THE URBANISATION OF THE SEA

From Concepts and Analysis to Design

Nancy Couling
Carola Hein (eds.)

TU Delft OPEN

creative industries fund NL

PORT CITY FUTURES
Leiden-Delft-Erasmus

THE URBANISATION OF THE SEA:
FROM CONCEPTS AND ANALYSIS TO DESIGN

Edited by Nancy Couling & Carola Hein

PREFACE

Philip Steinberg, Whitley Bay, UK

Every now and then, when I peer at the North Sea from my home on the northeast coast of England, I spot barges, topped by tall yellow structures, turning northward out of the River Tyne. A quick look at my ship-finder app reveals that these towers are not destined for land but for the sea itself. Produced in Hadrian Yard in the Tyneside community of Wallsend, these are wind turbine foundations headed for the Beatrice Field, an area of shallow continental shelf just off Wick, at the northern tip of Scotland. Once they reach their destination, the foundations will be implanted in the sea bed to support what is planned to become the fourth-largest offshore wind farm in the world.

The voyages of these wind turbine components, and that of the energy they will produce, exemplify ocean urbanisation. If urbanisation is defined as an intensified transformation of nature, and thereby a transformation of place, then the transportation of these steel scaffolds and their placement on the sea bed will turn the sea into a space of social relations, an *industrial* site, an arena of logistics and production. But the turbines will do more than this. Not only are they urbanising the ocean, they are also making urban complexes increasingly marine. Sea bed transmission wires tether these regional ocean energy complexes to the land, locking in a relationship that is not so much symbiotic as co-constitutive. With the placement of wind turbines, the offshore becomes something more than a resource extraction zone, or a surface across which goods are transported. It becomes a part of the urban industrial-energy complex, a part of the *urban*.

At one level, none of this is new. On their northward journey along the English and Scottish coasts, the turbine foundations will pass countless lighthouses and navigation buoys. For centuries, these infrastructural objects have been urbanising the ocean, turning it into a space supportive of habitation, even as the settlements they were supporting were rooted on land. Likewise, firms based at what was to become Hadrian Yard, the Wallsend industrial park where the turbine foundations were manufactured, have a long history providing components for the Tyneside shipbuilding complex. Since the 1990s, shipyards along the Tyne have been repurposed to serve the offshore energy industry, building on a long history of ocean-orientated urbanisation.

Nonetheless, there is something different in the current wave of ocean urbanisation. In their heyday, the shipyards, and the ships they produced, provided connections with far-off cities. The sea was always crucial for the region's survival, but the sea was a locational *resource* for the riverside shipbuilding economy, not a *part* of it. In his musical *The Last Ship*, Sting, who grew up in Wallsend, dramatizes the decline of the Swan Hunter Shipyard, which was adjacent to Hadrian Yard (and for which Hadrian Yard's Wallsend Slipway and Engineering Company produced engines). In the play's title song, the "last ship" produced at Swan Hunter is described as "a mountain of steel [that] makes its way to the sea." As it disappears beyond the mouth of the Tyne, it takes with it hope for the livelihoods of countless men and women dependent on Tyneside's shipbuilding economy. Sting's Wallsend exists *by* the sea, but it is not of the sea. Once the last ship leaves, the distant maritime connection that pumps life into the riverside community, bringing the "outside" "in," is gone. Indeed, once the play's protagonist, Gideon Fletcher, goes to sea, he too leaves Tyneside behind (at least until his prodigal return).

Today, however, the bright yellow "mountain[s] of steel" that depart the Tyne for the North Sea never really leave. Implanting towers in the sea bed, tethering them to land, and fuelling production and consumption far beyond the banks of the Tyne (or, for that matter, the North Sea coast), this wave of urbanisation brings the sea to the city and the city to the sea through a revolutionary transformation of maritime and coastal nature and space. As the chapters in this book reveal, the urbanisation of the sea is not a story unique to the North Sea. Nor is it an entirely new story. However a focus on the North Sea and the ways in which ocean urbanisation is occurring at an unprecedented scale there, to unprecedented effects, can tell us much about the changing shape of what the editors of this volume call our increasingly "viscous" world.

CONTENTS

THE NORTH SEA: NEW PERSPECTIVES
ON THE SEA-LAND CONTINUUM

Nancy Couling & Carola Hein

The North Sea region has been the nexus of northern European technological, cultural, and economic advancement. According to historian Michael Pye, "this cold, grey sea in an obscure time made the modern world possible."(1) Together with its neighbouring coastal areas, the North Sea is also an exemplary case of intense interactions across the land-sea threshold. The "commons" of the North Sea has long been central to the region's climatic and ecological balance, but also to its economies. After centuries of shared use, maritime and industrial processes have led to international border regulation, uninterrupted traffic along major transport corridors, intensified offshore capture and distribution of energy, and the erection of a multitude of structures. Related transfer sites have also created important nodes in coastal and hinterland areas. The sea itself has been so transformed that it has become an enigmatic urbanised space, charged with the task of increased economic production both from traditional and new maritime sectors while at the same time it has been emptied of imaginative narratives and cultural significance.

International laws and national institutions have divided the North Sea into seven parts based on national maritime borders attached to seven different countries, wholly consuming what was once a shared, fluid space. Each of the countries bordering the North Sea follows its own legal, planning, and policy approaches in order to manage extraction, green energy generation, and other areas of "blue growth" potential. Contemporary urgencies, such as flooding and other extreme weather events, ecological degradation, and predicted sea level rise, are increasing. These effects highlight the vulnerability of a continued industry-led sectorial approach to the North Sea and have drawn public attention to the unstable status of the sea itself. While collective policies and plans are needed, and EU Directive 2014/89/EU requires that all EU maritime areas must have strategic management plans in place before 31 March 2021, it is not clear whether such a transnational approach will be established at a time of dissolving European collaboration as signaled by Brexit.(2) To meaningfully address the challenges raised by the urbanisation of the sea, to avoid further overexploitation and to ensure

foresight in management and stewardship, we need a comprehensive approach with collaboration among diverse stakeholders and disciplines. Such an approach could make the North Sea the epicentre of a paradigm shift of spatial considerations, from conceptualisation to design.

The urbanisation of the sea and its relation to land-based developments cannot meaningfully be studied or undertaken through the lens of a single discipline or from a single national perspective. It requires a long-term historical and large-scale understanding of the space we are studying. It requires different tools and new perspectives that help us bring together diverse sources and languages. To initiate conversations, the editors present voices from many disciplines and geographic positions. The book builds upon discussions that took place during the Marie Curie Fellowship held by Nancy Couling in the Chair History of Architecture and Urban Planning from 2017–2019 at Delft University of Technology and brings together selected contributions from the 2018 TU Delft conference "Viscous Space: The Offshore Physicality of the North Sea between Solid and Liquid." This conference, convened by the editors, used thickness and resistance to flow as fundamental conceptual guidelines to link thematic sessions on representations, narratives and projections, infrastructure and heritage, and legal and theoretical constructions.[3]

The contents of the book are heterogeneous, combining artistic research, urban design projects in maritime contexts, and speculative proposals as well as academic papers, essays, contemporary and historic maps, photographs, and contemporary fiction. Presenting plural starting points offers potential for cross-fertilisation and opportunities to rethink cultural positions, spatial history, and practice. An excerpt from a novel offers a sense of ocean depth through an account of a physical descent into the deep ocean. The reader's experience of the ocean's interior differs from that of maritime planners who must weave conflicting economic and ecological threads together from above the surface. Policymakers are apt to view their task in the sea space as a battle against time. Researchers and designers report on the findings of specific studies, including artistic projects, where the investigation of sea sites has produced unexpected findings. This variety is intended to capture the richness and complexity of the topic, to facilitate different points of entry for readers who can then follow journeys from concepts through analysis to the design of possible futures. Together, these multiple perspectives present an illustrative overview of some of the ways that we can think of, think

with, and represent the sea as an urbanised space.

Our aim is to encourage understandings of shared land-sea spatial histories that go beyond the traditional exploration of development in the framework of nation-states or land-based entities. Employing a perspective *from the sea*, we aim to draw the sea-land continuum into discussions of urban and territorial development by investigating selected sites of critical interactions. These are sites that have been imagined, occupied, planned, and represented mostly by private actors, some of which have long operated autonomously, outside of classic land-based national and urban planning and policy frameworks that did not take the sea into account. Increasing in frequency and force, the effects of climate change have made the sea potentially more dangerous and unpredictable—conditions that neither directives nor technology are able to control. Our approach therefore promotes a three-dimensional understanding and calls for a trans-disciplinary investigation that is focused on space, society, and culture. The book argues that such an approach can help develop new directions in representation, design, and planning along the sea-land continuum and help dislodge inherited binary assumptions.

The geographic focus on the North Sea is not exclusive: we include perspectives from the Mediterranean, the Singapore Strait, the Pacific, the Barents, and the Baltic Seas. This allows us to gain a better understanding of what a paradigm shift from a land-based logic with fixed spatial and legal delineations to a more fluid, integrated, sea-based approach can mean for research, representation, and ultimately policy-making, planning, and design. In the next part of this introduction, we introduce two fundamental concepts to support our approach: the urbanisation of the sea and the port cityscape. We then offer a glimpse into the historiography of the North Sea, followed by a presentation of the issues at stake and the key analytical approaches. Finally, we provide a brief overview of the book.

URBANISATION OF THE SEA
AND THE PORT CITYSCAPE: THE CONCEPTS

Inspired by the influential work of Henri Lefebvre and his understanding of urbanisation as a multi-dimensional process including material structures and practices, regulations, and the modalities of everyday interactions, the theory of planetary urbanisation offers a comprehensive framework with which to conceptualise and critically

appraise processes unfolding around us.(4) In particular, extended urbanisation draws attention to the logistical, infrastructural, and legislative systems that transform space outside of familiar urban environments, thereby restructuring vast areas, frequently causing social upheaval and environmental degradation. Such areas, including the world ocean and seas, serve vital functions for urban agglomerations, yet the direct links and interdependencies between them have mostly been neglected in the "city" focus of urban studies discussions.(5) Today, what was previously considered rural or natural has been engulfed by networks, dedicated structures, and forms of labour that serve the requirements of what Lefebvre called a fully urbanised society, and the city must be differentiated from the processes of urbanisation extending far beyond it.(6)

In addition to material forms of its manifestation, urbanisation has many immaterial dimensions of social and cultural exchange that have been extensively researched by Manuel Castells and other scholars in the social sciences.(7) This land-based, city-focused approach has led to research in urban studies that occasionally looks out to sea, but either focuses on abstract economic dimensions or logistic flows, or on select and limited spaces of network structures, for example, in relation to port cities.(8) With the notable exception of Fernand Braudel, researchers have rarely explored people and infrastructure in the sea space—the foreland—or reflected on how they are directly linked to the hinterland.(9) Land-side decision-makers, often working in capital cities away from the coast, exert a profound influence on the sea, shaping its spaces and practices often with land-based tools. Institutions and scholars studying the North Sea region also often have a land-centred bias and study ports, cities, and their regions through select lenses. The port cityscape—that is, the network of port-related spaces in a larger port city region—is a conceptual framework that aims to overcome these divisions through a focus on the sea-land continuum.(10)

Developing from these two perspectives, this book provides an analysis of the sea as an urbanised space of transformed nature in relation to resources and not in relation to existing urban nodes. It also analyses expanding urban development from port cities encroaching further into the sea. These two spheres of inquiry are dealt with unsystematically in current literature.(11) Addressing this absence, we set out to investigate how the urbanisation of the sea is reshaping our regional economic, social, cultural, and human environments at sea,

through the spaces of the coast and to the hinterland. In particular, we draw port city regions into the analysis of the sea-land continuum, providing a diversified context for a networked approach. We also aim to identify tools, methods. and frameworks that can help reconceptualise the sea space as an integral part of our historical urban realm and restore its *cultural* relevance, thereby testing the role that narratives and representations play in such a reconceptualisation. The urbanisation of the sea requires multiple perspectives and has yet to be specifically defined. This book opens up a range of possibilities and calls for further discussion, using the North Sea as a point of departure.

