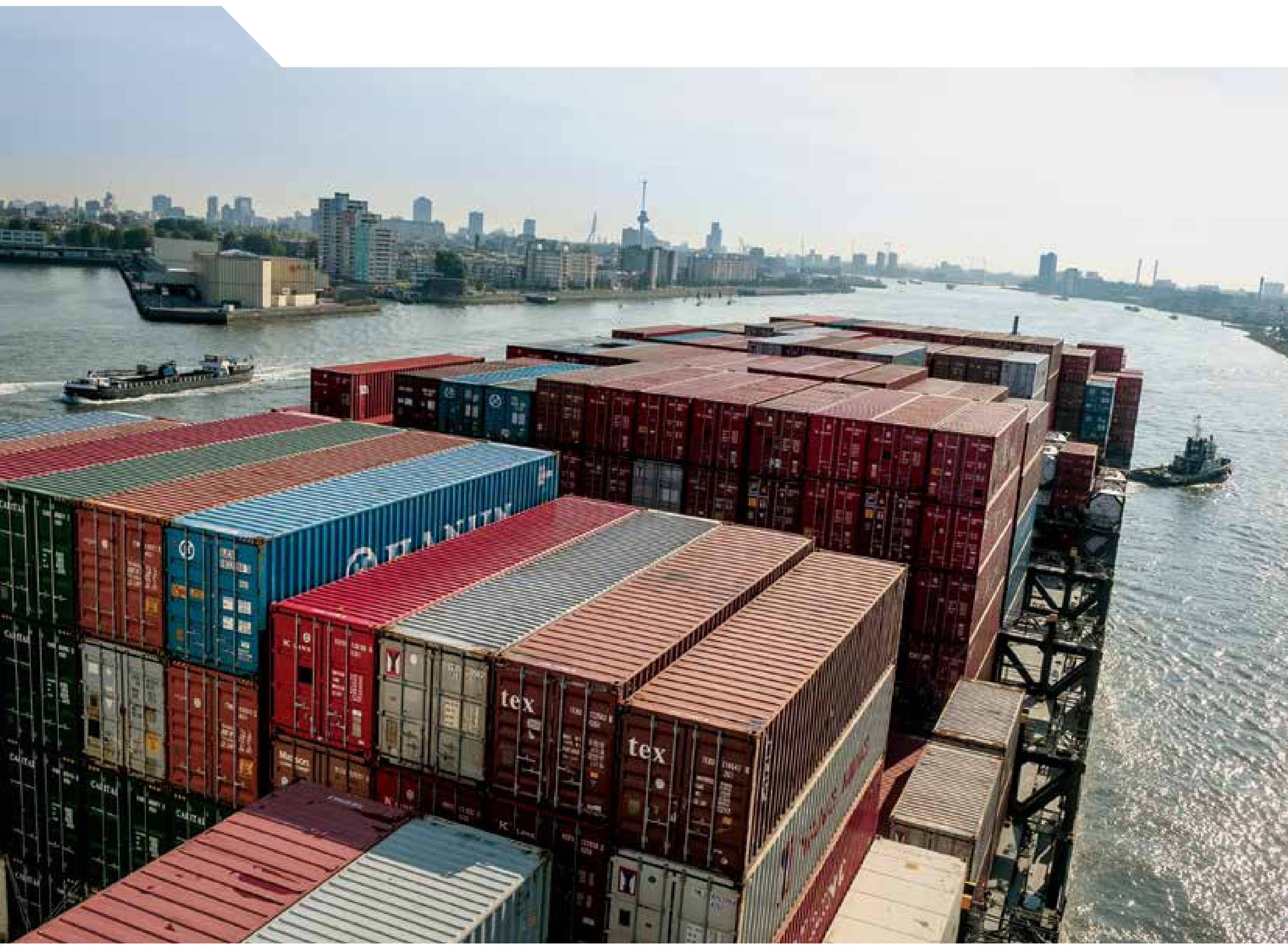
The Competitiveness of Global Port-Cities



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The Competitiveness of Global Port-Cities

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Foreword

Globalisation characterizes our current times, shapes economic trajectories and determines quality of life. Port-cities are at the frontline of globalisation; approximately 90% of external trade volumes is transported by ship and is loaded and unloaded in one of the world ports. A large majority of ports is located in cities, which makes the fate of cities interlinked with the fates of their ports. Some cities have been able to foster their port and use it as an urban economic asset, whereas other cities are declining despite a flourishing port. History is full of examples of cities that prospered thanks to their port; is history able to repeat itself in this respect? Can ports once again be drivers of urban growth? The presence of a port brings special challenges related to the environment, urban traffic and land use. The stakes for cities can be high, as these challenges directly relate to the well-being of their citizens.

Despite their relevance, research communities have focused relatively little attention on the inter-linkages between ports and urban development. Cities have found different ways to deal with policy challenges with varying rates of success, but fairly little is known about policy design, policy impacts and the conditions for success. What are the lessons for policy makers and which policies could be effectively used elsewhere?

The current book on port-cities fills this gap, providing the first comprehensive and internationally comparative benchmark study of port-cities. It aims to provide a systematic overview of impacts of ports on their cities, policies to make ports more competitive, to increase local benefits from ports and to mitigate the negative impacts from ports. It builds on a series of place-specific case studies of selected port-cities that provided detailed analysis of port performance, port impacts, policies and governance. These case studies were released as separate working papers, in addition to a series of thematic papers.

The report, as well as the Port-City case studies and related papers on the topic, can be downloaded from the OECD website: www.oecd.org/regional/portcities. Further enquiries about this work in this area should be addressed to: Olaf Merk (olaf.merk@oecd.org).

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This report provides a synthesis of main findings from the *OECD Port-Cities Programme*, created in 2010 in order to assess the impact of ports on their cities and provide policy recommendations to increase the positive impacts of ports on their cities. This Programme was directed by Olaf Merk, Administrator Port-Cities within the OECD Public Governance and Territorial Development Directorate (GOV) and its Regional Development Policy division, led by Joaquim Oliveira Martins.

This publication was directed and written by Olaf Merk; it draws on the work of a number of other contributors: César Ducruet, Jasper Cooper, Jing Li, Ihnji Jon, Maren Larsen and Lucie Billaud. The publication has benefited from comments from Bill Tompson, Nils-Axel Braathen, Jane Korinek, Cathy Berx, Dominique Lebreton, Nicolas Mat, Juliette Cerceau, Michel Ruffin, Kate Lancaster and Rene Kolman. The publication was edited by Vicky Elliott.

The synthesis report is based on findings from a series of OECD Port-Cities case studies. These case studies were conducted for Le Havre/Rouen/Paris/Caen (France), Hamburg (Germany), Helsinki (Finland), Marseille (France), Mersin (Turkey), Rotterdam/Amsterdam (the Netherlands), Antofagasta (Chile), Bratislava/Komárno/Štúrova (Slovak Republic), Durban (South Africa), Hong Kong (China) and Shanghai (China). Within the framework of these studies, study visits to these port-cities were conducted that included a series of interviews with the port-city actors and stakeholders.

The OECD Port-Cities Programme also benefited from visits to the following ports and port-cities and discussion with port-related actors in the following port-cities: Hong Kong, Shenzhen, Singapore, Casablanca, Venice, Trieste, Genoa, Valparaíso, Varna, Gdansk, Koper, Vienna, Antwerp, Felixstowe, Los Angeles, Long Beach, Sydney and Newcastle (Australia).

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Acronyms and abbreviations

ABP	Associated British Ports
ACTA	Alameda Corridor Transportation Authority
ADB	Asian Development Bank
AGV	Automatic guided vehicle
AIS	Aquatic invasive species
ASC	Automatic stacking crane
AISE	Approved International Shipping Enterprise
ASLE	Approved Shipping Logistics Enterprise
BASC	Business Alliance for Secured Commerce
BNSF	Burlington Northern Santa Fe
BWM	Ballast water management
CAMIS	Channel Arc Manche Integrated Strategy
CAP	Criteria Air Pollutant
CAAP	San Pedro Clean Air Action Plan
CAC	Common air contaminants
CAPMSA	*Corporación Antiguo Puerto Madero S.A.*
CARB	California Air Resources Board
CAT	Climate Advisory Team (Oregon)
CCATF	Climate Change Advisory Task Force (Miami-Dade County)
CCN	Cloud condensation nuclei
CDTA	Comprehensive double-taxation agreement
CEMS	Community energy management system
CFT	*Compagnie Fluviale de Transport*
CHE	Cargo-handling equipment
CIP	Critical Infrastructure Protection
CMP	Copenhagen Malmö Port
CNR	*Compagnie Nationale du Rhône*
COPASUD	*Comunidad Portuaria del Pacífico Sudamericano*
CTP	Clean Truck Program (Los Angeles)
C-TPAT	Customs and Trade Partnership Against Terrorism
CTMP	Comprehensive Truck Management Plan

CSI	Container Security Initiative
CSR	Corporate social responsibility
DCT	Deepwater Container Terminal (Gdansk)
DEA	Data envelopment analysis
DIS	Danish International Register
DLP	Drayage Loan Programme (Houston)
DPM	Diesel particulate matter
DPW	Dubai Ports World
DTA	Double-taxation agreement
EAWA	European Wind Energy Association
EC	European Commission
ECA	Emission control area
ECT	Europe Container Terminal
EDI	Electronic Data Interchange
EDSP	European Spatial Development Perspective
EIA	Environmental Impact Assessment
EIC	Education Information Centre (Rotterdam)
EEDI	Energy Efficiency Design Index
EEOI	Energy Efficiency Operator Indicator
EMDI	Espace Manche Development Initiative
ENMC	European Network of Maritime Clusters
EPA	US Environmental Protection Agency
EPC	Energy Performance Contracting
ERDF	European Regional Development Fund
ESI	Environmental Ship Index
ESPO	European Sea Ports Organization
EU	European Union
FEMA	Federal Emergency Management Agency
FOLOVAP	*Foro Logístico Valparaíso*
GDP	Gross Domestic Product
GEM	Gate Entry Management
GERD	Gross Expenditure in Research and Development
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GHG	Greenhouse gas
GIS	German International Register
GOP	Green Operators programme
GPA	Georgia Ports Authority

GRT	Gross Registered Tonnage
GW	Gigawatt
GWSTA	Global Water Recycling and Reuse Solution Technology Research Association
HC	Harbour craft
HDV	Heavy-duty vehicle
IAPH	International Association for Ports and Harbors
ICLEI	International Council for Local Environmental Initiatives
ICPR	International Commission for the Protection of the Rhine
ICT	Information and communications technology
IEA	International Energy Agency
IFSPA	International Forum on Shipping, Ports and Airports
ILA	International Longshoreman's Association
ILWU	International Longshore and Warehouse Union
IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
IRBM	Integrated River Basin Management
ICM	Integrated coastal management
ISO	International Organization for Standardization
ISPS	International Port and Ship Facility Security code
IT	Information technology
ITC	Investment tax credits
IWRM	Integrated water resources management
JNP	Jawaharlal Nehru Port
JNPT	Jawaharlal Nehru Port Trust
KMI	Korean Maritime Institute
LACMTA	Los Angeles County Metropolitan Transportation Authority
LCA	Life Cycle Assessment
LMIU	Lloyd's Marine Intelligence Unit
LLC	Limited Liability Corporation
LNG	Liquefied natural gas
MAS	*Museum aan de Stroom* (Antwerp)
MBA	Master's in business administration
MBM	Market-based measure
MCF	Maritime Cluster Fund
MEPC	Marine Environment Protection Committee of the IMO
MIDA	Maritime Industrial Development Area

MINT	Maritime Innovation and Technology Fund
MOU	Memorandum of Understanding
MPA	Maritime and Port Authority of Singapore
MPT	Mumbai Port Trust
MPV	Metro Port Vancouver
MW	Megawatts
NAFTA	North American Free Trade Agreement
NAPA	North Adriatic Port Association
NGO	Non-governmental organisation
NIA	Noise Impact Assessment
NIS	Norwegian International Ship Register
NOAA	National Oceanic and Atmospheric Administration (US)
NPDES	National Pollutant Discharge Elimination System
NDZ	No-discharge zone
OCAP	Organic Carbon Dioxide for Assimilation of Plants
OECD	Organisation for Economic Co-operation and Development
OES	Ocean Energy System
OGV	Ocean-going vessel
ORECCA	Off-shore Renewable Energy Conversion
OWE	Offshore wind energy
OWEP	Offshore wind energy plants
OWF	Offshore wind farms
PAI	Port of Antwerpen International
PORint	Port of Rotterdam International
PCC	Port Consultative Committee
PCS	Port Community Systems
PERS	Port Environment Review System
PM	Particulate Matter
PMSA	Pacific Merchant Shipping Association
PPCAC	Pacific Ports Clean Air Collaborative
PSGP	Port Security Grant Program
PSC	Private security company
PTC	Production tax credits
R&D	Research and Development
RCIP	Rotterdam Climate Initiative
RDM	Research Design and Manufacturing campus in Rotterdam
RETE	Association for the Collaboration between Ports and Cities (Italy)

RFID	Radio-frequency identification
RMA	*Resource Management Act* (New Zealand)
RORO	Roll-on/roll-off
RTE	Reciprocal tax exemption agreement
RTGC	Rubber-tyred gantry crane
SAFE	Security and Accountability for Every Port
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SDM	Self-Diagnosis Method
SECA	Sulphur emission control area
SEEMP	Ship Energy Efficiency Management Plan
SEVA-PORT	South-Eastern Virginia Partnership for Regional Transformation
SES	Secure Exports Scheme (New Zealand)
SME	Small and medium enterprises
STACS	Seaport Truck Air Cleanup Southeast programme
SUSMP	Standard Urban Stormwater Mitigation Plan
TAMP	Tariff Authority for Major Ports (India)
TAPA	Transported Asset Protection Association
TBT	Tributylin
TEN-T	Trans-European Transport Network
TEMPI	eThekwini Municipality Planning Initiative
TEU	20-foot equivalents
TMF	Traffic Mitigation Fee
TNPA	Transnet National Port Authority (South Africa)
TRIDENT	Platform for Test-bedding, Research, Innovation and New Maritime Technologies (Singapore)
TUD	Technical University of Delft
TW	Terawatt
UNCTED	United Nations Conference on Environment and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UP	Union Pacific
UV	Ultraviolet
V&A	Victoria and Alfred Waterfront (Cape Town)
VASAB	Visions and Strategies in the Baltic Sea Region
VGP	Vessel General Permit
VPD	Vessel protection detachment

VOC	Volatile organic compound
VOLY	Value of a Life-Year
VSL	Value of the Statistical Life
VSR	Vessel Speed Reduction programme
WEF	World Economic Forum
WHO	World Health Organisation
WPCI	World Port Climate Initiative
WTE	Waste to energy
WTO	World Trade Organization

Executive summary

Ports and cities are historically strongly linked, but the link between port and city growth has become weaker. Economic benefits often spill over to other regions, whereas negative impacts are localised in the port-city. How can ports regain their role as drivers of urban economic growth and how can negative port impacts be mitigated? Those are the questions that this report aims to answer.

Well-run ports produce many economic benefits. They lower the costs of trade, generate value added and employment and attract certain economic sectors. Doubling port efficiency of two countries has been found to increase their bilateral trade volume by 32%. One tonne of port throughput is on average associated with USD 100 of economic value added, and an increase of one million tonnes of port throughput is associated with an increase in employment in the port of 300 jobs in the short term. Moreover, ports are associated with innovation in port-related sectors. Nine out of the 10 world regions with the largest amount of patent applications in shipping are home to one or more large global ports, including Houston, Los Angeles/Long Beach, Tokyo, Oakland and Rotterdam.

However, a lot of these benefits from ports spill over to other regions. Firms in other regions also benefit from efficient ports when exporting and importing, and links with other sectors mostly take place outside the port region. Less than 5% of the economic linkages with suppliers take place in the port or the port-region, with a larger share in the main economic centre of the country, which could be relatively far away from the port, *e.g.* Ile-de France for the ports of Le Havre and Marseille; and Bavaria and Baden-Württemberg for the port of Hamburg. Large ports play a role of gateway for their countries.

Ports also have negative port impacts, mostly related to the environment, land use and traffic congestion. These impacts can be very substantial; *e.g.* more than half of the sulphur dioxide emissions in Hong Kong are related to shipping. A third of the land surface of the city of Antwerp consists of its port, which is not problematic in itself, but could raise the question of opportunity costs. In addition, port truck traffic accounts for more than 85% of total truck traffic on some sections of the highways in Los Angeles. Although shipping is global, including some of its impacts, such as greenhouse gas emissions, most of the negative impacts of ports are localised, taking place close to the port area (in terms of noise and dust) and in the metropolis (for air emissions, water quality, congestion and land use). These impacts have consequences for the health of local population. There is a port-city mismatch: the combination of benefits spilling over to other regions and the localised negative impacts. This presents a major challenge to mayors and other leaders of port-cities. How can this mismatch be resolved?

Evidently, the port must be competitive if cities want to benefit from it. Port-related value added and employment is strongly related to urban wealth. Ports can become more competitive by strengthening their maritime links, port operations and hinterland connections. Local goodwill for a port's functions in cities is essential and can be earned. Environmental policies and incentive schemes have reduced a variety of environmental impacts, transport policies in and around ports have mitigated congestion and port relocations have freed up centrally located urban land for other functions.

A key issue for cities is how to get more local value for money out of ports. Three main models exist that can help cities derive additional benefits from their ports: maritime services clusters, industrial development and port-related waterfront development. Maritime services clusters try to attract high-value-added services related to the maritime industry, such as maritime finance, consulting, law and engineering services. Industrial development related to ports has traditionally taken place because many industries are interested in being close to imported resources and consumer markets. Finally, waterfront development has frequently managed to capitalise on their port and maritime heritage and transform this into a source of urban growth.

A range of policy instruments can be applied to support these strategic orientations. These include incentive schemes, training and education, platform organisations and knowledge transfer schemes to attract high-value-added companies that could make the city an international maritime services centre; Singapore is a clear example of pro-active policies in this regard. With respect to industrial development on port sites, many initiatives have emerged that position the port as a site for industrial ecology (Rotterdam) and renewable energy (Bremerhaven). Master planning and financial mechanisms for redevelopment have been applied to waterfronts to create areas with a productive mix of functions that still maintain port functions, such as Port Vell in Barcelona.

Public policies can be effective in increasing port-city performance. There is some evidence of the effectiveness of certain transport policy instruments, such as the Clean Truck Program and terminal gate strategies both applied in the ports of Los Angeles and Long Beach. Several ports have also started to track environmental impacts, the reduction of which can sometimes be linked to policies. In terms of overall policy packages, there are clear indications, based on our research, of the effectiveness of port policies, transport policies and policies stimulating university-business co-operation: more active policies in these fields have a positive influence on performance.

Recommendations

- **Improve port competitiveness**. A port cannot be a driver of urban economic growth if it is not competitive. Port competitiveness can be improved by increasing maritime connectivity, effectiveness of port operations and hinterland connections. Ports cannot sustain their operations if they lack local support; so an essential element of the port competitiveness agenda should consist of acquiring support of the local population. Good practices analysed in this report could help to inspire local tailor-made solutions to improve port competitiveness.

- **Increase local benefits**. Port-cities should think more strategically about using ports as drivers of urban economic growth. The port could be used to develop the city into a leading maritime cluster, industrial complex or waterfront. Such development models should be based on deep knowledge about local port-city assets, possible development paths and a clear reflection on economic sub-sectors that should compose the new cluster. The most successful port-city economic models use a panoply of instruments, ranging from development support, spatial planning, incentive schemes, co-ordination mechanisms to human capital matching. The instrument mix should be adapted to the maturity of the sector.

- **Mitigate negative impacts**. Shipping is a global activity, so there are good reasons for global regulation of environmental impacts of shipping. In line with these, and in addition to these, ports should develop policies to reduce the health impacts of shipping and port activity on urban population. This could take the form of internalising external effects and polluter pays-principles. Incentive schemes for clean ships have started to appear, but should be introduced on a much larger scale. Traffic impacts of ports could be mitigated by better transport planning, intermodal strategies and more incentives to spread traffic flows over the day, including port gate strategies and urban congestion fees.

- **Strengthen policy coherence.** Policy instruments should not cancel each other and could be based on a comprehensive strategy that aligns different actors with their instruments and means. Ports and cities should look for synergetic development (win-wins), should at a minimum find mutually interesting compromises, but avoid antagonistic behaviour. Alignment of policies of different government tiers can facilitate effective policy implementation.

Chapter 1

Ports and their cities: An introduction

Ports and cities have a strong historical association, although the link between port and urban growth has attenuated over time. The various types of port-city face their own specific challenges; much depends on local circumstances. However, the question remains: are ports still drivers of urban growth, and how can they help to achieve such growth?

Ports and cities: A strong historical link

Ports are at the origin of many cities. Many cities started as trading posts, with the port as the natural interface of land with its maritime connections. This allowed small towns to become cities, and fuelled urban development, thanks to the prosperity associated with trade. Old city maps show the strong interlinkages between ports and urban development, and economic historians such as Fernand Braudel have stressed the importance of port-cities in the birth and development of the global, capitalist market economy. Ports are often still closely connected with their cities, and even when they have disappeared, they can continue to influence the city, because their heritage lives on, for example in urban form. This link has often been strong and persists in many emerging economies. A striking example in recent history is the case of Shenzhen, a small fishing village that became one of the world's largest metropolises and ports in a few decades, thanks to export-driven growth made possible by a free-trade zone and extensive port development.

Many of the largest cities have the largest ports. This is particularly the case in Asia, where Shanghai and Osaka-Kobe rank not only in the 20 largest metropolitan areas worldwide but also among the 20 largest ports in the world. Other Asian metropolises with very large ports include Guangzhou, Shenzhen, Tianjin and Hong Kong. The link between metropolitan size and port size can also be seen in North America, with New York and Los Angeles as prime examples, and to a lesser extent in Europe, which has a more limited number of very large metropolises, some of which, including London and Barcelona, also have large ports (Table 1.1). Not all the largest metropolitan areas have large ports, however. Buenos Aires and Rio de Janeiro, for example, are very large metropolitan areas with relatively small ports. Some of the world largest metropolitan areas have river ports, such as Chicago and Paris, and there are also examples of large metropolises that have no port, such as Delhi and Mexico City. The cities with the largest ports are not only the largest cities in the world, but are also the cities with the most global business connections.

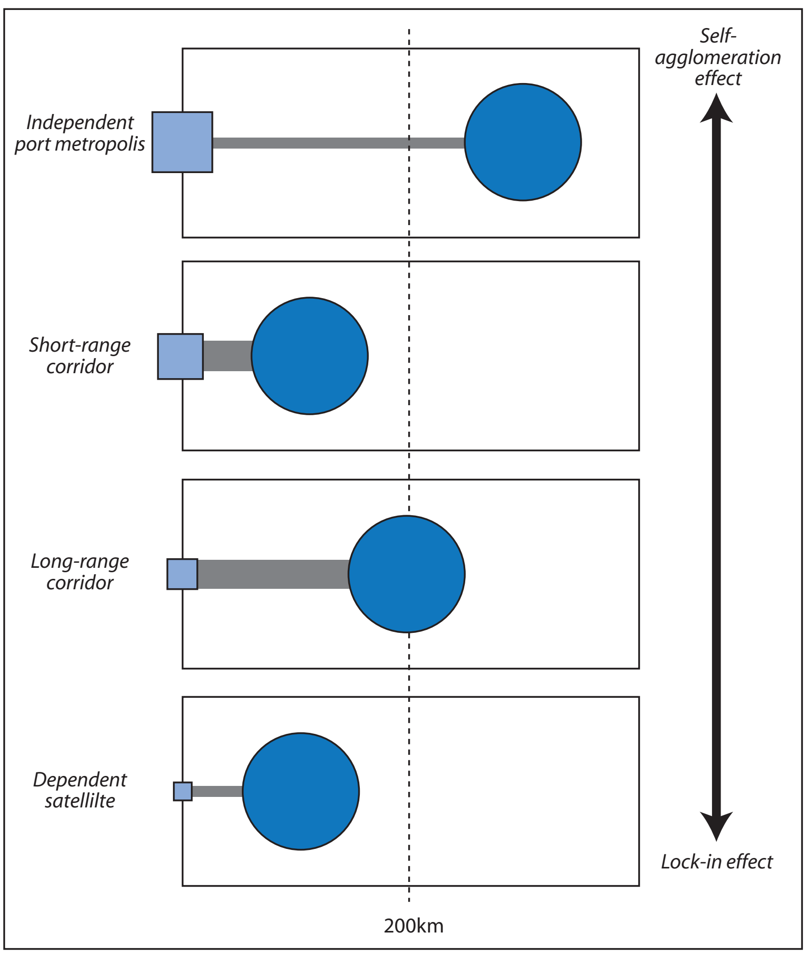
Table 1.1. Overlap of the world's largest metropolises and ports

	Top 20 metro-areas	Top 40 metro-areas	Top 60 metro-areas
Top 20 ports	Shanghai, Osaka-Kobe	Guangzhou, Shenzhen, Tianjin, Hong Kong	
Top 40 ports	São Paulo-Santos, New York, Los Angeles/Long Beach	Madras	
Top 60 ports	Tokyo	Bangkok	
Top 80 ports	Mumbai		
Top 100 ports	Kolkata, Karachi	London, Jakarta	Barcelona
Top 125 ports	Manila, Istanbul		Ho Chi Minh City, Chittagong, Miami/Tampa, Philadelphia

Source: Own elaborations based on data from UN Habitat and American Association of Port Authorities.

Although many large metropolitan areas do not have a port, their fate is often strongly dependent on the quality of their connection with ports. The smaller and the closer the port-city in relation to the inland metropolis, the more it can be considered to form part of this metropolis, whether in the form of a dependent satellite, or linked by short-range or long-range corridors (Figure 1.1). Dependent satellites are small and close by, including, for example, Civitavecchia in its relation to Rome, and San Antonio in relation to Santiago, Chile. Short-range corridor relations exist when an inland metropolis is located close to a relatively large port-city, such as in Santos-São Paulo, Port Klang-Kuala Lumpur and Incheon-Seoul. Long-range corridors are observed when inland metropolises are farther away from a relatively small port-city, *e.g.* Le Havre-Paris, Port Said-Cairo and Constantza-Bucharest. Finally, there are also constellations in which the inland metropolis is far distant from a port (more than 200 kilometres), in which case the port-city has the room to develop into an independent metropolis. This is the case for St. Petersburg (with Moscow as the inland metropolis), Durban (Johannesburg) and Odessa (Kiev) (Figure 1.2). Land-locked countries are dependent on other countries' ports, which can become problematic if they depend on one port, but is less challenging when they have links with many different ports. An example of such a country is Austria, which exports and imports through at least six ports located in different coastal zones: Rotterdam, Antwerp, Hamburg, Koper, Trieste and Constantza (Merk and Hesse, 2012).

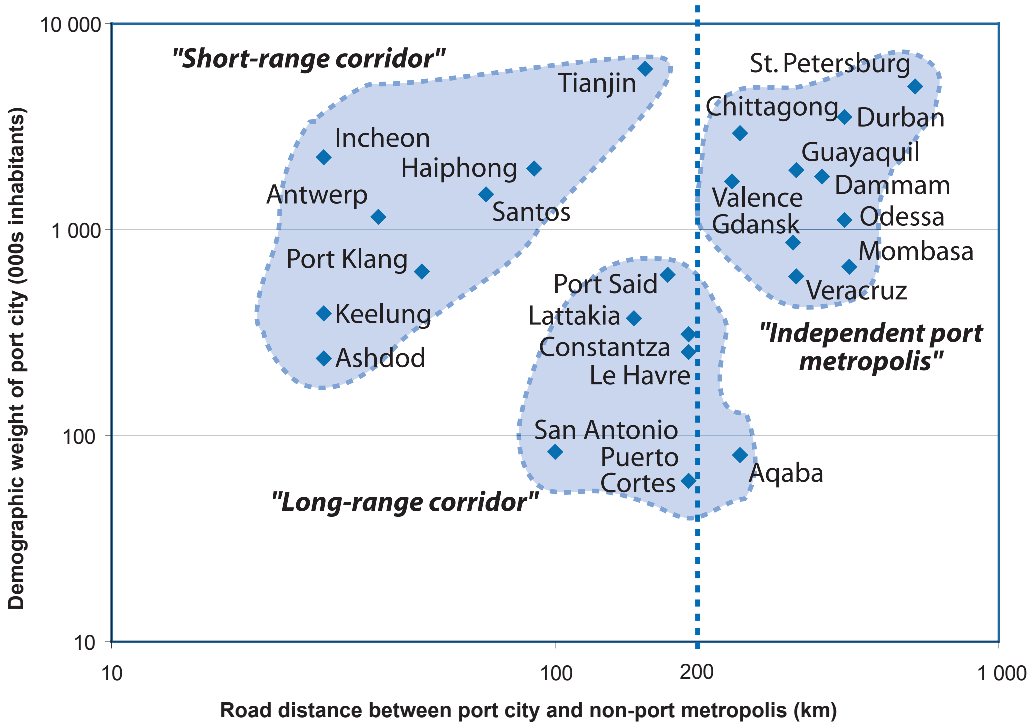
Figure 1.1. Typologies of inland metropolis-port relationships



Note: the circle represents the inland metropolis, the square represents the port-city. The larger the population of the inland metropolis, the larger the size of the circle, the larger the size of the port-city, the larger the square.

