BONUS BALTSPACE INTERNAL PROJECT REPORT

SPATIAL ECONOMIC BENEFIT ANALYSIS

Author: Barbara Weig[1]

[1] s.Pro | sustainable projects GmbH, Berlin

KIEL, JUNE 2017

Recommended reference: Weig, B. (2017): BONUS BALTSPACE internal project report: Spatial Economic Benefit Analysis.

BALTSPACE has received funding from BONUS (Art 185) funded jointly from the European Union's Seventh Programme for research, technological development and demonstration, and from Baltic Sea national funding institutions.

BALTSPACE

Contents

List of Figures and Tables

Chapter 2

Chapter 3

Chapter 4

Chapter 5

List of Abbreviations

BSH	Federal Maritime and Hydrographic Agency (Germany)
EBA	Economic Benefit Analysis
EEZ	Exclusive Economic Zone
MV	Mecklenburg-Western Pomerania (Mecklenburg Vorpommern)
MSP	Maritime Spatial Planning
RoRo	Roll on Roll off (container shipped on trailer or trucks)
SH	Schleswig-Holstein

1 Introduction

The BONUS BALTSPACE project aims to analyse integration as a key mechanism in Maritime Spatial Planning (MSP). Integration is understood as a multi-dimensional concept including policy and sector integration, multi-scale and transboundary integration, stakeholder integration as well as integration of knowledge base. The regional focus of the project is the Baltic Sea region, a forerunner of MSP.

The BALTSPACE project partners not only work on a better understanding of the roles, drivers and effects of integration in the Baltic Sea region, but also provide tools to MSP practitioners enabling them to respond to current and future challenges. In this context socioeconomic aspects are to be taken into account as well. A Spatial Economic Benefit Analysis (EBA) of different marine uses is proposed to cover this so far rather marginally covered topic in MSP research. Shipping, offshore wind, fishing, marine tourism, sand and gravel exploitation, cable and pipelines and aquaculture/ mariculture are fields of interest for this analysis. The listed sectors are quite divers, so that a solution "one approach fits all" does not seem realistic. Therefore shipping and offshore wind have been chosen for full analysis, including the development of an appropriate tool and its empirical testing. Additionally, first ideas of how to conduct a spatial EBA in marine tourism and fishing have been collected.

In the following report the developed approaches are presented, the results of the pilot study summarized and reflected regarding their applicability. Moreover the report gives answers to the questions: Who benefits from which marine use? Where are those beneficiaries geographically located? Which integration challenges can be met by the tool "spatial economic benefit analysis"? Which are the limitations of the tool?

The following report is structured by the different sectors taken into account. In chapter 2 the **shipping sector** is analysed regarding its value chain and possible approaches for a spatial EBA. In section 2.1 the chosen approach is described in detail, for the purpose of possible application on other regions. In section 2.3 the results from the case study of the German Baltic Sea coast is presented, analysed and reflected.

Chapter 3 is dedicated to the **offshore wind** sector. Section 3.1 points out the value chain of offshore wind farms. In section 3.2 two complementary approaches of a spatial EBA for the offshore wind sector are presented. Section 3.3 outlines the results of the pilot study, conducted for the German Baltic Sea coast.

Chapter 4 deals with **marine tourism** as another important economic sector influenced by maritime spatial planning. Some first ideas concerning an approach analysing spatial benefits of tourism are presented.

Chapter 5 is dedicated to the **fishing** sector. Some preliminary thoughts on how to conduct a spatial EBA in this sector is outlined.

In chapter 6, the developed approaches and outcomes of the two statistical case studies are reflected. Ideas for further research are presented and limitations pointed out. The used mapping program is presented and the contribution of the new approaches and their application for the aim of the project are discussed.

In chapter 7, the main findings of this report are summarized.

2 Shipping

The shipping sector has a long tradition in using the sea. In MSP, the freedom of navigation has long been untouchable. With more and more competing uses of the marine space however, planners have to take decisions on how to manage and organize different uses without jeopardising the safety of seamen, cargo and environment. Shipping might have to give way for other uses in the future.

Therefore a spatial EBA of this sector is highly relevant and might help taking sound decisions for future planning.

2.1. Value Chain versus Transport Chain in Shipping

The value chain of shipping consists of a highly complex system of services. All of them contribute to the main target: transporting goods and people across the sea. There are several possible perspectives to approach the economic benefits within this value chain.

One possibility is to focus on the actors along the value chain of shipping: shipping companies, port services, logistics, etc. However, shipping companies offer their services all over the world. A location analysis of shipping companies thus does not help regional or national maritime spatial planners to take decisions. Changes of a maritime spatial plan do not necessarily affect regional shipping companies more than others.

Therefore the concept of transport chains is used here: As starting point, ports in the respective region have been chosen. From those logistic hubs the transport chains are followed back to the source and forth to the sink. Shipping relations are looked at as well as hinterland connections. This approach allows answering the question: Who benefits from the existing ports and shipping lines? The approach focuses on the demand instead of the supply side of shipping services. It analyses the geographical distribution of those industries using the service of shipping.

Ports are geographical hotspots of logistics. Different shipping and hinterland relations start or end here. Goods and people are handled and therefore documented statistically. The approach suggests two axes with two dimensions each (see fig. 2.1): shipping – hinterland connections and past development – future prognosis.

1. **Shipping** refers to the seaside of the transport chain. It includes imports as well as exports by sea.
   a. **Where** do the vessels arriving in the port come from and where do they go to? This question is more easily to be answered for ships on regular routes, such as RoRo ferries (roll on roll off) or container lines. However, a large amount of vessels is used for different relations under a variety of charter contracts.
   b. **What** is transported by the vessels arriving or leaving the respective ports? Depending on the transported goods, different security measures have to been taken. Additionally, the answer on what is transported also gives an answer of who (which sector) benefits from the existing ports and shipping relations.
   c. **How** are the goods transported? Which kinds of vessels are visiting the respective port and how big are they? These information are also of relevance for planners as they influence the needs of the shipping sector.
2. **Hinterland traffic** refers to the landside of the transport chain. It includes goods transported to the port to be shipped as well as goods coming from the sea and being further transported to their final destination.
   a. **Where** do the exported goods come from and where do the imported goods go to? The final destination of those goods might be close to the port (loco transport), within the region (regional transport), far away in other parts of the country or even in other nations. In this context it is important to analyse if the port in

question is predominantly used by local/ regional industry or if it is used as a transportation hub for longer distance transportation.

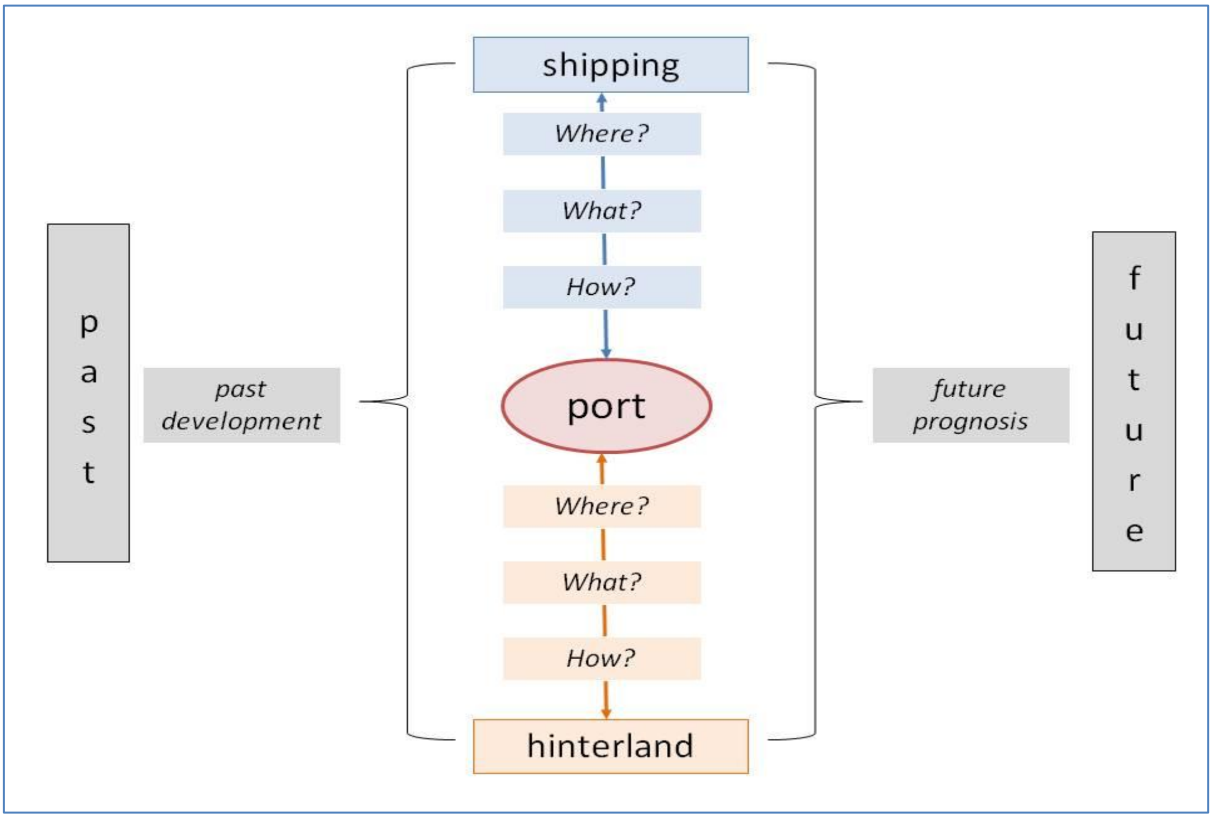
b. **What** is transported and how do goods differ in their needs?

c. **How** are the goods transported to their final destination by truck, train or inland vessel?

3. **Past development:** The where, what and how of shipping and hinterland transportation changes over time. An analysis of recent trends gives insights in the increasing and decreasing importance of different routes, goods and ways of transportation.

4. **Future prognoses** are important for planners. Their decisions influence future plans which cannot be adopted any time. Plans need to meet the needs of tomorrow. Future prognoses of routes, transported goods and means of transportation can be derived from past development and general prognosis for economic development.

Figure 2.1: Spatial EBA in Shipping



Source: own illustration

2.2. Spatial EBA: Methodological Approach for Shipping

Based on the presented transport chain approach the spatial EBA tool concentrates on the shipping side of the concept however covering also hinterland connections via train. Statistics from regional statistical offices have been used to analyse shipping relations. If official statistics are not available, data can be asked directly from the ports. The statistics should cover at least one whole year to avoid seasonal differences. For analysis it is important to harmonize the collected statistical data to avoid differences in aggregation. Official statistics tend to aggregate ports to shipping regions. That means, not the specific port of origin or destination is indicated but a region in which this port is located. For the hinterland connections, information is taken from *Kombiverkehr*, the main service provider in Germany.

Where?
First, the amount of goods exported to or imported from different shipping regions to the respective ports, have been calculated. Next, the regions have been clustered according to their importance as origin of imports or destination for exports. This information has then been mapped showing the regions of origin and destination sorted by their importance. This can be done for all ports of the case study, for one port only or for ports of specific regions. In this way it is possible to compare and figure out differences between shipping relations of ports. Additionally, the busiest shipping relations in the respective area have been extracted from the statistical data and collected in a table. Concerning hinterland connections by train, regular destinations are separated in direct and indirect connections via transhubs. Moreover the number of departures per week is indicated. This information is than mapped to show main destinations and origins.

What?
To analyse the goods handled in the respective ports it makes sense to first rank the goods according to their importance. This exercise can be done for all ports in the region or for single ports and for exports and imports separately or in total. In a second step, the most important goods handled in the respective ports have been chosen for further analysis of the shipping routes they take. Maps have then been designed to show where the most important regions of origin for this good are, where the most important ports of handling in the respective region are and where the most important destinations for exporting this good are. In this way, different goods can be analysed and compared. Where does the good come from? Where does the good go to? Which role does shipping play in connecting those places?

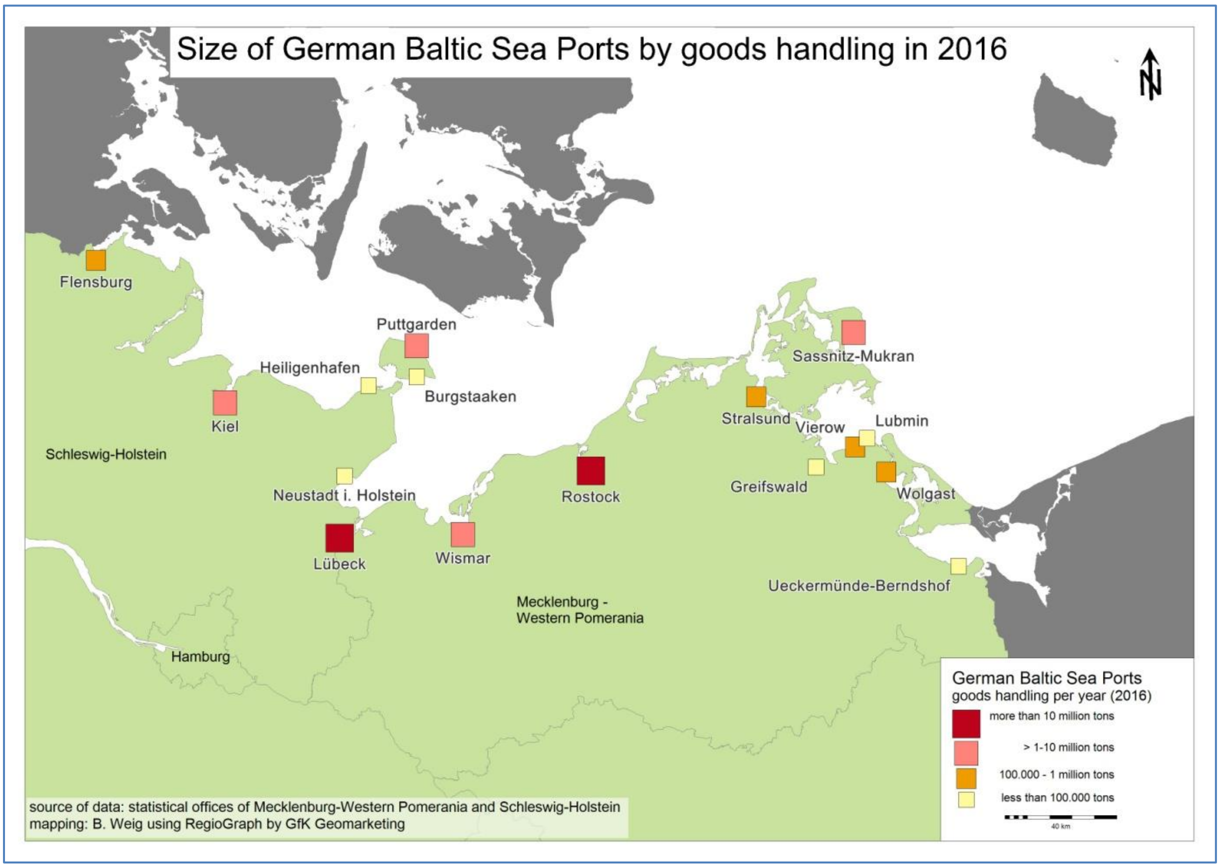
How?
To be able to describe the used vessels in more detail it is useful to analyse the data according to size and type of vessels. A map indicating the share of different vessels (tanker, container vessel, bulk, breakbulk etc.) calling at the respective ports gives a good overview and indicates differences between the ports. The size of ship might be presented by the size of the largest ship and an average of all ships calling at the respective port. This information might also be shown in a map to indicate differences between the ports.

This tool comprises the most important indicators for a spatial EBA in shipping. The implementation of this tool for the German Baltic Sea region reveals opportunities and limitations of this tool.

2.3. Shipping: The Case Study "German Baltic Sea"

The ports along the German Baltic Sea coast differ significantly in size and function. The major ports are clustered in the western part of the German Baltic Sea coast (see fig. 2.2). In the ports of Lübeck and Rostock more than 10 million tons of goods have been handled in 2016. Kiel, Puttgarden, Wismar and Sassnitz-Mukran also have a significant importance for goods handling, with more than 1 Mio. tons in 2016. Small ports in Schleswig-Holstein are Flensburg, Heiligenhafen, Burgstaaken and Neustadt in Holstein. Mecklenburg-Western Pomerania has a lot of rather small ports in its eastern parts: Stralsund, Greifswald, Lubmin, Wolgast, Vierow and Ueckermünde-Berndshof.

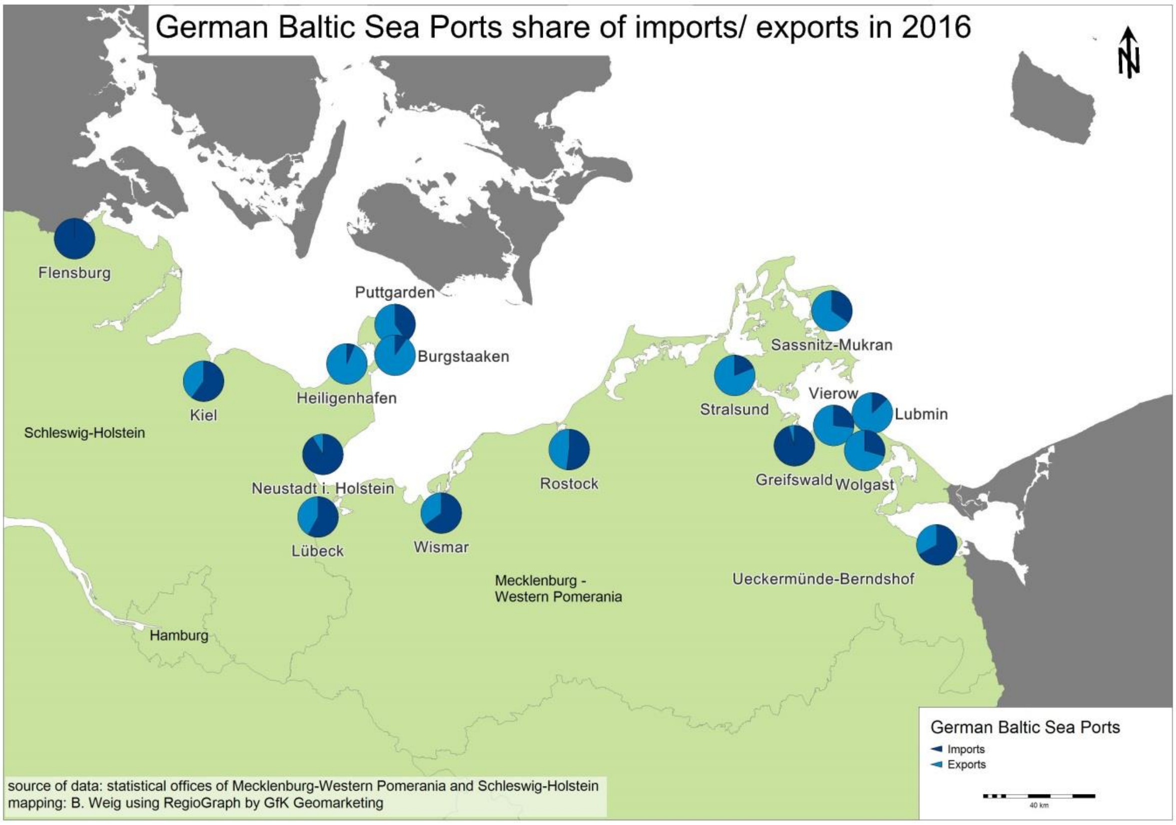
Figure 2.2: Overview German Baltic Sea Ports – goods handling per year (2016)



Source: own illustration

The ports not only differ in size, but also in their function and use. For instance the share of imported versus exported goods differ quite strongly. Since 2011, the port of Flensburg is only used for imports. Imports also predominate in the ports of Greifswald, Neustadt in Holstein, Ueckermünde-Berndshof, Wismar, Lübeck and Kiel. The port of Rostock is relatively balanced regarding imports and exports. All other ports however are predominantly used for exports (see fig. 2.3).

Figure 2.3: German Baltic Sea Ports share of imports/ exports in 2016



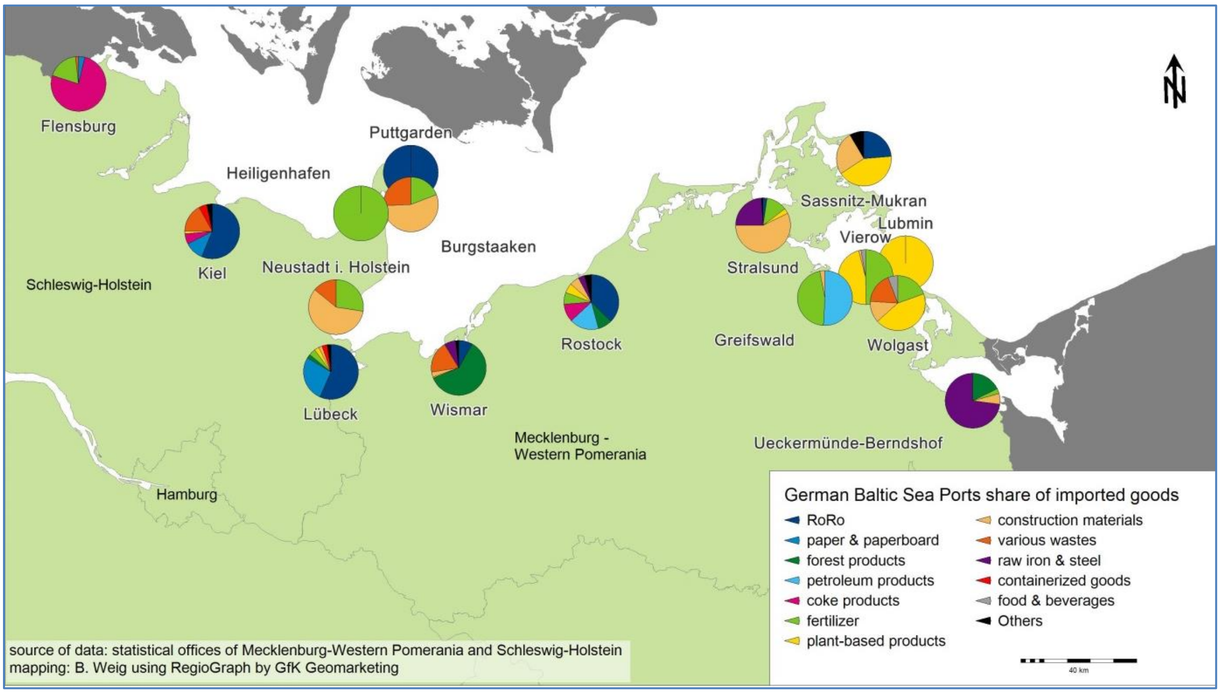
Source: own illustration

Another notable difference exists concerning the type of goods imported or exported. Some ports are specialized on the import of one product only (see fig. 2.4a). In Heiligenhafen the only import good is fertilizer. In Lubmin only plant-based products (such as grain, rapeseed or vegetable oil) are imported while the port of Puttgarden is completely specialized on RoRo goods (container shipped on trailer or trucks).

In other ports, one dominant import good exists besides others (see fig. 2.4a). For Flensburg the dominant good is coke. In Kiel, Lübeck and Rostock, RoRo goods are predominant. While in Stralsund, Burgstaaken and Neustadt in Holstein, construction materials play the major role in importing goods. In the port of Wismar, the import of forest products is most important. For Sassnitz-Mukran and Wolgast the import of plant-based products is most important while in Ueckermünde-Berndshof, the import of raw iron & steel is predominant. The port of Greifswald is mainly used for the import of fertilizer and petroleum, while the port of Vierow imports predominantly plant-based products and fertilizer.

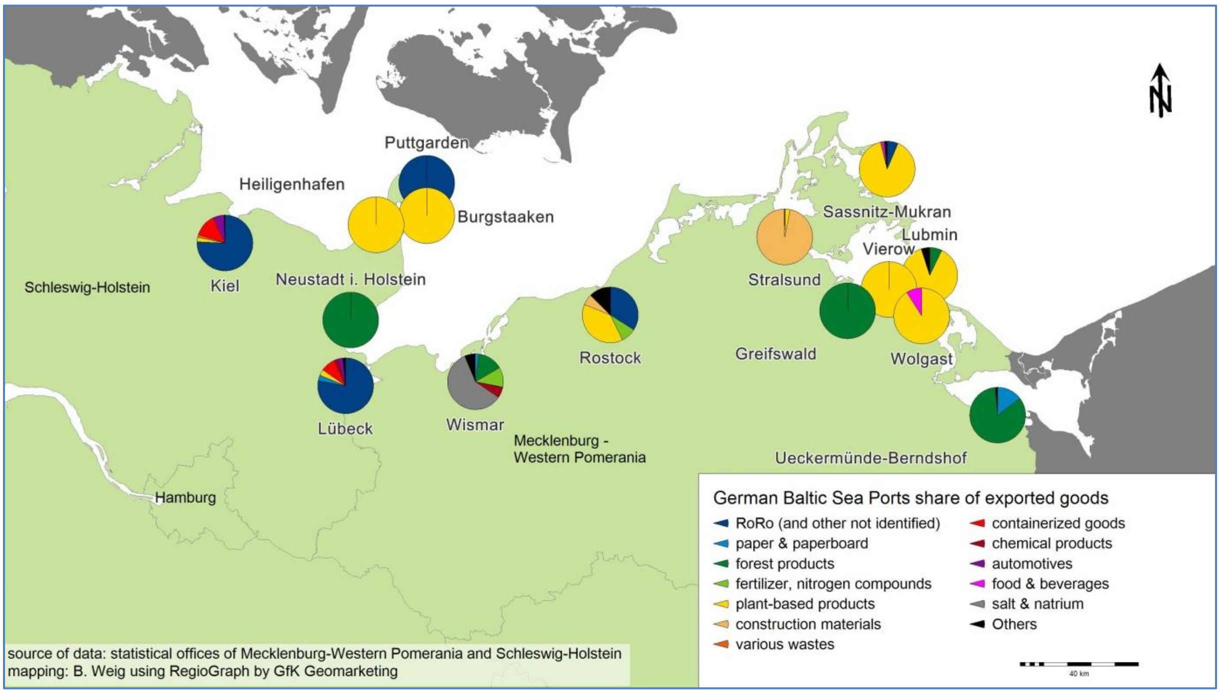
The goods exported are often not the same as the ones imported (see fig. 2.4b). Most ports show less diversity in exported goods than in imported ones. Again, some ports are completely concentrated on the export of one type of goods. The ports of Heiligenhafen, Burgstaaken and Vierow are exclusively exporting plant-based products. Neustadt in Holstein and Greifswald are specialized on forest products while Puttgarden is exporting RoRo goods. Most other ports show one dominant export product. This is RoRo for Kiel and Lübeck, salt/ natrium in Wismar, construction material in Stralsund, plant-based products in Sassnitz-Mukran, Wolgast and Lubmin and forest products in Ueckermünde-Berndshof.

Figure 2.4a: German Baltic Sea Ports share of imported goods (2016)



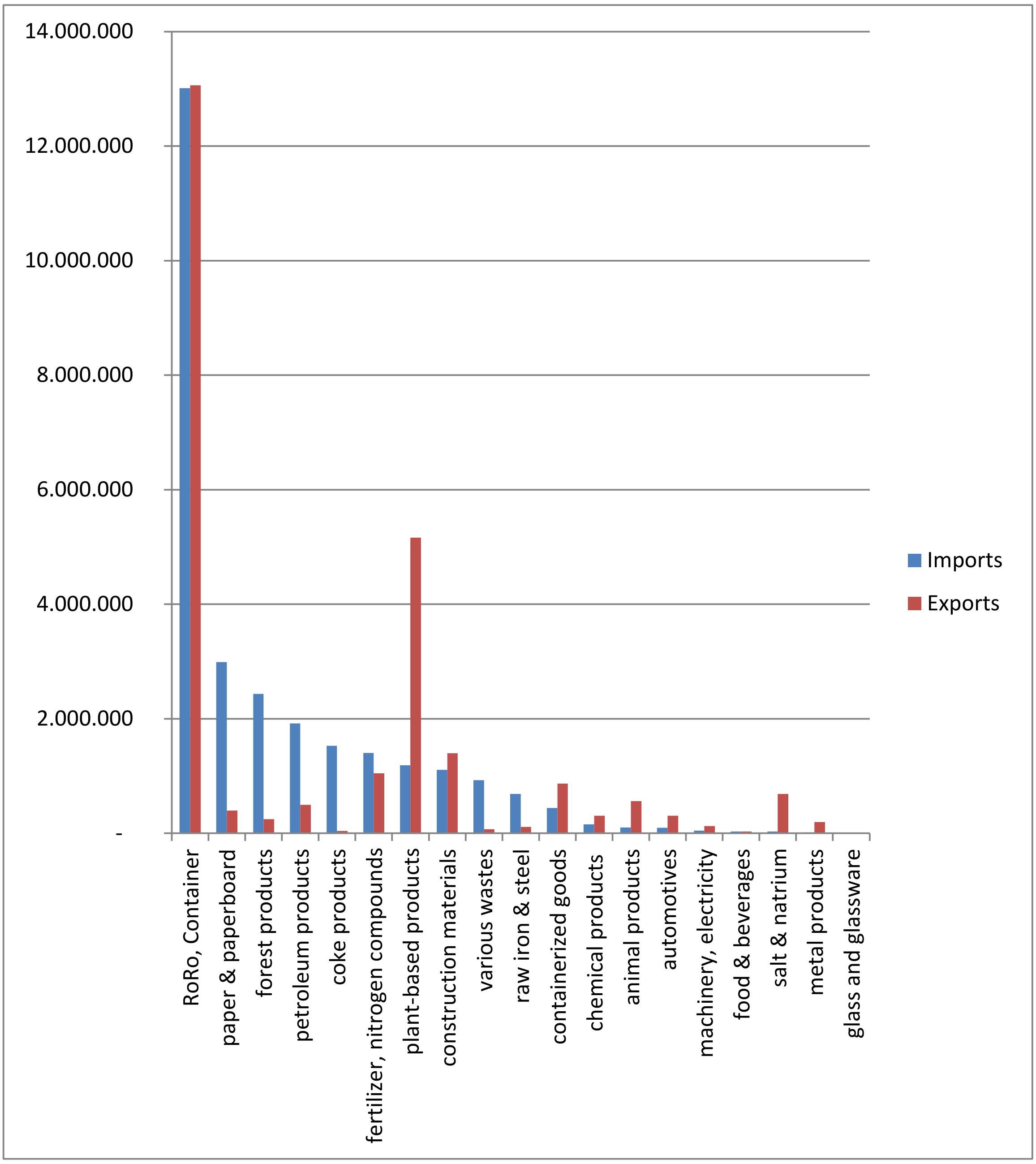
Source: own illustration

Figure 2.4b: German Baltic Sea Ports share of exported goods (2016)



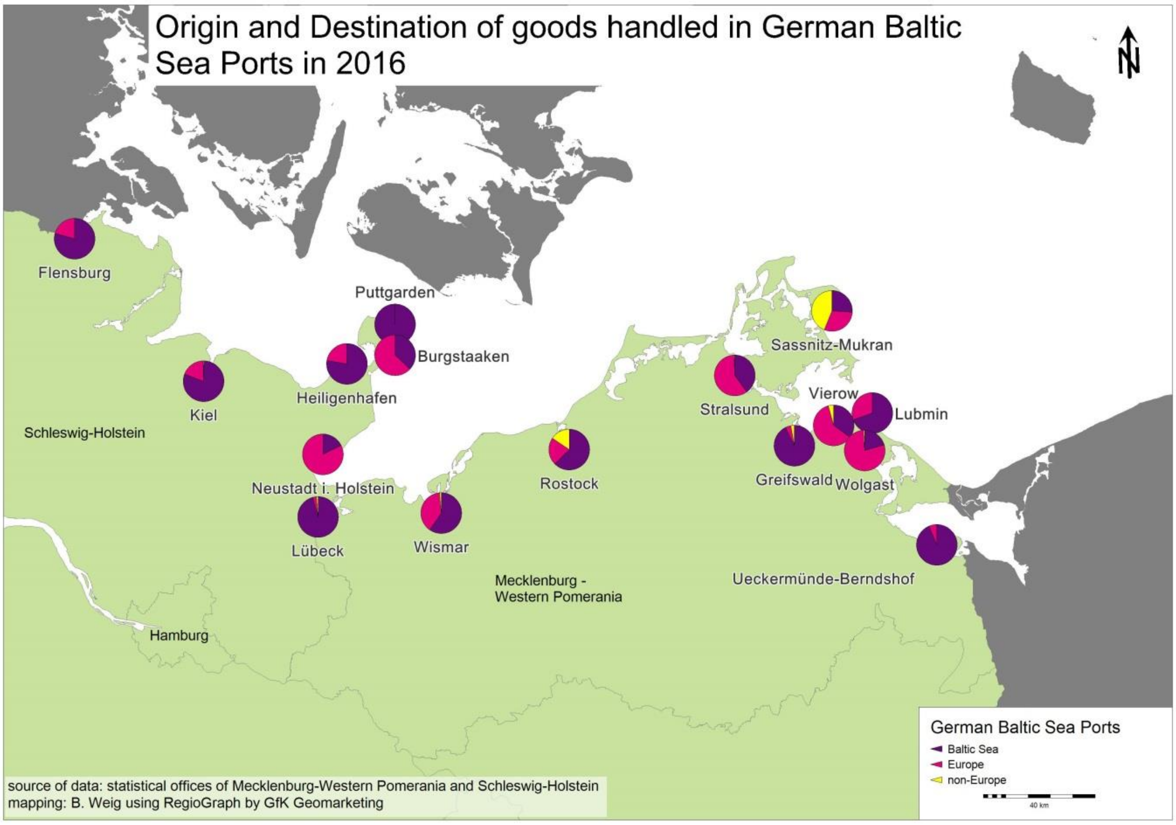
Source: own illustration

Figure 2.5: German Baltic Sea Ports imported and exported goods 2016 (in tons)



Source: own illustration

Figure 2.6: Origin and Destination of goods handled in German Baltic Sea Ports in 2016



Source: own illustration

Another difference relates to the connection of the ports. Some ports are mainly connected to other ports in the Baltic Sea region. Others handle mainly goods for/ from other European Ports or even from non-European ports (see fig. 2.6). While ports in Schleswig-Holstein only show a negligibly small share of non-European connections, some ports in Mecklenburg-Western Pomerania have significant connections with non-European ports. In the port of Sassnitz-Mukran this share reaches 44% and in Rostock 16%. Some ports are predominantly connected to other ports in the Baltic Sea coasts. These are Puttgarden (100%), Lübeck (96%), Ueckermünde-Berndshof (94%) Greifswald (93%), Kiel (81%), Flensburg (79%) and Heiligenhafen (78%). Other ports show higher shares in connections with non-Baltic Sea ports in Europe, e.g. Neustadt in Holstein (82%), Wolgast (79%), Burgstaaken (76%), Vierow (61%) or Stralsund (59%).