THE NORTH SEA: A BRIEF HISTORICAL INTRODUCTION

The North Sea—a complex topographic space characterized by a unique combination of natural and cultural features—provides the book's central case study. It is a relatively shallow "shelf" sea, with a maximum depth of around 70–80 metres, and, in the southern half, there are large areas of only 40 m deep or less. Scientific evidence points to the southern part of the North Sea being a fertile plain during the mesolithic period from 12,000 BC to 6,000 BC, and settled by large numbers of people, until it was finally flooded around 8,000 BC.[12]

Cities around the North Sea developed through a rich legacy of trade and cultural exchange, where before the rise of the nation-state, dynamic inter-regional influences were readily absorbed into local culture. The similar warehouses of the Hanseatic cities of Hamburg, Amsterdam, and Bergen are one architectural example. Knowledge and cultural practices were connected across the water and, around the sixteenth century, literacy rates were higher on the coasts than inland.[13] Michael Pye argues that in the formative period between 700 and 1700, people were constantly migrating around the North Sea and identities were not based on a notion as abstract as race.[14] Anglo-Saxons originated from Germany and Denmark in the fifth century and the Vikings settled all around the region. The Shetland Islands were Nordic for 600 years.

During this period of continuous exchange and maritime activity, the North Sea began to be modified and "constructed." Its sand has been extracted, it has been used as a dumping site, and, for hundreds of years, it has been dredged and trawled. In the mid-nineteenth century, highly developed areas on the North Sea's southern shore, where port cities like Amsterdam, Antwerp, and London served as nodes on the

sea-land continuum, began attracting growing numbers of residents, industries, and technologies, particularly related to the transport and transformation of petroleum.(15) The discovery of oil in the North Sea in the 1960s led to the growth of techno-logistical activities for oil and gas infrastructure in and around the sea. Today, the southern region of the North Sea boasts the highest population density in Europe. The densely populated areas, in conjunction with the existing maritime infrastructure, make it particularly attractive for development of the offshore wind energy sector.

The influence of the energy transition is evident in the offshore territories of wind parks, energy ports, empty sub-sea hydrocarbon formations, and left-over hydrocarbon infrastructure. This transition presents a challenge to planning and society as a whole, but also an opportunity to reimagine the on- and offshore energy landscape, which, as several contributions point out, will be no less "invasive" than the inherited landscape of fossil fuel—the petroleumscape.(16) Currently around the North Sea, the transition to, for example, wind energy, is concentrated, large-scale, and state-led. Because it is developing in the tradition of the older oil-based energy landscape, it is characterised by dedicated zones, fixed infrastructure, and a continuous circulation of components, capital, and labour. Energy and communication infrastructure has been extended into the sea over the past 150 years, but we have failed to conceptualise this extension, instead allowing planning decisions to follow inherited notions of temporary structures and a visually open horizon.

The ongoing physical modification of the North Sea—like many seas—has been paradoxically accompanied by the upholding of inherited conceptual binaries: sea and land, urban and rural, nature and culture. Sea spaces have become sites of intensive activity for logistics, the extraction of food and energy, which also feed production processes downstream. Public access to the North Sea is limited and large areas are dedicated to security zones around industrial installations. As a result, these binaries have not only persisted but they have enabled a particular type of industry-led urbanisation to take hold within a space otherwise perceived as "natural."(17) These binaries have also, until recently, prevented the sea from being perceived as an urban realm. From a cultural perspective, northern European society has also withdrawn from the sea. In his photography and film essays, Alan Sekula has poignantly documented the "disappearance of the sea" brought about by container

shipping.(18) Seafarers on the North Sea now lead a marginalised existence and contemporary maritime workers in other sectors are hired for their experience in steel, not the sea. Recent proposals, such as the creation of a giant dam across the North Sea, speak to a long-standing trust in technological solutions.(19) The need to change human patterns and perceptions has become urgent.

CARTOGRAPHY, NARRATIVES, AND DESIGN

Investigating the sea as an urban realm resonates strongly with the current call to recalibrate inherited concepts of "nature" and "culture."(20) It also challenges the notion of the "urban" as a discrete, bounded site.(21) The sea is a critical protagonist and partner to urbanisation processes. It,is paramount to the ecological well-being of the planet and to the emotional and economic well-being of the human population. Novel approaches that combine culture, imaginaries, and non-industrial narratives are needed to fully understand the North Sea and other oceans.

One language with which to tell this story is cartography. Cartography boasts a rich tradition on land and at sea, and is a useful way to communicate across disciplines, to identify gaps and common concerns, and, most importantly, to propose new perspectives. Cartographic representations help us see patterns and outliers, read critical territorial relationships, power structures, understandings, and belief systems, and derive meaning from huge, complex territories. But there can be no such thing as an objective map reproducing a pre-existing reality. Choices must always be made about what to represent and how, and what to exclude.(22) Mapping is therefore also an act of design: orienting, navigating, and in a state of becoming. Contributions to this volume show how cartography can capture both activity and desire and how it can narrate stories as well as delineate property and relate scientific facts.

Narratives are another way to rethink the North Sea. Author Tom Blass describes the North Sea as "too substantial, too terrible, to be glamorous,"(23) yet the sea's magnetic pull, a sensation felt by many Europeans, has not diminished, rather it has perhaps intensified, but has been channelled into specialized views, sites, and events. The sea is thick with activity and desire. We tell ourselves stories about the sea that fuel human emotion. These stories include those that assert myths of unlimited space and resources, those that build new cultural relations to

the sea, for example, around oil, and those that question our place in the world and our aesthetic interpretation of it. In each case, narratives can exert a powerful force.

The book takes a spatial view and is particularly interested in the formulation of speculative design proposals rather than purely theoretical reflections. Both cartography and narratives, sometimes working together, are used as design tools to reimagine relations between land and sea, and to reassert the public dimension. Design enables new forms of access to areas that, through industrialisation and privatisation, have become illegible, invisible, or impenetrable—frequent characteristics of the offshore spaces of the North Sea, and other seas, as well as multiple coastal and hinterland sites. Artists and designers are able to break down physical and conceptual barriers, to reconstruct dialogues between separated fragments, and to explore the design potential of the sea's spaces, rhythms, materiality, and intangible qualities.

OVERVIEW

Our approach is reflected in the structure of the book. Consisting of four parts, it is organised to assist the reader in establishing a perspective from the sea to the land, to gain a sense of what is at stake in the space of the North Sea and in imagining future possibilities. The book progresses from preliminary methodological foundations in Part I to explorations of concepts of the sea in Part II. Extensions across the land/sea threshold are discussed in Part III, with a particular focus on the North Sea. Possible future orientations are presented in Part IV, "Cultivations," which offers examples of art and design projects that have traced new pathways of understanding and representation. An introduction to the individual chapters is provided at the beginning of each of these parts.

The visual orchestration of maps and photographs between these sections sets the atmosphere for the ensuing topics and creates a pause in the on-going narrative. These elements intend to present the central contradictions of the urbanisation of the sea: on the one hand, the scale of industrial processes can be vividly portrayed and, on the other, the aesthetic qualities of selected seascapes around the North Sea capture the imagination and instantly communicate a common sensual and cultural experience. Throughout the book, maps convey what is otherwise invisible to the public, and sometimes the maps convey a sense of what

has been lost. Historic North Sea maps present a different sea—more populated, displaying more diverse types of maritime knowledge— than the North Sea we observe today. The ocean and seas comprise a sophisticated planetary system that exerts a sense of wonder. The book includes discussions on how the use of the stars in traditional navigation methods linked the sea directly to the cosmos, thereby connecting mystery and spirituality to the practical task of sailing from place to place.([24]) Quantitative evaluations of the economic potential of the sea should not replace awareness of the sea's intangible qualities and its connectedness to interscalar natural forces.

Several contributions argue that our current ecological crisis is accompanied by something potentially more acute: *a crisis of the imagination*.([25]) Hence, as an interwoven collection of episodes, this book aims to retell the story of our relationship to the space of the sea. Together, the encounters in these chapters lead us to imagine a multi-dimensional urbanised sea; deep, thick, layered, viscous, emergent, partially anchored to port cities and partly connected to temporary sites of offshore development. This urban sea demands new governance systems and more complete forms of representation, adapted to planning with time, understanding grades of permanence and the dynamics of tides, currents, and seasons. But the urbanisation of the sea is not a laissez-faire option. While the congestion and degradation of the North Sea clearly emerges through many contributions, this book argues that to urbanise the sea must also mean practicing a form of *cultivation*: we must take care of commons, ecologies, and synergies for the long-term and acknowledge deep cultural and spiritual ties. This represents a paradigm shift in current practices and demands an urgent cross-disciplinary effort. Current marine planning is faced with a myriad of complex issues and dynamic parameters that defy land-based planning tools. Spatial and environmental reserves are reaching critical limits.

As a place that has absorbed, facilitated, and forged divergent histories, the sea also offers us a place for creative futures. Therefore, we focus on ways forward for designers regarding questions of the sea space and issue a call for greater involvement from the creative industries in collaboration with complimentary experts. The book aims to inspire such involvement and encourage further collaborations in this emerging field.

(1) Michael Pye, *The Edge of the World : How the North Sea Made Us Who We Are* (London: Penguin Books, 2015).
(2) European Parliament and the Council of the European Union, "Directive 2014/89/EU Establishing a Framework for Maritime Spatial Planning" (European Union, 23 July 2014), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0089&from=EN.
(3) The conference was held 20-22 June 2018. See the website for details: www.viscousspace.com
(4) Neil Brenner and Christian Schmid, "Planetary Urbanization," in *Urban Constellations*, ed. Matthew Gandy (Berlin: Jovis, 2011). See also chapter six, this volume.
(5) Hillary Angelo and David Wachsmuth, "Urbanizing Urban Political Ecology: A Critique of Methodological Cityism," *International Journal of Urban and Regional Research* 39, no. 1 (2015): 16–27, https://doi.org/10.1111/1468-2427.12105.
(6) Henri Lefebvre, *The Urban Revolution* (Minneapolis: University of Minnesota Press, 2003).
(7) Manuel Castells, *La question urbaine* (Paris: François Maspero, 1973).
(8) Carola Hein, "Port Cities and Urban Waterfronts: How Localized Planning Ignores Water as a Connector," *WIREs Water* 3 (2016):419–38.
(9) Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II*, vol. 1 (New York,: Harper, 1972).
(10) Carola Hein, *Port Cities: Dynamic Landscapes and Global Networks* (London: Routledge, 2011).
(11) Carola Hein, "The Port Cityscape: Spatial and Institutional Approaches to Port City Relationships," *PortusPlus* 8 (2019).
(12) Laura Spinney, "Searching for Doggerland," *National Geographic Magazine*, December 2012.
(13) Blass, *Naked Shore*.
(14) Pye, *Edge of the World*.
(15) Carola Hein, "Oil Spaces: The Global Petroleumscape in the Rotterdam/The Hague Area," *Journal of Urban History* 44, no. 5 (2018):887–929.
(16) Hein, "Oil Spaces."
(17) See chapter 7.
(18) Allan Sekula and Noël Burch, *The Forgotten Space: A Film Essay Seeking to Understand the Contemporary Maritime World in Relation to the Symbolic Legacy of the Sea*, 2010, http://www.theforgottenspace.net/static/notes.html.
(19) Jon Henley and Alan Evans, "Giant Dams Enclosing North Sea Could Protect Millions from Rising Waters," *The Guardian* (12 February 2020), https://www.theguardian.com/environment/2020/feb/12/giant-dams-could-protect-millions-from-rising-north-sea.
(20) Timothy Morton, *Ecology without Nature : Rethinking Environmental Aesthetics* (Cambridge, MA: Harvard University Press, 2009).
(21) Neil Brenner and Christian Schmid, "The 'Urban Age' in Question," *International Journal of Urban and Regional Research* 38, no. 3 (May 2014): 731–55, https://doi.org/10.1111/1468-2427.12115.
(22) Geoff King, *Mapping Reality: Exploration of Cultural Cartographies* (Basingstoke: Macmillan Press, 1996); Mark Monmonier, *How to Lie with Maps*, third ed. (University of Chicago Press, 2018), https://www.press.uchicago.edu/ucp/books/book/chicago/H/bo27400568.html.
(23) Tom Blass, *The Naked Shore: Of the North Sea* (London: Bloomsbury, 2015).
(24) See chapters 5 & 8, this volume
(25) See chapters 14, 17, 20, this volume