Source: Merk, O. et al. (2011), "The Competitiveness of Global Port-Cities: The Case of the Seine Axis (Le Havre, Rouen, Paris, Caen), France", *OECD Regional Development Working Papers*, No. 2011/07, OECD Publishing, Paris, http://dx.doi.org/10.1787/5kg58xppgc0n-en.

Figure 1.2. Ports in relation to inland metropolitan areas



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There are large ports that are not located in cities, but there are usually very specific reasons for this: because they are close to natural resources or global shipping routes, or because of a deliberate decision to decongest urban ports. Ports located close to natural resources, such as coal, oil and ores, include Port Hedland (Australia), Richard Bay (South Africa), Corpus Christi (United States) and Novorossiysk (Russia). Large trans-shipment hubs close to intercontinental shipping routes include Salalah (Oman), Freeport (Bahamas), as well as Gioia Tauro (Italy), Algeciras (Spain), Port Said (Egypt) and Marsaxlokk (Malta), all in the Mediterranean Sea. Finally, the non-urban gateway ports that were in many cases deliberately created away from large cities in order to decongest the urban ports include Felixstowe (United Kingdom), Laem Chabang (Thailand) and Lianyungang (China).

Links between port and city growth have become weaker over the last decades

Urban population growth is only one of the determinants of port growth. Port growth also depends on GDP per capita growth, the growth of external trade and how resource-intensive production is. Various studies have observed that port volume growth is steeper than the GDP per capita growth and external trade growth, a ratio expressed in port to GDP growth multipliers and port to external trade growth multipliers. In addition, the container growth rate depends on the containerisation rate of cargo traffic, which has dramatically increased in recent decades, as an increasing share of freight is now being transported by containers. The container port growth to GDP growth multiplier in North-West Europe (the range between Hamburg and Le Havre), for instance, over the period 1990-2010 was 3.0. This means that an average annual GDP growth of 1% was associated with an average container-port growth of 3% (McKinsey, 2011). Finally, port growth is dependent on how well a port is linked to the hinterland. The most important ports for some countries are not their own ports, but foreign ports better connected to their country, such as the Belgian port of Antwerp in the case of France. Hubs and regional networks are thus of prime importance.

Although port and urban growth often go hand in hand, there are metropolises in OECD countries where this is no longer the case. Port decline can accompany urban growth; and population decline can combine with port growth. This can be concluded from comparing population growth and port volume growth in recent decades, from 1970 to 2010 (Table 1.2). In the majority of cases, population growth and port growth are still associated, in particular in the Asian port-cities, where both population growth and port volume growth have been spectacularly high, and where a distinction between strong and moderate population growth would be more appropriate (Table 1.3), excluding some Japanese cities that experienced population decline. Large North American cities, such as New York, Los Angeles, Houston, Seattle and Vancouver, have also witnessed simultaneous population and port growth, but several North American cities have shown population growth combined with port decline, as in Baltimore, Boston, Philadelphia and Montreal. Almost all of the North American cities where population has declined are cities without a port. In European cities, there are several examples in every category: growing cities with growing ports (Barcelona), growing cities with declining ports (Stockholm), stagnating cities with growing ports (Rotterdam) and stagnating cities with declining ports (London). All in all, a variety of trajectories exist, with some of the leading OECD metropolises having lost most of their port functions and some of the leading ports struggling to become successful metropolises.

Table 1.2. Port-cities and their population and port growth in Europe and North America (1970-2010)

	Population growth	Population decline/stagnation
Port growth	New York, Los Angeles, Houston, Seattle, Vancouver, Barcelona, Valencia, Dublin, Helsinki, Athens	Rotterdam, Hamburg, Antwerp, Amsterdam
Port decline	Baltimore, Boston, Philadelphia, Montreal, Stockholm, Oslo, Lisbon, Bordeaux	London, Copenhagen, Naples, Liverpool, New Orleans
No port	Chicago, Paris, Madrid	Berlin, Rome, Milan, Budapest, Detroit, Buffalo, Cleveland

Source: Own elaborations based on data from UN Habitat and *Journal de la Marine Marchand,* editions from 1970 to 2013.

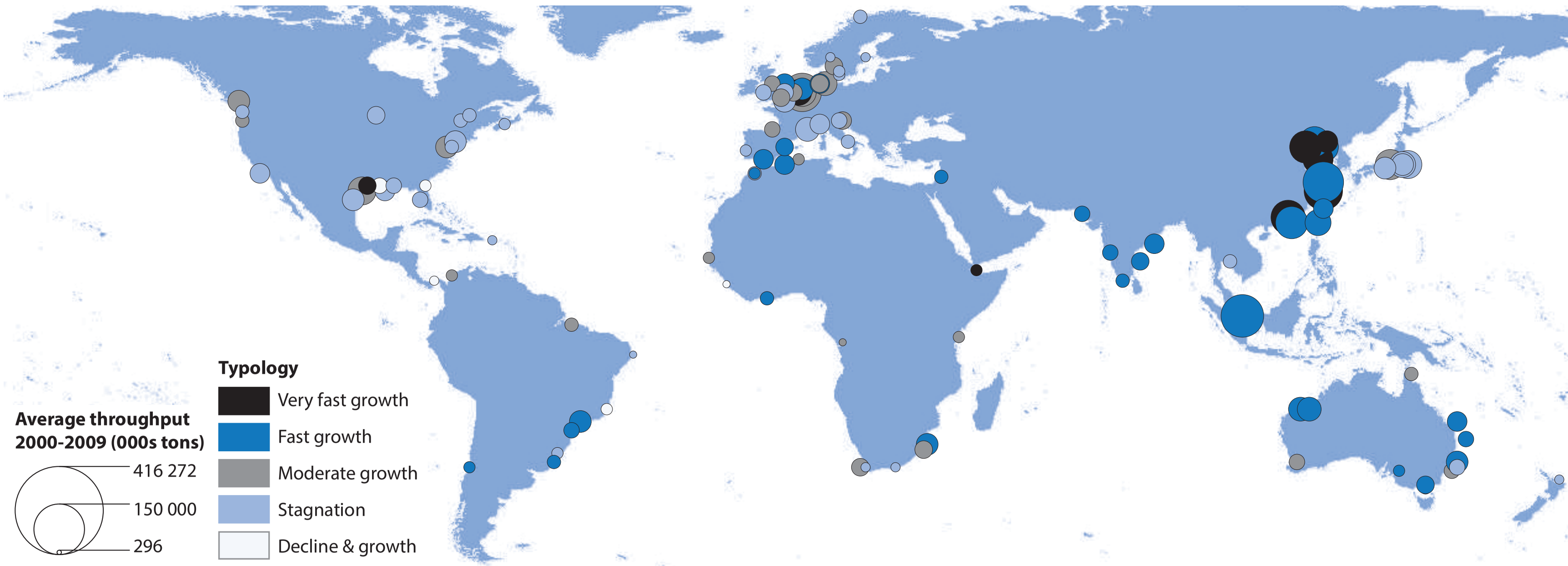
Table 1.3. Port-cities and their population and port growth in Asia (1970-2010)

	Strong population growth	Moderate population growth
Strong port growth	Shenzhen, Dubai, Shanghai, Singapore, Mumbai, Kolkata	Hong Kong, Busan, Nagoya
Moderate port growth		Kobe
No port	Delhi, Beijing	

Source: Own elaborations based on data from UN Habitat and *Journal de la Marine Marchande,* editions from 1970 to 2013.

These trends also reflect the shifting economic balance across continents in recent decades. In 1972, approximately 40% of all world port activity took place in Europe, 20% in North America and 20% in Asia. These shares had dramatically changed by 2009, when more than half of world port activity was taking place in Asia, around a fifth in Europe, and a tenth in North America. Ports in Asia, in particular Chinese ports, have shown very fast growth rates over the last four decades, whereas ports in North America and Europe have shown more mixed growth patterns, characterised by stagnation or a combination of stagnation, decline and moderate growth (Figures 1.3 and 1.4).

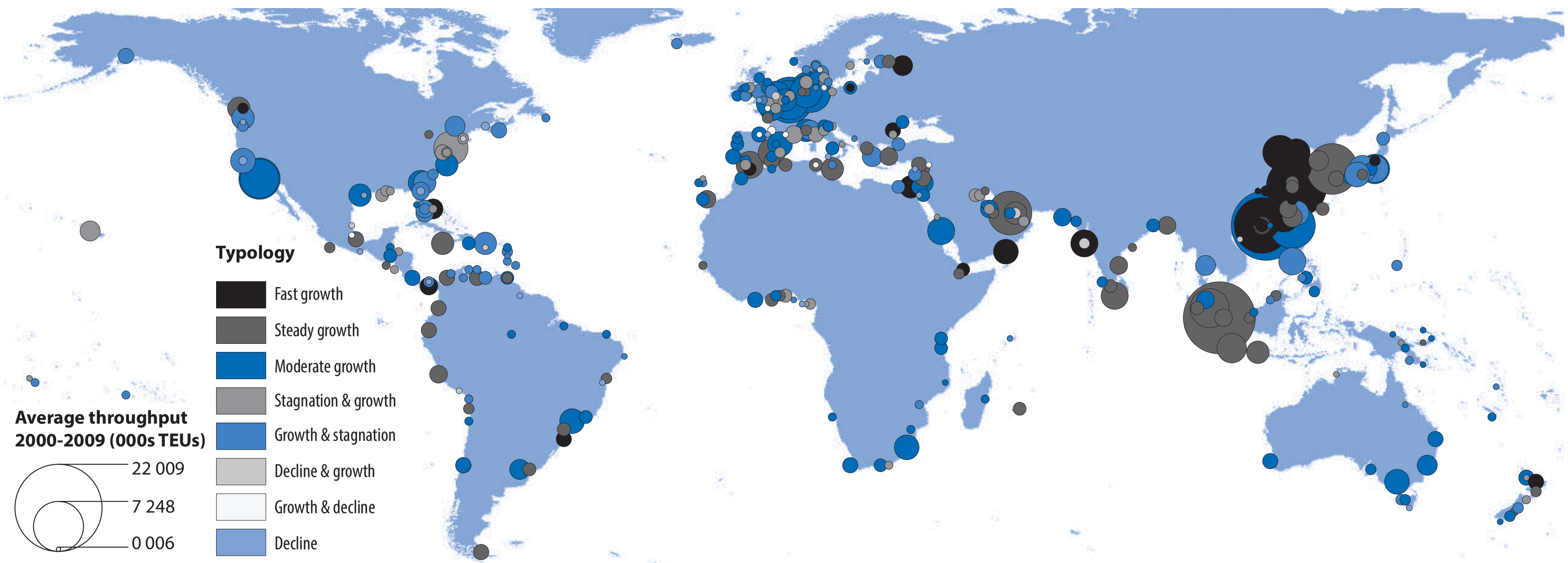
Figure 1.3. Port trajectories 1970-2009



Note: the category "decline and growth" indicates a succession of port decline and port growth over the four decades.

Source: Own elaborations based on data from *Journal de la Marine Marchande,* editions from 1970 to 2013.

Figure 1.4. Container port trajectories 1970-2009

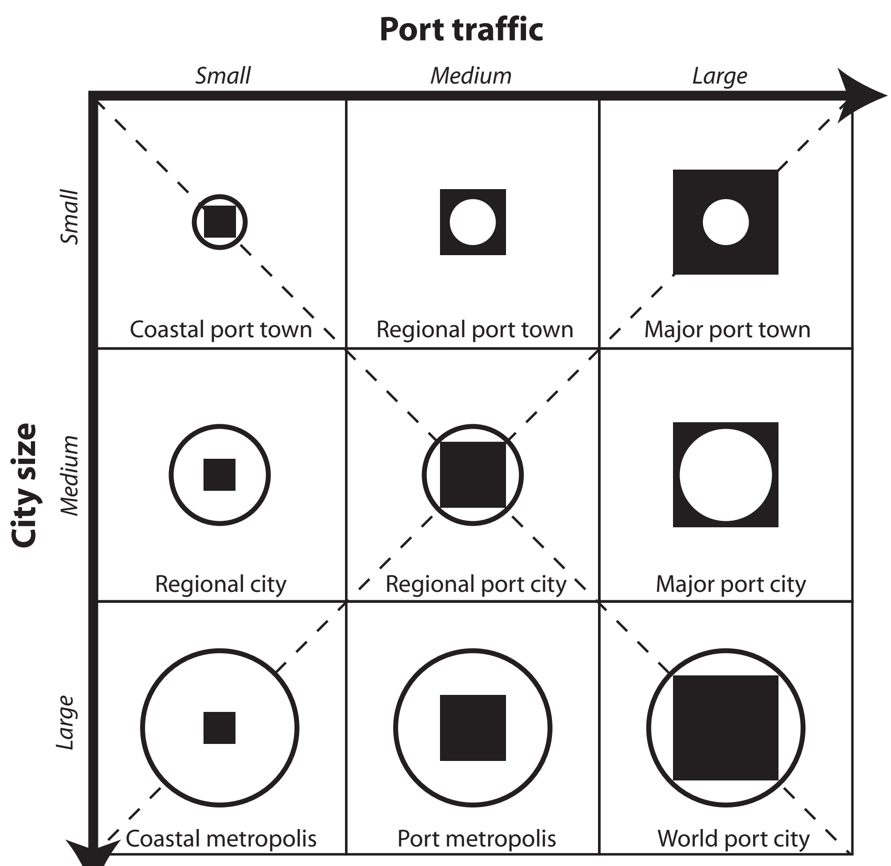


Source: Own elaborations based on data from *Journal de la Marine Marchande,* editions from 1970 to 2013.

Each port-city faces its own particular challenges

Different types of port-cities, dependent on port size and city size, range from coastal port towns to world port-cities (Figure 1.5). World port-cities are large cities with large ports; examples include New York, Hong Kong, Tokyo and Singapore. In a port metropolis, the urban function is large, whereas the port function is smaller but nevertheless considerable, as in Cape Town and Buenos Aires. When the port function is even smaller in a large metropolis, it can be considered a coastal metropolis (Stockholm, Baltimore and Tunis). However, the opposite phenomenon also exists; in these cases, the size of the port is relatively larger than the city. These could be called major port-cities, such as Rotterdam, Le Havre and Genoa, and major port towns, *e.g.* Freeport, Gioia Tauro and Laem Chabang. This study focuses on port-cities, in which either the city or the port is very large (a port metropolis or major port-city respectively) or both are large (world port-cities). There are clear differences between continents in this respect. North America's cities are chiefly on the coast, connected to the land by bridges, and the largest European cities are concentrated inland, but with many coastal gateways. Asia has a large coastal urban concentration, with low hinterland coverage.

Figure 1.5. Typology of port-cities



Note: the circle represents the city; the square represents the port. The larger the circle, the larger the urban population. The larger the square, the larger the port volume.

Source: Ducruet, C. and S.W. Lee (2006), "Frontline Soldiers of Globalisation: Port-City Evolution and Regional Competition", *Geojournal*, Vol. 67, No. 2, pp. 107-122.

Different port and urban growth patterns lead to distinctly different impacts and policy challenges (Table 1.4). The main challenge of port-cities with growing ports and a growing population is the development of new port sites. Here, the pressing issues include space constraints, congestion and under-capacity of the port, with the need for infrastructure investments and relocation of port sites. This subsequently opens up the possibility of transforming port land into housing or mixed urban development. Growing cities with ports that face declining traffic volumes typically convert to urban waterfront development. While they may also be dealing with a transformation of port land to different uses, like port-cities with growing ports and population, their port area simply shrinks. The cities in which the population is shrinking and the port growing have a different concern, which is to find port cargo outside the metropolis and better connections with the hinterland. Finally, the port-cities where both ports and cities are in decline need to find new sources of growth. Transformation of port areas there may require less new housing development and cultivate leisure or business areas instead, as well as attempts to attract new services and port niches.

Table 1.4. Policy challenges for different port-city types

	Growing city	Shrinking city
Port growth	New port sites (Singapore)	Extending hinterlands (Rotterdam)
Port decline	Urban waterfronts (Baltimore)	Economic transformation (Bilbao)

The following chapters will assess these challenges, and analyse policies to deal with them. Despite the variety of different port-cities, they share many similar challenges. The core question is how ports, often the source of a city’s historical development, can continue to add value to a metropolis. Can they still foster the prosperity and well-being of the metropolis today? The reality of port-cities remains complex, without a typical port-city. Their variety provides a rich range of experiences and examples to compare and from which to learn. Port-city relations evolve over time, and various authors have attempted to capture different stages of the dynamics of port-city interaction. The following chapters will make use of these sources to assess the impact of ports on their cities and suggest possible ways to improve on them.

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Chapter 2

The impact of ports on their cities

This chapter provides an overview of the impact of ports, their terminals and their related economic sectors and activities. Despite their economic benefits, they also have negative impacts, particularly on the environment, land use and traffic. It assesses how these effects are distributed, and identifies a mismatch between negative impacts, which are mostly localised, and their benefits, which spill over to other regions. This mismatch has intensified in recent decades, due to technological, market and other developments. The concluding section of this chapter assesses future developments that could pose additional challenges to policy makers.

Benefits from ports

The economic benefits of ports are manifold; an overview of the main benefits appears below. First, ports play an essential role in global supply chains, and act as facilitators of trade between port-regions and countries (see "Ports as facilitators of trade*"*). Ports also provide value added through the economic activities that they and the firms related to ports perform (see "Value added created by ports and port-related industries"*)*. This economic value translates into port-related employment (see "Port-related employment*"*). Finally, ports also offer spatial clusters for innovation, research and development (see "Ports and innovation*"*). Port-cities are at the source of these economic benefits, but are by no means the only places that benefit from port activity; this section concludes with an assessment of where the main economic impact is felt (see "Where do ports make an impact?"*)*.

Ports as facilitators of trade

Maritime transport costs make up a substantial share of the value of traded goods. On average, 5.1% of the imported value of manufactured goods can be attributed to shipping, compared with 10.9% for agricultural goods and 24.1% for industrial raw materials (Table 2.1). However, transport costs vary widely between various products and their countries of origin and destination. In general, goods shipped in containers have lower transport costs per tonne of merchandise shipped than non-containerised goods, as do goods shipped between major ports on well-travelled trade routes. The costs of shipping a container, for example, vary widely; on some routes, shipping costs can be ten times higher than on others. In the first half of 2008, the cost of shipping a container from Dubai to Singapore was USD 300, as compared with USD 2 849 from Brazil to the United States, a gap that persists even when corrected for differences in distance (Korinek and Sourdin, 2009). The cost of shipping into Africa is by far the highest, representing on average 25% of imported value. Some countries, mostly remote nations with very small markets, face such high maritime transport costs that they represent a significant drag on most exports; the maritime transport costs can account for 43% of the cost of exports from the Christmas Islands, for example (Korinek and Sourdin, 2009).

Table 2.1. Maritime transport costs for main economic sectors

	Maritime transport costs as % of import value	Maritime transport costs (USD/tonne)
Raw materials	24%	33
Agriculture	11%	81
Manufactured goods	5%	174
Crude oil	4%	18

Source: Korinek, J. and P. Sourdin (2009), "Clarifying Trade Costs: Maritime Transport and its Effect on Agricultural Trade", *OECD Trade Policy Papers*, No. 92, OECD Publishing, Paris, http://dx.doi.org/10.1787/220157847513.

Higher maritime transport costs are related to lower external trade volumes. Doubling of maritime transport costs between a given country pair is associated with a decline of 66%-80% in the value of imports and a decrease in trade volume of 26%-28% (Korinek and Sourdin, 2009). A wider range of reductions in trade volume (from 1.5% to 38%) was found in a study of Spanish exports to Poland and Turkey (Martinez-Zarzoso and Nowak-Lehmann, 2007). Yet another study identified that a 10% increase in bilateral maritime transport costs (USD/tonne) is associated with a decrease of approximately 8% in the value of agricultural imports on average. However, between products, the variation in transport costs can range from a 1.7% decrease for products of animal origin to a 11%

decrease for cereals, given a decrease of 10% in transport costs (Korinek and Sourdin, 2010). Large trade-transport cost elasticities (2.3-2.5) have repeatedly been found in different studies (Limao and Venables, 2001; Martinez-Zarzoso, Garcia-Menendez and Suárez-Burguet, 2003; Martinez-Zarzoso and Suárez-Burguet, 2005). External trade between countries can depend not only on maritime transport costs but also on the two countries' GDP, whether or not they share a common language or membership in a major regional trading agreement and on shipping distance.

In comparison, in land-locked countries, the costs of trade are higher. A study of 97 developing countries (of which 17 were landlocked) estimated that transport and insurance costs are twice as high for landlocked countries as coastal countries (Radelet and Sachs, 1998). This is related to the larger share of land transportation, considering that it is seven times more expensive to transport goods by land than by sea (Limao and Venables, 2001). As a result, a landlocked country trades approximately 80% less than a non-landlocked country (Raballand, 2003; Martinez-Zarzoso and Suárez-Burguet, 2005), and median land-locked countries have only 30% of the trade volume of the median coastal economy (Limao and Venables, 2001). However, there are considerable differences among land-locked countries: the greater the number of options for a land-locked country, the more the land-locked country imports, because it has more bargaining power to reduce transit costs than land-locked countries that only have connections with one seaport (Raballand, 2003). Examples of land-locked countries with multiple port options are Switzerland, Austria and the Czech Republic: these are highly contested hinterlands by ports as diverse as Rotterdam, Hamburg, Koper, Trieste and Constantza (Merk and Hesse, 2012).

An important determinant of the relation between transport and trade is time. Each additional day in transit reduces trade volumes by 1%, leads to an increase in the freight rate of USD 56 and adds 0.8% on average to the value of manufactured goods (Djankov, Freund and Pham, 2006; Hummels, 2001). A 10% increase in time reduces bilateral trade volumes by 5%-8% (Hausmann, Lee, Subramanian, 2005) and leads to a reduction in trade value of 5%-25% (Nordas, Pinali, Geloso Grosso, 2006). In addition, uncertainty in the shipping times has a bigger impact on decreases in trade. Korinek and Sourdin (2011) found that the reason for a delay makes a difference in trade impacts – if the delay is due to administrative reasons, for example, the trade impact is greater than if it is due to distance. This could be attributed to greater uncertainty in the case of the administrative issues; delays due to distance can be estimated and more easily allowed for. Delays matter more for time-sensitive perishable goods. Shipments of livestock are the most time-sensitive, whereas shipments of coal are the least. This can be derived from a measure of industry sensitivity to shipping times that was formulated by Hummels and Schaur (2012), reflecting the premium for air shipping that firms in an industry are willing to pay to avoid an additional day of ocean transport. Industries sensitive to shipping times are also sensitive to cargo logistics (Table 2.2). Moreover, firms tend to shift to more expensive air shipping when uncertainty in ocean shipping increases (Clark, Dollar and Micco, 2004).

Port efficiency is one of the main determinants of international transport costs. Of six different port characteristics, including port infrastructure, private sector participation and inter-port connectivity, efficiency was found to be the most important (Wilmsmeier, Hoffmann and Sanchez, 2006). Various studies have quantified the widely varying effects of increased port efficiency on the one hand, and decreased transport costs and increased trade volumes on the other hand (see Table 2.3). The role of port efficiency in reducing costs of trade is confirmed by other studies (Sanchez et al., 2003; Nordas and Piermartini, 2004).

Table 2.2. Time sensitivity of economic sectors

Industry sector	Time sensitivity index
Livestock and livestock products	2.590
Chemicals and allied products	1.659
Miscellaneous manufactured products	1.257
Stone, clay, glass and concrete products	1.224
Scientific and professional instruments	1.171
Fabricated metal products	1.100
Non-metallic minerals	0.998
Machinery, excluding electrical	0.905
Rubber and plastics products	0.904
Paper and allied products	0.881
Electrical machinery	0.788
Primary metal products	0.743
Printing, publishing and allied products	0.703
Apparel	0.666
Crude petroleum and natural gas	0.665
Transportation equipment	0.654
Food and associated products	0.591
Furniture	0.585
Fish, fresh or frozen and other marine products	0.577
Lumber and wood products	0.577
Textiles	0.575
Agricultural products	0.433
Petroleum refining and related products	0.359
Tobacco	0.279
Forestry products	0.268
Metallic ores and concentrates	0.000
Coal and lignite	0.000

Source: Hummels, D. and G. Schaur (2012), "Time as a Trade Barrier", *NBER Working Paper 17758*, National Bureau of Economic Research, Cambridge, MA.

Table 2.3. Link between port efficiency and trade/freight costs

Port efficiency measure	Impact on trade	Characteristics	Source
Double port efficiency	32% increase of trade volume	Top 100 non-US and top 50 US ports; 1991-2003	Blonigen and Wilson 2008
From 75th to 25th percentile	25% increase of trade volume	59 countries, 1996-2000	Clark et al., 2004
From lowest score to highest	Decrease of freight cost by 25.9%		Wilmsmeier et al., 2006
One point rise on WEF-index	4.3% reduction in *ad valorem* transport costs		Abe and Wilson, 2009
Make all ports as efficient as the most efficient port	82.5% increase in export volumes	14 Brazilian ports	Haddad et al., 2010

Note: The WEF-index refers to the port quality index of the World Economic Forum, ranging from 1 to 7.

Source: Authors'calculations based on Blonigen, B. and W. Wilson (2008), "Port Efficiency and Trade Flows", *Review of International Economics*, Vol. 16, No. 1, pp. 21-36; Clark, X., D. Dollar and A. Micco (2004), "Port Efficiency, Maritime Transport Costs and Bilateral Trade", *Journal of Development Economics*, Vol. 75, No. 2, pp. 417-450; Wilmsmeier, G., J. Hoffmann and R. Sanchez (2006), "The Impact of Port Characteristics on International Maritime Transport Costs", *Research in Transport Economics*, Vol. 16, pp. 117-140; Abe, K. and J. Wilson (2009), "Weathering the Storm: Investing in Port Infrastructure in Lower Trade Costs in East Asia", *World Bank Policy Research Paper*, No. 4911, World Bank, Washington DC.; Haddad, E. et al. (2010), "Regional Effects of Port Infrastructure: A Spatial CGE Application to Brazil", *International Regional Science Review*, Vol. 33, pp. 239-263.

Other port characteristics also determine maritime transport costs. Among the main characteristics identified are:

- **Port infrastructure**. Onshore infrastructure accounts for 40% of predicted transport costs for coastal countries, and various studies indicate a link between port infrastructure and maritime transport costs. Limao and Venables (2001) calculate that a country with relatively poor infrastructure (around the 75th percentile) that upgraded to the 25th percentile would reduce transport costs by between 30% and 50%.

  According to Martinez-Zarzoso, Garcia-Menendez and Suárez-Burguet (2003) an improvement of 10% in the port infrastructure of a destination country lowers transport costs by 1.4%; and an increase of port infrastructure of one standard deviation reduces the freight rate by USD 225, following calculations of Wilmsmeier and Hoffmann (2008). It should be noted that the port infrastructure of exporters is more important for transport costs than the importers' (Nordas and Piermartini, 2004; Korinek and Sourdin, 2011).