To sum up a short characterisation of each port included in the case study will follow.

Ports in Schleswig-Holstein (SH)

Flensburg is a municipal port. Since 2011 the port only imports goods, exports have been ceased. In Flensburg mostly bulk goods such as coal (for the local power plant), fertilizer, paper and scrap are handled. Most imports origin from Baltic Sea ports in Russia (103.653 tons in 2016), Latvia (80.253 tons) and Lithuania (30.146 tons). Cruise shipping plays a minor role in Flensburg. In recent years Flensburg had about three cruise arrivals per year.

Kiel is a municipal port. The port of Kiel is an important cruise port and starting point for several ferry lines to Norway, Sweden, Russia and the Baltic states. Main cargo is RoRo, paper, wastes and automotive. Most important shipping connections from and to Kiel are Lithuania (1.468.991 tons in 2016), Sweden/ Kattegat Area (Gothenburg) (1.269.311 tons), Southern Norway/ Oslo (749.317 tons) and Sweden/ Bothnian Bay (303.348 tons).

Heiligenhafen is a municipal port. It is mainly used for tourism and fishing, but also for the local agricultural sector. Fertilizer is imported and plant-based products from local farms are exported. Main shipping connections exist to Belgium (import of fertilizer) and to Rostock and Hamburg (export of agricultural products).

Puttgarden is a private port, owned by Stena Line Germany. A ferry line is commuting between Puttgarden and Rødbyhavn in Denmark constantly. The ferry is handling RoRo products only, transported by trucks or train.

Burgstaaken is a municipal port. The port is mainly used as a tourist attraction but it still shows significant handling of goods for local actors. Construction material, fertilizer and wastes are imported mainly from Belgium, Poland and Denmark. Plant-based products are exported to Hamburg, Rostock and other German ports.

Neustadt in Holstein is a municipal port. It is used for tourist navigation and by local actors. Imported construction material, fertilizer and wastes mainly come from Belgium, Netherlands and Hamburg, while forest products are transported from Neustadt to Denmark.

Lübeck's port is partly municipal (65%) and partly privately owned (35%). The port has a long tradition in RoRo ferry traffic to Scandinavian countries. 70 regular departures per week and 20 different destinations can be counted. Main cargo is RoRo, paper and wood, plant-based products and passenger. Lübeck also welcomes some cruise ships per year. Most important shipping connections for the port of Lübeck are Sweden/ Kattegat Area (6.785.475 tons in 2016), Finland (5.172.099 tons) and Sweden/ Bothnian Bay (1.319.758 tons).

Ports in Mecklenburg-Western Pomerania (MV)

Wismar's port is partly municipal (90%) and partly state owned (10%). The port has a long tradition in handling grain, wood and potash. Today it is a modern universal port with a focus on wood, salt, metal waste, fertilizer/ chemicals and components of wind turbines. A small number of cruise ships is calling Wismar every year. Wismar has shipping connections to a huge variety of ports in the Baltic Sea region and beyond. The most important connections are between Wismar and Norway/ Skagerrak (436.315 tons in 2016), Estonia (392.658 tons), Denmark/ Islands of Sealand and Bornholm (259.688 tons) and Sweden/ Kattegat Area (236.206 tons).

Rostock's port[1] is partly municipal and partly state owned. It is an important cruise and a modern multipurpose port. Right after the German reunification the port of Rostock suffered heavy losses of cargo handling. However in the 1990s the handling of RoRo cargo started and increased rapidly. Main cargo besides RoRo is wind power plants and project cargo, fertilizer, building material, grain and malt. Several companies are directly located at the port of Rostock: *Liebherr* (marine cranes), Power oil Rostock (oil mill), grain silo, one of the largest malt factories in Europe (supplying breweries in Germany, Europe and overseas), *Biopetrol Rostock* (biodiesel plant) and EEW Special Pipe Constructions (wind power plants). The port includes an oil port with several pipelines to important industrial sites. The specialized chemical port is used exclusively by *Yara* (fertilizer). Rostock has a huge variety of shipping connections within and outside of Europe. Most important shipping connections are Sweden/ Kattegat Area (4.850.957 tons in 2016), the South Coast of Finland (2.006.690 tons), Denmark/ Islands of Fuenen and Lolland (1.415.631 tons) and Russia/ Baltic Sea coast (1.362.952 tons) followed by Saudi Arabia (819.396 tons).

Stralsund has a long tradition in cargo handling. Main cargo is construction material, raw iron and steel as well as project and special cargo and refrigerated goods. Cruise shipping in Stralsund does mainly take the form of river cruise. There are different companies located in the port of Stralsund. Those companies are mainly dealing with

[1] Port of Rostock online: http://www.rostock-port.de/index.html

steel and metal processing. There are firms of the construction and food sector[2]. Most important shipping connections are between Stralsund and Norway/ Skagerrak (232.371 tons in 2016), England/ North Sea Coast (137.715 tons), Sweden/ Kattegat Area (133.885 tons) and Denmark/ Baltic Sea coast and Sealand/ Bornholm (110.122 tons).

Sassnitz-Mukran was built in the 1980s as the last big transportation project in the former GDR, to secure transport relation to Klaipeda. Sassnitz-Mukran is the only port in Central Europe with railway tracks based on standard and broad gauge (used in Russia and Finland). The port is closest to several offshore wind projects and thus used as installation and service port. Some cruise ships call at Sassnitz-Mukran. Main cargo is finished and semi-finished goods, plant-based products, construction material and food as well as steel. Companies located in the port are mainly from the offshore wind or construction sector but there is also a modern fish processing company[3]. Most important shipping connections in terms of tons handled at the port of Sassnitz-Mukran are Cuba (103.750 tons in 2016), Poland (99.917 tons), Iran (99.874) and Norway/ North Sea (92.338).

Greifswald's port is used for importing oil & gas and fertilizer and for exporting forest products. The future of the port depends highly on decisions concerning dredging[4]. Main shipping connections are Sweden/ Kattegat Area (47.672 tons in 2016), Lithuania (26.221 tons), and Russia/ Baltic Sea ports (5.680 tons).

Lubmin's port is owned by a local industrial association. An operating permit for the industrial port Lubmin has been granted in 2006. The aim of the relatively new port is to attract industry and to generate jobs in the region. Main cargo is plant-based products, wood and steel products as parts for port cranes and pipes for offshore power plants. Companies located in the port of Lubmin are *Liebherr-MCCtec GmbH* (port cranes), *Erndtebrücker Eisenwerke* and *Weserwind* (both wind energy)[5]. Main shipping connects to and from Lubmin are Denmark/ Baltic Sea coast and Sealand (12.578 tons in 2016), Bremerhaven (3.000 tons) and Oldenburg (2.929 tons).

Wolgast is a municipal port. The port of Wolgast is an important transhub for Baltic Sea shipping to inland waterway transportation via the river Oder to Berlin. Main cargo is plant-based products, fertilizer, food, wastes as well as construction material. The main shipping connections from and to Wolgast are England/ North Sea Coast (20.935 tons in 2016), Scotland/ North Sea Coast (18.626 tons), Scotland/ Atlantic Coast (16.809 tons) and Belgium (8.662 tons).

Ueckermünde-Berndshof was founded in 1913 as the regional port Ueckermünde. Between 1935 and 1990 the port was privately owned by the local brickyard. After the German reunification the industrial port Ueckermünde-Berndshof was founded. Main cargo is wood, raw iron, paper and plant-based products. The port supports mainly the local forest and building industry as well as the iron foundries in Torgelow and Ueckermünde[6]. Main Shipping connections are Lithuania (46.005 tons in 2016), Sweden/ Kattegat Area (30.723 tons) and Estonia (11.190 tons).

Vierow's main cargo is fertilizer and plant-based products. From the port of Vierow, there is quite a great variety of shipping connections. Main connections with regards to the amount of goods handled in 2016 are England/ North Sea Coast (73.288 tons in 2016), Sweden/ Kattegat Area (61.148 tons), Scotland/ Atlantic Coast (33.546 tons) and Portugal (30.133 tons).

---

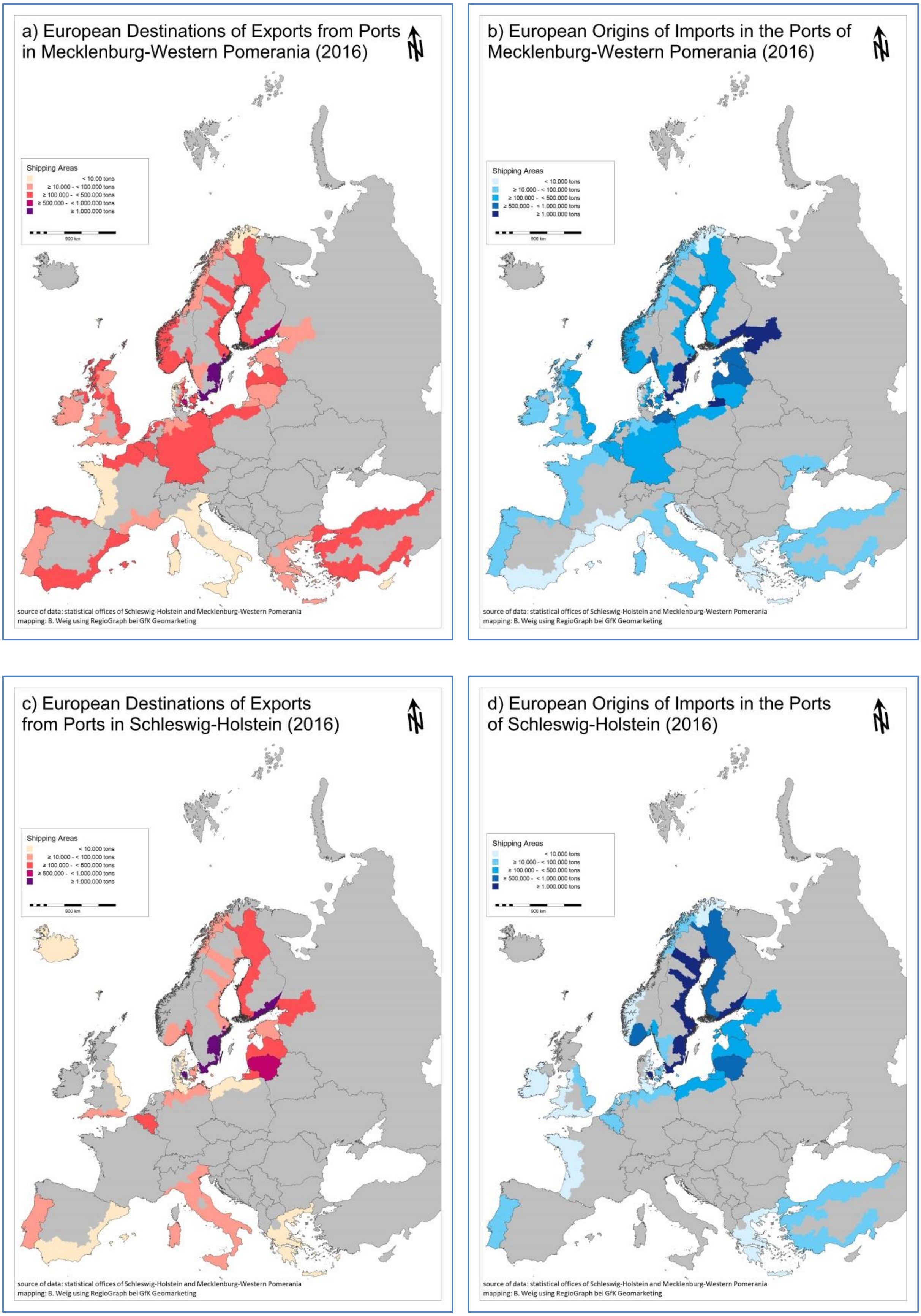
[2] Port of Stralsund online: http://www.seehafen-stralsund.de/de/portfolio/industrieansiedlung.html
[3] Port of Sassnitz online: http://www.mukran-port.de/leistungen/dry-port/unternehmen-im-hafen.html
[4] Port of Greifswald online: http://www.hlg-greifswald.de/
[5] Port of Lubmin online: http://www.hafen-lubmin.de/
[6] Port of Ueckermünde online: http://hafen-ueckermuende.de/industriehafen_profil.html

2.3.1 Shipping to and from German Baltic Sea Ports

The characterisation of ports already gave some insights in the where and what of goods handling in German Baltic Sea ports. The question of where do goods handled in German Baltic Sea ports come from and where do they go to, will be answered more systematically in the following section. How do shipping routes of imports and exports differ from each other geographically? Do ports in Mecklenburg-Western Pomerania have other shipping connections than ports in Schleswig-Holstein? Which are the busiest shipping connections in the region?

The most obvious finding, analysing the European destinations of **exports from ports in Mecklenburg-Western Pomerania** (see fig. 2.7a) is, that the most important export destinations are located within the Baltic Sea region (BSR). However there are also important destinations outside the BSR. Most important shipping regions for exports from MV are the ports at the Southeast Coast of Sweden, followed by the ports at the Gulf of Finland and on the Danish Islands of Fuenen and Lolland. Other important destinations in the Baltic Sea region are Poland, Latvia, Finland and Sweden (Bothnian Bay) as well as the Danish Baltic Sea ports. Outside the BSR, important destinations are Southern Norway, the English North Sea coast, Scotland and Northern Ireland, the Netherlands, Belgium and the North Coast of France, as well as Spain and Turkey. The ports of Mecklenburg-Western Pomerania are also important transhubs to the German inland waterways, so locations in Southern Germany connected via the main rivers and canals are also important destinations. 27,5 % of all exports from the ports of Mecklenburg-Western Pomerania have destinations outside of Europe. Most important destinations are: Saudi Arabia (979.837 tons in 2016), Iran (610.922 tons), Yemen (324.942 tons), Sudan (242.999 tons) and Oman (196.108 tons).

Figure 2.7: European destinations of exports and origins of imports; Mecklenburg-Western Pomerania versus Schleswig-Holstein (2016)



Source: own illustration

Concerning the **imports handled in the ports of Mecklenburg-Western Pomerania** (see fig. 2.7b), the most important regions of origin are similarly to the export destinations at the Southeast Coast of Sweden and at the Gulf of Finland. In addition the Baltic Sea coast of Russia plays a major role as origin of imports. Other important regions with between 500.000 and 1.000.000 tons of goods handled in 2016 are Estonia, Latvia, the Danish Islands of Fuenen and Lolland as well as the Oslo region in Norway. Compared to the exported goods the imports are more concentrated on the BSR. Imports from regions outside Europe make up less than 2% of all imports. Important origins outside Europe are Russia/ Far East (533.268 tons in 2016), Algeria (111.728 tons) and Colombia (37.269 tons).

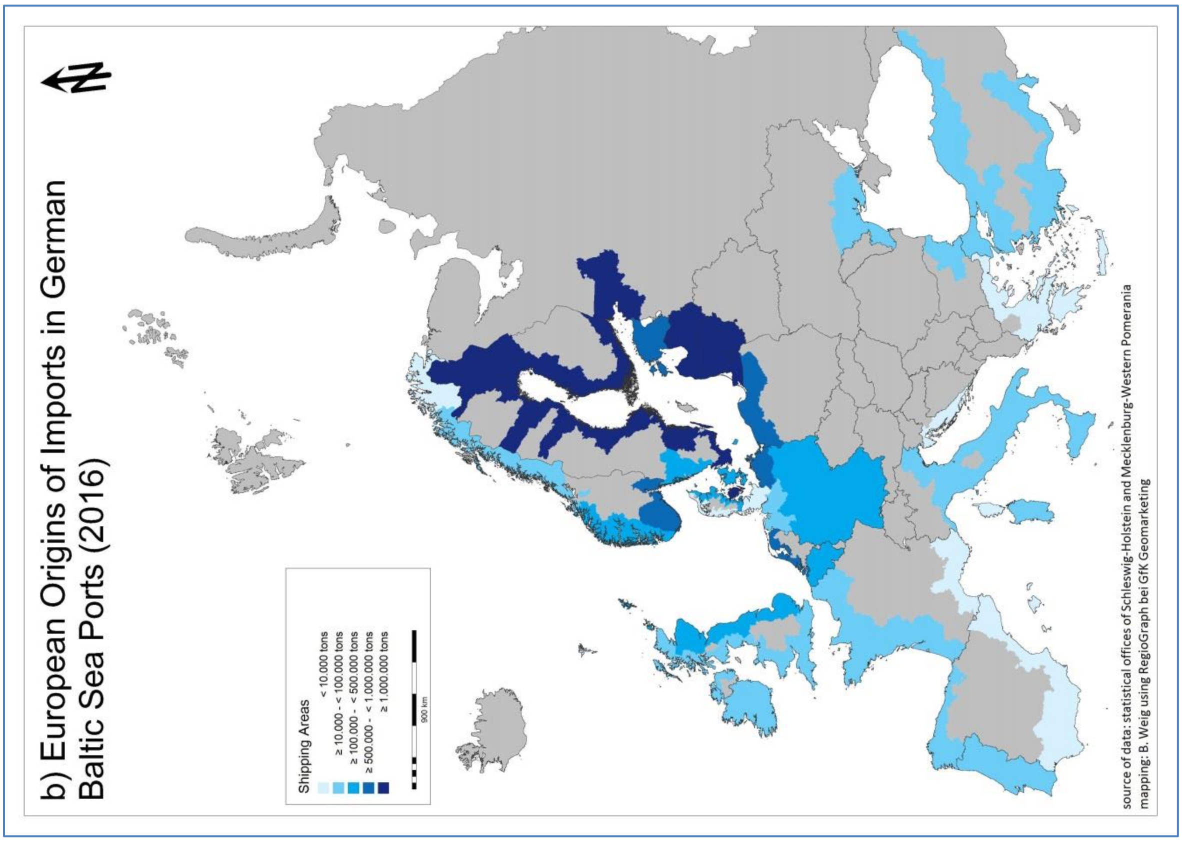
In the ports of **Schleswig-Holstein** the picture of shipping connections looks slightly different (see fig. 2.7 c & d). The shipping connections to and from Schleswig-Holstein are more concentrated on the Baltic Sea region. Other European and non-European destinations play a minor role. **Main destinations of exports** from the ports in Schleswig-Holstein are in the Gulf of Finland, at the Southeast Coast of Sweden and on the Danish Islands of Fuenen and Lolland. So far, the distribution of destinations resembles the ones from Mecklenburg-Western Pomerania. However in addition, Lithuania plays a major role as export destination from ports in Schleswig-Holstein. Other important export destinations with 100.000-500.000 tons in 2016 are to be found at the Finish coast of the Bothnian Bay, in Russia (Baltic Sea coast), Latvia, Oslo Region and Belgium. All other regions are of minor importance. Exports to non-European destinations make up only 2% of all exports. Main destinations outside Europe are Saudi Arabia (123.127 tons in 2016), Algeria (46216 tons), United Arab Emirates (21.999 tons) and Libya (19.131 tons).

Main import regions for the ports of Schleswig-Holstein (see fig. 2.7 d) are located at the Gulf of Finland and along the whole East Coast of Sweden as well as on the Danish Islands of Fuenen and Lolland. Further important regions of origin are Lithuania, Southern Norway and the Finish Coast of the Bothnian Bay. Similarly to the destinations of exports, the origins of imports are mainly located in the Baltic Sea region. While imported goods in Mecklenburg-Western Pomerania mostly come from the southern Baltic Sea, the northern parts of the BSR play a major role for imports in Schleswig-Holstein. Moreover a relatively strong connection between Schleswig-Holstein and Lithuania can be noticed. Imports from non-European ports did not exist in SH in 2016.

Summarizing the results from Schleswig-Holstein and Mecklenburg-Western Pomerania (see fig. 2.8) one comes to the conclusion that imports are rather regional (BSR) while exports show a greater geographic distribution (see fig. 2.8). Despite some regional differences the most important connections are the same for Schleswig-Holstein and Mecklenburg-Western Pomerania. The best connected regions are the Southeast Coast of Sweden, the Danish Islands of Fuenen and Lolland and the Gulf of Finland. The busiest routes thus are Lübeck - Southern Sweden (6.785.475 tons in 2016), Puttgarden - Denmark (5.208.560 tons), Rostock – Southern Sweden (4.850.957 tons) and Lübeck – Gulf of Finland (4.213.167 tons) (see table 2.1).

Shipping connections to non-European ports have no significance for Schleswig-Holstein and are of minor importance for the ports of Mecklenburg-Western Pomerania. Most important regions for exports are the Arabic Countries/ Middle East, North Africa, and Central America/ Caribbean. Non-European imports are mostly coming from non-European Russian ports and from North Africa (see table 2.2.).

Figure 2.8: European destinations of exports and origins of imports from German Baltic Sea Ports (2016)



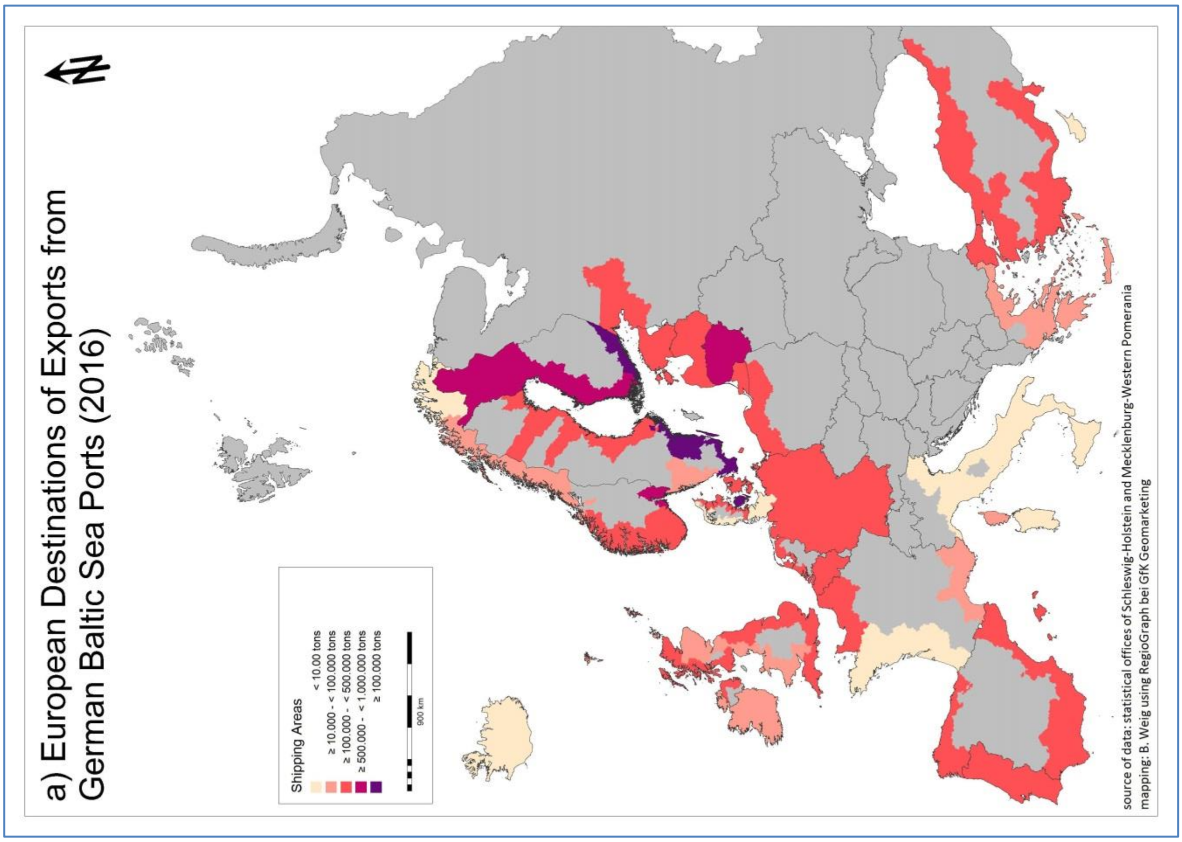


Table 2.1: Busiest routes in tons (2016)

	Busiest routes in tons (2016)		
1	Lübeck	Sweden; Kattegat region	6.785.475
2	Puttgarden	Denmark; Fuenen, Lolland	5.208.560
3	Rostock	Sweden; Kattegat region	4.850.957
4	Lübeck	Finland; Gulf of Finland	4.213.167
5	Rostock	Finland; Gulf of Finland	1.991.262
6	Kiel	Lithuania	1.468.991
7	Rostock	Denmark; Fuenen, Lolland	1.415.631
8	Rostock	Russia; Baltic Sea	1.362.952
9	Lübeck	Sweden; Bothnian Bay	1.319.758
10	Kiel	Sweden; Kattegat region	1.269.311

Source: Statistical offices of Schleswig-Holstein and Mecklenburg-Western Pomerania

Table 2.2: Non-European shipping connections

Non-European shipping connections	Imports to German Baltic Sea Ports (in tons)	Exports from German Baltic Sea Ports (in tons)
Africa (East)	60	170.401
Africa (North)	111.728	603.841
Africa (South)		118.504
Africa (West)		206.582
America (Central, Caribbean)	2.718	442.732
America (North)	35.505	138.494
America (South)	37.269	6.860
Arabic Countries/ Middle East		2.046.223
Asia (South)	3.650	1.858
Asia (Southeast)	6.599	8.673
Australia/ Pacific		29.664
China	396	35.000
Russia (not Baltic Sea)	356.581	1.505

Source: Statistical offices of Schleswig-Holstein and Mecklenburg-Western Pomerania

2.3.2 Goods Handled in German Baltic Sea Ports

In the ports of **Mecklenburg-Western Pomerania** plant-based products (5.307.229 tons in 2016), RoRo goods (3.575.498 tons), construction material (1.339.736 tons) and fertilizer (1.038.856 tons) are the most important export goods. Concerning imports however RoRo goods (4.273.829 tons), forest products (2.178.821 tons), petroleum products (1.891.890 tons) and coke products (1.143.602 tons) play the major role.