Part I   FOUNDATIONS

Part I presents the book's research origins at the École Polytechnique Fédérale de Lausanne (EPFL), Switzerland, and at the Chair of History of Architecture and Urban Planning, TU Delft. In chapter 1, Nancy Couling explores the urbanisation of the sea from a maritime perspective, and proposes a methodology for analysing and representing the sea as a regional territory. Couling makes the case for considering the sea as a cultural product formed through relations between its geophysical, biological, and socioeconomic attributes. It is thereby relational, and a space central to the region, rather than a domain peripheral to land. Using the Barents and Baltic Seas as case studies, she proposes two co-existing urban formats for each sea, which are derived from urbanisation processes interacting with the sea's inherent dynamics. This chapter summarises Couling's research in nine principles of urbanisation in the Barents and Baltic Seas, contributing to an understanding of the urbanisation of the sea foundational to this book.

The Delft cartographic method promotes research through mapping. It aims at gaining an understanding of a territory's long-term developments using geo-spatial historic mapping. Building on a study of the Netherlands in the period 800–2000 through the lens of landscape, infrastructure, and habitation patterns, in chapter 2 Carola Hein, Reinout Rutte, and Yvonne van Mil describe how they adapt the method to North Sea port city regions in the period 1300–2000 with a focus on the Rotterdam, London, and Hamburg areas and on the spaces shaped through the presence of the port, the port cityscape. Taken together, the two investigations showcase the potential of geo-spatial mapping as a tool for understanding the impact of long-term development on the present and how the technique can form a foundation for design decisions of the future. The investigations also highlight the need for a new conceptualisation of the spaces of sea and land as a shared, common, liquid territory and the need to develop a comprehensive theoretical framework for port city regions as nodes of distribution and the sea-land continuum as a developmental axis.

Chapter 1   OCEAN SPACE AND URBANISATION:
              THE CASE OF TWO SEAS*

Nancy Couling

Through her analysis of the Barents and the Baltic Seas,
Nancy Couling reveals initial insights regarding the
urbanisation of the sea as well as findings specific to these
two territorial contexts.

Currently Assoc. Prof. at Bergen School of Architecture, Norway, Nancy was
awarded a Marie Skłodowska Curie Individual Fellowship at the Chair of History of
Architecture and Urban Planning, TU Delft 2017–19 with the project "Oceanurb: The
Unseen Spaces of Extended Urbanisation in the North Sea." Trained as an architect
at Auckland University, New Zealand, she completed her PhD at EPFL in 2015 after
much international practice experience and cofounding her own interdisciplinary
practice in Berlin 1995–2010. Co-editor of the prize-winning "Barents Lessons-
Teaching and Research in Architecture" (2012. Zürich: Park Books), she frequently
publishes and lectures and is a member of the research group "Territories of
Extended Urbanisation," led by the ETH Zurich, & FCL Singapore.

Although many scientific fields investigate the ocean, research about ocean space is scarce. To begin filling this research gap, this chapter discusses case studies of the Barents and Baltic Seas. The research discussed establishes a methodological foundation for the study of the North Sea presented in this volume, and presents preliminary conclusions about the urbanisation of the sea. The investigations of the Barents and the Baltic Seas looked at—from an urban perspective—possible ways of addressing the quantum shift in scale and intensity of spatial demands on the sea through energy production, the extraction of resources, and infrastructural and logistical development. While these developments are ephemeral in relative spatial terms, often remote and hard to decipher, they also carve out vast territories and leave lasting physical legacies. The ocean has become a site of spatial and environmental convergence, a type of "hinterland" to urbanised territories at the same time as the urban has become more diffuse, porous, and far-reaching.

History is rich in examples of fluid forms of urbanisation that engaged the ocean as a network agent, without claiming territorial rights. Intensified activities, however, have led to the territorialisation of the ocean through the establishment of fixed Exclusive Economic Zones and the implementation of land-based planning tools within these zones. A fundamental contradiction between open ocean systems and bounded space becomes apparent. When boundaries have been established in the ocean, the outcome has been not spaces of human settlement, but rather specialist spaces with a range of purposes—both productive and protective—permitted for limited periods of time. The lack of settlement qualifies these spaces to become either mono-functional, semi-industrial landscapes or protected areas for important ecosystems—to name two extremes. In both cases, further planning processes have been unleashed through Marine Spatial Planning.

The lack of settlement has meant a lack of habitual interaction with ocean space. Since the ocean does not contain places of dense human occupation, offshore spaces appear increasingly autonomous, incomprehensible in terms of scale and similarly inaccessible in both visual/conceptual and physical terms. Their specialised nature and distance from settlement areas prevents organic contact. Our relationship is mediated and technicised. Specialist knowledge and skills are required to enter these realms on an individual basis, and therefore the ocean takes on an abstract, remote status that fuels the imagination but also, in the majority of cases, further determines the sequence and form of development.

In 1974, Henri Lefebvre wrote that "natural space is disappearing" and described how such spaces have become compartmentalised for a form of consumption subordinate to the dominant strategic modes of production.(1) In their essay "Planetary Urbanization," Neil Brenner and Christian Schmid describe the end of the wilderness as "one

of the four most marked and far-reaching worldwide socio-spatial transformations of the last thirty years."(2) If natural space has disappeared, we are challenged to find appropriate terminology and conceptual references for a volumetric environment geared toward the natural laws of flow and a physical body constantly in motion as it interacts with territoriality, fixity, and human-produced flows. For these reasons, contemporary urban conditions demand an expanded view of architectural relations, including geographic, geological, and hydrographical dimensions, since urbanisation processes now involve places that previously were buried, inaccessible, or that remained "natural."

Our two case study seas are coherent territories within which specific forms of urbanisation can be identified. I take a holistic, cross-disciplinary approach, departing from the geographical sea as a central relational space and draw on theory and literature, technical reports, GIS data, and fieldwork. While interactions with the coast are a constant occurrence in these two seas, the search for traces of urbanisation processes here is specifically focused on the sea space itself, and aims not to examine the littoral condition per se or the wealth of existing literature concerning the meanings of the coast. The chapter aims to find out what contemporary offshore phenomena could bring to a discussion on ocean urbanisation. Seas are cultural products, the result of intersecting relations between geographic properties and sociocultural activities. The analysis presented here of the Barents and Baltic Seas reveals specific territorial profiles. These maritime regions are each unique, and in each case I draw conclusions about the specific relations and dynamics of the urbanised sea. However, the analysis aims to shed light on recurring components and common processes, and to this end, I propose nine principles of ocean urbanisation.

OCEAN TERRITORY

Stuart Elden argues that territory has a series of culturally and historically specific meanings, which are "produced, mutable, and fluid."(3) One meaning is a politically contested and controlled space, depending on techniques of land surveying and cartography, which Elden calls "political technology."(4) According to Elden, fifteenth–sixteenth century spatial understandings are "still the overriding geographical determination of our world."(5) As a cultural product, ocean territory is comparable to land-based territory: each sea is the result of a unique combination of historical, political, cultural, and environmental forces. However, its dimensions are multiple. To understand these forces requires a holistic approach capable of reconciling poles of interest that are even farther apart than those on land.

To serve the interests of sailors and mariners, in 1952, the International Hydrographic Organisation took on the task of delineating the world's oceans and seas.(6) Their limits were roughly

based on bathymetry, had no political significance, and are still frequently referenced. The Barents Sea, for example, occupies a shelf of an average 230 metres in depth, which drops down to the Atlantic Ocean to the west and the Arctic Ocean to the north. The Baltic Sea is a semi-enclosed, relatively shallow sea with an average depth of 54 m, internally divided into fourteen parts by a series of gulfs and sub-basins.(7)

Primary oceanographic spaces and topographical limits therefore exist outside of political demarcation. Topography, flora and fauna, geological formations, and water flows are landscape characteristics shared by both land and sea, but which relate mostly to the surface condition. Not only is the sea more topographic than the land,(8) but it is deep, composed of different masses in constant flux according to seasons, currents, temperatures, salinities, and densities. Compared to land, the surface condition is inverted to the sea bed, and a new "surface"—the abstract ocean plane—takes its place on the horizon. Within this fluid volume, multiple exchanges create spaces and conditions that support the ocean's richness of life. These resources, including topographic features such as natural harbours, wind, and water currents, have then structured human interaction with the sea.

The spatial entity of a bathymetrically defined sea can be conceived of as territory, even if the Latin *terra* means land. However, the sea has a history of territorialisation distinct from land. The political technology Elden describes has only partially and recently been applied at sea, therefore the concept of ocean territory has yet to be accurately defined. Geometry, politics, and concepts of bounded space are not the only determining characteristics.

As an alternative to a definition based on contained space, French geographer Bernard Debarbieux, pursuing the line of thinking established by Claude Raffestin, defined territory as "the arrangement of material and symbolic resources capable of structuring the practical conditions needed to support the existence of an individual or a social community."(9) Ocean space—sparsely populated yet continually traversed, harvested, and tapped for energy—would seem to be better represented by this idea. Territorialisation can then be seen as the result of several forces: superficial (on the surface) legal boundaries, networks of human interests, communities of marine life occupying different zones at different times, and natural oceanographic events.

DEFINING OCEAN TERRITORY: A PROPOSAL

Rather than a territory defined by political borders, I propose an integrated, kinetic definition of ocean territory based on oceanography and biological thresholds with which urbanising forces interact. Both the ocean's inherent spatial properties and cultural interventions become active components. The fundamental physical

characteristics—the inherently spatial oceanography that forms a differentiated, dynamic, interconnected habitat—and a range of both organic and inorganic forces are active in this space to form an elastic territory with porous edges. This can be summarised as the interactions between the geophysical territory, the biological territory, and the socioeconomic territory [Fig. 1, p. 45].

The biological territory is closely connected to the geophysical base and together these spaces define the range of oceanic ecosystems, however edges are open and characterised by zones of transition. The socioeconomic territory, on the other hand, creates political borders, areas of resource extraction, and static systems of order that are used to define protected areas or to organise extractive or productive activities such as fishing, oil and gas exploration, and other forms of energy production. I used this understanding of territory as the analytical basis for urban research in the Barents and Baltic Seas.

