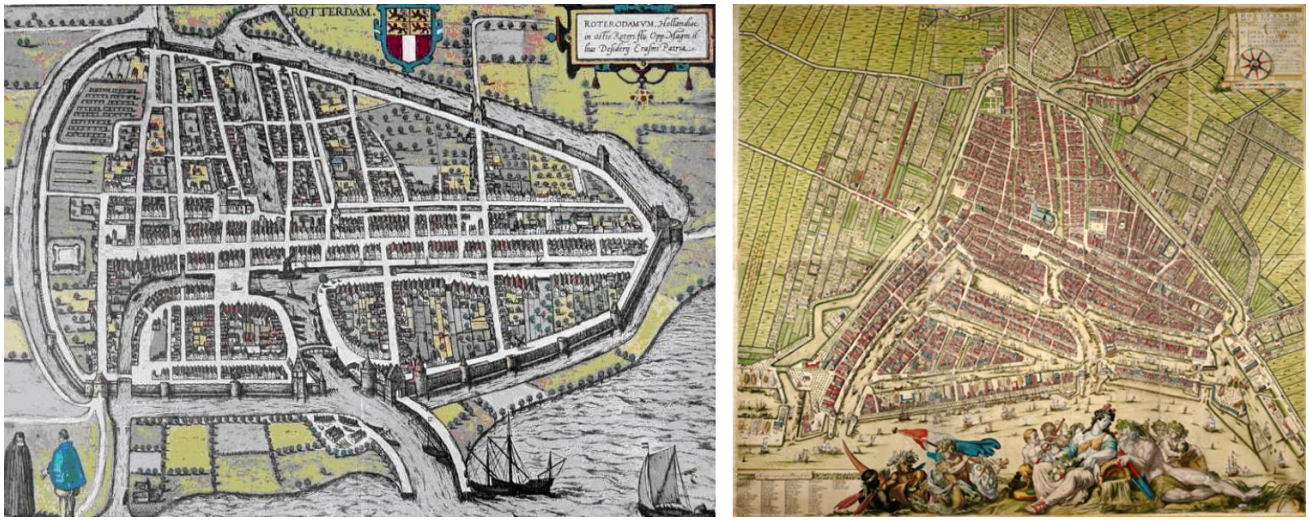

Figure 2. Rotterdam in 1588 and 1694. **(a)** Map of Rotterdam by F. Hogenberg, 1588 (left); **(b)** map of Rotterdam by Johannes de Vou en Romeijn de Hooghe, 1694 (right). Sources: Rotterdam City Archives (2009) and Hoogheemraadschap van Schieland en de Krimpenerwaard (2017).

urban spaces. Water access was a privilege largely reserved for trade. Rapid growth of trade, the emergence of petroleum as a fuel, and urbanization required port and city expansion. Private and public companies created new land in the estuary and made new docklands. In Hamburg, the general plan for the expansion of the port was adopted in 1860. The first harbor basin, the Sandtorhafen, was built between 1863 and 1866 on the Großer Grasbrook in front of the former sand gate of the destroyed city wall (see Figure 4). Land use plans for Rotterdam show that as the city of Rotterdam expanded along the south bank of the river Maas, designated port areas were drawn up, such as for the Rijnhaven (1887–1895) and Maashaven (1898–1905), for port purposes—that is, as harbors for the transhipment of bulk goods (see Figure 5). The land use register at the beginning of the 19th century for Koper shows residential buildings, buildings of special importance, green areas, and streets with squares (Figure 6). The harbors on the edge of the island were only defined by a line and no land use category was indicated for this land. During the period when the city and the port merged, Koper had already lost its importance due to the reduced accessibility of the port (Figure 3b) and the lost power of its protector, Venice. It was overtaken by the neighboring port of Trieste, which by the 1910s had become the fifth-largest port in Europe and the eighth largest in the world.

3. Contemporary Land Use in the EU and National Databases

In recent decades, Hamburg, Rotterdam, and Koper have started to expand their port areas further toward the sea and have begun to redevelop old port areas. All three ports have transit functions, but they differ in ranking, total port size, and in the ratio of city and port areas. The port of Rotterdam is the largest port in Europe, followed by Hamburg as the third largest on the continent. Koper is at least equal if not leading among the North Adriatic Ports Association ports. Although the total port area of Koper (760 ha) is much smaller than that of Hamburg and Rotterdam, the share of the urban area used for port activities is much larger; the port area occupies half of the built-up area of the settlement (Figure 7c). In Rotterdam, port areas also occupy a relatively large share of the urban land area; here, more than 30 percent (Merk, 2013, p. 39) of the urban land area is used for port activities (total area of 12,713 ha), although a large part of the port is located outside the city and the built-up area (Figure 7b). The port of Hamburg, which is located near the center of the city, but on the other side of the river, occupies just over 5 percent (total area of 4,331 ha) of the urban land area (Figure 7a; Merk, 2013, p. 39).

3.1. Existing Land Use Categories of Port Territories in the EU and National Databases

Port areas are not classified in the INSPIRE existing land use databases (HILUCS, or The Hierarchical INSPIRE Land Use Classification System, provides an application schema for land use data that defines a range of keys, but is as open as possible with respect to specific—national, European, and global—classification systems), although some land use types, such as specific types of raw material industries, commercial services and logistics and storage services, can be used to determine land use in port areas (European Parliament & Council of the EU, 2007). In the European land cover databases, port areas are better classified and port areas have their own classification (123 port area), further defined by type (12310 cargo port, 12320 passenger port, 12330 fishing port, 12340 naval port, 12350, 12360 local multi-purpose ports, and 12370 shipyards; Copernicus, 2018b).

In Germany, the Amtliches Topographisch-Kartographisches Informationssystem (ATKIS) also distinguishes port areas from their surroundings by categorizing the port as a 'Hafen,' but the industry in the port is not further defined (see Figure 8a). In the Netherlands, port areas (including chemicals, refineries, liquid and dry bulk, distribution, container storage, offshore activities, etc.)

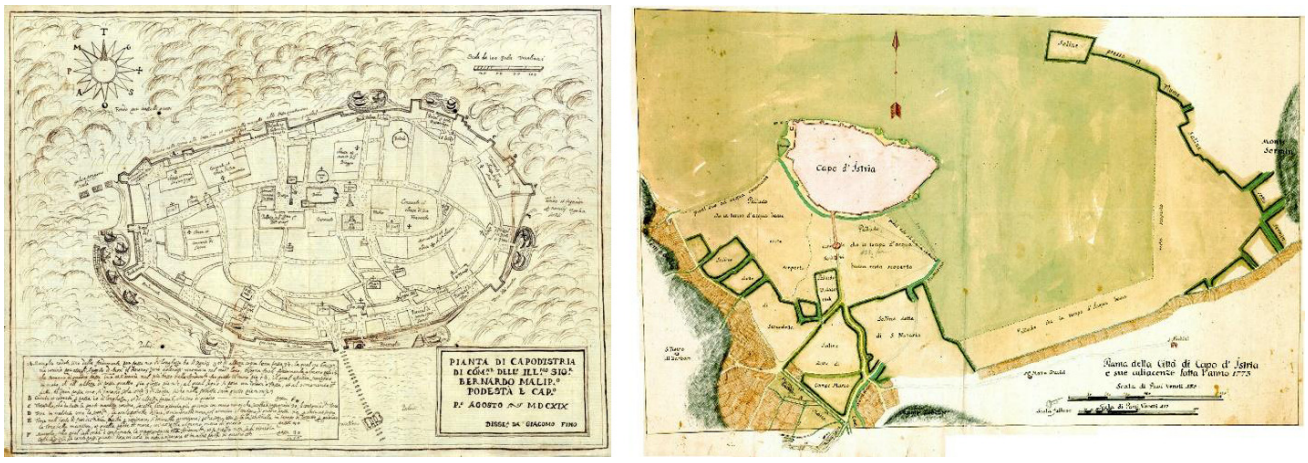

Figure 3. The island of Koper in 1619 and 1773. **(a)** Island of Koper in 1619 by Giordano Fino (left); **(b)** Island of Koper in 1773 by unknown author (right). Sources: Krmac (2009) and Archivio di Stato di Trieste (2021a).

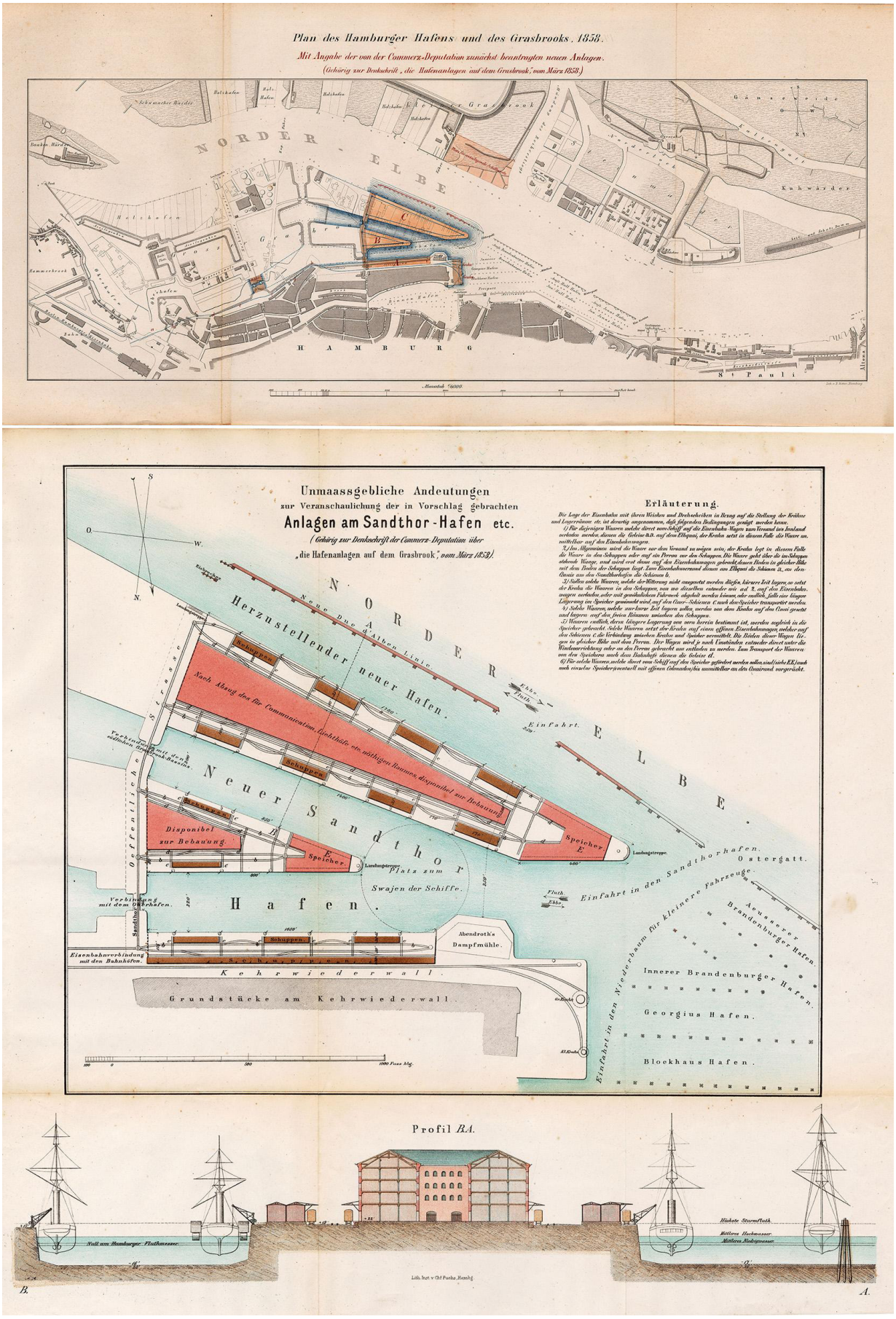

Figure 4. Plan of the port of Hamburg and the Grasbrook, with a proposal for used equipment at the Sandthor port. Source: Commerz-Deputation (1858).

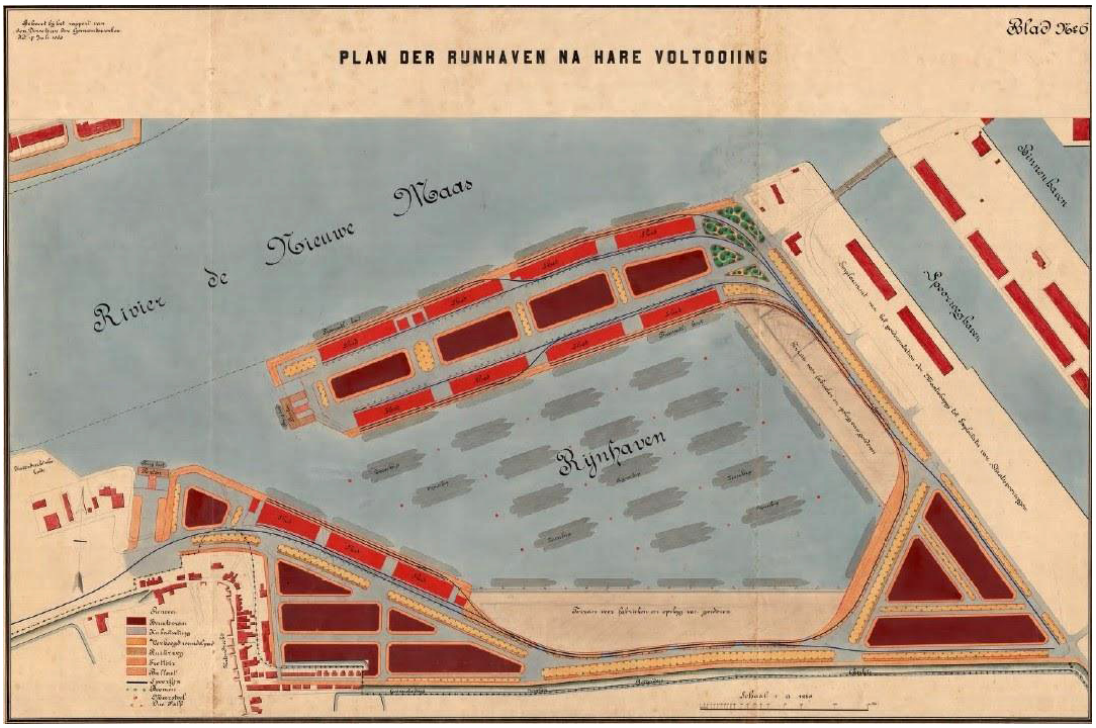

Figure 5. Expansion and zoning plan of the Rijnhaven by Gerrit de Jongh, director of the Rotterdam Municipal Works, 1888. This is one of the first plans for the south bank of Rotterdam, with land use exclusively for port activities. Source: de Jongh (1888).

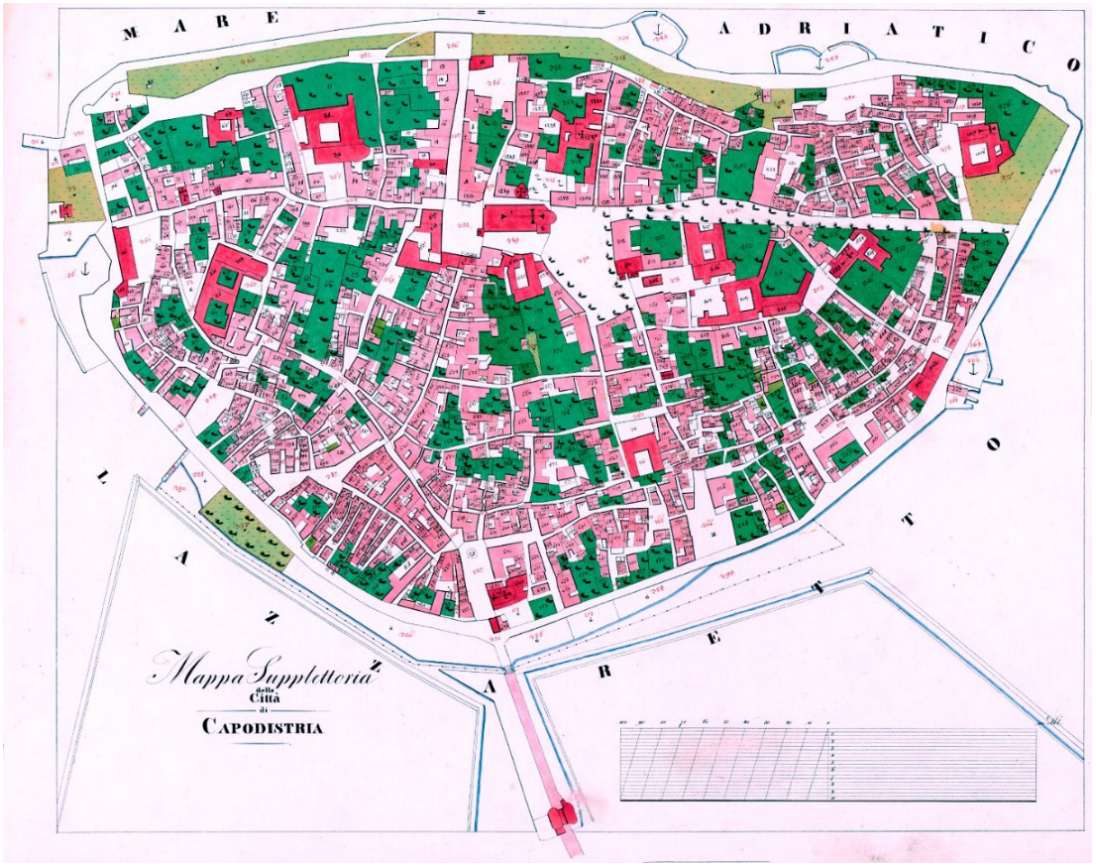

Figure 6. Map of Koper by The Franciscean or Stable cadastre from 1819. Source: Archivio di Stato di Trieste (2021b).

Figure 7. Sizes of the ports of Hamburg, Rotterdam, and Koper. **(a)** Size of the port of Hamburg in relation to the city and its surroundings. (top left); **(b)** size of the port of Rotterdam in relation to the city and its surroundings (top right); **(c)** the border of the national spatial plan for the port of Koper, 2011, which includes other land uses within the border area in the northern part (recreational areas, military zone, etc.) and in the south (bus station, etc.; bottom). Sources: ESRI Google Satellite and The Ministry of Environment and Spatial Planning of the Republic of Slovenia (2011).

are not defined separately in the Bestand Bodemgebruik (BBG) of the National Statistics Department and are categorized under 'commercial area,' as a subcategory of 'built-up area.' As a result, neither port is demarcated from surrounding areas and there is an overlap of land use between the city, the port, and the surrounding region (see Figures 8a and 8b). The surveying authorities in Slovenia only recently classified port area types among more detailed existing land use categories (Legal Order of the Republic of Slovenia, 2018), but this is not yet visible in the existing land use map and the port of Koper does not seem to have a clear demarcation of the port areas (Figure 8c), similar to the ports of Hamburg and Rotterdam.

3.2. Planned Land Use Categories of Port Territories in the EU and National Databases

In the current planning system, port designs begin based on existing land use, and when the design is complete, it defines the planned land use. INSPIRE has made recommendations for a classification for 'Planned Land Use' that includes supplementary regulation value based on types of conditions and constraints in spatial plans: the Hierarchical Supplementary Regulation Code List. This list has a class for port activities, defined as "harbor key functions associated with municipalities or regions on regional or state level planning" (INSPIRE Thematic Working Group Land Use, 2013, p. 168). This corresponds to the official zoning plan of the City of Hamburg. The port is classified as 'Hafen,' which creates a clear demarcation of the port area comparable to the existing land use data set ATKIS (see Figures 8a and 9). The category 'industry' in the ATKIS has disappeared in the planned land use data set, but the plan does indicate areas for supply systems and the recovery or disposal of sewage and solid waste.

The smaller-scaled zoning plan for the extension of the port of Rotterdam does not appear to provide more detailed information on land use. In the BBG, the existing land use in the port is classified as commercial area, which is consistent with the official planned land use in the municipality's land use plan for Maasvlakte II (see Figures 8b and 10b). However, if we look at a design for the planned land use for Maasvlakte II, the land use is much more precise and is classified as chemical

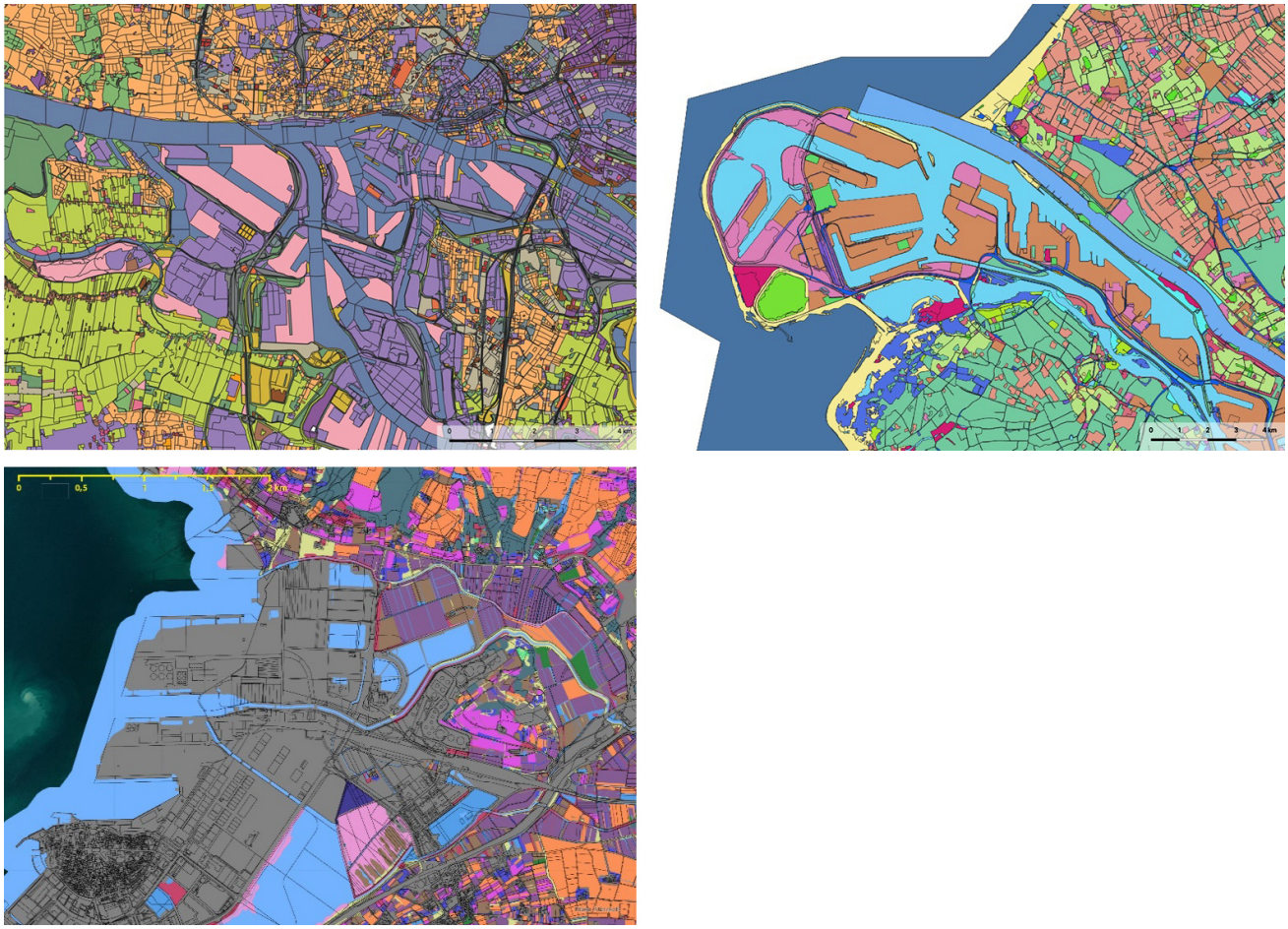

Figure 8. Fragments of the existing land use map of the ports of Hamburg, Rotterdam, and Koper. **(a)** Fragment of the existing land use map of the port area of Hamburg, based on the Landesbetrieb Geoinformation und Vermessung data set, which distinguishes between port area (pink) and industrial area (purple; top left); **(b)** fragment of the existing land use map of the port of Rotterdam and Maasvlakte II, based on the Dutch land use data set BBG 2015, in which the port area is defined as commercial (pink-orange-like), building site (light pink), and natural terrain (dark pink), as Maasvlakte II was still under construction in 2015 (top right); **(c)** existing land use and cadastre in the port area of Koper (the new categories in port areas are not yet applied; bottom). Sources: Landesbetrieb Geoinformation und Vermessung (2020), Publieke Dienstverlening Op de Kaart (2008), and The Ministry of Agriculture, Forestry and Food (2021).

Figure 9. Official zoning plan/land use plan for the City of Hamburg of 2020. Similar to the land use data set ATKIS, the port is defined as 'Hafen' (blue), but not further specified. Source: Stadtentwicklung und Wohnen Hamburg (2020).

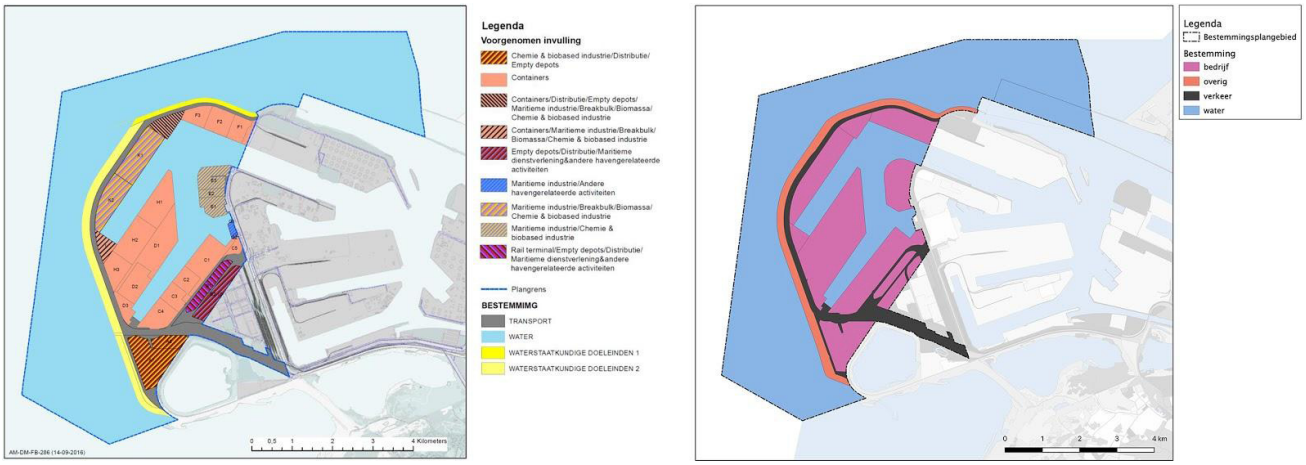

Figure 10. Zoning plans for Maasvlakte II. **(a)** A design for an 'intended land use' of Maasvlakte II established by Arcadis commissioned by the Port authority of Rotterdam, 2017 (left); (**b**) Official zoning plan/land use plan of the municipality of Rotterdam for Maasvlakte II, 2018 (right). Source: Arcadis (2017).

and bio-based industries, containers, distribution, empty depots, maritime industries, biomass, general cargo, maritime services, and other port-related activities (see Figure 10a).

The master plan for the port of Koper is a set of long-range planning documents that provide guidelines for future port growth and development (see Figure 11c) and gives an idea of future port development until 2030. There, the port structures are divided into car terminal, container terminal, fruit terminal, bulk terminal, European energy terminal, liquid cargo terminal, grain terminal, general cargo terminal, and transport networks with main and secondary roads and railway tracks (Figure 11a). If we compare this plan with existing land use, the detailed land use and the outer contours of the new design on the water side are lost (Figure 11b). This could only be a technical problem (perhaps the data set has not been renewed), as the contours of the old plan for the port of Koper are drawn in on the seaward side, and in contrast, on the landward side, the demarcation according to the new design plan is clearly visible. Another inaccuracy is the division of land within the fence around the port: it still represents the old agricultural land use patterns and not the existing or planned land use.

4. Porosity of Port Areas in the Three Selected Port Cities

Porosity of land use in the port areas of Hamburg, Rotterdam, and Koper can be observed in the current state and in the future planning proposals such as zoning plans and master plans. Looking at the various land use data, the port areas of Hamburg, Rotterdam, and Koper appear less delineated than they actually are; many port areas are fenced off and inaccessible. There seems to be a complete void of land use categories in the ports, while on satellite images such as Google Earth, numerous types of port functions are visible; in addition to the various industrial complexes devoted to chemical companies, oil refineries and the storage of containers, wet and dry bulk, there are a variety of office buildings, educational institutions, information centers, catering facilities, and so forth. Such a lack of demarcation can be also seen as a kind of porosity.

For interventions into the port areas (as a consequence of port expansions) or redevelopment of old port areas (as a consequence of the port leaving part of the city) mixed uses prevail. Hamburg is expanding the port in the direction of the Southern Elbe (Süderelbe) and is working on the Hafencity (including Grasbrook) redevelopment project. The port of Rotterdam is expanding with newly created areas in the North Sea (Maasvlakte I and II) and historic port areas near the old city center—Maritime District on the north bank (*waterstad*) and Kop van Zuid and Katendrecht on the south bank of the Maas (Rijnhaven)—are being reclaimed by the city and transformed into urban areas. The port of Koper withdrew from the old city center and made plans to expand the port territory into agricultural land in the adjacent hinterland. The port is currently closed off from the rest of the city. In order to link the separate parts of the city and the landscape, the new port design plan introduced distinctive landscape features (e.g., agricultural terraces, agricultural land uses on the roofs of the garages), hiding port boundaries and incorporating other land uses within the port area. Such porosity is not visible on the master plan layout, nor on the planned land use plan (as land use is only a two-dimensional tool), but only in the photomontage of the future development of the port on the orthophoto image (Figure 11c).

This comparison of land use of the master plans and legal planning documents in port areas of the three selected port cities confirms that port land uses are not classified precisely enough (e.g., defining specific land use keys) in land use data sets to permit easy recognition

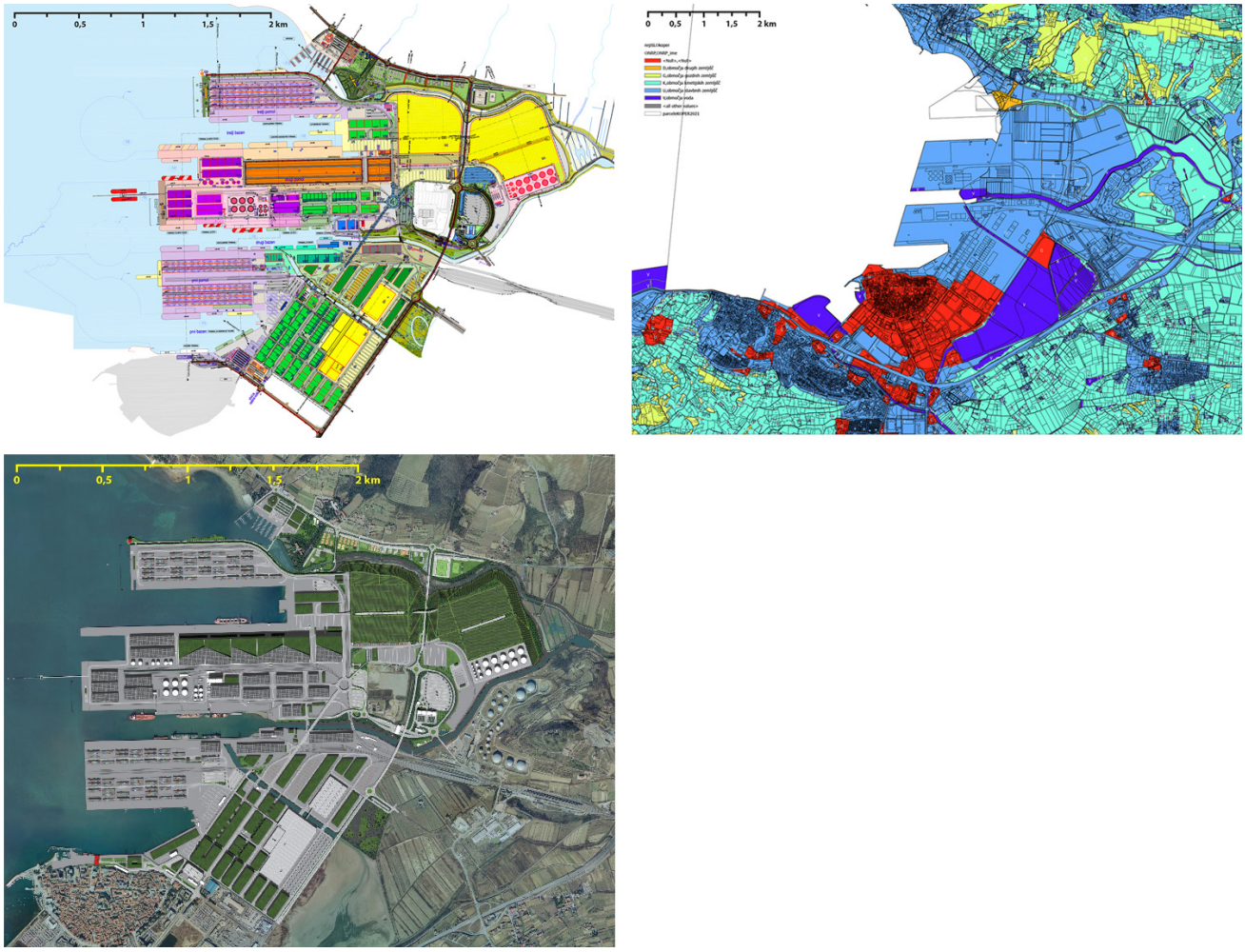

Figure 11. The port of Koper. **(a)** Professional guidelines for the master plan of the port of Koper with expected future development until 2030 (top left); **(b)** generalized planned land use database of the same area (top right); **(c)** orthophoto image of the future development (bottom). Sources: Ažman Momirski and Venturi (2010) and The Ministry of Environment and Spatial Planning of the Republic of Slovenia (2021).

of port activities in detail. The choice of land use keys for port areas is not determined by the size and functions of the ports, different social systems and different parts of a continent or sea. It is defined by the activities within the fence of the ports and is general for all ports. Although the land use categories do exist, as can be viewed in master plans for Maasvlakte II as well as in the expansion plan for the port of Koper, they appear in simplified versions in existing and planned land use data sets. European land use and land cover data sets contain some categorization of land use in port areas.