- **Port centrality**. If a country doubles its centrality in liner shipping networks, achieving a significant increase in direct liner services to a wider range of countries, transport costs can decrease by up to 15.4% (Wilmsmeier and Sanchez, 2009). An increase of connectivity of one standard deviation implies a potential reduction of the freight rate of USD 287 (Wilmsmeier and Hoffmann, 2008).

- **Port congestion**. A 10% increase in port congestion leads to 0.7% increase in maritime transport costs (Abe and Wilson, 2009). This is related to the quality of logistics services in ports. Devlin and Yee (2005) document the wide variation in logistics costs in Middle Eastern and North African countries and how they can influence shipping costs. Inefficient trucking services leave longer stand times on the dockside and costly inventory accumulation, as well as reduce export volumes, leading to less frequent shipping services.

The impact of port infrastructure and efficiency differs depending on industry and the stage of economic development. Martinez-Zarzoso, Pérez-Garcia and Suárez-Burguet (2008) find that a 1% improvement of infrastructure in the destination country lowers transport costs by 0.20% on average. However, that infrastructure variable is not significant for high value added sectors, such as household appliances and vehicle parts generally sold to the most developed countries, which already have the highest levels of infrastructure quality. In addition, infrastructure benefits middle-income countries more than lower-income countries. For a lower-middle-income country, a one-unit improvement in port infrastructure on the World Economic Forum's Global Competitiveness Report index for port infrastructure (ranging from 1 to 7) is associated with an estimated increase in trade of 139%; the figure is 236% for upper-middle income countries and 171% for high-income countries. This may be due to their ability to take advantage of trade-facilitating investments, which lower-income countries may be less able to do (Korinek and Sourdin, 2011).

Higher external trade can translate into higher economic growth. An overview of existing studies on the impacts of trade on economic output and growth indicates that the macroeconomic evidence provides support for the positive and significant effects of trade on output and growth. Microeconomic evidence lends greater support to the exogenous effects of productivity on trade, as compared with the effects of trade on productivity (Singh, 2010). In any case, high trade costs inhibit a country from taking advantage of potential gains from specialisation and trade in promoting economic development (Markusen and Venables, 2007).

Value added created by ports and port-related industries

Such value added can be substantial. For example, the value added of the port cluster in Rotterdam in 2007 was calculated at EUR 12.8 billion, representing approximately 10% of regional GDP. Even higher shares of regional and national GDP are attained for the port cluster of Le Havre/Rouen, which accounted for more than 21% of regional GDP in 2007, and the port cluster of Antwerp, which generates around 3% of the Netherlands' GDP (Merk et al., 2011). These numbers include direct and indirect value added, the categories most frequently covered in studies on the economic impact of ports. In general, four different types of impact are distinguished: direct, indirect, induced and catalytic. Direct impact covers jobs and income generated by the construction and operation of the port. Indirect impacts are the employment and impact of the suppliers of goods and services, and induced impact is the employment and income generated by the spending of income by employees created by direct and indirect effects. Catalytic impact is generated by the port as a driver of productivity growth and attractor of new firms (Ferrari, Percoco and Tedeschi, 2010).

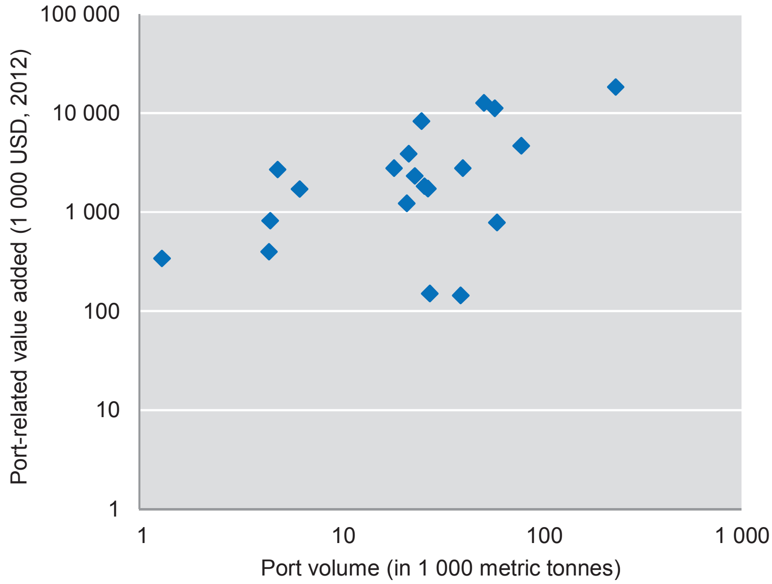
The larger the port, the more value added is created by the port and port-related sectors. A meta-study of approximately 150 port impact studies conducted for this report indicates that on average, one tonne of port throughput is associated with USD 100 of economic value added. Two-thirds of the ports in the sample have between USD 50 and USD 250 value added per tonne of port throughput (Merk, forthcoming). This number includes direct and indirect port value added. Our analysis, shown in Figure 2.1, which for reasons of comparability shows only US ports with port impact studies with similar methodology, indicate that larger ports have larger port-related value added (direct and indirect). Much depends on the types of goods that are handled in the port. There are very large differences in direct value added associated with different categories of goods handled in ports. Dry bulk and liquid bulk generally generate more limited value added per tonne than project cargo, general cargo and containerised cargo. Analysis of value added per cargo types in US ports shows that these values can vary by a factor of 10: one tonne of grain handled generates USD 20 on average; USD 220 for automobiles and USD 90 for containerised cargo (Table 2.4).

Table 2.4. Value added per cargo type (USD per metric tonne)

Cargo type	Average	Minimum	Maximum
Automobiles	220	116	331
Containers	90	40	149
Steel	60	23	118
Petroleum	45	11	183
Grain	20	9	37

Source: Merk, O. (forthcoming), "Meta-analysis of Port Impact Studies", *OECD Regional Development Working Papers*, OECD Publishing, Paris.

Figure 2.1. Relation between value added and port volume (2012)



Source: Merk, O. (forthcoming), "Meta-analysis of Port Impact Studies", *OECD Regional Development Working Paper*, OECD Publishing, Paris.

Ports can have large indirect economic effects (backward linkages). Our series of case studies, using a uniform methodology, found multipliers ranging from 1.13 to 2.47 (Table 2.5). A multiplier of 2.47 means that each additional euro spent in the port leads to EUR 1.47 additional demand for suppliers to the port cluster. These multipliers measuring the backward linkages of the ports sector were calculated by integrating port clusters into national input output-tables and assessing the inputs and outputs from the port cluster economy. The indirect impact of the ports of Rotterdam and Antwerp on the national economy was smaller than those found for the other European ports, namely Hamburg, Le Havre and Marseille. This could be explained by the fact that Rotterdam and Antwerp are very large ports in a relatively small country, and that a considerable part of the indirect economic effects of these ports may be benefiting other countries and not showing up in the multiplier. Overall, ports were found to have strong linkages with transport, storage and communication sectors; as well as with coke, refined petroleum and nuclear fuels and chemicals.

Table 2.5. Overview of port multipliers (backward linkages)

	Leontieff multiplier
Le Havre/Rouen	2.47
Marseille	2.01
Mersin	1.79
Hamburg	1.71
Antwerp	1.18
Rotterdam	1.13

Source: OECD Port-City case studies: Merk and Bagis (2013), Merk and Comtois (2012), Merk et al. (2011), Merk and Hesse (2012), Merk and Notteboom (2013).

Port-related industries can be differentiated according to firms providing services necessary to maritime trade (*port-required industries*), firms attracted to the region because of the presence of a port (*port-attracted industries*) and firms that have expanded markets by exporting through the port (*port-induced industry*), based on Yochum and

Agarwall (1987, 1988). Port-required industries include transportation services and port services (such as terminal operations, stevedoring, towage, etc.). Port-attracted industries are either firms that export commodities, or firms that import products or raw materials (*e.g.* refineries, steel factories). "Port-induced industries" is a much wider category and generally more difficult to capture, because it is difficult to assess their dependence on the port. Generally, direct impacts of ports will include impacts on port-required industries, whereas indirect impacts will cover port-attracted and port-induced industries. Some studies differentiate port-related industries (required or attracted) into industries that need direct quay access and those that do not, such as the national port monitor published annually in the Netherlands. A related concept is the seaport cluster, which can be considered to consist of port-required and port-attracted industries.

Ports tend to attract firms in a variety of industries, often including transport and logistics, warehousing and storage. Several ports are also sites for resource-intensive industries, such refineries, chemicals, steel and coal; and aerospace and renewable energy production, including offshore wind energy and biomass production. However, a variety of practices exist, apparently determined by available space, port strategies and also the structure of the economy of a region. Regional industrial specialisations correlate with (and may determine to some extent) the types of cargo handled in the port. Regions that specialise in agriculture, for example, have ports specialised in the handling of agricultural products, etc. (Ducruet, Itoh and Joly, forthcoming).

Strong inter-linkages can exist between ports and related industries. This can be concluded from our assessment of the backward economic linkages of various port clusters; the main economic sectors linked to the port sector – and the intensity of these links – are indicated in Table 2.6. Many of these links are also localised. Large chemical clusters, such as in Antwerp, Rotterdam and Tarragona, have developed in and around their respective ports. The port represents the principal access point for raw materials for the manufacturing of chemicals. The impact of the port on the economic success of the chemical clusters is also considered fundamental for exports (EPCA, 2007). These industries could in turn also be interlinked. Plans to set up a heavy steel and metal industry in Dunkirk were accompanied by large energy suppliers needed to supply these industries, and firms, such as Coca-Cola, interested in taking advantage of the proximity of intermediate products (such as white iron, used for producing cans for drinks) produced by other firms on the territory (Boutillier, Laperche and Uzunidis, 2011).

Table 2.6. Intensity of economic links between selected ports and other sectors

	Le Havre-Rouen	Marseille-Fos	Hamburg	Rotterdam	Antwerp
Transport equipment	3.28	2.83	2.47	1.04	1.18
Food, beverages and tobacco	n.a.	2.69	2.22	1.07	1.05
Coke, refined petroleum, nuclear fuel	2.76	2.67	2.15	1.24	1.20
Other manufacturing	2.47	2.57	1.90	n.a.	n.a.
Transport, storage and communication	2.02	1.92	1.79	1.25	1.39
Financial intermediation	1.96	1.96	1.64	n.a.	n.a.
Wholesale and trade	2.02	1.90	1.31	1.03	1.09
Non-market services	1.89	1.39	1.31	n.a.	n.a.
Chemical, rubber and plastics products	n.a.	n.a.	n.a.	1.34	1.36
Manufacturing metals/metal products	n.a.	n.a.	n.a.	1.06	1.07
Electricity, gas and water supply	n.a.	n.a.	n.a.	1.17	1.13
Electrical and optical instruments	n.a.	n.a.	n.a.	n.a.	1.03
Mining, quarrying and energy supply	2.31	2.45	n.a.	n.a.	n.a.
Construction	2.30	2.17	n.a.	n.a.	n.a.

Source: OECD Port-City case studies: Merk and Bagis (2013), Merk and Comtois (2012), Merk et al. (2011), Merk and Hesse (2012), Merk and Notteboom (2013).

Value added of industrial development in ports can be on a par with or even higher than those of direct port value added. The four largest European ports all have approximately half of their value added concentrated in non-transport-related industrial sectors. In Antwerp, the chemical sector alone represents more than a quarter of the total direct and indirect value added of the port cluster. Moreover, various large ports show indications of synergetic cluster effects; these can be measured through the intensity of economic linkages between the sectors within the port area: the backward linkages multiplier. In the ports of Rotterdam and Antwerp, substantial intra-port economic interlinkages were found (Table 2.7).

Table 2.7. Economic linkages within the port area (Rotterdam, Antwerp)

	Rotterdam	Antwerp
Total	1.03	1.05
Chemical, rubber and plastic products	1.08	1.10
Transport, storage and communications	1.07	1.13
Coke, refined petroleum and nuclear fuel	1.05	1.05
Electricity gas and water supply	1.04	1.04
Manufacturing n.e.c.	1.02	1.02
Food, beverages and tobacco	1.04	1.02
Manufacture basic metals/metal products	1.02	1.02
Transport equipment	1.01	1.05
Wholesale and retail trade, auto repair	1.01	1.03

Source: Merk, O. and T. Notteboom (2013), “The Competitiveness of Global Port-Cities: The Case of Rotterdam/Amsterdam, the Netherlands", *OECD Regional Development Working Papers*, No. 2013/08, OECD Publishing, Paris, http://dx.doi.org/10.1787/5k46pghnvdvj-en.

The value added generated by cruise activities is relatively limited. Cruise port-impact studies generally look at three categories of spending resulting from cruise tourism: cruise line spending, crew spending and passenger spending. Some reports claim that the “crew” category is often skewed and fails to measure crew members who come ashore (Vaggelas and Pallis, 2010). Passenger spending, nonetheless, generally accounts for the largest share of revenues from cruise tourism in ports of call, particularly in island economies (*i.e.* the Caribbean). The average spending per cruise passenger in a port amounts to USD 100, based on our meta-assessment of cruise port impact studies covering over 75 different ports. The average economic contribution per passenger in a cruise port is USD 200, although there is a large variation of values, so it is difficult to generalise from these findings (Table 2.8). The largest absolute economic contribution of cruise shipping was identified in the port of Piraeus in Greece, with a report economic turnover of USD 690 million. Although this is a substantial amount, it does not come close to the economic value added generated by cargo and industrial functions in many ports. For most seaports, the share or cruise-related value added remains fairly small.

Table 2.8. Economic contribution of cruise shipping

	Average	Minimum	Maximum
Spending per cruise passenger (USD)	100	34	309
Turnover per passenger (USD)	200	20	1 868

Source: Merk, O. (forthcoming), “Meta-analysis of Port Impact Studies”, *OECD Regional Development Working Papers*, OECD Publishing, Paris.

There are links between port activity and global firms, in particular maritime services, such as ship finance, maritime insurance, maritime law and maritime consultancy. The location and connectivity of multi-office firms in these sectors follow global cities hierarchies more closely than port hierarchies, as indicated for example by relatively strong positions of non-port-cities, such as Paris and Madrid, although the high ranks of Rotterdam and Hamburg present the exceptions to the rule (Jacobs, Ducruet and De Langen, 2010). For these economic activities, urban attractiveness is a more important criterion than the presence or size of a port, as illustrated by the case of London, a city where most port functions have disappeared in recent decades, but which has developed as one of the leading world cities in advanced maritime services, with the highest connectivity in terms of multi-office maritime services firms. Studies on the command centres in container shipping confirm that such high value added functions are often located in port-cities, but that being a port-city is no guarantee for attracting such functions (Verhetsel and Sel, 2009). Such services can provide large value added; the economic contribution of maritime business services to the British economy was estimated at approximately GBP 1.5 billion in 2011 (Oxford Economics, 2012).

In comparison with seaports, airports tend to attract more high-value-added activities, such as headquarter functions and high technology jobs. These are related in many parts of the world to hub airports that are able to offer a wide variety of inter-continental flights. It was estimated in the early 2000s that across all major US cities, the location of a hub airport in a given region attracted about 12 000 extra high-technology jobs (Button et al., 1999). Headquarters are important for a regional economy because they can in turn attract high-value-added business services. A study on the location of headquarters in the EU showed that a 10% increase in the provision of intercontinental flights leads to a 4% increase in the number of headquarters located in the urban area (Bel and Fageda, 2008). Airports, in contrast to seaports, attract a large cluster of business services, commercial retail, hotels and headquarters. This can be explained by the fact that servicing business passengers is the core business of most major airlines and airports, unlike seaports. Air cargo is mostly limited to high-value cargo. The combination of sea- and airports can create synergies for certain businesses. O'Connor (2010) has observed that more diversified gateways (*i.e.* those with multiple airports and seaports within a radius of 70 kilometres from the "core") generate more traffic and larger logistics sectors than more specialised gateways (*i.e.* those handling either air or sea freight). At the same time, the air and sea cargo sectors are in practice fairly disintegrated (*e.g.* for Europe [Ducruet and Van der Horst, 2009]). Some port authorities, such as New York/New Jersey, Portland and Seattle, also administer airports, which can generate substantial shares of value added.

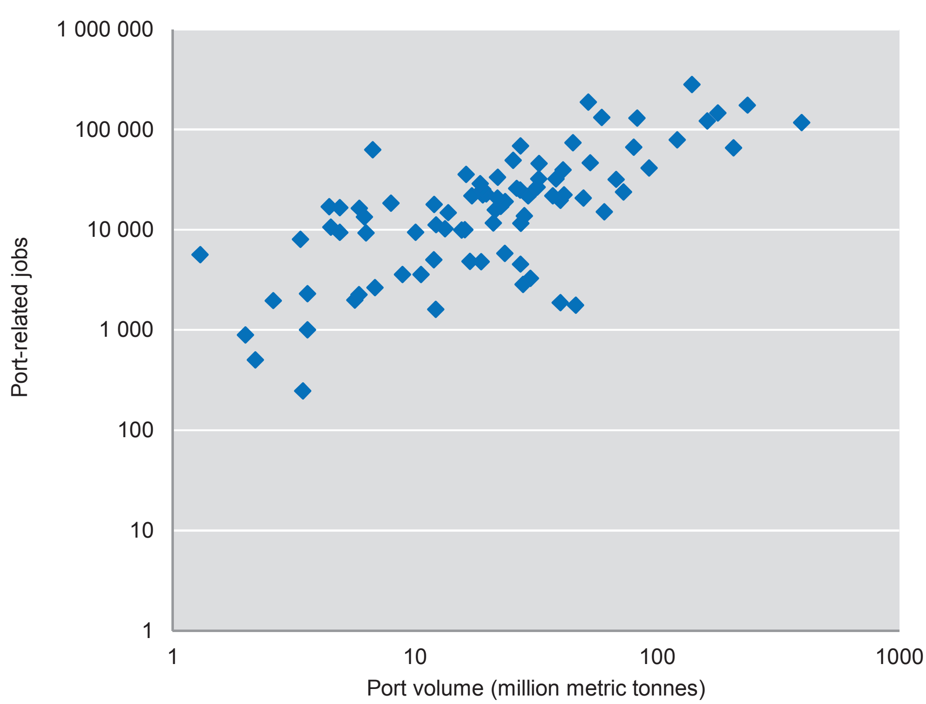
Port-related employment

Port industries require local employment, but this is relatively marginal in comparison with the wider regional economy in which ports operate. Even in the largest ports, port and port-required employment rarely exceeds a few thousand jobs. Several trends, including containerisation, automation and economies of scale, have made port operation and cargo handling increasingly capital- and land-intensive, and decreasingly labour-intensive. In recent decades, many ports have shed labour to become more productive and competitive. Direct port value added is also relatively small. The economic impact of a port is context specific and to some extent determined by its specialisation. Some commodities generate more value added for a port than others, with general cargo generating more value added per tonne of throughput and crude oil and containers the least in North West European ports, for which such an analysis was conducted (Haezendonck, Coeck, Verbeke, 2000).[1]

The larger the port, the more port-related employment. A meta-study of about 150 port impact studies conducted for this report indicates that on average, one million tonnes of port throughput is associated with 800 jobs. This number includes direct and indirect port jobs and should be interpreted with caution, as it is based on port impact studies that use different definitions of ports and apply different methodologies. The variation of results is fairly large, but two-thirds of the ports in the sample have between 200 and 1 500 jobs per million tonne of port cargo. A few outliers distort the correlation, but in general, the link between cargo volume and port-related employment holds (Figure 2.2.). With respect to cruise ports, the average number of direct and indirect jobs is 3.5 per thousand cruise passengers.

Port-attracted industries can represent a relatively large share of employment and value added of port regions, *e.g.* up to 10% of employment and 16% of value added of the main port regions in northwest Europe. Much depends on which sectors are included in the port-attracted industries. Some studies follow the boundaries of the port area in which case the industries located there are considered port-attracted industries.[2] Annual studies of the National Bank of Belgium on the economic impact of Belgian ports incorporate all activities located in the port areas (Mathys, 2010). Firms that may be located in the port need not in fact have a relation to the port, whereas other firms could be located near the port because they need good access to it. For this reason, a functional approach is often used to capture the port-attracted firms in certain defined regional boundaries. Input/output-models are frequently used to identify intersectoral links with the port, that is, their backward and forward linkages. Much depends on the port in question, but usually seaports have inter-linkages with the transport equipment sector and the wholesale and retail sector. The challenge is to find a coherent demarcation of port-attracted industries: what one study may consider port-related industry may be different in another. To overcome this discretionary distinction between port-related and non-port-related industries, an alternative approach has been to use differences in economic specialisation between port regions and non-port regions as a way to determine which sectors to consider as port-related sectors. This approach has been applied to Italy (Musso, Benacchio and Ferrari, 2000).

Figure 2.2. Relation between employment and port volume



Source: Elaboration based on compiled dataset of existing port impact studies, Merk (forthcoming).

At the same time, port throughput is positively correlated to employment in port regions, according to our analysis of European port-regions. This study indicates that an increase of one million tonnes of port throughput is associated with an increase in employment in the port region of 0.0003% (Ferrari et al., 2012). This means that in a region with one million employees, employment would increase by 300 units; in the long run, this increase would be 7 500 units. This impact is slightly larger on industry than on service employment. These conclusions are based an evaluation of the impact of port activity on regional employment in a sample of 560 regions in 10 European countries, 100 of which were home to one or more ports, from 2000-06. If liquid bulk is not included in port-throughput numbers, the employment impact in the region doubles: an increase of one million tonnes of port throughput is then associated with a regional employment increase of 600 units. This finding confirms the fact that only a few jobs are needed to handle liquid bulk, because of the loading and unloading of a large share of it by pipelines. No significant employment impact was found for (ferry) passengers.

Ports and innovation

Ports determine to some extent the direction of research and innovation. Port-cities are dominant in port-related patents, such as shipping, petroleum and hoisting/lifting. Almost all the ten world regions with the highest number of patent applications in shipping are home to one or more large global ports, including Houston, Los Angeles/Long Beach, Tokyo, Oakland and Rotterdam (Table 2.9). Of these regions in the top ten for shipping patents, only the Zürich region does not have a port. The regions of Stockholm and Rogaland have ports (Stockholm and Stavanger respectively), but they are not among the top 125 world ports. Port-regions are also strong with respect to port-related patents in a wider sense. These include patents in technologies used in the port sector (constructions and hoisting-lifting-hauling), or important commodities handled in port areas, such as petroleum and foodstuffs.

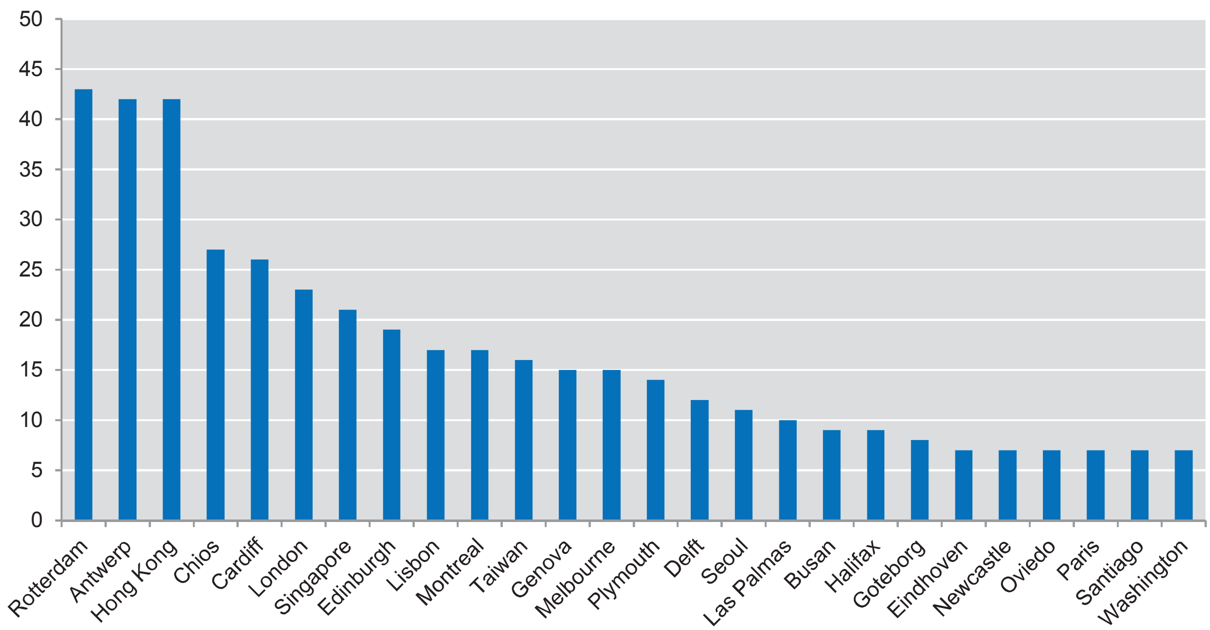
Table 2.9. Top 10 world regions for shipping patents (2005-07)

Region	Percentage of shipping patents	Top 125 ports
1. Houston-Baytown-Huntsville (US)	3.9%	Houston
2. Los Angeles-Long Beach-Riverside (US)	2.1%	Los Angeles and Long Beach
3. Tokyo (JP)	2.1%	Tokyo, Yokohama and Chiba
4. San Jose-San Francisco-Oakland (US)	2.0%	Oakland
5. Zuid-Holland (NL)	1.9%	Rotterdam
6. Västra Götalands län (SE)	1.5%	Gothenburg
7. Zurich (CH)	1.4%	
8. Stockholm (SE)	1.4%	
9. New York-Newark-Bridgeport (US)	1.3%	New York/New Jersey
10. Rogaland (NO)	1.2%	

Source: Authors'elaborations based on OECD (2014), "Patents by main technology and by International Patent Classification (IPC)", *OECD Patent Statistics* (database), http://dx.doi.org/10.1787/data-00508-en, (accessed 20 April 2013).

Port-related research is primarily conducted in universities in port-cities, and not in most other cities. This can be concluded from a count of the city affiliations of the authors and co-authors of 576 port-related articles published in leading peer-reviewed academic journals between 1997 and 2011 (Figure 2.3). Rotterdam ranks highest on this count, closely followed by Antwerp and Hong Kong. As becomes clear from this ranking, port-related research is conducted is strongly associated with the presence of ports: almost all the highly ranked cities in the list are port-cities and varies widely from worldwide university rankings, in which leading US and UK universities, such as Harvard, Oxford and Cambridge, tend to figure. Several of these port-cities, such as Hamburg, Copenhagen and Marseille, also offer maritime business education programmes, such as maritime MBAs.

Figure 2.3. Leading cities in port-related research

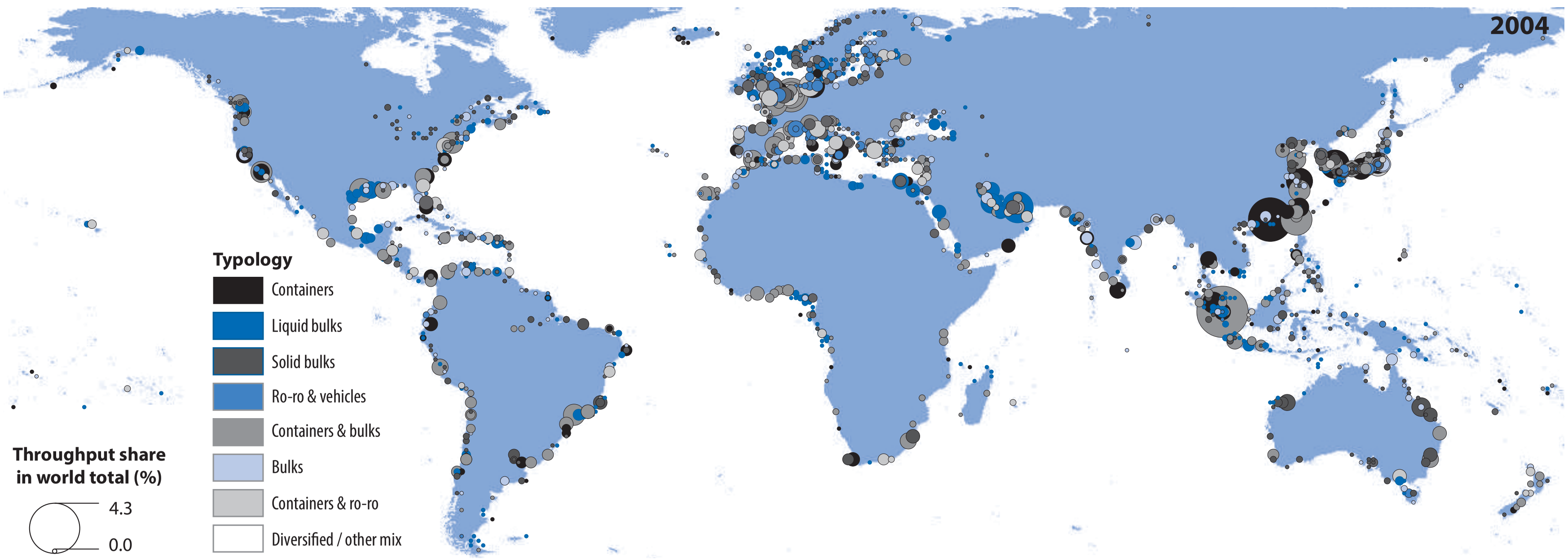


Source: Authors' data compilation based on list of articles mentioned in Pallis, A., T. Vitsounis, P. de Langen (2011), "Port Economics, Policy and Management : Content Classification and Survey", *Transport Reviews : A Transnational Transdisciplinary Journal*, Vol. 31, No. 4, pp. 445-471; www.porteconomics.eu.