TWO SEAS

Covering an area of 1,405,000 km², the Barents Sea is vast, remote, pristine, and rich in resources. Yet, its geographical location on the edge of the Arctic, the effects of climate change, and the discovery of significant offshore fossil fuel reserves have swiftly made the Barents Sea the focus of international attention. Urbanisation processes have accelerated. Easier access to the Northern Sea Route from Europe to Asia across the northern Russian coastline due to the receding ice front could save shipping companies valuable time and transport costs.(10) The Barents Sea holds an estimated 30 percent and 25 percent of the world's untapped gas and oil reserves respectively and exploration activities have intensified, but it is also "one of Europe's last large, clean and relatively undisturbed marine ecosystems," one of the most productive in the world, and among the most biologically diverse in the Arctic.(11) These interests steer the development of the Barents Region—a geographic entity, an ecosystem, and a political-economic construct created as recently as 1993 to "mark the end of the cold war and the beginning of something new."(12)

The Baltic Sea and the Barents Sea are very different—spatially, culturally, and geographically. The prosperous period of Baltic trade through the exploits of the Vikings and the Hanseatic League left a legacy of cultural achievement expressed architecturally in urban centres. Extensive maritime interaction continued with the Danish Kingdom, the Swedish Empire, and the contemporary post-Soviet collaboration among the Baltic States of Estonia, Latvia, and Lithuania. Centrally located in Europe, the Baltic Sea straddles geographic, cultural, and political boundaries in both an east-west and a north-south direction and is accessible to a large population, although at 393,000 km² it is only one-third the size of the Barents Sea. Development pressures indicating the Baltic Sea's

levels of urbanisation include some of the world's busiest maritime transport routes and the expanding wind-energy sector. Due to its brackish water and its ongoing transformation from lake to sea, it is ecologically unique and hosts a range of unique species specifically adapted to this change. The combination of a sensitive oceanographic predisposition and the intense coastal exchange bring the Baltic Sea to a tipping point where the sea as a resource in the broadest sense is endangered. As the focus of its nine surrounding countries, many efforts have been mobilised, in particular from the EU, to economically unite and strengthen this realm, while addressing the sea's pressing environmental issues. Hence the Baltic Sea is also a strategic political project.

I analyse the two seas in relation to their geophysical, biological and social-economic territory. I also consider networks, seascape, technology and ecology — the most prominent types of use of ocean space as well as subjects of important literature in urban studies.(13)

URBAN FORMATS IN THE BARENTS SEA

Territorial analysis of the Barents Sea reveals two urban formats: firstly the loose, flexible mesh of activities oscillating with the extreme seasonal changes in the region and tied to the seascape resources, and secondly, the strategic geometries which harden into marine highways and technical sites of extraction.

The first format is made up of interactions that set up patterns of settlement and trade liaisons which have been mediated by the sea itself. This form of urbanisation is not based on density, population numbers, or centrality, but rather on the double periphery of the littoral zone — both peripheral to the northern European continent and to the geographical sea itself — and connections presiding over large, dispersed areas of small settlements. Apart from the city of Murmansk, which was established during World War I within the Russian governmental policy of deliberately populating the north, the fringes of the Barents Sea have traditionally never given rise to dense urban areas. Instead, since the end of the last ice age, many small, widely dispersed settlements developed along the coast at natural harbours. Ocean trading routes were the vehicle of exchange between settlements and with international partners. Today, the towns that grew out of earlier settlements are connected through coastal services, are economically reliant on diverse forms of ocean production, and are remote and detached from nationally centralised modes of organisation. The density of ocean activities is comparable to activities on land [Fig. 2, p. 46].

The resulting spatial system embraces diverse forms of movement and exchange, which consolidate relationships and define the territorial dimensions: fishing, the seasonal transhumance of the indigenous Sami culture, seasonal population fluctuations, and border crossings. The Barents Sea is an extensive region of

negotiation, exchange, and flux. Since the shores of the Barents Sea are not suitable for commercial agriculture, the specialised crop cultivation and surplus food production that has been a decisive factor in urban history and increasing settlement density did not apply here. Instead, the urban morphology of the Barents region describes its own singular relationship between settlement and territory, mediated through the agency of the sea. Urban systems operate in a loose, shifting mesh across land and sea—a strategy seemingly well suited to an environment of extremes.(14)

The second urban format, overlaying the first, is comprised of strategic geometries. While exerting a powerful force on a map, these formats are still to be verified. They constitute a pre-urban phase of speculation, a phase the Barents region well understands from its history of "boom and bust" resource exploitation including coal mining on Svalbard, the Kirkenes and Kiruna iron-ore mines, and nickel-mining in Nikel. The establishment of offshore exploration grids, rigs, and pipelines represents an extension of this preliminary resource infrastructure as it developed first on land. Since the cycles of these industries are out of tune with natural cycles, and carry on year-round, the offshore Barents Sea environment holds them in check due to the difficulty and expense posed by deep, rough and cold waters. Its double periphery is a receptor for visions of extended urbanisation, always in a state of becoming: "the region is a complex field of unrealised dreams and visions."(15) In the Barents Sea, resistance to an urbanisation of strategic geometries confirms a co-relation between urban activities and oceanography, which is stronger than the co-relation of topography to the urban on land. On land, topography and the forms of organic organisation that adhere to it have largely been overtaken by efficient geometrical patterns of primordial order [Fig. 3].

URBAN FORMATS IN THE BALTIC SEA

Borders and enclosures in the Baltic Sea are abstract fixtures, some of which define operational systems such as zones of marine planning or traffic routes, and some of which are projections of competing activities not yet reinforced by law [Fig. 4, p. 47]. The zones earmarked for wind park developments and marine protected areas, which appear scattered and small in scale compared to the scale of environmental degradation, are examples of the latter. The result is a complex, fragmented series of singular but frequently overlapping spaces. Traversing the sea, a deep-water shipping route forms a central backbone of transit.

The bathymetric and morphologic division of the Baltic Sea into fourteen parts is exacerbated by the overlay of anthropogenic borders described above. In addition, the Exclusive Economic Zones of the nine surrounding countries create eleven zones that do not correspond to natural divisions, but which generate national and sometimes trans-

Fig. 3
Plan of Snøhvit
extraction area,
Barents Sea
(Couling)

boundary planning efforts to organise the space. Superposing these
layers, the combined shipping passages describe a space of perpetual
movement irrespective of borders. The history of the Baltic Sea
demonstrates a persistent network component, which has accelerated
interactions and created an interconnected space, which one study
has called the "sea common."(16) This is reinforced through the
relative proximity of ports and shorelines—a ship in the Baltic Sea
is at no point more than 130 km from land.(17) [Fig. 5, p. 48]. Intersecting
all of these spaces is the movement of species between important
natural habitats. Combined, these manifold relationships create a
dense network of spatial claims in the Baltic Sea that are inherently
contradictory. On the one hand, borders describe increasing forms
of static control applied to both the commercial/productive and the
environmental spaces of the Baltic Sea. On the other hand, networks of
linear connections define a common, fluid, periodic space, and over time
the networks appear, appear to wholly consume the space [Fig. 6, p. 47].
The environmental capacity is close to saturation.

　　　Urbanisation in the Baltic Sea is therefore characterised
by the complete interpenetration of spaces of movement, both
organic and inorganic, with an increasing number of fixtures and
artefacts. Technological seascapes are forming through wind parks,
with the leisure seascape and bird resting areas located nearby.
All kinds of boating activities use the space periodically and the
sea is characterised by a high degree of human interaction. This
interaction, both physical and virtual, has created a common
referential space that unifies the region. It is a complex realm of
cohabitation hanging in a delicate (im)balance.

URBANISATION IN THE BARENTS AND BALTIC SEAS

Urbanisation in the sea can be the result of a chain of interdependencies originating in oceanic features which produce habitats, followed by life forms attracted to these habitats that then become a resource utilised in production processes. The Barents Sea fishing industry is one example, originating in plentiful phytoplankton production at the marginal ice edge. However, the two seas demonstrate intensified interactions which go beyond this logical chain, such as in the offshore energy industries. The emerging energy seascape has a highly technological component and is spatially dispersed yet tightly connected through networks. Urban indicators are periodic, diffuse, unevenly dispersed over vast areas but embedded in abstract ordering systems, and are aligned to specific locations with absolute technical precision. These factors all contribute to the apparent unfamiliar and radical nature of urbanisation processes operating within the Barents and Baltic Seas.

Contemporary urbanisation processes have been able to link into "habitats" provided by the legacy of interactions facilitated by, and in connection with, these seas. The intensification of urbanisation processes has bought such habitats into relief, and enabled us to recognise their urban characteristics over the territorial scale, which until now, had remained unfamiliar. The radical nature of ocean urbanisation is also due to one further critical characteristic. The space outside of territorial waters but within an Exclusive Economic Zone, is, according to the Law of the Sea, both a common, fluid resource and a potential site for national production and extraction. Therefore, this space is a site of continual negotiation.

NINE PRINCIPLES OF OCEAN URBANISATION
IN THE BARENTS AND BALTIC SEAS:
1. The seas are vital producers.

Economic activities, and shipping in particular, dominate the use of both seas. Environmental aspects are either completely integrated into production through research and technology, as in the Barents Sea, or tentatively outlined through "soft" legislation and therefore largely ignored, as in the case of the Baltic Sea.

2. Production activities create new seascapes.

Energy production, which has not traditionally been located offshore, such as wind in the Baltic Sea or fossil fuel in the Barents Sea, is creating new seascapes. These technological seascapes are replacing the seascapes on which the fishing profession has traditionally relied. In the Baltic Sea, millions of ferry and cruise passengers experience the sea annually and the new seascapes are well-integrated in the urban imagination. In the Barents Sea, the new production sites are further offshore, characterised by less surface infrastructure, and they will not be experienced by the public.

3. Urbanisation is supported by specialised technology.

      The space of the sea is integrated into systems of monitoring, control, strategic forecasts, and economic programmes. The acquisition of knowledge is a primary step in urbanisation processes. Vast amounts of research data exist for the Baltic Sea—the most intensively urbanised of the two seas. Oceanographic scanning and monitoring require specialist technology and equipment and large-scale financial investment. The Barents Sea still contains large areas about which little is known, but the knowledge-base for both environmental purposes and petroleum-production are completely integrated; extensive scanning has been carried out in the areas deemed most promising for fossil fuel production. This knowledge is then translated into grids of potential exploration licences, which represent one of the most extreme urban typologies in the sea.

4. The seas are a common referential space.

      The cultural and historical context, combined with current political forces, determines the form in which this common space emerges. In the Baltic, manifold crossings and connections, both historical and contemporary, have constructed this space and they are currently being reinforced by political efforts to create a stable Baltic region on the EU border. In the Barents region, the ocean is richer in resources than the land. Regular interaction with the sea, and its connecting role between small scattered settlements, makes it a common referential space. Identity has developed under local conditions, since the northern districts are distant from central government control in both Norway and Russia. While the political efforts to reinforce this space under the title of the Barents Euro-Arctic Region have met with local scepticism, they are proof of the mounting strategic importance of a region with the Barents Sea as the central point of reference.

5. Both regional and international urbanising
forces are exerted on the seas.

      In the Baltic Sea, relatively evenly distributed urban forces issue predominantly from the regional coastline to structure different spatial strata—pipelines and cables on the sea bed, shipping movement across the surface, and wind-energy capture in the air space. In the Barents Sea, the two dominating forces of urbanisation issue from different sources: the local fishing industry and the international interests of the oil and gas industries.