5. Conclusions

Design for master plans defines land use in detail. But when this detailed information is converted to another database—in our example, land use records—it is lost, and huge port areas appear empty in land use representation, which is misleading. Introducing more detailed land use categories and a shared European land use categorization in port areas would bring a clear understanding of the general pattern of waterfront land use and of the similarities and differences in waterfront land use patterns. In order to have a better idea of the visible and invisible boundaries between port and city, a more detailed delineation and transparent publication of functional areas within ports is needed. Detailed land use keys can help integrate the current multiplicity of planning documents and databases. Waterfront land can be viewed as a natural resource to be managed wisely with the goal of improving the quality and efficiency of its use (Forward, 1969). Comparative studies of a larger number of ports would be possible, if data concerning port use were available. Precise data would also help port authorities redefine the port's relationship with border areas. When port land requirements extend beyond the boundaries of the port, land use planning and control by legislation alone can cause serious problems, including inflexibility, delay, and divided responsibility. The boundaries between city and port, and between the port and rural areas, have become increasingly important issues in advancing contemporary urban design port concepts.

Such proposals at the same time strengthen the professional importance of spatial planning as well as its innovative nature (Ažman Momirski, 2010). Land use concepts must adapt, and they need to be more detailed, with more specific categories of existing and planned land use.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Tangible and Intangible Boundaries: The Case of Baoshan Port-City Interface in Shanghai

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Abstract
Instead of stressing that port cities are characterised by institutional fragmentations with many resulting conflicts, we claim that port cities might be highly constructive in terms of changing tangible and intangible boundaries. To capture this quality, we use the concept of 'penumbral,' a combination of perceptional aspects as well as tangible and intangible spatial constellations. This perspective is applied in the case of the Shanghai Baoshan port-city interface through the investigation of the changing tangible and intangible boundaries, and how planning relates to boundary changes in a context of spatial, industrial, and institutional multi-layered structures. Tangible refers to physical boundaries between the port and urban structure or district, while intangible refers to immaterial boundaries created by actors' views on ports. Based on planning documents, direct observations, and 17 in-depth semi-structured interviews with local governments, port authority, planning departments, and companies, we find that one can indeed speak of penumbral boundaries, based on port-related values and ideas, and particularly on perceptions of the port and port businesses. Those perceptions are the initial power of changing and, following the idea of penumbral boundaries, blurring tangible and intangible boundaries. Finally, we suggest that, following the idea of penumbral boundaries, planning can play a stronger role in connecting the port and the city by first investigating how actors view the port and port businesses carefully, paying full attention to the specific relational context before formulating plans in the usual manner.

Keywords
Baoshan; institutional development; multi-layered structures; penumbral; port-city interface; Shanghai; tangible and intangible boundaries

Issue
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1. Introduction

Paasi (2010, p. 2300) states that "one special profession or group of advocates who are faced with the fragmented complexity of regions today are planners." Indeed, this fragmented complexity is what the port city planners are facing at the port-city interface, the redevelopment of which has been a prominent topic for decades (Hoyle, 2000) and continues attracting planners' attention (Hein, 2016; van den Berghe & Daamen, 2020). This article analyses the changing borders or boundaries—we use both words interchangeably—of the port-city interface and tries to understand how various stakeholders and planning institutions deal with the fragmented boundaries between the port and the city.

The port-city interface refers to a vacant space at the geographical frontier between port-owned land and urban zones (Hayuth, 1982). This vacant space was left by the previous harbour as a result of the port downstream movement to the open sea. Currently, this abandoned

area has experienced or is experiencing a transition process from focusing on harbour functions to focusing on urban or mixed port and urban uses. The port-city interface reflects the complexity of competition and complementarity between ports and cities (Association Internationale Villes et Ports, 2015), and provides a precious opportunity to sufficiently understand the aspect of boundaries.

Boundaries between the port and the city were first studied by researchers as tangible and intangible boundaries, which concern the spatial aspects and the functional aspects of port cities, respectively (Hesse, 2013; Müller, 2016). Nowadays, the institutional and administrative aspects of the port city boundaries have begun to attract scholars' attention. Teschner (2019) used case studies of seven port cities in Spain, Greece, and Israel to point out that there are no clear boundaries between ports and cities. This is because in terms of land ownership and land use rights, the port and the city are two entities that have a mutual interest relationship and are difficult to separate. At the same time, the uneven distribution of power also causes constant changes in the boundaries between ports and cities. Quite often, the Port Authority is stronger than the municipal government, which makes it difficult for some urban spatial plans to be implemented. Moreover, the institutional and administrative fragmentation of cities and ports has shaped the port's image as 'a city within a city,' which has exacerbated borders between ports and cities (Teschner, 2019; see also Hein, 2019; Hesse, 2018; Moretti, 2017; van den Berghe, 2018).

However, previous studies have seldomly comprehensively investigated the tangible and intangible boundaries of port cities from the spatial, functional, and institutional perspective, and have paid less attention to planning in border changes in port cities. This article attempts to fill the gap through investigating the research question: Based on the spatial, industrial, and institutional development at the port-city interface, how have tangible and intangible borders changed and how does urban planning relate to border changes? Tangible boundaries refer to physical borders between the port and urban structure or district, while intangible borders reflect immaterial boundaries created by actors' views on ports. Shanghai Baoshan is selected as a case to answer the research question. Through analysing related plans and 17 in-depth interviews with planners and companies, we contribute to the theoretical understanding of relations between boundaries and planning and empirical planning of the port-city interface.

The structure of this article is as follows: Section 2 is the theoretical basis focusing on theories related to boundaries in governance and planning, and the port-city interface. Additionally, the spatial, industrial, and institutional elements related to tangible and intangible boundaries between the port and the city are proposed. Section 3 presents empirical findings, which first briefly describes the research method and the background of the Baoshan port-city interface, and then analyses the changing of tangible and intangible boundaries and planning in border changes. The conclusion, Section 4, summarises the role of planning in changing tangible and intangible borders at the port-city interface through the refinement and generalisation of the research case study results.

2. Conceptual Framework

When contributing to a thematic issue on "Planning for Porosity: Exploring Port City Development through the Lens of Boundaries and Flows," one is confronted with a set of concepts (or lenses) right at the start: porosity, boundary, flow. In what follows, we first address those by outlining some central positions which are used for the interpretation of results. This is followed by conceptual positions regarding the port-city interface.

2.1. Boundaries in Governance and Planning

Within the field of geography and planning, which constitutes the academic point of reference for the authors of this article, the scientific discussion regarding 'boundaries' has taken quite some shifts over past decades, resulting in a paradox at least with respect to planning. Using here the work by Paasi and Zimmerbauer (2016), which stems from the field of border studies:

> We argue that the rise of the relational approach in planning is a fitting example of policy transfer, and embracing this thinking causes a 'planning paradox': in strategic planning, planners need to think increasingly in terms of open, porous borders despite the fact that in concrete planning activities, politics, and governance the region continues to exist largely in the form of bounded and territorial political units. (Paasi & Zimmerbauer, 2016, p. 1)

As Paasi and Zimmerbauer (2016) emphasise, the border has to be seen as a complex and 'context and practice bound' phenomenon. In their attempt to create or shape relations, locally and/or globally, various actors, from businesses to administrations, as natural people but also including institutional actors, construct and deconstruct borders or 'bounded entities.' They do this partly strategically and partly spontaneously, as can also be seen from the historic periods discussed for the case of Shanghai. Paasi and Zimmerbauer (2016) continue:

> We then extend the idea… and argue that borders in planning could be better understood as 'penumbral' borders rather than porous, since they are not solely either 'hard' boundary lines or 'fuzzy borderscapes,' but typically manifest themselves only in certain practices. More generally, our observations suggest that the relational character and possible 'boundedness' of regions is inevitably a phenomenon that

> is multilayered and complex as well as context-and practice-bound. (Paasi & Zimmerbauer, 2016, p. 1)

Penumbral comes from the field of psychology of perception and refers to a soft or blurred outline of a shadow and is as such one of the criteria that enable the visual system to distinguish between shadows and dark spots on the observed object. Transferring this to the question at hand, only when allowing for this soft spot are we able to actually identify the entirety of the object. With a view towards the issue of port city development, it is less so a question of hard boundaries that, at times, can become porous. On the contrary, the practices and also the means of defining boundaries or bounded spaces are fluent and cover many dimensions, like tangible or intangible, as in fences and regulations, and depend on the actual relational activity, or in other words, the actual strategic planning of the port-city interface. Seeing the border as a 'blurred' entity allows actors to shape their respective room of manoeuvres.

The suggestion to consider boundaries rather as 'penumbral' provides a connection with another popular concept in planning—that of soft spaces. Soft spaces, as prominently introduced by Allmendinger and Haughton (2009), shift the scientific attention to new forms of territorial governance, most notably emerging at the scale of urban regions. These new spaces of governance are understood as 'soft' given their fuzzy boundaries, being located in between formal levels of governance. Going a step further, these new spaces of governance are supposed to replace existing territorial governance structures in strategic ways, adding extra layers to an increasingly complex and fragmented governance landscape. Following this understanding, the central perspective rests on practices, or sets of governances, helping to assess a border and develop a clearer identification of how porous a border is and, importantly, in what ways.

The last element relates to flow. Since Castells' (1996) writing on the network society and the 'spaces of flows' within various disciplines, a discussion on the related aspects can be observed. For the topic of boundaries, an interesting proposition comes from Swyngedouw (2004), who conceptually embraced the floating character of space by suggesting 'scalar configurations.' Serving as a bridging figure between environmental studies and social sciences, Swyngedouw (2004, p. 132) notes that "scalar configurations… as well as their discursive and theoretical representation, are… an outcome of the perpetual movement of the flux of socio-spatial and environmental dynamics." Looking at the port-city interface, this interpretation provides a challenging perspective, calling for permanent adjustments to those dynamics. Planning actions need to be highly adaptable and responsive to changing constellations.

Taking all previous paragraphs together for a very first conceptual conclusion, thus, the port-city interface can be understood as a floating scalar configuration which is based on the continuous construction, re-construction, or de-construction of tangible and intangible boundaries, a penumbral zone that helps both the city *and* the harbour to 'see' and respond to internal and external challenges and to plan and develop the port-city interface in a consistent and responsive manner.

2.2. Theory of the Port-City Interface

It can be seen from the above discussions that the port city is highly constructive. The relationship between the port and the city is changing all the time and the boundary between them is constantly formed, disappearing, and re-forming again. This article assumes that the port-city interface fully reflects this transformed and complex relationship between the port and the city. There are two main reasons for this. First, the transformation of old port areas was urban scholars' focus. This corresponding research is classified as 'Urbanization of Old Port Areas' (Daamen, 2010; H. Wang & Luan, 2014). Hayuth (1982) noted that in the process of urbanisation, the development of areas adjacent to the waterfront was considered but the development of maritime activities located within the waterfront was ignored. Hayuth (1982) further claimed that the intersection between the city and the port was seriously neglected and defined this interaction as the port-city interface: a vacant space at the geographical frontier between port-owned land and urban zones. The space was left with the previous harbour moving downstream to the sea and is an area under transition between harbour functions and urban uses (Hayuth, 1982). This concept refines the perspective of the waterfront to a flexible and adjustable interface between the port and the city.

Second, the port-city interface can reflect the complex relationships formed by the intertwining of different factors. As reflected in the six-stage model of Hoyle (2000), the interface has witnessed the mutual prosperity of ports and cities from the Middle Ages to the mid-twentieth century, and has witnessed the entire process of the retreat of the port from urban centre, the separation of port and city functions, and the redevelopment of old port areas since the 1960s. It has withstood the scrutiny and test of various factors from the initial technology, economy to later society, environment, politics and laws, and regulations (Hayuth, 1982; Hoyle, 1989; Norcliffe, 1981; Slack, 1980). The institutional separation of port and city management departments that began in the 1990s made the development of the port-city interface more complicated. On the one hand, the port-city interface, as a kind of boundary, blocks certain original connections. On the other hand, it provides great potential for the development of strategic planning to link the port and city administration (Hein, 2011; Moretti, 2017).

Therefore, we focus on the port-city interface to explore the changing boundaries and the role of planning in those changes. The spatial, industrial, and institutional elements of tangible and intangible boundaries in existing literatures are summarised in Table 1. As it

is claimed that borders are multi-layered (Zimmerbauer, 2011), this comprehensive perspective including spatial, industrial, and institutional aspects offers precious opportunities to investigate border changes in a multi-layered context.

3. Empirical Findings at Shanghai Baoshan Port-City Interface

To investigate how tangible and intangible borders formed and how planning relates to borders in this process, we apply a qualitative and exploratory case study design (Yin, 2018). The rationale of using a case study is that the understanding of borders and planning requires strong local contextualisation. Moreover, the selected case should be experiencing the port-city interface redevelopment spatially, industrially, and institutionally at an early stage. Cases whose interface transformations have been ongoing for some time and have taken full shape, such as Barcelona and London (Daamen & Vries, 2013; Hoyle, 2000), are not in our consideration. This article pays attention to the port city of Shanghai, where the corporatisation of the port authority has been advocated institutionally (J. J. Wang & Slack, 2004) and the port is retreating from the inner city generally (H. Wang, 2014). Specifically, we focus on Baoshan District, whose port-city interface not only manifests the institutional port governance changes, but also underlines the industrial transformations of port-related activities to a larger extent. This is due to its historical base for heavy industry, which is further elaborated in Section 3.1.

Following case study design, the data was mainly collected from three sources: (1) documents including city and port planning documents, port governance laws

Table 1. Elements related to tangible and intangible boundaries between the port and the city.

	Tangible borders	Intangible borders
Spatial aspects	S-1 Fortified fences and walls that need permission (Hein, 2019; Hesse, 2018; Müller, 2016; van den Berghe, 2018)	
	S-2 Customs gate (Hein, 2019; Hesse, 2018)	
	S-3 Port-related space: previous harbour infrastructure and architectural design; docklands; railways (Hein, 2019; Müller, 2016; Teschner, 2019)	
Industrial aspects		IN-1 Port-related goods (Hein, 2019)
		IN-2 Port-related people (Hein, 2019)
		IN-3 Port-related activities (Hein, 2019; Müller, 2016; Teschner, 2019)
		IN-4 Port-related values and ideas (Hein, 2019; Müller, 2016)
Institutional aspects		INS-1 Governance: administrative jurisdiction (Hein, 2019; Hesse, 2018; van den Berghe, 2018); governance frameworks and legal systems (Hein, 2019); land ownership; land-use planning; activities allowed in port area; public access (Teschner, 2019)
		INS-2 Planning: planning guidelines; goals of politicians; planners; and other stakeholders (Hein, 2019)

and regulations, and government reports of Shanghai Baoshan; (2) direct observations; and (3) 17 in-depth semi-structured interviews with representatives from local governments, port authority, planning departments, and companies located around the port-city interface. Interviews were conducted from July to September 2019 and were coded through Atlas.ti 8. An initial set of codes were defined based on Table 1 and subsequent codes were complemented by sticking closely to interview data. Using a standard function of Atlas.ti, networks between codes and quotations as well as between different codes were built to explain the changing borders at Baoshan port-city interface in Section 3.2, and planning in border changes in Section 3.3.

3.1. The Context of Baoshan Port-City Interface

Baoshan, with an area of 270.99 square kilometres and a population of 2,044,300 (in 2019), is a district located in the North of Shanghai (see Figure 1). Baoshan has Wusong and Luojing, two ports in the east. Wusong Port, developed in the 1880s, is mainly engaged in international container freight and is the main port area of Shanghai's foreign trade (Compilation Committee of Records of Place Names in Shanghai, 1998; Shanghai Baoshan District Historical Records Compilation Committee, 1996). Luojing Port, built in the 1990s, is Shanghai's bulk cargo terminal and the largest coal transfer hub (Compilation Committee of Records of Place Names in Shanghai, 1998).

A large-scale enterprise cluster has been formed around Wusong and Luojing Ports (Shanghai Baoshan District Local Records Compilation Committee, 1992). It includes China's largest modern steel complex—Bao Steel—its largest port thermal power plant—the Shidongkou Power Plant—and its supercritical thermal power plant—Huaneng Shidongkou Second Power Plant. The iron and steel industry and the metallurgical industry have become the mainstay industries of Baoshan. Besides, multiple industrial zone and industrial parks have been developed in Baoshan to support its industrial development, for example Baoshan Industrial Park.

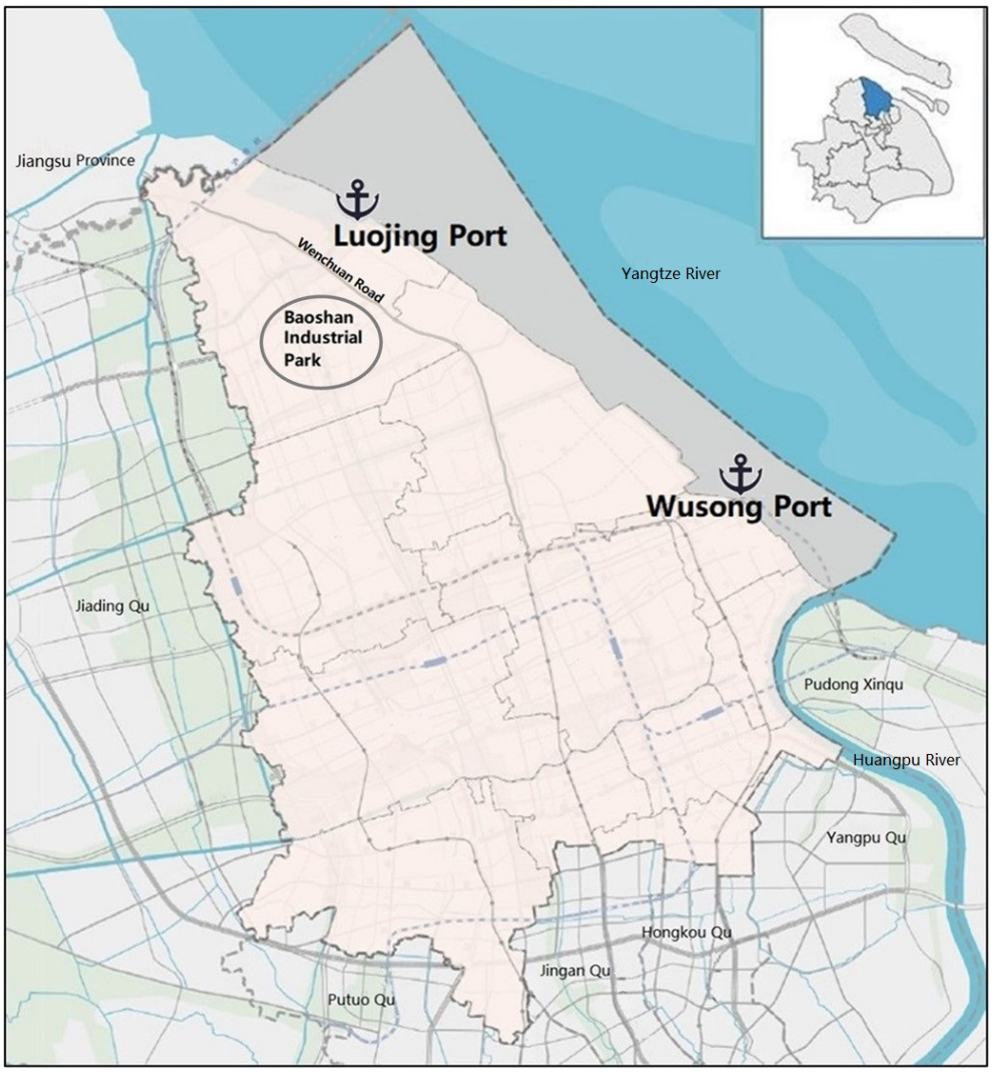

Figure 1. The layout of Baoshan. Source: Authors, modified from Shanghai Baoshan District People's Government and Shanghai Municipal Planning and Natural Resources Bureau (2019).

With the speeding up of Shanghai's urbanisation, Baoshan has entered a period of industrial transformation and upgrading of heavy industries in the early 21st century (Shanghai Baoshan District People's Government & Shanghai Municipal Planning and Natural Resources Bureau, 2019). At the same time, ports require a deep sea area because of the increasing ship size. By the time of the opening of Yangshan Deep-Water Port in 2005, a series of port-related industries like steel processing and transportation activities have gradually moved away from Baoshan to other areas in Shanghai. As a result, Baoshan port-city interface was formed at the intersection and vacant area between Wusong and Luojing Ports and the Baoshan urban area. This interface now faces the challenges of redeveloping the abandoned port area with changing boundaries, which is analysed in the following section.

3.2. The Changing Tangible and Intangible Boundaries

Through coding the interview data and linking thematic codes to quotations from respondents, the composition of the tangible and intangible boundaries at Baoshan port-city interface can be summarised as in Table 2. Spatially, we find respondents frequently related 'S-1 fences and walls' to tangible borders. One element which was not listed in Table 1 is the road. In China, roads are regularly used to distinguish territorial borders in planning documents. For instance, Wenchuan Road in Figure 1 is planned as the easternmost border of Baoshan Industrial Park. Regarding intangible borders, 'distances' and 'water' are added as new findings to Table 1. The reasons 'distances' raise intangible borders can be exemplified as follows:

> What is the relationship between the port, port-related industries and our industrial park? It has nothing to do with us. Baoshan Industrial Park, well, Bao Steel as a port-related company is located to the east of Wenchuan Road. But, Wenchuan Road is the Easternmost border of our industrial park. Our industrial park is located to the west of Wenchuan Road and has never been out of Wenchuan Road….This park is generally more than 8 kilometres away from the nearest port, even if the nearest point of this park is half a kilometre away from Luojing Port. (Baoshan Industrial Park manager)

The above quotation indicates that spatial distances, even if it is only half a kilometre away from the port, allow the industrial park manager to build an invisible boundary between the port and the industrial park collaborations. Since this 'half a kilometre' is somewhere to the east of Wenchuan Road, the interviewee expressed confusion about why he was asked to collaborate with companies or ports beyond the park's scope. His reaction implies that the soft intangible border between the port, port-related industries, and the city tends to become hardened because of the tangible border. This is a first interesting finding on border changes in spatial development. 'Water' is tangible, while here it is linked to intangible borders through relating mostly to water functions. Some respondents like urban planners claim that water should be used for real estate and entertainment development instead of for transporting goods. This cracks the port and the city invisibly.

We find that both intangible and tangible borders have relations with industrial development. Port-related goods, people, and activities can create tangible and intangible borders at the same time, as the names 'IN-X' and 'IN-X(Clone)' show. For example, some respondents connect 'port-related people' to intangible borders since they are looking for high-end talent to work with, while harbour workers are always considered as low-end talent. Yet, some respondents linked 'port-related people' to tangible borders because harbour workers are usually living near the harbour and vice versa. If a space is occupied by many harbour workers and people living around the harbour, they label this space as a port area and try to keep distance. Even if this space is not a physical harbour, they still treat it as a port place, as if there are real, tangible borders like fences. These two examples support our finding that not only spatial elements create tangible borders; industrial aspects do raise tangible borders between the port and the city as well.

Reasons for keeping distance from the port can be explained by how respondents look at the port and port businesses, which are listed under 'IN-4–1.' Non-harbour people refer to respondents who are not working on the port and port-related industries, like a Baoshan Industrial Park manager. According to their perceptions, the port is a dirty, polluted, and congested space with crowded cargo transportations, traditional industries, and less educated people. These kinds of negative views or perceptions on ports and port businesses keep respondents away from a space with strong port atmosphere. That formulates another finding that, from an industrial perspective, negative perceptions on ports and port businesses can harden the invisible, soft port atmosphere and finally create tangible, hard borders between the port and the city.

Additionally, we find that these negative perceptions are not much weakened by positive views on ports and port businesses from 'IN-4–2 harbour people' in Table 2, referring to people who are doing businesses related to ports, like the manager from a shipping building company. Why is this? Answers are linked to the institutional aspects. On the one hand, the port makes weaker voices because of the governance framework and land ownership in Shanghai. On the other hand, current planning guidelines lead the port to a much weaker situation and facilitate more negative perceptions on ports and port businesses.

As shown in Table 2, 'INS-1 governance' at Baoshan port-city interface is mainly operated by Shanghai Municipality, Baoshan District Government, and Port

Authority. The latter refers to a complex of the Ministry of Transport, Shanghai Municipal Transportation Commission—an administrative department under the municipality—and Shanghai International Port (Group) Co. LTD (SIPG)—a state-owned company at the city level. Port land is owned by Shanghai Municipality and SIPG leases it to other companies on behalf of the municipality. Under this governance framework and land ownership, the city governors do not regard the port as a separate entity which needs to be paid extra attention. One respondent from Shanghai Municipality mentioned that "we pursue the integration of industrial developments and urban developments. We do not talk about the integration of the port and the city." And the port itself is accustomed to accept the city's arrangement and planning without dissent. The port governors even seldomly think of competing with the city for something by taking the port as a relatively equal and independent entity with the city. "We do not have the definition of a port-city interface and the collaboration between the

Table 2. The composition of tangible and intangible boundaries at Baoshan port-city interface.

	Tangible	Intangible
Spatial aspects	S-1 Fences and walls: iron and steel fences; blue iron sheet; roads S-2 Customs gate S-3 Port-related space: docks; warehouses; berth; crane; handling machine and so on; there are no pedestrian roads, only traffic lanes.	S-4 Distances: harbour is 0.5–8kms from us S-5 Water: functions of water or how to use water
Industrial aspects	IN-1 (Clone) Port-related goods: cargoes IN-2 (Clone) Port-related people: harbour workers; people live around harbour IN-3 (Clone) Port-related activities: large spaces	IN-1 Port-related goods: cargoes IN-2 Port-related people: logistics workers; low-end talents IN-3 Port-related activities: shipbuilding industry; steel processing; logistics IN-4 Port-related values and ideas: IN-4–1 from non-harbour people—dirty; lots of pollution; cargo transportation; if the harbour stops providing jobs and serving cities then it does not need to exist; low end manufacturing; traditional with low technology; low added value; not matchable with the living environment of inner city; container trucks exacerbate traffic congestion; transforming old port areas into houses with sea views is a good option; it is fine to tear down all old harbour buildings to create new uses; Industries in Baoshan are related to Baosteel's high-quality steel and have nothing to do with ports; accommodating logistics workers in Baoshan means losing high-end talents IN-4–2 from harbour people: awareness of recognising harbour industries are traditional industries; accepting that they may bear certain losses in research and development and innovation; willingness of applying new technologies like the intelligentization of port terminals; fear of being marginalised by new technology or innovation; proactively seek for shipping talents; pollution is not caused by shipping industry but the planning of transportation network, because the urban is also expanding

Table 2. (Cont.) The composition of tangible and intangible boundaries at Baoshan port-city interface.

	Tangible	Intangible
Institutional aspects		INS-1 Governance: mainly governed by Shanghai Municipality; Port Authority; Baoshan District Government; Port land is owned by the municipal government and SIPG leases it to other companies on behalf of the municipal government INS-2 Planning: General guidelines: Baoshan Master Plan 2017–2035; 13th Five-Year Plan (2016–2020) of International Shipping Centre; Shanghai's 13th Five-Year Plan for Comprehensive Transportation; Goals of stakeholders: Goals of Shanghai Municipality: pursue the integration of industrial development and urban evolution Goals of Ministry of Transport: develop Shanghai International Shipping Centre Goals of Shanghai Municipal Transportation Commission: build and improve the collection and distribution system of the Shanghai International Shipping Centre Goals of SIPG: become a global multinational terminal operating company to actively participate in domestic and foreign port investment and construction Goals of Bao Steel: become the world's most competitive steel company and the most valuable listed company; gradually transfer its production capacity from Shanghai to its surrounding cities, in response to Shanghai's environmental protection requirements Goals of port-related companies like ship-building companies: "Meet environmental requirements and actively use new technologies" Goals of Baoshan government: "Baoshan will transform from a steel base to international cruise base and to cherry blossom tourism centre (from 'Ganghua,' 'Langhua' to 'Yinghua' in Chinese)" Goals of urban planners: "The port area is for work and the city is for life, so a space for life should be the main focus of the interface border" Goals of Baoshan Industrial Park management committee: develop a national strategic emerging industry base and an industrial base representing the high-end level of advanced manufacturing

port and the city. Because the port and the city are originally one unit and we always talk about them together," one respondent from Shanghai Municipal Transportation Commission said. In short, the port loses its independence gradually and makes weaker voices than the city.

Regarding 'INS-2 planning,' the statement that "the port and the city are originally one unit and we always talk about them together" has been verified neither in planning process nor in planning documents. In the planning process, no actor calls to connect the port and the city, though port-related organisations such as SIPG, Bao Steel, and port-related companies are involved. SIPG, as one respondent claimed, "as a state-owned company at city level, our focus is on the development of the

enterprise itself, and we will not actively consider the functional positioning and matching of the government and assume extra responsibilities." Bao Steel, a state-owned company at the country level, also focuses mostly on its own development. Port-related companies show the awareness of collaborating with and learning from urban companies, but their positivity is recognised only to a limited extent by the city.

In planning documents, general guidelines lead the port development at times to a worsened or contradictory situation. For Wusong Harbour, 'Shanghai's 13th Five-Year Plan (2016–2020) of International Shipping Centre' states that Wusong harbour would transform into an international cruise harbour by changing and upgrading the old industrial park (Shanghai Municipality, 2016a), while traditional port industries and low-capacity port-related industries such as steel-making and logistics are required to move out of Baoshan in 'Baoshan Master Plan 2017–2035' (Shanghai Baoshan District People's Government & Shanghai Municipal Planning and Natural Resources Bureau, 2019). Moreover, 'Baoshan Master Plan 2017–2035' plans Wusong as a Shanghai-level sub-centre to focus on the real estate industry. These plans enlarge urban stakeholders' negative perceptions of ports and port businesses. As one urban planner responded, "the port area is for work and the city is for life, so a space for life should be the main focus of the interface border." Another respondent from Baoshan Industrial Park emphasised that "port functions for us are no more than cargo transportations and logistics which bring a lot of pollution and transportation congestion. And they are going to be moved out of Baoshan." In the case of Luojing Port, documents propose redevelopment to connect with the local urban evolution, based on 'Shanghai's 13th Five-Year Plan for Comprehensive Transportation' (Shanghai Municipality, 2016b) and 'Baoshan Master Plan 2017–2035' (Shanghai Baoshan District People's Government & Shanghai Municipal Planning and Natural Resources Bureau, 2019), which is a positive signal. However, no more details than this sentence are given. Overall, from an institutional perspective, governance and planning strengthen intangible borders between the port and the city.