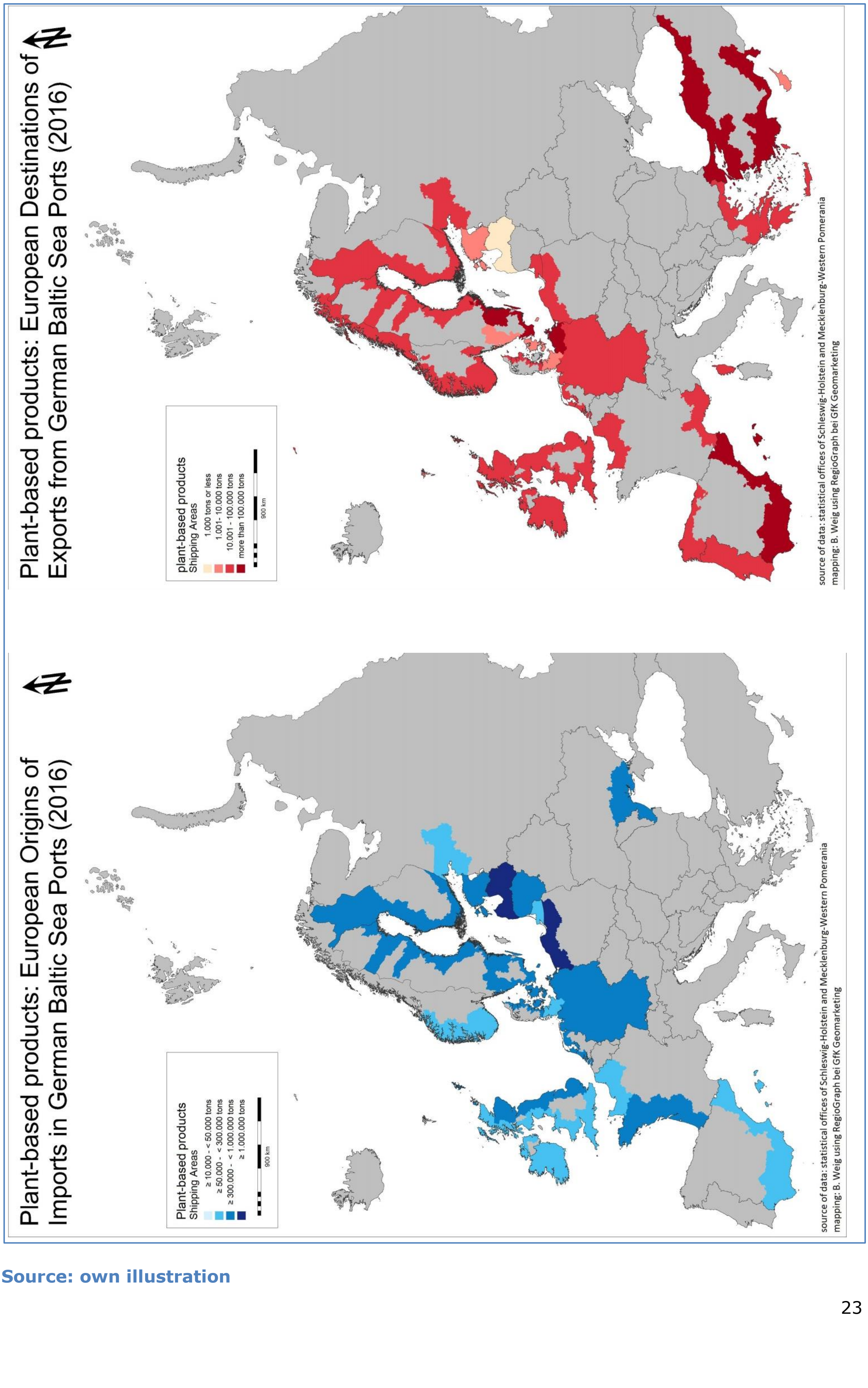
In **Schleswig-Holstein** RoRo goods are by far the most important export goods (9.483.092 tons in 2016). Containerized goods (775.751 tons) and plant-based products (416.514 tons) follow on the second and third place. Regarding imports RoRo goods (8.619.584 tons) again dominate all other goods. Paper & paperboard (2.716.309 tons in 2016), wastes (507.771 tons) and fertilizer (491.975 tons) follow in the ranking of major import goods.

The most important goods handled in the German Baltic Sea ports are thus RoRo goods, plant-based products, paper, forest products, construction material and fertilizer. The next section analyses the shipping routes of these goods across the Baltic Sea and beyond. Where do those goods come from, in which ports are they mainly handled and where are they exported to?

7.009.428 tons of plant-based products have been handled in German Baltic Sea ports in 2016. 88% of this amount was handled in ports of Mecklenburg-Western Pomerania. 82% of this amount was exported, only 18% was imported. Plant-based products include grain, grain-mill products, rape and rapeseed. Most imported goods of this category origin from Latvia and Poland (see fig. 2.9). Other important regions of origin are Finland, Sweden, Denmark, Estonia, Lithuania, Germany, Netherlands, England (East Coast), France (West Coast) and Ukraine. Most important destinations for exports of plant-based products are Spain (Mediterranean), Turkey and Sweden (Southeast Coast) (see fig. 2.9). Moreover, plant-based products are the main good exported to non-European regions. Most important destinations are Arabic countries (2.308.264 tons in 2016), Northern Africa (626.563 tons) and East Africa (170.400 tons). Plant-based products are handled in most German Baltic Sea ports. The most important import ports are Rostock (602.758 tons in 2016), Lübeck (256.171 tons) and Sassnitz-Mukran (175.948 tons). Most exports are handled in the ports are Rostock (3.922.951 tons in 2016), Sassnitz-Mukran (826.115 tons), Vierow (437.995) and Lübeck (225.108 tons).

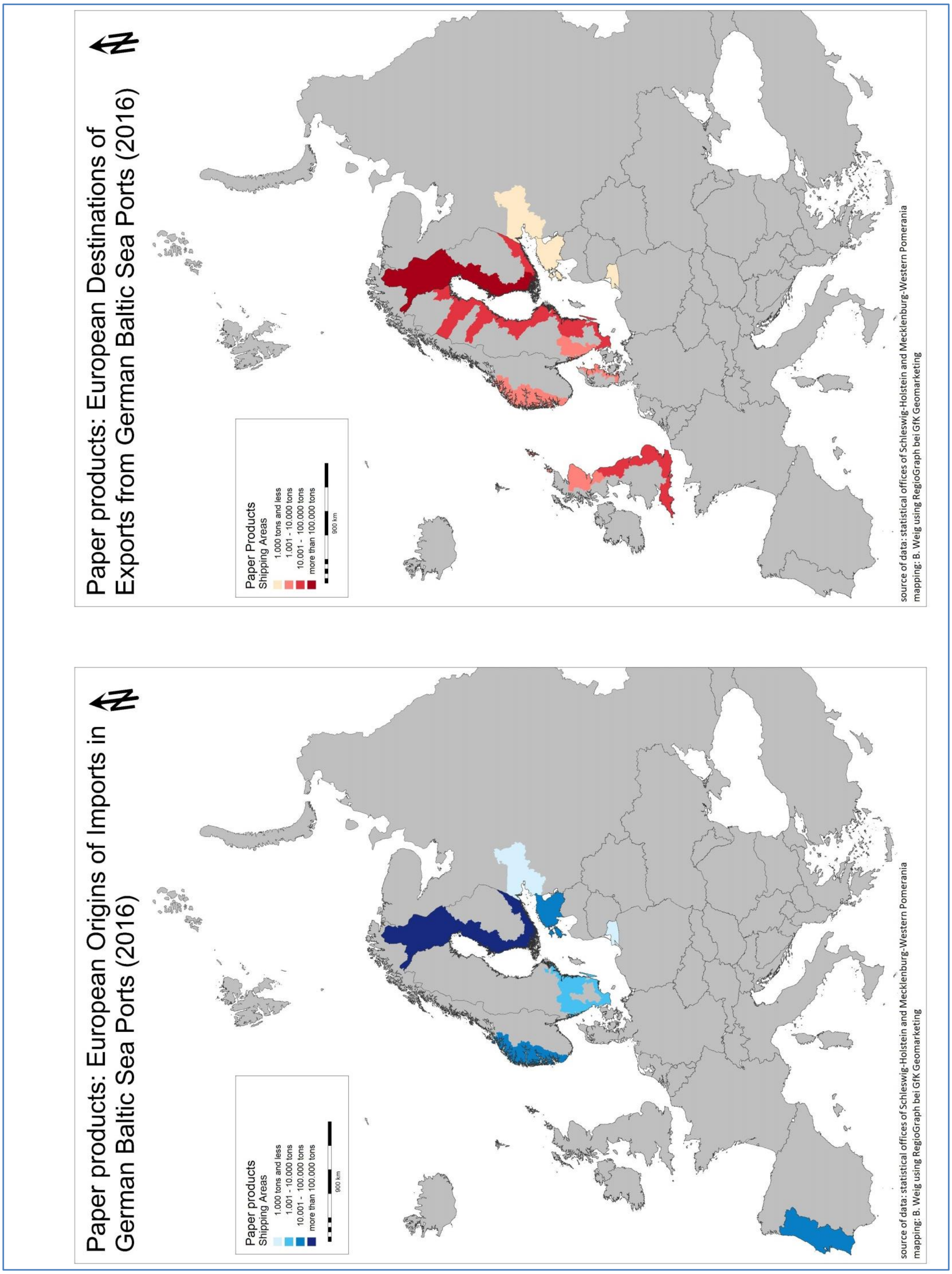
3.383.937 tons of paper and paperboard have been handled in German Baltic Sea ports in 2016. 87% of this amount was handled in ports of Schleswig-Holstein. 88% was imported, only 12% of the handled paper was exported. Most imported paper origin from Finland (see fig. 2.10). Other important regions of origin are Southern Norway, Southern Sweden, Estonia, Portugal and to a lesser extent Russia. Most important destinations of export are Finland, Sweden and England (North Sea Coast) (see fig. 2.10). Export of paper to non-European ports is limited. 5.937 tons were exported to Northern Africa. Paper products are handled in many German Baltic Sea ports. By far the largest import port of paper products is Lübeck (2.421.083 tons in 2016). Other major import ports are Kiel (284.242 tons) and Rostock (243.232 tons). The most important ports for exporting paper are Lübeck (212.283 tons), Rostock (147.065 tons) and Wismar (23.538 tons).

Figure 2.9: Plant-based products: European Origins and Destinations



Source: own illustration

Figure 2.10: Paper: European Origins and Destinations



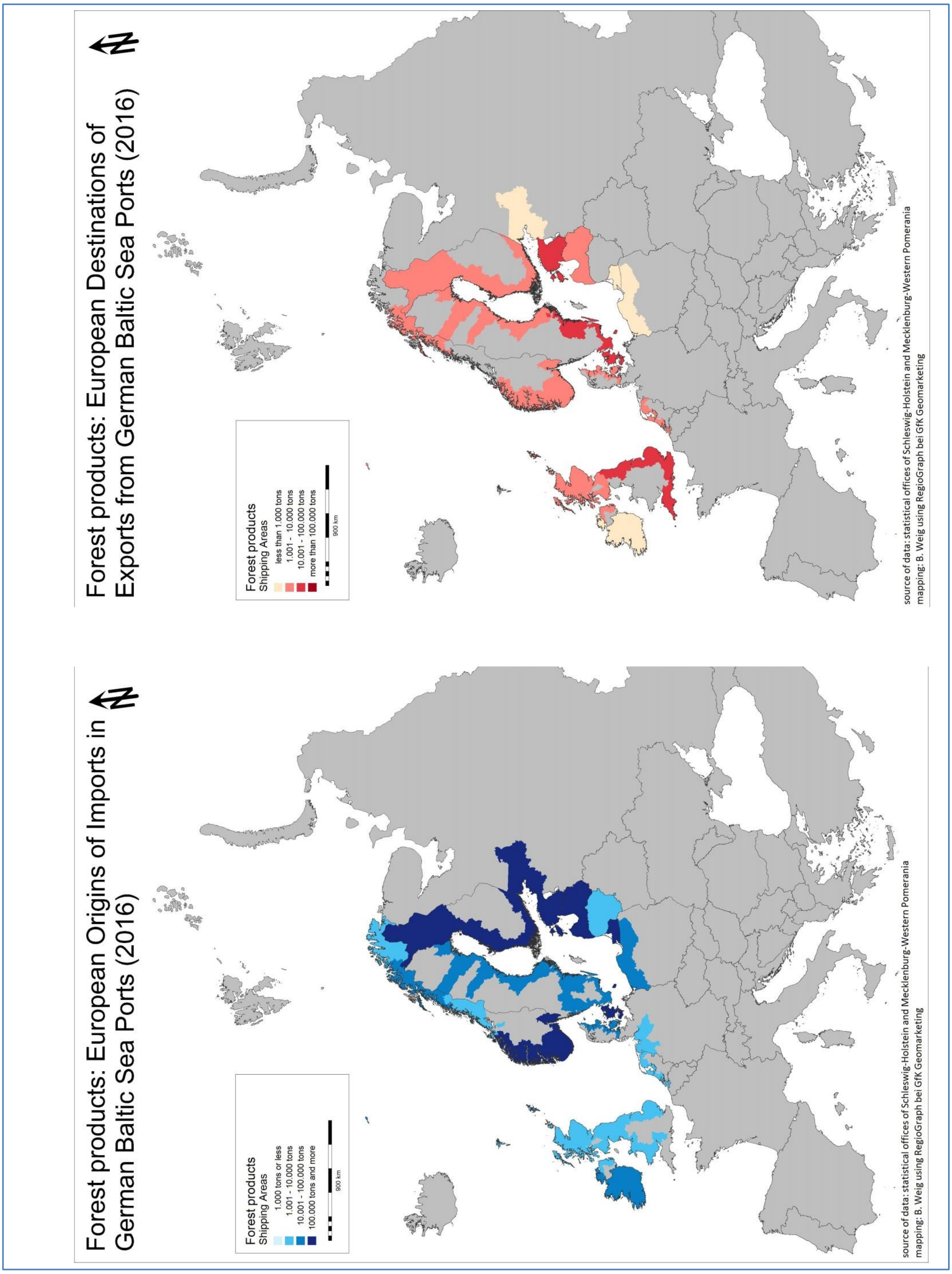
Source: own illustration

2.641.374 tons of forest products (mainly wood) have been handled in German Baltic Sea ports in 2016. 91% of this amount was handled in ports of Mecklenburg-Western Pomerania. 91% were imports; only 9% of the handled forest products were exported. Most imported wood origin from Finland, Southern Norway, Denmark, Russia, Estonia and Latvia (see fig. 2.11). Other important regions of origin are Poland, Sweden, Northern Norway and Ireland. Most important destinations for exports of wood are Estonia, the Southeast Coast of Sweden and England (Canal and North Sea Coast (see fig. 2.11). Additionally, forest products are exported to non-European ports in Northern Africa, Arabic Countries and Northern America. 3.313 tons of forest products have been imported from non-European parts of Russia. Forest products are handled in many German Baltic Sea ports. By far the largest import and export hub of forest products is Wismar (1.265.482 tons imported and 169.158 tons exported in 2016). Other major imports arrived at the ports of Rostock (901.558 tons) and Lübeck (216.845 tons), while exports are handled in Rostock (26.878 tons) and Berndshof-Ueckermünde (26.170 tons).

2.497.192 tons of construction material (cement, limestone, etc.) have been handled in German Baltic Sea ports in 2016. 89% of this amount was handled in ports of Mecklenburg-Western Pomerania. 56% has been imports while 44% of the handled construction material was exported. Most imported construction material origin from Estonia, Southern Norway and Scotland (see fig. 2.12). Other important regions of origin are Latvia, Southern Sweden, the Netherlands, England (North Sea Coast) and Denmark. Most important destinations for exports of construction material are Sweden, England (North Sea Coast) and Southern Norway (see fig. 2.12). Additionally, construction material is exported to non-European ports in West Africa and Southeast Asia. 2.718 tons of construction material was imported from Central America. Construction material is handled in many German Baltic Sea ports. The most important import harbour of construction material is Rostock (609.430 tons in 2016). Other major import ports are Lübeck (175.123 tons), Sassnitz-Mukran (107.637 tons) and Stralsund (99.084 tons). Most important export harbours are Stralsund (667.249 tons), Rostock (650.557 tons) and Lübeck (55.774).

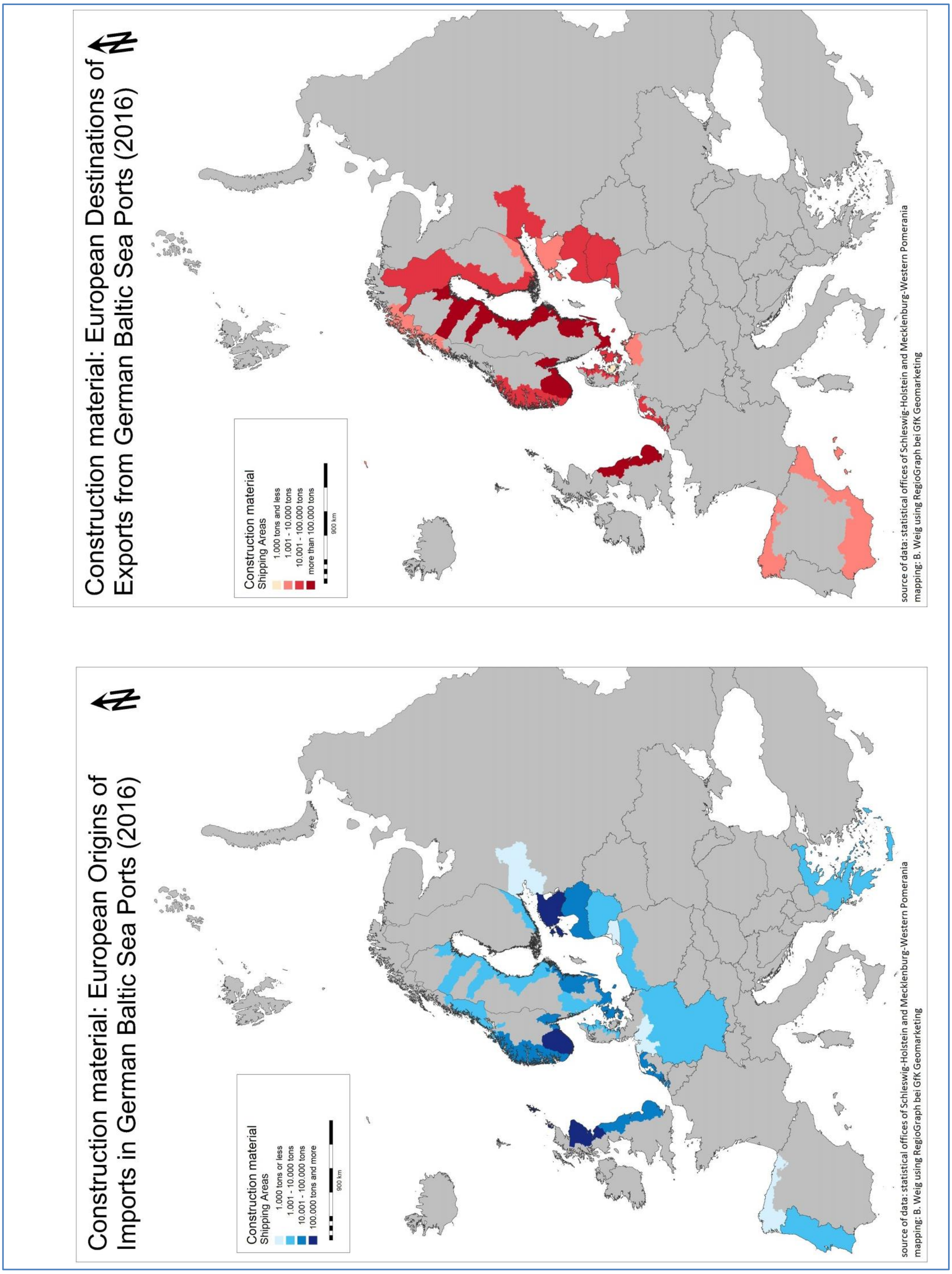
2.445.402 tons of fertilizer has been handled in German Baltic Sea ports in 2016. 80% of this amount was handled in ports of Mecklenburg-Western Pomerania. 57% were imports while 43% of the handled fertilizer was exported. Most imported fertilizer origin from Latvia, Lithuania, Southern Germany, the Netherlands and England (North Sea coast) (see fig. 2.13). Other important regions of origin are France, Poland, Sweden, Finland, Estonia and Russia. Most important destinations for exports are Sweden (East Coast), Finland, Poland, England, Scotland and Spain (North Coast) (see fig. 2.13). Additionally, fertilizer was exported to non-European ports in Southern Africa and North America. 81.619 tons of fertilizer was imported from Northern Africa. Fertilizer is handled in all German Baltic Sea ports. While most harbours import fertilizer, only four of them export fertilizer. Those are Rostock (903.545 tons in 2016), Wismar (133.461 tons), Lübeck (5.454 tons) and Sassnitz-Mukran (1.850 tons). Biggest import harbour of fertilizer is Rostock (745.385 tons in 2016), followed by Lübeck (359.488 tons), Vierow (79.989 tons) and Flensburg (54.402 tons).

Figure 2.11: Forest products: European Origins and Destinations



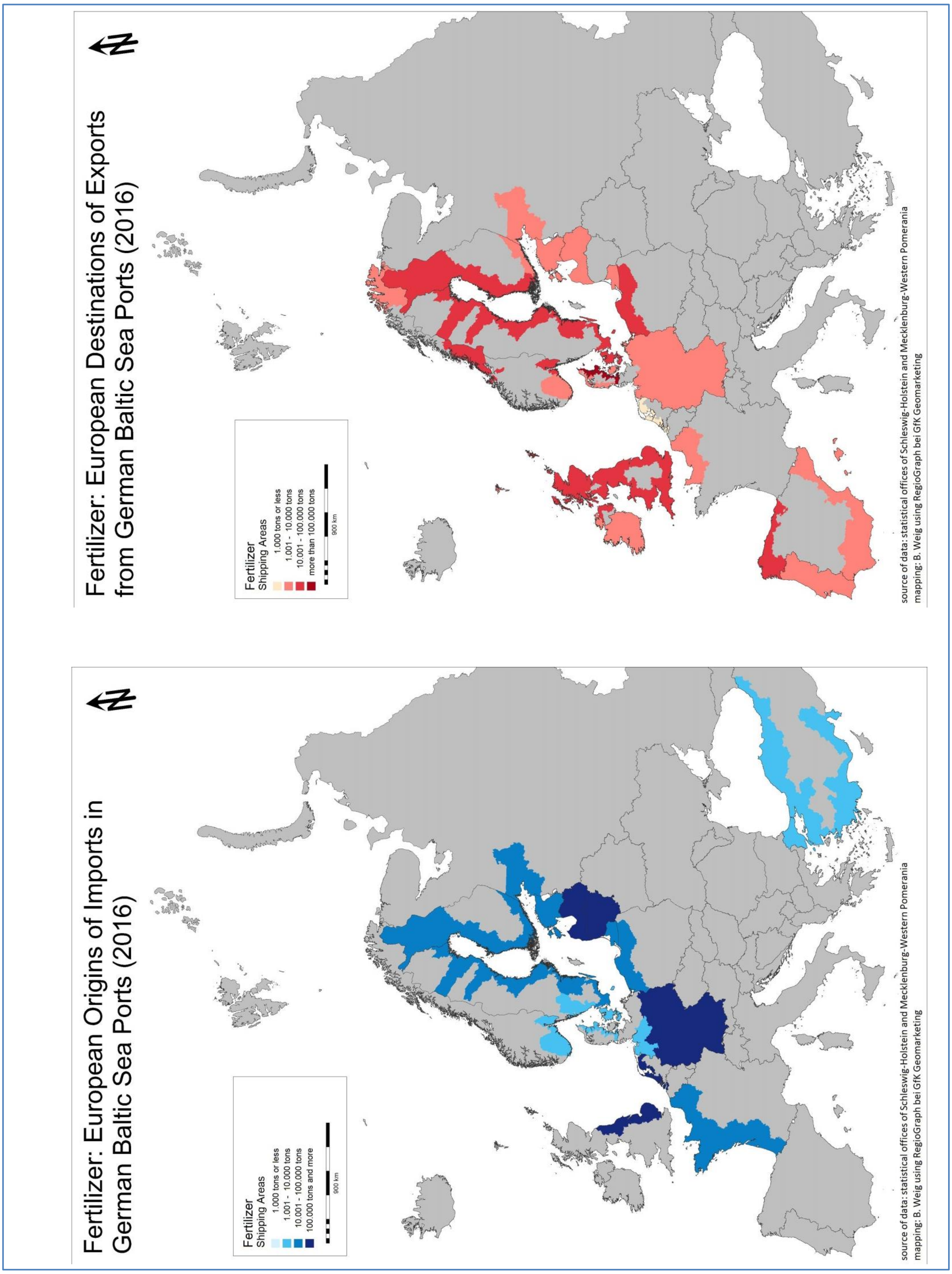
Source: own illustration

Figure 2.12: Construction Material: European Origins and Destinations



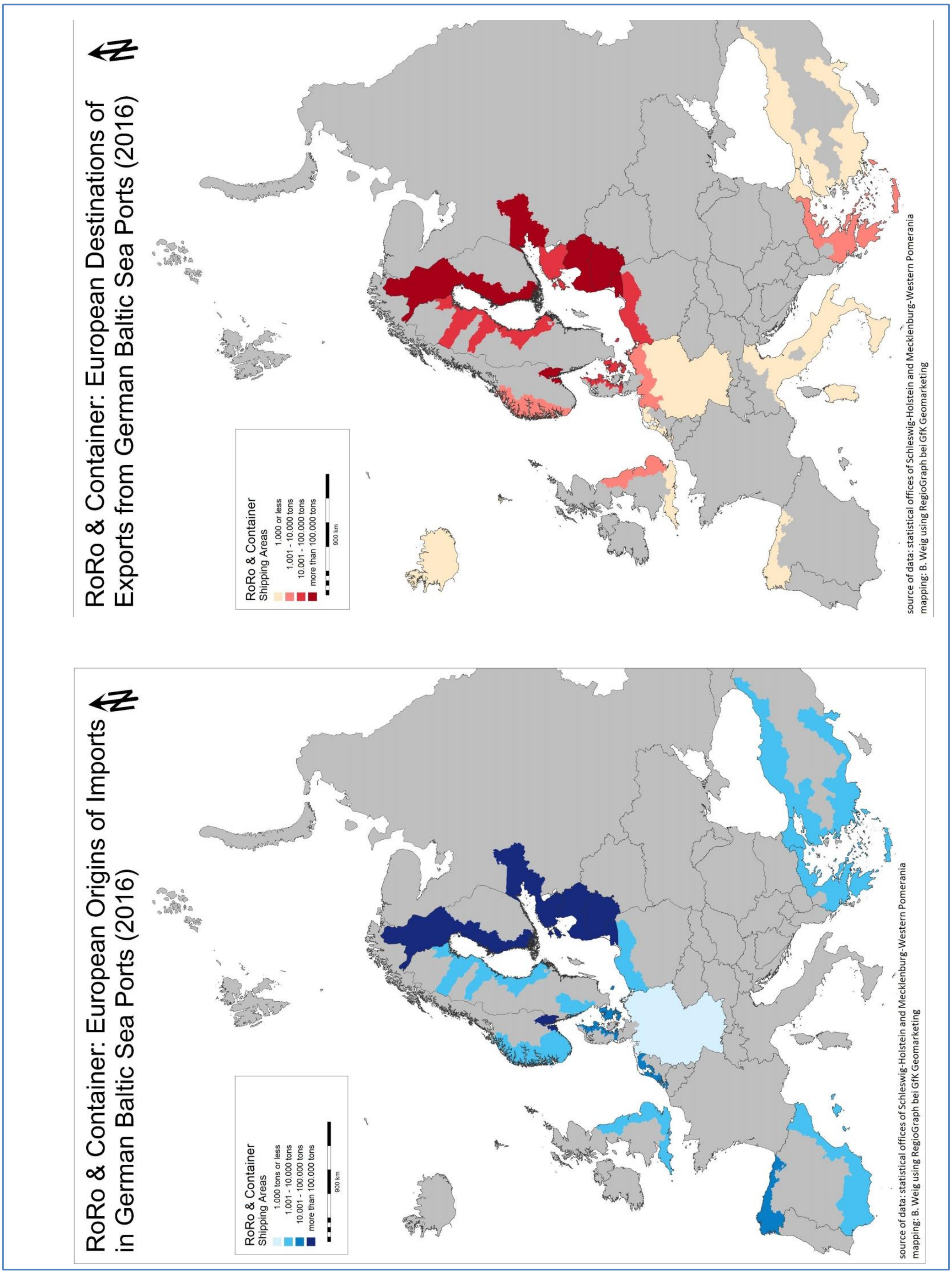
Source: own illustration

Figure 2.13: Fertilizer: European Origins and Destinations



Source: own illustration

Figure 2.14: RoRo & Container: European Origins and Destinations



Source: own illustration

27.239.495 tons of goods have been handled in German Baltic Sea ports as **RoRo and in Container.** 71% of this amount was handled in ports of Schleswig-Holstein. 49% was imports while 51% of the handled RoRo goods and container was exported. Most imported and exported RoRo goods and container were exchanged with Finland, Russia, the three Baltic States (Estonia, Latvia, and Lithuania) and the Oslo Region (see fig. 2.14). Other important regions of origin are Spain (North Coast), the Netherlands and Denmark, while other important export destinations are Poland Sweden and Denmark (see fig. 2.14). Additionally, RoRo goods and container are exported to non-European ports, mainly to Arabic Countries (55.002 tons in 2016), Northern Africa (9.961 tons) and Southeast Asia (3.101 tons). 3.650 tons of RoRo goods and container are also imported directly from South Asian countries to German Baltic Sea ports. RoRo goods and container are only handled in some German Baltic Sea ports. The most important RoRo and Container port at the German Baltic Sea Coast is Lübeck (5.621.185 tons export and 5.370.027 tons import), followed by Rostock (3.589.565 tons export and 4.043.066 tons import), Puttgarden (3.117.716 tons export and 2.090.844 tons import) and Kiel (1.519.942 tons exports and 1.557.956 tons import). Other ports handling RoRo and Container to a lesser extend are Sassnitz-Mukran, Wismar and Stralsund.

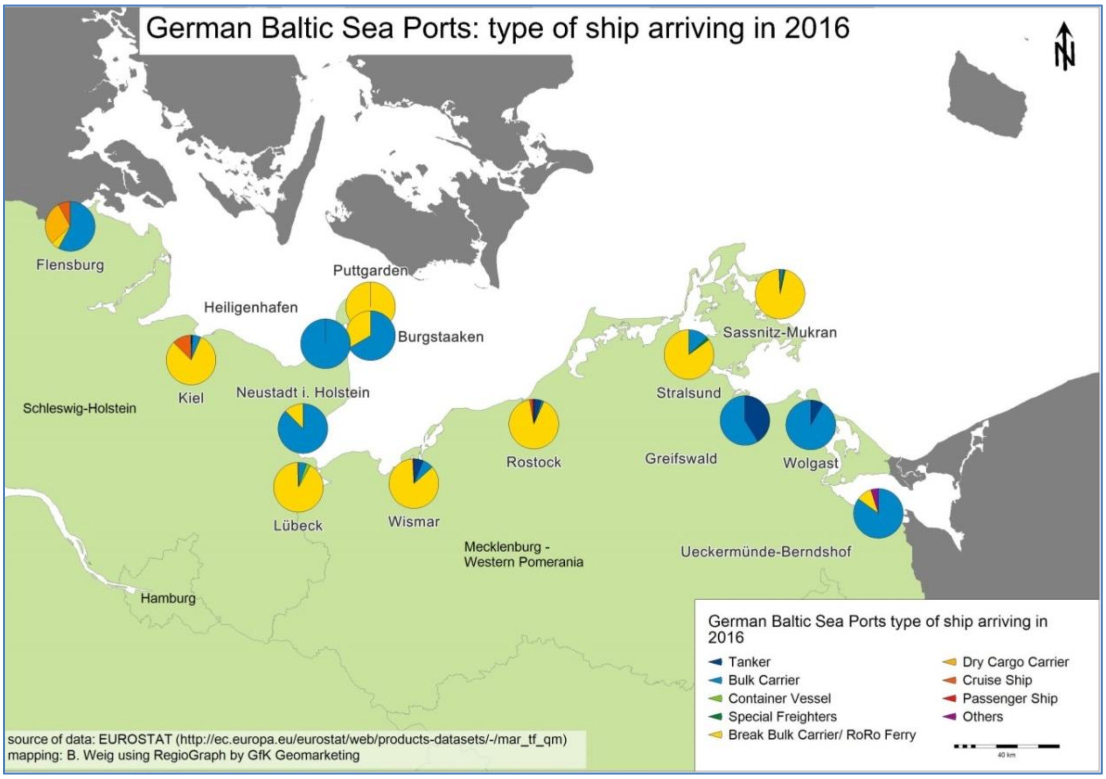
To sum up it can be noted that each good has different sources, routes and sinks. Those locations influence the shipping relations significantly. For most goods, special equipment for handling and storage is necessary, so that a spontaneous shift from one port to another is not necessarily possible. Who benefits most from the German Baltic Sea ports? Besides those working in the ports and in related services, major beneficiaries are the regional agricultural, forestry and industrial sectors. Main goods transported via German Baltic Sea ports are RoRo (mostly finished and semi-finished goods), plant-based products and fertilizer as import and export goods of the agricultural sector and wood and paper, which are forestry products. The ports serve mostly for goods from the Baltic Sea Region being imported in the German market or further transported to regions outside the Baltic Sea area.