6. Spatial and ecological budgets are closely linked in the sea.

      Ecological systems require a spatial budget. In the Barents Sea, marine life makes use of generous, uninhibited habitats over large areas and depths, further enhanced by the open oceanographic borders to the Atlantic and Arctic Oceans. However, the long-range

transport of pollutants poses environmental threats.(18) In the Baltic Sea, species suffer habitat loss and displacement due to spatial competition with wind farms, large transport vessels, and coastal development.(19) The same habitats are often favoured by both organic and "inorganic" species, such as shallow sandy bottoms for wind farm development, fish spawning grounds, and bird resting areas.

7. Urbanisation patterns are characterised by dispersed intensities.
       Urbanisation patterns in the Barents and the Baltic Seas are comprised of loose, diverse, shifting fragments that are widely dispersed, but connected by precise, specialised trajectories —more numerous and more frequent in the Baltic Sea. Rather than characterised by density, the seas are characterised by situations of periodic intensity, manifest as the technological link to a resource exploited for a defined period. While the intensity itself may be localised, singular, and of short duration, it relies on sophisticated, large-scale spatial systems that have been constructed on the basis of extensive research, coordination, and investment and are centrally controlled. Such a dispersed intensity can align networks, seascape, technology, and ecology within one single operation.

8. Infrastructure is the hardware of ocean urbanisation.
       The large-scale maritime spatial systems are mostly of an abstract nature, but extended urbanisation in the Barents and Baltic Seas is materialised through infrastructure. Infrastructure utilises linear arrangements that have an apparently negligible spatial impact in one direction, but are of a territorial dimension in another. Infrastructure fulfils the function of transferring forces, therefore the spatial implications of forces are also transferred, giving rise to oscillating spatial expansions and contractions.

9. Natural conditions support urbanisation processes.
       Extended urbanisation is anchored in systems utilising the natural properties of ocean space. Ice conditions, marine life forms, deep-water harbours, winds, currents, and bathymetry all support urbanising activities to varying degrees. Oceanic forces increase the efficiency of transportation methods and the common status of the space itself outside unilateral control allows for an enhanced freedom of exchange.

CONCLUSION: FROM URBANISING TO CULTIVATING THE SEA
       This research is based on the notion of seas as cultural products related to their respective geophysical territories, which are relational, in flux, and constantly transforming. Hence, what we understand as the entity of the "Baltic Sea" or the "Barents Sea" is more than a fluctuating geographical outline; these seas have been occupied, imagined, and cultivated through a long process, involving

both direct interaction in the sense of farming resources and negotiations to create diverse geopolitical units over time. The seas possess potential that draws them into socioeconomic relations with their inhabited littoral zones.

In the years since World War II, under accelerating urbanisation processes, not only have seas been drawn into the urban sphere by corporations and planners, but this urbanisation has been of an overwhelmingly industrial, infrastructural nature. Closer attention to the sea as an urbanised realm is a call to engage with the legacy of these interventions, including how they are now partially integrated into ecological systems and therefore part of what we must now nurture and cultivate.(20) As urban systems weave more extensively through sensitive, dispersed, fluid territories, practices must be adapted to ensure parallel cultivation of the material maritime world, and to reclaim public responsibility for this cultural territory.

(1) Henri Lefebvre, *The Production of Space*, trans. Donald Nicholson-Smith (Oxford: Blackwell, 1991), 30.

(2) Neil Brenner and Christian Schmid, "Planetary Urbanization," in *Urban Constellations*, ed. Matthew Gandy (Berlin: Jovis, 2011).

(3) Stuart Elden, *The Birth of Territory* (Chicago: University of Chicago Press, 2013), 330, https://press.uchicago.edu/ucp/books/book/chicago/B/bo15506915.html.

(4) Stuart Elden,"Land, Terrain, Territory," *Progress in Human Geography* 34, no. 6 (1 December 2010): 799–817, https://doi.org/10.1177/0309132510362603.

(5) Stuart Elden, "Missing the Point: Globalization, Deterritorialization and the Space of the World," *Transactions of the Institute of British Geographers* 30, no. 1 (2005): 8–19, https://doi.org/10.1111/j.1475–5661.2005.00148.x.

(6) International Hydrographic Organization, "Limits of Oceans and Seas," Special Publication (Monégasque, Monte-Carlo: International Hydrographic Organization, 1953).

(7) Matti Leppäranta and Kai Myrberg, *Physical Oceanography of the Baltic Sea* (Berlin: Springer, 2009).

(8) Ocean depths exceed the highest mountains: height Mt Everest = 8,848 m, depth Challenger depth in the Mariana Trench= ca. 11,000 m.

(9) See chapter 6 (Schmid) this volume, Vincent Kaufmann, *Rethinking the City: Urban Dynamics and Mobility* (Lausanne: EPFL Press, 2011:50). Originally published in Jacques Lévy and Michel Lussault, eds., *Dictionnaire de la géographie* (Paris: Belin, 2003).

(10) Bjorn Gunnarsson, "Future Development of the Northern Sea Route," *Maritime Executive* (18 February 2016), https://www.maritime-executive.com/editorials/future-development-of-the-northern-sea-route.

(11) World Wildlife Fund, "The Barents Sea Ecoregion: A Biodiversity Assessment" (Oslo: WWF, 2004), http://d2ouvy59p0dg6k.cloudfront.net/downloads/barentsseaecoregionreport.pdf.

(12) Morten Andreas Strøksnes, "The Inner Space of Barents," in *Northern Experiments. The Barents Urban Survey 2009* (Oslo: 0047 Press, 2009).

(13) Nancy Couling, "Formats of Extended Urbanisation in Ocean Space," in *Emerging Urban Spaces- a Planetary Perspective*, eds. Philipp Horn, Paola Alfaro d'Alençon, and Ana Claudia Duarte Carduso (Springer International Publishing, 2018), XII, 219.

(14) Harry Gugger, Nancy Couling, and Aurélie Blanchard, eds., *Barents Lessons. Teaching and Research in Architecture* (Zürich: Park Books, 2012).

(15) Espen Røyseland and Rø Oystein, eds., *Northern Experiments. The Barents Urban Survey 2009* (Oslo: 0047 Press, 2009).

(16) Jan O. Lundgren, *The Transformation of a Geopolitical Space into a Tourist Space: The Case of Passenger Shipping in the Baltic*, Les Cahiers Du Tourisme. Série C, no 186 (Aix-en-Provence: Centre des hautes études touristiques, 1994).

(17) Monika Stankiewicz, Hermanni Backer, and Nikolay Vlasov, "Maritime Activities in the Baltic Sea—An Integrated Thematic Assessment on Maritime Activities and Response to Pollution at Sea in the Baltic Sea Region," Baltic Sea Environmental Proceedings (Helsinki: HELCOM, 2010), http://www.helcom.fi/Lists/Publications/BSEP123.pdf.

(18) Royal Norwegian Ministry of the Environment, "Meld. St. 10. Report to the Storting (White Paper)First Update of the Integrated Management Plan for the Marine Environment of the Barents Sea-Lofoten Area," 3 November 2011, http://www.regjeringen.no/en/dep/md/documents-and-publications/government-propositions-and-reports-/reports-to-the-storting-white-papers-2/2010–2011/meld-st-10-20102011.html?id=682050.

(19) Environmetal Group, "Danish Offshore Wind. Key Environmental Issues- a Follow-Up" (Danish Energy Agency, 2013).

(20) See chapter 11, this volume.

Chapter 2   NORTH SEA CROSSINGS: HISTORICAL GEO-SPATIAL
MAPPING AS A TOOL TO UNDERSTAND THE LOCAL
DEVELOPMENT OF PORT CITIES IN A GLOBAL
CONTEXT

Carola Hein, Reinout Rutte, & Yvonne van Mil

Researchers at the Chair of History of Architecture and
Urban Planning, TU Delft, Carola Hein, Reinout Rutte,
and Yvonne van Mil use geo-spatial mapping methods to
reveal patterns of urbanisation on land and around the
North Sea coastlines, over long historical periods.

Carola Hein is Professor of History of Architecture and Urban Planning
(Delft University of Technology). Her books include *Adaptive Strategies for Water
Heritage* (2019), *The Routledge Planning History Handbook* (2017), *Port Cities* (2011), *The
Capital of Europe* (2004), *Rebuilding Urban Japan after 1945* (2003), and *Cities, Autonomy
and Decentralisation in Japan* (2006).

Reinout Rutte is Assistant Professor in History of Architecture and Urban Planning
at Delft University of Technology. He focuses on long-term development of Dutch
cities and has co-edited *the Atlas of the Dutch Urban Landscape* (2014)

Yvonne van Mil is researcher spatial history and cartographer, affiliated with the TU
Delft. She co-authored *Driven by Steel: From Hoogovens to Tata Steel 1918–2018* (2018) and
contributed chapters to *the Atlas of the Dutch Urban Landscape* (2014).

The North Sea has long been a hub of maritime flows. A relatively flat sea, for many centuries it has facilitated exchanges among people living on its shores. An analysis of medieval road systems seems to connect places in the Netherlands with those in Great Britain. Antwerp, Amsterdam, London, and Hamburg have been leading trade centres in Northern Europe since the medieval period, as part of the Hanseatic League, for example. Hamburg's trade and culture was more closely connected to London than to its hinterland as the joke suggests: "When it rains in London, Hamburg puts up its umbrellas." From the sixteenth to the eighteenth century, cities around the North Sea grew into colonial and global hubs. Since the Industrial Revolution, they have become industrial and transportation hubs as well as decision-making centers. Additional port cities have grown around the North Sea, including several of Europe's largest container ports, such as Rotterdam and Bremerhaven. Each of these ports and cities have responded in their own fashion to global flows of goods, people, and ideas from sea to hinterland. A comparative analysis speaks to the ways in which maritime flows and ocean urbanization have shaped coastal regions, port cities, and hinterlands.

As port cities around the North Sea became part of nations and then as industrialisation led to urban expansion and a land-based approach to planning took hold, the cultural power of the sea declined. Nonetheless, for centuries its extensions—the rivers and deltas that serve as connectors with and extensions of the sea—have featured prominently in representations of port cities.(1) References to shipping and the sea have also been part of the imaginaries, cultures, and maritime mindsets of many port cities.(2) Today in port cities, an awareness of the importance of water remains evident in mental maps and the experience of everyday citizens.(3) This awareness can be used to help revive or develop planning and design approaches that acknowledge the importance of the sea in general and the North Sea in particular.

To address contemporary urgencies like climate change, energy transitions, or sea-based migration we need to understand ocean urbanisation. We need to do something other than extending land-based planning or translating hinterland planning to the maritime foreland. Rather, we need to reimagine ocean space as a spatial, social, and cultural complex. Such an approach involves acknowledging coastal and port cities not only as extensions of land-based infrastructures and plans, but as maritime access points and almost as extensions of the sea. It also requires multidisciplinary collaboration and agreement and coordination of effort among port and city professionals as well as local citizens and maritime specialists. There is a need for information about the physical reality on sea and land in which human life and work take place in port city regions. The Leiden-Delft-Erasmus PortCityFutures (portcityfutures. nl) research group has taken on this challenge as its mission. It argues

that comprehensive development of port city regions as ecosystems, including the maritime foreland, can benefit from a methodology built on the analysis of spatial and cultural patterns. We are exploring how to complement the excellent data produced in economic geography on maritime flows with a space-based methodology and whether it is possible to create a new form of abstraction that allows us to consider the spatial, temporal, and functional elements of port, city, and region in a geographic context.