Where do ports make an impact?

Port-cities benefit from part of the economic impacts of ports. Most of the direct port-related value added is still created in port-cities. They also benefit from the effects of clustering industries in a port area, and the economies of scale and knowledge transfer associated with it. Several resource-intensive industries continue to be attracted by port areas, because location in a port limits their transportation costs. Port traffic is very sensitive to the local economy in which it is handled: in larger and richer regions with large tertiary sectors, the port volumes are often more diversified and include more high-value-added goods, such as containers and consumer goods, whereas agricultural and industrial regions are usually more specialised in bulk traffic (Ducruet et al., forthcoming). This is a relevant finding that could explain the wide variety of port specialisation profiles all over the world (Figure 2.3.).

Figure 2.4. Port specialisation profiles



Source: Authors' elaboration based on dataset from Lloyds' Marine Intelligence Unit (LMIU).

However, most of the indirect and catalytic effects of ports take place outside port-regions. Firms in other regions also benefit from efficient ports, in that they reduce their transport costs and facilitate imports and exports. Backward and forward linkages of port clusters extend to a whole country; the impact is usually fairly small in the port-city itself. This can be concluded from analysis conducted in the various OECD Port-Cities case studies, in which port clusters were integrated in multi-regional input/output-tables, which makes it possible to identify where main linkages take place. Our analyses show that only a very limited part of these linkages takes place in the port or the port-region, with a larger share in the main economic centre of the country, which could be relatively far away from the port, *e.g.* Ile-de France for the ports of Le Havre and Marseille; and Bavaria and Baden-Württemberg for the port of Hamburg. Port-related employment has tended to partly shift to other regions as well, in parallel with the relocation of logistics activity further away from ports. In many cases, spillovers take place not only to other regions in the same country, but also into other countries. The port of Rotterdam, for example, plays an important role for German industries, and several European ports for the land-locked central European countries.

Negative impacts of ports

Environmental impacts

There are a variety of environmental impacts related to port activity. These impacts are related to shipping activity in a port, the activity on the port land itself and the environmental impacts of hinterland transport to and from ports. The main impact falls on air emissions, water quality, soil, waste, biodiversity, noise and so on. These environmental impacts can have severe consequences for the health of the population of the port-city, especially for the poorer parts of port-cities.

Air emissions

Maritime shipping is the most carbon-efficient form of transport in terms of grammes of carbon dioxide emitted per cargo ton, compared to rail, road or air transport (WSC, 2009), but the sheer scale of maritime transport activities generates massive quantities of emissions. These affect the composition of the atmosphere, the climate and human health (Corbett et al. 2007; Eyring et al., 2005). The main compounds of concern emitted by shipping and port operations are sulphur dioxide (SO_2), carbon dioxide (CO_2), black carbon (BC), carbon monoxide (CO), nitrogen oxides (NO_x), and various kinds of particulate organic matter (OECD, 2011).[3] Sulphur is at the origin of many particulate matters that epidemiological studies have consistently linked with a range of illnesses, including pulmonary diseases and premature death (Eyring et al., 2010). Corbett et al. (2007) have estimated that, because the vast majority (70%) of these emissions occur within 400 kilometres of coastal communities, shipping emissions cause around 60 000 early mortalities each year, mainly in the seaside areas of East Asia, South Asia and Europe. Uncertainties in the data and methods used to calculate mortality limit this estimate to within the range of 20 000-104 000 (Eyring et al., 2010), but the impacts fall within a troubling order of magnitude.

Due to the huge differences in terms of air emission measurements and port characteristics, it is difficult to make comparisons of air emissions at each port. Several ports publish a sustainability report presenting different indicators of their environmental impacts, including air emissions, including Los Angeles, Long Beach, Houston, Vancouver, Seattle, Sydney, Auckland, Hong Kong, Gothenburg, Barcelona, Hamburg and Antwerp. As there is no definite list of common air contaminants, each port can make its own. For example, in its sustainability report, the port of Antwerp considers sulphur dioxide (SO_2), nitrogen oxides (NO_x), as well as particulate matter (PM_{10}) for air pollution, whereas the port of Vancouver takes into account more gases in its landside emission inventory, such as carbon monoxide (CO), volatile organic compounds (VOCs) and ammonia (NH_3).

Shipping emissions can present a large share of the total emissions in the port-city. These can represent up to half of the emissions of the port-city, as in Hong Kong and Los Angeles/Long Beach with respect to SO_2 emissions (Table 2.10). Ports can also have considerable impacts on other aspects of air emissions of cities, such as NO_x and PM_{10}. In addition, most large port-cities are also industrial estates with their own air emissions, which are not included in the table below. However, it is not easy to collect and compare these data, because of the different focus and scope of the air emissions inventories of ports and cities. City inventories do in many cases not include the port area, do not focus on transport-related emissions or focus on GHG emissions, whereas the main air emissions impacts from ports come from SO_x, NO_x and PM.

Table 2.10. Shipping-related emissions as share of total city emissions

Port	SO_2	NO_x	PM_{10}
Hong Kong	54%	33%	n.a.
Shanghai	7%	10%	n.a.
Los Angeles/Long Beach	45%	9%	n.a.
Rotterdam	n.a.	13-25%	10-15%

Source: Authors' data compilation based on port's air emission inventories.

Among the air contaminants in ports, $PM_{2,5}$ and NO_x present higher externalities, thus being the most pressing air contaminants to measure and mitigate. In their study on 13 selected Spanish harbours, the main pollutant regarding emitted quantity is NO_x, representing 86% of total emissions of air contaminants. However, it is important to underline that the kind of ship matters. Indeed, the Vancouver 2011 emission inventory explains that container ships and cruise ships play a particular part in port-related emissions. If containership represents 26% of total port calls, it is the main source of emissions of NO_x (33.6% of total). In parallel, cruise ships represent 14% of calls but 32.5% of port-related emissions of CO_2. Air pollution from ports can present large external costs to their cities (Table 2.11). For a standard city with a population of 100 000 people, a tonne of $PM_{2,5}$ presents social costs of approximately EUR 33 000, whereas it presents social costs of EUR 495 000 for a city of several million people. The same applies to SO_2, whose costs vary from EUR 6 000/tm to EUR 90 000/tm respectively (Holland and Watkiss, 2002, cited in Castells Sanabra, Usabiaga Santamaría and Martínez De Osés, 2013).

Table 2.11. External costs of shipping emissions in selected port-cities

Port	Indicator	Estimated cost	Source
Bergen (Norway)	Air emissions of ships at berth	EUR 10-22 million	MacArthur and Osland (2011)
13 Spanish ports	$PM_{2,5}$, SO_2, NO_x emissions	EUR 206 million	Castells Sanabra et al (2013)
Piraeus (Greece)	External cost per cruise passenger	EUR 2.9-10.4	Tzannatos (2010)
Kaohsiung (Ch.Tapei)	Air emissions of ships at berth	EUR 119.2 million	Berechman & Tseng (2012)

Source: Authors' compilation based sources cited in the table.

Water quality

Ports are a source of pollution of water, but detailed information on emissions in water is scanty by comparison with air emissions. One major source of water pollution in ports is oil spills, coming from port run-off, unloading and loading of oil tankers, removal of bilge water and leakages. Oil spills result from normal activities, accidents and illegal dumping practices. Although tanker accidents are thought of as an important source of water pollution, some estimates indicate that normal shipping operations are responsible for over 70% of the oil entering the sea from marine transportation. Statistics also show that 80% of oil spills occur in harbour waters (Miola et al., 2009). Bailey et al. (2004) note that in the year 2000, 8 354 oil spills were reported in US waters, accounting for more than 1.4 million gallons of spilled oil. These spills caused up to three times as much oil contamination as tanker accidents.

The other main source of water pollution is the transfer of harmful aquatic organisms (including dormant stages of microscopic toxic aquatic organisms such as dinoflagellates, pathogens such as the bacterium *Vibrio cholera*) due to the discharge of ballast water, which is used to stabilise vessels (Miola et al., 2009). According to the International Maritime Organisation (IMO), about 10 billion tonnes of ballast water is transferred each year, amongst which 3 500 million tonnes is discharged (Endresen et al., 2004). Other sources of water pollution are pollution from slop (residual chemical products contained in the tanks and of the product used in washing operations), whether it is treated or illegally discharged, and leaching of anti-fouling paints. These paints are used to coat the bottom of ships to prevent aquatic fauna and flora attaching to the hull, slowing down the ship and increasing fuel consumption (OECD, 2011).

Soil

Soil pollution from the maritime transportation sector is mainly linked to the terrestrial activities in port areas. There are multiple sources of soil pollution in port areas: discharge of oil on the soil (from vehicles and fuel deposits), chemical spills from ship demolition; and emissions of SO_2, NO_x causing acid rain and consequently, soil acidification. However, the main impact of ports on soil is erosion. Because the presence of a port modifies the natural transport of coastal sediment, it causes erosion. This can produce a degradation of natural habitat and harm biodiversity. It can also destroy land that could be used for recreational or productive uses (Miola et al., 2009).

Waste

Port activities produce waste, especially from oil terminals, fuel deposits and dry-docks operations, which produce oily and toxic sludges. Waste also comes from other sources, such as ships (Miola et al., 2009). A crucial role is played by cruise ships; although they represent less than 1% of the global fleet, they are responsible for 25% of all waste, consisting of glass, tin, plastic, paper, cardboard, steel cans, kitchen grease, kitchen waste and food waste (Miola et al., 2009). Waste is a challenge for port authorities, which have to collect and treat it. For example in 2010, the port of Antwerp collected more than 250 tons of oil-containing and various hazardous wastes in the waste dumps of the port and nearly 400 tons of non-hazardous waste (Port of Antwerp, 2010). Plastics are an important source of waste, and plastics released from vessels makes up almost 80% of all garbage found on shorelines and on the sea floor in the Mediterranean (Abdulla and Linden, 2008). Waste is linked to health and land use issues. Indeed, as the Port of Houston notes, improving waste recycling is a way to reduce landfills.

Biodiversity

Ports' impact on biodiversity is due mainly to air emissions, waste and ballast water (Table 2.11). One of the main sources of disruption of the balance of ecosystems is the introduction of non-indigenous marine species through the transfer of ballast water. Non-native species can compete with local species and cause heavy environmental damage. Sulphur and nitrogen compounds emitted from ships, oxidising in the atmosphere, can contribute to acidification, causing acid depositions that can be detrimental to the natural environment, such as lakes, rivers, soils, fauna and flora. NO_x deposition is also a vector of eutrophication, which can alter ecosystems. Dredging may have an impact on the ecosystem, but in most dredging projects the impact is temporary and often limited through environmental monitoring and compensatory measures. Finally, noise can disturb animals both at sea and in port areas. Economic valuations of port-related biodiversity loss appear substantial. Landside impacts of ports concern mainly birds, which can breed on port land. Light from industrial activity can also be detrimental to bird populations.

Table 2.12. Port impacts on biodiversity

Source	Effects	Species affected
TBT paint	Morphological change, change in population structure	Marine invertebrates
Anchoring	Sediment re-suspension, decrease of photosynthetic ability	Marine organisms living in harbours, seagrass
Oil discharge	Genetic damage, oxidative stress, behavioural abnormalities	Marine vertebrates, birds
Gas emissions	Ocean acidification	Plankton, coral, organisms with calcification process
Chemicals	Accumulation of substances in organisms that cause disruption of the endocrine system	Predators at the top of the food chain
Waste	Eutrophication	Seagrass, fish
Debris	Death by ingesting floating plastics	Seabirds, turtles, whales
Ballast water	Introduction of invasive non-indigenous species, extinction of native species	Entire ecosystem
Noise	Problems of communication for animals, collisions	Cetaceans, marine mammals
Collisions	Death	Cetaceans, other marine vertebrates (whales, dolphins, turtles)

Source: Authors'elaboration based on Abdulla, A. and O. Linden (eds.) (2008), "Maritime Traffic Effects on Biodiversity in the Mediterranean Sea: Review of Impacts, Priority Areas and Mitigation Measures", IUCN Centre for Mediterranean Co-operation, Malaga, Spain.

Noise

Noise impact from ports can derive from ships, cranes, trucks, trains and industrial activity. These different sources can have a large impact. In Livorno, the port-related road traffic of heavy vehicles was recognised as one of the main causes of noise in urban residential areas. In terms of absolute noise emission, the industrial area predominated, but the large distance from the urban area allows the impact to decrease to negligible levels. Berthed ships represent another significant noise source; a significant contribution comes from ferries and cruise vessels, because of the proximity of the passenger terminals to the city centre (Morretta, Iacoponi and Dolinich, 2008). A ship that falls within the external noise limits for ships set by the IMO is permitted to have a diesel generator exhaust sound power of 107 dB(A). If the sound power is 107 dB(A) and the noise limit for city residential areas is 40 dB(A), as is the case in various countries such as Denmark, the ship must be berthed more than 600 metres away in order not to exceed the noise limit (Lloyd's Register ODS, 2010).[4] Not surprisingly, noise has been one of the sustainability priorities of European port authorities over the last decade, consistently ranking in the top five most important environmental impacts as perceived by European ports, according to surveys by the European Seaports Organisation (ESPO, 2013).

A significant number of urban residents can be affected by port noise. This can be illustrated by Strategic Noise Maps that characterise the port noise climate, creating an acoustic map for each source of noise, as well as a map with overall port-related noise impacts. Through cross-comparisons between characteristic sound levels of the port area and the surrounding urban areas, it is possible to establish the number of residents affected. Based on a limited number of cases for which such an exercise has been conducted, the total number of people exposed to port-related noise ranges from 240 to 900 inhabitants per port (Table 2.12). A more critical situation may result from terminal and industrial activities that run 24 hours a day; for example, the number of people exposed to a nightly sound value greater than 50 dB(A) was 900 inhabitants, whereas the daily impact was 300 inhabitants (taking into account the daytime limit of 60 dB(A) (Morretta, Iacoponi and Dolinich, 2008). The number of people exposed to noise from water traffic and ports in Finland was estimated at between 100 and 500. However, many areas with special sensitivity to noise, such as schools, hospitals and cultural centres, are not only exposed to port noise, but also to other sources of noise, such as roads and railways. This can complicate the measurements, which makes it complicated to directly assess the particular impact of the port (Rizzuto et al., 2010).[5] The main harm that noise causes to the exposed population is annoyance and sleep disturbance, because they are more sensitive to noise levels than to other harmful effects.[6] According to the WHO, sound pressure levels on the facades of living spaces should not exceed 45 dB at night, so that people can sleep with their bedroom windows open (Berglund, Lindvall and Schwela [eds], 1999).

Table 2.13. Urban residents exposed to daily port noise

Port	Number of people exposed to daily port noise > 60 dB (A)
Amsterdam	242
Livorno	300
Valencia	856

Source: NoMEPorts (2008b), *Good Practice Guide on Port Area Noise Mapping and Management; Technical Annex*, Port of Amsterdam, Netherlands.

Health impacts of ports

Negative social impacts of ports are often health-related and generated primarily by pollution (air and water) and noise. Air pollution negatively impacts society by causing various respiratory and cardiovascular diseases, while water pollution from the storm run-off of port-related activities can result in skin and neurological health problems (Human Impact Partners, 2010). A concentration of more than 0.06 mg/m3, SO_x can affect the respiratory system and trigger bronchitis episodes and chest infections. Nitrogen oxides can also provoke serious damage to the breathing apparatus at a concentration of over 100 mg/m3, and even be lethal at 300-400 mg/m3 (Quaranta et al. 2014). Particulate matter (PM) also contributes to serious health problems, such as premature mortality, asthma attacks and millions of lost days of work (Miola et al., 2009). These environmental consequences, which render living conditions unhealthy can be categorised as direct effects. Several studies cite collisions and pedestrian safety as health issues directly related to living near a port. In addition, the British Department of Transportation considers indirect health impacts such as a lack of parks, community centres and clinics, which can contribute to mentally and physically healthier populations (Department of Transport, 2011). Perceived health impacts are also important to consider, as shown by a community survey in Seattle that discovered that 34% of residents in the two port communities of Georgetown and South Park rated their health status as "poor" or "fair", while only 10.5% gave this response in King County, Washington, as a whole (Community Coalition for Environmental Justice and Puget Sound, 2010).

Most of the studies concerning the health impacts of ports on the immediate population come from the United States, with several of these studies in Los Angeles and Long Beach, and mounting efforts in Houston, Seattle, and New York/New Jersey. Los Angeles/Long Beach appears to produce the most complete data regarding the health impact of ports. Data from the Los Angeles County Health Survey reveals that Long Beach communities in close proximity to the Port of Los Angeles experience higher rates (2.9 percentage points on average) of asthma, coronary heart disease and depression, compared to other communities in Los Angeles (Human Impact Partners, 2010). Additionally, the California Air Resources Board attributed 3 700 premature deaths per year to ports and the shipment of goods (Sharma, 2006). Europe has also made significant advances in assessing negative environmental effects of port activity, while not always linking these impacts to public health literature and studies.

As for air pollution, nitrogen dioxide and organic carbon emitted from various port activities have been linked to bronchitic symptoms (Sharma, 2006). Exposure to sulphur dioxide is associated with respiratory issues and premature births. Another port source of harmful air pollutants is trucks travelling in and out of the port that produce harmful emissions that degrade air quality (UCBHIG, 2010). The Healthy Port Communities Commission has growing concerns, stating that communities surrounding the Port of Houston have the highest air toxicity rates and also elevated rates of cancer and asthma compared to Greater Houston more generally (The Citizen, 2013). Specific pollutants found in water related to adverse human health conditions include tributylin, or TBT (used to ward off barnacles and other marine organisms), oil, toxic substances, and high concentrations of heavy metals. Additionally, ballast water can carry disease-causing organisms and contaminate seafood for human consumption (Sharma, 2006). Assessment of the health impact can be conducted through measures of mortality and morbidity, using either the Value of the Statistical Life (VSL) or the Value of a Life-Year (VOLY). The monetary value of health impacts has been calculated by the Environmental Protection Agency (EPA) in the United States, for example: the lifetime cost of one case of chronic bronchitis is worth USD 420 000 in 2010 income (Miola et al., 2009).

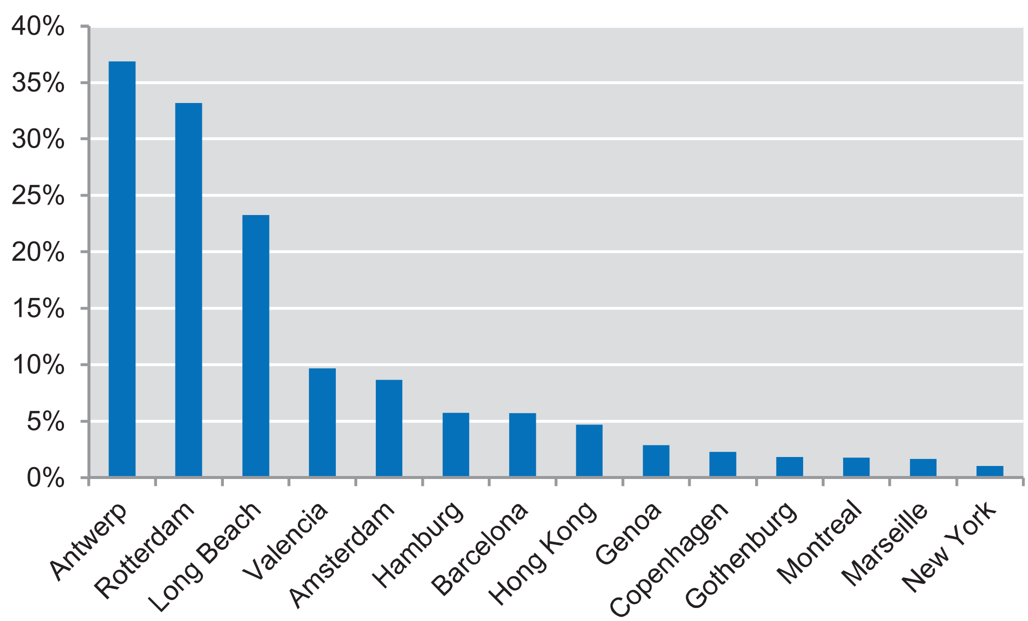
Noise from port operations can cause high blood pressure, heart disease and other stress-related symptoms. In Shanghai, for example, the population is said to suffer more from noise pollution than from air pollution caused by ports (Yang in Sharma, 2006). Children can be particularly affected by the noise generated by port activity, and delayed learning has been linked to noise in the public health literature (*ibid*). This "port noise" is caused primarily by diesel engines approaching and idling in the dock, activity that is capable of reaching between 80 and 120 dB, as well as the loading and unloading of goods (Sharma 2006; Morretta, Iacoponi and Dolinich, 2008). A study found that port-related vehicle traffic (in combination with public transport and train traffic noise, caused more than a third of residents in West Oakland, California, to be highly affected by noise, with eight myocardial infarction deaths (15% of all myocardial infarction deaths) per year attributable to this noise exposure, and one-third of residents at risk of sleep disturbance. Compared to a standard of 60 dB, the existing noise levels were said to have resulted in the possibility of a 29% impairment in recall and reading and a 4% impairment in recognition and attention, with potential consequences for the cognitive development of children in West Oakland. (UCBHIG, 2010).

Land use impacts

Another characteristic of modern ports is their space-intensity; they occupy a relatively large share of the metropolitan land surface. Among selected port-cities, Antwerp, Rotterdam and Long Beach occupy a very large proportion of urban land used for port activities (Figures 2.5 and 2.6). Other large ports tend to use a percentage of the city surface that is lower than 5%. Even a port like Hamburg, located in the very core of the city, occupies only slightly more than 5% of the land surface of the city. Caution is called for in these comparisons, because the administrative boundaries of cities vary widely but have a large impact on the outcome of these calculations. Still, comparisons are not meaningless. Land use impacts often become prevalent in case of port development projects, because they enter into competition for land with other uses of the city surface, or can degrade natural habitat and biodiversity if they occur in areas that were not previously developed, as is often the case.

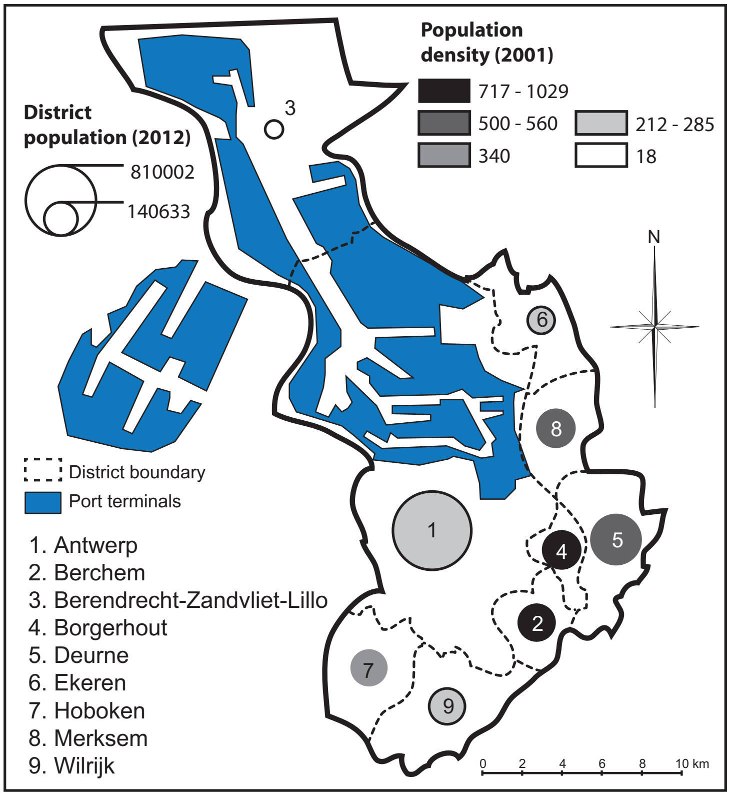
The economic consequences of port land use can also entail opportunity costs. Agglomeration effects and high job density are generally considered to be factors of urban economic growth, and these agglomeration effects may be constrained by the presence of large port areas. Since they are generally not easily accessible to the public, they cannot be expected to generate the agglomeration effects associated with urban areas in terms of knowledge spillovers, although clustering effects in port areas could be dependent on size.

Figure 2.5. Port land surface in selected port-cities (as share of total city area)



Source: Authors' data collection based on data provided by port authorities; Civic Exchange (2009), "Green Harbours II: Reducing Marine and Port-related Emissions in the Pearl River Delta Region", Civic Exchange, Hong Kong; Hong, Z., et al. (2013), "The Competitiveness of Global Port-Cities: The Case of Shanghai, China", *OECD Regional Development Working Papers*, No. 2013/23, OECD Publishing, Paris, http://dx.doi.org/10.1787/5k3wd3bnz7tb-en; Merk, O. (2013), "The Competitiveness of Global Port-Cities: Synthesis Report", *OECD Regional Development Working Papers*, No. 2013/13, OECD Publishing, Paris, http://dx.doi/10.1787/5k40hdhp6t8s-en; Starcrest Consulting (2011), "Port of Los Angeles inventory of air emissions – 2010", *Technical Report,* ADP#050520-525.

Figure 2.6. Land surface of the Port and the City of Antwerp



Traffic impacts

The presence of a port can lead to urban congestion caused by the hinterland traffic to and from the port area. A large share of freight transport between a port and its hinterland is by truck, which adds to road traffic volumes, and often to congestion costs in metropolitan areas that are struggling with congestion. For example, the costs of road congestion due to a 6% rise in freight volumes in the Port of New York/New Jersey have been estimated at between USD 0.3 billion and USD 0.8 billion per year (Berechman, 2009). Rotterdam and Antwerp provide relevant examples of port-cities that have experienced greater congestion due to the growth of port activity (Borger and Bruyne, 2011). The issue is even more pronounced in developing countries and emerging port-cities. Congestion in urban areas attributable to port activity and traffic heightens the negative economic and environmental impacts of the global shipping trade on metropolitan regions hosting port facilities. Such challenges require innovative policies to promote sustainable port activities and efficient transport between the port and the hinterland.

Urban congestion due to port-related traffic originates at the port-land interface. While containerised cargoes were, in part, made to facilitate intermodal movement between port and hinterland, urban areas are not unaffected by large shipments and movements of goods. Inadequate port services and cargo handling equipment, availability of storage space, excessive turn-around times and unloading time can all contribute to delays in urban traffic flows (Jaja, 2011). Furthermore, high truck volumes and their large cargoes contribute disproportionately to traffic accidents and ensuing delays (Giuliano and O'Brien, 2008).

Congestion on urban road networks due to increased cargo throughput at a port can, in turn, negatively impact the port. It is widely acknowledged that port activities and transport network operations cannot function independently of each other. The inefficiency of either one will forcibly negatively impact the other, which indicates how tightly inland networks and seaports are connected (Notteboom and Rodrigue, 2008). In US port-cities, intensified port competition can result from such congestion, as clogged networks tend to correlate to a shift from shipping companies to a neighbouring and often rival port (Wan et al., 2013).