2.3.3 Type of Ship Calling at German Baltic Sea Ports

The analysis of the German Baltic Sea ports reveals that there are two types of ports. The first group of ports is primarily used for break bulk, RoRo and container, e.g. Kiel, Puttgarden, Lübeck, Wismar, Rostock, Stralsund and Sassnitz-Mukran. The second group of ports is specialised on bulk carriers for dry and liquid cargo (see fig. 2.15), e.g. Flensburg, Heiligenhafen, Burgstaaken, Neustadt in Holstein, Greifswald, Wolgast and Ueckermünde-Berndshof. This division has consequences on goods handled, equipment and possible shipping relations.

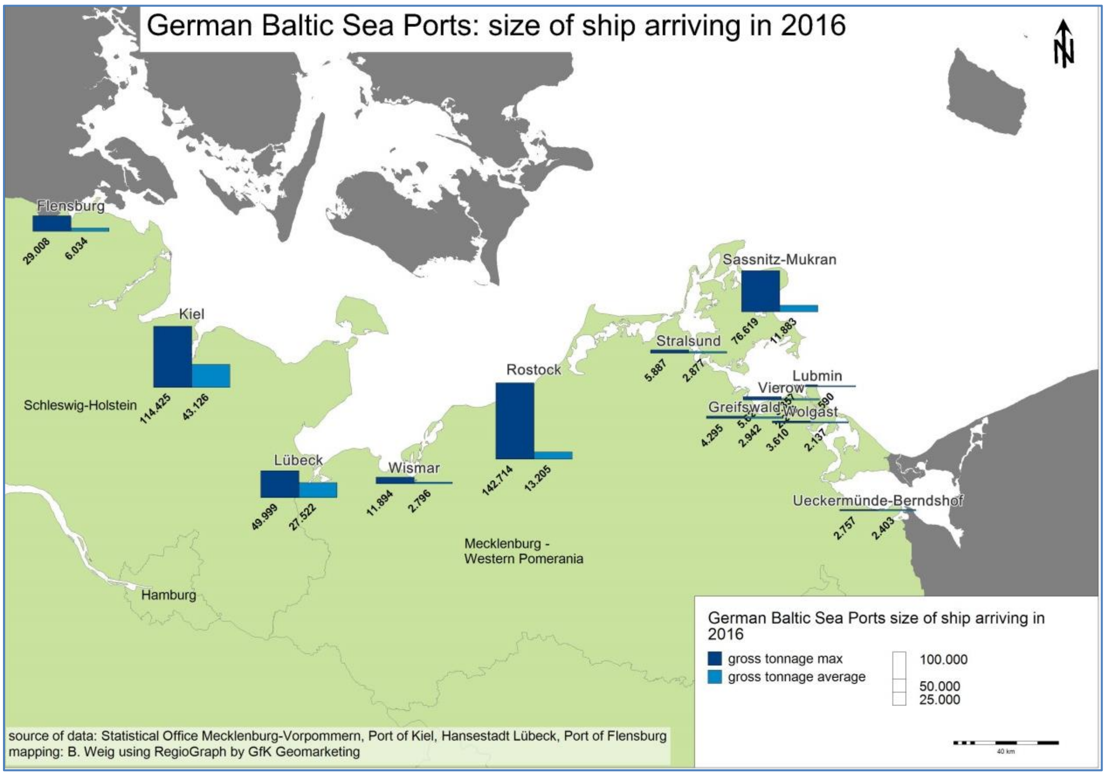
The size of ship calling at the different ports provides information on the possible sizes that can be handled. The map of all German Baltic Sea ports reveals that the biggest ship in 2016 called at the port of Rostock. However in average the ship arriving at Kiel are bigger with regard to gross tonnage. In general it can be noticed, that Rostock, Kiel, Lübeck, Sassnitz-Mukran and Flensburg are able to handle vessels with more than 20.000 in gross tonnages. The port of Wismar is somewhere in between with the biggest ship reaching a gross tonnage of around 12.000. While the other ports are rather suitable for smaller ship sizes up to a gross tonnage of 10.000 (see fig. 2.16).

Figure 2.15: German Baltic Sea Ports: type of ship arriving in 2016



Source: own illustration

Figure 2.16: German Baltic Sea Ports: size of ship arriving in 2016

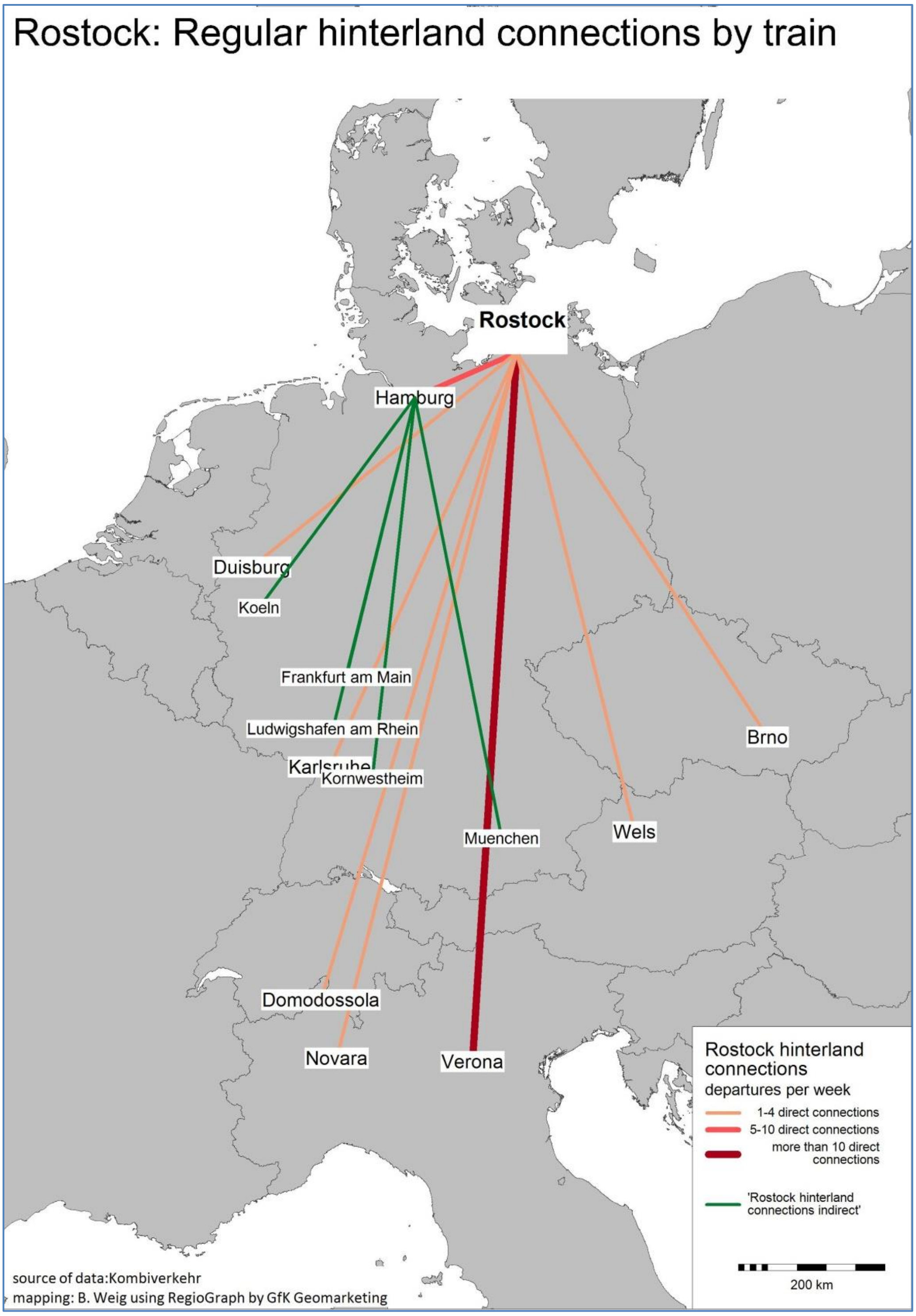


Source: own illustration

2.3.4 Hinterland Connections

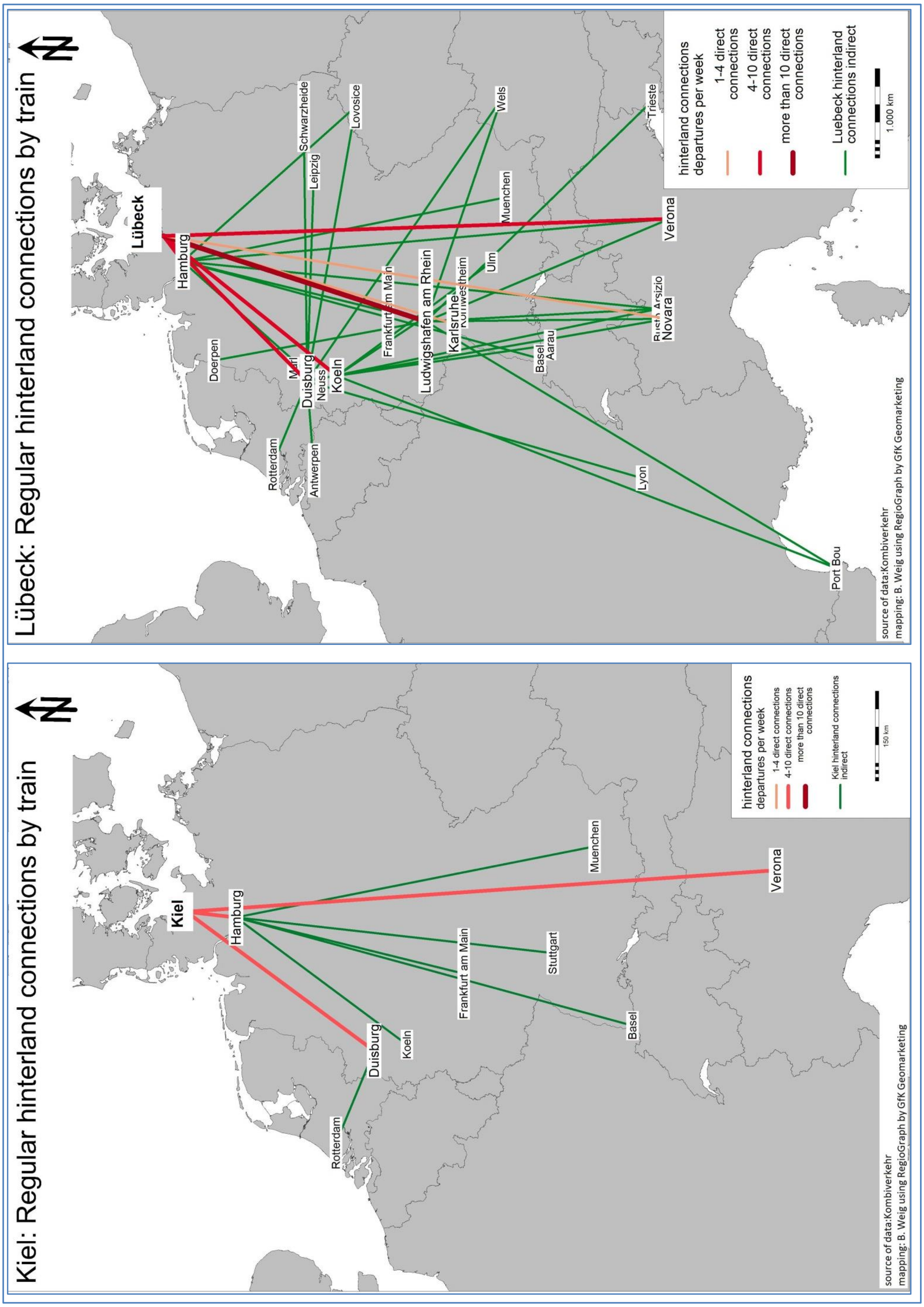
Another important issue in analysing the transport chain of shipping is the hinterland transportation. Goods arriving in the ports might be further transported by ship, inland water ways, trucks or trains. Because of a lack of data, the following analysis is focused on regular train connections to and from the main German Baltic Sea ports (Kiel, Lübeck and Rostock) only.

Figure 2.17: Rostock: Regular hinterland connections by train



Source: own illustration

Figure 2.18: Kiel & Lübeck: Regular hinterland connections by train



Source: own illustration

Rostock and Lübeck are the most important German Baltic Sea ports regarding the amount of goods handled. Thus the regular hinterland connections by train are most divers and frequent from those ports either. From Rostock (see fig. 2.17), the most important connections are Verona and Hamburg with more than five trains per week. Hamburg is mainly used as a transhub to other locations in Germany. Further direct connections exist to Brno (Czech Republic), Wels (Austria) as well as Novara and Domodossola (both Italy). Those trains leave between once and four times a week.

Lübeck shows the tightest network of hinterland connections (see fig. 2.18). Main connections from the port of Lübeck are Ludwigshafen am Rhein, Hamburg, Köln, Duisburg and Verona (Italy). There are more than five connections per week to those locations. Another direct connection exists to Novara (Italy) with less than five trains per week. Hamburg, Duisburg and Köln are mainly used as transhubs to other locations in Germany and other European countries. Important destinations are Port Bou and Lyon (both France), Busto Arisizio and Trieste (both Italy), Wels (Austria) and Lovosice (Czech Republic). Indirect relations via Duisburg connect Lübeck with the big North Sea ports of Rotterdam (Netherlands) and Antwerp (Belgium).

The port of Kiel is less busy than the other two presented ports (see fig. 2.18). Nevertheless hinterland connections by train are quite divers. Direct connections exist to Duisburg, Hamburg and Verona. Those trains leave four to ten times a week. Hamburg and Duisburg are used as transhubs to other German locations as well as to Rotterdam (Netherlands) and Basel (Switzerland). A new direct connection to the Mediterranean Port of Trieste (Italy) has been installed beginning of the year 2017. The relation is established aiming to connect Turkey via Trieste and Kiel with other ports in the Baltic Sea Region (BEHLING 2017).

To sum up it has to be noticed that hinterland connections by train are just one possibility to bring goods to the ports or to further transport imported goods. The analysis of regular hinterland connections by train from the three main ports at the German Baltic Sea Coast reveals some main regions of origin and destination of goods handled. Besides different industrial regions in Germany, Northern Italy seems to be the most important region, followed by Czech Republic, Austria and France. Another important relation connects the big North Sea ports of Antwerp and Rotterdam with the German Baltic Sea ports of Lübeck and Kiel.

2.3.5 Reflections: A Spatial EBA for Shipping in Germany

Shipping is a highly complex system of services. Therefore several approaches of a spatial EBA are conceivable. It depends on the questions that are to be answered, to define the most suitable one. In this case, the focus is on the shipping side of the transport chain, analysing goods, their destinations and origins as well as the type of ships used. In addition regular hinterland connections by train have been studied for the three most import ports Lübeck, Rostock and Kiel.

The tool is clearly limited by the availability of data. It is very difficult to combine different statistical sources, as information varies substantially between sources. To collect own data in this field is almost impossible because of the high amount of data needed and the limited access. Thus the available data determine which kind of analysis is possible. Official statistical data from regional or national offices seem the best way forward. If those are not available, asking for data directly from the ports is possible but the data might not be comprehensive and harmonization between the different ports can be difficult. The less sources of data the better.

Another limitation is given by the method of mapping. Maps are suitable to show geographical distributions. However, too much information on one map reduces the readability and therefore the message of the map. Thorough decisions on what to show on the maps, is highly relevant to develop a useful tool for practitioners in MSP.

A third limitation is time. To find access to suitable data and to analyse and present them graphically takes several weeks of fulltime work. The statistical data has to be harmonized and prepared for analysis. The categories have to be chosen and the mapping program has to be adjusted to the data.

Nevertheless, the tool is applicable on other regions as long as data is available. Unfortunately, official European statistical sources like EUROSTAT do not provide data on the necessary level of detail. The tool described here, shows one possible method. However, it has to be adjusted for other case studies. Therefore there is no standardised method, as every set of data might look different.

Besides all limitations the pilot study on the German Baltic Sea ports has revealed, that it is possible to get interesting insights in the where, what and how of shipping. Several questions asked by maritime spatial planners can be answered. The effort is worth it.

Moreover there are still open fields and questions for further research. The hinterland transportation is an interesting and important field to be studied in more detail. Especially the question, if goods handled in the ports serve for regional industries or just pass through, is an important one that cannot be answered with the available data yet. Furthermore, a more historical perspective on how shipping, goods handling and hinterland transportation in the respective ports developed over recent years might provide interesting insights. However, more data would be needed for those analyses. Another important field concerns future prognosis. Therefore an extra methodology is necessary. UNICONSULT (2014) has developed such a method to estimate the future development of different goods handled in ports of Mecklenburg-Western Pomerania. This might be a starting point for further analysis.

To sum up it can be noticed that shipping is an interesting multi-layered sector with a huge variety of possible approaches to analyse the geographical distribution of economic benefits. The developed tool and its first empirical testing provide first interesting insights and encourage further research.

3 Offshore Wind Industry

Unlike shipping or other traditional uses of the sea, offshore wind farms are not mentioned in existing MSP instruments, such as international (MARPOL, Espoo etc.), European (common fishery policy, marine strategy framework directive etc.) or regional conventions (OSPAR, HELCOM etc.). Offshore wind energy is a relatively new use of marine space, competing with traditional sectors for dedicated areas (JACQUES, S ET AL. 2011).

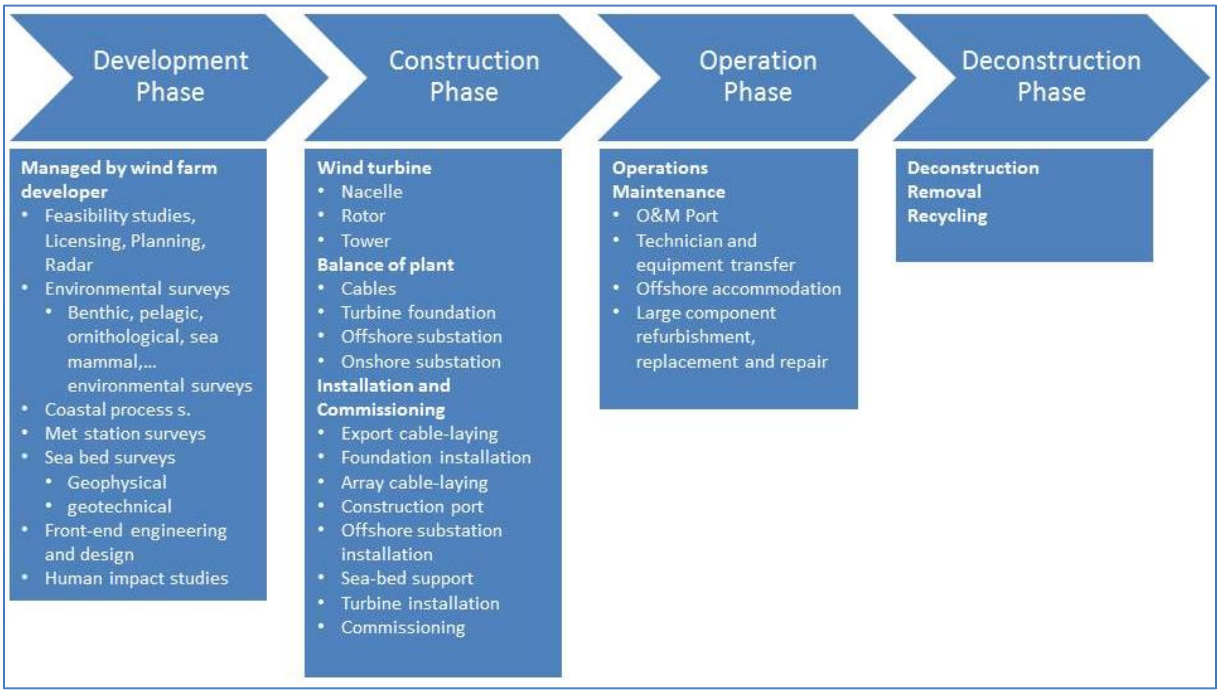
National German regulations on energy transition aim to establish 25.000 MW in offshore wind farms by 2030 (KÄPPELER 2012). To reach this goal, a substantial amount of areas have to be provided for offshore wind farms including corridors for connecting cables.

Those areas then are no longer available for other uses. Offshore wind energy requires fixed structures, not allowing other uses in the same area. Spatial conflicts are predestined (BLAKE 2013). Therefore a spatial economic benefit analysis of this sector is highly relevant and might help taking sound decisions in the future.

3.1. Value Chain Offshore Wind Industry

Offshore wind farms are highly complicated systems. Many different enterprises with a variety of backgrounds, knowledge and technical know-how are involved. To be able to develop and carry out a spatial EBA, it is important to understand the stages of the value chain and to know the different tasks to be done. A variety of steps has to be taken into account: surveys, planning processes, production, services for installation and logistics, just to name a few (see fig. 3.1).

Figure 3.1: Value Chain Offshore Wind Farm by Tasks



Source: own illustration based on BVG Associates (2010)

The development phase usually takes 4-6 years. During this time the project is managed by the wind farm developer. Several surveys and studies are carried out to reach approval status. Environmental surveys including benthic, pelagic, ornithological and sea mammal environmental surveys analyse the impact of a future wind farm on different animals. Onshore environmental surveys are designed to investigate the ecological impact of cable-laying and the installation of onshore substation. The impact of offshore wind farms on sedimentation and erosion of the coastline is in the focus of coastal process surveys. Geophysical and geotechnical surveys of the sea bed are supposed to reveal characteristics of the sea floor, such as water depth and stratigraphy. Met stations are erected within the potential area of the wind farm to monitor and analyse all kinds of meteorological and oceanographic conditions. Front end engineering and design studies tackle fields of technical uncertainty and develop the concept of the wind farm adapted to local conditions. Human impact studies assess the impact of proposed wind farms on coastal communities, concerning visual and noise disturbances. This phase ends, at best, with the approval of the wind farm.

The construction phase takes 2-4 years. During this time, the wind turbines are constructed. Many different components have to be put together. Substations are built and cables produced, to connect wind turbines and substations (offshore and onshore). Installation and commissioning complete this phase (see fig. 3.1).

Each wind turbine consists of many, very different components: One important section is the ***nacelle***, which typically weights about 200 tons. It consists of the nacelle bedplate and cover, the main bearing, the main shaft, the gearbox, a generator, the power take-off, a control system, a yaw system and a yaw bearing. Moreover, the nacelle includes a nacelle auxiliary system, small engineering components, fasteners and a condition monitoring system to facilitate maintenance later on. The assembly of a large nacelle takes 10-20 man-days (BVG Associates 2010). The ***rotor*** is another important component of each wind turbine. It consists of blades, a hub casting, blade bearings, a pitch system to adjust the pitch angle of the blades, a spinner, a rotor auxiliary system, steel components and structural composite materials, fasteners and lightning protection. The third important module is the ***tower***, basically made of steel. It includes personnel access and survival equipment, a tuned damper, an electrical system and tower internal lightning.

The wind turbines in a wind farm would be of no use without array ***cables***, connecting them with the ***offshore substation***, and export cables to bring energy onshore. Cable protection is needed to avoid damages. Another important component is the ***turbine foundation***, consisting of a foundation structure, a transition piece, to connect foundation and turbine, a crew access system, a J-tube, to route the array cable, scour protection and a sacrificial anode. The offshore substation is used to reduce electrical losses by increasing the voltage before exporting the energy onshore. It includes an electrical system and provides facilities to support the operation and maintenance of the whole wind farm.

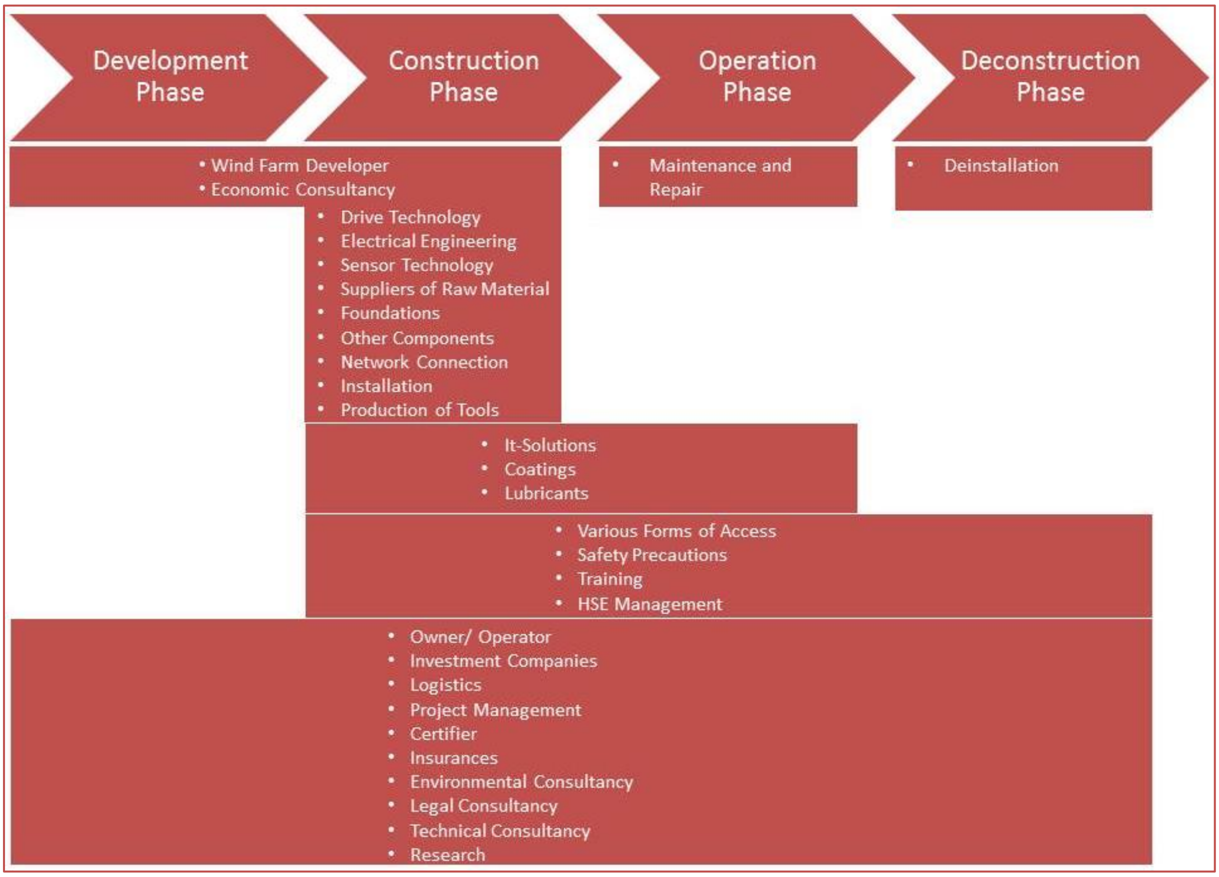
Installation and Commissioning comprises different services like cable-laying, installation of foundations, turbines and substations. All components and parts installed have to be certified, before using them.

The operation phase of offshore wind farms is limited to 20 years, with 5 years of possible extension. During operation, the performance of the wind farm has to be monitored, maintenance schedules have to be planned and customer and supplier interaction should be managed. Observation, service and repair are the main tasks to be done. A port nearby is usually chosen to function as operation & maintenance port, providing facilities. Technicians and equipment have to be transferred to the farm and accommodated in cases of longer stays. In case of damages, components have to be replaced.

The deconstruction phase has not yet been described in detail, as no large offshore wind farm has reached this stage yet. However, some enterprises already developed a concept for future deconstruction, removal and recycling of offshore wind farm components.

All those described tasks, involve a huge variety of economic sectors. The following illustration (see fig. 3.2) shows, who is implementing which steps in the value chain. Based on this model, enterprises can later be assigned to different phases.

Figure 3.2: Value Chain Offshore Wind Farm by Implementing Sectors



Source: own illustration

Development Phase: Enterprises of various sectors are already involved during the development phase (see fig. 3.2): The most important players are the wind farm developer and the owner. Often, different investment companies get involved to raise the high amount of investment money needed. Economic, environmental and technical consultancies are contracted to conduct the necessary surveys and gather important information for the process of approval. For offshore studies, specialised vessels and helicopters are needed to fulfil logistic services. Those enterprises are specifically needed in the first phase, but most of them continue their work in the following stages of the project. Project management gets established during the development phase, to carry out the whole project. Certifiers sign off on all technical components and their installation before use. Insurances are contracted to minimize the risk and legal consultancy is used to solve conflicts between contracting partners. Research is central for new insights in all aspects of offshore wind energy. Natural, social and engineering sciences are equally involved in improving the offshore wind energy sector and its acceptance in society.

For enterprises in the offshore wind sector, the **construction phase** is the busiest time (see fig. 3.2). Manufacturers provide the wind park with their products. What is needed can be divided in the following fields: raw material, drive technology, electrical engineering, sensor technology, foundations, network connection (production and laying of cables), production of tools and other components. IT-solutions are developed and installed to be able to operate and maintain the turbines. Coatings are used for protection against corrosion and lubricants enable a smooth running of the machines. Different forms of logistics and access is needed for installation of the wind farms. Vessels, cranes and helicopters are used as well as climbers and divers, to fulfil the manifold tasks. Safety precautions are installed in form of lighting systems, signs and fire as well as lightning protection measurements. The development of a comprehensive health and safety management is necessary to avoid accidents and to be able to help in cases of emergency. Training and special education of offshore workers is very important as they are exposed to specific dangers.

Within the **operation phase**, the focus is on maintenance and repair. Only a few sectors are involved in monitoring and repairing the wind farm. Logistics are still needed, coatings and lubricants have to be renewed from time to time and components have to be replaced in case of damage. Besides technical monitoring, environmental monitoring plays a role during the whole lifecycle of the wind farm. Insurances, legal consultancies and research continue with their work. Investment firms as well as the owner intend to get back their money during operation phase. IT-providers check and improve their systems continuously. The project management is responsible for a smooth running of the system.