The above analysis exemplifies border changes from spatial, industrial, and institutional perspectives, respectively. Through our examples, we notice that three aspects are related to each other in border changes. Taking these three aspects as separate layers, our result confirms the declaration from Zimmerbauer (2011) that borders are deeply multi-layered. In order to visualise complicated border changes in multi-layered contexts, a network between codes and respondents' quotations is mapped out in Figure 2. The circle made up of all codes in Figure 2 shows that in the interviewees' minds, borders between ports and cities are more intangible than tangible. The lines between codes and quotations indicate in which way borders are mentioned by respondents.

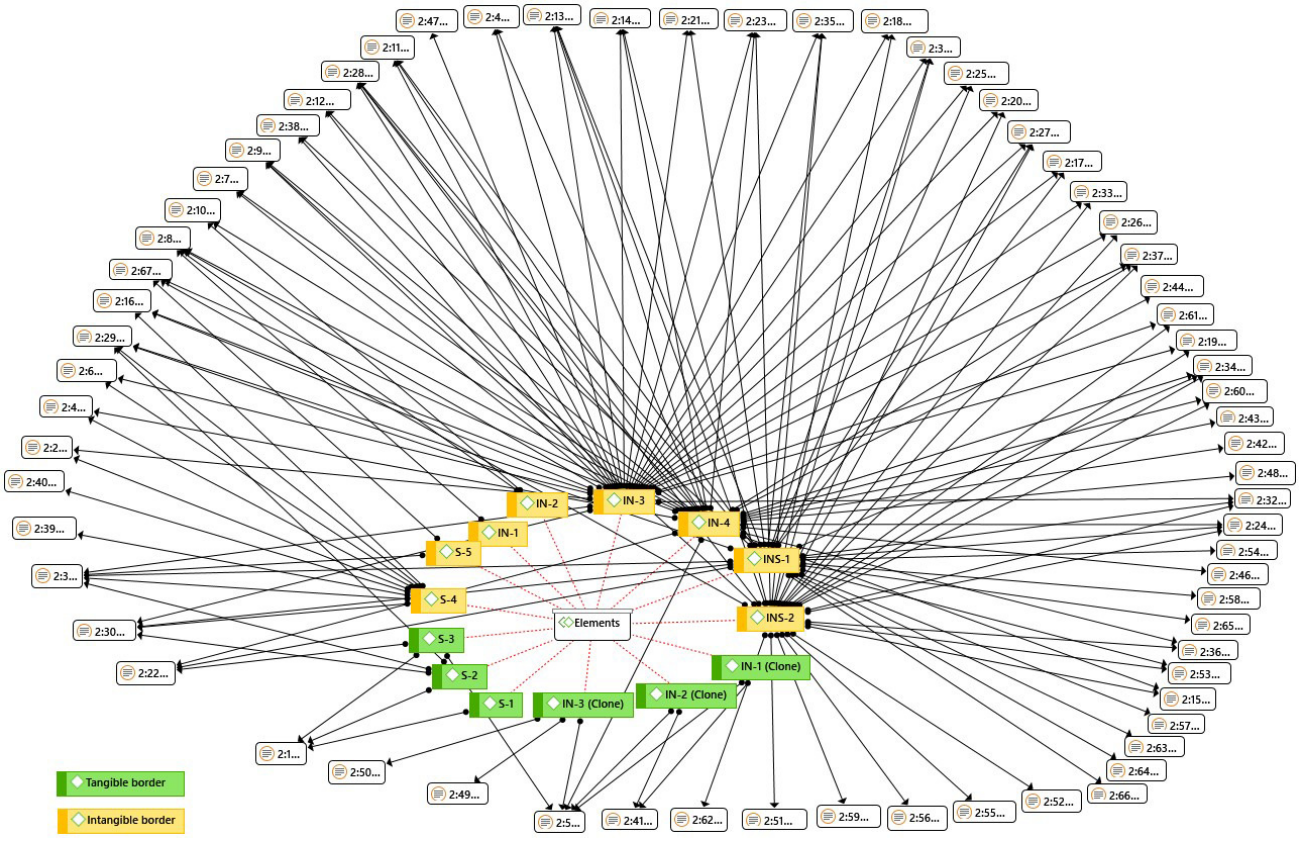

Figure 2. A network between codes and respondents' quotations.

By looking at those lines, especially lines inside the code circle, we find that both tangible and intangible borders are linked by codes 'IN-4 Port-related values and ideas' and 'INS-1 Governance.' This is consistent with our above findings and has been verified by some of our examples. For instance, in the analysis of 'port-related people,' we have explained how 'IN-4–1 negative perceptions' harden the invisible, soft border and finally create tangible, hard borders between the port and the city. In the following section, we further investigate elements 'IN-4 Port-related values and ideas' and 'INS-1 Governance' to identify porosity for planning.

3.3. Boundaries, Perception, and Planning

As proposed in the theoretical discussion, the porosity for planning in border changes occurs around the penumbral, blurred outline between the port and the city. Thus, the identification of penumbral boundaries between the port and the city helps us better understand the role for planning. A relationship network of all codes from three layers and two borders is depicted in Figure 3. Six relations are generated based on the analysis of Table 2. 'Is associated with' and 'is part of' stand for basic relations between two objects; 'is a cause of' presents causal relations; 'positive interactions' presents mutual active influences; 'negative interactions' presents mutual passive influences; and 'contradicts' presents opposing, incompatible, or exclusive relations.

From left to right, Figure 3 displays tangible borders to intangible borders. As it shows, generally, the spatial layer (codes named as S-X) makes borders more tangible, while the institutional layer (codes named as INS-X) makes borders more intangible. The industrial layer—codes named as IN-X and IN-X(Clone)—shifts between tangible and intangible, hard and soft boundaries. Thus, key elements in boundary changes should be in the industrial layer and the penumbral character can be found around those key elements. Considering two elements ('IN-4 Port-related values and ideas' and 'INS-1 Governance') from the last step, we initially identify that the key element is 'IN-4 Port-related values and ideas' and the exact penumbral character can be detailed in specific context. In Figure 3, 'IN-4' is made up of 'IN-4–1 Port-related values and ideas from non-harbour people' and 'IN-4–2 Port-related values and ideas from harbour people.' It seems assertive to make decisions in this way. However, we come to the same conclusion by looking into different relations.

In the relationship network, 'INS-1 Governance' represented as intangible borders does not connect with tangible borders directly. Besides, our identification that a penumbral perception can be found in port-related values and ideas is in line with our conceptual setting that penumbral comes from the field of psychology of perception and refers to a soft or blurred outline of a shadow. After confirming that 'penumbral' is around port-related values and ideas, we explain how a penumbral perspective helps planning to change borders to connect the port and the city. Here is one example from a respondent:

> What is the relationship between the port, port-related industries, and our industrial park? It has nothing to do with us….This park is generally more than 8 kilometres away from the nearest port, even if the nearest point of this park is half a kilometre away from Luojing Port….However [sic], if the water area inside the harbour can be allocated to our industrial park I think it would be really nice and then we can really enact industrial park evolution with the port development. I think we can really do it. Although ports are not directly related to us, we have manufacturing industries and we can connect this to cruise ship industry. (Baoshan Industrial Park manager)

Generally, this quotation shows how the port and the city can finally be connected with each other through changing borders. Border changes begin with: "However [sic], if the water area inside the harbour can be allocated to our industrial park." By saying this, the park management is authorised to partly govern the water area and water can be used for more than transporting goods. The respondent then continued that: "I think it would be really nice and then we can really enact industrial park evolution with the port development." Here, possibilities between the port and the park evolution are expected. Later, the respondent confirmed his proposal and added that "although ports are not directly related to us, we have manufacturing industries and we can connect this to cruise ship industry." By proposing this, collaborations between the port and the park are planned concretely and practically.

If we translate this process into our relationship network, it happens as follows: First, 'S-4 Distances' cause intangible borders between the port and the city (for more details see Section 3.2) which is reflected as 'contradicts' between 'S-4 Distances' and 'INS-2 Planning.' Second, 'the INS-1 Governance' of 'S-5 Water' causes changes of industrial park belonging to 'IN-4–1 Port-related values and ideas from non-harbour people.' Third, an industrial park manager changes his negative views or perceptions on ports and port businesses and begins to expect possible cooperation between the port and the park evolution. Negative views here are mainly caused by 'S-4 Distances.' Namely, in this step, the line labelled as 'negative interactions' from 'IN-4–1' to 'INS-2' is changed as positive ones. Fourth, 'INS-2' causes specific developments of 'IN-3 Port-related activities.' As a result, collaborations the port and the city are developed.

Going back to the question before, the above example exemplifies how a penumbral perspective helps planning to change borders to connect the port and the city. In the above process, the port and the city are finally connected by 'INS-2' going to 'IN-3.' However, 'INS-2' is influenced by 'IN-4–1.' Moreover, intangible borders caused

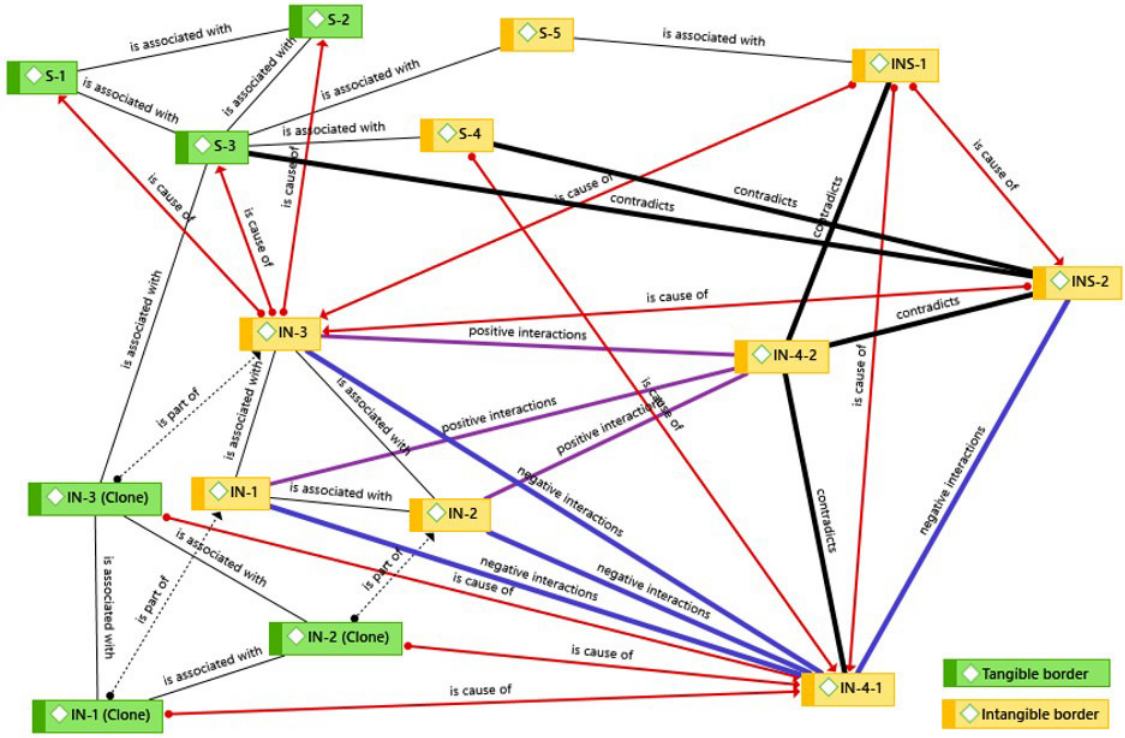

Figure 3. The relationship network between codes.

by 'S-4' are also changed by 'IN-4–1.' In other words: 'IN-4–1 Port-related values and ideas from non-harbour people' is particularly the perception that the port is not that far away from the industrial park. When this is recognised by the industrial park manager, he begins to expect possible collaboration opportunities between the port and the city. A later step emerges as a specific plan, connecting manufacturing industries with the cruise ship industry. This example demonstrates that a penumbral perspective is a precondition of specific development plan which changes borders and connects the port and the city concretely.

The above is just one example. If we look at Figure 3, there are multiple ways to change borders by planning with penumbral around 'IN-4 Port-related values and ideas.' They could include promoting positive relations to reduce or counteract passive relations, or improving or clearing up passive relations such as 'negative interactions' and 'contradicts' directly. For example, removing 'contradicts' between 'IN-4–2 Port-related values and ideas from harbour people' and 'INS-2 Planning.' According to the previous analysis in Section 3.2, more positive voices from harbour people can be included in the planning. This will lead positive changes to 'IN-3 Port-related activities.' Looking at lines around 'IN-3,' tangible and intangible borders are further re-connected and blurred. In the long term, the improved changes of tangible borders will cause positive changes to 'IN-4–1 Port-related values and ideas from non-harbour people,' where 'negative interactions' between it and 'IN-1,2,3' and 'INS-2' will be further improved. In the end, tangible and intangible borders across different layers will be weakened, and collaborations between the port and the city will enter a virtuous circle.

Thus, in changing borders to connect the port and the city, planning needs to first develop a penumbral perspective around 'IN-4 Port-related values and ideas,' and then apply this to specific development plans.

4. Conclusions

This article investigates changing tangible and intangible boundaries and the role of planning in border changes through a comprehensive analysis of spatial, industrial, and institutional elements, based on a case study of Baoshan port-city interface. Compared to previous port-city studies on tangible and intangible boundaries, we find that, besides spatial elements, tangible boundaries are also related to industrial aspects such as port-related goods, people, and activities. Regarding the formation of intangible borders, we add the elements of 'distances' and 'water.' Water always increases competition and conflict between the port and the city in the port-city interface literature since Hayuth (1982), though this element seems to be ignored in border studies. Our finding brings water back into the discussion and confirms that water does create intangible borders between the port and the city.

Taking spatial, institutional, and industrial aspects as three layers, our result confirms the declaration from Zimmerbauer (2011) that borders are deeply multilayered. As Paasi and Zimmerbauer (2016, p. 13) further argue that "while some layer might be highly permeable, other layer(s) can simultaneously make borders high

and hard," we specify that the spatial layer makes borders more tangible because spatial elements like roads harden the border. While the institutional layer makes borders more intangible, because on the one hand, the current governance framework and land ownership in Shanghai cause the port to make weaker voices than the city, on the other hand current planning guidelines lead the port to a worsened situation and facilitate more negative perceptions on ports and port businesses. The industrial layer shifts between tangible and intangible, hard and soft borders. That is because industrial aspects such as port-related goods, people, and activities raise intangible borders between the port and the city; meanwhile, industrial aspects like negative perceptions on ports and port businesses create tangible borders by hardening the invisible, soft port atmosphere.

Our case exemplifies our conceptual summary that the porosity for planning in border changes occurs around the penumbral, blurred outline between the port and the city. First, based on a network between codes and respondents' quotations and a relationship network between codes, we verify that a penumbral perspective is constituted around port-related values and ideas. Second, using the example of Baoshan industrial Park, we further demonstrate how a penumbral perspective can help planning change borders to connect the port and the city. The Penumbral perception here is particularly presented in the statement that the port is "not being that far away" from the industrial park. Defining such blurred sphere, the industrial park manager begins to expect possible collaboration opportunities between the port and the city. Finally, a specific plan connecting manufacturing industries with the cruise ship industry is approached.

Thus, we claim that, in changing borders to connect the port and the city, planning needs first to pay attention to port-related values and ideas before creating specific development plans because boundaries are firstly changed by perceptions of actors. As analysed in the example of Baoshan Industrial Park, before taking what we would call a penumbral perspective, the manager concludes a totally different approach of the port and the city which emphasises that there is no relationship or possibility to facilitate collaborations between the and the city. However, accepting a penumbral perspective, the 'impossible' becomes 'possible' and even reasonable. Then, specific plans occur to make change or collaborations more concrete. In short, we point out that in the process of changing boundaries, planning needs to investigate such penumbral perspectives, especially how actors look at the port and port businesses carefully, and then planning can formulate specific plans as it usually does.

Furthermore, this article opens opportunities to investigate tangible and intangible border changes from a multi-layered perspective. Table 2 provides a conceptual framework of the comprehensive perspective and Figure 3 visualises the complicated relations embedded in three layers across two borders at the port-city interface. Specifically, Figure 3 can be used to guide plan-making empirically. In particular 'IN-4 Port-related values and ideas' seem to be a good starting point. They could promote positive relations to reduce or counteract passive relations, or improve or clear up passive relations such as 'negative interactions' and 'contradicts' directly. As the example of removing 'contradicts' between 'IN-4–2 Port-related values and ideas from harbour people' and 'INS-2 Planning' in Section 3.3 illustrates, in the end, tangible and intangible borders across different layers will be weakened, and collaborations between the port and the city will enter a virtuous circle, making the port-city interface a highly dynamic and constructive border space.

Though this article shows some promising outcomes, we recognise its limitations as a single case study in China. Our findings can be considered as preliminary and explorative, and need further testing in different contexts. Thus, we encourage researchers to investigate planning and multi-layered border changes with different port city practices based on our conceptual framework and findings in order to get a better understanding of the port-city interface as a penumbral zone that helps both the city *and* the harbour to 'see' and respond to internal and external challenges, and to plan and develop the port-city interface in a consistent and responsive manner.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Port-City Transition: Past and Emerging Socio-Spatial Imaginaries and Uses in Rotterdam's Makers District

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Abstract
This article explores old and emerging socio-spatial imaginaries and uses of Rotterdam's Makers District. The district comprises two urban harbors—Merwe Vierhavens and Rotterdamsche Droogdok Maatschappij—historically in use as bustling trade, storage, and ship yarding nodes of the city's port activities. At the turn of the millennium, technological advancements made it possible to move many port-related activities out of the area and farther out of the city, gradually hollowing out these harbors' port-related economic foundations and opening opportunities for new uses and imaginaries. This article traces the transition by detailing how the boundary between the city and the port has become more porous in this district. It does so by offering original empirical evidence on the flows of users in and out of the area in recent years, based on location quotients, while also applying a content analysis of the profiles of companies and institutions currently inhabiting and working in these transformed port-city spaces. On the one hand, the results show how the ongoing port-city transition in Rotterdam's Makers District combines carefully curated interventions and infrastructure plans seeking to progressively adapt the area to new purposes, while maintaining some of its former functions. On the other hand, they highlight the pioneering role of more bottom-up initiatives and innovative urban concepts, springing from the creative industries and maker movement. The article offers insights into the emerging uses and imaginaries attached to the district, while also showing the resilience and adaptation of port legacies.

Keywords
imaginaries; innovation ecosystem; maker movement; port-city interface; Rotterdam; transition; waterfront

Issue
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1. Introduction

Port-cities hold a special place in urban planning, due not just to their topological positioning at the boundary of sea and land, but also to the socio-technical transition challenges they have been—and continue to be—presented with. The port-city interface, that is the spatial, social, and economic overlap of port and urban functions (Hesse, 2018), has changed drastically in the last century. The changing port-city interface offers a vantage point from which to observe post-industrial dynamics and processes of reindustrialization, and to assess the extent to which they provide more locally embedded and socially inclusive forms of economic development (Grodach & Gibson, 2019). In this optic, waterfront regeneration projects, accelerated in recent decades by the desire to attract creatives and knowledge workers and accrue socio-economic gains, have given new purposes to areas where functional port activities were in retreat—yet they have often been coupled with controversial outcomes

and concerns over commercialization, marginalization of communities, and standardization of uses (Jones, 2017; Smith & Garcia Ferrari, 2012). More recently, imperatives relating to decarbonization, digitalization, and the circular economy have set new challenges and opportunities for port-cities, changing spatial demands and adaptation needs for businesses and city planners (Gladek et al., 2018; Van den Berghe & Vos, 2019).

In the port-city of Rotterdam, the neighbourhoods designated under the umbrella term 'Rotterdam Makers District' offer a prime location from which to explore how the port-city interface is evolving, and how the city is regenerating its waterfront while also approaching a return of manufacturing to the city. In fact, the creation of this district in 2018 is closely interlinked with the recent history of the changing relationship between port and city. Historically in use as bustling trade, storage, and ship yarding nodes of the city's port activities, the Makers District is part of the second wave of urban redevelopment of the city of Rotterdam which kicked off in the early 2000s (Aarts et al., 2012). Figure 1 shows a map of the area and its location in the port-city of Rotterdam. At the turn of the millennium, technological advancements made it possible to move many port-related activities out of the area and farther out of the city, gradually hollowing out these harbors' port-related economic foundations and opening opportunities for new uses of the area.

As with many areas that experienced a retreat of port activities, "becoming ghost districts, challenges to urban development" (Hein, 2016, p. 429), similarly this district did not just lose its livelihood, but in part its sense of seaport identity (Kermani et al., 2020). Today, the Makers District redevelopment is coupled with 'imaginaries' (Jessop, 2012) defined as frames that capture actual and aspirational accounts of the area's transformation. In the case of the Makers District, such imaginaries capture an area striving to become the heart of innovative manufacturing industry in the city (Port of Rotterdam, 2018). Moreover, both areas fit into the CityPorts' vision of incorporating a role for the creative class "as pioneers who acknowledge the quality of a newly developed area or characteristic heritage site" (Ontwikkelingsmaatschappij Stadshavens NV, 2005, p. 82; see also Stadshavens Rotterdam, 2009). Yet the two neighbourhoods within the Makers District display variations in their imaginaries. While Merwe Vierhavens (M4H) is home to "pioneering and artisanal manufacturing firms…creative entrepreneurs and companies in the eco-manufacturing industry", Rotterdamsche Droogdok Maatschappij (RDM) is the "hotspot for innovation in the port" (Rotterdam Makers District, 2021a, 2021b). As the area vision and its implementation unfold in the area, the maritime identity and water-related heritage values have been highlighted as important connectors in urban renewal and redevelopment (Kermani et al., 2020).

In this article, we explore how old and new functions and jobs have evolved in the area now designated as Rotterdam Makers District, in order to gain insights into port-city transitions and the 'purposive adaptation' (Tomlinson & Branston, 2014) of the former maritime cluster, whereby we show how the area has adapted to exogenous change (in particular, the decline of traditional port activities) and diversified its profile, including sectors with higher urban value. In so doing, we assess how the evolution of jobs aligns with fulfilling the policy imaginaries for the area. Few studies have integrated the study of port transitions at the level of spatial claims on space, but also imaginaries of the future (see Grodach & Gibson, 2019). The Makers District offers a unique setting for a fine-grained analysis of transitions on the ground, from the perspective of uses, flows, and imaginaries. This leads us to the following research questions: To what extent have the boundaries between the city and the port become more porous in the area designated as Rotterdam's Makers District in terms of its spatial function and the flow of port and creative industry users? And how do old and new users relate to imaginaries of the district?

In what follows, we first map the field of extant research on port-city transitions. We then set out the empirical approach that has guided us in this investigation. Finally, we report on the results of our analysis. The article offers a longitudinal and contemporary

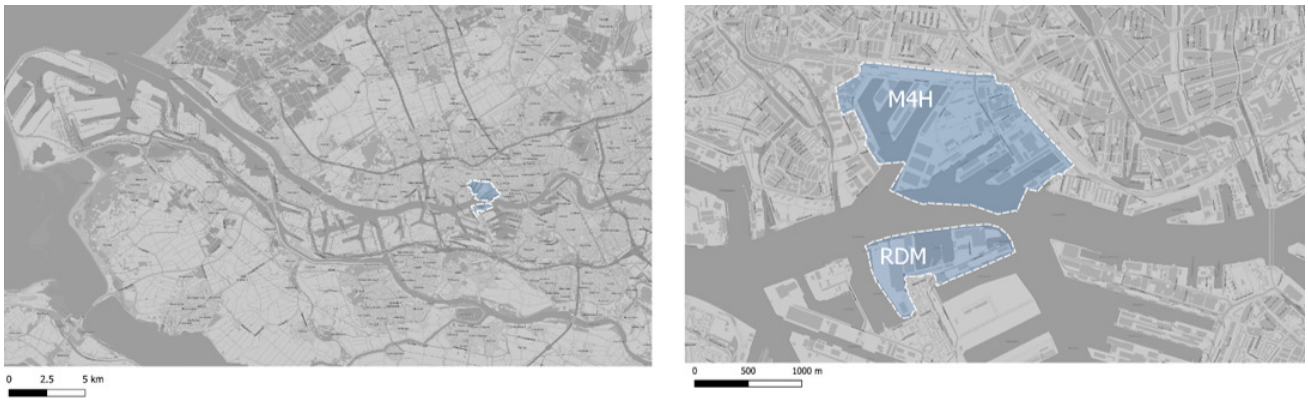

Figure 1. Rotterdam Makers District, located to the West of the city centre. The port industrial activities have expanded westwards. Source: Figure by Erasmus UPT (2020), based on Publieke Dienstverlening op de Kaart (2021).

snapshot of current business occupants of the district. The results support the relevance of the conceptual lens of porosity in urban planning (Wolfrum, 2018), insofar as they show that the area's transition can be typified by the withdrawal of certain (port) activities, the persistence and innovation of others, and the arrival of new activities and users. The article contributes to existing literature that calls for a paradigm shift in waterfront regeneration, aligning it to a more progressive and long-term planning agenda calling for more socially responsible change (Jones, 2017; Stouten, 2017). Moreover, the article offers novel data to substantiate the interconnections of policy vision, legacy of the area's former uses, and new embodiments.

2. Literature Review

The relation between port and city has been the subject of numerous strands of research over the last forty years. In particular, the evolution of ports has drawn attention to their implications on urban development, decline, and reinvention—and to the underlying competition or cooperation between port and city (see Witte et al., 2018). We can distinguish three main contributions.

Firstly, the relation between port and city has been the subject of research into integration of functions and the potential conflicts which may arise from oppositional claims for space (Daamen & Vries, 2013; De Langen, 2006; Dooms et al., 2013; Parola & Maugeri, 2013). Such studies have drawn attention to the underlying tensions between the port as an economic engine, and the impact of its externalities on the larger region, not least environmental impacts on noise and pollution levels, and societal impacts on neighbouring communities (see Hein, 2016). Moreover, it raises the attention to the growing complexity and diversity of the stakeholder interests at play in port-city interfaces. Research has looked at how industrial and residential land-uses can be combined, highlighting the complexities of pursuing an innovation agenda and attracting high-skilled knowledge workers, while also giving space to a diverse economic base including urban manufacturing (Grodach & Gibson, 2019; see also Hill et al., 2018; Hill et al., 2020). Such tensions play out against the background of a renewed optimism in relation to entrepreneurial activities engaging in small-scale urban manufacturing that combines design and production—often referred to as the 'maker movement' (Hatch, 2013; Wolf-Powers et al., 2017). The movement is spurred on by changes in consumption patterns and a growing demand for customized items that are small-batch, locally sourced and produced (Hirshberg et al., 2017). Making constitutes a strong component of the imaginary of the Makers District, this research will thus show how and in what ways it has become an integral part of the area's development.

A second strand of research emerged from the notion of port-cities as ecosystems (Hayuth, 1982; Jansen, 2020; Witte et al., 2018). In this ecosystem approach, stakeholders and institutions in the port city strive to reconcile economic and societal values, in a sustainable way. In this perspective, clusters of economic activities are often based on collaborative action and shared value creation (Jansen, 2020). Recent policy strategies in Rotterdam have sought to enable the emergence of an innovative ecosystem in former port areas, for example through acceleration programmes for port-related start-ups and in refurbishing industrial heritage buildings into combined infrastructure of incubators, test facilities, and shared working space (Witte et al., 2018). Improvements to the quality of life in the city "became necessary to seek high-level headquarters and a high-quality labour pool" (OECD, 2013, p. 86). Our analysis therefore seeks to explore how the notion of innovative ecosystem applies to the area, exploring the collaborative spaces that are present in the area and the types of emerging activities they host.

Thirdly, and connected to the quality-of-life dimension just mentioned, the port-city interface has been the focus of research on waterfront redevelopment and revitalization (Bird, 1963; Daamen & De Vries, 2013; Hoyle, 1989, 2000; Wiegmans & Louw, 2011). Taking a historical perspective offers insights into the spatial evolution of the relation of port and city: Subsequent phases of expansion and shrinkage, leaving behind port wastelands, are closely connected to logistic and technical developments in port processes and activities (Hoyle, 1989; Kokot, 2015). Maritime identities faded as port and city moved away from one another, and as urban functions started to move into disused port areas on the waterfront near the city (Gordon, 1996; Hein, 2016). Particularly since the 1980s, the revitalization of waterfront areas, marginalized by the moving out of port activities, has often set in motion processes of gentrification, characterized by the upward mobility of land use values and the subsequent social displacement and exclusion of former residents (Lees, 2000). In the resulting port-city relations, while the pace of port expansion is seen as slowing down, urban uses and functions have moved in (Wiegmans & Louw, 2011). In Rotterdam, a number of former port and industrial areas have become refashioned as higher-end areas of consumption (Doucet et al., 2011). Moreover, scholarship has shown how waterfront districts and harbour areas are particularly appealing to creative and knowledge workers, for whom the distinctive 'look and feel' of the neighbourhood in which they chose to locate can pay dividends in terms of their own positioning in a competitive market (Smit, 2011). We thus seek to explore the new users of the area, exploring the profiles of creative and knowledge workers who have moved in, and emerging spaces of consumption.

Rotterdam's Makers District lends itself to an exploration of the port-city interface from these three perspectives. In doing so, we explore the reintegration of the area in the productive heart of the city. The research presented in this article is explorative in its ambition, using a combination of longitudinal quantitative and qualitative

data on companies in the area. The aim is to explore the recent evolution of jobs in the area now designated as the Makers District and to compare current and past uses of the area, and to subsequently zoom into exemplar buildings and facilities. In so doing, we seek to trace the transition in uses, while assessing how observed trends fit within the changing port-city interface, and align with policy aspirations and visions.

3. Methodology

In this article, we seek to explore the flow of port and creative industry users in/out of the area, and to see how old and new users relate to the policy vision and imaginaries for the district. To address these questions, the researchers collected data of companies which have established in the area designated as Rotterdam Makers District, drawn from the Dutch LISA (2017) employment dataset. The information retrieved included the number of companies per sector, company address, and employees per year for a time series of 2000–2017. The timeframe captures the area's transition from the early policy vision (Ontwikkelingsmaatschappij Stadshavens NV, 2005) to the spatial planning vision (Municipality of Rotterdam and Port of Rotterdam Authority, 2011) and the creation of denomination of the Makers District in 2018. Data was restricted to postal codes, that capture the geographical boundaries of the Makers District: selected postcodes within NL-3029 for M4H and NL-3089 for RDM. To further demarcate the area, the researchers further selected only those companies that are located within the physical space of the Rotterdam Makers District, in line with urban planning policy documents by the municipality and port authority of Rotterdam. Based on the companies' standard business information (SBI) code from the Central Bureau of Statistics, we then classified them according to five categories. These categories allowed us to explore the transitions in the traditional port sector, while also exploring the extent to which the area's policy vision and imaginaries connected to creative sectors and manufacturing were fulfilled. The five categories are:

(1) Port-related: companies with the SBI codes covered by the Dutch Port Monitor (Erasmus UPT, 2020), the annual monitoring report published by Erasmus Centre for Urban, Ports and Transport Economics, commissioned by the Dutch Ministry of Infrastructure and Waterworks, which provides insights into the employment, business activity and added value of the Dutch seaports;

(2) Creative industries and (3) information and communication technology (ICT): for these two categories, we based our classification on the SBI codes used in the Monitor Creative Industry (Media Perspectives, 2019). For the ICT category, one SBI code (2790) is also included in the Port-related category, following the Dutch Port Monitor classification. Therefore, companies with this specific SBI code are considered Port and ICT related.

(4) Manufacturing (other): for this category, we used the 'Industry' SBI classification (Central Bureau of Statistics, 2008), excluding any sectors that were included in the port or creative industries categories above. This provides a list of SBIs that we considered as Manufacturing (other).

(5) Other: the remaining companies were combined in the category 'other,' which includes the other sectors, such as wholesale (other), retail, car repair and maintenance, and education.

Location quotients were calculated for the five categories and two areas encompassed within the Rotterdam Makers District (RDM and M4H), exploring their evolution over the time period 2000–2017. The two areas were considered separately, allowing for a more nuanced analysis of the sectoral similarities and differences over time, comparing them to the wider Rijnmond region. The location quotient measures the concentration of a particular business sector, clusters, or category of economic activities, relative to the concentration of the same industry at a regional or national level. For example, we can use these measurements to see how the port clusters evolved in comparison with the rest of the Rijnmond region. By exploring relative measures of concentration of particular sectors over time, we can assess to what extent new economic sectors have blended in with typical port functions that have traditionally occupied the waterfront areas.