Other negative impacts of ports

Ports also have other impacts that can be a source of nuisance to local citizens. These include:

- **Visual impacts**: First, industrial activities, of ports, with bulk cargo piles and stacks of ugly materials may give an unpleasant impression (Economic and Social Commission for Asia and the Pacific, 1992). Then, particles and NO_2 linked to air emissions from maritime transport activities, as highlighted by Holland et al. (2005), can have impacts on visibility, by reducing the visual range (Miola et al., 2009). The last issue in relation to the visual impact of ports concerns artificial lights burning 24 hours a day. Lighting may cause a nuisance to nearby residents and also have negative effects on wildlife, including disorientation and a confusion of biological rhythms. Lighting can cause mortality among bird populations, because they are attracted to brightly lit buildings, and circle these structures until they die of exhaustion or run head into them (Bailey et al., 2004).

- **Odour**: Diverse port activities can provoke unpleasant smells that can harm local residents' quality of life. The port of Antwerp, in its sustainability report, notes that if the petrochemical industry appears to be the largest source of environmental damage in the port area, the majority of the complaints involve complaints about odours. It thus appears that a discrepancy exists between the concerns of port authorities and what local residents consider the most important negative impacts, because odours are not part of the top concerns of port authorities (ESPO, 2013).

- **Dust**: This is produced in ports mainly by bulk cargo handling and storage, construction work and road traffic. It is measured by suspended particulate matter (Economic and Social Commission for Asia and the Pacific, 1992). Particles can penetrate the human respiratory tract and exacerbate respiratory conditions such as asthma (Fortescue, 2011).

- **Social impacts**: These include all the impacts of the development of ports that could influence the life of local communities, such as relocation of villages, disruption of lifestyle, formation of slums, etc. Indeed, modernisation brought by the development of ports can change the cultural traditions and the everyday life of the local community, for example by disturbing the local fishery operations, as well as increasing the risk of accidents, which is of concern for local populations (Economic and Social Commission for Asia and the Pacific, 1992). Furthermore, oil and wastes discharged from ships can reach beaches and disturb recreational activities, as well as tourism.

- **Security issues**: Ports are often associated with military installations, nuclear power plants, oil refineries, fuel tanks, pipelines, chemical plants and major cities with dense populations. First, transport of hazardous goods poses risks of explosions. For example, in November 2002, an explosion involving improperly stored fireworks and calcium hypochlorite containers (a bleaching agent used in swimming pools) caused one death and extensive damage to the 4 389 TEU *Hanjin Pennsylvania* and its cargo off Sri Lanka (OECD, 2003). Furthermore, ports are crucial places for international contraband; as Monson Jessup and Casavant (2006) note, 12 seaports surveyed by the United States Interagency Commission on Crime and Security in American Seaports accounted for 69%, 55% and 12% respectively for all cocaine, marijuana and heroin seized nationwide (by weight). The use of containers for illegal purposes is facilitated because it is impossible to inspect all containers. In the United States, only 4% to 6% of containers' content is verified (Monson, Jessup and Casavant, 2006). It is noteworthy to underline a dramatic shift after the September 11, 2001 terrorist attacks: security concerns shifted to assessing threats of possible terrorist attacks, through the smuggling of weapons of mass destruction shipped into a country and detonated at a port, using containers for transport or even an entire ship as a weapon.

Although this does not constitute an impact of ports on their environment, seaports are particularly vulnerable to climate change impacts, because of their location in coastal zones, low-lying areas and deltas. They can be particularly affected by rising sea levels, floods, storm surges and strong winds. Climate change is expected to have a range of diverse environmental, social and economic effects. In its Fourth Assessment Report, published in 2007, the Intergovernmental Panel on Climate Change (IPCC) estimated that global average sea level would rise from 18 centimetres to 59 centimetres by the last decade of the 21st century (US EPA, 2008). One recent study has estimated that assuming a sea-level rise of 0.5 metres by 2050, the value of exposed assets in 136 port megacities may be as high as USD 28 trillion (Lenton, Footitt and Dlugolecki, 2009). Ports will also have to consider anticipated sea levels not only for economic reasons, but also to prevent leaching of contaminants. The severity of these impacts will vary widely by geographical location and depend on a number of factors, and uncertainty over their exact magnitude makes it difficult to implement adaptation measures.

Where do the negative impacts take place?

Port impacts have generally become suburbanised. Many port sites have relocated from city centres. Port relocations and gradual spatial disintegration of ports and cities over time have taken place in many countries and have had a profound influence on ports. Remaining port functions near highly populated areas have been constrained because of public resistance to their negative impact. However, there is a large variety between port-cities. Because ports are capital intensive, port relocations are often not immediately possible and the shift has often been gradual, through new terminal development away from city development. Several ports have thus developed on multiple sites, which adds a new layer of complexity to evaluating the positive and negative impact. Port layout also is important, because the boundary of the port area and a city is the location of most environmental impacts. If this boundary abuts on a large concentration of population, the intensity of port impacts will evidently be larger. Finally, the governance component to this discussion, where most of these impacts affect surrounding municipalities, often calls for a metropolitan or regional approach.

The effects of pollution, dust and noise are all very localised, and most of the congestion costs occur close to the ports. Other regions are also subject to the negative impacts of the hinterland transport of port cargo to or from their region, but these effects are more diluted than the impacts in the port-city. Moreover, the negative impacts are skewed; large port-cities can be considered environmental hotspots. According to our estimates, the largest 25 ports in the world account for around half of the shipping emissions in all the world's ports (Merk, 2012), implying a large difference in negative port-city impacts depending on port size. Other environmental impacts from shipping are evidently global, and many take place at sea, but these become particularly evident in port-cities.

Weighing ports' benefits against their negative impacts

The overview of impacts presented in this chapter shows that ports' costs and negative effects are localised, whereas benefits are usually generated at the supra-regional (national) and even supranational level (Table 2.13). This finding is in line with the mismatch suggested by various authors (*e.g.* Hesse, 2006). There are substantial benefits from ports, but they can have considerable leakages to other regions. These spillovers include lower costs of external trade and indirect economic linkages, including supplier linkages and economic specialisations that spill over to other regions. Maritime-related engineering services are to a limited extent located in Rotterdam, for example, but to a much larger extent in the Rotterdam metropolitan region and the rest of the Netherlands (Merk and Notteboom, 2013). Port-related employment is increasingly de-concentrating, in many cases away from port regions. The port can be a revenue source for local governments if they are in charge of the ports, but in many cases, the national government receives the net profits. Ports can provide interesting sites of renewable energy production, and in particular biomass production, considering the large diversity of commodity flows and sophisticated refinery infrastructure, but this production capacity will most likely serve a wider area than just the port region. These spillovers are not problematic from a national or supra-national perspective – and might in fact be desirable considering the gateway role that ports play for their countries – but pose particular challenges for port-cities and their mayors that would like to use the port as an engine for an urban economy.

All the more since most of the negative effects of ports are localised, including the environmental effects identified in this chapter. The impacts of hinterland traffic are also mostly local, because most of the short-range hinterland traffic is by truck (and in many cases more polluting), whereas most of the longer-range hinterland traffic is by modes with less negative externalities (rail and barge). Comprehensive evaluation of this mismatch is difficult to quantify, in particular due to difficulties in measuring negative impacts. However, various studies have been conducted in recent decades to quantify negative impacts (Box 2.1).

Table 2.14. Costs and benefits of global ports

	Local	National	Supra-national
Costs			
- Economic	Infrastructure investments Opportunity costs, land use	Infrastructure investments	
- Environmental	Air, water, waste, noise, odour Hinterland traffic		
Benefits			
- Economic	Port-related value added Agglomeration effects Knowledge spill-overs Lower costs of trade	Forward/backward linkages Lower costs of trade	Lower costs of trade
- Environmental		Renewable energy production	

Box 2.1. Methodologies to measure negative port impacts

One of the emerging approaches for economic appraisals of the port-city relationship – in particular the impacts on city population – is the contingent valuation method, based on an analysis of the local population's willingness to pay for certain policies or to avoid certain proposed measures (Saz-Salazar, García-Menéndez and Merk, 2013). Such studies include one on the renewal of vacant port areas for recreation purposes in the Spanish port-city of Castellón (Saz-Salazar and García-Menéndez, 2003), and one assessing negative externalities resulting from port expansion in Valencia (Saz-Salazar, García-Menéndez, Feo-Valero, 2012). The Valencia study calculated that the average compensation required would be around EUR 100 per family negatively affected, amounting to a present value of the costs borne by local citizens of approximately EUR 41 million. A more or less comparable study of Tianjin (China) showed that citizens had no statistically significant preference for or disapproval of port construction (Zhai and Suzuki, 2008). Another approach for quantifying port impacts is the hedonic price analysis, measuring the effect of different economic parameters on the cost of housing.

Hedonic price analysis studies have found that proximity to industrial zones has negative price effects, but this is not necessarily true for port areas.[7] Proximity to an industrial site exhibits a statistically significant negative effect on the value of residential properties in the Randstad region (Netherlands), but the effect of closeness to a port area was found to be insignificant (De Vor and De Groot, 2010). Hedonic price analysis conducted in Saint-Nazaire (France) showed no linear and univocal relation between proximity to the port industrial zone and housing prices, which could possibly be explained by a positive effect of proximity to place of work or easy access to the transport network, which can offset air pollution or environmental risks (Maslianskaia-Pautrel, 2009). Similarly, close proximity of housing to a seaport was found to have an insignificant effect on individual well-being in Ireland (Brereton, Clinch and Ferreira, 2008). Some evidence suggests proximity to the port-industrial complex of Port Jérôme, which is part of the Rouen port cluster, has negative effects on house prices. Hedonic price analysis, taking into account a house's intrinsic characteristics, shows that close proximity to this port-industrial complex leads to a price discount of approximately 12% of the average price for a similar house. Proximity to the River Seine leads to an even larger reduction, namely 38%; the Seine is thus not considered an asset in this regard (Travers et al., 2009). The lack of a broad base of quantitative assessments makes it difficult to generalise about the extent of the port-city mismatch of benefits and negative impacts; much is unknown and much depends on local circumstances.

Another negative port impact relates to the external costs of hinterland traffic, including costs related to congestion, accidents, air pollution, noise and other external costs. Haezendonck, Dooms and Coeck (2006) calculated the external costs of hinterland traffic related to the port of Rotterdam to be around EUR 240 million in 2000. Even if these calculations are dependent on the data quality and underlying assumptions, a growing academic literature supports such results (Maibach et al., 2008).

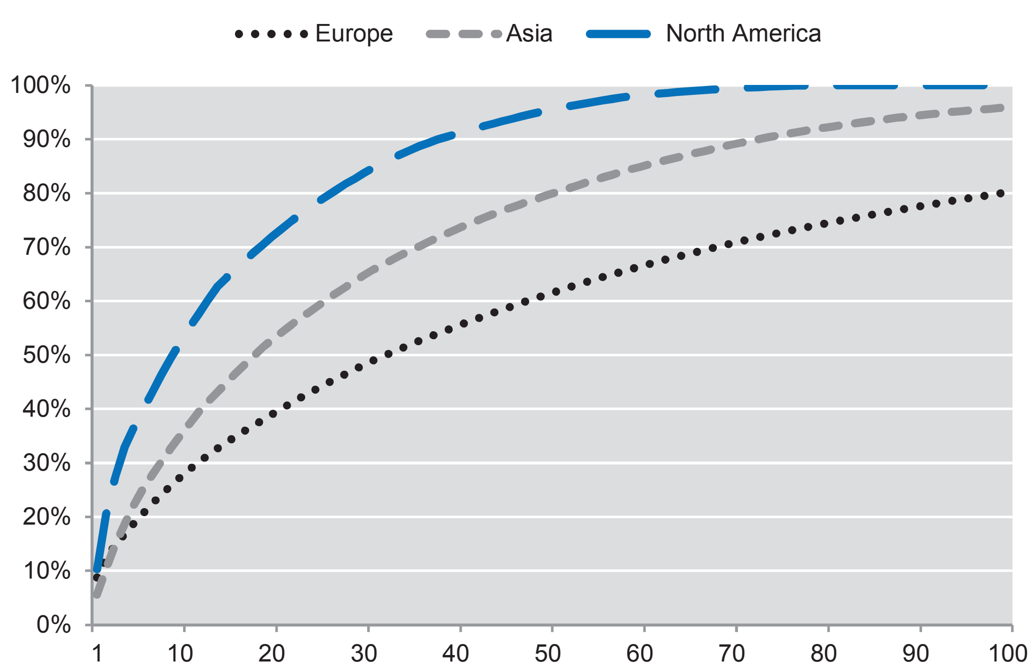
Source: Zhai and Suzuki, 2008; De Vor and De Groot, 2010; Maslianskaia-Pautrel, 2009; Brereton, Clinch and Ferreira, 2008; Travers et al., 2009; Haezendonck, Dooms and Coeck, 2006; Maibach et al., 2008.

The nature of the port-city interface, however, does have an effect. This can be illustrated by the distinct perspectives for Rotterdam and Amsterdam, the largest and fourth-largest European seaports, both located in the Netherlands. In spatial terms, port functions and urban functions have become increasingly dissociated in Rotterdam. The newest and most active port terminals are now situated at more than 40 kilometres from the city centre, and part of port activities take place in inland terminals (at extended gates such as Moerdijk). In Amsterdam, port functions have retreated to some extent, but a significant part of the port activity still takes place relatively close to the city centre. As a result, the port-city challenges are different. In Rotterdam, the congestion and environmental impacts of the port-industrial cluster can be felt in the city, but most of the port jobs are now held by workers from outside the city and the connection of urban citizens and businesses to the port complex is becoming attenuated. In Amsterdam, there is strong pressure to convert parts of the port premises to other urban functions, such as housing and office development (Merk and Notteboom, 2013).

Emerging trends that influence port impacts

Several developments have increased the port-city mismatch of benefits and impacts in recent decades. Containerisation has led to a standardisation of cargo handling, requiring less local labour. Growing ship sizes resulted in port concentration and the emergence of hub-and-spoke port networks. The top ten North American ports in 2009 handled half of the total port volume on their continent whereas the share was 35% for Asian ports and 27% for European ports (Figure 2.7). The concentration among container ports has increased in recent decades, as indicated by the increasing scores on the Gini coefficients among ports in Europe, NAFTA and Asia. Analysis of the most dominant relationships of each port with other ports, based on a dataset of vessel movements, shows that ports are indeed subject to hub and spoke tendencies, and that a limited number of ports, such as Singapore and Hong Kong, act as a central node for many other ports.

Figure 2.7. Port concentration in Europe, North America and Asia (2009)



Note: Horizontal axis indicates the top 100 ports; the vertical axis indicates the cumulative traffic share of the first port to the first 100 ports.

Source: Authors' elaborations based on data from *Journal de la Marine Marchande,* editions from 1970 to 2013.

As a result, port functions in several cities declined or stagnated. Logistics activities moved out of port regions to places with more available land, spreading out port-related employment. Large ports expanded their hinterlands towards new regions, reducing their dependence on the port-city. Consolidation and globalisation of the shipping and port terminal industry changed port authorities' influence. Terminal operations used to be a public or local activity, but in recent decades, global terminal operators have massively expanded, often at the cost of local operators, and are now present in all large world ports. Operators with fewer local connections are less inclined to take into account the benefits or impacts on local communities. Global carriers have emerged as important players with huge market power that are able to shift almost instantaneously from one port to another. This has had considerable consequences for local ports, since some of the large carriers can represent up to a quarter of local port traffic (Table 2.14). Moreover, these carriers have been able to transfer the costs of increased vessel sizes, such as dredging and hinterland infrastructure, to public authorities.

Table 2.15. Port use shifts by global carriers

From	To	Volume TEUs	Date	Carrier
Singapore	Tanjung Telepas	1 000 000	2005	Maersk
Gioia Tauro	Port Said and Malta Freeport	700 000	2011	Maersk
Algeciras	Tanger-Med	500 000	2010	Maersk
Ningbo	Busan	400 000	2007	MSC
Tacoma	Seattle	180 000	2009	Maersk
Barcelona	Tercat	130 000	2009	Evergreen
Tercat	Barcelona	120 000	2009	Maersk
Barcelona	Tarragona	70 000	2009	ZIM
Seattle	Tacoma	n.a.	2012	Grand Alliance
Auckland	Tauranga	n.a.	2011	Maersk
Manzanillo	Lazaro Cardenas	n.a.	2004	Maersk
Valencia	Barcelona	n.a.	2007	China Shipping
JNP	Mundra	n.a.	2011	Hapag Lloyd

Source: Own data collection based on articles in *Port Strategy* magazine.

These developments are expected to continue. The average size of a container vessel has doubled in the last decade from an average capacity of 2 000 20-foot equivalent units (TEU) in 2000 to more than 4 000 TEU in 2010, a trend that is continuing with as a current wave of new vessels up to 18 000 TEU come into operation. This will no doubt reinforce the process of port concentration. A process of port regionalisation is under way in several countries, which will arguably further distribute the employment and value added related to port activity. Emerging markets are attracting the interest of global port terminal operators, which could reduce the local affiliations of ports in these countries.

The implications of these developments are increasing pressure on port-cities to show that ports can continue to be an asset for urban development. With economic benefits spilling over to other regions and negative impacts highly localised and concentrated, in line with port concentration, port-cities will be increasingly confronted by existential questions eroding their local support and “license to operate”. Port-cities must find ways to address such imbalances. How can they ensure that the port creates value for the city and that negative impacts are mitigated? How can they formulate a new balance of benefits and impacts? These questions will be discussed in the next chapter.

Notes

1. For example, the Bremen weighing rule states that the value added created by one ton of general cargo (conventional cargo, RORO and containers) equals the value added of three metric tons of dry bulk and 12 tons of liquid bulk. The Dupuydauby Rule attributes the following co-efficients to the different traffic categories: 12 to crude oil, 9 to liquid bulk, 6 to dry bulk, 3 to containers and RORO and 1 to conventional cargo. The Range Rules uses the following co-efficients: 1 for RORO; 1 for conventional cargo; 3 for containers; 5 for dry bulk; 2 for liquid bulk; and 18 for crude oil. See Haezendonck, Coeck, Verbeke, 2000.

2. Excluding the industries that are port required.

3. Air emissions can be divided into two groups: Common air contaminants (CACs) and greenhouse gases (GHGs). Each of these groups covers various gases. The main CACs are oxides of nitrogen (NO_x), oxides of sulphur (SO_x) and particulate matter (PM), among others. GHGs are gases present in the Earth's atmosphere that reduce the loss of heat into space (Starcrest Consulting, 2011). The main GHGs are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). GHGs affect climate as they concentrate in the Earth's atmosphere and trap heat by blocking some of the long-wave energy normally radiated back into space. Common air contaminants have a local or regional impact on air quality, whereas GHG pollutants have global impact on climate. Considering other types of air emissions, Schreier et al. (2006), underline that particle emissions from ships change the physical properties of low clouds, for the so-called indirect aerosol-effect. Particles and their precursors from ship emissions are able to act as cloud condensation nuclei (CCN) in the water vapour saturated environment of the maritime cloud (Miola et al., 2009).

4. Ship noises come from the diesel generator engine exhaust, the ventilation inlets and outlets, and secondary noise sources, such as pumps and reefers. The diesel generator is used to generate power on board of the vessel, and presents often the most predominant source of noise radiating from the ship to the surroundings. The diesel engine exhaust is often placed at the top of a funnel, which has a significant height compared to the surrounding landscape. This means that if the noise is not dampened, it may easily cause high noise levels in surroundings areas, even at large distances. The sound power in a selection of ship engines was found to vary between 135 dB(A) to 142 dB(A); and of the ventilation fans between 81 to 110 dB (A). Large hold ventilation fans are mainly used on RORO ships for ventilating car decks. Noise measurements of secondary noise sources such as reefers (cooling containers) show that the sound power of a single reefer is in the range of 90 dB(A). Each time the number of reefers is doubled, the sound volume increases by 3 dB. In general, the sound power of ships increases with the size of ships (as expressed in dead weight tonnes) (Lloyd's Register ODS, 2010).

5. With exposure limit above 55 dB.

6. EU Directive 2002/49/EC, Art.2, letter (r).

7 Hedonic prices are the implicit prices of attributes, which are revealed to economic agents from observed prices of differentiated products and the specific characteristics associated with them. This helps to explain house prices in terms of the house's characteristics, such as the type of dwelling, age, floor area, neighbourhood and job accessibility. It can also explain the impact of undesirable facilities on house values due to perceived disamenities. Such concerns (for example, worries about air pollution, health risks and public image) can manifest themselves in property markets, as buyers are likely to pay more to reside in locations farther from perceived disamenities.

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Chapter 3

Making ports competitive

How can ports keep their competitive edge? That is the core question of this chapter, which is of prime relevance to port-cities, given that only well-functioning, competitive ports are able to create economic value. The three main determinants for competitive ports, identified here, are: extensive maritime forelands, effective port operations and strong hinterland connections. Long-term competitiveness of the port is also dependent on the support of the local population, which is necessary to sustain port functions in metropolitan areas.

Table 3.1. Overview of policy instruments for competitive ports

Determinant	Instrument	Examples
1) Maritime connectivity	Trans-shipment	Singapore
	Nautical access	Deep-sea ports
	Internationalisation strategies	Rotterdam, Antwerp
2) Port operations		
Quality of inputs	Skills mapping and matching	New York/New Jersey
	Training and education	Singapore
	Social dialogue	Antwerp
	Upgrading equipment	Hamburg
	Land availability	
Quality of organisation	Port planning	Rotterdam
	Port information systems	Valencia
	Competition	Most large ports
	Co-ordination between ports	Copenhagen/Malmö
3) Hinterland	Links port with other transport modes	Rotterdam
	Dry ports and extended gates	Gothenburg
	Freight corridors	Betuwe-line
4) Local goodwill	Port centres	Genoa
	Port education	Long Beach
	Maritime museums	Antwerp
	Port events	Rotterdam
	Information and social media	Incheon
	Public access to port	Hamburg
	Other goodwill projects	Valparaíso

Table 3.1, a schematic representation of policy instruments that facilitate competitive ports, is based on the extensive literature on port choice. A competitive port is a port that is chosen more regularly than other ports, facilitating the growth of its market share. Port choice has been studied intensively in recent decades, in particular to identify the main actors and criteria determining port choice. An overview of these studies shows that shippers rank as the main decision-maker on port choice, followed by forwarders, shipping companies and terminal operators. The studies (Table 3.2) identify a large variety of port choice criteria, but some generic conclusions obtain. Port selection is most often seen as involving several actors, rather than simply one. In addition to a port's attributes, its integration in a wider set of criteria concerning global supply chains is of special importance (Magala and Sammons, 2008; Robinson, 2002; Bichou and Gray, 2004).

Table 3.2. What determines the choice of a port?

Decision maker on port choice	Port choice criteria (in order of importance)	Sources
Shippers	Costs, port operations quality, port location, frequency of shipping services, speed/time, service efficiency, port efficiency, port facilities, port information systems, hinterland connections, port congestion, port services, flexibility for special cargo	Slack (1985), Branch (1986), Murphy et al. (1992), Murphy and Daley (1994), Kumar and Vijay (2002), Nir et al. (2003), Tiwari et al. (2003), Malchow and Kanafani (2001), Malchow and Kanafani (2004), Song and Yeo (2004), Cullinane et al., 2005), Guy and Urli (2006), Ugboma et al. (2006), De Langen (2004), Leachman (2008), De Martino and Morvillo (2008)
Forwarders	Port efficiency, port operations quality, reputation, cost, frequency, location, speed/time, port information systems, hinterland connections	Slack (1985), Bird and Bland (1988), Murphy et al. (1992), Tongzon (1995), Tongzon and Sawant (2007), De Langen (2004), Grosso and Monteiro (2008), De Martino and Morvillo (2008), Tongzon (2009)
Shipping companies	Cost, port location, port facilities, port operations quality, speed/time, port efficiency, port congestion, frequency of shipping services, hinterland links, port information systems, information availability, port administration, port services, flexibility for special cargo	Murphy et al. (1992), Ha (2003), Song and Yeo (2004), Shintani et al. (2007), De Martino and Morvillo (2008), Meersman et al. (2008).
Terminal operators	Port facilities, port operations quality, cost, location, hinterland connections, port information systems, port congestion, port efficiency	Song and Yeo (2004), Acosta et al. (2007), Meersman et al. (2008), Wiegmans et al. (2008)

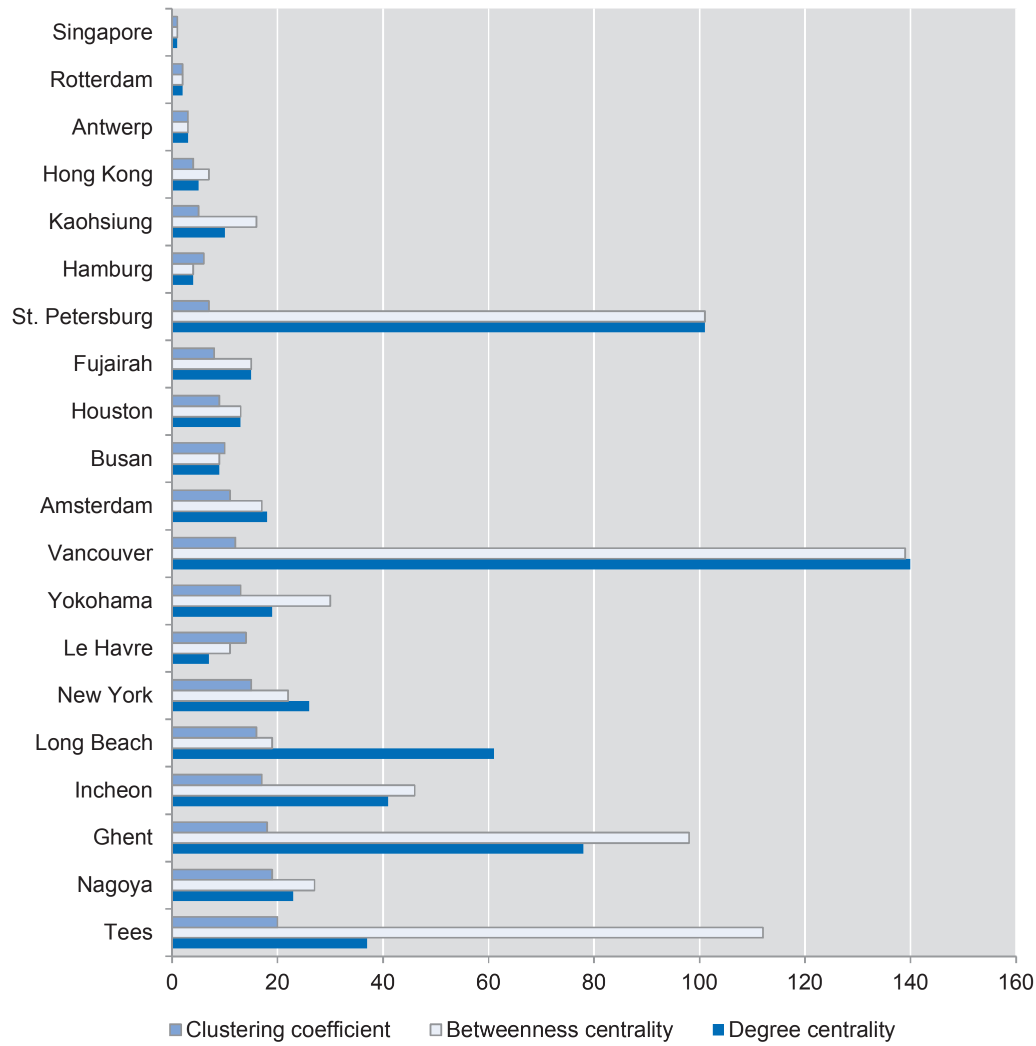
Source: Literature overview based on Aronietis (2013) and own compilation.

Maritime connectivity

Maritime connectivity is essential for competitive ports, as it increases the frequency of shipping services. Ports with extensive maritime connections are more attractive to shippers, as they can offer direct services and speedier delivery of goods. If a sufficient volume of goods is shipped between these ports, frequency of shipping services and thus greater reliability can be guaranteed. If maritime forelands provide a competitive advantage for ports, and can attract additional shipments, maritime connectivity is also a dependent variable: more competitive ports will be more attractive for various reasons (*e.g.* port efficiency or good hinterland connections), attract new traffic, and thus achieve more extensive maritime forelands. There are, however, also specific policy instruments to increase maritime connectivity, as discussed below.