Academics in separate disciplines have tended to study maritime flows and port-city relationships independently of each other, with different goals, focused on separate values and different scales. The study of ports and port cities is dominated by quantitative and abstract data-based approaches that often fail to consider qualitative aspects and local particularities. Other research has explored the individual development of these cities, their architectural and urban history, mostly within their national context. There is a need for analytical links between the two types of literature.(4) Scholars have written comparative histories, but these writings do not illuminate how port cities translated global demands or hinterland challenges into spatial transformations.

Studies of hard values need to be aligned with a study of soft values, including in the spatial and social sciences and the humanities. Such collaboration requires a methodology that connects currently disparate sectors and types of knowledge and understanding. We argue that the scale of such an investigation should be that of the port city region, including the sea space, and not just that of the port city, the area where port activities leave their footprint. An assessment of conflicts and opportunities at the intersection of port and city interests warrants consideration of spatial, social, and cultural factors.

Examining the challenges and opportunities of geo-spatial mapping, this chapter calls for a methodology that parallels abstract quantitative economic modeling of port city regions and their networks with historical investigation of individual port city regions—sea and land—with their specific local challenges and opportunities. Quantitative mapping, while informative for ports and shipping, remains without scales and features, and lacks the topographical aspects that are key to spatial, social, and cultural experience. These aspects can be captured in historical geo-spatial mapping, revealing how diverse governance structures have created policies, laws, and administrative borders as well as physical spaces.

Building on the Delft geo-spatial method presented in the journal *Over Holland*, we aim to establish a socio-spatial and cultural approach focusing on maritime connections and their impact on port cities to better understand their historical evolution over time, and to highlight how practices of the past shape the present and the design of the future. The studies of port cities around the North Sea serves

as our first case study. Following an explanation of the geo-historical mapping developed at TU Delft for the western Netherlands, we present visualisations of the historical development of three port city regions that have developed in relation to each other around the North Sea and that we are using as pilot studies: Rotterdam, Hamburg, and London.(5) We conclude that this type of geo-spatial analysis can connect quantitative and qualitative approaches and help identify historical forms, spatial structures, and governance patterns with lasting importance for decision-making in port city regions.

Historical geo-spatial mapping is a research tool that provides an opportunity to connect diverse data in space and over time. To make this research meaningful, a number of decisions have to be made relating to scale, time, and research perspectives. Identifying scales at which data is available and can be meaningfully presented, determining moments in time that capture moments of change, and identifying the most relevant information are key challenges of mapping. The decisions are relevant for a specific location and are only partly transferable as, for example, ports and cities exist and grow at different scales, as the introduction of new technologies or energies is picked up at different moments in time. For our research on port cities around the North Sea we use the findings and decisions made for mapping the Netherlands as a starting point.

THE DELFT HISTORIC GEOSPATIAL MAPPING METHOD

In 2011, researchers of the Chair History of Architecture and Urban Planning and the Department of Architecture at Delft University of Technology published with the University of Amsterdam's historical research group "Twelve Centuries of Spatial Transformation in the Western Netherlands in Six Maps."(6) We used geo-spatial mapping to study the urbanisation process in the area now known as the Randstad, the so-called Rim City in the western part of the Netherlands. Changes in landscape, habitation patterns, and infrastructure are shown in six maps that indicate the situation in AD 800, 1200, 1500, 1700, 1900 and 2000. These "snapshots" provide an overall picture of (a) the history of habitation and the urbanisation process and (b) changes in landscape and infrastructure. The six maps showing the spatial transformation of the western Netherlands focus on the landscape on a regional scale [Fig. 1, p. 49]. We reconstructed unknown situations using a series of comparable maps. While we did not depict the sea separately, it is possible to see the relation between sea and land and the ways in which land reclamation and urbanization pushed back the sea.

In the spatial disciplines, drawings, including cartography, are valuable both as research tools and research output. Research output can be recorded pictorially as well as text. At the same time, drawing is itself a way of analysing source material, creating links that may lead to new insights. Not only is the drawing methodology exact and

substantiated, but the design and analytical skills of map-makers enhance the impact of the final drawn result.

The series of six maps was created using a set of interrelated information. Within the specific area of the western Netherlands a patchwork of maps (or map sections) was used for each of the six years, together with written source material and sketches showing relative changes in the landscape. We used a retrogressive approach to reconstruct a number of earlier maps. We analysed and compared spatial structures to fill in missing pieces of the puzzle. We used elements from later dates, for example habitation patterns, to reconstruct earlier ones, and in some cases vice versa. As the study progressed, the results of the various maps were compared, and this in turn led to new insights. The drawn material—the series of six maps—thus became a new source of information.

To what extent can a study such as this provide a representative picture of the situation in each of the years chosen, indicating processes of urbanisation and features that remain unchanged? Can the long-term development of the western Netherlands be divided into periods on the basis of spatial transformation?

In 800, we can see a very thinly populated natural landscape in which sand, peat, clay, and water were the predominant features. By 1200, many of the peat and clay areas had been reclaimed and dyked and the urbanisation process had begun. Three centuries later, the western Netherlands was a cultivated landscape full of towns connected by a dense network of waterways and by unpaved roads. By 1500, the distribution of towns over the landscape was fixed. By 1700, some of the towns had expanded into cities, the water infrastructure had become denser and overland roads had been improved. At the same time, peatland areas had been substantially altered by peat dredging and land drainage. The main features of the map for 1900, apart from a number of major polders, were infrastructural changes and renewed urban expansion: railways, paved roads, new urban districts, and suburbs. A hundred years later, in 2000, the most striking features were large-scale urbanisation associated with the motorway infrastructure.

We can conclude that the sand, peat and clay subsoil that formed before 800 determined the structure of what is today the Randstad. Another crucial factor was the wet infrastructure in the watery delta from the eleventh to the fifteenth century, when Holland emerged as a region in its own right and experienced its first period of growth. The same period determined the distribution pattern of cities and towns in the Randstad. From the fifteenth to the seventeenth century, the landscape was partly transformed, and a clear urban hierarchy developed during the Golden Age. After more than 150 years of stagnation, urbanisation resumed in the western Netherlands beginning in the late nineteenth century. At first, this growth was mainly within the spatial framework that had developed earlier, but

later the new infrastructure played a greater role—at first the railway system, but after the Second World War, increasingly the motorway network.

The series of six maps shows that existing spatial structures, such as reclaimed peatland, habitation patterns, and infrastructure, tend to be remarkably persistent in the long term. This phenomenon, often referred to as inertia, implies that large-scale spatial interventions do not occur easily. The term also indicates that existing infrastructure and habitation patterns have a major impact on the continuity of spatial distribution of economic activities in a given area. It is easier to bring about a change of function within an existing physical structure than to make substantial alterations to a spatial pattern. Such spatial pattern alterations usually come about as a result of external factors such as a flood disaster, war, or a change of position on the international political and economic stage.

Finally, it should be noted that large-scale government intervention in the spatial planning of the Randstad area during the second half of the twentieth century was exceptional. If we look at the design and spatial transformation of the landscape in the western Netherlands over the long term, we can see that this was mainly due to private initiative and largely the result of mechanisms that are today referred to as "project development," such as the dykes in the south-western delta and many of the major polders. In some cases, such as the mediaeval reclamation of the peatlands, a local ruler, a count or a bishop played a leading part, in what we might now call a public-private partnership. Substantial changes were usually made in times of economic prosperity. One of the main prerequisites for prosperity was closely bound up with the landscape and its cultivation: the water infrastructure. There was not usually much planning, let alone central management. The new railway infrastructure in the nineteenth century was also largely the result of private initiative; the central government was forced to take a hand in its development simply to ease bottlenecks notably of mobility. Only in the cases of the IJsselmeer polders, the Delta Works, the motorway system, and post-war urbanisation up to the 1990s does actual or attempted government intervention—rather than interaction between economic potential, private interests and geographical conditions—appear to have been the predominant factor.

This Delft geo-spatial method shows how it is possible to understand the present by mapping long-term developments. Making a series of uniform maps with uniform legends we can reconstruct the past to gain new insights in the present and to design a just future. For Dutch cities and landscapes, the discussion of how to deal with sea-level rise and increased flooding is clearly one of survival.(7)
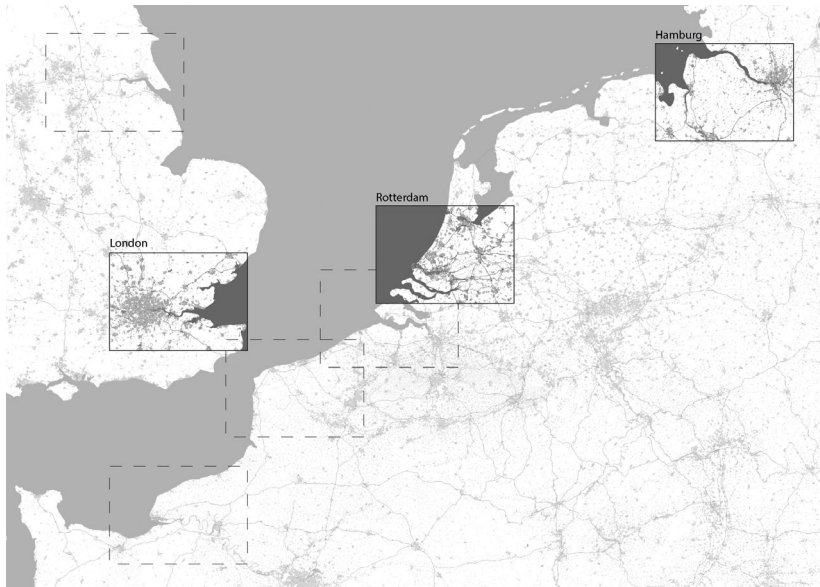
Fig. 2
Research area of
North Sea studied
in the Chair Histo-
ry of Architecture
and Urban Plan-
ning, with case
study of London,
Hamburg, and Rot-
terdam with other
potential port
city areas framed
with a dashed line.
(Yvonne van Mil)

COMPARATIVE GEO-SPATIAL MAPPING OF PORT CITY REGIONS ROTTERDAM, HAMBURG, AND LONDON

The methodological and content-related findings of the mapping of the Randstad have the potential to be further developed through the lens of ocean urbanisation and port city relations. We think that the findings offer a foundation for historical geospatial mapping of ocean urbanisation and port city regions, allowing us to compare and analyze their spaces and institutional structures in the context of other port cities around the North Sea.

Selecting a shared body of water—the North Sea—as the foundation for a comparative research program on port city regions allows us to establish and test a methodology for historical and spatial analysis [Fig. 2]. For our pilot study, we have chosen three port city regions on which we have already worked and for which we have sufficient data. The port city region of the Nieuwe Waterweg, around the port of Rotterdam, serves as an example of the challenges and opportunities that large port city regions face worldwide. In our current areas of investigation, Hamburg and London provide examples of other planning challenges for port city regions of past, present, and future. Each of these three case studies shows different historical interactions between port and city in the larger region. The continued importance of Rotterdam, Hamburg, and London as port city hubs confirms their relevance as key places to begin.