The **deconstruction phase** is not yet experienced. However, for deinstallation, transportation and recycling of the different components, a variety of enterprises is needed, similar to the construction phase.

3.2. Spatial EBA: Methodological Approach for the Offshore Wind Industry

To conduct a spatial economic benefit analysis in offshore wind industry, two different but complementary approaches are suggested:

1. A study of the enterprises involved in planning, constructing and maintaining the offshore wind farms in the respective area of study.
2. A study of all national enterprises involved in the offshore wind sector in general.

For the **first approach**, a very important source of information is the website of 4C Offshore Ltd. consultancy: http://www.4coffshore.com/windfarms/. For all countries worldwide, this site provides information on the status of planned or realized offshore wind farm projects, including a list of enterprises, contracted to contribute to the project. For each offshore wind farm it is possible to extract a list of involved companies, including the name of the enterprise and the type of contribution. A link to the company's own website makes it easy to find the address of the head quarter and regional branch offices. At this point a challenge has to be taken up: which location to choose for the analysis, if there are several ones. Once decided, if the headquarter is chosen or the nearest local office, the analysis should be conducted in a stringent way. In some cases, 4C Offshore even indicates in the description, which enterprise location was involved in the case of the respective wind farm.

The result of this online survey is a list with company names, functions and locations, using postal codes. This list enables a first mapping exercise, showing the locations of all companies on a map. In the next step, the companies can be categorised by their functions. The value chain approach helps to find suitable groups of companies. This task helps to better differentiate the maps, indicating which groups of activities are located in which geographical areas.

The advantage of this first approach is the possibility to compare different offshore wind farms concerning the spatial distribution of the involved companies. Moreover, the list only contains companies that are/ were actually involved in the respective wind farm(s). However the list of 4C offshore is not complete even though the site gets updated from time to time. Further investigations on firms, involved in the respective wind farms might be necessary and helpful to supplement the list. Most companies show references on their websites pointing to all projects they are/ were involved in. A google search "wind farm xy" is an easy way to fill up the list of involved companies.

The **second approach** focuses on all enterprises of the respective country or geographical area that have been involved in the development, installation or maintenance of any wind farm worldwide. This approach enables to identify potential future suppliers for wind farms that are still in an early planning phase. Maritime Spatial Planners have to be oriented versus the future, because their decisions once taken are valid for several years. Therefore potential future suppliers are at least as important as current ones. To establish a database with information on enterprises, their location and possible tasks in the value chain, a comprehensive research is necessary. Good starting points for review are membership lists of offshore wind associations and participation lists of fairs and specific thematically relevant conferences, meetings or presentations.

Analogous to the first approach, the aim is to build up a database with names, postal codes of the firms' locations as well as a description of the tasks they are able to fulfil, for categorisation. The advantage of this approach is a much more comprehensive picture of the existing enterprises within a certain geographical area such as a region or nation state. But there are also challenges to accept: Enterprises may have different locations. A decision has to be taken: should all national locations be included in the map or the national headquarter only? Moreover, a decision has to be taken concerning foreign companies with national branch offices. Should they be included or excluded. Second, enterprises may offer a variety of services and/ or components, so they may at the end show up in different categories. The biggest challenge however is to determine which enterprises are involved in the offshore wind sector. Most enterprises develop services or components for different applications. They are not exclusively serving the offshore wind industry. Therefore a look at the site of references is often helpful to decide, if a company is worth integrating in the database or not.

Those two approaches have been tested for the "German Baltic Sea Region". The results, specific challenges and their solutions are summarised in the next chapter.

3.3. Offshore Wind Industry: The Case Study "German Baltic Sea"

Within the German Baltic Sea, two offshore wind farms are fully commissioned: EnBW Baltic 1 and EnBW Baltic 2. The wind farm VENTOTEC Ost 2 is currently under construction. The park is also known under its former name Wikinger. The offshore wind farm Arkonabecken Südost is under pre construction while Arcadis Ost 1 (also known as VENTOTEC Ost 1) is consent authorized. Those five offshore wind parks will be included in the case study.

For eleven more offshore wind farms in the German Baltic Sea, application has been submitted (Adlergrund gap, Adlergrund 500, Adlergrund Nordkap, Beta Baltic, Baltic Eagle, Baltic Power, Ostseeschatz, Ostseeperle, Wikinger Nord, Strom Nord, Windanker). Three more wind farms (ArkonaSee Ost, West and Süd) are in a very preliminary phase of early planning. ArkonaSee Ost has some overlapping with Windanker, so there is only the possibility to realize the one or the other. The list of involved enterprises concerning those parks is still too short for a serious spatial EBA, so they will be excluded.

The five offshore wind farms under consideration vary in different aspects. As table 3.1 shows, two parks are located within the 12 nautical miles zone, under responsibility of the state of Mecklenburg Western Pomerania. The other three parks are located in the exclusive economic zone (EEZ), with the Federal Maritime and Hydrographic Agency (BSH) being responsible.

Table 3.1: Overview German Baltic Sea Offshore Wind Farms

	location	area	Number of turbines	Date of commiss-ioning	Total output	Turbine producer	operator
EnBW Baltic 1	16km north of peninsula Darß/Zingst (12nm zone Mecklenburg-Vorpommern	7km²	21	May 2011	48,3 MW	Siemens	EnBW
EnBW Baltic 2	32km north of the island of Ruegen (EEZ)	27km²	80	September 2015	288 MW	Siemens	EnBW
VENTOTEC Ost 2	75km north of the island of Ruegen (EEZ)	34km²	70	Planned: 2017	350 MW	Adwen	Iberdrola
Arkona-Becken-Südost	35km northeast of the island of Ruegen (EEZ)	39km²	60		385 MW	Siemens	E.ON
Arcadis Ost 1	17km north of the island of Ruegen (12nm zone Mecklenburg-Vorpommern	29km²	58		348 MW	GE Energy	WV Energy Holding

Source: own illustration based on information by C4 Offshore Ltd.

Germany has started to plan and install offshore wind farms in the North Sea much earlier. Thus, there is more experience and know-how located in Germany, as can be expected from the Baltic Sea Case. Therefore it is reasonable to conduct both approaches. Gaining knowledge on which enterprises are involved in the actual wind farms in the Baltic Sea and which enterprises have experiences in other regions, being possible contractors for future projects in the Baltic Sea.

3.3.1 Analysis of Existing German Baltic Sea Offshore Wind Farms

The analysis of the five offshore wind farms in the German Baltic Sea with significant progress so far, reveals similarities and differences. The number of enterprises involved varies according to the progress of the wind farm. EnBW Baltic 1 and 2 are fully commissioned and therefore reach a higher number of involved companies (102 for EnBW Baltic 1 and 108 for Baltic 2)(see table 3.2). For Arcadis Ost 1, the list only shows 25 enterprises so far, as many tasks have not yet been contracted. The share of German enterprises varies between 88% for Arcadis Ost 1, respectively 80% for EnBW Baltic 1 and a low rate of 51% for VENTOTEC Ost 2. The offshore wind sector is highly international, as can be seen and VENTOTEC Ost 2 is operated by a Spanish company (IBERDROLA).

Table 3.2: Number of enterprises involved and share of German enterprises

	Number of enterprises involved	Share of German enterprises
EnBW Baltic 1	102	80%
EnBW Baltic 2	108	66%
VENTOTEC Ost 2	47	51%
Arkona-Becken-Südost	44	70%
Arcadis Ost 1	25	88%

Source: own illustration, derived from database

The spatial distribution of the enterprises involved in the five offshore wind farms, reveal some regional hotspots in coastal areas but in general, benefiting companies are also located in southern Germany, especially in the Southwest (see figure 3.3-3.5).

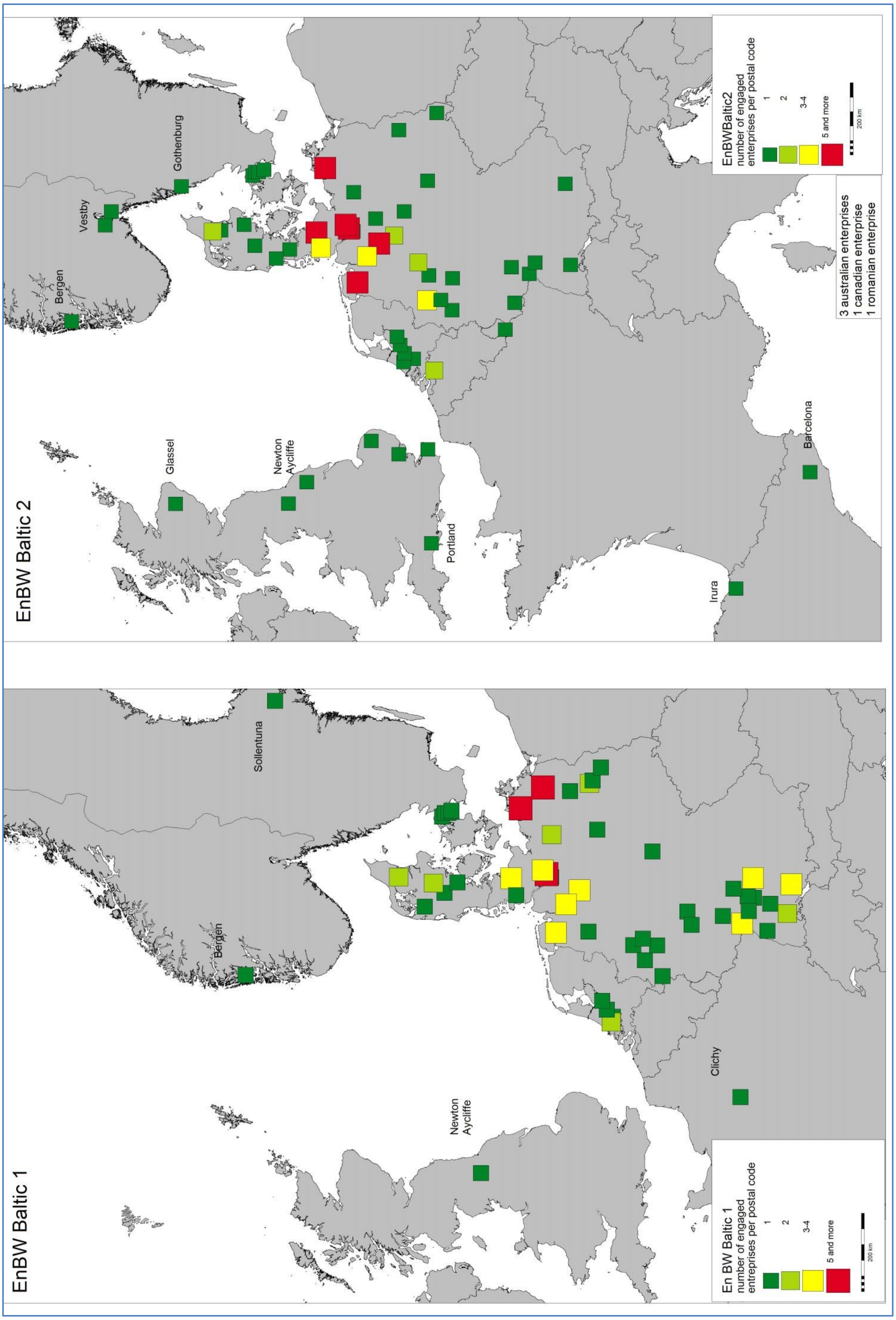
Prominent geographical areas are Mecklenburg-Western Pomerania, Schleswig-Holstein, Lower-Saxony as well as Bremen and Hamburg. Besides those coastal states, there is a significant number of companies from the Rhine valley and the Ruhr area, from Berlin and Baden Württemberg. Other German states such as Bavaria, Saxony, Thuringia and Hesse show almost no activity. Foreign companies, involved in the German Baltic Sea offshore wind farms are mostly from Denmark, GB and the Netherlands. Some enterprises are located in Norway, Sweden, France or Spain. German companies are exposed to an international competition.

EnBW Baltic 1 and 2 have a lot in common: the operator is EnBW, the turbines are produced by Siemens (in Denmark) and they are the first two German offshore wind farms commissioned in the Baltic Sea. However, EnBW Baltic 2 is much bigger and located in the EEZ, while EnBW Baltic 1 is located in the territorial seas of Mecklenburg-Western Pomerania. The distribution of involved companies also shows some differences (see fig. 3.3): While enterprises participating in constructing EnBW Baltic 2 are concentrated in the German coastal states, EnBW Baltic 1 shows more activity in southern Germany and involves a lower share of international companies. Especially enterprises from UK are much more involved in EnBW Baltic 2.

VENTOTEC Ost 2 and Arkonabecken Südost are not as far developed as the EnBW offshore wind farms. The total number of enterprises analysed is much lower. Still, the pattern stays the same, enterprises in the German coastal states are dominating (see fig. 3.4). Moreover, the example of VENTOTEC Ost 2, operated by a Spanish company, reveals the influence of the operator in choosing contract partners. The share of international companies lies ways higher for this offshore wind farm than for all other parks.

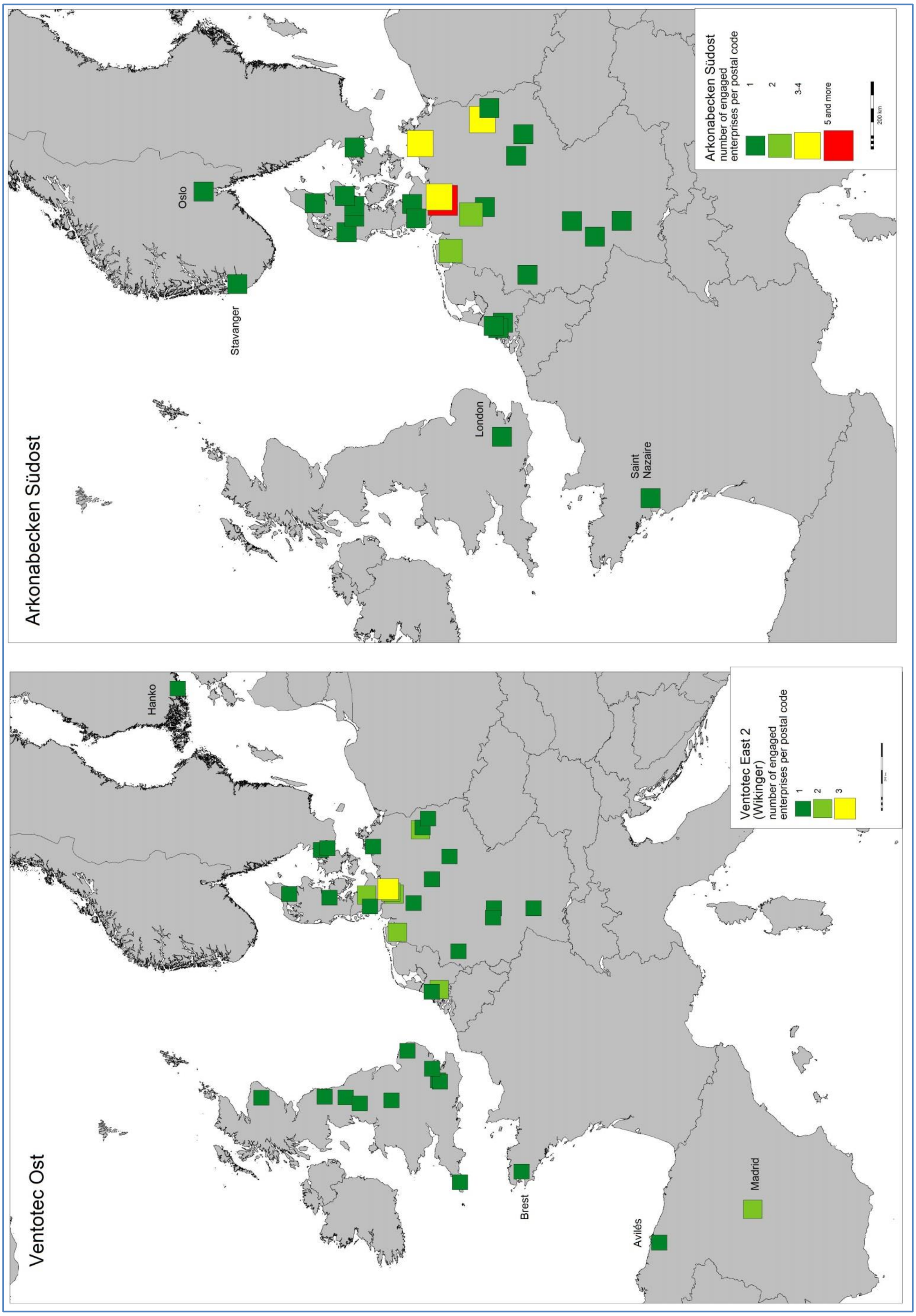
BALTSPACE

Figure 3.3: Comparison EnBW Baltic 1 and EnBW Baltic 2 – geographical distribution of involved enterprises



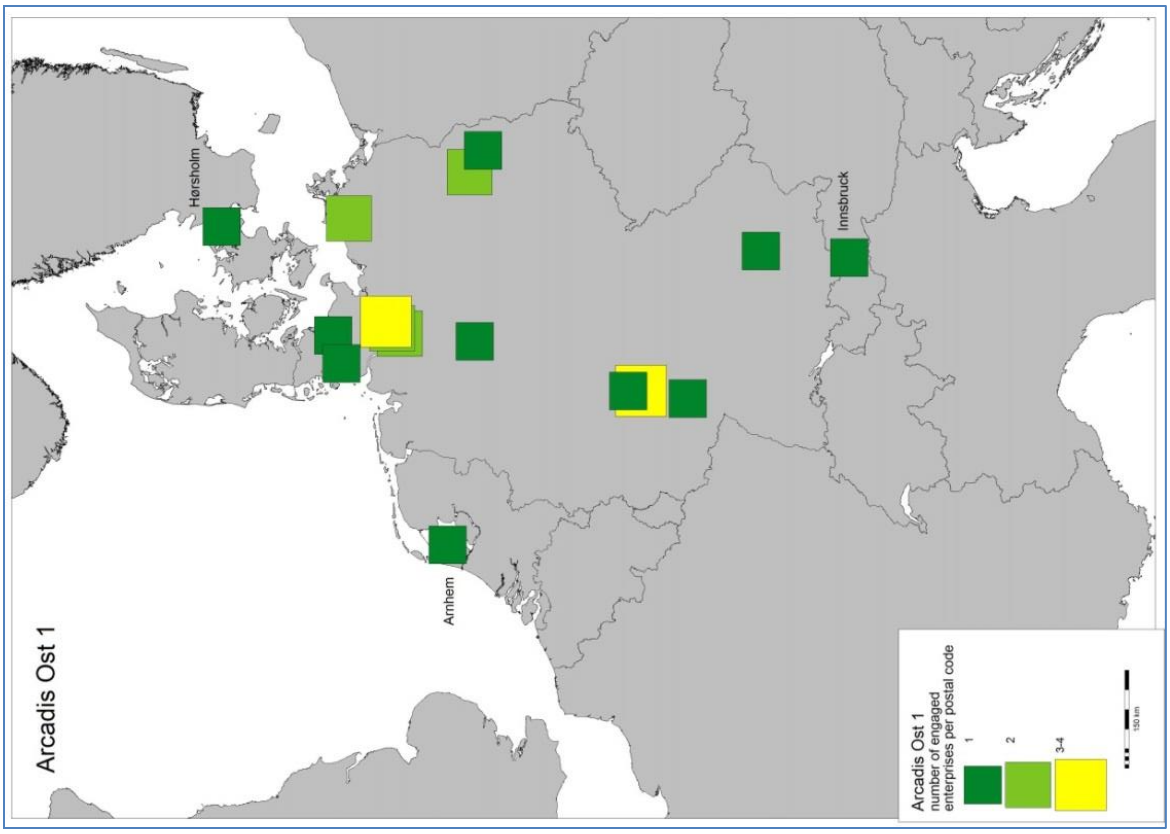
Source: own illustration (using RegioGraph by GfK Geomarketing)

Figure 3.4: Comparison VENTOTEC Ost 2 and Arkonabecken Südost – geographical distribution of involved enterprises



Source: own illustration (using RegioGraph by GfK Geomarketing)

Figure 3.5: Arcadis Ost 1 – geographical distribution of involved enterprises



Source: own illustration (using RegioGraph by GfK Geomarketing)

Arcadis Ost 1 is the least developed offshore wind farm in the German Baltic Sea so far. The distribution of involved enterprises shows, that especially the first steps (mostly environmental surveys for approval) are conducted by Northern German actors, while operator and investors are located in the South of Germany (see fig. 3.5).

To sum up it can be stated, that coastal areas are the most benefiting regions related to the offshore wind sector. However, benefits are not exclusively generated at the coasts. Some German regions, like the Rhine valley, the Ruhr area, Berlin and Baden-Württemberg host industrial sectors and service companies that are involved in the German Baltic Sea offshore wind development. A more detailed spatial analysis by tasks will be conducted within the scope of the second approach. This analysis will reveal, if there are regional hotspots concerning certain activities.

Moreover, offshore wind parks are an international endeavour. For German enterprises, this leads to an international competition for contracts, to be involved in German projects. On the other hand, German enterprises get the opportunity to use their experiences and the technological know-how in other countries.

The second approach will reveal in more detail the strengths of German enterprises involved in the offshore wind sector and their regional distribution.

3.3.2 Analysis of German Enterprises Involved in the Offshore Wind Sector

The second approach aims to look at the German offshore wind sector from another angle. Instead of looking at the wind farms built in the German Baltic Sea and the enterprises involved in those, the approach includes all enterprises located in Germany and contributing to the offshore wind value chain.

The first challenge is to build up a database of enterprises. Such a comprehensive list does not exist yet. The information for the database has been gathered from several sources (see fig. 3.6), such as offshore wind fairs, sector associations and clusters. No claim is made to completeness. In addition, there is a lot of change in the sector, actors appear and disappear and enterprises amalgamate or merge with each other, or are acquired by another company. Such a database needs permanent updates.

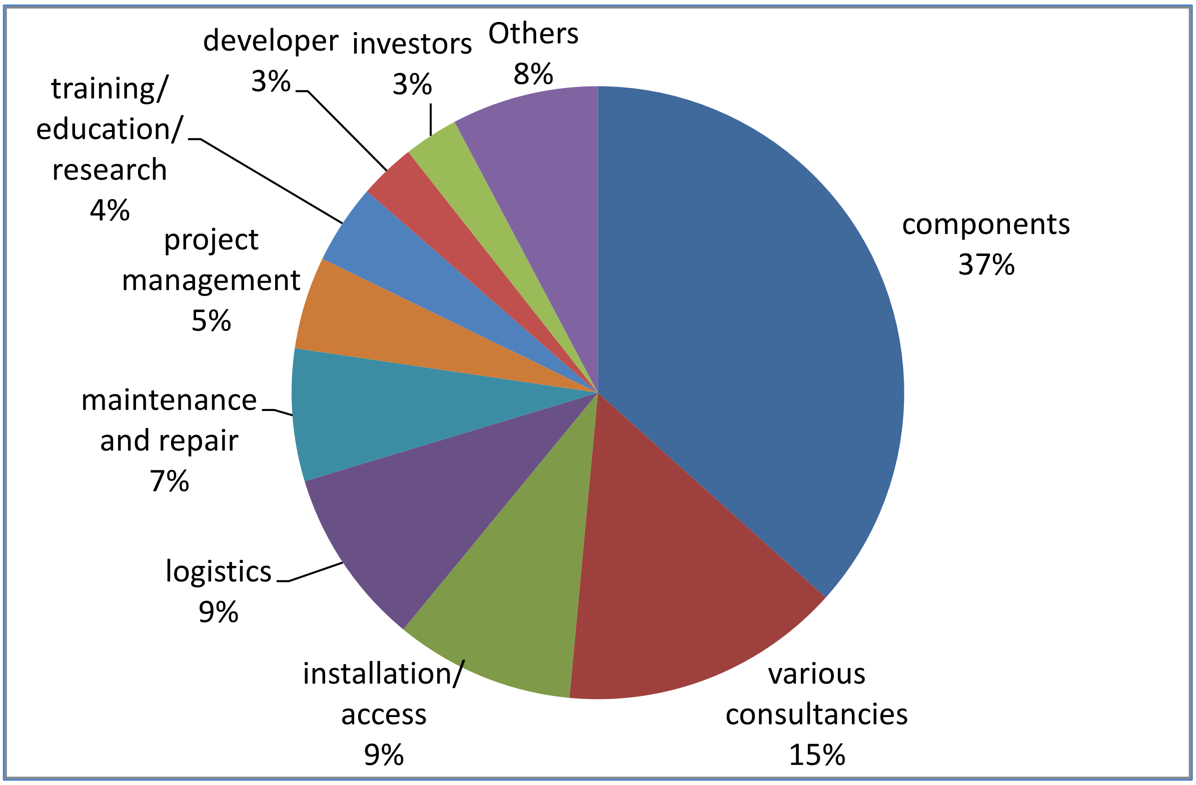
Figure 3.6: List of sources to gather German enterprises involved in the offshore wind sector

- **German and Danish Offshore Wind:** http://www.gadow-offshore.net/de/unternehmen
- **Hamburg wind fair:** http://www.windenergyhamburg.com/die-messe/aussteller-produkte/ausstellerverzeichnis/#/suche/t=2
- **International Economic Forum for Renewable Energies:** http://www.iwr.de/wind/offshore/ & http://www.offshore-windindustrie.de/firmen
- **KiWi:** Various participation lists of „Kieler Branchenfokus Windenergie"
- **Maritime Cluster Northern Germany:** http://maritimes-cluster.de/Mitglieder/Mitgliederliste
- **National Association WindEnergy:** https://www.windindustrie-in-deutschland.de/firmen
- **Rostock wind fair:** http://w3.windmesse.de
- **WAB – the windenergy agency:** http://www.wab.net/index.php?option=com_alphacontent&view=alphacontent&Itemid=93&lang=de
- **WindEnergy Network:** http://www.wind-energy-network.de

Source: own compilation

The database used for the following approach comprises 744 enterprises (see fig. 3.7). 37% of these companies produce components used for the construction of offshore wind farms. Another 15% of the enterprises provide services in the various fields of consultancy (environment, legal, economic and technical). 9% of all companies in the database provide forms of access and/ or are involved in installation tasks. 9% of the firms are in logistics, while 7% are dealing with maintenance and repairing. 5% of the companies are contracted for project management. 4% of the listed actors are involved in training, education and research. 3% of the enterprises are developers and another 3% are investors. All other enterprises reach a share of 8%.

Figure 3.7: database share of sectors



Source: own illustration

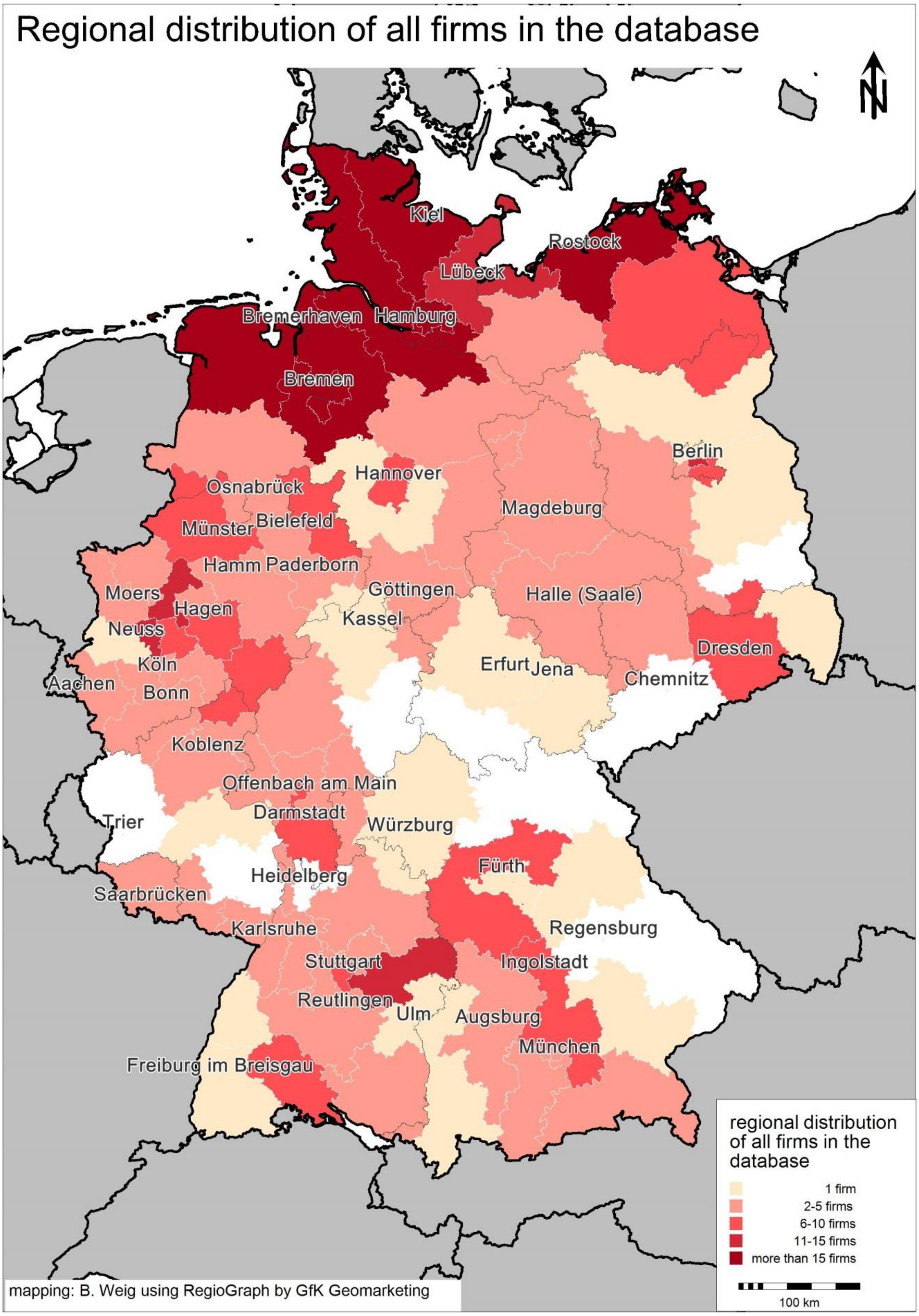
In the next step, the enterprises in the database are analysed spatially (see fig. 3.7). The picture supports the findings from the first approach. Most enterprises involved in the offshore wind sector in Germany are located in coastal areas. However, the sector also reaches more southern regions. Especially the Rhine valley and North Rhine Westphalia in general are locations of offshore wind enterprises, same as areas in Baden-Württemberg. In general, big cities like Berlin, Dresden, Munich, Stuttgart, Frankfurt and Hannover are hotspots of offshore wind activities outside the coastal region.

There are regions without any enterprise in the offshore wind sector, such as the eastern and northern part of Bavaria, parts of Hesse, Thuringia, Brandenburg and Rhineland Palatinate. The companies are not spread evenly over the country. However they are not exclusively located at the coasts, either.