Maritime connectivity not only refers to the number of connections with other ports, but also to a port's positioning in networks (centrality). Various indicators measure port centrality, including degree centrality, "betweenness" centrality and clustering coefficient (see note of Figure 3.1 for a definition of these terms). Larger ports are generally more connected and centrally positioned in maritime networks, but there is not a perfect correlation between size and port centrality; some large ports manage to be much more connected than other ports of similar size (see Figure 3.1 for the most central ports in the world). Ports that are closely located to each other can have the same profile of maritime connections, as is the case for Hong Kong and Shenzhen (Figures 3.2 and 3.3), but also be complementary to each other with respect to maritime connections. For example, the port of Hamburg has strong maritime connections with Asia, whereas the nearby port of Bremerhaven has strong maritime connectivity with North America, which provides synergies between the two ports (Merk and Hesse, 2012).

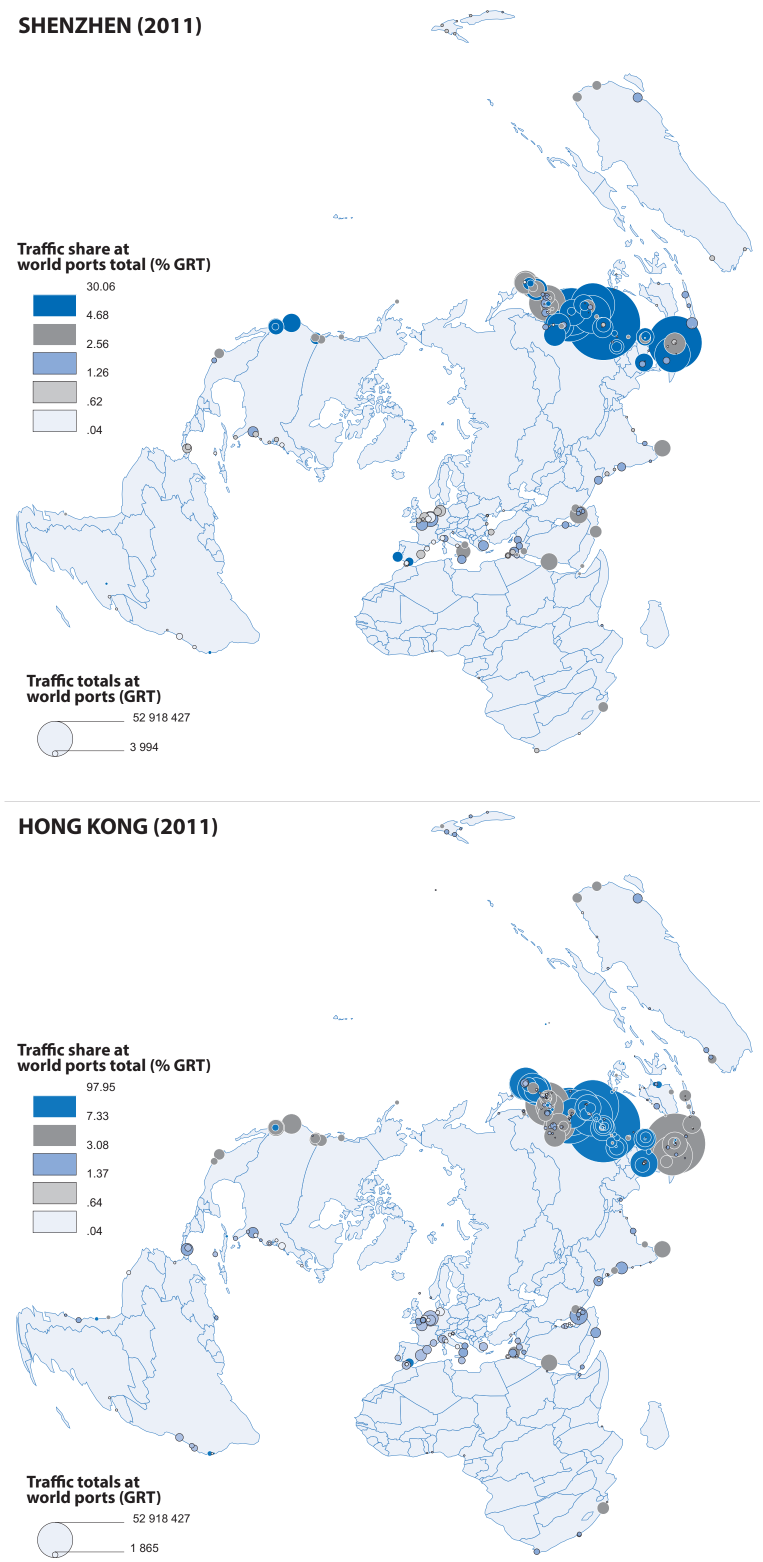
Figure 3.1. World ports ranked by centrality measures (2011)



Note: The horizontal axis indicates the port rank on the three different indicators. *E.g.* Singapore ranks number one on all three centrality measures. The three centrality measures can be defined as follows. *Degree centrality* expresses the number of adjacent neighbours of a node; it is the simplest and most commonly accepted measure of centrality. It often correlates with total traffic (more connections imply more traffic). *Betweenness centrality* expresses the number of shortest paths going through each node. The *clustering coefficient* estimates whether the adjacent neighbours of a node are connected to each other (*i.e.* "My friends are also friends"), thus forming triangles (triplets); the coefficient is the ratio between the number of observed triplets and the maximum possible number of triplets connecting a given node.

Source Authors' elaboration based on dataset from Lloyds' Marine Intelligence Unit (LMIU), 2011.

Figure 3.2. Maritime forelands of Shenzhen and Hong Kong (2011)



Source: Merk, O. and J. Li (2013), "The Competitiveness of Global Port-Cities: The Case of Hong Kong, China", *OECD Regional Development Working Papers*, No. 2013/16, OECD Publishing, Paris, http://dx.doi.org/10.1787/5k3wdkjtzp0w-en.

Trans-shipment provides a way for large ports to increase their maritime connectivity. Most ports of large port-cities are gateway ports, in so far as most of the port traffic serves the metropolitan area and its hinterland. Some ports at strategic locations close to main shipping routes have developed into pure trans-shipment ports, that is, ship-to-ship traffic and limited interaction between maritime and land transport. Gateway ports can also perform trans-shipment functions to a greater or lesser extent. These functions are generally less profitable for the port-city, as they do not generate a lot of value added, but take up port capacity. However, because of the lumpiness of port infrastructure and equipment, many ports are not at their optimal utilisation rate; trans-shipment can help to reach an optimal utilisation rate, while it also helps to increase maritime connectivity, as it can facilitate a network of connections that would otherwise not be sustainable.

Good nautical access is essential for maritime connectivity of ports. In recent decades, ships have rapidly become bigger and deeper. The draft of the largest container ships is now approximately 14.5 metres, deeper than most ports can accommodate. Port depth thus becomes a competitive advantage for attracting the largest ships and a challenge for ports that are estuary ports with no direct deep-sea access. For example, the biggest container ships are only able to call at the Port of Hamburg within certain high-tide time slots. For this reason, many ports dredge port berths, access channels and indeed whole rivers, to ensure sufficient depth. The ongoing expansion of the Panama Canal has provoked wide interest among US East Coast ports in port dredging. However, many ports face concerns over the environmental impact of dredging. Recent new port development projects often involve offshore ports on reclaimed land that can ensure sufficient nautical access.

Ports can increase maritime connectivity by engaging in internationalisation strategies. Ports traditionally market themselves in relation to shipping lines, freight forwarders and shippers, which is self-evident, considering their important role in port choice. However, some ports are increasingly focusing on co-operation with ports in emerging markets. The port of Rotterdam has financial participations in the ports of Sohar (Oman) and Suape (Brazil), where Antwerp has similar partnerships in Duqm (Oman) and India. Other forms of co-operation with ports in emerging markets include consultancy and training provided by the port authority or one of its subsidiaries, for example, the Port of Antwerpen International (PAI) and Port of Rotterdam International (PORint). Some of these co-operation arrangements seem to be based on links from the past, *e.g.* partnerships of the Port of Rouen with West-African ports (Merk et al., 2011), but such partnerships could well be transformed into occasions for attracting traffic from these regions. The financial participation of the Port of Rotterdam in the port of Sohar has generated strategic value for the maritime cluster in Rotterdam, facilitating market access to maritime service providers, such as dredgers, from Rotterdam into Oman (Van den Bosch et al., 2011).

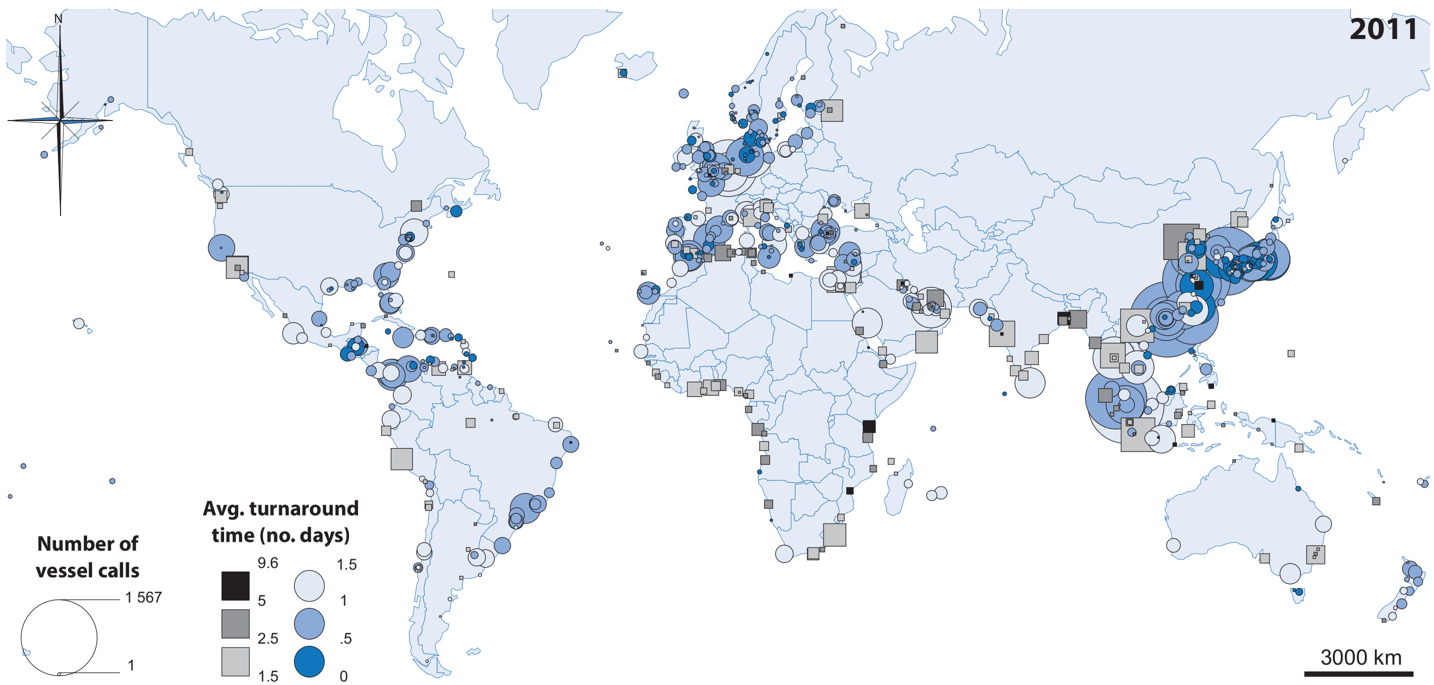
Measuring effective port operations

Various performance indicators for port operations exist, all of which contribute to port performance. Main performance metrics exist at the level of cranes, berths, yards, gates and gangs, both in terms of utilisation rates (such as 20-foot equivalent units, or TEUs/year per crane, vessels/year per berth, TEUs/per year per hectare, and containers/hour per lane) and productivity (moves per crane-hour, vessel service time, truck time in terminal and number of gang moves per man-hour). These statistics are collected and sold by specialised consultancies; their databases indicate that on average, large port terminals handle around 110 000 TEUs per crane, 25-40 crane moves per hour, a dwell time of import boxes of 5-7 days and export boxes of 3-5 days. Performance benchmarks on terminals other than container terminals are rare.

A large number of port efficiency studies exist, but also have their flaws. Academic research has focused on port performance from the perspective of port efficiency: how many throughputs (tonnes or TEUs) are reached using similar inputs (such as cranes, quay length and terminal surface). Most of these studies use data envelopment analysis (DEA) or stochastic frontier, approaches, and almost of all these studies focus on container ports or terminals, with the notable exception of Olivieira and Cariou (2011), which also look at ore and coal terminals, and Merk and Dang (2012), which include oil, ore, coal and grain. Although port efficiency studies have their merits in terms of appreciating the value for money of port terminals, they also have their flaws and tend to be misinterpreted. Because most of these studies examine outputs and inputs in one particular year, the results in other years can be quite different, considering the lumpiness of port terminal investment. Moreover, port equipment is in almost all these studies considered a proxy of labour, which ignores differences in labour productivity between ports, which can be assumed to be substantial.

Vessel turn-around times provide a relatively balanced assessment of port performance. This is the average time that a vessel stays in a port before departing for another port. This is available in detailed vessel movement data, as collected by Lloyd’s Marine Intelligence Unit (LMIU). This turn-around time is generally considered to be an important determinant of port competitiveness, as a quick turn-around allows for a reduction of port congestion and larger port throughputs. An overview of average turn-around time per port is provided in Figure 3.3. The most time-efficient ports are found in East Asia, Europe and the Caribbean, whereas the least time-efficient ports are located in Africa and South Asia (including India). An assessment of vessel turn-around times over time illustrates the rapid increases in time efficiency of Chinese ports; whereas they were still very inefficient in 1996, these ports became among the most time-efficient ports in 2006 and 2011. When analysing vessel turn-around times in different ports worldwide, it becomes evident that they involve an important national factor, as many ports in the same country have more or less the same vessel turn-around times (Ducruet and Merk, 2013).

Figure 3.3. Average turn-around time (in days) of ports in the world, May 2011



Source: Ducruet, C. and O. Merk (2013), "Examining Container Vessel Turnaround Times across the World", *Port Technology International*, Issue 59.

The general picture arising from all these port performance indicators is fairly consistent: ports with the most effective operations seem to be located in Southeast Asia, the Far East, Middle East and Northwest Europe. A few examples suffice to illustrate this: the average crane productivity in 2009 was 136 531 TEU per crane per year in the Middle East, 124 581 in the Far East and 119 276 in Southeast Asia; the lowest scores were logged in Eastern Europe (56 063) and North America (71 741) (Drewry, 2010). The top ten ports in terms of berth productivity in 2012 were located in China, the United Arab Emirates, Malaysia, South Korea, Oman and the Netherlands (JOC, 2013). Many Chinese ports can be identified among the more efficient in port efficiency studies, and ports in the Far East score very well in terms of time efficiency (Ducruet and Merk, 2013).

How can the effectiveness of port operations be explained? What are the determining factors that help ensure an efficient port? Based on our review of literature and survey of a wide range of actors in worldwide ports, we assume that effective port operations are dependent on the quality of inputs and the quality of organisation and institutions. Both building blocks for effective port operations are discussed below.

Quality of inputs

Effective port operations evidently depend on the quality of the inputs needed for port operations: labour, equipment and land. Port operations are generally capital and land intensive and have become less labour intensive. However, labour continues to be an important production factor, even in automated terminals. Containerisation and increased economies of scale in shipping have underlined the importance of equipment and large port premises.

Labour

Labour is an important production factor for port terminals, since labour costs can account for more than half of their operating costs. The share of labour costs in total operating costs ranges from 15%-20% in dry bulk terminals, to 40%-75% at general cargo terminals and 50%-70% at container terminals (Barton and Turnbull, 2002; van Hooydonk, 2013). This translates into considerable labour costs per goods shipped. The average labour cost is close to USD 200 per container shipped into Los Angeles. These labour costs are only to a limited extent sensitive to market fluctuation: the labour costs to box costs is non-negotiable, because of the duration of the terms negotiated with the trade unions, usually six years in the case of the International Longshore and Warehouse Union (ILWU), the dominant trade union at the US West Coast (Kelly and Agnone, 2009). An efficient labour force is an important element in the decisions made by shipping lines and terminal operators. Jaffe analysed how in Jaxport (Florida) labour-management conflicts between the International Longshoreman’s Association (ILA) and the shipping lines Mitsui/Tra-Pac and Hanjin influenced the selection decisions of terminal operators and global shipping lines, with make-or-break threats to take cargo elsewhere along the East Coast (Jaffee, 2010).

The fundamental challenge of port labour markets is the irregular demand for workers, determined by the irregular arrival of ships in the port. In addition, port work can be more or less seasonal; traffic flows in ports often depend on the time of harvest of agricultural products such as grain, cotton and fruit (van Hooydonk, 2013). However, the irregular character of shipping has changed over time. Containerisation has facilitated the enhanced accuracy of ship sailing schedules, reducing the irregularity and unpredictability of employment (Haralambides, 1995). Demand for port workers has in many container ports become relatively stable and predictable, but work remains largely irregular in bulk ports and small ports. The irregularity of demand is solved by overtime and extra shifts, but also by casual workers who supplement the core workforce; the casual workers may be port pool workers, workers temporarily hired out by other cargo handling companies, workers supplied by sub-contractors, temporary agency workers or occasional workers. In most cases, casually employed workers have no income guarantees (van Hooydonk, 2013).

As a response to the casual nature of port employment, various controls on the free market system have come into place in ports, also referred to as dock labour schemes. These systems attempt to control the labour supply, ranging from union hiring halls on the United States' West Coast, to worker co-operatives in Italy, state-mandated registration schemes, as in Belgium, mandatory labour pools and other measures that could be considered restrictions on employment, such as prohibitions on permanent employment, prohibitions on self-employment, the requirement of union membership and nepotism (Turnbull 2012; van Hooydonk, 2013). These practices continue to characterise port labour markets, even if the casual nature of port employment has decreased. In Germany and the Netherlands, employers are able to hire permanent company employees directly from the external labour market, but any additional (casual) labour must be hired from a state-regulated labour pool. In both countries, this pool is a stronghold of union organisation (Turnbull and Wass, 2007). Fifteen out of 22 EU member states have some kind of port labour pool system, and in 11 of these pool workers have preferential rights (van Hooydonk, 2013). The differences between ports in this respect can be large, even between ports that are similar in many other aspects: the share of workers in labour pools in the port of Antwerp was 62% in 2000, but only 14% in Rotterdam (Smit, 2013).

In the last decade, port employment has suffered major changes. The port industry has become less labour-intensive, because it is less focused on break-bulk handling and more on specialised operations. As a result, port workers became more multi-skilled and specialised, with more formalised training that replaced the previous informal on-the-job training. Permanent employment became more dominant in an industry long characterised by casual hiring. The port workforce diversified, less dominated by males; in Valencia, 12% of the port labour pool consists of women (ILO, 2012; Turnbull 2011). Ship operators increasingly expect service 24 hours a day, seven days a week, which means that staff is employed on flexible working schedules. Continuous work with individual rather than collective breaks, flexible start times, variable shift lengths and weekend work have all figured prominently in contract negotiations in recent decades (Turnbull and Wass, 2007). In return for uninterrupted and efficient cargo handling, port workers world-wide received guarantees of high wages and regular pay, regardless of fluctuations in the need of dock labour. Port privatisation, however, has sometimes also increased the vulnerability of port workers, illustrated by the case of Port Klang in Malaysia, which mainly employs semi-skilled and unskilled migrant workers from South Asia (Hill, 2012).

Containerisation and information technologies have changed the content of port labour. Many functions formerly performed at port sites have been consolidated in back-office computer laboratories, or shifted to locations outside the traditional port premises. The skill sets of the port workforce have been restructured and the white collar/blue collar distinction has blurred. This restructuring corresponds to a rebalancing of job content in the logistics sector as a whole, with a shift from physical handling of goods to the organisation of work via automation and electronic information systems (Butcher, 2007). Some of the jobs that remain in ports have experienced contraction, routinisation and work intensification. An integrated form of managing the labour process has been created, which leads to situations where the exercise of control becomes opaque, as is illustrated by a study on managerial control at the Port of Melbourne and Port Botany, Sydney (Gekara and Fairbrother, 2013). The restructuring of labour that is taking place in many ports has resulted in a smaller and more versatile workforce, with port management increasingly seeking to recruit those working with advanced technologies from outside the port.

There are a considerable number of skills gaps in the port and logistics sectors. A study on future skills needed in the transport and logistics sector identified a substantial number of changes in competences that would be required in shipping and logistics; ranging from 18 for ship officers, 21 for sea transport managers and 26 for business and finance professionals, out of 29 main competences identified (Davydenko et al., 2009). Thai (2012) identified 65 essential competences for port personnel, partly based on surveys with port personnel in Singapore and Vietnam, that go beyond competences in port operations and engineering, but also include a wide scope of other competences, including management and business skills, and logistics competences.

A growing number of ports and terminal operators offer elaborate training programmes for new entrants and existing workers, to adapt to these new realities of port work. The Eurogate terminal in Rotterdam introduced semi-autonomous team work, abolishing the old gang-work and supervisory system, with multi-skilled teams that must ensure that two cranes are available and operational at all times throughout the shift. Now, 90% of the company's dockers can perform all tasks on the container terminal. Another container terminal in the port of Rotterdam, Europe Container Terminals (ECT), spent up to 10% of its annual turnover on training to ensure that all of its port workers can now undertake up to four different jobs on the container terminal, and the company's collective agreement provides for "functional combinations" of two or three jobs to be performed within the same shift (Turnbull, 2012).

However, port training is often found to be insufficient. An investigation of port training systems of new EU member states identified important training challenges related to meeting customer needs, as well as safety and security (Casaca, 2006). Another study found that the majority of port workers in the dry bulk sector receive little or no training to work in the operating conditions they encounter, despite the challenging and hazardous nature of working on board ships and within stockyards (Martin, Bang and Martin, 2011). However, there is a large difference between ports in terms of the training and education offered to port workers (De Langen, 2008).

In many ports, recurrent strikes and other forms of industrial action have caused significant delays for shipping. Current port strikes rarely approach the 134 days duration attained in the 1971 strike on the United States' West Coast, but frequently last for several weeks (Table 3.3). Even in countries with few port strikes, the proportion of the total national shares can still be relatively high. This relative share of port strikes was exceptionally high during the 20th century and beginning of the 21st century in the Netherlands, with the most recent share of port strikes (in total national shares) reaching 13% (Smit, 2013). The costs of such strikes can be large. The costs of the 11-day lockout of US West Coast ports in 2002 were calculated at USD 2 billion a day, a figure contested by Hall (2004), since such calculations do not take into account the possibilities for substitution in distribution and production. But even if strike costs are a fraction of this amount, they are not negligible: the forgone direct and induced effects of cargo-handling activities would amount to USD 70 million a day. Barzman notes the importance of the way that strikes gain public attention. He cites union leaders, who suggest that it is not the strikes themselves, which are considered to be relatively light and short, that are at the root of the decline of French ports, but the dissemination of news about strikes in France, by comparison with Rotterdam and Antwerp, where port leaders are discreet about strikes that take place (Barzman, 2012).

Table 3.3. Labour strikes in a selection of seaports

Seaport	Period	Duration
Hong Kong	March-May 2013	40 days
Antofagasta, Chile	March-April 2013	3 weeks
Marseille	November-December 2010	33 days
Durban	May 2011	17 days
Sokhna, Egypt	February 2013	16 days
Karachi	December 2012	11 days
Auckland	February-March 2012	

Unions have had and continue to have a large impact on port labour systems. Dockworkers of 2010 have little in common with those of the 1950s or 1930s, except for a culture that continues to form the basis of a collective identity in which trade unionism is still very much a live force, according to Pigenet (2012). Political and economic structures of place can outlast the people who initially created them, providing a pool of tradition and resources on which workers can draw (Carmichael and Herod, 2012). Militancy in Merseyside (England) has been sustained over time, even as industrial restructuring has devastated employment on the docks and in the region's car plants, from which it initially emerged (Darlington, 2005). How unions can determine the outlook of port labour can be illustrated by the different pathways of the ILWU on the United States' West Coast and the ILA on the East Coast. The ILWU developed a strong and co-operative dock regime based on participatory democracy and union capture of hiring, which enabled union leadership to negotiate effectively with members and employers. In contrast, the ILA developed a weak and non-co-operative dock regime based on localist politics and no capture of hiring, making it hard for union leaders to negotiate effectively. These different pathways have led to different outcomes: the ILA has a loose master contract and weak local contracts, has lost control of certain technologies and jurisdiction and is a weak bargaining force, according to Kelly (2008). This has had an effect on port workers' earnings. Although dockworkers on all three US coasts are the notable exception to the trend that port-logistics workers in large port-cities do not achieve higher annual earnings than otherwise comparable workers, this is particularly the case on the US West Coast, where residence in one of the large port-cities is correlated with additional significantly higher earnings, benefiting – among other things – from the strong bargaining power of unions (Hall, 2009).

Globalisation of port terminals and shipping has led to a call for a reconstituted scale of collective bargaining, transcending national boundaries, as is for example the case with the cross-national maritime trade union Nautilus International (Carmichael and Herod, 2012). The union campaigns against the EU Port Services Directives proposed in 2001 and 2004 demonstrated that they can influence European policy making if they project their domestic claims onto international organisations and foreign actors (Turnbull, 2010).

Equipment

Good port equipment is a minimum requirement for effective port operations. This means well-maintained port infrastructure, such as quays, access channels, seawalls, warehouses, and road and railway connections on the port site. Another necessity is port superstructure, including ship-to-shore-cranes and the equipment for the terminal yards, such as the rubber-tyred gantries deployed in half of the world's container terminals, and rail-mounted gantries or straddle carriers, which are used mainly in European terminals. The equipment required is fairly specific, according to the type of cargo. Whereas most of the cargo in the past was loaded or unloaded with general cargo cranes, the equipment has become more specific. Containers are loaded/unloaded with container cranes, liquid bulk with pipelines and dry bulk with elevators, loading and unloading arms. Roll-on roll-off (RORO) traffic needs a RORO ramp, and only cruise ships need relatively little equipment. Every cargo type has different requirements for storage: liquid bulk in tanks, dry bulk in warehouses, silos or stockpiles, refrigerated cargo in refrigerated warehouses or reefer plugs (if transported in reefer containers).

The quality and capacity of equipment has a direct relation to port efficiency. More numerous and larger pipelines can load/unload more liquid bulk at a time, as is the case for other cargo types. Container cranes come in different types, depending on the ship that must be loaded. Whilst container ships are categorised according to the straits that they can still navigate, container cranes have a categorisation that mirrors this to some extent, with the reach of the crane as one of the main distinguishing factors: a Panamax crane can load and unload containers from a container ship capable of passing through the Panama Canal (ships 12 to 13 containers wide), a Post-Panamax crane (for ships too wide to pass through the Panama Canal) has a maximum reach of 18 containers wide, whereas the largest modern container cranes, the Super-Post Panamax, are suitable for vessels of about 22 or more containers wide. The most modern container cranes are able to lift several containers at the same time via double lift or tandem lifts, so their throughput per lift is higher than other cranes. Vessel turn-around time will be higher depending on the number of cranes that can be used per ship (although there are decreasing marginal returns) and yard efficiency will be higher, the more yard equipment is employed.

At the same time, considering the cost of all this equipment, port terminals attempt to optimise the capacity of their equipment in relation to the projected peak cargo flows. Optimal capacity is in practice difficult to reach and not always possible to achieve. Industry intelligence shows that a yard occupancy ratio of around 70% will allow terminals to work at maximum efficiency, and that working consistently above this threshold reduces efficiency. Similarly, the optimum level of berth occupancy for a container terminal is estimated at around 65%; beyond this point, ship queuing tends to increase significantly and service quality to drop. Dedicated terminals with tightly scheduled ship arrivals can achieve higher berth occupancy levels without congestion, whereas common-user terminals with a mixed pattern of ship arrivals reach their congestion point at a lower berth-occupancy level (Drewry, 2010).