Complementary to the longitudinal data, the researchers collected qualitative data on a sample of 216 companies currently located in the district. The data was collected via the websites of RDM, M4H Makers District, makerspaces within the area (e.g., Keilewerf), as well as company websites and profiles on LinkedIn. Data collection was also complemented by several visits to the area, to identify any companies not included in the abovementioned sources. We compiled the information in a single database, structured according to the following information: name, address, date of establishment, company size, facility used, sector of activity, tag line, and 'about' and/or mission statement of a company. We then created word clouds using the taglines used by companies in our database, to explore prominent themes and activities per area, allowing us to compare the predominant features of the M4H and RDM. We then zoomed into some of the areas' iconic locations, exploring their contemporary uses. In addition to the quantitative data, this more qualitative approach allowed us to explore the extent to which the companies located in these areas and particular buildings fit within the imaginaries and policy visions for the Makers District.

4. Findings

4.1. A Makers District in the Making

The Makers District falls within the remit of the Rotterdam CityPorts Development Company (Ontwikkelingsmaatschappij Stadshavens NV, 2005), set up in 2004 by the Rotterdam municipality and the port authority with the goal of regenerating the area through a mixed-use strategy (Ministry of Infrastructure and Water Management, 2010). The CityPorts spreads over 1,500 hectares (1,000 land, 500 water area), situated on both sides of the Maas river, between the main port in the west, the Delft delta technology in the north, and the Rotterdam city centre nearby in the east. It consists of four distinct port areas: Waalhaven and Eemhaven on the south bank, Merwehaven and Vierhavens on the north bank. The Rotterdam CityPorts Development Company was tasked with organising and realising the transformation of the city port into a sustainable combination of port and urban functions, reaping the economies of scale of accelerated shipping, while also addressing growing demands for space for urban economic activities and housing. The strategy was based on a strong relationship between both city and port developers, reflected in the CityPorts cooperative governance model, which operates as a limited company with 50% shares for the Port of Rotterdam Authority and Municipality Rotterdam.

Within the CityPorts' transformation started at the turn of the millennium, the Makers District materializes the city's ambitions to meet the challenges of the new economy, developing a testing ground for future-proof innovative technical entrepreneurship and innovative manufacturing (see Table 1 for a timeline of the area). A former shipyard, the redevelopment of RDM was intended to focus on new, small enterprises in the sectors of education, culture, and leisure, maintaining of its neighbouring areas—the Heijsehaven—as an "Urban Shipyard" (Ontwikkelingsmaatschappij Stadshavens NV,

Table 1. Timeline of key events in the area currently designated as Rotterdam Makers District.

Time	Scope	Milestone
1902–1996	RDM	At shipyard RDM, 355 seagoing ships were built, of which 18 submarines
2002	RDM	City Council decides to acquire RDM-site and hand-over exploitation to Municipal Port Authority Rotterdam
2002	RDM	Albeda College takes over company school from RDM
2004	RDM	Corporatisation of Port of Rotterdam Authority, RDM-site tran[3pt]sferred to Port of Rotterdam Authority
2004	RDM/M4H	Rotterdam CityPorts Development Company formally founded with aim to transform CItyPorts area
2007	RDM	Renovation of RDM engine room factory, by founding partners Port of Rotterdam Albeda College, Rotterdam University of Applied Sciences
2008	M4H	Opening of renovated Vertrekhal Oranjelijn as collective building for creatives
2009	RDM	Innovation Dock in use for education by Albeda College and Rotterdam University of Applied Sciences
2009	RDM	Official opening Innovation Dock and Dry dock and former RDM headquarters
2012	M4H	Erasmus Centre for Entrepreneurship established in Rotterdam Science Tower at M4H
2013	RDM	RDM Centre of Expertise learning community launched
2014	M4H	Opening Central Storehouse, as Innovation Centre for Sustainable Construction
2014	RDM/M4H	Publication of the Maakstad Rotterdam by the municipality of Rotterdam
2014	M4H	Start of Keilewerf initiative
2015	RDM	Opening Submarine dock
2015	RDM	Brand name RDM Rotterdam, which comprise RDM Business, RDM Campus and RDM Events
2017	M4H	Opening Keilewerf II
2018	RDM	Partnership agreement signed between Port of Rotterdam, Rotterdam University of Applied Sciences and Technical College Rotterdam
2018	RDM/M4H	RDM Rotterdam and M4H form Rotterdam Makers District
2019	M4H	Municipality and Port Authority set out the spatial framework for M4H
2020	RDM/M4H	Community Platform Rotterdam Makers District launched

Source: Rotterdam Makers District (2021a, 2021b).

2005). Industrial heritage and characteristic port constructions would be made available for temporary or permanent spaces for start-ups, creatives, restaurants. On the other side of the river, the M4H port basins were developed in the 1930s for breakbulk cargo (mainly fruit and vegetables) which were handled with conventional cranes and manpower. Up until the 1990s the area was a bustling port area, but gradually these perishable goods began to be shipped in temperature-controlled 'reefer' containers, leading to a shift of port activities to container terminals elsewhere in the port.

Following this historical overview, we now turn to the findings derived from the analysis of location quotients of sectoral employment in the two areas of the Makers District, drawn from the LISA (2017) dataset (for the period 2000–2017, exploring the historic evolution of the area's profile). The findings are presented in Figures 2 and 3. The figures offer an overview of the location quotients for five sectors: Port, Creative, ICT, Manufacturing (other), and Other.

The location quotient by number of jobs for the M4H area point towards a number of trends (see also accompanying map in Figure 4). First, we see a relative decline in port-related jobs compared to the wider region (from over 2,5 times the regional average to just under 2). The number of port companies has also decreased. The type of port jobs also changed: We see a decline in engineering and technical port-related jobs, cargo and fruit and vegetable handling and support activities for water transport, while handling in drinks, and manufacturing of chocolate and sugar confectionary remain stable or grow. In 2004, while M4H was still a logistics hub for handling of fruit and juices, the Port of Rotterdam presented plans to gradually move this cluster of companies to the south side of the river, at Waalhaven-Eemhaven. Indeed, facilities in the area were no longer deemed suited to particular trade functions, resulting in rising building disuse, area decline and impoverishment, and ensuing problems of social marginalisation. The area's decline was exacerbated by road and railway

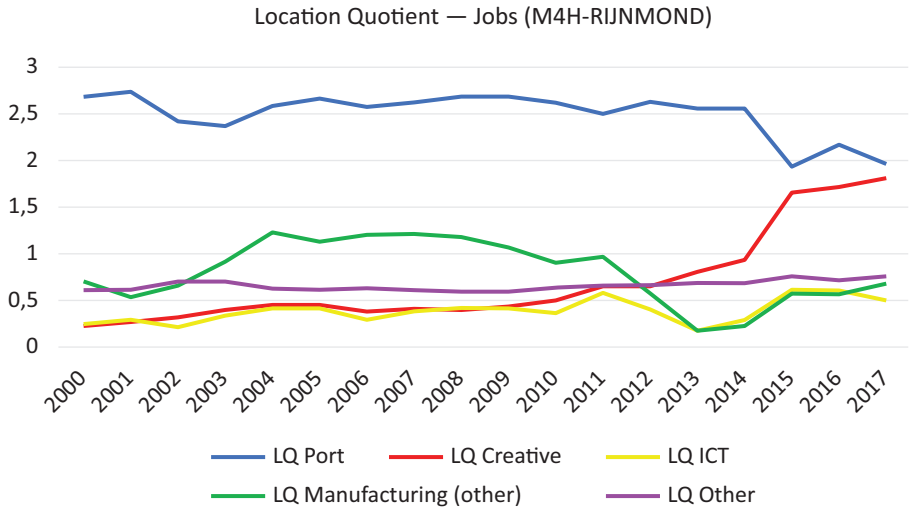

Figure 2. Location quotient results for M4H by sector classification. Source: LISA (2017; data from 2000–2017).

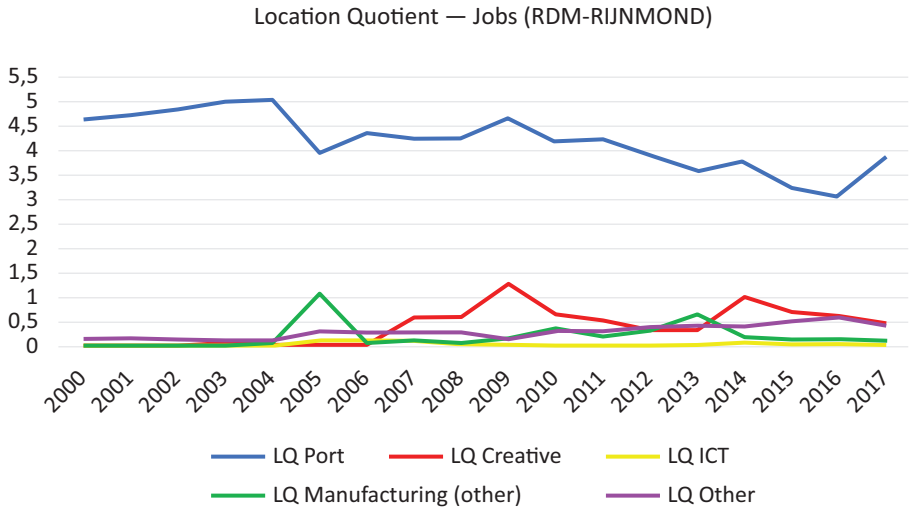

Figure 3. Location quotient results for RDM by sector classification. Source: LISA (2017; data from 2000–2017).

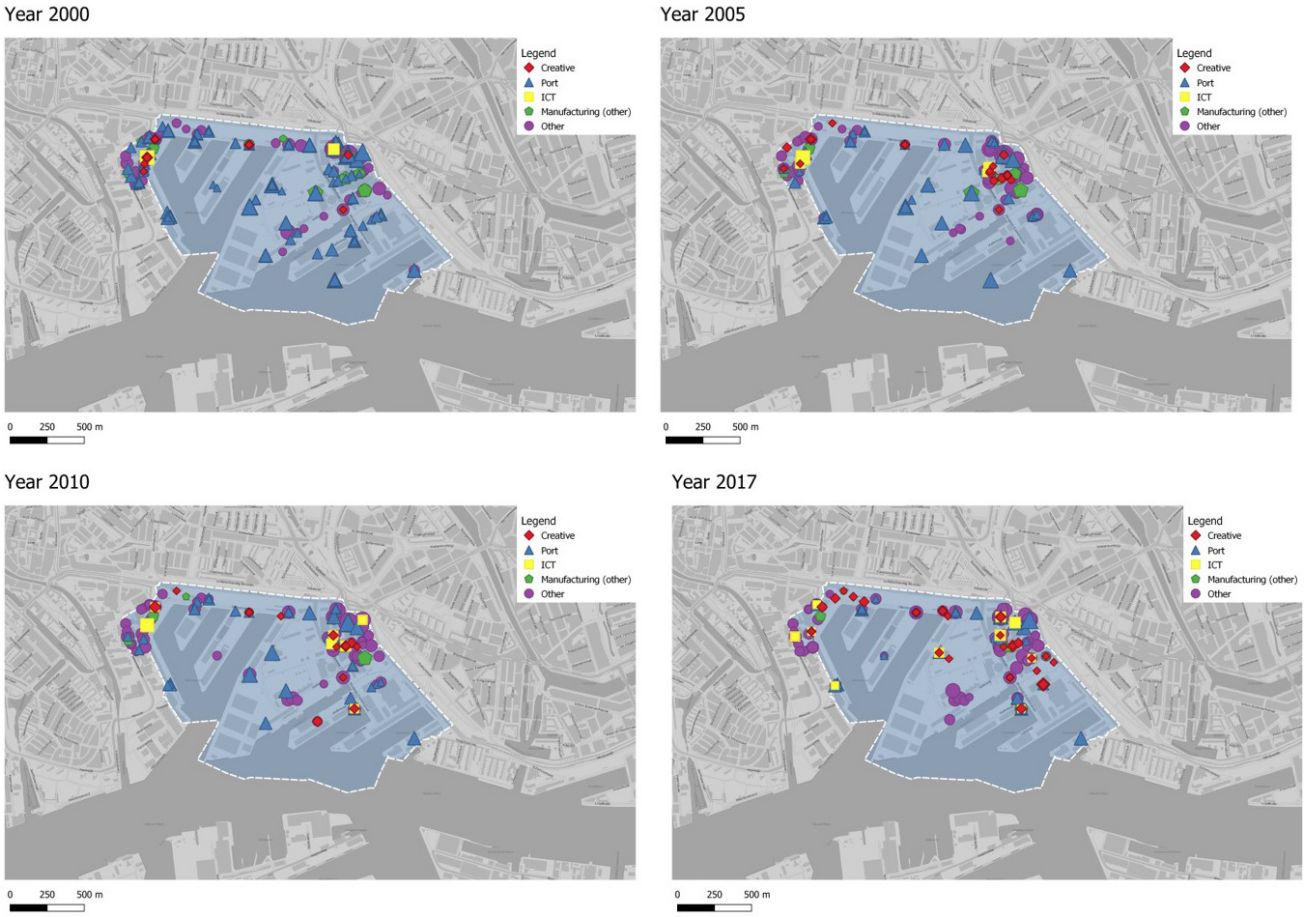

Figure 4. Companies in M4H by sector, 2000–2017. The symbol size represents the number of jobs. Source: Figure by Erasmus UPT (2020), based on LISA (2017) and Publieke Dienstverlening op de Kaart (2021).

infrastructure barriers causing heavy traffic which separated it from the rest of the city—however, it was transformed in 2014 into a shopping mall with a rooftop park and citizen driven communal garden.

In the manufacturing category, which comprises manufacturing jobs that are not port or creative industry related, we see an alternation of growth, decline, and revival—yet generally the concentration of jobs in these manufacturing sectors, as well as in the 'Other' category, do not diverge greatly from the regional profile. The number of 'manufacturing other' companies shows a small increase—notably in the manufacturing of furniture, interior construction, and manufacture of business furniture, but also food processing (bread and fresh pastry) and medical instruments. In the 'Other' category, we see a decline in municipality services (housing, civil works) and non-life insurance, and an increase in jobs in secondary vocational education and adult education, medical services, and justice and judicial activities. In 2015, the Erasmus Centre of Entrepreneurship moved into the Science Tower in M4H, establishing itself as an open and collaborative education and innovation setting. Moreover, the area is characterized by a relatively stable number of jobs in retail selling do-it-yourself articles and equipment—which connects to the area's maker profile.

The trend is different for the creative industries though, where we see a location quotient increasing from 0,23 to 1,79 which shows an increasing concentration of creative jobs relative to the profile of the Rijnmond region. Creative industries were identified as important pillars of urban economic growth in the early stages of the redevelopment (see Rotterdam Development Strategy, 2005); while the M4H area plan for 2009 identified how "creative pioneers, entrepreneurs and developers" had set their sites on the area, symbolizing the initial stages of an accelerating area metamorphosis (Stadshavens Rotterdam, 2009, p. 17). Compared to the region, the area has become attractive in attracting companies and related jobs since 2014 shared facilities for creatives, such as the Keilewerf, were launched. In 2017, M4H attracted almost twice as many creative jobs compared to the rest of Rijnmond-region. Notably, we see an increase in jobs in architecture, writing, graphic design, industrial and product design, and marketing and advertisement. Jobs in new creative sectors also appear, for instance motion picture and TV programme production and support activities for the performing arts. The ICT category is less concentrated in M4H compared to the Rijnmond region (0,5 times), with some upward trends in writing,

producing and publishing of software, webportals, and computer consultancy and support, while printing activities are in decline. The number of jobs remained relatively stable in the period 2000–2017, while the number of companies increased. Looking ahead, between 3,500 and 5,000 new homes are planned in the area by 2035 (Programmabureau Rotterdam Makers District, 2019), ideally blending in with creative industries, makers, and urban services facilities in an "versatile living-and-working environment" (Programmabureau Rotterdam Makers District, 2019, p. 4). The area foresees a mixed crowd of young urban professionals, entrepreneurs, residents, city farmers, and visitors, coming together in a test bed of the circular economy (Programmabureau Rotterdam Makers District, 2019).

Our analysis of job evolution in the RDM area shows a different trend compared to M4H (see Figure 3 and map in Figure 5). In the early 2000s, the area had a strong maritime profile, with around five times the number of jobs in port-related sectors compared to the rest of the region. This concentration of jobs has declined slightly over the period of observation (from 4,6 in 2000 to 3,5 times the regional average in 2016), but remains strong. Meanwhile, the number of port-related companies increased in the period 2000–2017 (from 16 to 21 companies). Yet within this category we see a change in the types of sectors over time; most notable is the decline of jobs in the ship building industry. Jobs in wholesale of chemical products, fuels, and other mineral materials have also left the area. Cargo handling, warehousing and storage, freight forwarding, and ship's agents remain rather stable, while we see a growth in support activities for water transport (heavy lift, mooring activities), and wholesale articles for ships and fishing. Engineers and other technical design and consultancy area are also in the area.

The area has a relatively limited creative industry profile, with the exception of architecture firms and a foundation supporting sustainable housing. In ICTs we found jobs in writing, producing and publishing software, and manufacture of other electrical equipment—yet the number of jobs and companies are marginal. It should be noted that jobs relating to artificial intelligence, IoT, and additive manufacturing that are present in the area fall within other categories, notably manufacturing or 'other' (e.g., IoT under education). In the 'manufacturing (other)' category there is a furniture maker. In the 'other' category, we see a growth in non-university higher education and other (vocational) education institutions and related services, including business education and

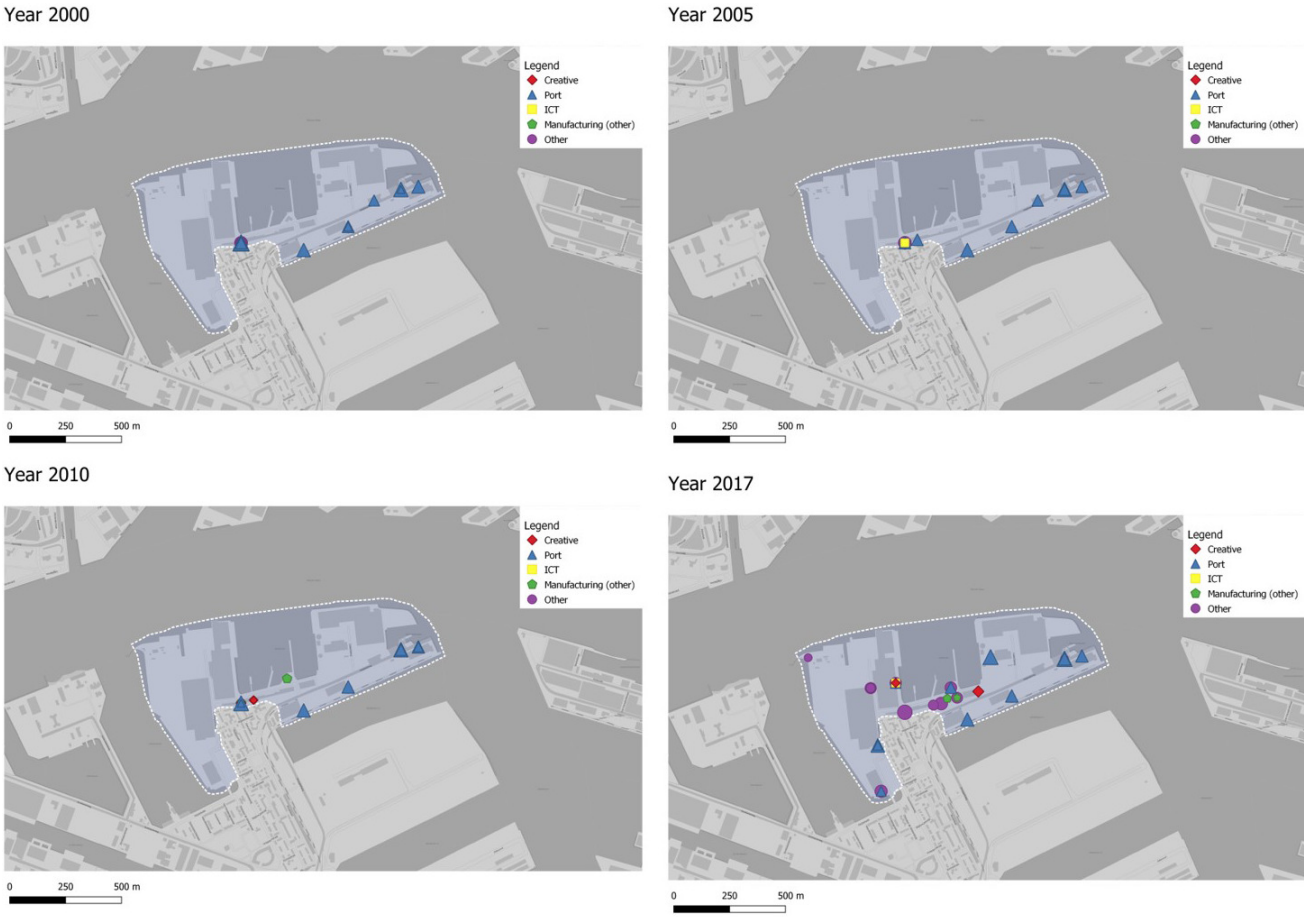

Figure 5. Companies in RDM by sector, 2000–2017. The symbol size represents the number of jobs. Source: Figure by Erasmus UPT (2020), based on LISA (2017) and Publieke Dienstverlening op de Kaart (2021).

training. Indeed, the collaboration between Rotterdam University of Applied Sciences and Albeda College in 2007 was the start of the education campus at RDM. With its arrival, RDM gained a campus for technical vocational and higher education in the domains of mechanical engineering. In 2005, Rotterdam University of Applied Sciences set up a joint venture with the Shipping and Transport College for nautical education. This collaboration was strengthened in 2011 with the establishment of the Rotterdam Mainport Institute, which in turn gave a strong impulse to the learning community Center of Expertise 'Sustainable Mainport Innovation.' The RDM Center of Expertise offers modern 'context-rich' learning environments, where experimentation at the crossroads of education, research, and business is stimulated. Apart from this strong focus on education, the 'Other' category shows some dynamism in the area, with many new types of activities appearing in the area in the period 2014–2017, for example management and business consultancies and employment agencies. In this category we also see the phasing out of certain wholesale and road freight transport activities.

4.2. Urban Experimentation in Old Buildings

In her seminal work *The Death and Life of Great American Cities*, Jacobs (1961/1992) purported that innovative ideas require old buildings to thrive; innovative ideas are risky, and new, dedicated facilities would enhance that risk. This dynamic is seen as at the heart of artist-led urban regeneration of dilapidated and rundown neighbourhoods. Urban experiments need "a good lot of plain, ordinary, low-value old buildings, including some rundown old buildings" (Jacobs, 1961/1992, p. 187). In the Makers District, we see Jacobs' inkling in action: disused, wharf buildings are populated by new users, who give the spaces new purposes and functionalities, often with a collaborative ethos.

An analysis of the taglines of companies located in the Makers District in 2021 sheds further light on the transition the area is undergoing (see Figures 6 and 7). The making ethos of the area translates in frequent words such as design, make, work—which are common across the two areas. Zooming in on M4H, other frequent words include reference to work settings such as studio and workshops, materials including wood and plastic, and product and projects, from furniture to art. In RDM, business and economic sector-oriented terms are more frequent, such as company, market, service, and industry. Innovation and training are also frequent, while port and offshore connect more clearly to the area's past. To take a closer look at the profiles of current occupants of the area, we zoom into some of the key facilities with a distinctive profile in the district. We provide a review of their past and present uses, including creative practices and urban manufacturing and connection to the port or urban functions (see Table 2 for a full overview).

The Keilewerf complex is situated in M4H and is constituted of two separate buildings (Keilewerf I and II), totalling 6,000 m2 and around 80 entrepreneurs. The Keilewerf was opened in 2014 in an empty wharf, while the second was added in 2016. With the tagline "The wharf where you can make anything/have anything made," it is a complex where creative start-ups and entrepreneurs cluster and converge around shared spaces, facilities and equipment. A 2019 publication presenting the Keilewerf and its history shows wide array of almost 300 'werfers,' some of whom have moved to other premises and workspaces (Van den Berg et al., 2019). Their profile is relatively young (predominantly in the 25–35 age group) one-person companies (Van den Berg et al., 2019). Moreover, these makers work with traditional tools but also with 3D-printers, laser, and CNC machines. The buildings are rented from the municipality and plans to demolish them after 2021, to make way for new buildings, are temporarily postponed. In Keilewerf, the port legacy is least tangible. Indeed, none of the new users maintain a connection with more traditional port activities—with the possible exception of companies active in food production, given the area's fruit-handling activities. Most occupants can be characterized as a mix of designers and makers, some of whom have an orientation towards circularity. Most of its users are designers and producers, who prefer to work with (used) wood and metals, but also industrial designers and interior designers who have developed themselves into circular entrepreneurs. They build their concepts and products on passion for 'vintage' materials they use and turn it into something new. Users in this space also value transversal collaboration, social inclusion, creative design processes,

Figure 6. Word cloud derived from M4H company taglines.

Figure 7. Word cloud derived from RDM company taglines.

Table 2. Overview of users in Makers District key buildings.

District	Building	Professions	Examples of company taglines
M4H	*Keilewerf I*	Artists, architects, engineers, designers, software engineers	— "Design+Making" (Studio Met) — "Artisan and contemporary" (Bink Meubel) — "Interior design, vintage sales" (De Verbaasde Ree) — "Hackerspace in Rotterdam" (Pixelbar) — "Look and feel design" (Albert Potgieter Design) — "Digital design and production" (Letolab)
M4H	*Keilewerf II*	Artists, architects, industrial designers, manufacturers, visual artists, educators, small retailers	— "Electric navigation, silent, sustainable, carefree" (Taurus boats & Tenders) — "We. Design. Create. Work. Fix. Chaos" (We.Umbrella) — "From the bottom of my city" (Bakkie Trots) — "To understand the culture you must live it" (KAVVA) — "Explorations in matter and space" (Studio Iwan Pol) — "An iconic piece of Rotterdam at home" (The Talk of the Town)
M4H	*Rotterdam Science Tower*	Artists, software engineers, industrial designers	— "The future of Maritime Innovation starts here" (PortXL) — "All you need for a complete lab" (LabHotel) — "We develop people in their entrepreneurial competences with the academic knowledge and network of Erasmus University Rotterdam." (Erasmus Centre for Entrepreneurship)
M4H	*Vertrekhal Oranjelijn*	Architects, engineers, researchers, software engineers, small retailers	— "We design and develop meaningful and sustainable breakthrough products" (Spark Design and Innovation) — "We partner with founders and companies to design and develop digital products" (Awkward) — "Pure ingredients artisanal made" (Jordy's Bakery) — "Quality coffee in an iron packaging" (Santas Koffie)
RDM	*Dokloodsen*	Artists, energy engineers, designers	— "Creative, problem solving, innovative" (De Timmerij) — "We raise awareness on renewable energy in an interactive, educative and fun way" (Energy Floors) — "The inspiration spot for architects and designers where aesthetics and sustainability meet" (ICDUBO) — "Designers and furniture makers" (Maatwerk Interieurs)
RDM	*Innovation Dock*	Software engineers, designers, manufacturers, educators	— "Fuelling possibilities" (Arktura) — "Challenging architecture" (Studio Rap) — "Metal parts on demand" (Ramlab) — "Provides sustainable 3D printing services and 3D printers in stone like, durable and sustainable materials." (Concr3de) — "Resilient realism. Sustainable building on water (Publek Domein Architecten) — "Innovative small wind turbines, ebike charging and distributed energy" — "Leading in simulation and virtual solutions" (Vstep) — "Boost your workforce and reduce risks of injuries using exoskeleton solutions" (Skelex) — "Making autonomous shipping a reality" (CaptainAI) — "Aerial inspections and data engineering" (Dutch Drone Company)
RDM	*Medische Dienst*	Industrial designers, marketeers, engineers	— "Connects and renews the industry" (iTanks) — "Pressure calculations for pipeline components and equipments" (Red-Bag) — "The force is yours" (McNetiq) — "Simply lifting high" (Tetrahedron) — "Online marketing in the port of Rotterdam" (PortAble) — "Lead generation marketing for the maritime industry" (Kelson)

Table 2. (Cont.) Overview of users in Makers District key buildings.

District	Building	Professions	Examples of company taglines
RDM	*Scheepsbouw loods*	Marine engineers, educators	— "Your global partner for integrated rigging and mooring solutions" (Franklin Offshore) — "Largest technical vocational college in Rijnmond region" (Technical College Rotterdam)

Notes: Dutch taglines have been translated into English by the authors. Information on the companies and taglines were drawn from area and company websites and LinkedIn.

and contributing to an inclusive and sustainable society. The societal innovation component is also noticeable in the open character of some of the spaces, where publics of all ages are welcome for workshops for re-use and upcycling of construction materials (e.g., Buurman, De Bouwakademie). In addition to makers, Keilewerf I is also the place where you can find a higher number of artists compared to the other spaces. Keilewerf II is also an incubator for creatives. Companies here are relatively young (seven years on average). Keilewerf is home to a number of entrepreneurs who value sustainability, durability, and circularity. They use with a mix of materials: recycled plastics, textiles, glass, and use a variety of techniques from sculpturing, laser, and 3D printing. Other entrepreneurs have design studios, engaging in multidisciplinary work. Beyond the Keilewerf, M4H houses numerous other companies that share a similar creative ethos and attention to social innovation and circularity. Some entrepreneurs are very explicit on their principles and strive for zero waste, a circular adaptive and sustainable society, clean air, water, and energy.

A historic and protected landmark in M4H is the Vertrekhal Oranjelijn, with its rich history as location of Thomsen's stevedoring company. After decades of being disused, the municipality of Rotterdam acquired the building in 1990 and sold it again in 2003 to an entrepreneur with ambitions to set up a coffee roasting company. At present the building is a relatively small facility and has a similar profile to Keilewerf I and II, housing food companies, design, and architectural firms. The Erasmus Centre for Entrepreneurship is a key user of the Rotterdam Science Tower and has the ambition to support the development and acquisition of academic and entrepreneurial competences. The other high-profile tenant of the Science Tower is PortXL, an accelerator founded by the port of Rotterdam. PortXL offers facilities and opens up an ecosystem of investors and corporate partners to accelerate innovations in the port and maritime industry.

Of all the buildings in Rotterdam's Makers District, the Innovation Dock in RDM is possibly the most the 'port-related,' while also housing many relatively new companies. Compared to creative spaces in the M4H district, the entrepreneurs at RDM are more into designing and developing concepts for industry. The products which are developed here are a mix of digital solutions—Artificial Intelligence for autonomous applications in (underwater) drones, internet of things technology, robotics—and innovative materials, e.g., by use of additive manufacturing. RDM also provides a base for innovative makers who have outgrown the phase of craftsmen or 'makers,' such as the scale up of Ampelmann and Franklin Offshore. Users of this space value sustainability and are keen to use computer and internet-based engineering to build their solutions. The building at Medische Dienst is a smaller space with a relatively strong port heritage. The building used to accommodate the shipyard's health services—but the only connection to its former use is now in its name (Medical Service building). Users of this space develop services and solutions for the port industry, often using web-based marketing, solutions, and software. The companies who find a workspace here have a connection with iTanks a network innovator with a strong network in the port industry. Core values are innovation, technology, solution-driven, and a strong focus on the port industry.

5. Conclusions

This article sought to answer the following research questions: To what extent have the boundaries between the city and the port become more porous in the area designated as Rotterdam's Makers District in terms of its spatial function and the flow of port and creative industry users? And how do old and new users relate to imaginaries of the district? To answer the questions, we relied on a combination of quantitative and qualitative dataset of companies, capturing the recent evolution of the area's economic profile. Our analysis of sectoral employment data from 2000 to 2017 (LISA, 2017) shows that the area's evolution can be typified a type of adaptation that combines the persistence of traditional port activities, the innovation of port activities, and the arrival of new activities and users, in particular new creative, manufacturing, and education profiles. Are we witnessing a porous port-city in the making, a carefully coordinated adaptive planning approach to blend in urban functions in former port areas? Indeed, the plans envision mixed use of spaces by a variety of users, but to what extent is it a deterministic process? Our data challenge the separation of port and city that has been hypothesised and modelled in the past (see, for instance, Bird, 1963; Charlier, 1992; Hoyle, 1989, 2000). Indeed, the Rotterdam Makers District as a waterfront area lends

itself to an exploration of the tensions between and competition among port and urban uses (Daamen, 2007), revealing new forms of symbiosis and development.