But who is located where? A first division in four categories (1. operators/ owners/ investors, 2. producers of components, 3. service companies and 4. consulting companies) reveals some regional differences:

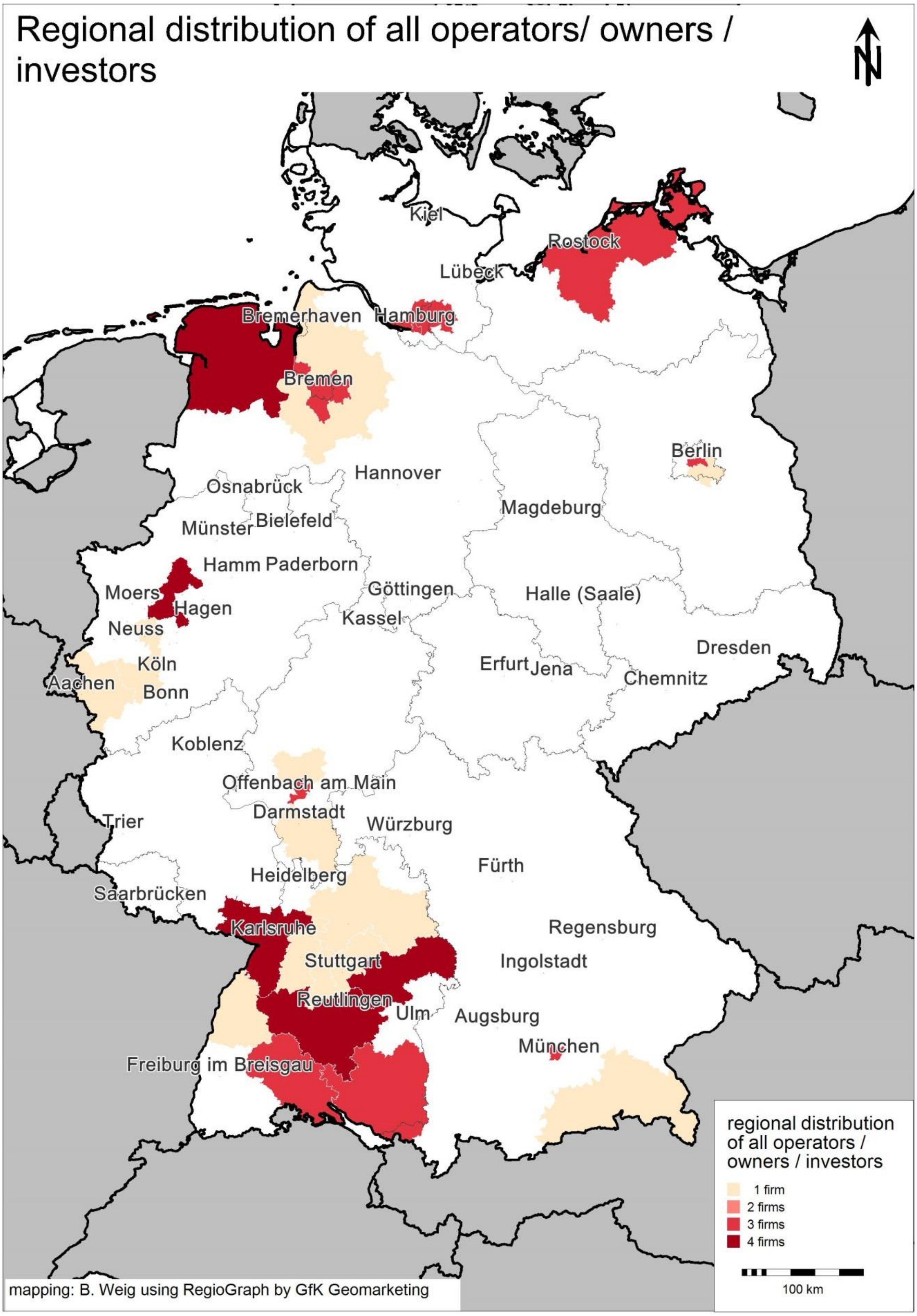
The group of operators/ owners/ investors is comparably small. The database comprises only 50 companies belonging to this category. Operators and investors are clearly concentrated in Baden-Württemberg and big cities such as Hamburg, Berlin, Essen, Bremen, Frankfurt and Munich (see fig. 3.8). East Frisia and the Region of Western Pomerania play a special role in this context. Those regions are closest to most offshore wind farms in Germany and therefore host the operating companies. Those enterprises are particularly established to develop and run one or several offshore wind farms.

Figure 3.8: Regional distribution of all firms in the database



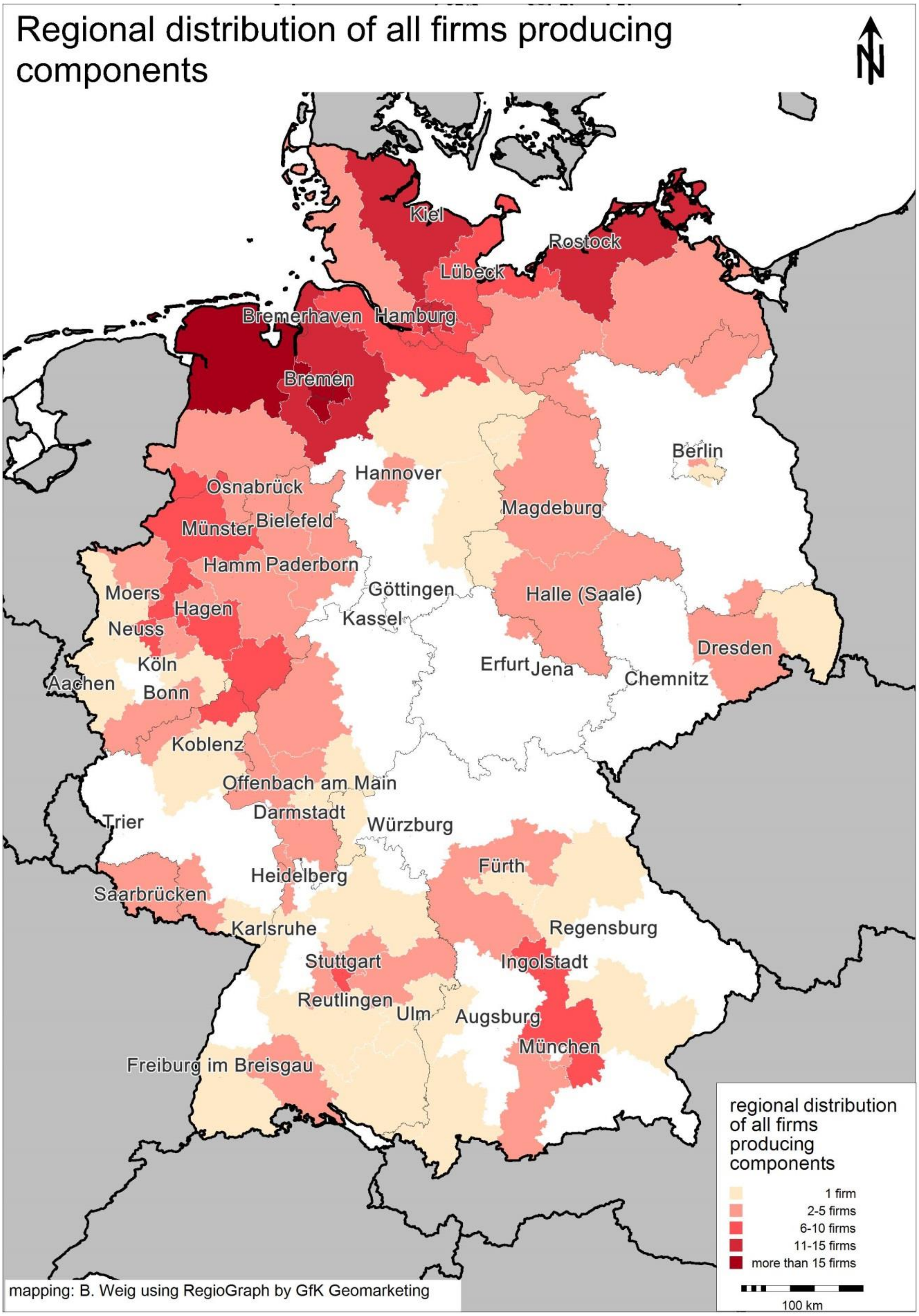
Source: own illustration

Figure 3.9: Regional distribution of all operators / owners / investors



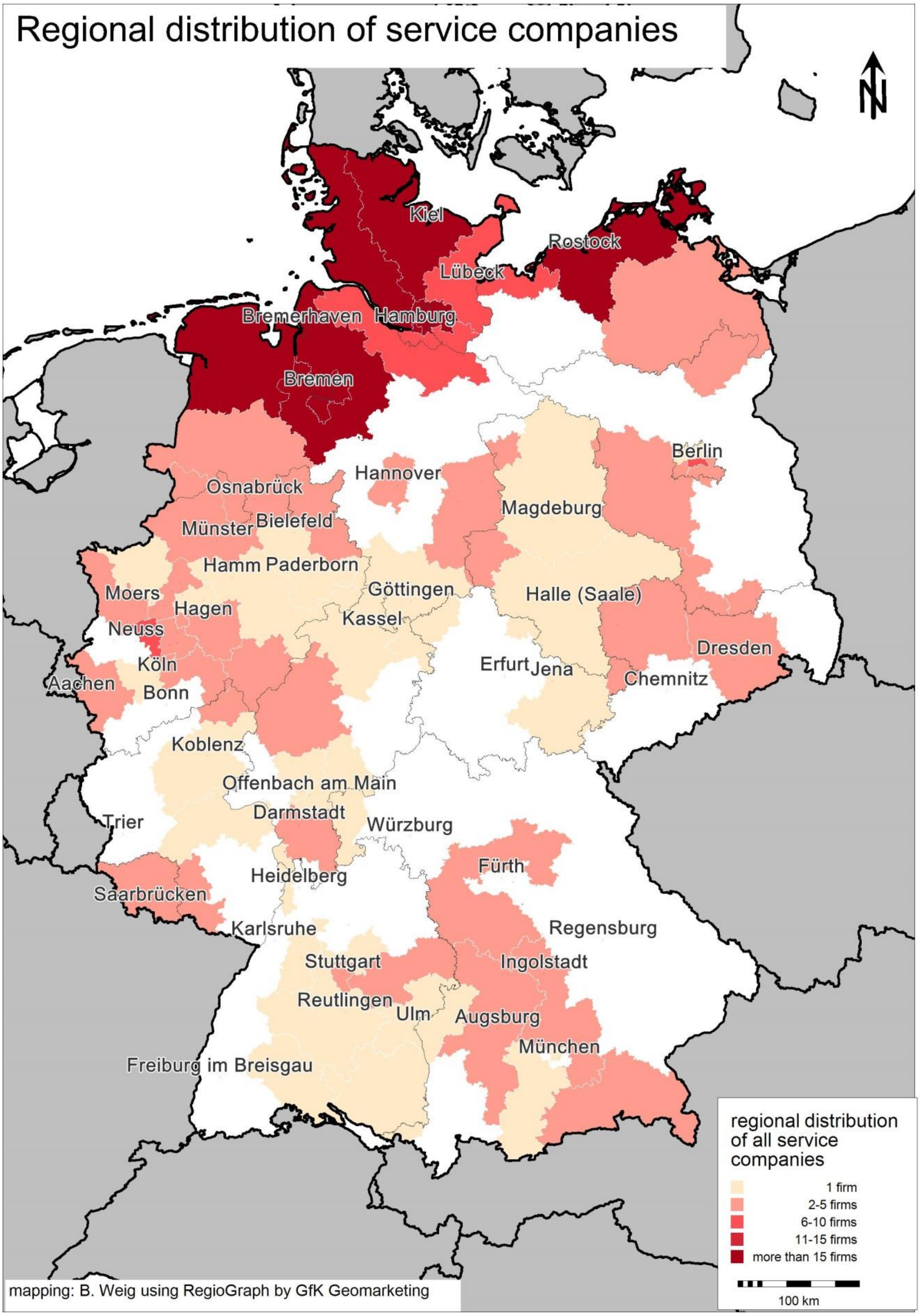
Source: own illustration

Figure 3.10: Regional distribution of all firms producing components



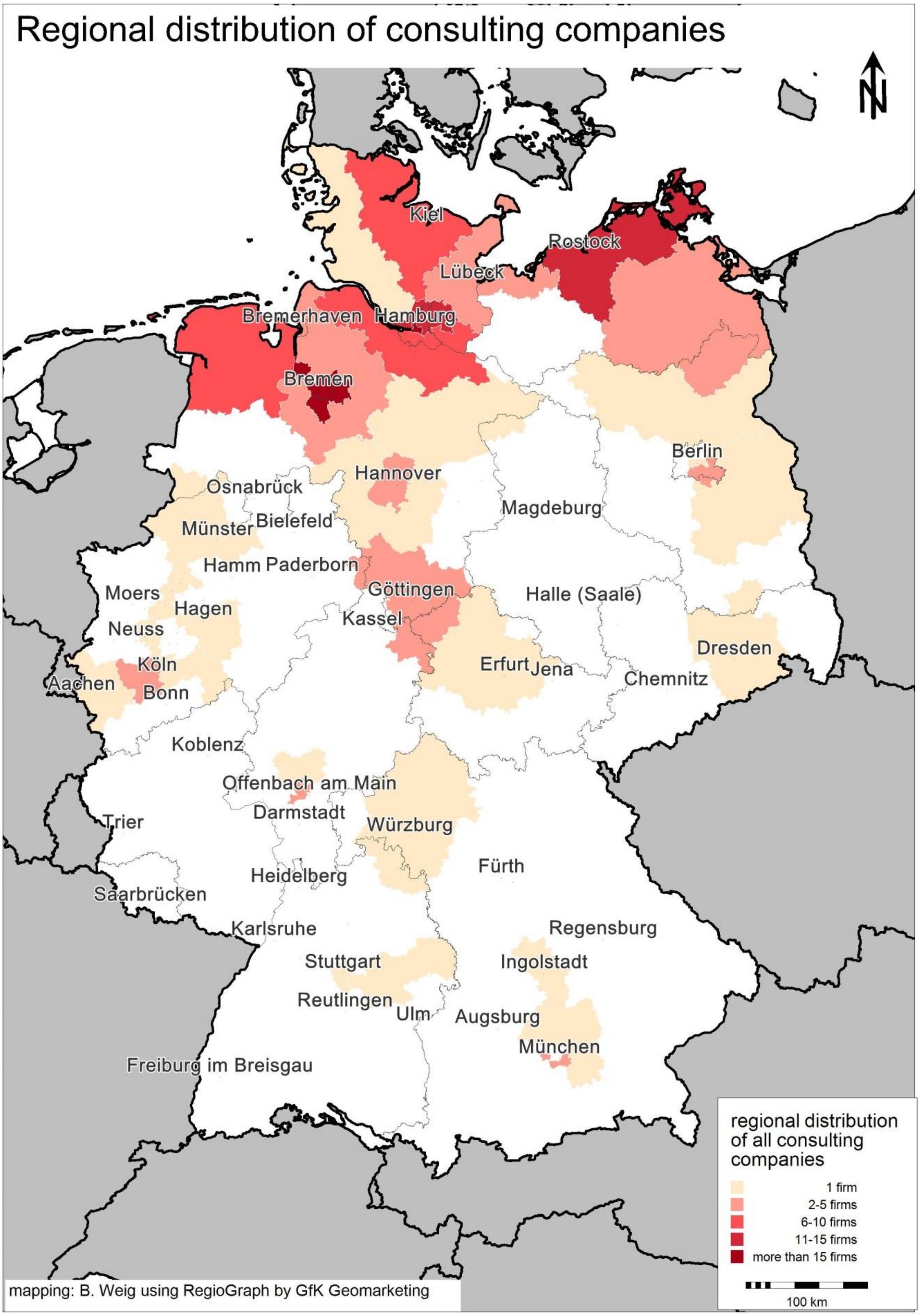
Source: own illustration

Figure 3.11: Regional distribution of all service companies



Source: own illustration

Figure 3.12: Regional distribution of all consulting companies



Source: own illustration

The group of firms producing components for offshore wind parks listed in the database consists of 262 enterprises (see fig. 3.10). Companies of this group produce raw material, components of the turbine and the substations, as well as technological parts and cables to connect everything. This group shows a clear geographical focus in northern Germany, including the Rhine Valley. Regional hotspots are East Frisia and the Bremen area, the East Coast of Schleswig-Holstein, Hamburg and the area around Rostock. Some smaller hotspots can be identified north of Munich and in Stuttgart.

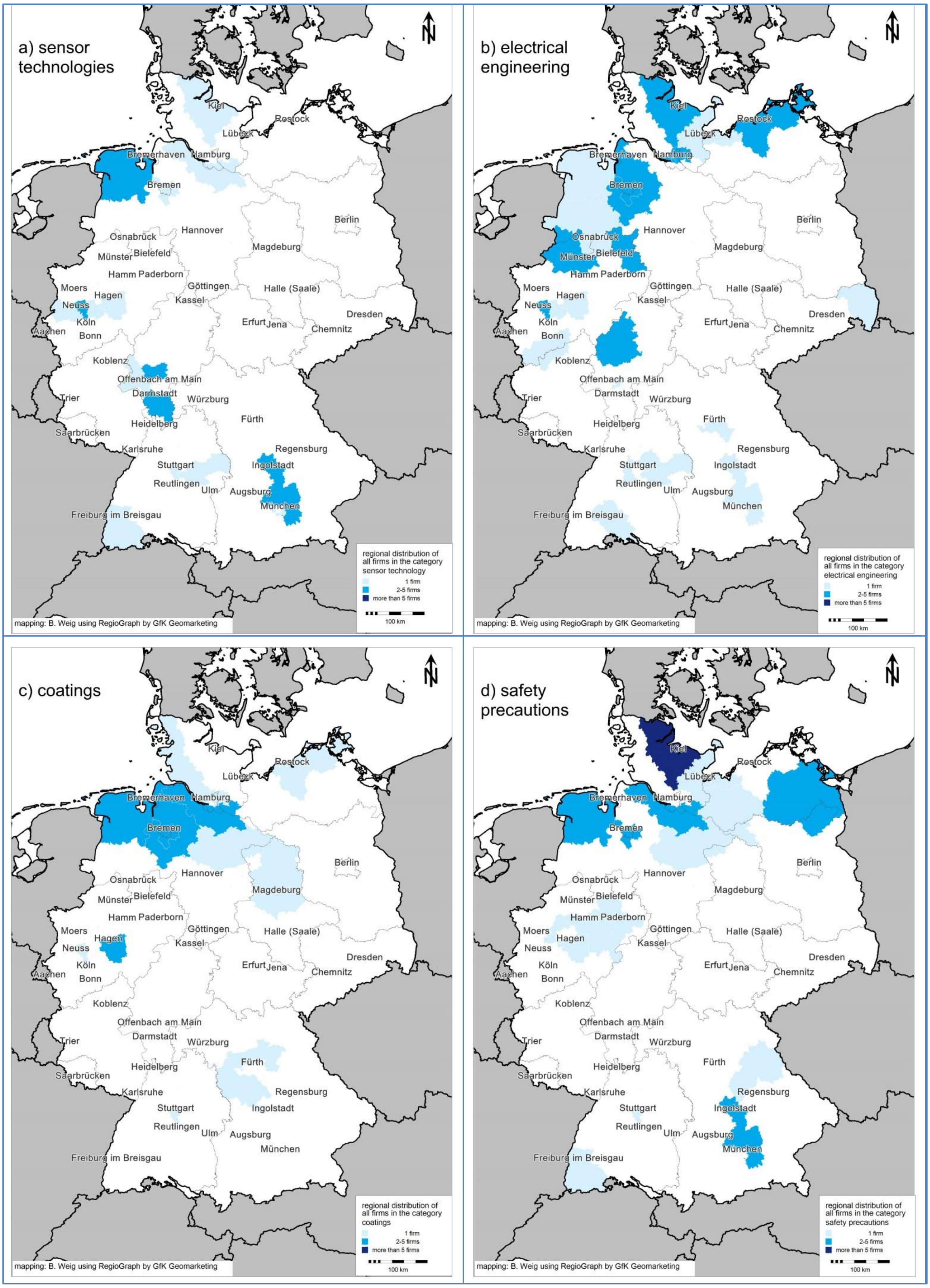
The group of service companies is most represented in the database with 376 enterprises in total. Service companies include logistic companies, installation and access, health and safety issues, insurances and certifiers as well as the fields of training, education and research. The geographical distribution shows an even stronger focus on coastal regions. The main hotspots are located like a chain along the German Coast. Some companies are located further south, but no regional hotspot can be found outside the coastal region (see fig. 3.11).

The group of consulting companies includes 128 firms, providing information in form of expert reports, necessary to plan, install and operate an offshore wind farm. Consulting companies can be divided in environmental, economic, legal and technical consulting. The geographical distribution shows strong hotspots in Bremen and Hamburg, followed by the area of Rostock. Of minor importance are the East Coast of Schleswig-Holstein, the Lower Elbe area in Lower Saxony and East Frisia. The share of consulting companies located in southern regions is very limited. Berlin, Köln/ Bonn, Hannover, Göttingen, Munich and Frankfurt show some activity in this field. However a clear focus is on the coastal regions (see fig. 3.12).

To sum up, this more detailed spatial analysis confirms that offshore wind activities are located mainly in the coastal North of Germany. However there are actors in the South as well. These can mainly be found in the group of operators and investors. But also within the group of producing companies, a significant share of companies is located with distance to the sea (especially along the Rhine river). Service and consulting companies are however stronger concentrated in the North. However exceptions show that companies from southern states are able to participate and benefit from the development of the offshore wind sectors.

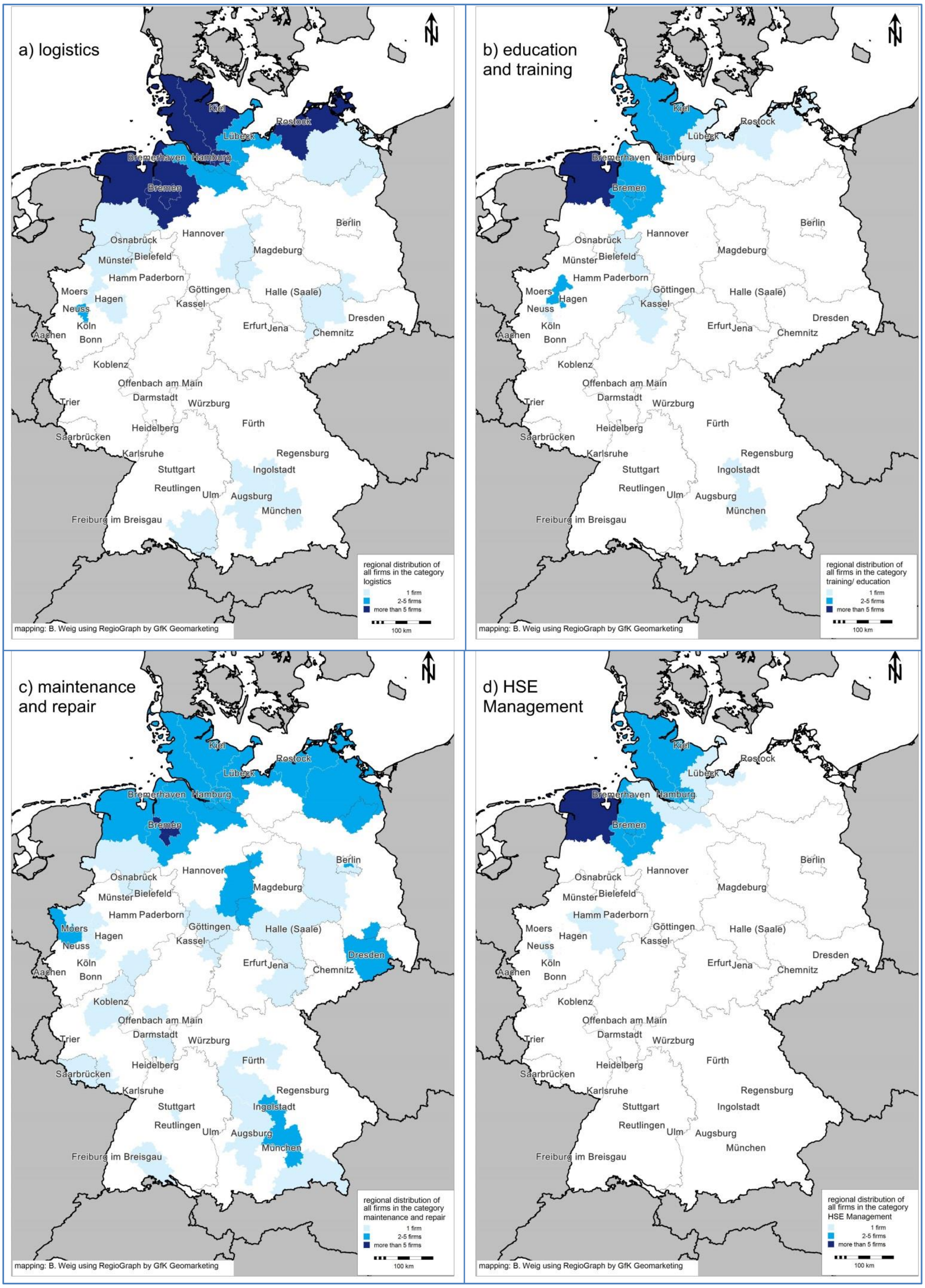
A more detailed analysis of single sectors reveals some more differences. While in the producing sectors, sensor technology and electrical engineering companies are much more spread over the country (see fig. 3.13), the production of coatings and safety precautions is rather concentrated in coastal areas. While sensor technology and electrical engineering have different applications, coatings and safety precaution are much more specific to maritime sectors and offshore wind energy. This explains the differences in the geographical distribution.

Figure 3.13: Selection of producing sectors and their geographical distribution



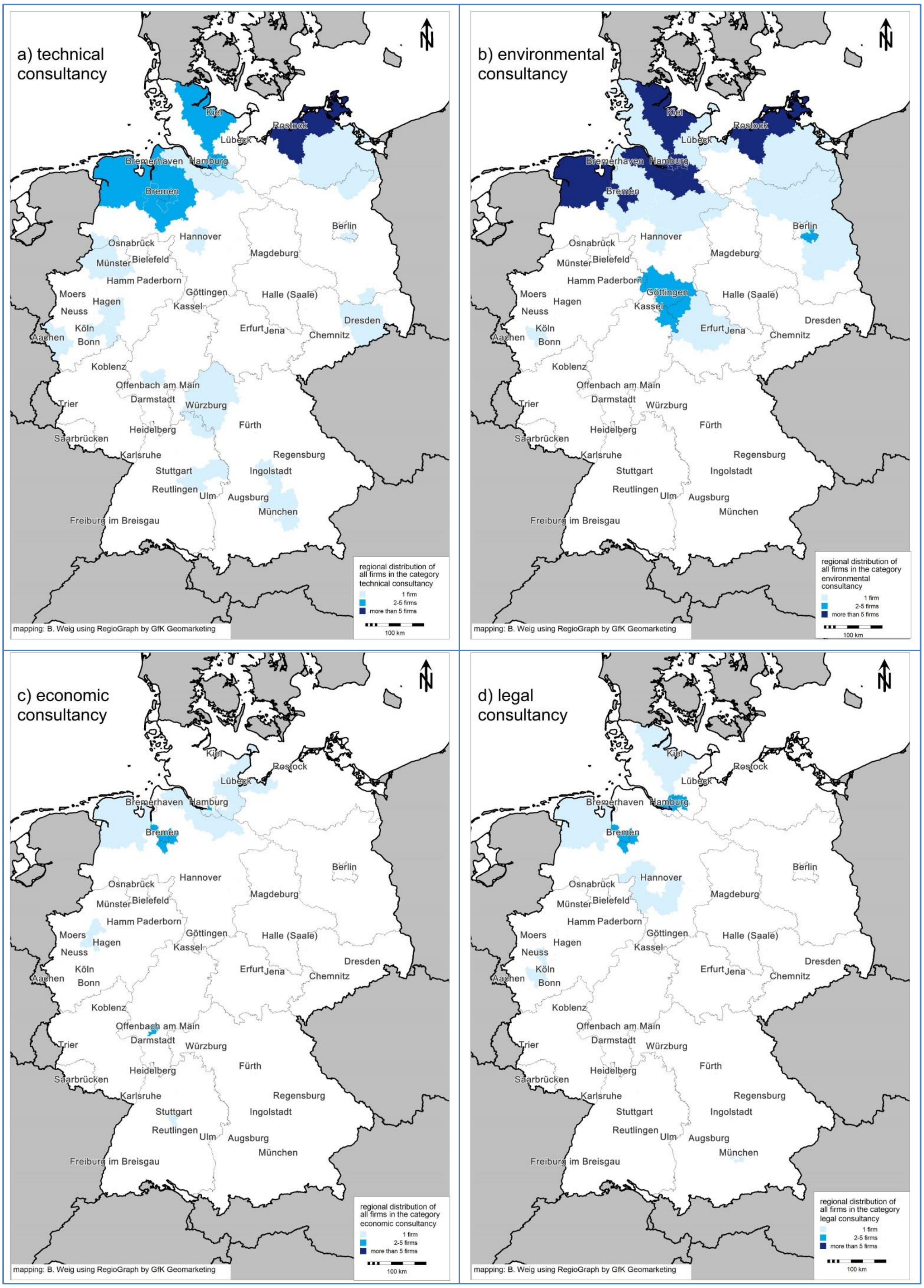
source: own illustration

Figure 3.14: Selection of service sectors and their geographical distribution



Source: own illustration

Figure 3.15: Comparison of different consulting fields and their geographical distribution



Source: own illustration

Service providers for offshore wind energy are in general located closer to the wind farms than producers. However, there are still geographical differences between different sectors. The enterprises involved in offshore wind logistics are spread along the German coast (see fig. 3.14). Same can be said about the maintenance and repair sector. However, in this case, enterprises from more southern regions are included. They are probably experts in certain technologies and needed for maintaining the wind farms. On the other hand, enterprises in the fields of HSE Management and education & training are quite concentrated in Schleswig-Holstein an along the North Sea Coast of Lower Saxony. There seems to be some specific regional expertise in these areas.

In the field of consultancy, different sectors show quite different geographical distributions (see fig. 3.15). Economic and legal consultancy is only represented by a comparably small number of enterprises. Those are basically located in Bremen and Hamburg. Technical consultancy shows several hot spots in the main regions of offshore wind industry (Coastal Lower Saxony, East Coast of Schleswig-Holstein and Western Pomerania). Single enterprises are spread all over Germany. Environmental consultancy shows four main hot spots (East Frisia, Lower Elbe/ Hamburg, East Coast Schleswig-Holstein and Western Pomerania). Surprisingly, Berlin and the region of Göttingen also show quite some activity in this field.