The continuous increase in ship size necessitates a regular upgrading of port infrastructure. Most ports anticipate to some extent the increasing economies of scale in shipping, but developments have been rapid. Over the last decade, the average size of container ships in operation has doubled. This has had a major impact on the container handling equipment needed in ports. In July 2013, Maersk took into operation the first Triple E-ships, with a capacity of 18 000 TEUs, the largest container ship currently in operation. This ship is 23 containers wide and can be handled by Super-Post-Panamax cranes, which are available in some large world ports, but by no means in a majority of them. These ships do not call in ports that do not have the necessary equipment. If ship size increases to 20 000 or 25 000 TEU are achieved, as predicted by some observers, a new round of upgrading of container cranes would be needed even in the best-equipped ports of the world. Similar tendencies prevail in other sectors, such as bulk carriers and cruise ships, requiring upgrades in port terminal infrastructure and superstructure.

Table 3.4. Overview of automated container terminals

Seaport	Terminal	Year of introduction	Type
Rotterdam	ECT	1993	Automated
Hamburg	CTA	2002	Automated
Tokyo	Wai Hai	2003	Semi-automated
Kaohsiung	Evergreen	2006	Semi-automated
Rotterdam	Euromax	2008	Automated
Busan	Han Jin	2008	Semi-automated
Taipei	Taipei Port	2009	Semi-automated
Busan	PNC	2009	Semi-automated
Kaohsiung	Yang Ming	2011	Semi-automated

Source: Own elaboration based on Yang, Y. and K. Shen (2013), "Comparison of the Operating Performance of Automated and Traditional Container Terminals", *International Journal of Logistics Research*, Vol. 16, No. 2, pp. 158-173.

To some extent, there is a trade-off between labour and terminal equipment. A few port terminals have been automated, as in Rotterdam and Hamburg. At such terminals, automated guided vehicles (AGVs) are used to transport containers between quayside and yard side, and the stacking of containers is performed using automated stacking cranes (ASCs). Some ports in countries like Korea and Taiwan have adopted semi-automated container terminals, in which the stacking process is automated but not the transport between quayside and yard side, which is done by trailers (Table 3.4). The investment needed for automated terminals is higher than for traditional terminals, but the profitability, quality, safety and environmental performance is all considered to be higher than in traditional terminals (Yang and Shen, 2013). Drewry (2010) confirms that automated terminals perform better than the world average (in terms of TEU per metre of quay per year, TEU per crane and TEU per hectare), but notes that they do not achieve a performance comparable to large terminals in general. Automation of container terminals leads to an optimisation of the workforce, which implies the replacement of various relatively low-skilled jobs with a few high-skilled supervisory jobs. They key justification for automation could be to reduce labour costs in high-wage environments. In countries with low wages, it is usually cheaper and more efficient to remain non-automated, according to Drewry (2010).

Land

Modern port terminals require a relatively large amount of land. At a minimum, a functional container port terminal would need a few berths for handling various ships at the same time, a quayside for ship-to-shore operations, a container transfer area, a storage area, an area for delivery and receiving connected to road and rail lines, a depot for empty containers, a customs area and a truck waiting area. In many cases, logistics activities, such as distribution centres, would also take place in or around the port area. In addition, various ports also locate industries that benefit from the proximity of the port. Most large modern ports cover thousands of hectares, depending on their functions and characteristics.

The land-intensive character of ports is associated with containerisation and increasing ship size. The history of shipping is characterised by a continual drive to reduce costs, resulting in economies of scale, containerisation and continuously increasing ship sizes.[1] This has radically transformed ports and waterfronts in recent decades. Traditional port pier-structures became dysfunctional and were abandoned and left for other uses, or were filled in to create larger terminals, with longer quay length and larger temporary storage space. In many cases, new terminals are built farther away from city centres, with fewer space constraints.

Quality of organisation and institutions

The quality of input factors, presented above, is in itself not sufficient for effective port operations. These inputs also need to be organised efficiently, so their successful application is determined by the quality of organisation and institutional arrangements. This organisational quality includes planning, port information systems, competition and co-ordination between ports.

Port planning

Good port planning can have an important impact on port performance. Port master plans describe the main functions of the port, their location and inter-relations; these plans should indicate where new traffic will be allocated and which actions are required to achieve this. Such a master plan forms the basis of detailed planning on various levels, such as berth allocation planning, yard planning, traffic planning within the port area, planning of intermodal operations, lock operation planning and planning related to tidal conditions in estuary ports. All these elements must be aligned for smooth port operations. The gains of sound port planning can be considerable. The difference between good and bad yard planning in similar conditions can have an impact on handling time of about 30%, according to Roy and Koster (2013).

In addition, several ports are engaged in long-term strategic planning. Such long-term engagements are expressed in strategic visions that are to a more or lesser extent publicly available. These plans, which can cover a time horizon of several decades, can identify new directions of development, prioritise investments and identify future bottlenecks. If well designed, the strategic planning process can help to engage the principal stakeholders, strengthen links with clients and create local goodwill. Long-term planning is most effective when these long-term perspectives act as a catalyst for innovation and new perspectives. To achieve this, the planning horizon of these strategies needs to be long (Table 3.5), targets need to be flexible and embedded in different scenarios, and the vision needs to be imaginative rather than technocratic. Such long-term strategic plans are best translated into in operational plans and regularly updated and revised.

Wide stakeholder involvement in such a shared vision is essential, along the lines of the long-term strategic planning in Rotterdam. The Port Vision 2030 of the Port of Rotterdam, adopted in 2012, focused less on targeting future throughputs, but gave careful thought to the issue of what the port's future could look like, based on a comprehensive assessment of a variety of trends that could change ports' role in the coming decades. In the case of port volumes, it described a range of scenarios, emphasising the flexibility that would be needed to be forward-looking. One of its main observations was the changing European landscape of energy production (including the rationalisation of refineries) and the port's ambition, in close co-operation with Antwerp, to become the main petrochemical and energy hub in Europe. However, the most important accomplishment of the Port Vision 2030 may be the process of stakeholder consultation and engagement, which not only informed the port authority of challenges perceived by its clients and stakeholders, but also created buy-in from these stakeholders in the strategic vision of the port.

Table 3.5. Ports with a long-term strategic vision

Seaports	Timeframe
Hamburg	2012-25
Melbourne	2009-35
New York/New Jersey	2005-20
Rotterdam	2011-30
Vancouver	2010-50
Liverpool (Peel Ports)	2011-30

Port information systems

Port information systems facilitate data-sharing among actors in the port community. Such Port Community Systems (PCS) are one of the determining factors influencing port choice by various port users, such as shippers, shipping lines, forwarders and brokers, as well as transport operators (Keceli et al., 2008). A PCS can be defined as a neutral and open electronic platform that optimises, manages and automates smooth port and logistics processes through a single submission of data, enabling intelligent and secure exchange of information between public and private stakeholders (EPCSA, 2012). These systems are set up for the purpose of eliminating, as far as possible, the number of paper documents and clerical work used in port operation (Long, 2009). The goal is to streamline the procedures and reduce manual errors through a synchronised and integrated program. The increase in transport capacity, especially for containerised cargo, requires immediate data exchange on the location and status of the cargo. In this sense, port information systems can ensure the flow of information in an accurate and timely manner by allowing for simple and smooth administrative procedures, thereby increasing the handling speed and improving operational efficiency. They can also help to avoid the redundancy of data input, improve data quality and integrity, and support port management operations (Vincent, 2003; Zygus, 2006). At the same time, information systems are used to automate the security and control operation, such as customs and inspection. Moreover, the development of technologies like radiation detection and radio-frequency identification (RFID) can greatly improve productivity and provide accurate information to all relevant port users. Nevertheless, a main challenge of Port Community Systems is to find a balance between security regulations and trade facilitation, aimed at increasing the smoothness of supply chains.

The fundamental prerequisite of a successful port community system is the participation of all relevant actors involved in the port community and the integration of information systems into one comprehensive network system. It is essential to establish common goals and reach consensus for a shared action plan among the members within the port community in order to achieve the desired development of a PCS (Long, 2009). By providing a proven and effective means of information exchanging, the application of Port Community Systems has been widely adopted by many ports in the world. Using the Electronic Data Interchange (EDI) technology, various local information technology (IT) systems can be integrated within a PCS to simplify, standardise and accelerate efficient interactions between different port communities and responsible government authorities on institutional communication and processes. The sophisticated information systems of the Port of Singapore Authority have helped improve cargo handling capacity, making the port of Singapore one of the world's most efficient ports (Lee-Partridge, Teo and Lim, 2000).

Implementation is in practice driven by three different actors: national government, the port community and port authorities. The first category of projects is driven by the national government initiatives or a national customs project, where the PCS are initially considered to be a form of the "National Single Windows" and an important component for the e-Government process. KL Net in Korea was created under one of the initiatives led by the Ministry of Land, Transport and Maritime Affairs in Korea to bring in standardisation in documentation formats to 30 ports in the country. The second driving factor is related to the logistics community. Some PCS are established on the basis of consensus within the logistics sectors to improve the operational efficiency in ports, such as gate operation at terminals. Later on, these PCS can be extended to a regional or even national level to create a unified application for the logistics community, to cope with their needs for operating in multiple ports. For instance, the AP+ in France and destin8 in the UK are two nationwide PCS adopted by ports in each country. The third type of PCS initiative is spearheaded by the local port authorities as an element of the port's strategic plan. It is conceived as a means to enhance a port's competitive edge. The PCS in Spain is one example, where each main port has established its own information system, whereas the Portbase system developed by the Port of Rotterdam is actually a joint outcome in co-operation with the Port of Amsterdam (IAPH, 2011). The Port of Valparaíso (Chile) has developed two platforms for the local port community: the Foro Logístico Valparaíso (FOLOVAP) and SILOGPORT, a digital platform that allows the exchange and dissemination of information at various stages of the logistics process.

As ports increasingly become linked to dry ports and inland terminals, data sharing needs to be extended to these places as well. A more comprehensive port community system that connects and integrates maritime, port, and landside operation collaborating at a broader scale is recommended to promote seamless cargo movement, reduce costs and potentially enhance competitiveness for more users. In addition, it provides opportunities to diffuse good practices by integrating more ports, including inland terminals, into a wider system. The Port of Valencia has established a PCS that not only provides services related to maritime transactions and shipping companies on the basis of the existing core port operations, but also incorporates inland and rail transport services (García de la Guia, 2010). Current developments go beyond this, focusing on interconnection between the different Port Community Systems, so that these systems can communicate with each other. *E.g.* the PCS in Marseille is inter-connected to systems in Hamburg, Tunis and Haifa.

Competition

There are indications that intra-port competition improves port performance. This refers to a situation where two or more different terminal operators within the same port are vying for the same market. This competition prevents monopolistic rent seeking of port service providers and is a means to achieve economies of scope and flexible multi-service organisation structures (De Langen and Pallis, 2005). Internationally based stevedore companies have been found to have a positive impact on the efficiency of container terminals, but not port operators driven by global carriers, such as CMA-CGM and MSC (Cheon, 2009a). At the same time, there are barriers to entry in the port sector. A survey of 28 European ports in 2004 showed that there was only one service provider of container handling services in almost half of the ports surveyed (De Langen and Pallis, 2007). Intra-port competition can be limited by relatively long terminal concessions. Although there is no accepted rule of thumb about the duration of concessions in the port sector, there is agreement that the duration of the concession will vary according to the amount of investment required. Port authorities have several reasons to aim at relatively short concessions: to maximise revenues, reduce entry barriers and optimise the possibility of port redevelopment. When the length of concessions is long, concession holders will seek compensation if they are affected by port re-development (Pallis, Notteboom and De

Langen, 2008). Port authorities need to find a balance between a reasonable payback period for the investments made by terminal operators on the one hand and the maximum chance of attracting potential newcomers on the other (Theys et al., 2010).

Table 3.6. Presence of the four largest global terminal operators in world ports (2012)

Number of large global terminal operators	Port
Two	Antwerp, Sydney, Brisbane, Chennai, Dammam, Guangzhou, Ho Chi Minh City, Marseilles, Le Havre, Qingdao, Shanghai, Xiamen, Zeebrugge
Three	Busan, Hong Kong, Rotterdam, Xingang
Four	Buenos Aires, Laem Chabang

Source: Calculations and elaborations of OECD Secretariat based on data from global terminal operators.

Co-ordination between ports

Ports of all sizes increasingly recognise that some degree of co-ordination with other ports can enable increases in efficiency and supply chain integration that, far from reducing competition, in fact increase ports' competitive standing. The impetus to increase co-ordination among ports has in part been driven by their changing role within global supply chains, whose structure they no longer determine alone. The rise of global terminal operators and vast shipping networks has diminished the individual capacity of ports to shape trade routes (Notteboom 2004; Slack 2007). Ports must now provide a range of incentives to shippers and operators in order to attract trade volume, and building co-operative relationships with other ports is one of the ways they can do so.

There are several degrees of inter-port co-ordination (Bengtsson and Kock 1999; McLaughlin and Fearon 2013). At the lowest degree of co-ordination is its complete absence. Absence of co-ordination can lead to direct competition, characterised by strong inter-port rivalry, or it can lead to simple situations of co-existence. In co-existence arrangements, ports interact in a complementary fashion, although no formal framework for collaboration exists. The ports of Ghent and Zeebrugge in Belgium, or of Seattle and Tacoma in the United States, co-exist in this manner, operating in clearly demarcated markets.

Even under situations of competition, ports can co-ordinate their activities. When ports co-ordinate even though they are competing with one another, we can refer to this as collaboration: collaboration is often based on ad hoc arrangements that endure for the life of a given project, such as joint ventures, or temporary initiatives. Rotterdam and Amsterdam, for example, though competitors in the field of break bulk (and containers, to a lesser extent), began collaboration on the Portbase project as of 2009. Portbase, which facilitates information exchange between companies and authorities, was formed through a merger of Port infolink in Rotterdam and PortNET in Amsterdam. The aim of the program is to become the national platform for all ports and airports within the foreseeable future, and it could thus provide the momentum for broader forms of port co-ordination throughout the Netherlands' system. Other examples of collaboration between competing ports could include, for example, joint regulation (*e.g.* the Clean Air Action Plan of the ports of Los Angeles and Long Beach), and lobbying and knowledge-sharing organisations (such as the European Sea Ports Organisation, International Association of Ports and Harbors, Eco-Ports network, RETE, Pacific Ports Clean Air Collaborative, World Port Climate Initiative, and so on).

When ports co-ordinate their activities in a way that minimises competition, this can be referred to as partnership. Partnership denotes long-term, institutionalised forms of inter-port co-ordination. This can take various forms that are both voluntary and mandatory. Voluntary measures include common port boards (such as the Haropa between le Havre, Rouen and Paris), the formation of national port organisations (Israel Ports, Spanish National Ports and even the equalisation system between Spanish ports), entering into joint ventures, stakes in inland ports and terminals and stakes in foreign ports to secure maritime forelands.

Mandatory measures include obligatory strategic plans and nationally imposed inter-port committees (such as those for ports along France's Atlantic coast, including Bordeaux, La Rochelle, and Nantes-Saint-Nazaire). In its most advanced form, mandatory partnership results in the merger of port authorities. This usually takes place at a metropolitan scale, where cities with multiple ports merge the authorities into one umbrella structure, as was the case in 2008, when the Canadian government merged the Port of Vancouver, the Fraser River Port Authority and the North Fraser Port Authority. Mergers can also take place across national borders, as was the case with the merger of Copenhagen, Denmark, and Malmö, Sweden, in 2001, although this merger was entered into voluntarily. Indeed, the amalgamation of these ports was seen as a way of improving land use planning, marketing, financial resources, operational efficiencies and interactions with the shipping industry. The merger of ports is also determined by their respective specialisations. In Western Australia, which has many small export ports connected to the regional mining industry, around a quarter of which are managed by the Department of Transport, the merger of these small ports into four medium-sized port authorities was seen as a way of reducing levels of bureaucracy and improving their co-ordination and planning. Table 3.7 below provides a summary of some recent port mergers around the world:

Table 3.7. Recent port mergers around the world

Year	Countries	Former Ports	New Entity
1998	Netherlands	Terneuzen Port Authority; Vlissingen Port Authority	Zeeland Seaports
2001	Denmark and Sweden	Port of Copenhagen A/S; Malmö Hamn AB	Copenhagen Malmö Port AB
2006	China	Ningbo Port; Zhoushan Port	Ningbo-Zhoushan Port
2007	France	Port of Caen-Ouistreham; Port of Cherbourg	Ports of Normandy Authority
2008	Canada	Port of Vancouver; North Fraser Port Authority; Fraser River Port Authority	Port Metro Vancouver

It is also worth noting that in countries with one single, national-level port authority, ports are co-ordinated in a de facto partnership. In South Africa, for example, the Transnet National Port Authority exercises a mandate over all of the ports. Because Transnet also controls rail provision, this institutional framework has significant consequences for inter-port relationships in South Africa, both in the fore- and hinterlands (Notteboom 2010; Rodrigue, Cooper and Merk, 2014). For example, the authority has proposed the use of differential tarification structures that would subsidise trans-shipment to the ports of Ngqura and Port Elizabeth, through a levy on trans-shipment to Durban, as a way of redirecting flows to the former from the latter. In such cases where partnership aggregates decision-making at the national scale, the port system is non-competitive, and more likely to be co-ordinated in accordance with other national policy objectives such as regional development. National integration of port systems can thus be used to align maritime transport policy with objectives that might not usually sit at the forefront of a typical port authority's concerns (such as the socio-economic development of distant hinterlands).

The different examples of merger indicate the importance of scale, in addition to degree, when considering port co-ordination mechanism. It is possible to distinguish between inter-port relationships according to the various scales (international, regional, proximate) and directions (foreland, inland, hinterland) that shape inter-port co-ordination.

A range of mechanisms is used for port foreland co-ordination at an international scale. Sometimes, port alliances include multiple ports spread out along a given trade route, such as the Comunidad Portuaria del Pacífico Sudamericano (COPASUD) including Callao (Peru), Buenaventura (Colombia), Guayaquil (Ecuador) and Valparaíso (Chile), which was formed to help facilitate better regional integration of South American ports on the Pacific coast, and provide better cargo service to Asia. On a slightly smaller scale, the North Adriatic Port Association (NAPA), including Venice (Italy), Trieste (Italy), Koper (Slovenia), and Rijeka (Croatia) was created in 2010, positioning itself as an alternative to northern European ports. Through this mechanism, these relatively small ports had planned to co-ordinate investments into road, rail and maritime networks, and worked towards the harmonisation of their regulations and procedures to make service delivery smoother. So far, however, co-ordination of planning and investments has proven difficult, and the NAPA functions more as a marketing tool than as a mechanism for steering development policies.

International foreland co-operation is also maintained at a bilateral level between ports through the signing of agreements, often formalised as Memorandums of Understanding (MOUs). In 2013, the ports of Hamburg and Los Angeles, for example, signed an MOU for the purposes of sharing best practices and strategies for enhancing competitiveness and environmental impact mitigation. MOUs can be broad, signalling a general desire to collaborate and share knowledge (as in the case of the MOU between Amsterdam and Mumbai, for example) or very specific, aiming to jointly target one policy area, such as environmental protection or maritime security (as in the MOU between Hong Kong terminal operator Modern Terminals and the Port of Los Angeles in 2003). Typically, they do not bind the parties in any mandatory or enforceable fashion, and are thus very popular communication tools for issuing statements of intent or joint policy positions.

This last example highlights yet another, path of co-operation: that of private-led co-ordination. Through mergers, acquisitions, joint ventures and various forms of sub-contracting, the private sector shapes a de facto network of global port co-operation (Notteboom and Rodrigue 2011). For example, Hutchison Port Holdings (HPH) has terminals in Hong Kong, Shenzhen and Guangzhou. This is also true for port community systems. MGI has now installed its cargo community system, AP+, in almost all French ports, which provides the basis for greater exchange of information.

In addition to such international mechanisms for inter-port co-ordination, there are a number of mechanisms that exist at more proximate scales that do not necessarily cross jurisdictions. Mergers at the metropolitan scale have been discussed above. Following Brooks et al. (2009), we can add to these: forms of joint promotion of one another’s facilities (or even the establishment of joint marketing agencies); the joint application of new technologies and planning of port developments; joint investments in hinterland infrastructures that will be shared; joint regulatory efforts, in the domains of environmental protection, safety and security, for example; and all manner of information-sharing instruments. Often, these more local forms of inter-port co-ordination constitute strategies that are turned towards inland ports, aiming to improve the hinterland connectivity of major gateways. A number of initiatives exist between the port of Hamburg and the other ports on the Elbe River, Cuxhaven, Brunsbüttel and Glückstadt, as well as with the Baltic Sea ports Lübeck and Kiel. Such inland port-to-port co-ordination increases the attractiveness of major gateways because it improves service delivery at several points in the supply chain. For this reason, many ports now employ a mix of different inter-port co-ordination mechanisms to enhance their competitive advantage, as is the case in the ports of the Yangtze River Delta (Box 3.1).

Box 3.1. Yangtze River Delta: Inter-port co-ordination mechanisms

The Yangtze River Delta is one of China's three major port regions, the other two being the Pearl River Delta and the Bohai Rim. The Yangtze River Delta includes major ports such Shanghai, Ningbo and Lianyungang. Since 2011, Shanghai has become the largest container seaport in the world. The Yangtze River Delta regional port system involves three different jurisdictions, the Shanghai municipality and Zhejiang and Jiangsu provinces. Although regional port governance has for long been fragmented (Comtois and Dong, 2007), with intense competition between the main ports, Shanghai and Ningbo, current developments point towards more regional co-ordination, which takes the form of co-ordinated planning, common institutions, co-ordinated finance and co-ordinated operations.

An impetus for co-ordinated planning has been given by the national government. In the National Strategy for the Yangtze River Delta, approved in May 2010 by the State Council, a section on the regional port system lays out development directions and detailed plans for the ports' development and co-ordination. The plan positions Shanghai as the international shipping centre, Ningbo-Zhoushan as the regional hub, supported by other extension and feeder ports in the Yangtze River Delta. Moreover, development plan outlines have been detailed for individual ports, *e.g.* to accelerate general container port infrastructure in Shanghai port, to provide better port infrastructure in Ningbo port, in particular for iron ore and crude oil transportation. Such development outlines have also been applied to inland ports in the region, *e.g.* to develop several feeder ports and transit hubs in Jiangsu, to provide connections between Shanghai and hinterland upper stream in the Yangtze River.

Although similar visions in the past have encountered implementation difficulties (Wang and Slack, 2004), there appear currently to be more institutional mechanisms to follow up on this strategy. All container port operations in the Yangtze River Delta are co-ordinated by a single entity, the Shanghai Port System Management Committee, created in 1998. The committee is represented by the deputy minister of communications, deputy mayor of Shanghai, deputy governors of Zhejiang and Jiangsu provinces, as well as senior government officials in charge of economic development and transportation from Shanghai, Zhejiang and Jiangsu. Moreover, since 2006, a Port Management Committee has co-ordinated administration of two nearby ports (Ningbo port and Zhoushan port) in the Zhejiang province. The two ports have subsequently been merged, as reflected in a new name – Ningbo-Zhoushan port.

This institutional co-ordination has been supported by the financial participation of the main ports in the area. The two major ports in the Yangtze River Delta, the Shanghai Port and Ningbo Port, set up a joint venture in 2010, Shanghai Port and Shipping Investment Co. Ltd., to invest in transport, shipping and ports, energy and related areas. Since each side holds around 50% of the shares of the joint venture, investment carried out by this joint venture is perceived to benefit both ports.[1] According to news sources, the two ports have started to discuss co-operation in more areas, such as co-ordination of future investments and operations.[2] Prior to that, Shanghai Port Group Corporation had invested in several inland container terminals since 2005 – Wuhan, Jiujiang, Nanjing and Chongqing, all upstream of the Yangtze River. As a result, container volume growth in cities such as Chongqing has been exponential (Notteboom, 2007). Closer links between the port of Shanghai and Ningbo have also been created by involving private terminal operators. For example, the terminal operator Hutchison Whampoa has interests in Shanghai Container Terminals, as well as terminals in the Ningbo Port.

Notes: 1. Ningbo Port Corporation Limited (2011), open announcement for related party transactions in 2010 and 2011 (stock market listing code 601018), in Chinese.

2. China Shipping and Trading Network (2010), "Ningbo Port Explains Competition and Co-operation with Shanghai Port", interview with Weiping Huang, spokesperson of the Ningbo Port Group Corporation on 30 July 2010, www.snet.com.cn, accessed 10 May 2011, in Chinese.

Finally, co-ordination can even take place between different kinds of port, at the metropolitan or regional scales. Various mega-logistics regions in the world consider the presence of a large seaport and a large airport an advantage. O'Connor (2010) has observed that more diversified gateways (*i.e.* those possessing multiple airports and seaports within a radius of 70 kilometres from the "core") generate larger traffic volumes and logistics clusters than those that specialise exclusively as air or sea gateways. Although air and sea cargo sectors are fairly fragmented on most continents (Ducruet and Van der Horst, 2009), there are several cities, such as Hong Kong, Brisbane and San Pedro, that have developed air-sea terminals where goods are shipped directly from one mode to another. A similar facility is available in Dubai Logistics City, aimed at increasing the possibility for certain goods to be transported by a sea leg, followed by an air leg, to reduce travel time. In 2009, Dubai's Port of Jebel Ali Free Zone joined forces with the Dubai Aviation City Corporation to form one of the largest multi-modal logistics platforms in the world, linking sea, land and air cargo.

In each case, inter-port co-ordination can be seen as a strategic response to a competitive environment, in which jointly led activities give participants an upper hand. In short, co-ordination between ports generates a whole that is larger than the sum of its parts. In most cases, inter-port co-ordination at varying degrees and scales improves information transfer, supply chain integration and the effective allocation of infrastructure. Key to the success of these co-ordination mechanisms is to identify the areas of common interest between stakeholders as the basis for future action, and to make sure that these areas are enshrined in a clear blueprint for action from the very outset of collaboration.

Cultivating strong hinterland connections

Governance of port-cities is increasingly influenced by the development of trade corridors. The goal is to integrate the port system in a multimodal transportation network, to improve market access, fluidity of trade and integration in an industrial network. In this context, a port must have interfaces between major oceanic maritime trade and economic activities of ports and inland terminals that provide intermodal structures and connections between the foreland and hinterland (Klink and van den Berg, 1998; Notteboom and Rodrigue, 2005). Obviously, business transactions require an adaptation to hinterland means. Conversely, amplifying the capacity of transport modes may allow for the expansion of trade. These bonds of mutual causality are now present in the traffic of port-cities. The quality and capacity of hinterland modalities, roads and relays are essential to any expansion of trade.

Strong hinterland connections require certain provisions within the port. This includes direct rail access to the quays, smooth interconnections with the railway network outside the port, and canals linking berths with inland waterways. These provisions are far from universally available. In many ports, several moves are required before a container (or other cargo) is placed on a train or barge; the more moves needed, the less competitive these modes of transportation become in comparison to truck transport. In other ports, there is no direct link with inland waterways, which means that barges have to reach the port terminal by sea, which many barges are not authorised to do, and which requires special vessels or changes in ship design. These examples are in many cases related to flaws in port design, which are not always easy to resolve. The ports that have achieved sustainable modal splits have extensive railway tracks on port terminals and may have dedicated river terminals and short sea terminals. In some ports, such as Hong Kong, port feeder barges are used to directly transfer cargo from sea-going vessels to barges, without needing quay access.

In addition to these measures, regional approaches towards freight transport, *e.g.* distribution centres and extended gates, are often needed to create enough critical mass for non-truck transportation. Trucks generally have a competitive advantage for short-distance transport; only at a greater distance does freight transport by train generally become competitive. Large economies of scale can result, but a certain logistical organisation is required, in the form of distribution centres where a large volume of containers and cargo can be gathered before being dispatched to individual destinations. Such a system of selective dry ports or distribution centres has made it possible for relatively small container ports such as Gothenburg to achieve high railway shares in total hinterland traffic. A related approach is that of extended gates, which basically relocate part of the port closer to the hinterland, by relegating cargo handling, customs and other procedures to an inland port, thereby decongesting the port. This tactic has been used by the port of Antwerp, which has evolved a large number of partnerships, creating a network of inland extended gates. Ports have become aware of the need to be better linked to hinterlands, and have variously acquired stakes in inland terminals and distribution centres, created dry ports, merged with inland ports and facilitated part of the hinterland transportation.