Our data show that the port-city interface transition in Rotterdam is complex, and that even within a single port-city, distinctive trajectories can be found when zooming into specific former port neighbourhoods. The scale of retraction and redevelopment is also connected to the area's former uses, facilities, and the potential for reuse of skills and infrastructure. In RDM, the decline of traditional port sectors has given way to an innovative port industry, which protracts the area's significance in the regional port cluster. Meanwhile, M4H rapidly rebrands itself as an urban makers' district, maintaining some links to its former past in produce handling. Our analysis of the occupants of the Makers District shows some differentiation between areas (RDM and M4H) and buildings within these areas in terms of their port and urban orientation. While in RDM the port-industrial and maritime legacy live on in the identity and sectoral orientation of numerous occupants (see also Kermani et al., 2020), in M4H we find a clearer integration in the urban fabric of Rotterdam. In this area, we find that users project alternative imaginaries of the port-city, that are less anchored in its past and more oriented towards a more creative and socially innovative practices, including societally-engaged artistic expressions and small-scale manufacturing that is technologically advanced and often circular in its use of materials. This area is defined not just by its experimental approach, but also for new connections between education and business, collective learning, and shared practices—the social innovation element is stimulating a wider socio-cultural shift in the city, encouraging alternative consumption practices.

Overall, the Makers District in Rotterdam constitutes an ambitious and large-scale port-city waterfront planning redevelopment, striving to combine sustainable urban development with innovative manufacturing industries and creative entrepreneurship. At RDM, the integration is taking shape as aims and objectives of communities of practices integrate using the former shipyard buildings as spaces for technical vocational education, open spaces for experiments and innovation, often related to the maritime industry. The new partnerships between educational institutions are not only intended to adapt education to this age of rapidly advancing technology, but also to enable pathways for entrepreneurship, accelerating innovation and lifelong learning. The evolution also shows interventions by public authorities and actions by private actors are taking place simultaneously. Attractiveness is enhanced whenever refurbishing of buildings are finished, combined with marketing activities of carefully curated images set by port-city planners, but also by bottom-up initiatives by entrepreneurs themselves. The users gradually give the spaces new purposes, whereby the port industrial heritage buildings are the connectors between the old and new, giving home to new imaginaries and thereby supporting users in giving the areas new and authentic identities. The area's transition appears to align with the socio-economic imaginaries defined in strategic and policy documents setting out the area's development and ambitions.

The area embodies the city's ambition to promote the Next Economy paradigm (TIR Consulting Group, 2016), centred on collaborative, open, flexible production, enhanced by digitization and embedded in local value chains. Our qualitative analysis shows that regeneration strategies of Rotterdam Makers District to some extent embody what Jones (2017) describes as more socially responsible, innovative, entrepreneurial, and integrated regeneration objectives. Yet our data does not allow us to uncover whether such developments have the inclusive nature Jones (2017) advocates. The area's location and attractive character open up a dilemma for inclusive and progressive waterfront regeneration, as the new users contend with rising demands for urban space. In fact, the innovative and experimental nature of the area contends with pressure on the housing market, whereby the target for 3,500 to 5,000 new homes by 2040 is largely to be accommodated in former port areas (Hill et al., 2018). Some of the most vibrant and innovative collaborative spaces in the area, such as the Keilewerf I and II, are faced with an uncertain future in their current locations. The Rotterdam Makers District is often referred to as a testbed for innovation for a more circular and inclusive city. The real test will be whether the lessons learned here can lead to sustainable business and social innovation models that can both accommodate upscaling of manufacturing by the new makers while also accommodating diverse residents and uses in the area.

The article has some limitations, which future research should address. To begin with, our quantitative analysis of data on jobs and companies goes up to 2017, while our qualitative data is contemporary. Our data does not allow us to provide a quantitative analysis of employment from 2018. Secondly, while the categories we use to analyse the data allow us to explore sectors dynamics in the area, distinguishing between areas of activity that have been and are crucial to the area's development (port, creative industries, manufacturing, and ICT) they also mean that some of the numbers are too small to say something meaningful about particular sectors, for example ICT in RDM. Moreover, future analysis could also benefit from combining all manufacturing activities in one category (including port and creative industry-related manufacturing), to gain a clearer sense of the evolution of this sector in the area. Finally, future analysis would also benefit from the integration of land use data, allowing for deeper insights in the shifting 'urban housing frontier' in these centrally located waterfront areas (Wiegmans & Louw, 2011). In this respect, the two areas of RDM and M4H occupy very different positions in relation to the city centre, the former being farther afield, on the south side of the river Maas.

A port-city transition is as complex as it is uncertain, especially because of the long-time horizon. We can argue whether the flexible, adaptive approach to make the transition of port-city waterfront redevelopment works better than a plan-led development (Daamen & Louw, 2016), but by having a degree of urban porosity allows for a process of identity creation that builds on the port-city's past as well (Kermani et al., 2020). Moreover, it takes time to set the right conditions for a more heterogeneous category of urban industries vis-à-vis the former more homogeneous port logistics industries. This may suggest ambivalent plans and unclear approaches but accepting some degree of ambiguity can be good for new imaginaries to set root. This is especially needed when transition processes, systems, and multiple interlinkages between stakeholders and authorities are too complex to understand upfront. The art of creating new imaginaries is to collaboratively construct future realities for these port city areas where people are pulled in rather than pushed out.

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Conflict of Interests

The authors declare no conflict of interests.

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Article

Shanghai's Regenerated Industrial Waterfronts: Urban Lab for Sustainability Transitions?

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Abstract
In China, Shanghai often serves as a place to introduce and try out new ideas. This is certainly the case with experimental urban planning and design solutions and sustainability transitions. This article identifies and evaluates the role of pilot projects and demonstration zones along the Huangpu River. These clusters and zones are supposed to guide the urban regeneration of the former industrial waterfronts and to accelerate innovative development in Shanghai and the wider Yangtze Delta Region. The Huangpu River as a whole is considered an urban lab and a showcase of ecological civilisation policies, with a strong 'people oriented' focus on improving the overall quality and attractiveness of urban life. Following three decades of rapid urban expansion, Shanghai's urban development model is shifting toward one that emphasizes densification and the reuse of existing elements. The motto of Shanghai's latest master plan is "Striving for an Excellent Global City." One of the pathways to realize this expectation is the creation of thematic clusters for creative industries, financial institutes, AI, and technology, media and telecommunication industries. These clusters are high-density investment projects meant to support and accelerate the transformation of Shanghai into a service economy. There are important similarities between these projects in Shanghai and the role of urban labs in theories of sustainability transitions. Drawing on these theories and those of ecological civilization, this article examines how these so-called 'experimental' urban megaprojects along the river contribute to Shanghai's effort to take the lead in developing sustainable urban transitions.

Keywords
ecological civilization; global city; port city; sustainability transitions, urban lab; urban megaprojects; urban regeneration; waterfront transformation

Issue
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1. Introduction

This article examines recent waterfront regeneration projects in Shanghai that are expected to play an experimental and exemplary role. These projects have a strong spatial and socioeconomic impact. By reconnecting the city with the Huangpu River, the waterfronts, after losing their former port role, have once again become the main driver for urban development. Approaching this phenomenon through the lens of sustainability transition theories has not been done before in the Chinese context and fills gaps in the still limited research on recent waterfront transformations in Shanghai (den Hartog, 2019, 2020; Li & Li, 2016; Li & Zhong, 2020; Yang et al., 2020).

Shanghai's urban development has shifted from an urban expansion model with new towns (den Hartog, 2010) to a model of urban densification and regeneration within red lines that prevent the city from sprawling outward (Shanghai Planning and Land Resource Administration, 2018a). Simultaneously the city is implementing ambitious projects and policies to facilitate an urgently needed shift from quantitative planning toward qualitative planning. The subtitle of Shanghai's latest Master Plan (2017–2035) is: Striving for an Excellent

Global City (迈向卓越的全球城市; Shanghai Planning and Land Resource Administration, 2018a). According to this plan (abbreviated as Shanghai 2035), the city wants to compete, and possibly surpass, global cities such as New York, London, Singapore, and Tokyo in terms of economy, image, and quality of life. Shanghai 2035 promises to realise "a city of innovation, a cultural city, an ecological city, and a modern socialist metropolis with world influence" by 2035 (Shanghai Planning and Land Resource Administration, 2018a). The urban regeneration of the Huangpu riverfronts plays a key role with no less than 120 kilometres of waterfront transformation intended to eliminate polluting industries, create a continuous open public space (den Hartog, 2019), to make new ecological connections (den Hartog, in press), to reuse industrial heritage (den Hartog, 2020), and to add new landmarks. More than 50 kilometres new waterfronts have been already implemented. This work, accompanied by large real estate clusters, dwarfs other waterfront transformations worldwide.

The research objective is to understand the underlying motivation and effects of emerging pilots and demonstration zones (see Section 2.1) in Shanghai, which are supposed to function as urban labs. The academic objective is to use sustainability transition theories (Section 2.1) in an adjusted way, to analyse and evaluate these urban labs on sustainability aspects, with additional insights from ecological civilisation philosophy (see Section 2.2). The main research questions are: How can an urban lab be identified in the context of Shanghai? How do these pioneering projects contribute to a sustainable transition effort? The following criteria will be examined: adjustability, inclusiveness, functionality, low-carbon impact, and urban vibrancy (see Table 1). Based on this assessment, recommendations for improvement will be made in Section 5.

Empirical evidence comes from multiple daily-life field observations between 2008 and 2021. Between 2012 and 2021 multiple sections of the waterfronts were analysed intensively in the context of research and design studios with students from Tongji University (7 semesters North Bund, 2 semesters South Bund, 1 semester Yangpu waterfront and Fuxing Island). In 2019 and 2020 more than 300 questionnaires were completed, with student assistance, amongst visitors (tourists, office workers, etc.) on multiple locations along the river. The questions were concerning usability and appreciation of the new public space and buildings. Semi-structured interviews were conducted with two leading real estate analysts, three developers, more than 20 designers and planners involved in relevant projects, three local officials, and more than 10 scholars. Relevant planning documents, media reports and publications were studied, with translation and interpretation assistance available when needed. Preliminary research results have been presented and discussed during workshops and seminars in Shanghai and elsewhere.

2. Sustainability Transition Theories, Experiments, and Ecological Civilization

2.1. Urban Labs and Experiments

In this article concepts of the sustainability transition discourse frame the empirical analysis and argumentation. These concepts help explain how promising visions of a sustainable future and attractive urban realities are translated on the ground, and how these projects can help shift the urban reality into a more sustainable order. The concept of sustainability in this article follows the Brundtland Report (United Nations, 1987): "Humanity has the ability to make development sustainable to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs."

A century ago, scholars from the Chicago School of Sociology approached the city as an urban lab and used the concept of social experimentation (Park, 1929). In contemporary mainly European-centred discourse on sustainable urban transitions, the term urban (living) lab is used for socio-technical experiments with a participatory nature (Steen & Van Bueren, 2017), usually on a neighbourhood-scale. Urban labs are not necessarily physical, but "represent sites" and "allow stakeholders to design, test and learn from socio-technical innovations in real time" (Wirth et al., 2018, p. 230). Urban labs are tools to find new forms of urban governance to address complex problems; they function as an inspiring sample. They have tended to focus on public spaces such as infrastructures (e.g., NACTO) or greening projects (e.g., Naturvation Atlas).

In the field of sustainability transitions scholars investigate radical shifts toward sustainable socio-technical systems of production and consumption (Evans et al., 2016; Grin et al., 2010; Kivimaa et al., 2017; Sengers et al., 2016; Weiland et al., 2017). Urban labs are usually community-based and follow processes with many steps and turns and not always satisfying results (Karvonen, 2016). Yet, there are successes among these so-called urban transition arenas (Wittmayer et al., 2014).

Three key concepts in this discourse are 'expectations,' 'socio-technical experimentations,' and 'unfolding innovation journeys.' 'Expectations' addresses how stakeholders use tempting visions of a better future in their urban development projects. These visions or "statements about the future" circulate (Van Lente, 2012) and are 'performative,' helping to create a new future reality by coordinating roles and activities amongst actors (Konrad, 2006), and by legitimizing certain investments (Borup et al., 2006). To be effective, these expectations or visions need to be shared by multiple actors (Schot & Geels, 2008). To translate expectations of creative, innovative, and sustainable urban solutions into realities they are tested and developed in experimental real-life settings: urban labs. Experiments can be seen as key to change. A process of 'socio-technical

experimentation' by a wide variety of societal stakeholders can transform expectations or visions into reality. Socio-technical experimentation is an open-ended 'unfolding innovation journey' (Van de Ven et al., 1999) or, more specifically, a 'sustainable innovation journey' (Geels et al., 2008), full of uncertainty (Garud et al., 2014). In contrast to experimentation in the natural sciences—which usually takes place under strictly controlled conditions and is aimed at finding objective certainties—there are multiple external influences possible in an urban lab. Therefore, scholars in the field of sustainability transition studies describe them as 'socio-technical experiments,' which can be defined as: "An inclusive, practice-based and challenge-led initiative, which are designed to promote system innovation through social learning under conditions of uncertainty and ambiguity" (Sengers et al., 2016, p. 162).

How can we identify and evaluate urban labs in Shanghai? In Chinese urban planning and design there are basically three different levels of experimental projects:

First, pilot projects are experiments located in one or several places to be further adjusted and expanded nationwide. They are expected to aid in reformulating relevant policies (e.g., a 'low-carbon pilot'; den Hartog et al., 2018). Second, demonstration projects (or zones) are considered successful experiments that can be replicated and can function as a national or international sample (e.g., Chongming Island as National Ecological Demonstration Zone; den Hartog et al., 2018). Finally, model (文明) projects have been deemed 'excellent' (卓越) social management models that support political principles, e.g., ecological civilisation (see Section 2.2).

These different labels for projects are linked with different financial and governance constructions and can overlap. In Shanghai 2035 the Huangpu River's waterfront as a whole is labelled a "demonstration zone for the development capability of the global city of Shanghai" (Shanghai Planning and Land Resource Administration, 2018b). This is a socio-technical experiment on a municipal level. The waterfront redevelopment is designed and implemented at the district level; each district has founded its own government-owned development company (e.g., West Bund, see Section 3.3). Within these administrative bodies, there are smaller pilot projects for testing specific aspects, such as 'AI Town pilot' and 'art zone pilot' at West Bund (see Section 3.3). All these demonstration zones and pilots have pioneering and guiding roles. They most probably will be awarded with the honourable title 'model project' afterwards. While urban labs, especially in the European context, are usually limited in impact (Scholl & De Kraker, 2021), the demonstration zones and pilots described in this article have a considerable impact that redefines almost everything, by creating a 'new world.'

2.2. Ecological Civilization as National Socio-Technical Experiment

Ecological civilization (Sheng Tai Wen Ming, 生态文明) is a socio-technical experiment that can be defined as a "dynamic equilibrium state where humans and nature interact and function harmoniously" (Frazier et al., 2019, p. 1). According to some scholars, it originated in the discourse on ecological modernization (Zhang et al., 2007). However, it has strong roots in Marxism and some scholars claim that it has the potential to challenge or even replace global capitalism (Gare, 2020). Nevertheless, the concept of ecological civilization has received many sceptical reactions (Hansen & Liu, 2017; Wang et al., 2014; Wang-Kaeding, 2018). Realizing an ecological civilization means a paradigm shift and drastic societal reform of all aspects of life, including the economic system. Recurring terms in the discourse of urban planning and design in China are 'beautification' and 'harmonization.' Both terms originate from the ecological civilization campaigns and have been promoted by the national government since 2007 (Hansen et al., 2018). Beautification refers to improving the overall urban image, and harmonization means to improve the quality of life and fortune of the society. In Shanghai's urban regeneration efforts beautification and harmonization are apt to mean polishing street life by eliminating whatever does not align with prosperity and modern urban living in the view of local leaders. Informal street markets and old working-class housing are examples of targets for removal. Beautification and harmonization are principles to provide social guidance and reflect strong state control over urban planning and design practices. This State control is also reflected in the new waterfronts of the Huangpu River (den Hartog, 2019). This transition from an industrial civilization to an ecological civilization contains three dimensions that need to be brought into harmony, according to the Communist Party's constitution: the environmental, the economic, and the social. General Secretary Xi continually emphasizes ecological civilization as a more balanced model of economic growth.

3. Socio-Technical Experimentation: The Huangpu River Waterfront as Stage for Innovation and Ecological Civilization in Shanghai

3.1. Shanghai's Frontier-Role

Shanghai is China's gateway to the world and economic Head of the Dragon, as announced by revolutionary and former statesman Deng Xiaoping in 1992 (Foster et al., 1998). Hence this world port city positions itself as urban laboratory (den Hartog, 2010, 2016). With this 'frontier' role, Shanghai is the stage for many experiments. The former port-related industrial waterfronts have a crucial position in this; they have become a porous interface for new urban development and a way to reconnect city and

river. City leaders nationwide see Shanghai as an inspiring model with access to new ideas. Many initiatives and trends that started in Shanghai are transplanted elsewhere in China, such as the concept of Xintiandi (den Hartog, 2017).

The origins of Shanghai are inseparable from its location beside the water (Ball, 2017; King, 1911). The strategic deltaic location made Shanghai into an international hub for exchanging goods, finance, and knowledge. The former foreign concessions were zones of exemptions with exclusive rights for a select group—somehow the precursors of current demonstration zones—that accelerated international trade and global connections. It made Shanghai the third-largest banking and finance centre in the world during the 1930s, with the classic Bund as icon. The city's location in the Yangtze River Delta is also a vulnerable one, with flood risk and conflicts between urban, industrial, ecological, and agricultural land use. This location makes Shanghai an excellent place to experiment with new urban planning and design approaches that aim to make the city more sustainable and resilient. The master plan Shanghai 2035 promises this metropolis will play a pioneering role and lead the reform into the era of ecological civilization. The expectation is to become an "environment-friendly, economically-developed, culturally-diversified and safe liveable city" (Shanghai Planning and Land Resource Administration, 2018a, p. 17). In Shanghai's more detailed master plan for the Huangpu River, the expectation is to build a "world-class waterfront development zone" (世界级滨江发展带). This plan distinguishes three key functions for the river: (1) the river as spatial and functional carrier; (2) the river as the city's public living room with rich human connotation (referring to heritage and identity); and (3) the river as an ecological corridor for a harmonious coexistence between humans and nature, in terms of 'ecological civilization.'

A main 'expectation' as stated in Shanghai 2035 is to become "a more adaptable, resilient eco-city and benchmark for international megacities in terms of green, low-carbon and sustainable development" (Shanghai Planning and Land Resource Administration, 2018a, p. 25). This ambition will be showcased in demonstration zones. According to Shanghai 2035, ecological civilization requires a new balance between top-down and bottom-up governance approaches and an exploration of public–private partnerships and new forms of participation. Citizen participation is mentioned frequently in the final chapter (Shanghai Planning and Land Resource Administration, 2018a). Ecological civilization means a shift to a new planning approach: a process of exploration and new balances between rigid control and flexible adaptation (Chen & Du, 2018; Xu et al., 2017).

Within the wider context of waterfront regeneration, the various municipal districts of Shanghai developed a dozen large thematic real estate clusters, each of them comparable in size to Canary Wharf in London or Hudson Yards in New York (Figure 1). These clusters contain attractive new functional programs, usually related to arts and creativity, but their main share consists of offices, five-star hotels, and exclusive retail. Less than 5% is (upscale) housing. In the next sections (Sections 3.2–3.4), three prominent zones that contain several of these clusters are described in more detail, chronologically. They have been selected because the municipality has deemed their transformations exemplary and trendsetting.

3.2. Former Expo 2010

The expectation that development projects should reconnect the city with the river began in 2002 with the Regional Comprehensive Development Plan for the Huangpu River and preparations for Expo 2010, themed "Better City, Better Life," located on former docklands on both sides of the river (Pudong District and Huangpu District). For this event navy-owned shipyards and about 27,000 housing units were removed. The event accelerated multiple urban projects (Wong, 2010) and made Shanghai "China's pioneer for urban regeneration" (Li & Li, 2016, p. 342). Across the city it resulted in refurbished facades, green decorations, and the accelerated removal or hiding of everything, especially informal street life and low-income neighbourhoods, that did not fit the desired international image. Expo 2010 was primarily a socio-technical experiment to encourage people to become 'model' citizens (Chen, 2018; Wong, 2010) as part of an early phase of ecological civilization implementation. For example, there were educational campaigns on how to behave in public spaces, for example the tradition of wearing pyjamas outdoors was (temporary) discouraged. Besides being an international business event, Expo 2010 was a moment to experiment with new forms of public–private partnership, loans, and bonds (Chen, 2020). After the event, the innovation journey was interrupted (den Hartog, 2012): Post-event reuse of the area was delayed for 5 years, because suburban development was still more profitable. The well-visited iconic Power Station of Art, China Pavilion, and Mercedes Benz Arena have been exceptions. The Urban Best Practices Area was a showcase with pioneering samples of low-carbon and passive buildings during the expo. The Urban Best Practices Area was meant to become a cultural cluster after the expo (Li & Li, 2016), but this was postponed until 2019 because West Bund took over the role, thanks to more successful experimental collaborative governance (see Section 3.3). Currently the Urban Best Practices Area is in the process of revival. Since 2015 the Pudong side of the expo has been filling up with office clusters and malls (Figure 2), instead of needed (affordable) housing.

3.3. West Bund

After Expo 2010 the West Bund area started to be redeveloped by a state-owned enterprise with the same

name, in Xuhui District. Since the mid-19th century, cement and coal deposits, wharfs, and a military airport have dominated the area. This was a pioneering zone during China's industrial development, with new industries and technologies. The 'expectations' were to make the riverside a scenic space for citizens and to establish a pilot International Art Industry Cluster (den Hartog, 2020; Hastings, 2019; Zhou, 2017). The West Bund is

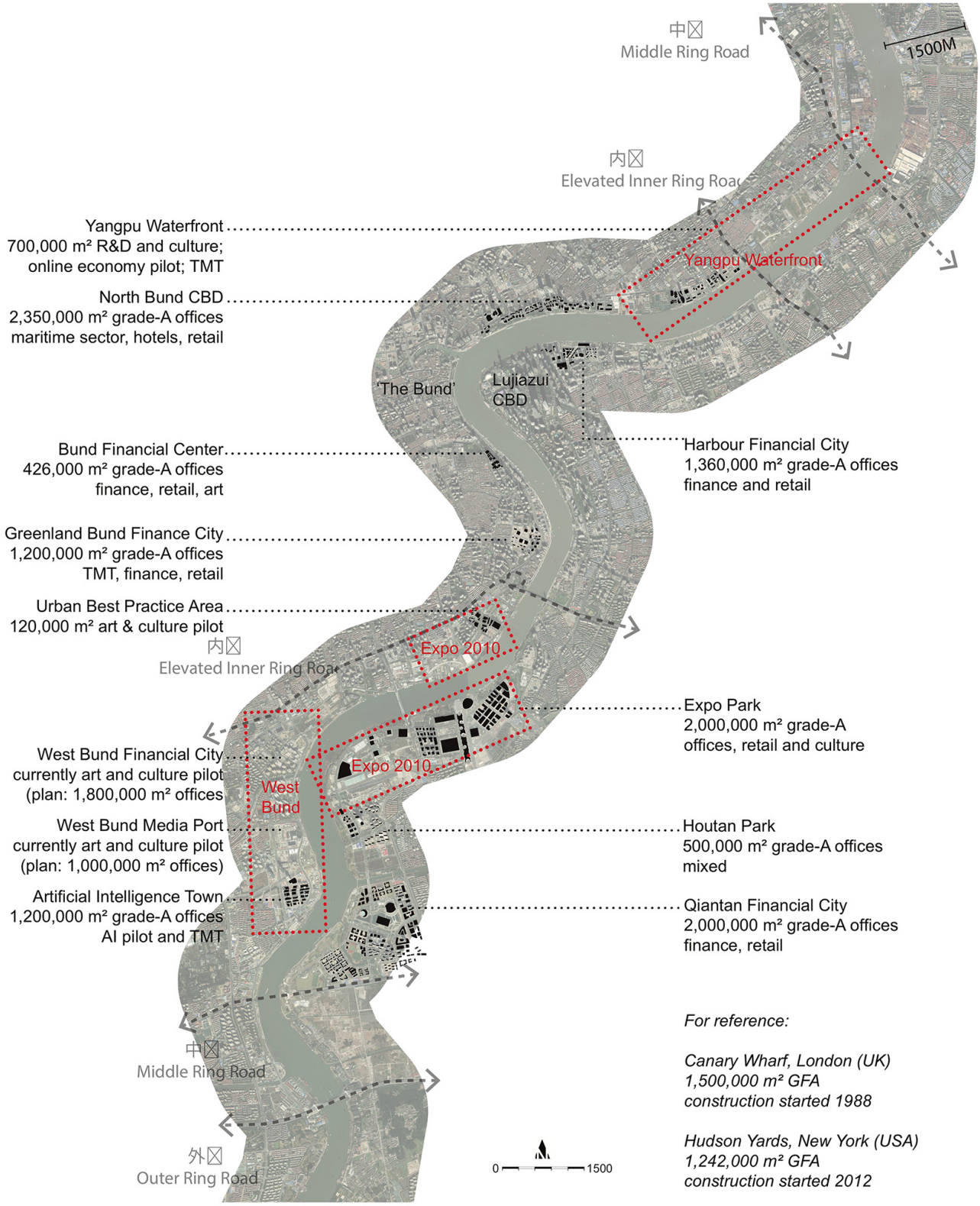

Figure 1. Map with urban megaprojects since 2012 along the central section of the Huangpu River. Source: Image by Harry den Hartog and Jiawei Hu; Satellite photo as underlay by Shanghai-tianditu (2021).

Figure 2. Two pictures of the former expo area filled with grade-A offices around remaining expo-pavilions. Source: Author (Summer 2020).

also a Cultural and Financial Cooperation Pilot Zone that experimented with new forms of "government-led regeneration with market-oriented management and collaborative governance" (Qiu, 2019). Its innovation journey started with the experimental West Bund biennial in 2013 in a former airplane factory. Since 2015 this biennial is renamed in Shanghai Urban Space Art Season, co-organized by West Bund and the municipal Urban Planning Bureau. With a range of onsite events and installations along the waterfront, the aim has been to attract people and (international) investors. West Bund has become a brand. In line with Museum Mile in New York and South Bank in London, a range of museums, galleries, and art events were invited to West Bund. In 2019 even Centre Pompidou opened a branch in the presence of Emmanuel Macron, president of the French Republic. The planning is said to be in accord with ecological civilization by using "culture-oriented, eco-based and technological-innovation-driven" development principles (Shanghai Planning and Land Resource Administration, 2018a). West Bund is (after the classic Bund) the most intensively used of the new waterfronts in Shanghai. It enjoys experimental exceptions in its freedom of use: Unlike in most other sections visitors are allowed to bring pets and play with kites. Picnic blankets and tents can be spotted on the lawns. There is a large area for electronic dance music events and a skate park. This all has put West Bund on the mental map of a culture-oriented, educated, young, and middle-class section of the population and of international expatriates. In terms of square meters, West Bund is one of the largest art districts in Asia. Its success can be attributed to the proximity of high-end neighbourhoods, tax incentives, and rent-free leases for cultural institutes (Zhou, 2017). In 2013 several buildings were offered for short-term lease to local architecture offices for their emerging practices, and to add a sense of creative entrepreneurial flavour. As soon as the pilot AI Town is completed (Figure 3), these studios could be dismantled. After an innovative journey of branding by creating

Figure 3. On the left, the AI Town under construction. Between the towers, several art institutes are still visible. On the right, the TANK Shanghai, a pioneering and multifunctional art centre in former oil storage. Source: Author (September 2020).

a scenic landscape and attracting cultural institutes, the area is gaining a more formal corporate image, aimed at competing for investment on the global stage under the catchy slogan "Art & AI as engine."

3.4. Yangpu Waterfront

Decades before West Bund, Yangpu District's waterfront was a pioneering area for modern Chinese industry, with textiles, shipbuilding, pharmaceuticals, soap making, tobacco, machine manufacturing, public utilities, and more. Together with North Bund (Hongkou District) this waterfront is in the former American Concession, one of the foreign enclaves founded after the Treaty of Nanjing (1842) as a basis for international trade. Late in the last century, the area was run-down, with polluting industries and dilapidated working-class neighbourhoods. Urban regeneration started in 2012 when a textile factory was transformed into the Shanghai Fashion Centre, an outlet mall. Also, at the Yangpu waterfront a Shanghai Urban Space Art Season biennial was organized in 2019 (after the first two editions at West Bund in 2013 and 2015, in 2017 a third edition took place at the East Bund). Today Yangpu promotes its waterfront as a 'World Class Waterfront Development Belt' in an attempt to attract foreign investors. The project is nicknamed "from rustbelt to brainbelt" (Lv & Wang, 2017). The square meter prices for residential real estate are already up to €13,000 per square meter (2021). In November 2019, General Secretary Xi visited Shanghai. During his visit he only visited the Yangpu waterfront, which underlines its strategic importance and demonstration role. In the fall of 2021 a key meeting will be held in Shanghai with General Secretary Xi attending, and a large conference venue is under construction at the North Bund waterfront in Hongkou district, not far from the place he visited previously, in a highly visible spot. The original ambitious plans were to make the Yangpu waterfront into an innovation belt with jobs for more than 170,000 people (Lv & Wang, 2017), but over the past year economic and political realities have changed the innovation journey. Responding to the Covid-19 pandemic the adjusted expectation is to transform the area into a large Online Economy Park (Yang, 2021) based on 5G technologies and the fast-emerging technology, media and telecommunication sector, which by 2020 already occupied more than 15% of Shanghai's total office stock. This innovation journey is expected to continue with lower density and much more green space. Today the adjacent plots are still derelict, with several remaining working-class neighbourhoods ready for demolition. The migrant workers who live here seldom use the waterfront spaces, because they have almost no free time. The lack of connectivity between the river and run-down neighbourhoods and the negative connotation in the collective memory (pollution, poverty) of this part of the city make this waterfront still less intensively used than other waterfronts in the city (Figure 4). This trend is expected to be completely reversed over the next five years.

4. Discussion

In the international discourse urban labs are supposed to supplement or even replace traditional urban planning approaches, especially following the global economic crash of 2008. Local authorities frequently use urban labs to mask a lack of funding, or to suggest public–private partnerships (Karvonen, 2016). The Covid-19 pandemic accelerated the use of urban labs (Honey-Rosés, 2021; Rowe, 2021). In contrast to the grassroots elements in urban labs, the demonstration zones and pilot projects along the Huangpu River are initiated in a top-down manner and are controlled by the local government, usually with substantial international help: investors, engineers, designers and other professionals. Some of these projects experiment with public

Figure 4. Behind the scenic Yangpu waterfront, working-class neighbourhoods are being demolished. Source: Author (May 2021).

Table 1. The three cases compared on several aspects.

	Expo 2010	West Bund	Yangpu Waterfront
Governing body:	Pudong District and Huangpu District	Xuhui District	Yangpu District
Developed by:	Bureau of Shanghai World Expo Coordination	Shanghai West Bund Development Group (West Bund)	Shanghai Yangpu Binjiang Investment and Development Co., Ltd
Size of zone:	5.28 square kilometers	9,4 square kilometers	12 square kilometers
Main expectation:	Better City, Better Life; Reconnect city and river	Art & Artificial Intelligence as engine; Reconnect city and river	Demonstration zone for the construction of a people-oriented city
Main experiment(s):	1. First large-scale waterfront regeneration experiment; 2. Urban Best Practice Area as showcase for sustainable building techniques, and (post-expo) reuse as Pilot for International Art Industry	1. Cultural and Financial Cooperation Pilot Zone (government-led regeneration with market-oriented management and collaborative governance); 2. Pilot Artificial Intelligence Town	1. Pilot Online Economy Park
Timeline / innovation journey:	2006–2010: event-led urban regeneration to prepare Expo 2010; 2010–2015: partly demolition of former expo site; most remaining buildings stayed vacant; Since 2015: redevelopment with office clusters; Since 2018: redevelopment of UBPA targeting on art events	2010: start waterfront regeneration; West Bund 2013 and SUSAS 2015 (two urban planning and design biennials) acceleration by event-led urban regeneration; Since 2018: start construction AI Town and West Bund Media Port; preparations for West Bund Financial City; 2019: Centre Pompidou opened a branch	2010: start waterfront regeneration with transformation of a former textile factory into a fashion outlet; SUSAS 2017 (urban planning and design biennial) as start large-scale and event-led urban regeneration
Inclusiveness:	Removal large amounts of working-class neighborhoods; no new housing available on this site	Only new high-end housing; public space is very well-used by all kinds of people	Removal of large amounts of working-class neighborhoods, partly replaced by high-end housing complexes
Functionality:	Mostly still desolate, except UBPA and River Mall	Well-functioning	Still rather desolate
Low-carbon impact:	Removal of polluting industries; all new constructed buildings received low-carbon labels	Removal of polluting industries; all new constructed buildings received low-carbon labels	Removal of polluting industries; all new constructed buildings received low-carbon labels
Urban vibrancy:	Many visitors during Expo in 2010, but almost no visitors afterwards. There is a gradual revival since 2018, but half the lands are still bare. There are preparations to construct a large urban park. Half of the remaining lands are currently used for offices and retail, but these are largely vacant (except the River Mall, the China Pavilion, the Mercedes-Benz Arena, and the Power Station of Art).	The West Bund can be seen as experimental 'free zone' with much tolerance for all kind of spontaneous activities. It is a relatively successful area, well visited, and with many art-related events and exhibitions.	During SUSAS 2019 there were temporary many visitors, but much less afterwards. Reuse of the venues is still under consideration.

participation (Chen, 2018; Shanghai Planning and Land Resource Administration, 2018a), but mainly through incentives (Zhou, 2017).