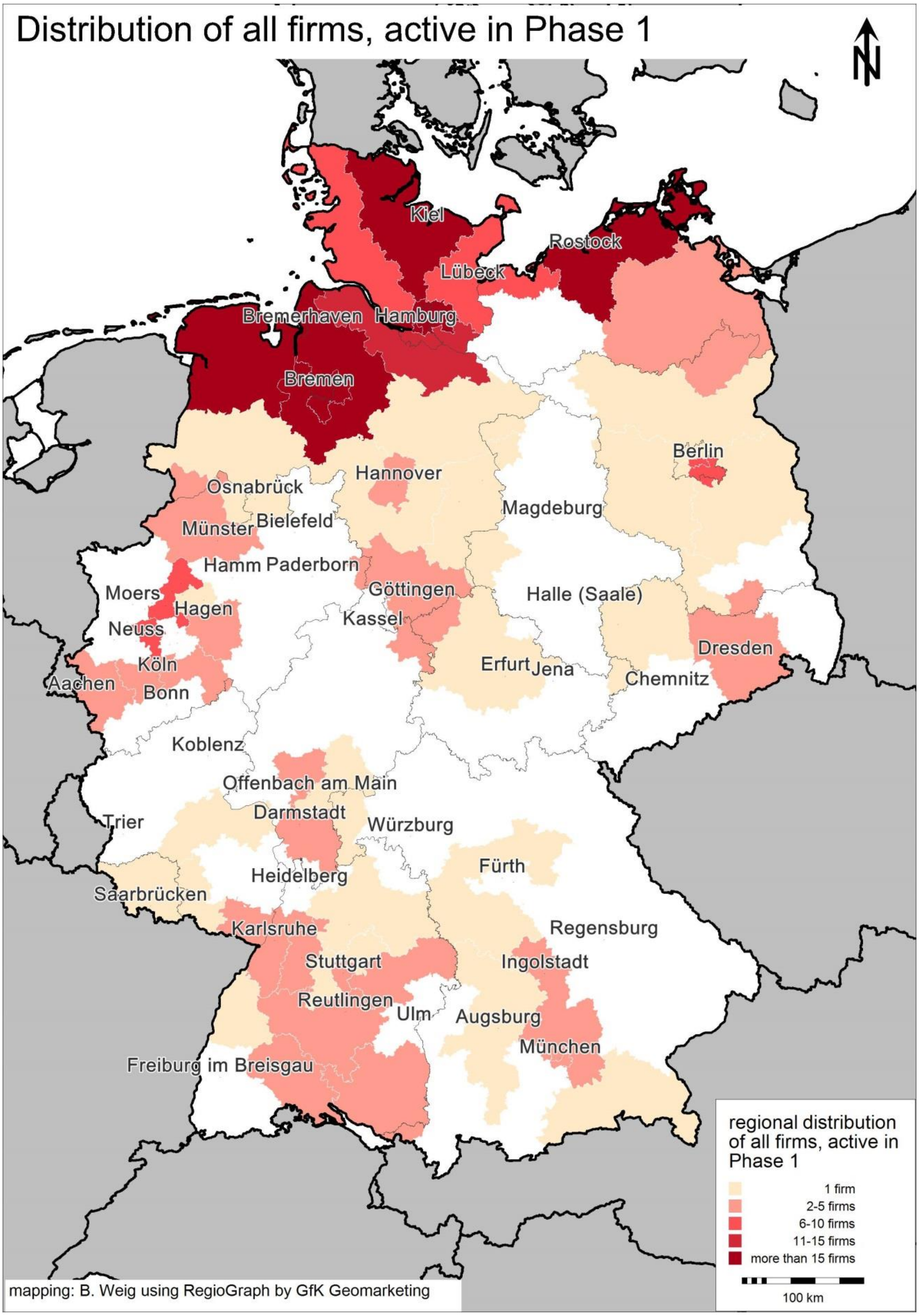
In summary, the more specific a sector is bound to offshore wind or other maritime applications, the more it is clustered in coastal areas. In general investors and operators are least dependent on coastal locations. Production is taking place at the coast and in more southern regions, while service and consultancy providers are rather located close to the wind farms.

3.3.3 Phases of the Offshore Wind Value Chain

The offshore wind farms go through four different phases. Not all enterprises are involved in all phases. Some enterprises benefit only once by delivering a component or conducting a survey, others benefit over a longer period of time, for instance in maintaining the wind farm. For maritime planners the question of who benefits in the short and who in the long run is quite important. Therefore an analysis of actors in the different phases has been conducted.

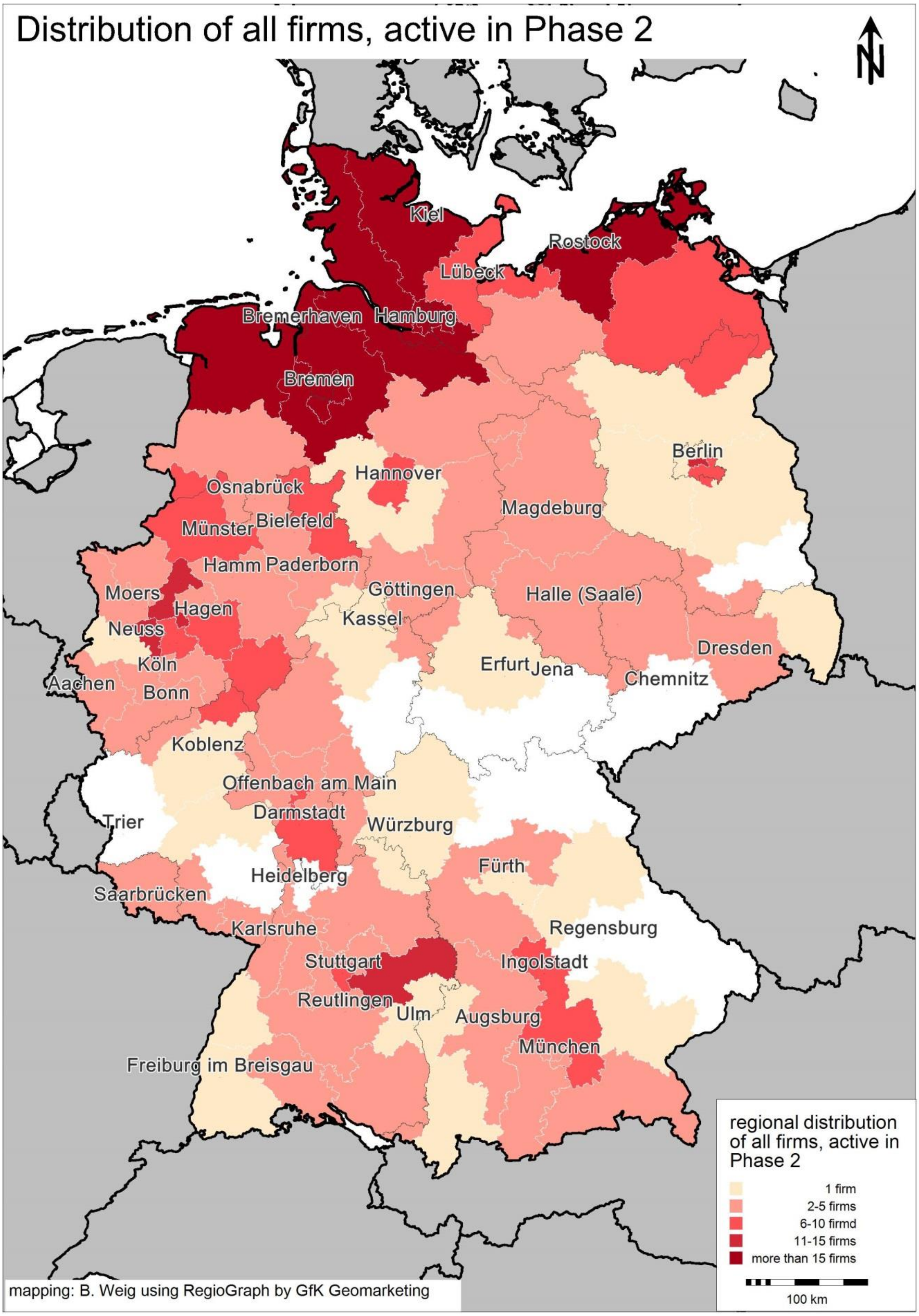
As can be seen in fig. 3.16 during phase 1 (development phase) mainly enterprises from coastal regions are active. During this phase surveys do play the major role. The aim is to analyse the environment of the planned wind farm, to conduct an economic benefit analysis and first technical studies for a better planning the whole project. The enterprises involved in conducting those surveys or providing the necessary logistical equipment have to know the marine context very well. So it is not surprising, that coastal actors are in the lead.

Figure 3.16: Distribution of all firms, active in Phase 1



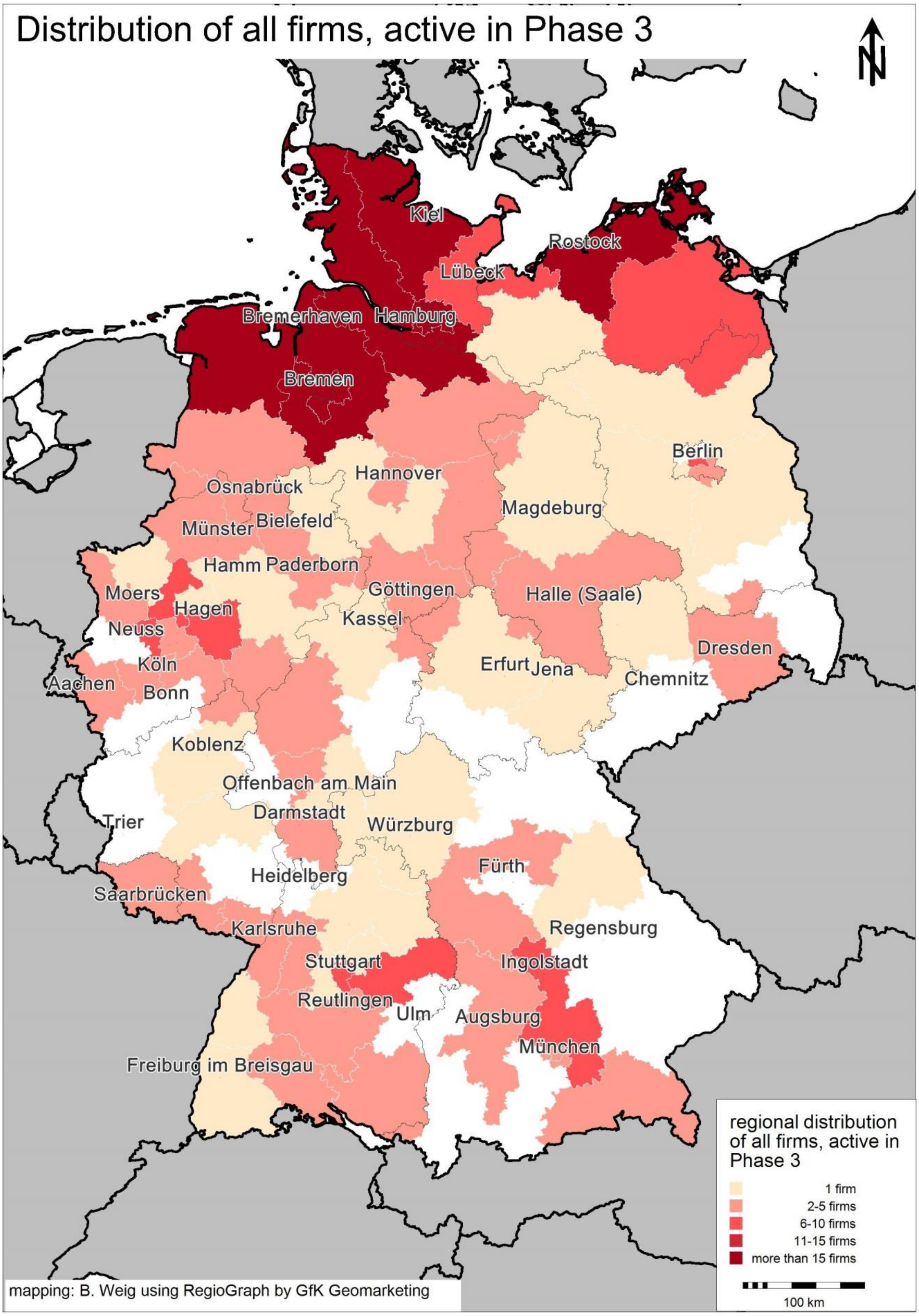
Source: own illustration

Figure 3.17: Distribution of all firms, active in Phase 2



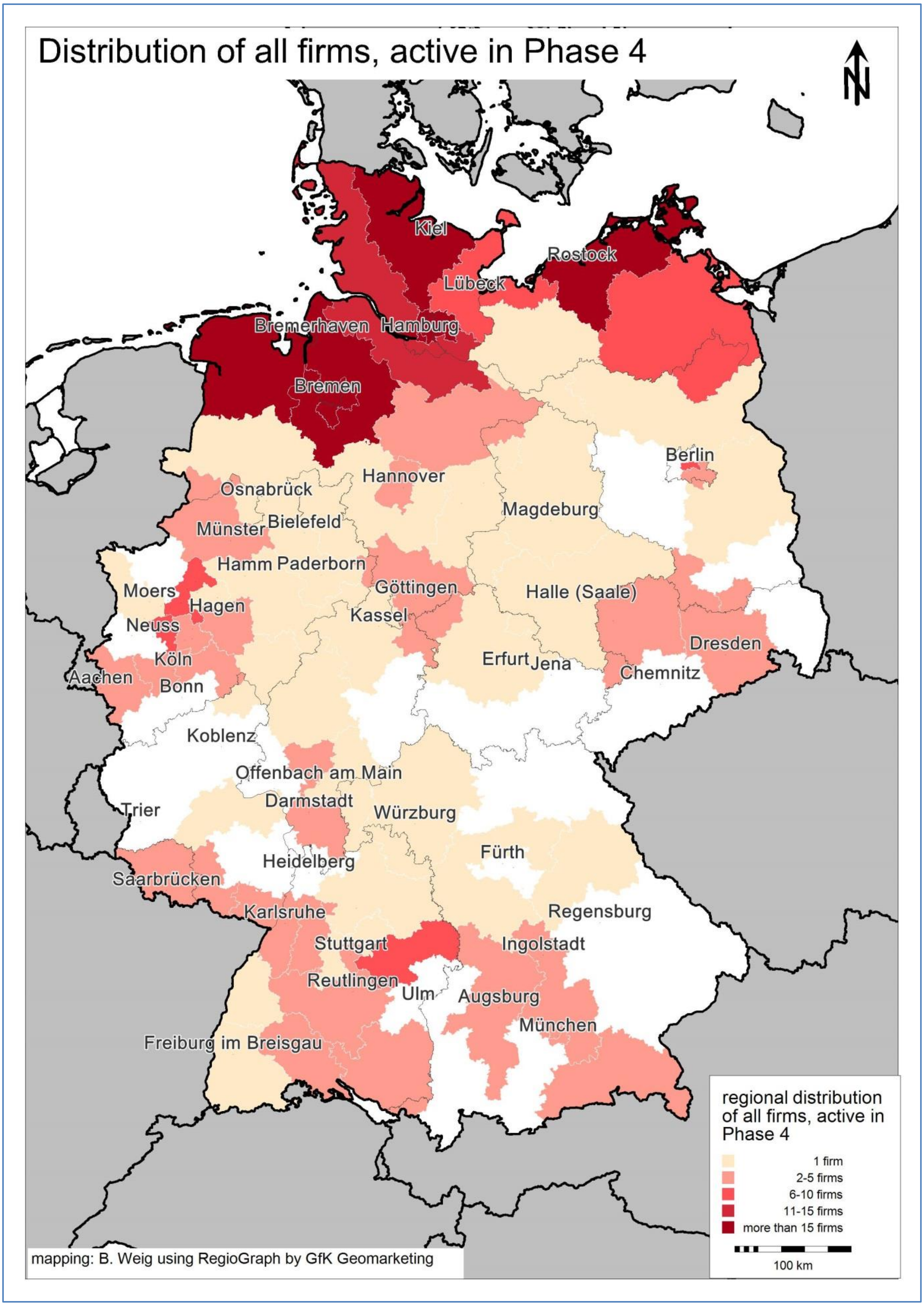
Source: own illustration

Figure 3.18: Distribution of all firms, active in Phase 3



Source: own illustration

Figure 3.19: Distribution of all firms, active in Phase 4



Source: own illustration

Phase 2 (construction phase) is dominated by enterprises with a technological background. The wind farm and all its components have to be built, installed and connected. Therefore different experts for a variety of materials and technologies are needed. Most enterprises that contribute to produce such a complicated product as a wind farm are active in different value chains, optimizing their specific knowledge. Therefore, technologies developed for non-maritime sectors might be involved to construct a wind farm. In phase 2, the distribution of the active enterprises shows a much higher geographical extension. Enterprises from the Rhine valley, from Southern or Central Germany are needed as experts for certain technologies (see fig. 3.17).

Phase 3 (operation phase) shows a reduction of southern German activity (see fig. 3.18). However, as specialised enterprises, providing technologies for offshore wind farms are also in duty to monitor and repair their own products, they are not completely out during operation of the wind farm.

Phase 4 (deinstallation and recycling) is not yet well known, as no big offshore wind farm has yet reached this stage. However, from the tasks needed during this phase and the supply of the enterprises one can estimate, that a variety of sectors will be involved in deinstallation, similar to those who were active in installation (see fig. 3.19).

Based on those phases it is interesting to raise the question: how will the order situation for different groups of firms in the offshore wind sector look like in about 5, 10, 15 or 20 years? The construction of wind parks has just started in many countries and approvals are given one by one; other countries have not yet started and still discuss offshore wind potential in their seas. Thus it is difficult to estimate, how long it will take until all possible wind farms are built. With each approval for a wind farm the four phases start again offering theoretically orders for all contributing firms. Many firms do anyways contribute to several phases in the value chain. Additionally, most firms in the offshore wind sector are not exclusively dependent on offshore wind farms. Moreover, firms extend their activities to foreign markets. All those facts make it difficult to predict if some firms will suffer a loss of orders in some years. Moreover it is not known yet, what will happen with the offshore wind parks after 20 or 25 years of operation. Will there be a repowering of offshore wind farms? Will there be a deconstruction? Will there be new wind farms? Do new technical possibilities and political strategies foster other types of energy by then? The future is unknown and difficult to predict. It depends on their adaptability to changing market conditions, if firms survive or not.

3.3.4 Reflections: A spatial EBA for Offshore Wind Industry in Germany

To construct, install, operate and maintain an offshore wind farm, many different companies from a variety of sectors is needed. Two different approaches for a spatial EBA have been developed here. One approach focuses on the enterprises involved in one specific wind farm. The other approach includes all enterprises in the field of offshore wind located in Germany.

One limitation of this tool is the availability of official data. For the first approach, data is provided by 4C Offshore Ltd. consultancy: http://www.4coffshore.com/windfarms/. This approach can be easily transferred to other offshore wind farms in different states worldwide. For the second approach data was collected from various sources. To apply this approach on other cases, sources have to be found. The applicability of the tool thus depends on the availability of data. Homepages of offshore wind associations and fairs or specific thematically relevant conferences, meetings or presentations have been useful sources for the case study of Germany. This search for data needs to be adapted to national characteristics and possibilities.

A second limitation is given by the mapping program used. The features of the program restrict the possible level of detail. In the tool used here, the smallest possible geographical entity is a two-figure postal code area. For the pilot study in Germany, this is a suitable basis. Otherwise, another program or addition features have to be chosen.

The third limitation is time. Especially the gathering of data for the second approach is very time consuming. Enterprises have to be found and information on address and activities in the offshore wind sector has to be identified.

Nevertheless the tool is applicable on other cases. The sources of data might be different, but the categories can be used for other regions as well. Furthermore it should be reflected on the geographical entities necessary for suitable results. Are two-figure postal code areas ok or should another basis be applied? The answer depends on the necessary geographical level of detail.

Besides all limitations the pilot study on Germany has revealed, that it is possible and worthwhile analysing the geographical distribution of enterprises involved in the offshore wind sector. The maps serve as a good basis of information for discussions and decisions in MSP. But not only maritime spatial planners benefit from those outcomes. Practitioners from regional planning and economic development are also interested in the tool. The maps help them to identify regional strengths and weaknesses.

There are still open fields and questions for further research. So far, each enterprise has only been studied concerning its location and contribution in the value chain. Further study on the number of employees in the sector and their geographical distribution might be of special interest. Some first studies to approach this question have been done by PWC and within the Interreg Baltic Sea Region Project BEA-APP (Baltic Energy Areas – A planning perspective). Additionally a more thorough study of the structure of the enterprises might be interesting. How big are they? How many locations do they have and where? In which other fields of application are they active? And it would be interesting to weight the different tasks by their financial share of the whole offshore wind project. Who benefits most, financially?

To sum up it can be concluded that the offshore wind sector is an interesting new sector, worth studying in the context of MSP and beyond. The developed tool and its first pilot study provide new insights in this sector and open up new fields of research.

4 Marine Tourism

Tourism is one of the main economic sectors for coastal regions and generates jobs in often rather peripheral regions with little industry. However most of these jobs are seasonal and low-paid. With regard to MSP tourism plays a major role at the interface between land and sea. Hotels, transport infrastructure and most attractions are based on land. However, tourism also affects the sea. Along the coast, several marinas offer services for yacht tourism, pleasure boats operate along the coast, cruise tourism gets more and more popular and beaches are used in many ways (e.g. swimming, surfing, kite surfing, jet-ski). Moreover, stakeholders in the tourism sector are among the most sceptical persons concerning offshore wind farms. They fear a decrease of tourists, if the free view over the sea is not guaranteed anymore. Additionally the tourism sector is interested in an unspoilt environment; however activities for tourists should not be restricted. Different interests even within the sector trigger tensions and conflicts that need to be addressed by MSP.

In summary, tourism is an important economic sector in coastal regions and causes conflicts based on different interests. Therefore marine tourism seems to be an interesting sector for a spatial EBA.

4.1. Spatial EBA: Methodological Approach for Marine Tourism

Like shipping, tourism is a multi-layered service sector with many actors in different fields. Thus a spatial EBA can highlight different perspectives for analysis.

Tourists are an interesting point of departure: Where do tourists in the respective region come from? How long do they stay? Is the length of stay correlated to the distance they have travelled? Do tourists spend the whole journey at one place or do they move and change location in between? Do tourists come every year for holidays to the same place or do they just come once? How do the tourists use the sea during their stay and where do they go for which activity? What is the radius tourists accept for excursions during their vacations?

A second possibility is to look at the supply side. Who owns the hotels, apartments etc. in the respective region? Are the operators private entrepreneurs, regional enterprises or big international corporate structures? The same question is interesting concerning other enterprises in the sector (restaurants, shops, tourist attractions) and for secondary beneficiaries like suppliers of hotels, laundries etc. Another related group of beneficiaries are the employees in this sector. Is the staff mainly recruited from the region or are foreigners hired, because they accept to work for less money? Do people move to the coast to work in the tourism sector? Do they stay the whole year in the region or only during the season?

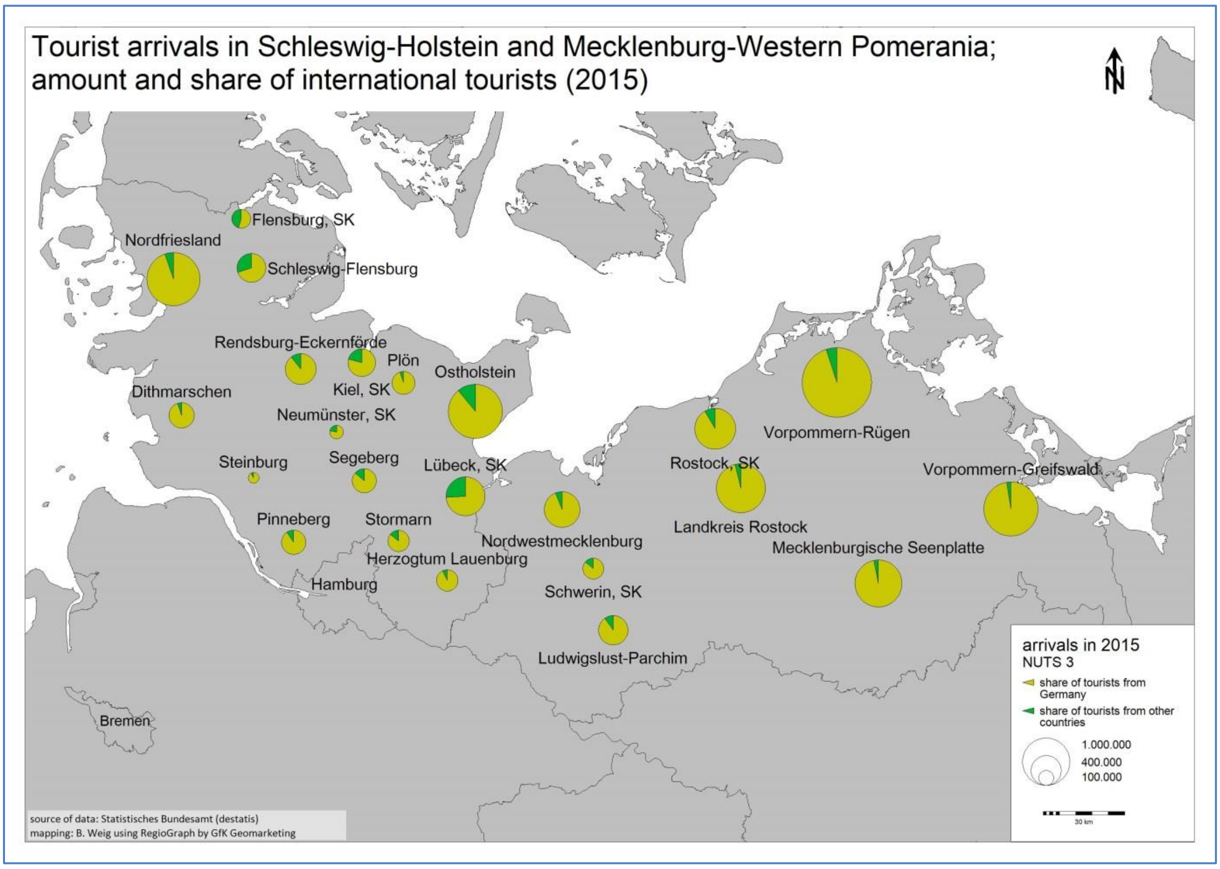
A third approach is focused on the communities. Which costs arise for touristic communities to provide infrastructure and services like cleaning the beaches and streets? How do they finance those expenses? Do tourists have to pay extra taxes? How are costs and receipts balanced in the communities? Which communities benefit from tourism, only the ones directly at the coast? How broad is the geographical area along the coast that benefits from marine tourism?

It became apparent that data availability is very limited for topics related to the tourism sector. Time for own data collection was not given. Therefore the case study on the German Baltic Sea coast covers only some of the described aspects on a rather superficial level. Deeper insights in the spatial distribution of economic benefits in this sector would ask for own empirical surveys.

4.2. Marine Tourism: The Case Study "German Baltic Sea"

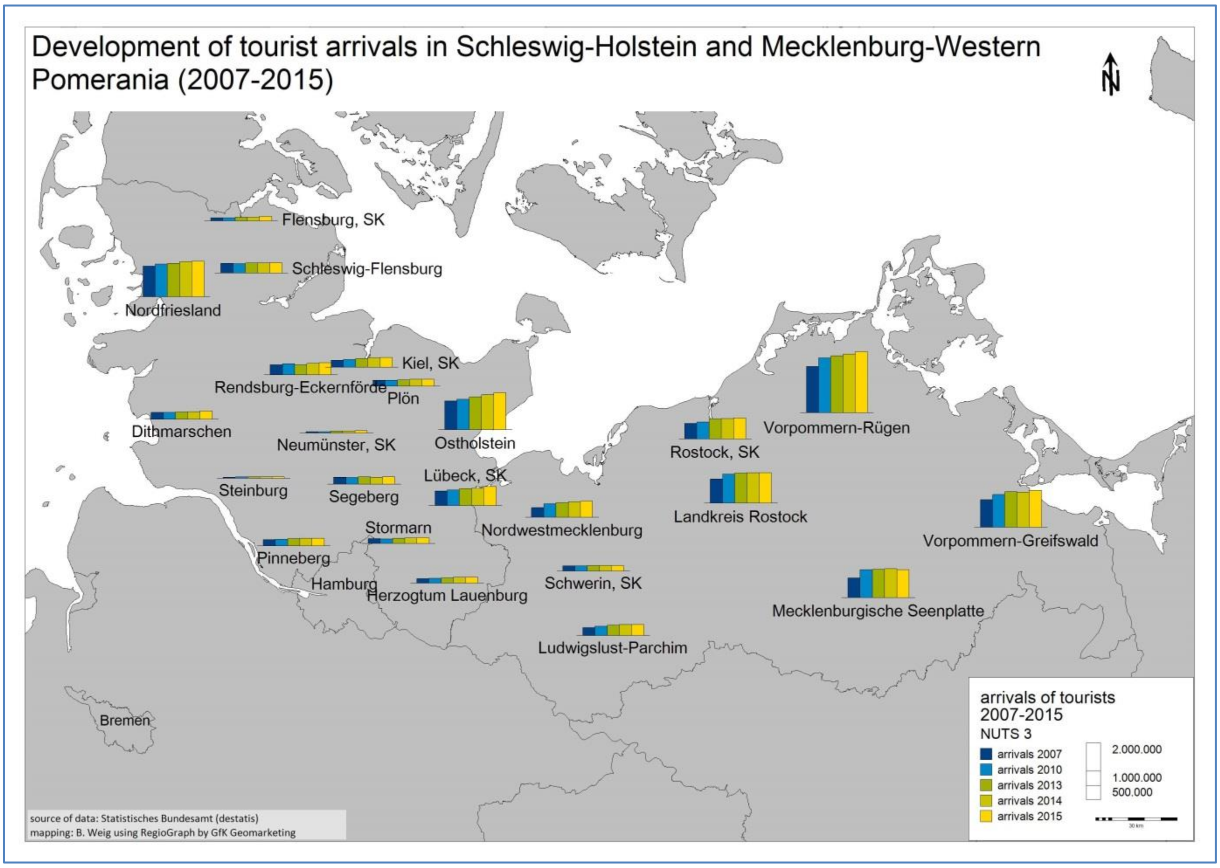
The German Federal Statistic Office provides data on the arrival of tourists, at least on the NUTS 3 level and by indicating if the tourist is German or not. In Mecklenburg-Western Pomerania, the NUTS 3 areas are larger than in Schleswig-Holstein, which results in higher amounts of arrivals per region in MV. Nevertheless, regional touristic hotspots can be identified (see fig. 4.1). According to the amount of tourist arrivals, Western-Pomerania, including the island of Ruegen is the touristic hotspot in MV. The region of Ostholstein is the most popular touristic destination in SH. Furthermore it can be noticed that foreign tourists rather choose Schleswig-Holstein as destination. Highest shares of foreign tourist arrivals are reached in Flensburg and in the region of Schleswig-Flensburg. This is probably a result of the closeness to the Danish border. However, also the cities of Kiel and Lübeck, as well as the region of Ostholstein show relatively high shares of foreign visitors compared to the NUTS 3 regions in Mecklenburg-Western Pomerania.

Figure 4.1: Tourist arrivals in Schleswig-Holstein and Mecklenburg-Western Pomerania



Source: own illustration

Figure 4.2: Development of tourist arrivals in SH and MV



Source: own illustration

Analysing the recent development of tourist arrivals, it gets obvious that arrivals increased over the last years in most regions (see fig. 4.2). Between 2007 and 2015 highest rates of increase appear in the regions of Mecklenburg-Western Pomerania, but also in Ostholstein and Luebeck. Other regions in Schleswig-Holstein are characterized by a rather stable amount of arrivals per year.

