

## North Sea Crossings

### Historical geo-spatial mapping as a tool to understand the local development of port cities in a global context

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#### Publication date

2020

#### Document Version

Final published version

#### Published in

The Urbanisation of the Sea: From Concepts and Analysis to Design

#### Citation (APA)

Hein, C. M., Rutte, R. J., & van Mil, Y. B. C. (2020). North Sea Crossings: Historical geo-spatial mapping as a tool to understand the local development of port cities in a global context . In N. Couling, & C. Hein (Eds.), *The Urbanisation of the Sea: From Concepts and Analysis to Design* (pp. 33-44). NAi Publishers.

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## 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.

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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.<sup>(1)</sup> References to shipping and the sea have also been part of the imaginaries, cultures, and maritime mindsets of many port cities.<sup>(2)</sup> Today in port cities, an awareness of the importance of water remains evident in mental maps and the experience of everyday citizens.<sup>(3)</sup> 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](http://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.<sup>(4)</sup> 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.<sup>(5)</sup> 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."<sup>(6)</sup> 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)

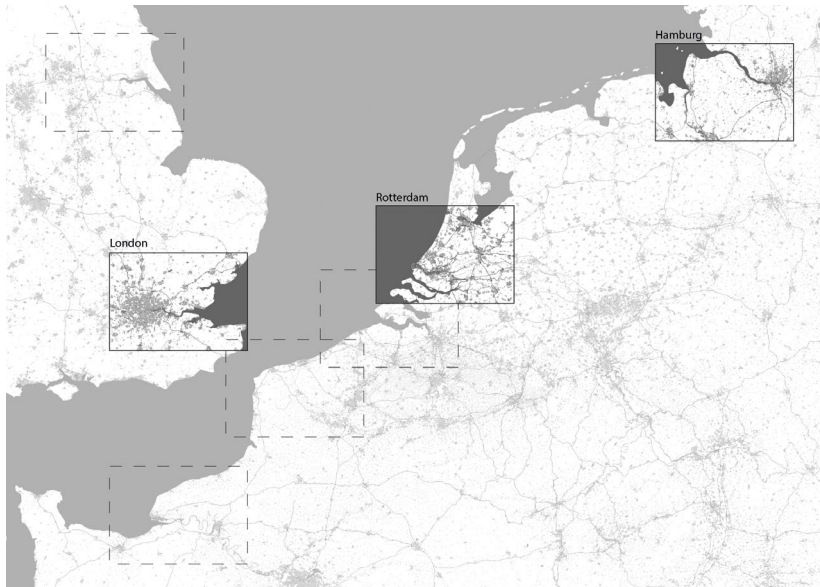


Fig. 2  
Research area of North Sea studied in the Chair History of Architecture and Urban Planning, with case study of London, Hamburg, and Rotterdam with other potential port city areas framed with a dashed line. (Yvonne van Mil)

#### 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.<sup>(8)</sup> 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 were 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

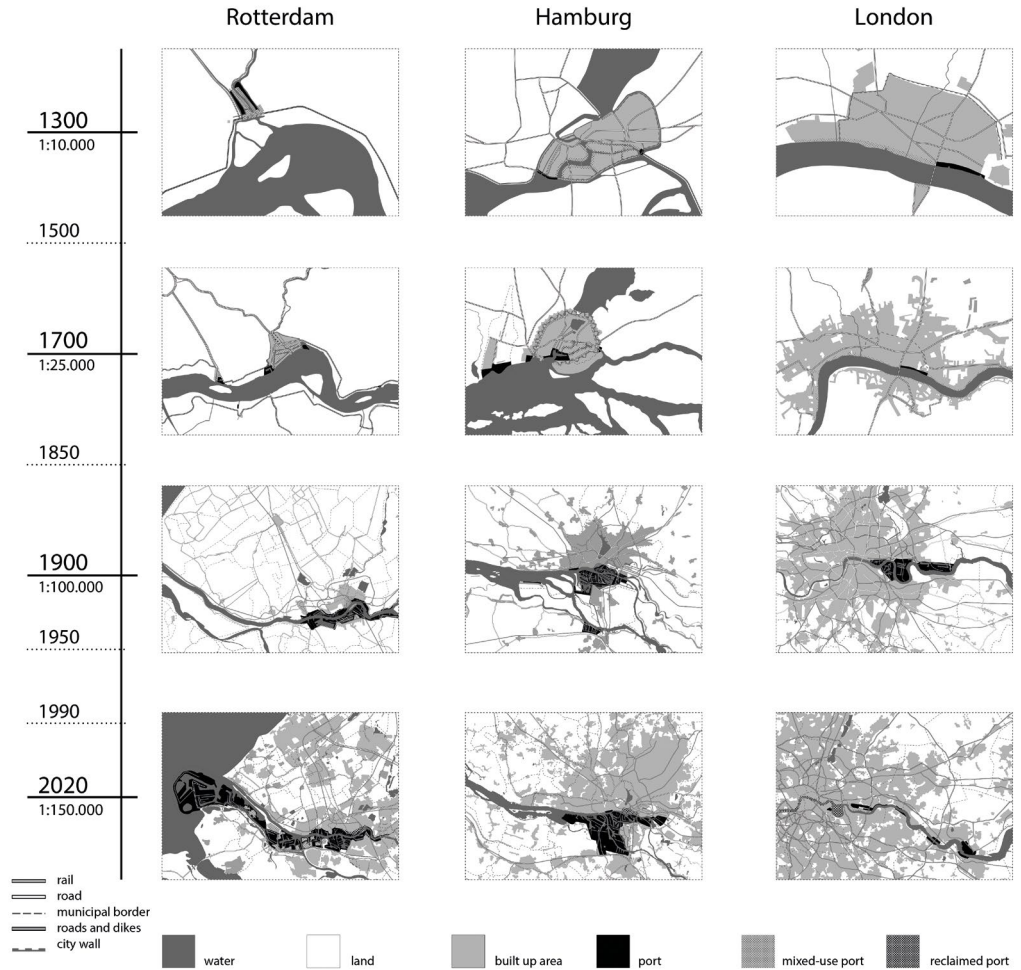


Fig. 3  
 First draft for comparative geospatial mapping methodology, case study of London, Hamburg, and Rotterdam. (Carola Hein, Yvonne van Mil, Blanka Borbely, and Batuhan Özaltun)

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.

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