In fact, these projects are urban megaprojects (Christiaanse et al., 2019; Del Cerro Santamaría, 2013; Hanakata & Gasco, 2018). Megaprojects can be characterized as "comprehensively planned mixed-use complexes, operated under a single authority and governed by exceptional regulations," usually in public–private partnership (Christiaanse et al., 2019, p. 15). They are intended to function as an accelerating tool in urban regeneration processes aimed to revalorize urban centres. Urban megaprojects—such as Canary Wharf in London or Hudson Yards in New York—are expected to be 'agents of change' (Surico, 2020). Like urban labs, they are powerful drivers of 'urban innovation,' but in the case of Shanghai, the processes are accelerated and amplified. Urban megaprojects have their roots in post-war American urban planning (Altshuler & Luberoff, 2003), and have been used as a tool by local governments to quickly generate money. With their large-scale and often monumental architecture they "express strong political will, under different political regimes," often supported by neo-liberal motives (Christiaanse et al., 2019, p. 20). Urban megaprojects are the arena where global ambitions meet local values, with socioeconomic gentrifying effects on surrounding neighbourhoods (He, 2007). In Shanghai, they have led to the displacement of large groups of residents and the demolition of characteristic and traditional, but dilapidated, neighbourhoods. In esthetic terms they are "carefully laid-out urban developments" (Christiaanse et al., 2019, p. 15) with a public purpose, used for place-making and identity creation.

Worldwide, urban waterfronts have been used as neoliberal urban policy experiments (Brenner & Theodore, 2002; Iovino, 2018; Sassen, 2014; Zukin, 2020). In Shanghai since the late 1990s, urban planning practice has been increasingly combined with market-driven developments. This trend in some ways represents a departure from the socialism-with-Chinese-characteristics approach that emphasized adapting Marxism-Leninism to local Chinese conditions and aimed to improve the quality of life of millions by stimulating the national economy. The emergence of speculative urban megaprojects (Figure 5) along the Huangpu River is characteristic of what Harvey identifies as 'neoliberalism with Chinese characteristics' (Harvey, 2005).

So, what is innovative in these thematic GDP-driven megaprojects along the Huangpu River? At first glance they appear to follow a real estate formula analogous to, for example, Hudson Yards in New York—the largest private real estate development in the US (Sorvino, 2016) that received fierce criticism (Kimmelman, 2019; Wainwright, 2019). The urban megaprojects along the Huangpu River are a mixture of private and state capital, and the spatial and socioeconomic shockwaves they have made in the city and wider region needs research that goes beyond the scope of this article. Nevertheless, compared to the usual urban planning practice in contemporary China, the demonstration zones and pilot projects along the Huangpu indeed introduce new elements, such as walkable and car-free environments, functional mixing, and the inventive use of underground spaces. Innovative in the context of Shanghai and China is also the large amount of green and public space aimed at recreational use. Less than a decade ago there were hardly any walking or cycling paths, and the concept of a leisure society is still unknown. Moreover, pilot projects with high-end art, AI industries, and an online economy are unique in China and far beyond. These urban megaprojects can compete in appeal with those in other world cities, and are perhaps even better designed. Most of the buildings and public spaces are actually designed with the help of leading international architects, including David Chipperfield Architects, Foster + Partners, Heatherwick Studio, Kengo Kuma, KPF, OMA, Sanaa, Sou Fujimoto, and also many emerging local talents such as Atelier Deshaus and OPEN Architecture.

Figure 5. Emerging urban megaprojects AI Town (left picture) and Houtan (right picture), with super-tall landmarks. Source: Author (March 2021).

With the exception of the International Art Industry pilot at West Bund, as described in Section 3, other megaprojects along the Huangpu experience difficulties attracting office tenants, as well as users of the eye-pleasing public spaces. From field surveys with students a range of shortcomings came to light. Most of the new waterfront spaces lack facilities and have functional limitations (Figure 6; den Hartog, 2019). Local government-related institutions and companies have been relocated here, while (international) art institutes have been attracted by incentives (Zhou, 2017). Although most museums are intensively used, most office areas are still under-occupied. From field surveys and conversations with real estate specialists, it became clear that most of the offices are merely used for speculative investment, with a third of the offices taken up by foreign investors. According to leading experts from Cushman & Wakefield, the average vacancy rate in Shanghai is about 20%, though in some waterfront projects it is much higher; other office locations such as Hongqiao Hub are preferred due to lower pricing and better connectivity (personal communication, 29 October 2020; see also Hatton, 2020). From personal conversations with multiple users of the buildings, it became evident that the actual vacancy rate is far higher than this average. More than a few buildings are completely empty several years after completion, and were empty even before the start of the Covid-19 pandemic and the US–China trade dispute (Hammond, 2019). There is uncertainty about the actual need for these office spaces. Exemplary is the well-known Shanghai Tower, the world's third tallest and presented as sustainable (it has a LEED Platinum label), but more than a third of its floors have been empty since 2016 (personal communication with users, September 2021)! Such projects provide scenic backgrounds for taking photos, analogous with the crowded classic Bund, where swarms of tourists take selfies with the skyline as background (preferably without freight ships). The new waterfronts mainly facilitate a new white-collar (upper) middle class and tourists. Interviews by students with users on site during the autumn of 2020 revealed that most users are occasional visitors living at least half an hour away by car or public transport. The new waterfronts are still relatively unknown to local citizens, even though local authorities launched multiple publicity campaigns and events along the water, such as marathons and music events. Words such as art, creativity, and innovation are happily used for branding with specific target groups. 'Culture' has become a market currency (Zhou, 2017). While the future of West Bund is not yet sure, the main venue of Shanghai Urban Space Art Season 2017 at East Bund will be reused as a museum for the Chinese Communist Party. Former venues of the Shanghai Urban Space Art Season in 2019 are still empty, with "reuse under consideration" (Personal communication with key stakeholder, 22 May 2021).

In short, the megaprojects along the Huangpu River appear to be primarily oriented to support the desired image of a global city, and to stimulate the economy with investment and tourism. They provide an excellent illustration of 'neoliberalism with Chinese characteristics' (Harvey, 2005). Usability for citizens in daily life seems secondary (den Hartog, 2019; Li & Zhong, 2020). Ecological values will be studied further in another article by this author (den Hartog, in press). Perhaps the inspection of the Yangpu waterfront last year by the General Secretary might change this unsustainable tendency, since he emphasized serving the people (为人民服务) and taking a people-oriented (以人为本) approach, two recurring terms associated with ecological civilization.

Urban planning and design in China is characterized by impressively large investments in advance for public infrastructures (including public space and cultural facilities). This helps to create an attractive environment for investors and citizens, which are expected to come eventually, even after years of vacancy (Shepard, 2015). In the People's Republic, all urban land is owned by the state. Selling land-use rights is a main source of income for local

Figure 6. Multiple vacant offices, here at North Bund, and limitations in the use of public space, here on former Expo 2010 site. Source: Author (Autumn 2019).

authorities. Shanghai's regenerated waterfronts are thus an investment vehicle for the city. Simultaneously, the new skyline and green décor adds to the desired 'excellent global' image and attracts tourists. This speculative approach has strong analogies with the functioning and image of the classic Bund with its line-up of bank buildings, the starting point for international trade and foundation of the former concessions (Figure 7). These 'new bunds' are like enclaves with different regimes, aimed at trade and investment. Though their boundaries are physically porous, they create new socioeconomic limitations and have strong gentrifying effects on the surrounding city. After decades of socioeconomic decline, China is using its current period of prosperity not only to catch up, but also to invest in its future by creating overcapacity in square meters of office space, museum space, and so forth. As long as the percentage of workers in the service economy in Shanghai is significantly lower than in competing global cities such as London and New York, there will be interest in building more offices, even when there is little demand for them yet. From this point of view, the creation of oversupply during economic prosperity can be explained as sustainable development. Still, this causes friction with the before-mentioned common definition of sustainability (United Nations, 1987), especially since unquestionably it is not inclusive to replace affordable working-class neighbourhoods with exclusive (and mainly empty) real estate.

What makes these projects sustainable? Besides the removal of polluting industries and building low-carbon buildings in return, the projects are pedestrian-oriented. However, only half of the real estate clusters are within walking distance of a metro station. All buildings meet the National Green Building standard; in many cases even international labels such as LEED are obtained, although the labels are questionable here (den Hartog et al., 2018). Yet, as described in Sections 3 and 4 the motivation behind the projects is primarily economically based, but goes along with an intention to improve the image and quality of life. Environmental concerns are taken into consideration, but are not yet prioritized (den Hartog, in press). The megaprojects focused on finance and innovation or tourism and creative industries are expected to make Shanghai into an excellent global city. According to Sassen (1991) a global city is a 'post-industrial production site' characterized by strategic transnational networks that support significant specialized financial and producer services that keep the globalized economy running (Sassen, 1991). Shanghai certainly excels in terms of city branding through architecture and new public waterfronts of high quality. In contrast to small-scale urban (living) labs, the

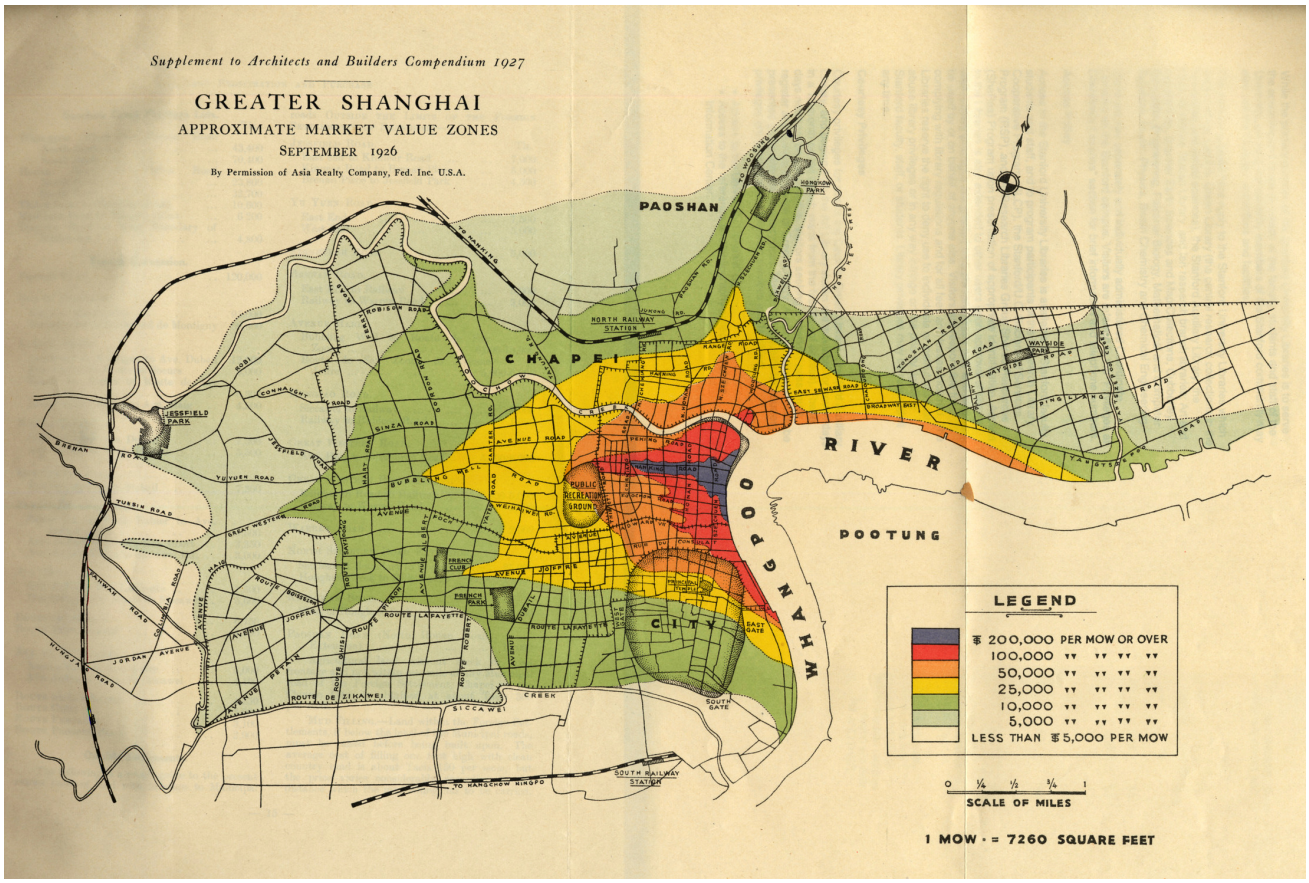

Figure 7. During the period of foreign concessions, Shanghai's Nanjing Road area and Bund (both in purple) became the new heart of the city, and housed multiple headquarters, foreign banks, and shipping companies. The former foreign concessions used to be closed to local Chinese citizens. Source: Brooke and Davis (1927).

large-scale pilot and demonstration projects along the Huangpu River do have an impact: They finance the city, enable the relocation of polluting industries, upgrade the overall city image, and add desirable qualities through place-making and greenery.

Should these megaprojects be considered urban labs as discussed in sustainability transition theories? The quantity and quality of their public space and real estate along the waterfront is impressive. Their 'statements about the future' are robust and shared by multiple actors (Schot & Geels, 2008; Van Lente, 2012), although citizens are excluded (den Hartog, 2019; Li & Zhong, 2020). The projects are also practice-based and challenge-led (Sengers et al., 2016) in their approach. Governance processes in Shanghai involve a complex interplay of multiple groups or departments (Miao & Lang, 2014; Zhou, 2017), and interplay between top-down authority and bottom-up agency (Li & Zhong, 2020), but they operate as one entity that can overrule all non-governmental stakeholders. The local government has absolute ownership and mandate over all urban lands. This makes it necessary to redefine the urban lab as concept in the Chinese context. The term 'lab' suggests that failure is possible, while the terms 'demonstration zone' and 'pilot project' point to an excellent 'expectation' that excludes failure. Thus, the described projects are not as intended to be open-ended (Van de Ven et al., 1999) as urban labs are in the international (mainly European-centred) discourse. System innovation is a controlled process in Shanghai. This means that social learning factors including feedback from end-users have generally been excluded, although some initial steps have been taken to consider that feedback (Li & Zhong, 2020; Shanghai Planning and Land Resource Administration, 2018a). Urban labs are tools to find new forms of urban governance. Experimentation has helped China introduce innovative policies, and local officials are encouraged to experiment to find innovative solutions and to give feedback to help adjust national policy formulations (Miao & Lang, 2014). This has even created opportunities to experiment with 'exemptions' allowing marketization in a planned economy (Zhou, 2017). The government especially encourages innovation clusters as incubators for new industries and as a source of change. Yet, due to the urge to catch-up socioeconomic experimentation in China often resembles making something quickly, followed by adjustments during implementation—i.e., improvising. Urban planning and design is usually an innovation journey based on collecting best practices for inspiration and improving or adjusting them as needed (den Hartog, 2010). This offers unlimited flexibility, especially since labour costs in Shanghai are still relatively low. Compared to urban labs, the described projects in Shanghai are characterised by large-scale functional programming without direct relationship to their context. They are built in a short time, without a clear time horizon or plans for (re)use. As enclaves of 'neoliberalism with Chinese characteristics' (Harvey, 2005) the projects are indeed "niches where disruptive innovation takes place" (Loorbach, 2014).

5. Conclusion and Recommendations

In summary, approaching the demonstration zones and pilots through the lens of urban transition theories is helpful to identify bottlenecks, but the terms 'demonstration zone' and 'pilot' are indeed more suitable than 'urban lab' based on their emphasis on image-building and steering roles. Differences in governance structure, socioeconomic context, scale, stakeholders, and impact, make it necessary to explain the described cases through the lens of ecological civilization philosophy. Adjustment of perspective is needed to be helpful in developing recommendations for improvements in governance and possible new directions. If ecological civilisation claims to be an alternative to global capitalism (Gare, 2020) and expects to bring harmony by balancing environmental, economic, and social dimensions, than the megaprojects along the waterfronts are for the moment not a convincing demonstration of this potential. How can we find a way to adjust or improve the effects of the demonstration zones and pilot projects along the Huangpu? Based on the discussion above, some recommendations can be made.

A first recommendation is to add sufficient (affordable) housing, including new housing typologies aimed at more diversity of households, including young talents. The locations discussed offer sufficient space for a great deal of housing. A returning keyword in the discourse on ecological civilization is 'high quality of life.' Shanghai wants to excel as a global city, attract foreign investment, and offer a comfortable living environment. But in practice, this comfortable living environment is only accessible for a selective upper (middle) class (Chen & Sun, 2007). Such exclusiveness does not add to urban vibrancy. According to interviewed real estate analysts, inclusiveness and diversity in population and housing will result in more attractive urban street life, which is crucial to attract foreign companies and investment (personal communication, 29 October 2020).

A second recommendation is to fill vacant floors (temporarily) with SOHO units (small-office-home-office) and start-up companies. This will add 24-hour urban vibrancy and diversity. This is especially recommended for the former Expo 2010 site. The scale of the current oversupply dwarfs the market failure of Canary Wharf in London in the 1990s (when 60% of the offices were vacant, followed by a revival a decade later). The new mode of working due to the pandemic makes vacant offices even less likely to be used soon, as confirmed by multiple real estate experts worldwide. Yangpu waterfront is already anticipating this.

This leads to a third recommendation that a user-oriented approach is needed in advance, along with a more flexible and open setup able to absorb unexpected shocks (e.g., trade disputes and pandemics); in other

words, what is needed is resilience. The creation of a buffer is only sustainable if oversupply can be changed into other usages easily, instead of being redundant. This fits with the mentioned principles of ecological civilisation and also with before mentioned concept of sustainability (United Nations, 1987).

The formerly inaccessible waterfronts have been made more porous and accessible to the public, but still there are limitations in accessibility. Meanwhile, the thematic corporate and cultural clusters form socioeconomic enclaves, due to their exclusive character and the mode of targeting specific users. A fourth recommendation is improving connectivity with surrounding neighbourhoods by increasing porosity in all cases described (people-oriented for all people). Additionally, lessons should be learned from experiences in other world-port cities, especially New York, where large-scale urban development has been counterbalanced by opportunities for small-scale and grassroots developments resulting in urban vibrancy (Jacobs, 1961).

A fifth recommendation is to nurture the promise of ecological civilisation regarding the reintroduction and stimulation of grassroots elements in governance (Li & Zhong, 2020; Miao & Lang, 2014). This is also explicitly included in Shanghai 2035 (Shanghai Planning and Land Resource Administration, 2018a). More creative, inclusive, and participatory forms of experimentation are needed. For this purpose, studying lessons from urban (living) labs in other countries with consideration of potential scalability is recommended. Vice versa other cities could study cases in Shanghai, since there are promising outcomes in terms of quality, scale, and effectiveness. Nevertheless, tailor-made approaches and adjustments are needed in other contexts because of differences in preferences, appreciation, and governance. Shanghai is in a different phase of socioeconomic development than established global cities and needs to deal with a different audience, with other priorities and expectations.

China's unique socioeconomic journey toward an ecological civilization and sustainability transition will certainly make an impact in Shanghai, elsewhere in China, and even far beyond, such as in the Global South. Ideally, more inclusive experiments will follow and transform Shanghai into a world-leading lab for sustainable transition and innovation.

This study has limitations. Not all stakeholders were able to meet or speak with the author. There might be differences in definition or interpretation, although translation was continually available. The complexity, scale, and impact of the subject offer options for further research on multiple aspects. The timeframe of the current Shanghai Master Plan spans until 2035. Many unforeseen changes could happen in that time. This journey, filled with uncertainty, will continue.

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Conflict of Interests

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Article

Porous Kirkenes: Crumbling Mining Town or Dynamic Port Cityscape?

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Abstract
The great number of actors in port city regions, such as port authorities, municipalities, national governments, private companies, societal groups, and flora and fauna, need to develop shared visions. Collaborative approaches that focus on combined values can help achieve long-term resilience and enable a sustainable and just coexistence of port and city actors within the same territory. However, the sheer focus on economic profit generated by port activities overshadows and ignores equally essential cultural, societal, and environmental values and needs. The lack of pluralities in planning and decision-making processes creates challenges for the cohabitation of the many actors and their interests within port-city regions. On the one hand, contemporary spaces in port cities cannot be classified and defined by traditional dichotomies anymore. On the other hand, the perception of spatial and institutional boundaries between port and city leads to a positivistic-driven definition of a rigid and inflexible, line-like interface physically and mentally separating the port from the urban activities and stakeholders, neglecting the inseparable character of many parts of our society. By investigating and re-imagining the future port-development plans within the historic mining town of Kirkenes, located around 400km above the Arctic Circle in Northern Norway, the aim of this article is to explore and combine the concepts of negative and positive porosity and liminality and arrive at a renewed perception of the port cityscape, which can function as dynamic thresholds inbetween the multiple dualities and realities of various port and city actors. The article bridges the theoretical/conceptual sphere of urban porosity and the practical approaches of liminal design. By using Design Fiction as a tool for creating new, innovative, and pluralistic port city narratives, the article contributes to contemporary research that aims for imaginary, value-based, and history-informed approaches to designing future-proof, resilient, just, and sustainable port cities.

Keywords
borders; boundaries; Kirkenes; liminality; porosity; port cityscape; synergistic and adaptive ecosystems

Issue
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1. Introduction

Next to the construction and expansion of infrastructure and facilities supporting the 24/7 dynamic economic viability of a port, port cities need to accommodate urban functions that are crucial for an expanding city and its region (Hein, 2019). However, a healthy equilibrium within those complex, fluid, and ever-changing socio-spatial patterns in port cities has been disturbed by a growing imbalance of power and voice, leading to global elites engaging in exclusive decision-making processes in local places. Instead of explicitly categorized spaces, precisely defined by functions, clear boundaries, and exclusive user groups, contemporary spaces in port cities unfold through multiple dichotomies, such as global–local; center–periphery, economy–culture, and economy–ecology. In order to accommodate a balance among those flows of materials, people, and ideas produced by the diverse port city actors and their needs, port city regions need to allow for urban porosity. As described by Wolfrum (2018), porosity is an analytical metaphor to describe the fragmentation of contemporary urbanized territories into borderscapes (Harbers, 2003) to accommodate diverse and interrelated flows of people, ideas, and resources migrating from one space to another.

Nonetheless, decision-makers, academic experts, and planners all look at the many dualities, for example pollution–urban development, culture–production, or economy–climate change (PortCityFutures, n.d.) and the simultaneous realities of many actors (e.g., the port authority, national and regional governments, global maritime companies and local entrepreneurs, international visitors, inhabitants of different social ranks) as opposing and conflicting parts of spatially and institutionally separated entities. This creates further division, separation, and negative porosity, that is rigid and conflicting socio-spatial environments, within the urban territory. There is a need to identify, interpret, and highlight all the different stakeholders' values to define strategies and arrive at shared, just, and inclusive visions for a future-proof port-city development. The socio-spatial dimensions, the inevitable contradictions of coexistence, and the possibilities for collaboration of port and city actors remain under-investigated (Hein, 2020). Approaches to port cities from a holistic spatial planning perspective need to focus equally on spatial, institutional, social, and environmental resilience rather than addressing only technological or economic measures (Hein, 2011). Those new and creative imaginaries take place in between the multiple borders of a porous port cityscape.

The purpose of this article is to merge theoretical interpretations and conceptualizations of the porous port cityscape as the permeable fabric between port and city, with practical yet imaginative and creative design and planning approaches, in order to create and maintain urban porosity and accommodate societal and material flows and interactions without functional, spatial, and institutional separation, division, and exclusion. The main goal is to make sense of these porous spaces through spatial planning and design, which is operationalized by the concept of liminality (Turner, 1969). Liminality describes and utilizes the dialectics of cultural, political, temporal, social, historical, and natural dimensions and their coexistence in time and space that create the complex web of interrelations in port cities. A combined approach can help to turn the pores into flexible, open, and connective edges of the urban tissues between the port and the city. These pores—in-between spaces where different values, goals, and needs meet and often conflict—become an experimental and creative threshold space (Moretti, 2020) for synergistic collaboration among port city actors.

The first part of this article gives a broad overview of multiple conceptualizations of borders and porosity within the context of a transforming 'cosmopolitized' and 'networked' society from a sociological and geographical perspective. It explains how technological developments, globalization processes, and the changing socio-spatial and socio-economic compositions in port cities have led to the spatial and institutional separation of port and city entities. The article elaborates on the limitations of a 'false' dichotomy between port and city, which are thought of spatially and institutionally separated when in reality, port and city are inseparable due to their economic, cultural, and environmental impact on each other. The mutual impact provides a strategic base for planning and collaboration. Combining the two concepts of liminality and porosity is vital for underpinning the importance of a historically informed, place-based, and value-driven research and design framework. Such a holistic approach allows for creating new imaginaries of economically sound, socially just, and environmentally sustainable port cities. A goal of those new imaginaries is to question the status quo of decision-making in order to give voice to the otherwise unheard and excluded actors and to elaborate on how their social positions will inform the vision of 'their' port city (Luning et al., 2020).

The second part focuses on bridging the theoretical investigations of part one with the practical research-by-design approach elaborated in the case of Kirkenes, Norway. A synthesis of the author's master's thesis, this part of the article focuses on the operationalization of designing a 'liminal port cityscape' as a strategic socio-spatial environment that will help to re-imagine port cities as one synergistic and adaptive ecosystem. Uncertainties driven by climatic changes, the struggle of being trapped in a 'path dependency' (Hein & Schubert, 2021) of mining history, and a multitude of strongly opposing values of global and regional economic powers, local indigenous cultures and traditions of the Sámi, and a broad section of society being torn in-between create the challenge for sustainable and inclusive development within the port cityscape of Kirkenes. Design Fiction (Bleecker, 2009), as a form of the scenario-building process, can be one of the tools through which spatial practices can mediate the cultural, economic, and ecological needs and values of all interrelated stakeholders in port cities. Within the overarching framework of research-by-design (Roggema, 2016), Design Fiction offers freedom from outdated, monofunctional, and one-dimensional planning and decision-making concepts in port cities, often solely focusing on economic and technocratic criteria. Design Fiction, as a fusion of scientific facts, fictional narratives, and creative design, can become a tool to cut loose from practices that are obviously broken, unsuitable, and restricting and allow for new imaginaries (Bleecker, 2009). Finally, the design of additional value in the form of arising synergies between port and city actors and their different economic, cultural, and ecological values is translated into principles of planning and designing liminality in port cityscape, which can function as the basis for further research and projects.

2. Borders, Porosity, and Liminality Within the 'Port Cityscape'

2.1. Fewer Boundaries, More Borders: The Duality of Porosity

Borders in the form of tangible constructs—e.g., the physical built environment—and intangible ones—

e.g., market forces, governance structures, and social identities—are manifestations of human ties and agencies. They depict the socio-spatial construct of the interdependence of the varying powers and influences of different actors. Increasing transnational flows of money, materials, humans, and ideas, driven by ongoing globalization and technologization, change how modern space is perceived. The so-called 'Spatial Turn' (Rumford, 2006) results in a chaotic and vast transformation of former traditional and dichotomous socio-spatial environments into complex porous spaces with blurry edges between them.

On the one hand, "we find ourselves faced with an extraordinary, little-noticed phenomenon: the explosion of spaces. Neither capitalism nor the state can maintain the chaotic, contradictory space they have produced" (Henri Lefebvre in Brenner, 2016). Globalization produces spaces/nodes of flows and creates a "space of flows" contradicting the "space of place" (Castells, 2000). The loss of measurable space, primarily through digitalization, global economic flows, mass mobility, the fluidity of identities, cultures, and societal constructs, and the dismantling of separating boundaries results in an increase in dualities within contemporary socio-spatial constructs.

On the other hand, the ongoing dismantling of separations creates an overproduction of borders (Moretti, 2017, p. 252). The new spatiality, in which the center and periphery of measurable economic, social, and cultural space become diffused, is characterized by simultaneous processes of reducing, thinning-out, multiplying, and doubling borders. Those processes of 'debordering and rebordering,' or 'waxing and waning' (Rumford, 2006) of borders, are a result of ever-changing socio-spatial flows and interrelations or porosity.

Those two identified phenomena, firstly the deconstruction of separating and impermeable boundaries, and secondly a new overproduction of borders due to an increase of interrelated flows and fixities, shed light on the character of porosity as a concept that describes the intricacy of socio-spatial environments. The growing porosity of borders, acting less like a boundary, and therefore the increased potential for many different actors to change, shift, and cross them creates a state of complexity within the urban space that allows for a diversity of identities and cultures and social interactions. The ambiguity of the multiple patterns of power, identity, and territoriality within the socio-spatial environment, shift the focus on the border as the conceptualized space itself by giving it a variable three-dimensional thickness. This positive connotation of porosity becomes the potential of the space to accommodate a balance between the interrelating tangible and intangible interests of economic, cultural, societal, and environmental flows and fixities.

Nonetheless, the sedimentation of unequivocally describable and manageable entities goes hand in hand with an increasing number of regional, even global, decentral, and autonomous levels of governance and power relationships. The result of sheer individualism created by this multiplication and doubling of the borders due to interrelated but conflicting agencies often do not seem to know commitment or good reason and finally disbands any form of collaboration from which might emerge common ground and commitment beyond individual benefit. From such a point of view, an increase in porosity can become the reason for renewed segregation and division, especially when governance and decision-making processes are unbalanced and within the power of elites. Therefore, the dominance of one-sided imaginaries of urban spaces leads to increased isolation, disconnected porous space, and the unheard voices and needs of ignored actors.

2.2. The "Non-Place" Port and "Non-Port" City Interface

Looking at port cities as porous and complex land/sea-scapes, in which the port and its actors become a nodal point within a global network of flows and meets with cities' "space of place" (Castells, 2000), can show the two-sided edge the concept of porosity brings with it.

On the one hand, porosity can help describe the need for a flexible, permeable, and multi-functional urban fabric, allowing for connectivity and interaction across its borders and absorbing flows of people, materials, and ideas. Port and city once were a single integrated and non-divided entity, a unique phenomenon of maritime urban culture. No boundaries existed between the various functions diversely used by different actors at different times within the same space.

On the other hand, porosity in port cities is strongly related to the "efficiency and instrumentalization of reason" that comes with spatial and institutional separation of functions and governance (Wolfrum in Haenni, 2020). Within the past sixty years, when ports increasingly needed to compete within a globalized economic market, this spatial, functional, and administrative integrated symbiosis decayed. Innovations in cargo handling, like containerization, growing ship sizes due to increasing demand for goods and materials, and the technologization of infrastructures have led to the transformation of existing port structures and the emergence of new facilities in the outskirts of cities (Daamen & van Gils, 2006; Hein, 2016; Pinheiro & van Dijk, 2011). The exodus of ports out of host cities has gone hand in hand with the separation of port cities into two different administrative entities.

The transformation of the port into a node within a global economic network and the accompanied expansion of this network towards the maritime foreland and the regional hinterland shifts the focus of the port-city relationship away from the traditional waterfront towards the notion of 'scape' (Appadurai, 1990). The constant dismantling and the re-urbanization of obsolete port milieus within the city environment might have led to the reconnection of the city and the sea but it also supported the ongoing transition of port and city into two spatially and institutionally separated entities

(Ducruet, 2011). The emerging administrative boundary creates a division between urban and maritime activities. The emerging port city interface (Hoyle, 1989, 2000) becomes an interactive economic system of openness and connectivity. However, it often creates the narrative of a localized, cross-sectional, and line-like administrative, spatial, and functional boundary between port and city, limiting collaborative governance and collective planning approaches among actors.