In accordance with the mapping method used for the 2011 *OverHolland* project, we reconstructed the historical settlement of the three port cities, based on current European data sets, historical maps, and written sources. For a comparative study of port city regions, we used geo-spatial mapping (GIS), overlaying different data

layers with a similar level of abstraction and a uniform legend. While the approach is similar to that of *OverHolland*, the research question and associated layers as well as temporal and spatial frameworks are different. To better understand port city region relationships and their connection with the hinterland, we opted to show port and city areas, important infrastructures and political boundaries as a foundation for a comprehensive sea-land historical analysis [Fig. 3]. Rather than analyzing the spatial development of a pre-defined area (as we did with the Randstad), we aim to systematically identify and map the extent of the port city region. We therefore need to understand the scale at which port cities operate. The relationship between the size of a port, the size of the metropolitan area, and its location in relation to the hinterland has changed over time. In the case of Rotterdam, Hamburg, and London it is therefore necessary to analyze the port cities not only on the scale of the medieval city at 1:10 thousand or 1:25 thousand, but also on a regional scale at 1:100 thousand and 1:150 thousand.

The remaining section focuses on methodological implications of geo-spatial mapping and the representation of data for the analysis of three port cities that are interconnected by shared maritime practices. Our aim is to get a preliminary sense of what historical geo-spatial mapping can add to economic modelling-based research in terms of spatial, institutional, and cultural development. Details of the history of these three cities can be found in two published articles.[8] The maps presented here are aimed at exemplifying the challenges and opportunities of mapping port and city space and regional governance at four moments in time: 1300, 1700, 1900, 2020 [Fig. 3].

The series of maps from 1300 show the estuary, the morphology of port and urban areas, and the infrastructure. The fledgling cities controlled dykes and dams, intersections between rivers (Rotterdam and Hamburg), and bridges (London). In general, the cities developed alongside the river. Urban spaces and buildings were dense and multifunctional. There was no clear distinction between dedicated port areas with fixed infrastructures nor any specific identification of multifunctional spaces. In 1300, Hamburg and London ware already well-established North Sea cities, but the urbanization of Rotterdam had only just begun. The city of Rotterdam is therefore many times smaller than the other two, although the port of the three cities is almost the same size.

The relation between ports and cities changed around 1700, as shown on the maps. In Rotterdam and Hamburg, the ports expanded considerably through reclamation and the formation of new port islands in the rivers Maas and Elbe. New settlements grew also on the estuary near the main cities: Delfshaven near Rotterdam and Altona, the Danish port, near Hamburg. The form and function of urban areas was closely aligned with the needs of their local geographical, political context. Rotterdam provided—with neighboring port
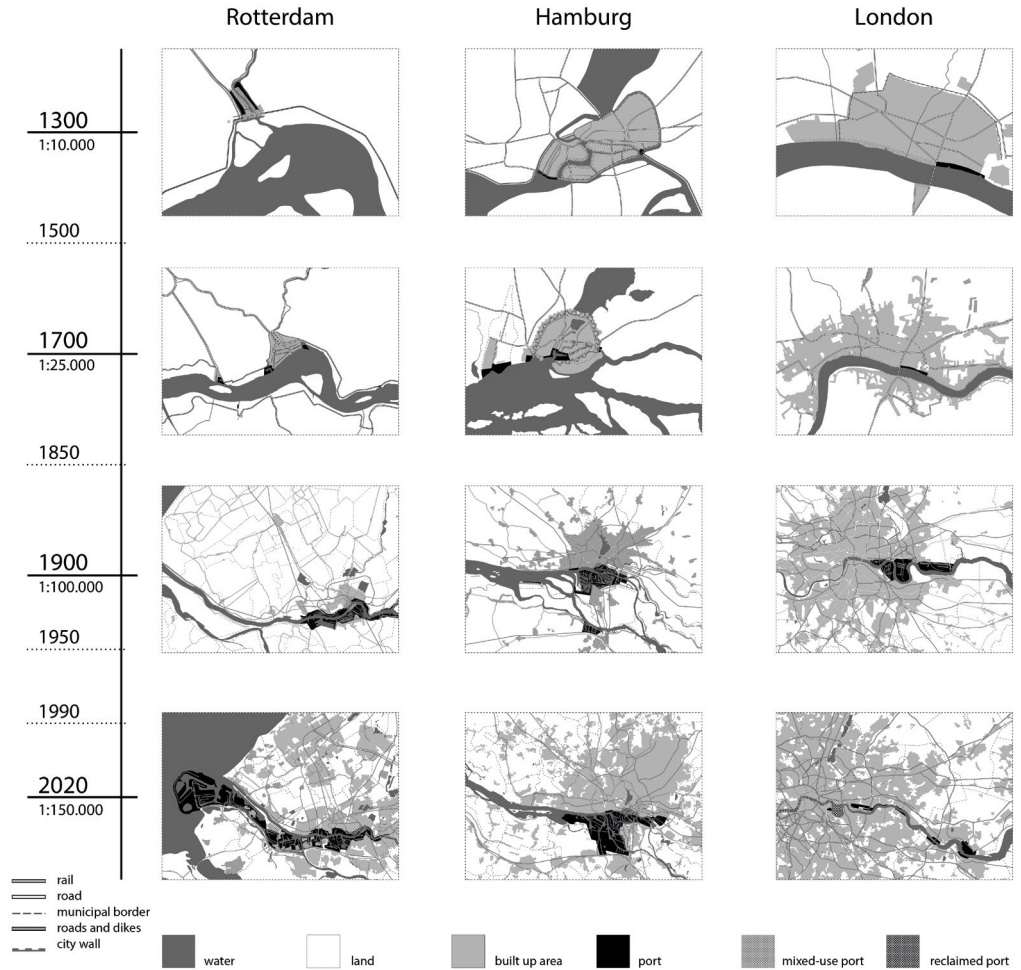
Rotterdam   Hamburg   London

1300
1:10.000

1500

1700
1:25.000

1850

1900
1:100.000

1950

1990

2020
1:150.000

rail
road
municipal border
roads and dikes
city wall

water   land   built up area   port   mixed-use port   reclaimed port

Fig. 3
First draft for
comparative geo-
spatial mapping
methodology, case
study of London,
Hamburg, and
Rotterdam. (Carola
Hein, Yvonne
van Mil, Blanka
Borbely, and
Batuhan Özaltun)

cities Delfshaven and Schiedam—access to inland transportation
via Delft and Leiden to Amsterdam. Hamburg, a city-state without
its own rural areas, surrounded itself with strong walls and a dense
spatial pattern as another port city, Danish Altona, grew just outside
its walls. London, a capital on an island did not need that kind of
protection and instead spread along the river.

Beginning in the early nineteenth century, enormous port areas
were carved out of the land and facilitated shipping and warehousing.
With industrialisation and new forms of transport, private actors,
port companies, and some city governments created dedicated port
areas separate from the urban spaces in all three cities. Water access
was a privilege largely reserved for trade. Rapid growth of trade, the
emergence of petroleum as a fuel, and urbanisation required port
and city expansion. Extensive landside route and rail infrastructures
connected the port to the hinterland. Specific patterns varied, but in
every case, port spaces expanded dramatically and started to occupy

land in the estuaries. In Rotterdam, the port expanded and merged with the port of Schiedam and in 1886 annexed Delfshaven. The ports of Altona and Harburg grew next to Hamburg, and would be integrated into the city state in 1937. In London, the port grew beyond the administrative boundaries of the city.

As the maps of 2020 show, the scales of decision-making have shifted over time and no single institution can compete with or control the region, which has grown beyond the scale of a single government entity that depends on is influenced by the port. To adjust to contemporary needs, new ports have been built and historic ports left behind as heritage. Containerisation played an important role in the separation of port and city as less and different work was available in the port. The arrival of larger and often automated port terminals pushed the industrial ports away from the city. In Rotterdam, the port authority has consciously built the port toward the sea, creating new boundaries with rural instead of urban areas (see Dunne, this volume) where fewer citizens are affected. In Hamburg, port and city are still intertwined in the same city-state, but the river itself has become a barrier. In the case of London, private actors moved the port beyond the boundaries of the city where environmental, infrastructural conditions are less restrictive. New multifunctional spaces have emerged, where heritage ports serve urban and often non-maritime functions, such as dwelling and leisure.

CONCLUSION

Ports have a foreland that is now global and a hinterland that extends often beyond national borders. They are crucial elements of economic flows and shipping movements and they are physical entities and socio-spatial constructs. Models and maps offer a means to show similarities and patterns in a world of differences and make it possible to understand the complexity and diversity of port cities within their context. Historical contexts can be difficult to compare. Cultural aspects are not documentable in a way that lends itself to visualisation based on widely agreed upon facts and used for comparative purposes. Any attempt to understand the spatial extent of shipping requires an examination of the spatial footprint of the port beyond its legal or administrative boundaries. Additional conversations are needed to theorize ocean urbanisation in relation to port city regions through in depth study, including around the North Sea.

A first conclusion regarding the development of the three cities around the North Sea can be drawn to show that a single maritime system—like the North Sea—can generate a range of diverse and complementary port city spaces and governance systems, each with their own particularities. Such analysis can provide an opportunity to understand, but also to influence and design. The goal is to identify how ports and cities have evolved spatially in relation to each other

and to understand the role that private and public actors, political interests, economic opportunities, or social preferences play in the implementation of these challenges. This will allow us to identify areas that will be under pressure due to competing port and city interests. Port cities around the world experience the same type of challenges, but local responses vary in line with political, economic, geographical, historic, social, and cultural conditions.
The methodology introduced here for the North Sea region can be used to gain a better understanding of many other regions with shared waters, such as the Mediterranean, the Black Sea, or the Gulf of Mexico, and provide a better foundation for decision-makers.

(1) Carola Hein, "Hamburg's Port Cityscape. Large-Scale Urban Transformation and the Exchange of Planning Ideas," in *Port Cities: Dynamic Landscapes and Global Networks*, ed. Carola Hein (New York: Routledge, 2011).

(2) Hilde Sennema, "Experience Port City Cultures from Your Couch," PortCityFutures, https://www.portcityfutures.nl/news/experience-port-city-cultures-from-your-couch; Sabine Luning, "Port City Culture - Culture(S) and Cultural Practices," https://www.portcityfutures.nl/news/port-city-culture-cultures-and-cultural-practices; Yvonne van Mil et al., "Mapping Maritime Mindsets: Towards a Shared Methodology," PortCityFutures, https://www.portcityfutures.nl/news/mapping-maritime-mindsets-towards-a-shared-methodology.

(3) Maurice Harteveld, "Mapping Maritime Mindsets: Mental Maps," https://www.portcityfutures.nl/news/mapping-maritime-mindsets-mental-maps; Sarah Sannen, "Maritime Mindsets of Rotterdam's Port Communities," https://www.portcityfutures.nl/news/maritime-mindsets-of-rotterdams-port-communities-0.

(4) Carola Hein, "Port Cityscapes: Conference and Research Contributions on Port Cities," *Planning Perspectives* 31, no. 2 (2016).

(5) Carola Hein and Yvonne van Mil, "Towards a Comparative Spatial Analysis for Port City Regions Based on Historical Geo-Spatial Mapping," *PortusPLus* 8 (2019).

(6) G Borger et al., "Twelve Centuries of Spatial Transformation in the Western Netherlands, in Six Maps: Landscape, Habitation and Infrastructure in 800, 1200, 1500, 1700, 1900 and 2000," *OverHolland* 10/11 (2011).

(7) Rolf Schuttenhelm, "In Face of Rising Sea Levels the Netherlands 'Must Consider Controlled Withdrawal.'" https://www.vn.nl/rising-sea-levels-netherlands/.