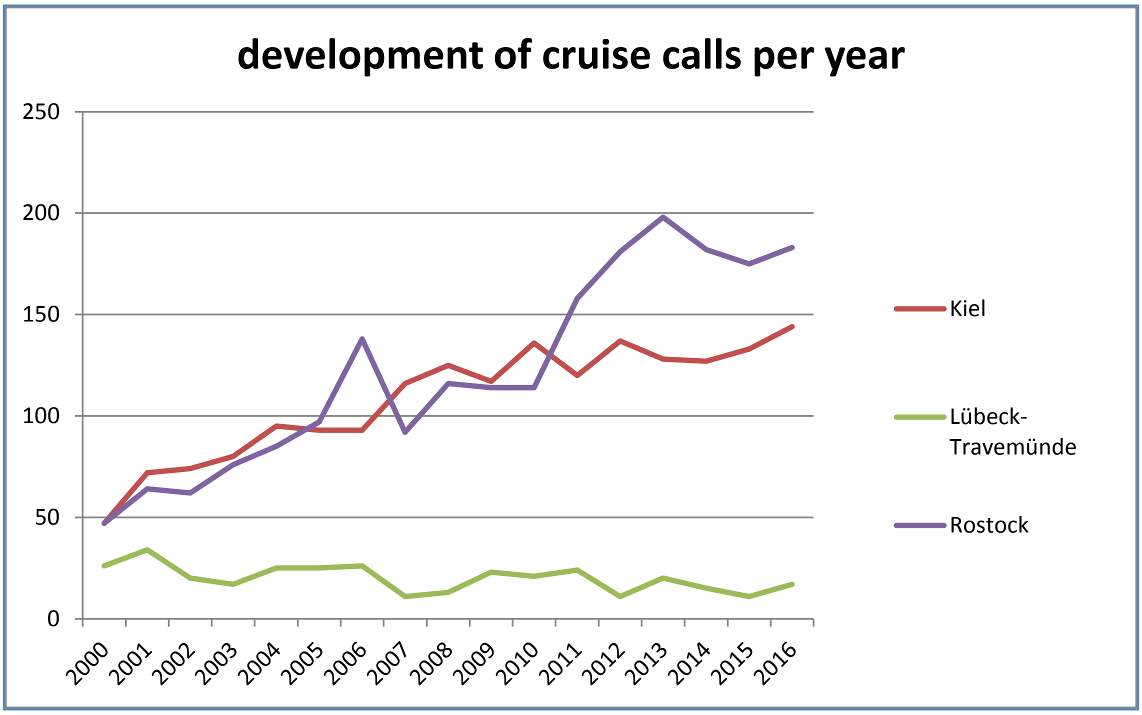
4.2.1 Cruise Shipping

Cruise Shipping is a growing business not only in the Baltic Sea. Several German Baltic Sea ports are offering services for cruise ships. In 2016 Rostock had the most arrivals (183) followed by Kiel (144). Those two ports are by far the most important cruise ports at the German Baltic Sea coast. However, there are also arrivals at the ports of Stralsund (18), Lübeck (17), Wismar (8) and Flensburg (3). For MSP cruise shipping is important as it is one of the fastest growing sectors at the interface of tourism and shipping. However, not all German Baltic Sea ports benefit the same way from this development. While cruise calls in Kiel and Rostock rose continuously from 2000 until 2016, the amount of calls in Lübeck stagnated (see fig. 4.3).

Furthermore, the length of stay in the different ports varies significantly. An average cruise stop in Rostock takes 12,5 hours, in Sassnitz-Mukran even 13 hours and in Wismar 12 hours. The stops in Schleswig-Holstein are significantly shorter. An average stop in Kiel takes 11,5 hours, in Lübeck 11 hours and in Flensburg only 6,5 hours[7]. During these hours, the passengers have time for sightseeing and shopping. The amount of time cruise tourists spend in the respective region affects the benefits of the region.

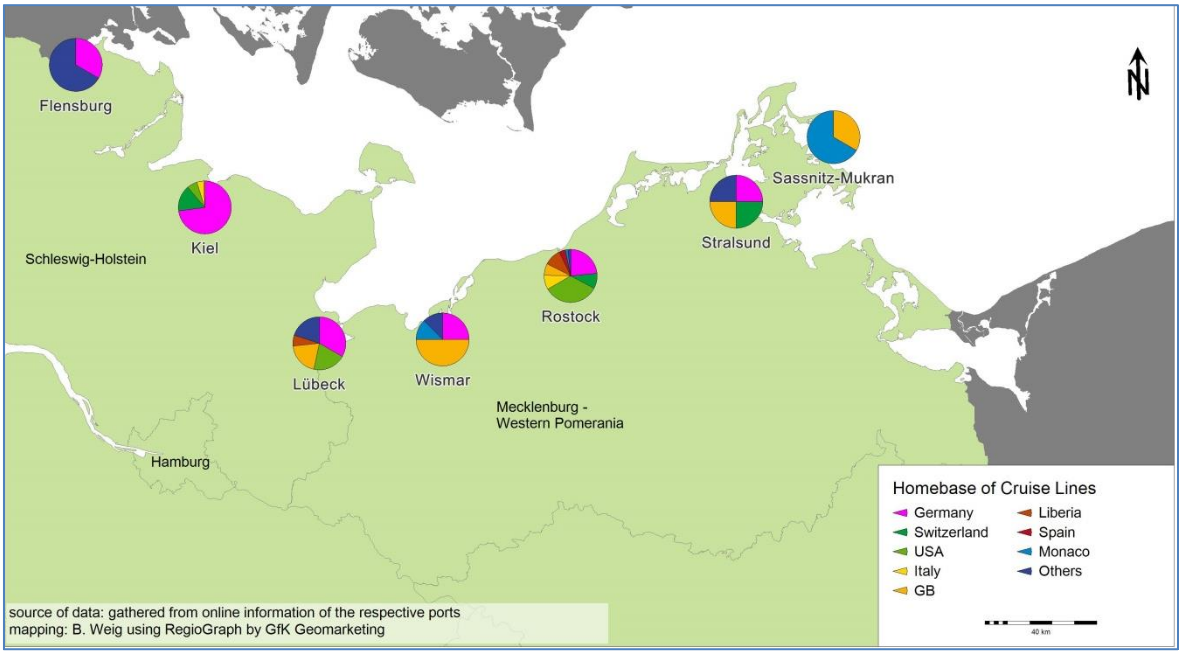
[7] Analysis of cruise lists from respective ports.

Figure 4.3: Development of Cruise Calls per year



Source: Cruise Baltic Market Review

Figure 4.4: Homebase of Cruise Lines calling at German Baltic Sea Ports (2016)



Source: own illustration

Another important beneficiary of cruise tourism is the cruise line. Interesting questions in this context deal with the origin of the operators. Do regional, national or international cruise lines call at the ports? An analysis of the cruise companies calling at German Baltic Sea ports reveals that there are quite big differences between the ports. More than 70% of all cruise ship calling at the Port of Kiel belong to German based cruise lines. In all other German Baltic Sea ports, this share is much lower. In the Port of Rostock, the share of cruise vessels owned by US-American lines is even higher than the share of

German owned vessels. Other important origins of cruise lines are Switzerland, Great Britain, Italy and Monaco. A special case are those cruise lines based officially in Liberia. Those companies are usually US-American lines with an official base in Africa out of financial and insurance matters.

To sum up it can be concluded that marine tourism is a highly relevant sector for MSP. However the weak data availability results in limited outcomes of a spatial EBA in the German Baltic Sea region, so far. Empirical surveys are needed to analyse the geographical aspects of this sector in more detail.

5 Fishing

Fishing is a marine sector with a very long tradition. Nowadays however, the economic importance of fishing is declining in many regions. Several developments reduce the economic efficiency in the sector. Environmental pollution of the seas and the climate change threaten the resources of the sector, fish. Overfishing is a self-made problem of the fishing sector. Huge trawler compete with small fisher boats. As response to these developments, governments on different geographical levels have introduced regulations for fishing, to ensure sustainability. However, those regulations affect the sector and lead in many regional cases to a reduction of fleet and employment in the sector. A high number of fisherman only fish part-time as a secondary employment, because they cannot make a living of their traditional job. In addition, new uses of the sea (offshore wind farms), cables, mining etc. affect fishing. MSP is a suitable instrument to organise a balanced and sustainable coexistence of those different uses. A spatial economic benefit analysis of the fishing sector is therefore highly relevant.

5.1. Spatial EBA: Methodological Approach for Fishing

Fishing can also be looked at and analysed from a variety of angles. Based on the value chain of fishing, fisherman, cooperatives of fisher men, fish-processing industry, producers of machines for the fish-processing industry and the share of imported fish processed and sold in the region might be of interest.

Concerning the fisherman, it would be interesting to know, how many fishermen are working in the different fishing ports? How many people work full-time and how many part-time in fishing? How many fishing boats are registered in which port? Which type and size of ship is used? Which fishing methods are used in which regions? How big is the catch and how does it develop? Which types of fish are harvested? How are the fishermen in the region organised? Whom do they sell the fish?

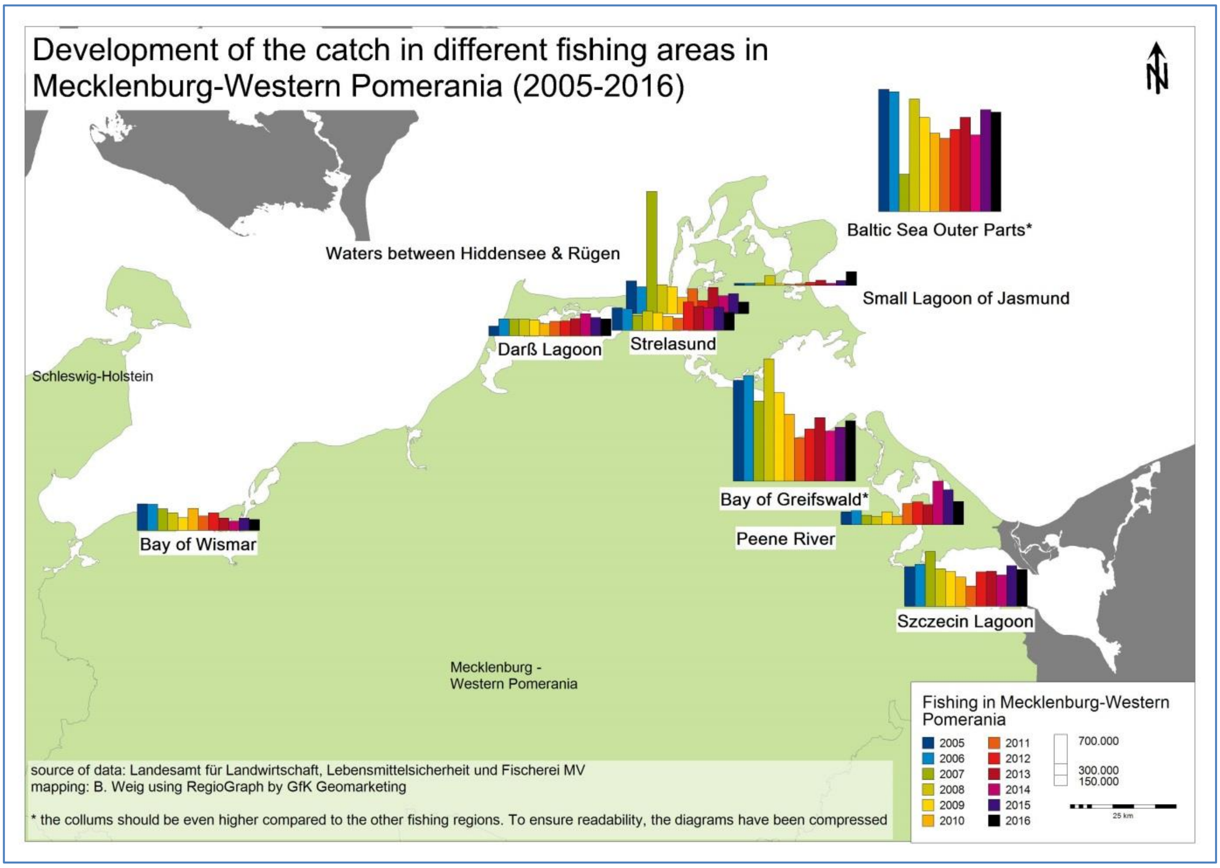
A second approach focuses on the processing of fish. How many jobs do fish-processing companies in the region offer? How is the fish processed in smokehouses, for fishmeal, as frozen fish, in tins, etc.? What is the share of local catch in those factories? Where does imported fish come from? Where are the machines for processing fish produced? There are many interesting questions to be answered by a spatial economic benefit analysis in fishing.

5.2. Fishing: The Case Study "German Baltic Sea"

The Baltic Sea is the largest brackish water body in the world. Because of the low level of salt, the amount of species in the Baltic Sea is rather low. Fishing is reduced to small-scale coastal fisheries. Two main methods are used by the fishermen at the Baltic Sea coast, trawling and gillnet fishing (von Thünen Institut).

In Mecklenburg-Western Pomerania 383 fishing companies were registered in 2016. 255 of them work full-time, 128 fishermen use fishing as secondary employment. Most fishing companies are operated by one person only, a few of them are family businesses. Most full-time fishermen are organised in cooperative structures (Landesamt für Landwirtschaft, Lebensmittelsicherheit und Fischerei MV).

Figure 5.1: Development of the catch in different fishing areas in MV



Source: own illurstration

Most fish is caught in the Bay of Greifswald and in the Outer Parts of the Baltic Sea (see fig. 5.1). Importing fishing areas close to the coasts are the Szezecin Lagoon, Bay of Wismar, Peene River, Darß Lagoon, Strelasund and the waters between the islands of Hiddensee and Rügen as well as the Small Lagoon of Jasmund. The amount of catch varies between different years and in the respective regions significantly (see fig. 5.1). In the Bays of Greifswald and Wismar the amount of fish caught is rather decreasing, while in other regions, this development cannot be noticed.

In Schleswig-Holstein, 1.019 fishermen (2014) are registered at the Baltic and North Sea. 505 of them are full-time fishermen, 514 of them use fishing as a secondary employment. The number of fisherman has been continuously decreasing in the last years. In 2006, 1.419 fishermen were active in Schleswig-Holstein. In 2014 471 boats belonged to the fishing fleet at the Baltic Sea coast of Schleswig-Holstein. 101 trawler and 81 fishing boats were used by full-time fishermen. 10 trawler and 279 fishing boats were used only part-time. All together fishermen at the Baltic Sea coast in SH caught 11.324,1 tons of fish in 2014. 6.303,2 tons were used for consumption in SH, 616,9 tons were consumed outside SH and 4.404 tons were landed in other Baltic Sea Countries, by fishermen from Schleswig-Holstein (Landesamt für Landwirtschaft, Umwelt und ländliche Räume Schleswig-Holstein). In Schleswig-Holstein fishermen are organised in four fishing cooperatives and twelve fishing associations. Each Association gets quota to catch a specific amount of different kinds of fish.

Küstenfischer Nord e.G. is responsible for 30 members, fishing in the Baltic and North Sea. The ports of Heiligenhafen, Kappeln and Maasholm are run by the cooperative. A high share of the catch is exported by the cooperative to the Netherlands, France and Denmark.

Fischereigenossenschaft Fehmarn consists of 22 members. The catch is further processed in the smokehouse and sold in the fish shop, which both belong to the cooperative.

Fischverwertung Lübecker Bucht is a cooperative of fishermen in the bight of Lübeck. Fishermen located in the ports of Travemünde, Timmendorf, Niendorf, Gothmund and Schlutup are cooperating in marketing of their catch. Fresh fish is sold directly at the ports of Travemünde and Niendorf.

Fischverwertung Kieler Förde eG includes fishermen from Eckernförde, Heikendorf, Laboe, Strande and Kiel.

The fishing sector is quite good represented by governmental and industrial organizations. Data availability is rather good. Nevertheless, time for a full spatial economic benefit analysis was not given within the BONUS BALTSPACE project. Further research is highly recommended.

6 Reflection on the tool(s)

This chapter is dedicated to the reflection on the "Spatial Economic Benefit Analysis" developed within the BONUS BALTSPACE project and described in the present report. Opportunities and limitations of the tool are pointed out and the used software is presented. The contribution of the tool and its empirical testing for the aim of the project is discussed. Finally remaining questions for further research are raised.

The BONUS BALTSPACE project aims inter alia to develop a tool for analysing the spatial distribution of economic benefits related to different uses of the sea. First of all it has to be stated, that official statistics aggregate economic sectoral data in categories that do not allow for extracting maritime sectoral data exclusively. This data gap is the reason, why an alternative method to approach economic benefits had to be chosen. The developed approach puts the actors in the centre of the analysis. It analyses which enterprises/ industries in which regions benefit from the different uses of the sea considered in maritime spatial planning. The tool offers a new and alternative perspective, revealing interesting actor-centred insights regarding the analysed sectors.

Second it has to be stated, that the relevant sectors differ so much that a single approach is not reasonable. Sector-specific tools seem to be more appropriate. The given task can be approached from different angles: beneficiaries can be understood as being firms (as in the offshore wind approach), users of services (as in the shipping case), jobs, tax income for regions/ communities or other indicators.

First limitation is the data availability. The empirical application of the tool is limited by the access of data. Not for all sectors suitable statistics are available. Therefore own research and/ or data compilation from different sources is necessary. The second limitation is time. Data collection, preparation, analysis and graphical presentation are very time consuming. A third limitation is given by the method of mapping. Putting too much information in one map reduces readability of the map and therefore its usefulness. Careful selection of indicators and thorough categorisation are two important steps within the approach, to develop useful maps.

The used software is called RegioGraph, provided by GfK Geomarketing. The program provides basic maps for Europe including different NUTS levels and the two digit postcode level. Moreover large and medium sized European cities are georeferenced and listed. The program allows the import of own databases to design maps. To present qualitative and quantitative characteristics of geographical entities the program offers different forms of point, line and area signatures as well as diagrams that can be assigned to geographical locations. This array of possibilities for design opens up many possibilities to present information in a geographical context.

Despite those limitations the tool is applicable to other regions. The presented value chains, the categories and indicators are helpful to replicate the analysis and to save time. However, access to data may differ from region to. Suitable data has to be found for each region individually. The sources used in the German case study may give a first idea of where to look for data. Moreover the relevant questions might differ from region to region. For large countries like Germany, with a shoreline in the North and vast parts of the country that are far away from the sea, it is quite interesting to analyse how far south the benefits of marine uses reach. For countries like Denmark, with no region far from the sea, the question of interest might be slightly different. In this case, the tool enables the analysis of regional differences regarding strengths and weaknesses of different sectors.

How does the tool contribute to the aim of the project: to overcome integration challenges in MSP? First of all, the presented tool enables **knowledge integration.** The main contribution of this tool is to generate sectoral knowledge about different uses of the sea. The maps showing the regional distribution of economic benefits can be used as decision support tools in practical MSP. Maps have the advantage that they facilitate an overview at a glance and an understanding of geographical relations without the need of expert knowledge. Maps based on the Spatial Economic Benefit Analysis tool can be used as basis for discussion, to support arguments and to justify decisions.

Second, the tool supports policy and sector integration with a focus on **sector integration**. The comparison of different sectors allows for balancing between sectors. Similarities and differences concerning their distribution of economic benefits can be analysed and taken into account for decisions.

Third, the tool allows for **multi-scale and transboundary integration**. Mapping is a method well suited for looking at different scales. The hinterland connections by train for instance reveal transboundary effects in form of benefits for northern Italian industries using German Baltic Sea ports. Economic benefits do not stop at national borders. **Land-Sea integration** is another challenge that is addressed by the tool. It basically analyses the effects caused by decisions in MSP on economic development. Which regions benefit most from an expansion of offshore wind industry? Which industries in which areas benefit from supporting Baltic Sea ports? Land and sea are closely linked. Decisions in MSP have consequences on the economic wellbeing of regions.

Last but not least, the challenge of **stakeholder integration** is taken up in this approach. Economic benefits are important values for entrepreneurs, employees, regional politicians and others. The group of actors interested in economic development is divers. Therefore sound decisions in MSP are important. MSP can thus be used to foster sustainable economic development. This tool enables a better understanding of the geographical distribution of sectors and their beneficiaries.

The tool approaches all integration challenges defined in the BALTSPACE project. However, complex structures and relationships cannot be analysed in a simplified and standardised way. Therefore this tool can only be seen as a starting point to address questions related to the geographical distribution of economic benefits in marine sectors. The results provide interesting insights. However several questions and future areas for research are still open and untouched. In the field of shipping, hinterland connections, the historical development of shipping relations and future prognosis are interesting fields to continue. In the offshore wind sector, further analysis of jobs generated in the sector, the financial share of enterprises regarding one wind farm and the structure of the enterprises would be interesting starting points for further analysis. In marine tourism open question relate to the origin of tourists, the owner structure of touristic enterprises and the origin of employees in the tourism sector as well as the costs and benefits of communities. Fishing is another interesting sector that has been touched only on the surface in this report. Other marine uses like aquaculture, sand & gravel exploitation as well as cable & pipelines have not been taken into account so far.

This tool not only helps practitioners in MSP to exchange with stakeholders and to take sound decisions. The tool also helps planners on land, politicians and all people dealing with economic development. It might also be of interest for business associations in the respective sectors and for regional administrative bodies. This huge variety of possible applications encourages further research in this direction.

7 Summary

The presented tool "Spatial Economic Benefit Analysis" aims to support a spatial analysis of economic benefits in MSP relevant sectors. The respective sectors are too different to squeeze them in one tool that fits all. Therefore several approaches have been developed for shipping, offshore wind industry, marine tourism and fishing. The first two sectors have been studied in detail. Several approaches have been developed and tested empirically using the case study area of the German Baltic Sea coast. The tools for marine tourism and fishing are outlined and complemented with some sectoral information within the case study region. A full testing of the tools was not possible because of limited data availability and time.

The analysis of the **shipping** sector reveals that most but not all goods imported in the German Baltic Sea ports origin from the Baltic Sea region. Same applies to the exports. However there are significant differences between the ports of Mecklenburg-Western Pomerania and Schleswig-Holstein. The latter ones depend more on regional transports within the Baltic Sea while the ports of MV show more diversified connections to other ports in Europe and beyond. Moreover the shipping relations depend on the goods handled and the distribution of the respective industries. An analysis of the hinterland connections by train reveal that the three main ports (Rostock, Lübeck, Kiel) are well connected with the industrial centres of Germany, with Northern Italy (including ports at the Mediterranean) as well as with the important North Sea ports of Rotterdam and Antwerp. Further train relations connect land-locked countries such as the Czech Republic, Austria and Switzerland with the Baltic Sea. However especially the ports in MV also host local industrial enterprises using the port for their needs. Some smaller ports in SH are specialized to serve the regional agricultural sector, importing fertilizer and exporting plant-based or forest products.

The analysis of the **offshore wind industry** follows two different approaches. The first approach analyses the geographical distribution of all enterprises involved in a certain wind farm. The survey reveals that this distribution depends on the owner of the farm. While German based owners engage a higher share of German suppliers, international owners contract more international suppliers. The second approach is based on a database including enterprises in the offshore wind sector located in Germany. A spatial analysis of those enterprises reveals that the coastal regions host the majority of those firms. However, regions in the Rhine Valley, in Baden-Württemberg and in some other German industrial and economic centres do also benefit. The distribution varies significantly depending on the sector. While service companies are more likely to be located in coastal areas, investors are quite often from Baden-Württemberg. Producers of components are rather spread over Germany with some southern hotspots like the Rhine valley and Munich besides locations at the coast.

Marine tourism is a multi-layered service sector. Therefore several approaches are needed to analyse different groups of beneficiaries. Tourists, the suppliers of services in the tourism sector as well as the coastal communities are to be studied to fully understand the spatial distribution of economic benefits in this sector. Current trends like cruise shipping and yacht tourism should be included for a comprehensive understanding.

Fishing is a traditionally very important sector in coastal areas. However, conditions for fishing in the Baltic Sea gradually deteriorate. The number of fishermen working full-time in this job as well as the amount of trawler and fishing boats has been reduced continuously in the last decades. Most remaining fishermen are organized in cooperatives, who organize the marketing of the catch. Cooperatives run their own shops, restaurants and smokehouses and they organize the export. A spatial analysis of the beneficiaries in the value chain of fishing and fish processing could reveal interesting insights.

The pilot studies using the developed tools lead to the finding that coastal regions benefit most from marine sectors but not exclusively. Depending on the sector, beneficiaries can be located in southern parts of Germany and even in other countries.

The developed tools tackle all integration challenges that are to be analysed within the BONUS BALTSPACE project. New knowledge on different sectors is provided in form of maps that can easily be understood without the need of expert knowledge. The maps can be used for discussions, sound decisions and to support arguments.

Literature

BEHLING, F. (2017): Von der Förde ans Mittelmeer (Kieler Nachrichten, 25-1-2017). Online: http://www.kn-online.de/News/Aktuelle-Wirtschaftsnachrichten/Nachrichten-Wirtschaft/Hafen-Direktzug-von-Kiel-nach-Triest (6.2.2017).

BLAKE, K.M. (2013): Marine Spatial Planning for Offshore Wind Energy Projects in the North Sea: Lessons for the United States. Online available: https://digital.lib.washington.edu/researchworks/bitstream/handle/1773/22801/Blake_washington_0250O_11501.pdf?sequence=1 (14.11.2016).

BVG Associates (2010): A guide to an Offshore Wind Farm. Online available: https://www.thecrownestate.co.uk/media/5408/ei-a-guide-to-an-offshore-wind-farm.pdf (14.11.2016).

JACQUES, S., KREUTZKAMP, P. & JOSEPH, P. (2011): Offshore Renewable Energy and maritime Spatial Planning. Online available: http://www.seanergy2020.eu/wp-content/uploads/2011/11/111020_Seanergy2020_Deliverable3.2_Final.pdf (14.11.2016).

KÄPPELER, B. (2012): Maritime Spatial Planning in the German EEZ. Online: http://51.255.195.60//En/image.php?id=241 (14.11.2016).

LANDESAMT FÜR LANDWIRTSCHAFT, LEBENSMITTELSICHERHEIT UND FISCHEREI MECKLENBURG-VORPOMMERN. Fischer und Fahrzeuge. Online: http://lallf.de/Fischer-und-Fahrzeuge.308.0.html (22.6.2017).

LANDESAMT FÜR LANDWIRTSCHAFT, UMWELT UND LÄNDLICHE RÄUME SCHLESWIG-HOLSTEIN: Abteilung Fischerei. Online: http://www.schleswig-holstein.de/DE/Themen/F/fischerei.html (22.6.2017).

PORT OF GREIFSWALD: Homepage. Online: http://www.hlg-greifswald.de/ (8.2.2017).

PORT OF LUBMIN: Homepage. Online: http://www.hafen-lubmin.de/ (9.2.2017).

PORT OF ROSTOCK: Homepage. Online: http://www.rostock-port.de/index.html (7.2.2017).

PORT OF SASSNITZ-Mukran: Leistungen des Hafens. Online: http://www.mukran-port.de/leistungen/dry-port/unternehmen-im-hafen.html (9.2.2017).

PORT OF STRALSUND: Industrieansiedlungen. Online: http://www.seehafen-stralsund.de/de/portfolio/industrieansiedlung.html (8.2.2017).

PORT OF UECKERMÜNDE: Industriehafen. Online: http://hafen-ueckermuende.de/industriehafen_profil.html (14.2.2017).

PWC (o.J.): Offshore Windenergie kommt gewaltig in Fahrt Online: http://www.pwc.de/de/energiewende/offshore-windenergie-kommt-gewaltig-in-fahrt.html (25.1.2017).

UNICONSULT (2014) Regional Economic Effects through the development of infrastructure - The logistics region Mecklenburg-Vorpommern within the ACL corridor. Online: www.regierung-mv.de/serviceassistent/download?id=153051 (9.2.2017).

VON THÜNEN INSTITUTE: Website of the institute. Online: https://www.thuenen.de/de/of/ (22.6.2017).

BALTSPACE

Statistical Sources

4C OFFSHORE LTD. CONSULTANCY: List of companies involved in building and operating offshore wind farms. Online: http://www.4coffshore.com/windfarms/ (4.11.2016).

EUROSTAT: Schiffe in den Haupthäfen nach Schiffstyp und Schiffsgröße (basierend auf dem gemeldeten eingehenden Verkehr) - vierteljährliche Daten (ab 2006) [mar_tf_qm]. Online: http://ec.europa.eu/eurostat/web/products-datasets/-/mar_tf_qm (13.6.2017).

GERMAN AND DANISH OFFSHORE WIND: list of members. Online: http://www.gadow-offshore.net/de/unternehmen (5.10.2016).

HAMBURG WIND FAIR: list of participants. Online: http://www.windenergyhamburg.com/die-messe/aussteller-produkte/ausstellerverzeichnis/#/suche/t=2 (19.10.2016).

INTERNATIONAL ECONOMIC FORUM FOR RENEWABLE ENERGIES: list of firms in the offshore and offshore wind sector. Online: http://www.iwr.de/wind/offshore/ & http://www.offshore-windindustrie.de/firmen (26.9.2016).

KIWI: Various participation lists of „Kieler Branchenfokus Windenergie".

KOMBIVERKEHR: Fahrpläne für Hafenhinterlandverkehre. Online: https://www.kombiverkehr.de/de/verkehr/#fahrplan (20.2.2017).

MARITIME CLUSTER NORTHERN GERMANY: list of members in the field of offshore wind. Online: http://maritimes-cluster.de/Mitglieder/Mitgliederliste (29.9.2016).

NATIONAL ASSOCIATION WINDENERGY: list of members. Online: https://www.windindustrie-in-deutschland.de/firmen (28.9.2016).

PORT OF KIEL: list of cruise calls. Online: http://www.portofkiel.com/Kreuzfahrt.html (27.4.2016).

ROSTOCK WIND FAIR: list of participants. Online: http://w3.windmesse.de (4.10.2016).

STATISTIKAMT NORD (Statistical Office of Schleswig-Holstein and Hamburg): Seeverkehrsstatistik Schleswig-Holstein 2016 (sent on demand).

STATISTISCHES AMT MECKLENBURG-VORPOMMERN (Statistical Office of Mecklenburg-Western Pomerania): Seeverkehrsstatistik Mecklenburg-Vorpommern 2016 (sent on demand).

STATISTISCHES BUNDESAMT (DESTATIS): Tourismus: Gästeübernachtungen, Gästeankünfte nach ihrer Herkunft - Jahressumme -regionale Tiefe: Kreise und krfr. Städte. Online: https://www.destatis.de/DE/Startseite.html (22.2.2017).

WAB – THE WINDENERGY AGENCY: list of members. Online: http://www.wab.net/index.php?option=com_alphacontent&view=alphacontent&Itemid=93&lang=de (12.10.2016).

WINDENERGY NETWORK: list of members. Online: http://www.wind-energy-network.de (18.10.2016).