As a result, this 'false dichotomy' of port versus city, local versus global, economic versus social versus ecological, as separated and contradicting spatial and institutional systems, keeps port city actors, decision-makers, and planners from seeing alternative relations, narratives, and new possibilities within this web of interrelated complexity. The contemporary decision-making processes between actors and the resulting developments of planners in port cities are defined by homogenous, measurable, and dividable, spatial, political, economic, cultural, and environmental contexts. Those contexts are "a polite but potent word in repressing anything that does not fit in" and therefore is "insuring that nothing sticks out, offends, or challenges" (Sennett, 2006). From an interpretive and designing perspective, the port city seems to get robbed of a milieu that allowed open structures, connectivity, and transition. These unique socio-spatial environments, which created a distinctly urban-maritime character or 'portuality,' as described by Moretti (2020), have become victims of a renewed separation and division and turns places into spaces lacking identity. The consequences are porous voids in the form of "non-place" ports and "non-port" places (Augé, 2008; Tang, 2012), caused by overdetermination and integration of the same, thus spatially separating the opposite.

2.3. Liminality and Porosity: Betwixt and Between Port and City

How can spatial research, planning, and design professions add to the already diverse and rich studies of port cities and use their strength as holistic professions combining social, political, cultural, environmental, and technical research skills with artistic and aesthetic representational ones? The rigid physical environment in port cities that evolved through many transformation processes can neither accommodate the ambiguous, plural, heterogeneous interrelations of actors nor a sustainable balance between economic, social, and ecological needs and values. Looking at urban porosity means looking at the 'betwixt and between,' the space of contradictions that creates frictions and opposition but has the ultimate potential to erode the rigid porous urban fabric of conflicts to create a permeable porous space of social, economic, and environmental interaction and collaboration.

Sennett (2006) calls those permeable pores 'ambiguous edges' that work as the interaction-space between the physical creation and social behavior of multiple city agents. Within this context, globalization and its impact on the urban form "deborders" the historical boundaries, the center, and the periphery of the port city and transforms the borders between port and city into a 'port cityscape' (Hein, 2011). Therefore, the focus needs to be set on a port city interface working as a liminal space (Hayuth, 1982). Such a perception accepts the ambiguity of time, space, human beings, or whole societal groups, resulting in 'Paradoxsynergy Scape' (Höller, 2020) or a threshold space of variable thickness (Moretti, 2017).

According to the anthropologist Victor Turner, the 'betwixt and between' or 'neither here nor there' leads to an in-between of two identities. Different from simply 'between,' this liminality, where socio-spatial environments have not yet transformed from one status to the other, ultimately focuses on the in-between place, trying to bridge the "what is," as the transition within space and the "what will be," as a transition in time (Turner, 1969). These scapes 'betwixt and between' port and city are filled with the heterogeneity and incomparability of different agents, their agencies, and their often oppositional and competitive values and interactions. This plurality describes the hybridity of spatial and temporal conflicts and their sensemaking, which is the inescapable reality when dealing with porous liminal spaces.

By combining the concepts of porosity and liminality, spatial planning can gain operative force in envisioning and imagining those porous spaces of "unnameable hybridity" (Koolhaas & Mau, 1997, p. 969). Liminality allows for adapting to those fluid conditions within the porous fabric of the port city by experimentally manipulating the dualities and exploring the effect of interventions on the contemporary situation. Finding combined and shared values between the multiple imaginaries creates the opportunity for the coexistence of various stakeholders and for defining the port city as one 'Synergistic and Adaptive Ecosystem,' which is bigger than its parts. The design of those liminal porous scapes, being one of many possible solutions, rather than an ultimate masterplan, requires creative thinking to trigger unexpected, innovative, flexible, yet specific and carefully investigated hybridities within the spatio-temporal environment of the port cityscape.

3. Switching Lenses: Research and Design of the 'Betwixt and Between'

3.1. Kirkenes as a Liminal Playground

This section connects the theoretical and conceptual base and the liminal design approach of a future port city development within the case study city of Kirkenes. By combining the concept of porosity and liminality, the goal was to develop an imaginative and experimental, multi-scalar, and multi-perspective approach. This approach utilizes the conceptual shift from a simplistic and binary interface between port and city towards a complex port cityscape that widens the research and

design perspective to include the liminality of the borders by giving them variable thickness and thresholds. It uses the fictional design framework of the Leiden-Delft-Erasmus Port City Futures Program, which emphasizes value-based approaches and focuses on understanding historic spatial-temporal transformations within the urban fabric in order to inform future design and planning decisions. The project elaborates on new maritime mindsets in the form of alternative urban development trajectories. Those fictional scenarios trigger and incentivize regional integration and synergy between ports as entry points into global dynamics and the city as a place-specific urban environment.

Researching port cities as open, pluralistic, and dynamic urban environments is a paradoxical, liminal process itself (Sennema, 2020). The project's first step was to identify the societal, economic, and natural actors by drawing, mapping, and describing the current landscape of various borders on land and sea. The Arctic, with its high contrasts of diverse natural and human actors, the need for economic development, and the necessity for climate change adaption, offers a unique variety of dualities, where the liminality of land- and sea-scapes becomes an indispensable factor in understanding the current configuration of the region.

The sparsely populated harbor town of Kirkenes, founded in 1905, is located more than 400 km above the Arctic Circle. Although now of relatively little economic significance, the former mining town near the Norwegian–Russian border has strategic importance. It is one of the main areas expected to change due to increasing navigability within Arctic maritime territories. As the self-claimed Capital of the Barents Region, Kirkenes is seen as becoming Europe's gate and a new logistic node in the soon-to-be ice-free Northern Sea-Route, creating a 40% faster trading route between Asia and Europe (Ministry of Transport and Communications, 2019, p. 4). As part of China's "Polar Silk Road" initiative, but also because of the growing international interest in oil and gas reserves within the Barents and Norwegian Seas, new development is planned for the port of Kirkenes, which currently serves the fishery and oil/gas industry within the Norwegian and Barents Sea and is a turning-station on the Hurtigruten Post-Boat cruise-ship route between Bergen and Kirkenes (Figure 1). Since the closure of the iron ore mine, the driver of the constant boom-and-bust economy and of urban development, the city has struggled to script legitimate scenarios for its future. Despite the efforts to reinvent Kirkenes and change its face from industrial development towards a future-proof Barents Region, historic and current mining and other industrial activities prevent the region from escaping its path dependency as a mining and industry town. Furthermore, many other stakeholders imagine a different future for Kirkenes, one of a future-proof, sustainable, and resilient port city that retains the region's remote character, rich in seemingly untouched nature in close relation to the well-being of the Sámi, the only officially recognized indigenous people in Europe, who have inhabited the territory for thousands of years.

As a second step, one needs to see the identified actors and their often conflicting values in close

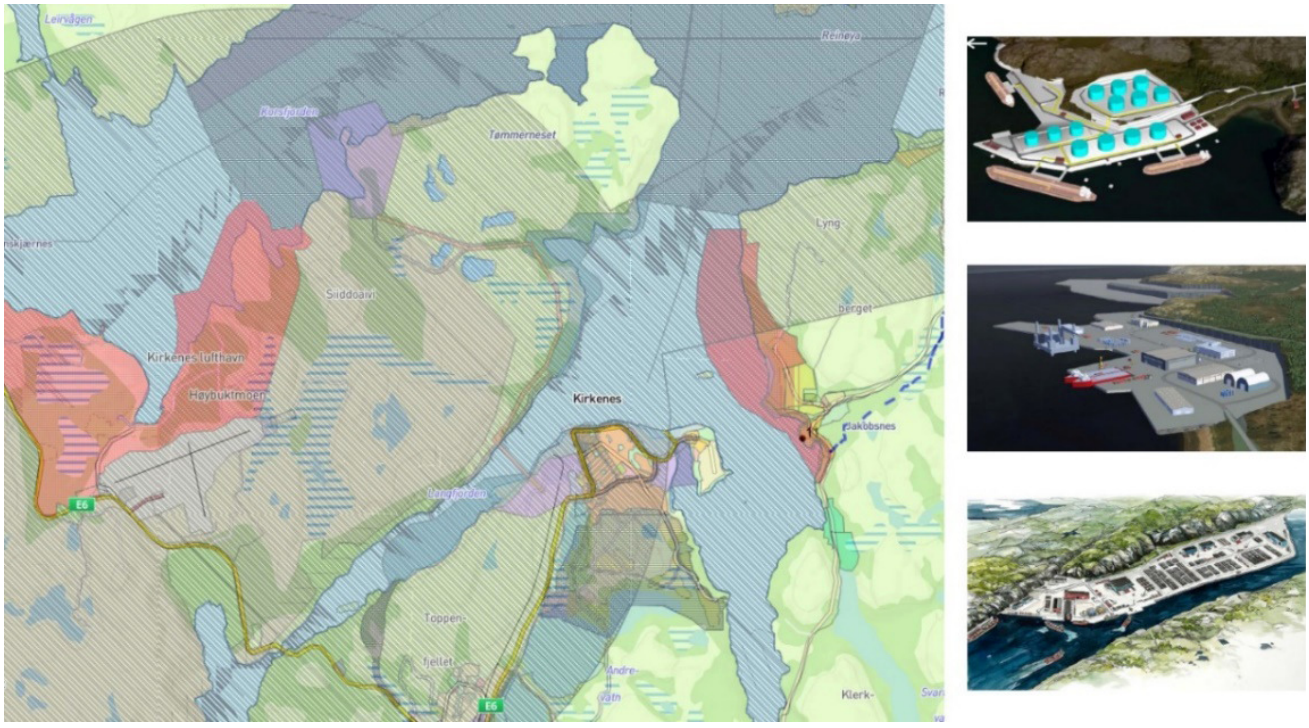

Figure 1. Extract of municipal map of Kirkenes showing the two last remaining options for the potential new port development at Leirpollen or Slambukta. Sources: Statens Vegvesen (2015) and Norconsult (2020).

interrelation. Quantitative often positivistic data and numbers are essential for understanding administrative as well as technical, functional, environmental, economic, and cultural processes within port cities. Still, it is only possible to fully understand the interrelations when those data are set into a physical-geographical context. Therefore, mapping the actual place-specificity of the borders where the physical limits of two spatial territories coincide with the administrative one is pivotal (Hein, 2016). Together with the National Government, the municipality envisions a new and massive extra-urban port development along the neighboring peninsula, transforming the currently small port into one of Scandinavia's biggest container ports, equivalent to the current capacity of the Port of Gothenburg (Höller, 2020).

Furthermore, logistic and supportive railway activities in the form of an internationally envisioned Arctic Railway (Ministry of Transport and Communications, 2019) will connect the proposed port in Kirkenes with Rovaniemi, Finland, and create access to trade flows towards the Baltic Hinterland and Western Europe. On the one hand, the opening of faster shipping routes between Europe and Asia and the increasing reachability of newly discovered and valuable fossil and mineral resources in land and sea, driven by global warming and its accompanying effects on the retreating sea-ice, is increasing the international interest for strategic port and maritime developments within Arctic territories. On the other hand, the regions' remote and natural state is endangered by this two-sided impact of natural changes and anthropogenic activities. Furthermore, a mismatch between the local needs of inhabitants and natural participants, e.g., the large variety of animal and plant communities, and global, primarily economic interests, pressuring and disturbing the often fragile socio-ecological system of the 'High North' creates further frictions and conflicts (Figure 2).

The planned port development in Kirkenes can be seen as the socio-spatial manifestation of the 'between' in the meaning of managing and regulating conflicts of spatially and institutionally separated entities, e.g., between the reindeer herding activity of the Sámi and the new port operation (Figure 3). However, the outsourcing of port infrastructure towards the coastline of the neighboring peninsula and the continuous dismantling of the port's milieu, which is currently embedded within the urban environment, weakens the perceived interrelation between port and city activities, needs, and goals. The physical as well as institutional separation of port and city disables spatial planning's ability to become a mediator for sensemaking between the different entities, their actors, and their corresponding values, goals, and wishes, even though overlapping values exist. The current municipal plan of the port infrastructure, where port and city are spatially disconnected and function as separated decision-making institutions, emerges an accumulation of singular territories. Those territories are divided by boundaries and create an impermeable, inflexible, and unbalanced socio-spatial port-city environment that supports the creation of friction and neglects the possibility of coexistence, collaboration, and synergistic partnerships within shared space.

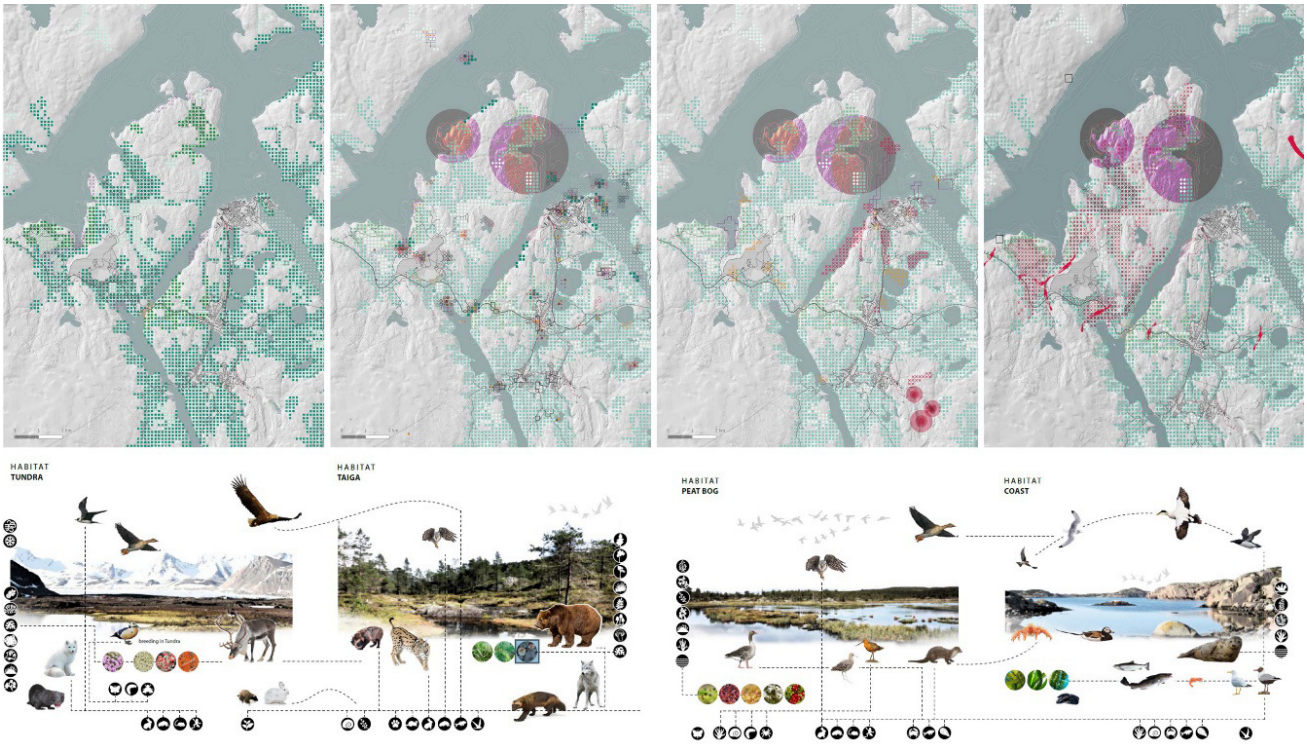

Figure 2. Series of maps overlapping different ecological territories with the friction area of the proposed port development by the municipality. Source: Höller (2020).

Figure 3. Cree leaders join an anti-Arctic Railway demonstration of the Sámi in Finland. Source: APTN National News (2018).

3.2. 'Betwixt and Between' Friction and Fiction: Designing the Liminal

> It is unknown, thus science fiction provides opportunities for an epistemological version of a future in which it is known. (Larsen & Hemmersam, 2018, p. 45)

The re-imagination of the port city of Kirkenes can profit from the concept of porosity and liminality. Such a re-conceptualization can help develop imaginative mental images and experimental representations of alternative socio-spatial port city environments and help create a base for a new socially just, economically prosperous, and environmentally sustainable maritime mindset or 'portuality' (Moretti, 2020). The design proposes socio-spatial environments that are neither part of the port´s nor part of the city's territory allowing for multiple narratives, values, and needs of different port and city actors to coexist (Figure 4). By utilizing the concept of liminality, this approach bridges the 'what is there' and 'what is to come' to re-imagining the port cityscape of Kirkenes as flexible, innovative, temporally dynamic, and multi-layered urban pores.

The most crucial step of the design process is to physically and mentally re-locate the globalized port back into its localized context, which increased the strategic and reflexive awareness for new possible forms of collaboration and coexistence of functions and values in time and space. The fictional design of the Port of Kirkenes works as a form of counter-mapping, allowing the territories of port and city actors to be redrawn so that actual liminal 'ParadoxSynergy Scape' in-between their edges can occur (Höller, 2020). The main proposal is a floating port structure located between Kirkenes' current waterfront and the coastline of the neighboring peninsula, where the municipality officially proposed the port. This step is essential in giving thickness and consistency to the porous space in between sea and land that becomes the liminal accumulation zone of the imaginative and creative richness of the new 'portuality.' Intentionally juxtaposing contradicting elements within Kirkenes' land/sea-scape initiates a sensemaking process that allows for a gradual transition in between two or more port city realities. Implementing a floating port as a design concept creates new spaces for coexistence, collaboration, and synergy between the various dualities. This conceptual decision led to four unique, explorative, and synergistic new port cityscape: the Floating Port, the Reindeer-Energy Port, the Urban Port, and the Wetland Port (Figure 6).

3.2.1. Floating Port

The Floating Port (Figure 5) functions as the overarching and connecting conceptual construct and allows for the emergence of the other three land-sea, port-city, global-local 'ParadoxSynergy Scape.' The floating structure also combines multiple technological innovations aimed at increasing capacity, adaptability, and flexibility for global maritime trade, with ecological adaptation strategies that focus on a healthy local coastal environment. Using underwater storage facilities for containers, the compactness can reduce the use of land by otherwise large-scale logistic infrastructures. The principle of creating flexibility and open endings in design anticipates the need to adapt to future economic or environmental changes and challenges. For example, a floating port can be easily dismantled and shipped to newly emerging and more essential trading grounds, e.g., deeper in the Arctic maritime territory. Also, technological progress, such as transforming containers into the actual shipping and logistic device itself, can lead to new development strategies. The storage of containers at local port facilities is no longer necessary; thus, such obsolete space can be made useable for other port city functions. In such a future projection, the underwater container storage used as infrastructure within the global value- and logistic chain of port activities can now be reused as an

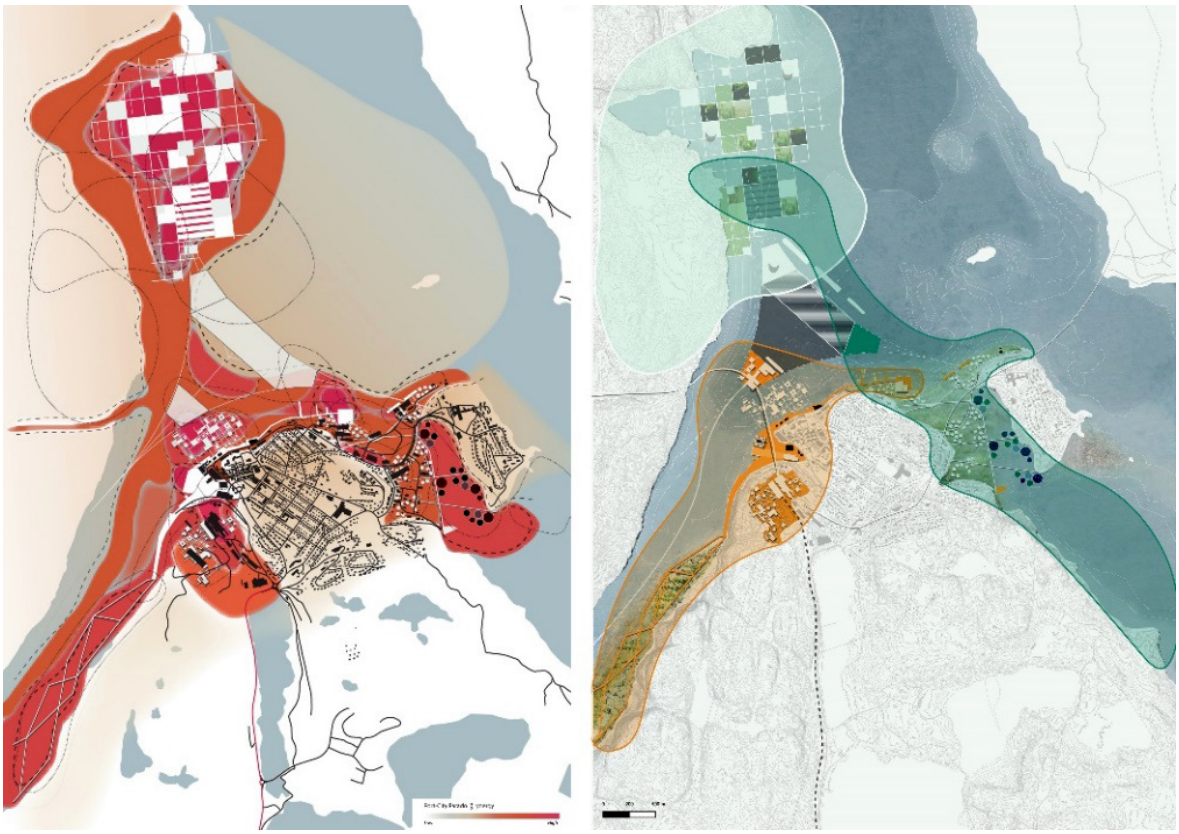

Figure 4. The synergistic interrelations between local specificities of the city and its surrounding and the port, resulting in a multiple set of spatial and temporal implementations and interventions. Source: Höller (2020).

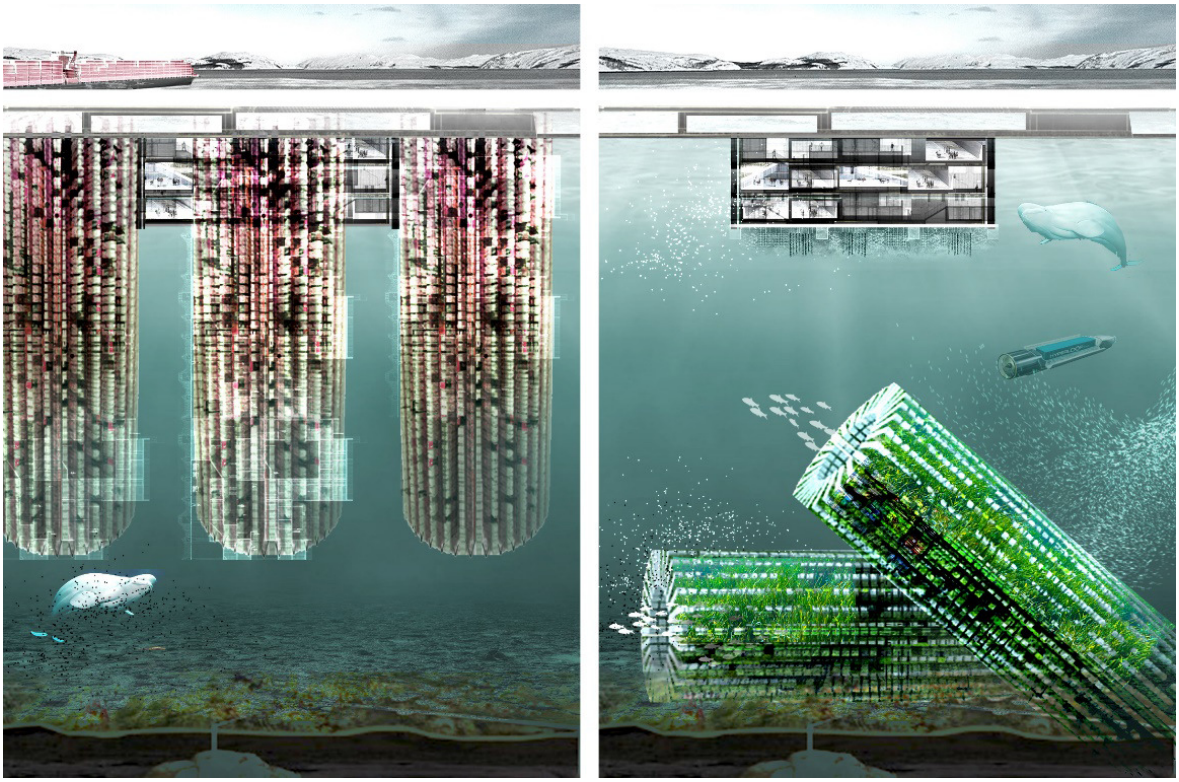

Figure 5. Imaginative and fictional design of the proposed floating port transforming from container-storage to an artificial reef for the aquatic ecosystem. Source: Höller (2020).

artificial reef to support local maritime flora and fauna. By connecting the global values of maritime trade with the local goal of an adaptive, flexible, and environmentally sustainable coastal region, the contradicting liminalities interrelate through space and use. However, they are separated by the factor of time. This hybridity creates liminal scapes in between the needs of different port city actors by including design strategies that focus on a future transition of space, technology, and flows from the port to the city sphere.

3.2.2. Reindeer-Energy Port

The first of the three emerging imaginative liminal spaces is the Reindeer-Energy Port, located along the land-sea continuum between the floating port structure and the Tømmerneset Peninsula. This port cityscape's liminal and pluralistic character derives from the land-use conflict between local/regional reindeer herding activity and the proposed development of the port and logistic facilities along the peninsula. The spatial design imagines a port city environment where the contradicting and currently conflicting dualities of the local cultural and economic practice of reindeer herding, a vital part of the indigenous Sámi´s socio-ecological livelihood, and the proposed global maritime activities can coexist and even create synergistic values for each other. On the one hand, the specific symbiosis of algae and fungus is an essential winter food source for the reindeer, currently becoming scarce because of climatic and pollution impacts. On the other hand, the symbiosis mechanism functions as a potential natural producer for hydrogen to potentially fuel ships with a sustainable alternative to fossil oils in the near future.

The Design Fiction equips the edges between the port facility and grazing ground with a Floating Lichen Farm. The intervention bridges the spatial and institutional sphere of reindeer herding and grazing on land with the artificial farming of lichen for nature-based hydrogen production. The design provides a space of coexistence and synergy production between the Sámi and their reindeer as cultural and ecological stakeholders, the new technological production of sustainable fuels for maritime logistic and shipping companies, and the economic distribution of alternative energies by the municipality. Based on the different spatio-temporal dynamics of reindeer herding, which mainly takes place on this specific location in the winter months, and maritime shipping activities, which mainly peak in summer, due to retreating Arctic sea ice, the Floating Lichen Farms are used by different actors for different activities during different temporal segments. This form of liminal design allows the port cityscape to change its spatial form and size and the occupation by different actors and their related activities depending on different periods. In the winter, space is used as an additional reindeer herding and migration area. Part of the Floating Lichen Farm functions as grazing and sheltering space for the reindeer. During the summer, the platform works as a hydrogen production facility and functions as a recreational and tourist hot spot within the artificial land-sea ecosystem between the lichen farms. Such a temporally separated but spatially shared use of territory needs institutional collaboration and integrated planning.

3.2.3. Urban Port

The second 'ParadoxSynergy Scape' of the new synergistic and adaptive port city ecosystem of Kirkenes is the Urban Port. Here, multiple dualities between the global and local port and city actors as well as their economic, cultural, and environmental activities create the liminal design of the socio-spatial environment. The new narrative aims for new, future-proof and hybrid configurations of port operations that can be integrated with the city´s urban fabric, allowing for coexistence and creating mutual benefits and shared values. First, the design proposes a new cruise ship terminal as part of the floating port, which serves the needs of global tourism, which plays an essential economic role for the region in and around Kirkenes. The new multimodal transport hub connects the various sea-and land-based transport infrastructures, such as cruise ships, regional ferries, the mining train potentially being redeveloped for local commuting, and the newly proposed Arctic Hyperloop into the Norwegian and Finish hinterland as an alternative to the proposed Arctic Railway. As a local centerpiece, a floating extension is proposed of the urban residential area, in the form of housing and recreational activities in between the global cruise ship terminal and the local waterfront.

Embedding global tourism and mobility functions in the city's local context allows for renewed multifunctionality and ambiguity of the port city milieu. The permeable and porous in-between scapes can accommodate shared or combined activities. Spatially and temporally layering those activities allows for the coexistence of non-integrable port and city values and achieves a compact spatial development. Furthermore, the design transforms flows of resources and materials from global into local value chains and vice versa. The new narrative looks for the transition of the current function of the port, which functions as a bulk port for iron ore and as a service and maintenance port for regional fishing and maritime oil and gas exploitation, into a makers' district that focuses on circularity and the re-purposing of global resource flows for local usage. One example is the re-purposing of mining waste, which is currently dumped into a nearby fjord and causes environmental problems: They are used as building materials for the local construction industry. Within such a development strategy, the infrastructure and facilities of the mine and the bulk port, which also have significant cultural importance, can be reused to become a circularity hub. Simultaneously, the former dumping side along the fjord can be gradually re-natured and used as an

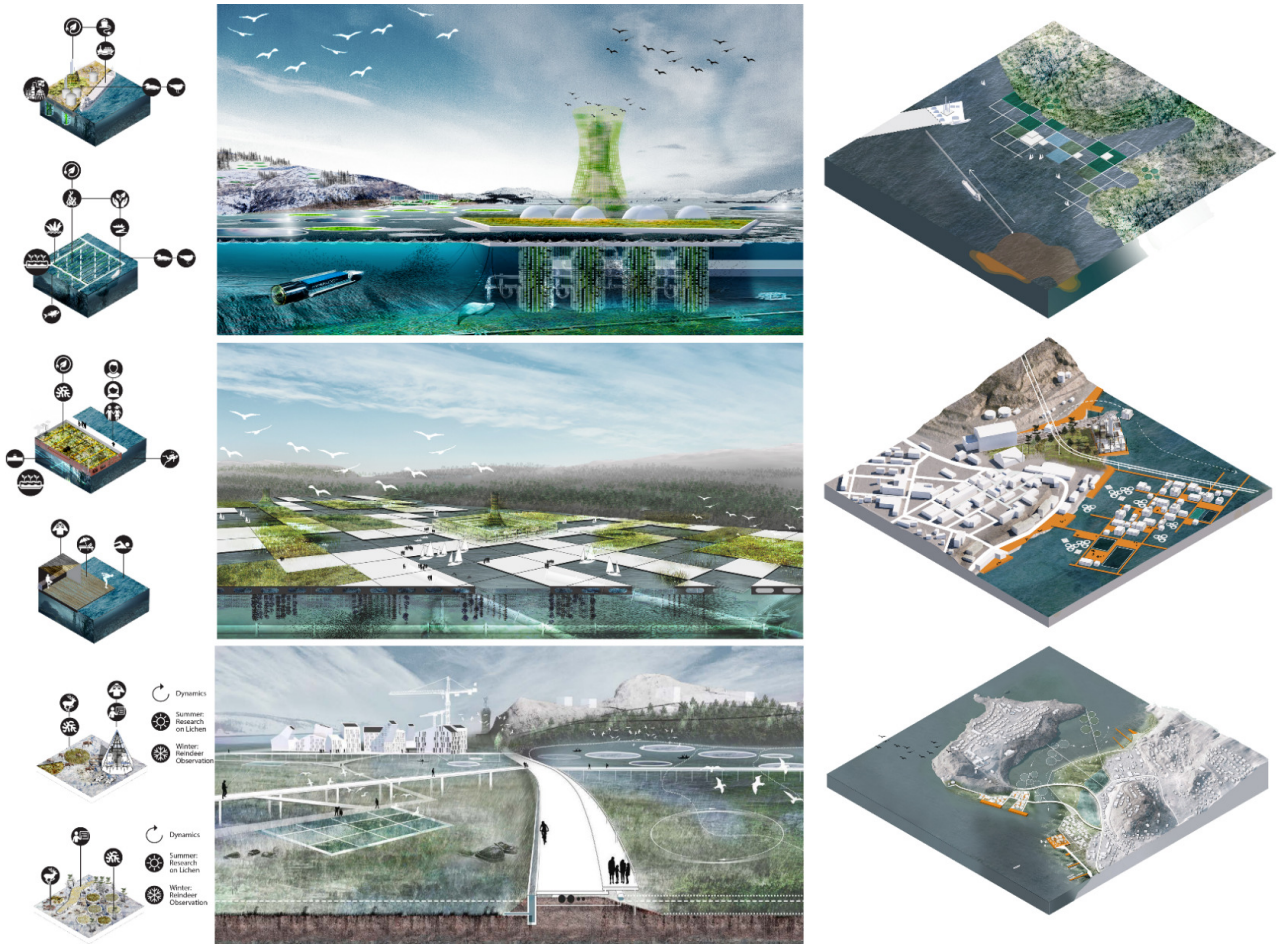

Figure 6. Visualizations of the three "ParadoxSynergy Scapes": Reindeer-Energy Port, Urban Port, and Wetland Port. Source: Höller (2020).

artificial beach for recreation and eco-tourism. Another example is the reuse of the obsolete dry-dock and repair hall. While the new dry-dock will be relocated towards the floating port structure, the old facility can re-purpose global maritime scrap materials and recycled shipbuilding resources. Those can be used to produce urban building blocks for the local floating residential area and the makers' district, using the culturally significant but obsolete maintenance crane as a device for self-adaptation.