(8) Carola Hein and Dirk Schubert, "Resilience and Path Dependence - a Comparative Study of the Port Cities of London, Hamburg and Philadelphia," *Journal of Urban History* (2020); Carola Hein and Paul van der Laar, "The Separation of Ports from Cities: The Case of Rottterdam, Springer," in *European Port Cities in Transition*, eds. Angela Carpenter and Rodrigo Lorenzo (Springer, 2020).

[Fig. 1] G Borger et al., "Twelve Centuries of Spatial Transformation in the Western Netherlands, in Six Maps: Landscape, Habitation and Infrastructure in 800, 1200, 1500, 1700, 1900 and 2000," *OverHolland* 10/11 (2011).

[Fig. 2 & Fig. 3] Copernicus, "Corine Land Cover. Version 18.5. Copernicus," (2016); Eurogeographics, "Euroglobalmap. Version 10.0. Eurogeographics,"(2017); Global Administrative Boundaries, "Gadm Data. Version 36–2018. Global Administrative Boundaries," https://gadm.org/download_world.Html.
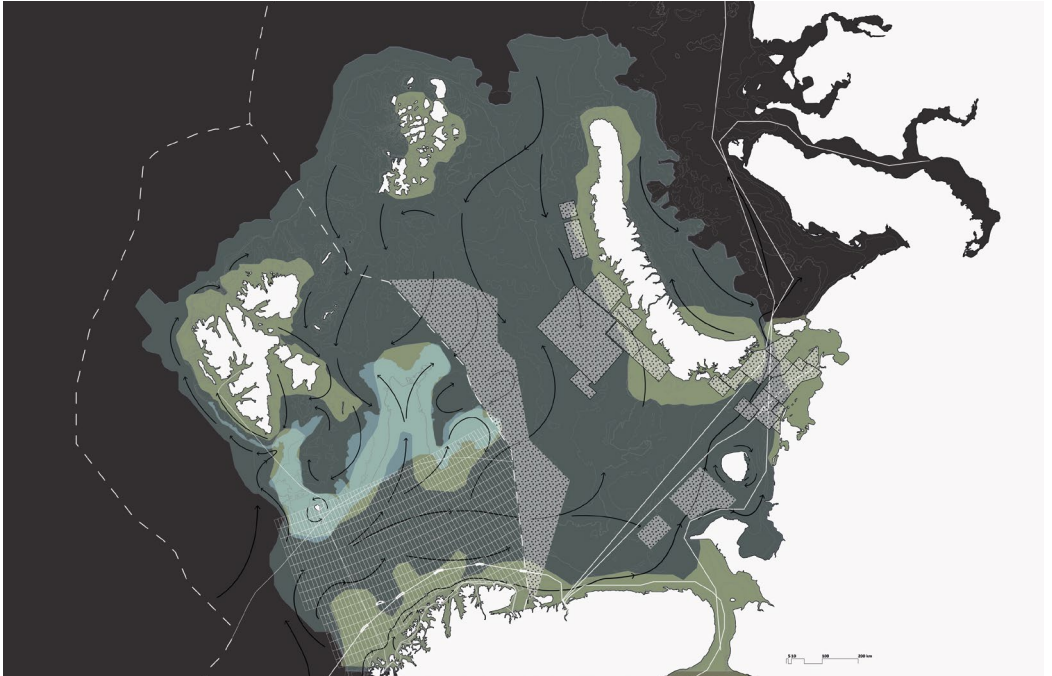
Fig. 1
Barents Sea: the
socio-economic
territory
superimposed over
the geophysical
and the biological
territories
(Couling)

Fig. 2
Barents Sea: a
loose, dispersed
mesh across land
and sea (laba,
EPFL).

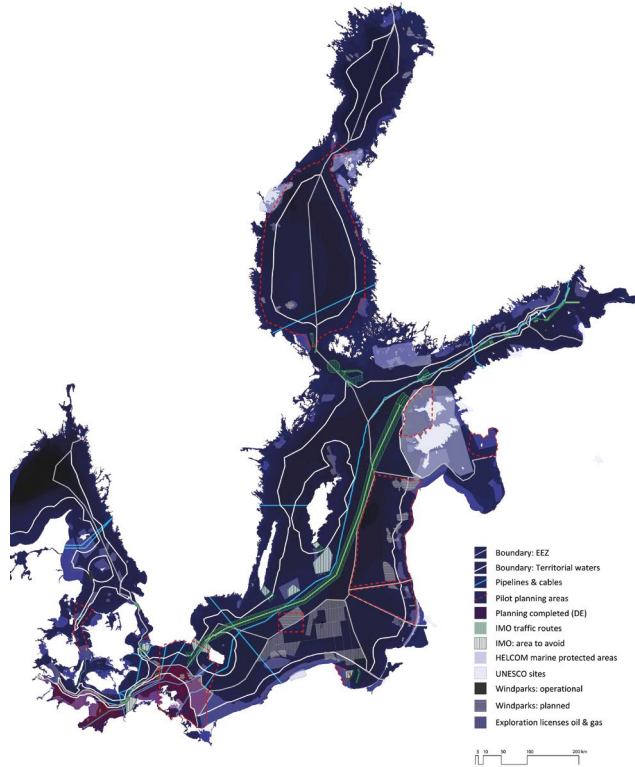Fig. 4
Borders and
enclosures,
Baltic Sea
(Couling)

Boundary: EEZ
Boundary: Territorial waters
Pipelines & cables
Pilot planning areas
Planning completed (DE)
IMO traffic routes
IMO: area to avoid
HELCOM marine protected areas
UNESCO sites
Windparks: operational
Windparks: planned
Exploration licenses oil & gas

Fig. 6
Baltic Sea:
a saturated
sea of shipping
movement
(Couling)

Windparks: existing or under construction
Windparks: in planning
IMO Traffic separation scheme
IMO Deep water route
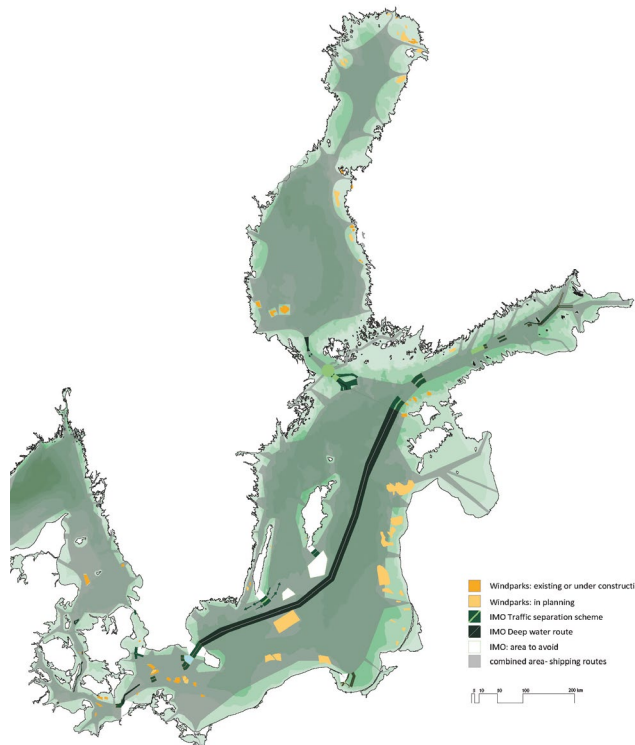IMO: area to avoid
combined area- shipping routes

Fig. 5
Sea Common,
Baltic (Couling)

Fig. 1
Series of six maps showing the
transformations of the western
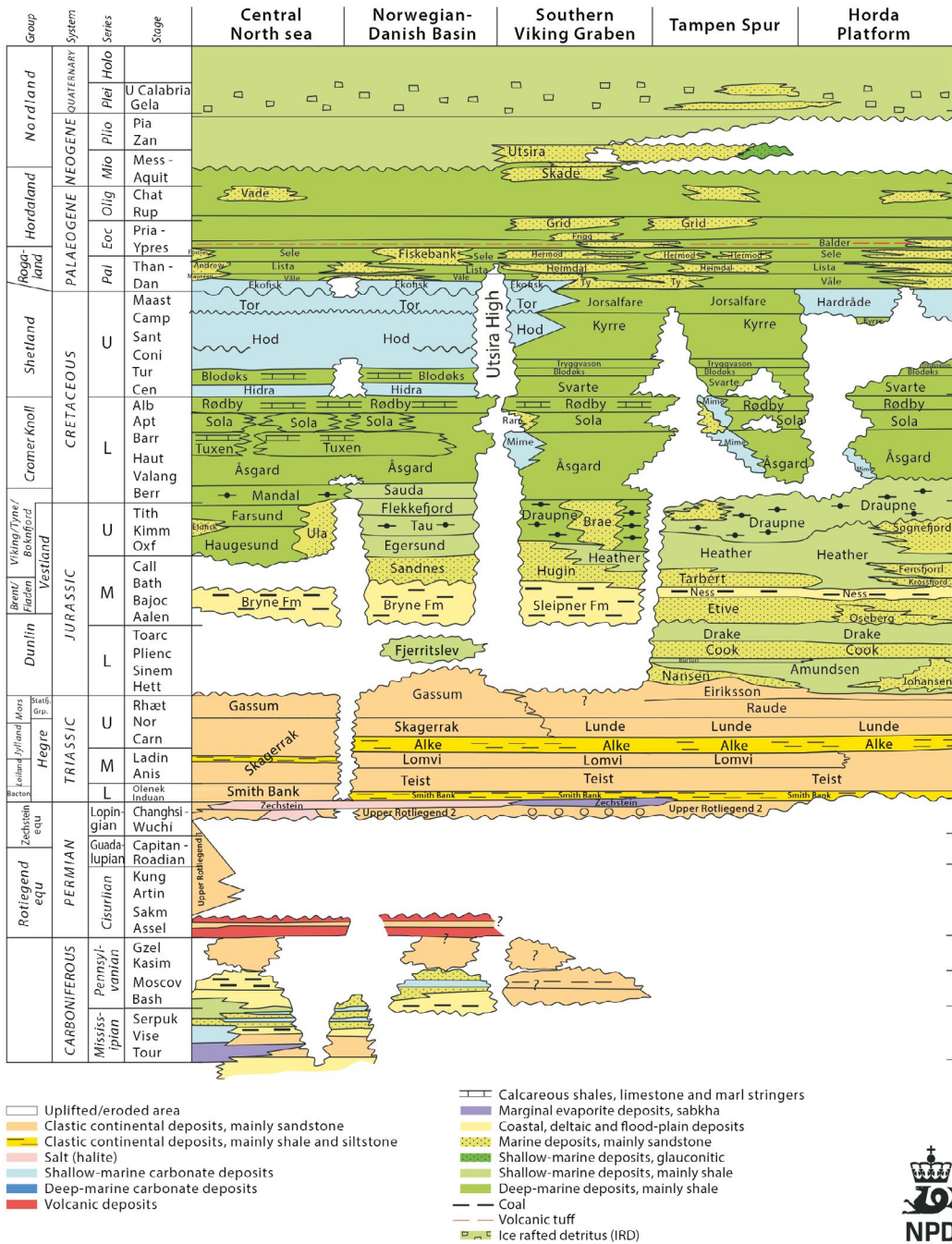Netherlands in AD 800, 1200, 1500, 1700,
1900 and 2000.

Fig. 1
Lithostratigraphic
chart of the
Norwegian North
Sea (Norwegian
Petroleum
Directorate)

Fig. 2
Brent Delta
topside arriving at
Able Seaton Port,
Hartlepool 2017
(Able UK)