3.2.4. Wetland Port

The Wetland Port is the third and last area envisioned during the fictional design. The strategy aims for the notion of port cities as natural ecosystems and highlights their interrelation with maritime and coastal natural and cultural resources. The design envisions a liminal port cityscape where fishing activity gradually shifts from being part of a global/international economic activity in marine or coastal areas of the Barents Sea to being part of the local culture and livelihood of independent fishers. The area between Kirkenes and the Prestoya Peninsula, which has been reclaimed for the development of port facilities and other commercial activities, will be re-natured as an intertidal wetland, interconnecting local and global fishing, local living, and global tourism and it will function as a new artificial ecosystem for maritime and terrestrial plant and animal communities. The proposed production of fish, algae, and other maritime products for regional and local supply allows combining flows of humans and resources from both spheres and integrating them into one liminal design. One of the main design decisions is the development of a food hub located on one of the obsolete quays, which encounters the floating fishing hub used for commercial and large-scale fishing activities. On the one hand, this hub can accommodate international fishers, mainly from Russia, and bring them and their product closer to the local inhabitants and global tourists. The food hub can be used as a square for weekly markets and events. On the other hand, local food producers can use the food hub to distribute and sell the unique and local seafood products that the algae and fishing aquaculture will produce within the re-natured intertidal wetland to local and global end-consumers. The global maritime shipping industry's waste products—e.g., greywater and food waste from cruise ships and waste from the commercial fishing industry—will be cleaned and reused as nutrients

for local seafood production. The new wetland works as a living machine, a nature-based wastewater regeneration facility that helps to circularize waste flows, offering service, production-related, recreational, and environmental value to global and local port and city actors equally.

4. Conclusion

Looking at port-cities through the combined lens of porosity and liminality can help elaborate the translation of conceptual elements and finally arrive at principles and strategies that can help plan and design flexible, innovative, connected, and permeable 'Port Cityscape' (Hein, 2011). Those new imaginative and liminal hybrid spaces profit from the dynamic, multi-scalar, and complex relationships of economic, environmental, cultural, and political actors and institutional decision-makers. The careful sensemaking of relationships in the form of a physical design and governance strategies enables the port city to become more than the sum of single elements and allows it to withstand the uncertainties and create future-proof synergistic opportunities. Approaching the port-city as a complex land-/sea-scape from a spatial perspective makes it possible to overcome universalizing outdated approaches and monofunctional developments that have been mainly focused on managing separated port and city entities. By gradually elaborating on the theoretical and conceptual elements of porosity and liminality, the article makes a methodological shift away from mainly focusing on rigid and inflexible line-like boundaries between port and city towards port-cities "as [a] system or as a concept or as a series of mechanisms that, collectively and individually, link port and city" (Hoyle in Moretti, 2017, p. 251). By elaborating on the dualities and resulting synergies between different agents and by investigating flows and dynamics instead of focusing strictly on either the city, the port, or the ecological shifts, the focus is on the in-betweenness of port and city and spotlights the port city relationship as the result of many pluralistic, contradicting, heterogenic, complex and often confusing social, economic, and environmental dynamics: "Instead of thinking of places as areas with boundaries around, (places) can be imaged and articulated moments in networks of social relations and understandings "(Massey in Raffestin, 2012, p. 126). The article's conceptual and practical investigation of port city liminality and the gradual threshold between different physical and non-physical realities represents only one experimental approach dealing with the exploration and re-imagination of future port cities. However, there is a need for more experimental and imaginative projects focusing on port cityscape as porous and fluid 'scapes,' that combine theoretical/conceptual work with practical, designing, and planning approaches. Spatial planners, as part of a holistic and interdisciplinary team of professionals, can help translate and facilitate the needs of all heard and especially unheard stakeholders to create a future-proof built environment that goes beyond the paradigm of the waterfront. Spatial planners can thus redefine port-city-region relationships worldwide. Spatial planning as holistic, maybe even liminal professions can become the mediator between the many local and global stakeholders, including human/natural inhabitants, economic entrepreneurs, and academic professionals, thus gaining operational power to help research and design future, sustainable, and adaptive port cityscape.

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Conflict of Interests

The author declares no conflict of interests.

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Article

Materiality in the Seam Space: Sketches for a Transitional Port City Dome District

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Abstract
Biomass material volatility generates new opportunities for port-city relationships. Alternative energy markets require specialized port facilities to handle new bulk commodities like biomass. Wood pellets, a type of biomass, present warehousing challenges due to combustion danger. The industrial response to this risk has generated new storage forms for port regions. The return to bulk cargo reintroduces materiality as a focus for port city research, which had generally been regarded as a peripheral concern since the advent of the shipping container. The container had come to represent a borderless, 'fast capitalism' throughput model, but research on port 'accidents' has complicated this reductive globalization narrative. The programmatic dynamism of wood pellet dome structures suggests new spatially-porous possibilities for an interstitial border space at the port-city interface with material commonalities and hybrid potentials for resilient logistics and civic facilities. In contrast to container cargo unitization, the dome signifies the standardization of the coastal/riparian port environment. Dome structures can help ports plan for the complex challenges of cargo material behaviors and increasing extreme weather events. The article begins with wood pellet materiality to then explore programmatic possibilities that industrial construction technology generates. Conceptually, this joins the proposal of port as 'seam space' with port-city resilience planning and the porosity celebrated in recent urbanism literature. Scaling up from wood pellet materiality to an interstitial port-city district, the article contributes to calls for increased attention to materiality as a means to envision new urban agendas.

Keywords
biomass; energy transition; logistics; materiality; port geography; seam spaces

Issue
This article is part of the issue "Planning for Porosity: Exploring Port City Development through the Lens of Boundaries and Flows" edited by Carola Hein (Delft University of Technology, The Netherlands).

1. Introduction

Wood pellets are a category of biomass, an alternative energy that is part of a larger international strategy for climate change mitigation through carbon reduction (Gumundsdottir et al., 2018, p. 579; Jenkins et al., 2018; Ramos, 2020). Alternative energy markets require specialized port facilities that can handle new bulk commodities like biomass (Dafnomilis, Lodewijks, et al., 2018), which balkanize shipping consolidation around container port facilities. Wood pellet warehousing presents challenges due to dangers of material combustion (Huang & Rein, 2016), and the industrial response to this risk introduces new storage forms to port regions. The return to bulk cargo raises materiality and its behavior as a focus for port city research, which had heretofore generally been regarded as a peripheral concern with the advent of the shipping container (Gregson et al., 2017). Biomass material volatility—the very potential energy it is transported for—presents challenges that also generate new porous possibilities for port logistics, port-city relationships, and broader port geographies. The issue's theme on port geography and its managed borders is an opportunity to ask how empirical, interdisciplinary study of port functionality and trade flows can inform porous planning practices celebrated in contemporary urbanism literature.

Recent port-city research describes urban waterfront environments as "hybrid (and complex) locations of

ecological, economic, and social zones of transition and dispersal" (Taufen & Yocom, 2021, p. 366). Geographer Deborah Cowen (2010) proposes the concept of ports as 'seam spaces' to describe this hybrid condition, within the broader logistics 'space of action' between production and consumption. Increased militarization of urban spaces and global trade routes rely on digital surveillance rather than physical walls for what Urbanist Stephen Graham (2010) terms 'ubiquitous borders'; everywhere yet no *where* (Cowen, 2014; Khalili, 2020). The port is a node within a broader metropolitan matrix, communicated through overlapping networks of electronic information and transportation, which become more determinant for issues of access and flow than traditional political borders (Wall, 1999, pp. 234–235). Yet in spite of literature that underscores port-city hybridity, transition, and metropolitan infrastructural integration, port-city spatial separation continues to pose planning challenges (Carpenter & Lozano, 2020; Hein & van de Laar, 2020; Yu et al., 2020).

In addition to the programmatic and spatial separation of port from city, there are also the ever-increasing risks of sea-level rise and climate change that disproportionately impact port cities. There is now an extensive literature concerning the need for integral planning and design for port and port-city resilience in the face of these risks (Cutter et al., 2008; Cutter et al., 2010; Meyer, 2009; Pelling & Blackburn, 2013; Ramos, 2021; Rebuild by Design, 2021).

The risk of biomass combustion in warehousing has generated constructed material solutions in dome-shaped silos designed to safely store wood pellets in transit. The dome material is also used for shelter spaces to protect communities during extreme weather events. New social opportunities emerge for porous port-city interface when we consider that biomass storage silos can also be programmed as community shelters. An interstitial district with programmatic hybridity could take advantage of building material resilience for improved logistics management against freight 'accidents' (Gregson et al., 2017), while also mitigating the climate risks that port cities increasingly face. Building on materiality and continuous surface research in architecture (Picon, 2020), and that of urban surface programming (Wall, 1999), the article suggests materiality as a renewed field of port city research for logistics and resilience.

The article begins with a selective overview of the literature on porosity and the city, and a review of supply chains, port technology, flows, and borders. After a brief discussion of the port's role in energy transportation, the article then looks at the emergence of biomass as an extractive alternative energy source, and the particular material challenges it poses as it is 'unitized into freight' and transported internationally (Arboleda, 2020; Gregson et al., 2017). After, the article traces the emergence of the dome construction technology and its resilient application in logistics and civic facilities. The article then proposes an interstitial district, further integrating port and city, comprised of dome structures for resilient programmatic hybridity in the face of increased material warehousing and extreme weather risks. It is precisely the dome's hermetic protection for each structure—warehouse, school, church, museum—from internal and external threats that could join those programs, often separated in port cities, to form new porous districts between port and city and better communicate the two. The article's speculative proposition—from the scale of material behavior to the broad spatial considerations of port-city interface—offers sketches of a more integrative, resilient urban agenda for international port geographies.

2. Porosity and Ports

Recent urbanism literature has retrieved Walter Benjamin and Asja Lacis's 1925 essay on the coastal city of Naples as inspiration for 'porous' planning and design (Benjamin, 2005; Sennett, 2015; Stavrides, 2007; Viganò, 2009; Wolfrum et al., 2018). The essay celebrates the material qualities of the city's iconic stone architecture ("porous," "craggy"), and its temporal and open possibilities (Benjamin & Lacis, 1986). The material becomes a metaphor for how the city's architecture faithfully represents and reproduces its intricate, animated social life. Contemporary authors leverage the porosity metaphor as a variation on the critique of modern planning use/program separation. The metaphor also serves as the basis for the porous city proposal, which encourages social, economic, and use comingling without borders to engender a civic, more vibrant and authentic 21st century city. The "gritty and fleshy realities" of the Naples porous stone (Bakker & Bridge, 2006, p. 8)—its materiality—are scaled up to imagine such a city, and the inspiration and aspiration for it.

Naples is a port city (De Martino, 2020), and the porosity Benjamin and Lacis celebrate could also describe ports' liminal transition space where sea and land interpenetrate. The port is the 'knot' that joins maritime and land space (Weigend, 1958, p. 185), gazing simultaneously outward to sea and the world beyond and inward toward the hinterland. The port city is a cosmopolitan place where many cultures come together and blend. The pluri- and interdisciplinarity of port research is also testament to its transversal, porous qualities, encompassing a broad spectrum of themes from the technical to the cultural (with many others therein; Hein, 2011; Ng, 2013). The nested scales of research join port, to region, to world, within one another. In 1989, when Manuel Castells wrote of telematic 'spaces of flows' as "the material support of simultaneous social practices communicated at a distance" to describe the new spatial condition of the information age (Castells, 2010, p. xxxii), in many ways these practices were already centuries old in port cities.

3. Seam Space: Borders, Flows, and Accidents

Port boosters generally advocate for open borders, knowing that more freight handling earns more money. In 1911, E. J. Clapp wrote of the Port of Hamburg, "the port's function is to bring countries into contact, and to enable them with the least possible friction and loss of energy, to effect [exchange between them]" (Herod, 2014, p. 268). It is the state, of course, which intervenes periodically with policies to regulate borders and trade flows, but the deregulatory initiatives of the 1980s, and the multinational trade bloc agreements of the 1990s helped to promote freer international trade. Accelerated trade coordination helped time conquer space, and the science of logistic management led to a new global 'fast capitalism' (Ohmae, 1989), where just-in-time assembly required increased cargo throughput speeds and greater port efficiency (Golhar & Stamm, 1991; Klaus & Muller, 2012). The shipping container also served as metaphor to convey this imaginary of "pure movement of units of information, production, and consumption on the circuits of systems" (Klose, 2015, p. 76; see Gregson et al., 2017).

Much of the early scholarly literature on supply chains comes from sociology and geography. Gereffi and Koreniewicz (1994) developed their foundational model of global commodity chain analysis, and later Gereffi et al. (2001) researched global corporate value chains as the optimal corporate strategy for path efficiency and vertical integration (Bair, 2005; Cattaneo et al., 2010). Critical geography has focused more on issues of ecology and political economy (Bernstein & Campling, 2006a, 2006b; Hughes & Reimer, 2004; Sheppard, 2015; Werner, 2020), and the "multiple, simultaneous spatial strategies" (Zalik, 2015, pp. 2452–2453) that capital deploys to construct, balance, and maintain production, distribution, and consumption across supply chains (Simpson, 2019, p. 124; Smith, 1984; Storper & Walker, 1989). The sites of production and consumption along the supply chain are comprised of "complex interplay of technology, culture, commerce, distribution, their respective and constitutive politics," forming territories that "converge and part dynamically" (Lyster, 2006, p. 221). Tracking these mercurial, shifting geographies helps to reveal the political complexities of supply chain assemblage and border behavior (Ramos, 2020, p. 2).

With the ascendance of the security state after 9/11/01, Geographer Deborah Cowen proposed the concept of ports as 'seam spaces,' transitional zones of authority between inside and outside, opening and closing, where borders are blurred, and porosity policed (Cowen, 2010, p. 603; Gregson et al., 2017). Seam spaces are not merely incidental nodes along a seam*less* imaginary of global value chain flows conjured in globalization narratives (Ohmae, 2005). Rather, they are zones of security and surveillance that are prone to diverse logistical practices of 'stickiness' and 'frictions' (Gregson, 2017; Herod, 2014; Lawhon, 2013). Seam spaces can be located at national borders or sites for intermodal exchange (each of which are characteristic of ports), but Gregson et al. (2017, p. 383) point out that seam spaces can also occur offsite from ports, in places such as distribution centers, and wholesaler and manufacturing sites where commodities are unpackaged, packaged, and repackaged. The conceptual move helps to identify trade commodity heterogeneity, the value-added function of the logistics chain, and the power of logistics to impact global spatial organization (Cowen, 2014; Tsing, 2009). The observation also helps to consider how traditional onsite port logistics practices and functions are being re-bordered deeper into port hinterlands (Hall & Jacobs, 2010).

Geographer Michael Simpson (2019, p. 115) offers broad categories for these frictions as either "imperfections, accidents, or disruptions." Imperfections are those points where supply chain design or management has yet to be perfected by logistical sciences (intermodal transfer, cargo heterogenous, unitization), accidents are diverse technological failures along the supply chain, and disruptions occur when human actors try to intentionally disrupt supply chain functionality (Simpson, 2019, pp. 115–117). Simpson (2019, p. 117) recognizes that these categories may vary, depending on where we "draw our line between the internal and the external" of logistics chains. The categorical and conceptual flexibility of that internal/external border distinction gets to the essential challenge of precise articulation of port geography bordering due to the functional, jurisdictional, and spatial complexity of international logistics networks; or, as Simpson (2019, p. 117) poses, "the extent to which we believe that the science of supply chain logistics can effectively manage, govern, or account for the entire vast field of socio-ecological unruliness." Citing contemporary resource geography on materiality and nonhuman objects (Bakker & Bridge, 2006; Braun, 2005), calls emerged for future research to address the specific material qualities of commodities and how these qualities impact logistics processes, temporalities, and spatial strategies for their movement (Simpson, 2019, p. 125). In the following sections the article addresses this call, and that of the thematic issue, by exploring the materiality of wood pellets in their international transport and storage, and how the risk of combustion accidents can lead to new porous spatial opportunities between port and city.

4. Energy Transition, Ports, and Biomass

Ports have long served as essential nodes for energy transportation, particularly since the industrial revolution, for commodities such as coal, petroleum, and natural gas (Hein, 2018; Rodrigue, 2021). More recent recognition of the nefarious impacts of fossil fuel energy on environmental quality, and its central role in global warming, has led to the search for more sustainable energy systems to replace fossil fuels. We are in the midst of an energy transition in which certain countries commit

gradually to alternative energy sources with the intention, however far off in the future, toward full independence from fossil fuel use (Hafner & Tagliapietra, 2020). One such alternative energy source is biomass. Examples of biomass include cordwood, waste paper, wood chips, wood pellets, and select agricultural products and by-products considered to be renewable energy sources (Pellet Fuel Institute, 2019).

The 1997 United Nations Framework Convention on Climate Change (UNFCCC) Kyoto Protocol determined that in order to transition toward a more sustainable energy system, biomass energy would be categorized as carbon neutral, and was eligible for alternative energy credits and incentives (UNFCCC, 2008). There is scientific debate as to whether biomass is, in fact, carbon neutral, or heavily carbon positive, depending on how much of the overall biomass supply chain cycle one chooses to quantify and over what length of time (Canham, 2013; Johnson, 2009). Nevertheless, both the European Union (EU) and United Kingdom authorities have repeatedly backed the carbon-neutral categorization for biomass energy, and EU member countries are committed to it in their strategic goals for energy transition (Brack et al., 2018; European Climate Foundation, 2019; European Commission on Energy, 2019; Volpi, 2019). Japan's Feed-In Tariff program commits to have biomass comprise 20% of its renewable energy generation—approximately 15 and 20 million tons per year (MTPY)—by 2030 both for domestic residential use and for major utility companies (Forest2Market, 2019, p. 11). South Korean wood pellet demand could be over eight MTPY by 2025. These new markets, along with others, will search all parts of the globe for lumber feedstock to sustain this alternative energy generation (Fischer et al., 2019; Mai-Moulin et al., 2019; Proskurina, 2018). Similar to other energy sources, the biomass industry engages in "aggressive pursuit of economies of scale in production and refining, and in transportation" (Bridge, 2008, p. 406; see Watts, 2009), with the addition political incentives of climate change and low-carbon energy transition credits.

In transit, biomass is considered a bulk material, in the category of minerals, earthly materials, processed materials, and agricultural products (Shah, 2017, p. 3). But biomass requires specialized port equipment during its transport and storage due to its material volatility (Dafnomilis, Lodewijks, et al., 2018, p. 148; Hancock et al., 2016), and specialized ocean vessels to transport it (Svedberg et al., 2008). Biomass decomposition in transit produce safety risks of dust production and explosion, self-heating and ignition, and respiratory issues (Craven et al., 2015). Specialized port equipment includes 'grabs' to minimize product deterioration, enclosed transportation and storage facilities, spark detectors, fire detection, and temperature monitoring (Dafnomilis, Duinkerken, et al., 2018; Dafnomilis, Lodewijks, et al., 2018). Some of these safety issues have been partially mitigated through industry warehouse material research and development, but the dangers still exist (Kittler et al., 2020). Wood materiality is essential to the technology and infrastructure of the biomass supply chain network (Bakker & Bridge, 2006; Braun, 2005; Simpson, 2019, p. 125). Biomass objects are contingent, volatile, almost ephemeral, but their materiality is the core of their state sustainability claims mentioned above (Harris, 2017; Nightingale, 2018; Ramos, 2020). The following section explores the materiality of biomass wood pellets.

5. Wood Pellet Materiality

Wood pellets are unitized potential energy units formed through a denaturing process that packages saw dust in casings to endure one migratory trip through the supply chain (Figure 1). To make the pellets, a raw material is developed from multiple sources of wood, which is dried and extruded using special dies. After, the material is exposed to high pressure (45,000 PSI) and temperatures (110–130°C), and the wood's lignin softens and coheres to form the pellets (Jones & Harper, 2009). Wood pellets are low in moisture content: 4–8% water content, compared with 26% water of raw biomass (Jones & Harper, 2009). They are also low in ash content (1–3%, due to very low bark content), which produces a higher British thermal unit energy value (Ramos, 2020, p. 5). Their uniform size—designated in the International Organization for Standardization ISO 7225–2—allows for standardized storage, processing, and transportation, which helps save costs (Ramos, 2020, p. 5; Thrän et al., 2019).

In spite of wood pellet promise as an alternative energy, its global transport and storage have been plagued continually by smoldering fires (Biofuel Watch, 2021; Dust Safety Science, 2020; Hobbs, 2019). Some of these fires occur at pellet plants, but most occur at warehouse facilities on or near port grounds. Pellets are stored in large bulk piles, where they occasionally produce spontaneous combustion 'hot spots' throughout the piles that cause extended smoldering fires. The fires are difficult to extinguish because they can be located deep within the pile (Huang & Rein, 2016). Older pellet warehouses made of wood with asphalt roofs have been consumed in smoldering fires, as have newer aluminum and steel warehouses with state-of-the-art sprinkler systems (Hobbs, 2019).

Recalling Simpson's categories of port frictions, pellet fires are both imperfections and accidents. The logistics managerial science has yet to resolve the system design to avoid pellet combustion, and the safety systems (sprinkler systems, etc.) either fail, or are not sufficiently able to protect the warehouse structure. Also recalling Simpson's point about where to define the border between inside and outside the process, warehouse construction companies suggest the fires are sometimes caused by combustion that occurs outside the warehouse and have accidently been brought in by conveyor belt (personal communication with Lane

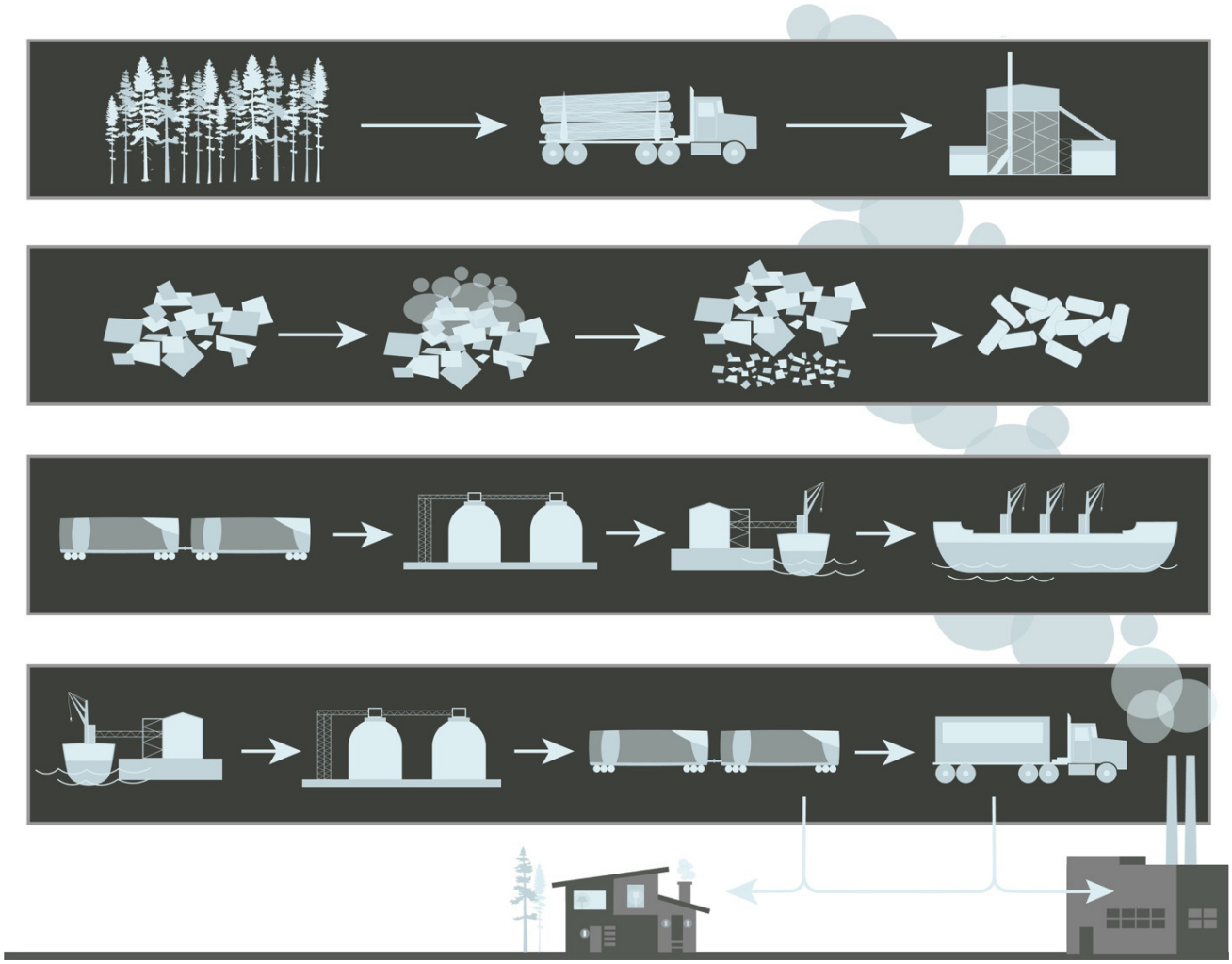

Figure 1. Wood pellet supply chain diagram. Source: Ramos (2020, p. 6).

Roberts, November 23, 2020). A company in the United States northwest with a history of grain storage facilities designed new warehouses that reduce dust accumulation with vibrating floors, gravity-fed loading, and limited oxygen silos to mitigate wood pellet combustion risk.

6. Dome and Dome District

The Dome Technology company began in Idaho in the late 1970s. They developed a patent for dome construction that begins by inflating a form, attaching an insulated layer of urethane, applying a reinforced steel mesh, and then applying a cementitious material. Once the structure is sufficiently dry and supported, the original inflated elements is removed (South & South, 1979; Figure 2). The dome structures were used for diverse bulk storage, including grain, fertilizer, cement, sugar, and coal (Dome Technology, 2021).

In 2010, the Peeples Industries in Savannah, Georgia needed to expand their wood pellet storage capacity due to their increasing success in shipping wood pellets to European markets in the United Kingdom, Belgium, and the Netherlands (Ramos, 2020). They contacted Dome Technologies, and after seeing that they could save money with increased material risk mitigation, Peeples contracted two wood pellet storage domes, each with a diameter of 200-ft and 100-ft height and a capacity of 25,000t (Dome Technology, 2021; Figures 3 and 4). Dome Technology partnered with Drax and Enviva, two of the world's largest wood pellet producers, and their domes are now the industry standard for wood pellet warehousing (Figure 5).

In addition to warehousing, the company's domes have also been used for community storm shelters, beginning with their first project in 2004 in Beggs, Oklahoma. The dome construction technology meets the Federal Emergency Management Agency 361, ICC-500, and National Storm Shelter Association standards for protection against tornadoes, hurricanes, and typhoons. The construction material is approved to withstand hurricane and tornado winds exceeding 250 mph (Dome Technology, 2021). The shelters are located on school campuses, and when not serving as protection shelters they are used as gymnasiums (Figure 6). The domes are also used for faith centers and museums (Dome Technology, 2021; Figure 7).

Figure 2. Dome silos under construction at the 20 Power Station in Selby, North Yorkshire, England. Source: Dome Technology (2021).

Figure 3. Peeples Industries—Wood Pellet bulk storage at the East Coast Terminal on the Savannah River. Source: Dome Technology (2021).

Figure 4. Peeples Industries—Wood Pellet bulk storage silos. Source: Dome Technology (2021).

Figure 5. Albioma Wood Pellet Dome in Martinique. Source: Dome Technology (2021).

Figure 6. Kingsville Independent School District Community storm shelter in Kingsville, Texas, on the Gulf Coast. Source: Dome Technology (2021).

Figure 7. 73-ft high dome at Faith Chapel in Birmingham, Alabama, completed in December 2002. Source: Dome Technology (2021).

The dome construction provides safety through isolation, the essence of modernist separation. But this material commonality in which the dome helps to protect human and non-human cargo from internal and external environmental threats is an opportunity to scale up. Material commonality might help to design dome districts as liminal, transitional spaces that could enable more porous communication between ports and cities.

One can begin to imagine the dome district: Shelter domes in the district could be used as gymnasiums, churches, and museums when there is no weather threat. Each structure could also have space reserved for pellet warehousing for unexpected spikes in import or export that overwhelm storage capacity, as has often been the case during the excess and scarcity that ports have faced during the Covid-19 pandemic. Seasonality (hurricane seasons, production schedules, consumer heating needs, etc.), temporality (rise and fall of warehouse activity depending on time of the day), and culture (kinds of sports, worship, leisure activities particular to each port city culture) are just some of the many factors to consider for flexible, responsive dome programming. Dome housing could also be included for port and dome district workers. The housing would be useful in the case of longer, more extreme weather events, when it could offer additional comfort and privacy possibilities to the mass gymnasium shelters.

These are very brief sketches, but it is not difficult to see how such a district could integrate warehousing and civic facilities in a transition space between port and city, and perhaps more importantly, serve as central, easily identifiable resilient gathering and protection locations for port cities.

7. Port Material Futures

"Let us listen to the counsels of American engineers. But let us beware of American architects!" (Le Corbusier, 1986, p. 42; see Banham, 1986). Le Corbusier, along with other modern architects, took formal inspiration from the industrial grain elevators and silos located along the United States railroad corridors from the nineteenth century. In this light, we can find new formal and programmatic potential for the dome as part of a new logistics cluster for the port's intermodal seam space. If the shipping container revolutionized the wave of cargo freight standardization (Cudahy, 2006; Levinson, 2006), the dome, at once, standardizes the coastal/riparian port environment, and, in its material resilience and formal plasticity, enables new programmatic diversity at multiple sites and scales. The metaphor is not as poetic or immediate as the craggy Neapolitan stone, but the dome material and the protective seal it provides suggest adaptive possibilities that could increase porosity between industrial port spaces and public civic spaces—a new 'knot' (Weigend, 1958, p. 185). The dome material itself is hermetic, impermeable, but its programmatic adaptability may provide new communication and integration of port and city functions that have frequently been identified as planning challenges for port cities (Carpenter & Lozano, 2020).

These material and contextual commonalities are what Geographer Cindi Katz (2001, p. 1230) refers to as the 'contour lines' across global supply chains, which help to analyze larger themes without losing site of situated knowledges and experiences (Fischer et al., 2019, p. 179; Haraway, 1988). The dome is a risk form for the 21st century port (Beck, 1992; Schubert, 2019).

8. Conclusion

Inspired by the material celebration of porous stone as metaphor in Benjamin and Lacis's essay (1986), the article considers flows and borders in energy transition and biomass global logistics, and the particular material behavior of wood pellets in warehousing and transit. Cowen's (2010) proposal of ports as seam spaces and Simpson's (2019) proposal of logistics imperfections and accidents help provide a new frame for port protagonism in global supply chains (see also Hall & Jacobs, 2010). Wood pellet volatility, and the risk of its combustion have precipitated innovation in constructed material and safety system solutions through dome technology; a construction technique which, until 2010, was used for other kinds of bulk storage. The dome construction technology has diversified and is also used for civic spaces such community shelters and faith centers. The dome construction resilience helps to envision how it might be deployed in the design of dome districts, within port seam spaces, that could include programs of bulk warehousing, community shelters for extreme weather events, and even more quotidian uses such as museums and gymnasiums. Further, the material would also facilitate programmatic diversity within individual dome structures that could potential fuse industrial and civic functions. Given the multiple challenges that port cities face in planning for security, resilience, economic trade flow pressures (Mansouri et al., 2010), and calls for increased porous communication between port and city at various scales, these dome sketches help to envision how the design of such porous districts could begin to address these multiple challenges. Challenges which, moving forward, will only increase in scale and complexity.

Conflict of Interests

The author declares no conflict of interests.

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