In some countries, dedicated freight lanes and corridors are created. Such freight corridors facilitate fast and uninterrupted freight transport, as they allow for limited intermingling of freight with urban passenger transport. These corridors differ in length. The Alameda Corridor, 32 kilometres long, connects the ports of Los Angeles and Long Beach to US transcontinental railways (Box 3.2); the Rotterdam Betuwe line includes 120 kilometres of dedicated rail track to Germany (Box 3.3); and the planned dedicated freight corridor between Delhi and Mumbai will run for approximately 1 500 kilometres. Although these dedicated freight corridors are not a guarantee for achieving high railway shares in total hinterland transport, countries where freight and passenger traffic both use the railways have to find ways to accommodate their co-existence. In some countries, passenger rail gets priority to the detriment of rail freight. Inland waterways are used in many countries to link seaports with inland destinations (Figure 3.4) and several seaports have a financial interest in inland ports, to strengthen their hinterland connections (Table 3.8).

Box 3.2. The Alameda Corridor

The Alameda Corridor is a 32-kilometre freight rail cargo facility connecting the transcontinental rail lines near downtown Los Angeles, California, to the Ports of Long Beach and Los Angeles. The project is one of the largest public infrastructure works in the United States, with a USD 2.4 billion investment. The corridor began operation in 2002. The centrepiece of the project is the Mid-Corridor Trench, which carries freight trains on triple-track lines in an open trench that is 16 kilometres long, 10 metres deep and 15 metres wide. The corridor was built by the Alameda Corridor Transportation Authority (ACTA), a joint powers authority formed by the cities and ports of Long Beach and Los Angeles in 1989. It is a public-private partnership project that involved various stakeholders, such as the two ports, the Los Angeles County Metropolitan Transportation Authority (LACMTA), the Southern California Association of Governments (SCAG), the private railroad companies Union Pacific (UP) and Burlington Northern Santa Fe (BNSF), as well as the eight cities that the corridor passes through. Its funding came from a unique mix of public and private sources, including a federal loan, grants from the LACMTA, user fees paid by the railway companies, investments from the ports and revenue bonds. According to the ACTA, the goal of the Alameda Corridor is to consolidate train traffic and eliminate at-grade conflicts, as well as improving the air quality in the Southern California basin through reducing traffic congestion at rail crossings.

As a dedicated intermodal railway designed to improve the efficiency of transporting container cargo from the two ports to the national rail system, the Alameda Corridor has generated a number of benefits. It has resulted in more efficient rail movement, with a reduction of train transit time from more than 2 hours to 45 minutes, as well as increased train reliability. Moreover, it eliminated conflicts at 200 at-grade rail crossings that reduce traffic delays and emissions from idling automobiles and trucks. As of April 2012, which marked its 10-year anniversary, ACTA estimated that more than 150 000 trains and more than 20 million TEUs (twenty-foot equivalent units) had moved through the Alameda Corridor, resulting in more than 13 000 tons of total emission reductions from the consolidation of freight rail operation and the alleviation of traffic congestion at rail crossings in the Southland. The ACTA also provided training to about 1 300 local residents and created more than new 1 000 jobs during its construction. The corridor has average daily traffic of 43 trains and cargo volume of 12 359 TEUs.

One key factor in the timely completion of the Alameda Corridor was the process of reaching a consensus among various stakeholders from the public and private sectors. The ACTA was able to resolve conflicts of interest between stakeholders and created a publicly acceptable project by taking actions to accommodate their needs and concerns (Agarwal, Giuliano, Redfearn, 2004). The ACTA had negotiated settlements and signed memoranda of understanding (MOU) with each mid-corridor city, and also provided assistance in local economic development measures in order to secure their co-operation with project approval and construction.

Box 3.3. Betuwe line: A dedicated freight rail link between Rotterdam and Germany

The Betuweroute is a double-track dedicated freight rail track towards Germany and into Europe. For the section from Rotterdam to the large shunting yard at Kijfhoek, existing tracks were reconstructed, but three-quarters of the line is new, from Kijfhoek to Zevenaar, near the German border. The rail stretch in Germany is referred to as the Hollandstrecke. Together, they formed Project No. 5 of the Trans-European Transport Network program (TEN-T). The first discussions on the dedicated freight track date back to 1985. Work on the Dutch part of the track began in 1998. Before and during its construction, the route generated a lot of controversy. In 2000, the Court of Audit stated that promoting river transport should have been considered as a realistic alternative. In 2004, the Centraal Planbureau concluded that the construction would never pay its way. Delayed by two years, the railway was finished in mid-2007, at a cost of EUR 4.7 billion, more than two times the original budget.

The Betuweroute is managed by Keyrail. The shareholders of Keyrail are Prorail, which manages rail infrastructure in the Netherlands (50%), Rotterdam Port Authority (35%) and the Amsterdam Port Authority (15%). In 2010, rail traffic on the 120-kilometre stretch between Kijfhoek and Zevenaar increased by almost 80%, to 17 600 trains. The market share of the Betuweroute in comparison with the other border crossings for freight transport by rail to and from Germany has increased to more than 70% in 2010, as compared with 45% in 2009. The main impetus behind this growth has been active tariff policy and, at the end of 2009, the electrification of the Port Railway Line, the stretch between the Maasvlakte and the Kijfhoek shunting centre. As a result, many carriers switched from the "mixed network" to the Betuweroute. In addition, the Port of Amsterdam was connected to the Betuweroute in March 2011 via a railway connection to the Betuweroute near Meteren/Geldermalsen. The Betuweroute is now serving both ports.

Figure 3.4. Inland port-cities in Europe

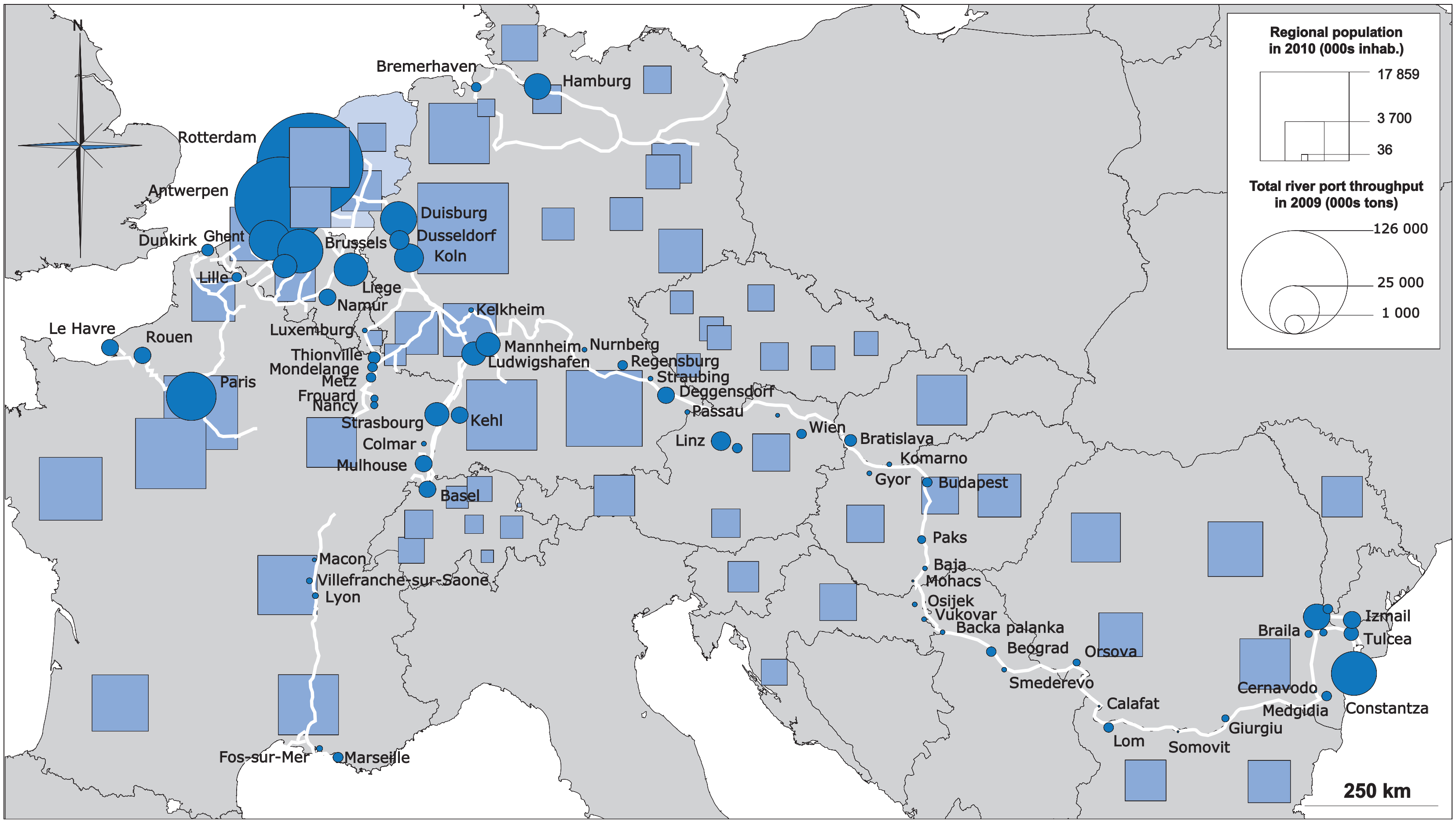


Table 3.8. Participation of seaports in inland ports/terminals

Seaport	Inland port	Share (in %)	Other shareholders
Ningbo	Taicang, Wanfang Int. Terminal	100%	
	Nanjing, Mingzhou Terminal	100%	
	Jiaxing, Fuchun Terminal	100%	
	Wenzhou, Jinxin Terminal	45%	Wenzhou Port Group
	Taicang Wugang Terminal	55%	Hong Kong Wugang, Sino-Trans&CSC, BM Holdings
South Carolina	Greer Inland Port	100%	
Virginia	Virginia Inland Port	100%	
Shanghai	Chongqing Container Terminal	50%	Chongqing
	Jiujiang Terminal	50%	Jiujiang municipality
	Wuhan Container Terminal	49%	Wuhan municipality
	Nanjing Longtan Container Terminal	25%	Nanjing Port, COSCO
	Jiangyin Container Terminal	30%	Baohua Group, Jiangyin Port
	Wenzhou Container Terminal	20%	
Barcelona	Zaragoza Terminal	21.55%	Mercazaragoza, Aragon government
	Guadalajara Multimodal Terminal	49%	
	Perpignan Saint-Charles Terminal	5%	
Antwerp	Geleen Rail Terminal	33.3%	Ewals Intermodal, Meulenberg
	Beverdonk Container Terminal	20%	DP World
Le Havre	Paris Terminal Gennevilliers		
Marseille	Lyon Terminal	16%	Compagnie Nationale du Rhône (CNR), Compagnie Fluviale de Transport (CFT), Naviland Cargo
	Pagny Terminal	10%	Chambre of Commerce and Industry of Bourgogne and Saône-and-Loire

More sustainable hinterland transport also requires regulation and incentives that are supportive. Truck transport remains in many cases the cheapest hinterland transport option, at least for relatively short distances. This is partly due to limited internalisation of external costs of truck transport, to the larger number of moves that are generally needed when using other transport modes, but also to regulatory constraints. Several countries have maritime cabotage rules that prohibit foreign flag vessels to be active in national short-sea shipping; as a result of such legislation and rules (*e.g.* the Jones Act in the United States) short-sea shipping remains undeveloped as a transport mode. Various countries have not yet liberalised their railway operations, which in effect limits the competition for rail freight. Such regulatory barriers would need to be tackled to stimulate more sustainable modes of hinterland transport.

Guaranteeing the support of the local population

The support of a local population is essential for ports in order to keep their licence to operate and remain legitimate economic actors. Local support will evidently be facilitated if there are local benefits and if negative impacts are limited or mitigated, but long-term and sustainable support requires more. What distinguishes successful port-cities from less successful and more polarised port-cities is the sense of pride and "ownership" of the port by the population and business community. This pride is in many cases based on a sense of history, but maintained by deliberate policies of port and city authorities, *e.g.* by transparent port communication and activities or facilities that create links between the port-city population and its port, and refer back to the maritime heritage of the city.

Guaranteeing the support of the local population not only legitimises their operation, it is also an important part of innovative marketing communications that take into account the challenges of seaports that are service-based businesses. In recent years, port authorities have experienced a dramatic wave of changes in governance settings, in response to organisational, operational and financial concerns that emerged in many ports

(Parola et al., 2013). Leading port authorities pursue growth strategies aiming to exploit business opportunities and expanding their international reputation and visibility. To achieve such objectives, they have adopted innovative governing strategies, which include innovative marketing and communication strategies for sharing a greater amount of information with major stakeholders. Today's port marketing communication strategies are broader than attracting and retaining customers: they now include informing and educating other stakeholders, such as employees and the local community, about the benefits provided by the seaport (Cahoon, 2007). In reshaping their relations with leading stakeholders, port authorities are targeting more effective forms of communication; the range of port authority actions may include international exhibitions, seaport days and direct business trips, school visits and the creation of a seaport education centre, etc.

Furthermore, ports have been cultivating a more open and pro-active approach in their annual reports. Empirical findings revealed how port authorities emphasise innovative themes that extend beyond the traditional content of disclosure (*e.g.* operational and infrastructural data), shifting to economic and financial data and Corporate Social Responsibility (CSR) information (for example, social and environmental contribution and sustainability reports) (Parola et al., 2013). Larger ports, or the ports that host a higher number of international terminal operators, are more inclined to initiate the disclosure of innovative information, to strengthen relationships with local actors involved in port-related activities and to mitigate customer bargaining power.

The port can also be a defining element of city marketing. The city of Rotterdam, for example, promotes itself as a world port-city, identifying its port as a driving force in the economy and also as a defining characteristic of the city. Preserving port heritage can also become an important tool in branding. With its historic city centre and docklands, the port-city of Liverpool has become the Maritime Mercantile City designated as a UNESCO World Heritage Site. In addition, the existence of international cruise terminals makes it easier for a port-city to market itself as a global city, since cruise ships bring in international tourism and interaction with the outside world. Montreal, for example, describes itself as "a cruise destination par excellence" within the cruise terminal services at the Port of Montreal.

Port centres

Several ports have adopted open and active communication strategies to inform and engage local citizens and stakeholders. This can take the form of port centres, as in Genoa (Box 3.4) and various other ports (Table 3.9). Port centres are built and promoted mainly by port authorities or city governments to make known the role and value of the ports, engaging local communities, students, children and the general public. In general, the key objective of these port centres is to improve the image of the port and forge a stronger links between the port and the city, by providing accessible information about the port's operations, industrial area and economic contribution.

Table 3.9. Overview of port centres

City, Country	Centre Name	Year opened	Number of visitors per year
Antwerp	Port Centre Lillo	1988	42 000
Genoa	Genoa Port Centre	2009	14 000
Rotterdam	EIC Mainport	1994	22 000
	FutureLand	2009	100 000
Melbourne	Port Ed	2002	4 000
Busan, Korea	New Port Visitors' Centre	2011	n.a.
Groningen, Netherlands	Seaport Xperience Centre	2012	10 000

Port centres often target young people as their main audience, offering various kinds of educational programmes and theme visits for students; for example, the Port of Rotterdam's Education Information Centre (EIC) Mainport Rotterdam and the Port of Melbourne's Port Education Centre (Port Ed) introduced special port education centres for children and students, which offer guided tours to operating ports, visits to cargo-handling/ship repairing companies and training seminars. Their focus on youth can also be extended to developing future professionals. The Port of Groningen, through its Seaport Xperience Center, aims to develop the technical labour market by introducing the upcoming generation to port-related professions.

Some port authorities see port centres as a tool to advertise their new port or the construction of the new port. For instance, FutureLand, the visitor centre for the Maasvlakte 2 expansion project in Rotterdam, introduces the construction of the new port to the public through technological activities, such as a virtual trip over the Maasvlakte as it will look in 2033, with the Future Flight Experience. Busan Port Authority also established Busan New Port Visitors' Centre, which aims to introduce the New Port, providing specific information and opportunities to experience the operating port to local community and the general public. In addition, a port centre can also be developed by the private sector: Porto Lab, a school laboratory, is an initiative owned and designed by the Contship Italia Group, which aims to communicate the value of container port and intermodal transport activities through educational activities for primary school children.

Box 3.4. Genoa's port information centre

The Genoa Port Centre was created in 2009 to promote the port and highlight the economic and social role of the maritime industry. Its aim is to stimulate strategic alliances between the port, businesses and the general public. The exhibition centre is an introduction to the port, its present and future and its role in national and European Union strategies. The centre plays an important educational role, and aims to attract students, teachers and parents. It organises guided visits, lectures and workshops and has developed educational material and other information. The Genoa Port Centre also has a role in broader communication through specific cultural projects (seminars, conventions and technical meetings) and exploration of the port of Genoa, such as visits to the port and the various areas of the port itself, in close collaboration with the port operators involved in the partnership. The initiative is promoted by the Port Authority, the province, the university and the Porto Antico company, which is responsible for property development in the old port of Genoa, where the Port Centre is located. The Genoa Port Centre builds on the experience of the ports of Antwerp and Rotterdam, which created their port centres in the late 1980s.

Port education

Several port authorities offer different types of educational programmes through their port centres, their websites, boat tours designed for school children, visits to schools and summer activities, etc. The aim of these programmes is to support the social integration of port and city and helps to cultivate future generations of employees, neighbours and stakeholders of the port operations and related industries. When Port of Rotterdam and Port of Melbourne have their own port education centres, the port centres of Genoa and Antwerp also provide educational activities for children and students. The Genoa Port Centre invites students to discover the professions involved in the port's operations through original devices and technologies such as webcams, simulators and touch screens. The Lillo Port Centre in Antwerp organises the *Jonge Haven* (Young Port) project for children in the fifth and sixth years of primary school to inform them about port professions and industry in the port.

Port-related educational programmes can also be provided through the websites of the port authorities, which contain downloadable classroom materials and teachers' guides. For example, the Port of Long Beach website offers "Port of Long Beach: Classroom", a series of lessons that combines real-world Port of Long Beach situations, with content from the California state-approved curriculum. The Port of Melbourne website also makes teacher and student resources available to download. In addition, other activities, such as boat tours and visits, are often used for educational purposes. The Port of Barcelona offers educational activities on traditional boats, including a Balearic cat-boat built in 1922, which allows young people to get in touch with the cultural and historical heritage. The Port of Los Angeles provides free one-hour educational boat tours to school groups (fourth grade through college) to demonstrate the dynamics of world trade. Visits of the port authorities to the schools, on the other hand, suggest active initiatives the ports can take to increase their visibility. The Port of Naples organises an event, "The Port of Naples Meets the Schools", a school visit by the President of the Port Authority, to explain the different types of jobs performed in the port (Table 3.10).

Table 3.10. Port education programmes

Port	Programme title	Target age group
Rotterdam	Programmes at EIC	Secondary schools, vocational institutions, up to university students
Melbourne	Port Education Program	Grades 5 and 6, Year 9 and 10
Genoa	Citizens of Port	8-18 years old
Antwerp	*Jonge Haven* (Young Port)	Fifth and sixth year of primary school, first and third year of secondary school
Long Beach	Port of Long Beach Classroom	12th grade, middle school and high school
Los Angeles	School Boat Tour	From fourth grade to college
Barcelona	Around the Sea	Not specific
Naples	Port of Naples Meets the Schools	Not specific
Bremen/Bremerhaven	Economics in the Port	Grades 8 to 10 and up
Reykjavik	Faxaports – Port of Reykjavik Youth Programme	11- to 12-year-olds, 14- to 18-year-olds

These activities are probably more effective if they are not considered exclusively as marketing exercises, but are coupled with transparency about port activities and their impact, for example, corporate sustainability reports of port authorities. Several port authorities in the United States have public harbour commission meetings and open access to their documents. In addition, several ports are active on social media and have a large range of followers that they inform and involve in port-related activities. All these can help promote high local approval rates, especially if they form part of a consistent strategy of stakeholder involvement in port-city development. Many ports go further and try to create links with the local population, either through maritime museums, waterside leisure activities and cultural projects with port and global city brand marketing in which the port plays a visible role.

Maritime museums

Most large port-cities have a maritime museum, which can have an important role in shaping and maintaining the collective identity of a port-city, and indeed, a nation (Hicks, 2001). Some of these museums are national museums; for example, the Australian National Museum in Sydney presents the National Maritime Collection, which mainly deals with the objects linked to Australian national history. The most recent example of such a national maritime museum is the China Maritime Museum in Shanghai, which was jointly built by the Ministry of Transport of China and Shanghai Municipal People's Government in 2009. It is the first and largest national maritime museum that attempts to "carry forward the spirit of 'Patriotism, Good-neighbourliness, Friendship and Scientific Navigation.' "

Many of the maritime museums in port-cities have a more local character. The maritime museum of Rouen focuses on the preservation of the city's history as a port-city, whereas the Port Natal Maritime Museum in Durban aims to offer insight into the influence of maritime culture on local life. In addition, for a port-city, maritime museums not only give the community an occasion to conserve the local port's heritage and culture, but also become tourist attractions that contribute to the vibrancy of the regional economy. The opening of the Merseyside Maritime Museum in Liverpool, which was built with the support of Merseyside County Council, led the way in revitalising the Albert Dock area. The dock is now a major tourist attraction, with many small shops, bars, flats, restaurants, hotels and other businesses.

A new wave of maritime museums not only focuses on local port community and culture, but also on the current role of the port in the city (Navarro, 2012). Antwerp's Museum aan de Stroom (MAS) has a collection of objects connected with the port, but also presents MAS Port Pavilion, an introduction to the operations of the Antwerp port through a virtual family guide. Maritime Museum Rotterdam also attempts to introduce the operating port, now far from the city centre, through a special exhibition: "MainPort Live – Feel the Rhythm of Rotterdam Port", which allows the public to experience the operating port in miniature and watch the ships in real time.

The involvement of port authorities in supporting maritime museums is fairly modest. Port authorities can be one of the initiators, as in the case of Antwerp and the MAS, and the Maritime Museum of Barcelona, a public entity formed by the local council and the Port Authority of Barcelona, but these cases are rare. Port authorities may be financial sponsors of such museums, as in Rotterdam and Amsterdam, but in general, this is unusual.

Port events

Many ports organise special activities staged in the port. For example, port days, maritime days, cruise days and port anniversaries showcase to the public the port's vessels, activities and people, as well as its maritime heritage (Anderson and Edwards, 2001). Such events, which can take an international dimension, enable city governments to attract tourists and raise the profile of maritime cities (Navarro, 2012). The Port of Hamburg celebrates its Port Birthday every year at the beginning of May; Busan Port Authority and Busan Metropolitan Government have organised the annual Busan Port Festival since 2008, which includes water leisure and sports activities, as well as exhibitions on maritime culture and science.

Some ports try to improve their image by opening the port to the public. The port authority and municipality of Rotterdam present World Port Days, whose goal is to familiarise visitors with the port and to create a positive attitude towards the port and its surrounding maritime city. Marseille and La Rochelle host Open Port Days for local citizens and the general public to discover the working port. The Port of Auckland also introduces a similar event, "SeePort", an open-weekend event offering local citizens the opportunity to see their port in action.

The transformation of port areas is in many instances also used to reconnect the local population with its port. Sydney Harbour is no longer used for cargo handling and has been transformed in a leisure area, but has somehow kept its maritime character, thanks to marinas and old harbour buildings. The transformation of the old port of Genoa has reconnected the city with its port, through some of its new activities, such as cultural centres and an aquarium. The port can also be a defining element of city marketing; as in the case of Rotterdam, which promotes itself as a world port-city. Such activities can help to create or sustain local goodwill.

Other than port-related events, several port authorities also support other cultural or community events, aiming either to attract tourism or engagement with the local population. For example, the Port of Las Palmas collaborates on a cultural event, *Puerto de Culturas*, which aims to celebrate and promote the cultural diversity in the Puerto Canteras area. Classical concerts have been organised in a container terminal in the port, where the Symphony Orchestra of Gran Canaria performed a Beethoven symphony for the International Festival of Theater, Music and Dance of Las Palmas. The Port of Marseille-Fos actively participates in the city's cultural projects for the European Capital of Culture, represented by the event *Trois saisons d'exposition sur le Port* (Three Seasons of Exhibition on the Port), which is composed of three differently themed exhibitions. Another interesting example is "Rock on the Dock", an annual rock festival in the port of Antwerp, which contributes to the port's appeal (Van Hooydonk, 2007). Port Metro Vancouver, on the other hand, is involved in supporting and participating in a number of community-level cultural events and initiatives, such as the Children's Art Festival, Steveston Salmon Festival and Richmond Maritime Festival, etc.

Social media

Social media has become an important communication tool for port authorities. The most common channel used is Twitter, used by port authorities to communicate their container traffic, weather forecasts for the port area, community events and other initiatives. Those with the highest number of followers are Incheon Port Authority and Port of Los Angeles (Table 3.11). With its Twitter account, Incheon Port Authority not only reports daily weather forecasts and the port's contribution to the local economy, but also draws attention to job opportunities in port-related industries, the history of the port and its environmental campaigns. The Port of Los Angeles' Twitter account mainly promotes community events and development projects on the Los Angeles waterfront. Facebook accounts are also often used to highlight pictures and videos. Some ports use other online communication materials. For example, the Port of Portland runs a blog, "PortCurrents", in which the port publishes articles on environmental and community issues. Hamburg's Port Authority has its own channel on YouTube, "Hafen TV", which aims to introduce the work of the port authority and the business activities conducted in the port.

Table 3.11. Use of social media by selected world ports

Port	Number of Twitter followers	Number of tweets	Facebook subscribers
Incheon, Korea	8 733	2 214	4 040
Los Angeles	5 702	404	12 471
Seattle	3 311	719	1 999
Vancouver	2 687	1 602	-
Valparaíso	2 436	972	-
Rotterdam	1 531	857	-
Antwerp	1 249	5	-
Gothenburg, Sweden	747	924	-
Auckland	157	363	553
Cartagena, Colombia	135	6 157	-
Manzanillo, Mexico	-	-	112

Public access to ports

In addition to the “Open Days” offering the public access to operating ports, port authorities offer various ways to access to the port sites: free boat tours, bike paths around the port, port viewing sites and port-city interface areas. Free boat tours are one of the most popular ways to access the port, for observing port sites more closely from the water. The Port of Houston has run the “Sam Houston Boat Tour” since 1958, a free 90-minute round-trip cruise ride along the Houston Ship Channel. During the tour, passengers can enjoy passing views of international cargo vessels, and operations at the port’s Turning Basin Terminal. The Port of Long Beach also proposes free harbour tours from May to October, which are in high demand. The Port of Auckland provides free public boat tours on the Waitemata Harbour, giving the public an opportunity to view the operations from the sea; the hour-long tours take visitors alongside the container terminals, where they can see the big cranes and other machinery at work.

Some ports introduce bicycle paths (cycle routes) around the port, enabling the public to explore the port sites and observe the working port activities. The Port of Hamburg has introduced an extensive network of 45 kilometres of cycle routes, offering views of the loading and unloading of containers and crossing impressive bridges; a route map can be downloaded on its website. The Port of Antwerp also provides bicycle maps that give an overview of the bicycle routes in the port, which include 20 sights in and around the port. The Port of Melbourne, on the other hand, presents “Port Heritage Trail”, which establishes a link between significant heritage sites and structures located around the port by placing easily identifiable markers at several locations; each site marker contains information and historical images, enabling visitors to explore the history of the Port of Melbourne as they walk or cycle along existing trail networks. The Port of Auckland launched “Red Fence Heritage Walk” in 2012, which introduces the historical wharves and ways to access the port.

Public access to port areas has been also significantly increased through investments in building port-city interface or redevelopment of the spaces where the port and the city meet. The Port of Valparaíso, for example, has been developing urban spaces such as Puerto Baron and Muelle Prat. Muelle Prat, built in 1850 to transport passengers, is now frequented by tourists and locals who enjoy the promenades, craftsmen and artists beside the sea. Boat rides are available from which to observe the port, cargo operations and unloading of ships. Developing a port-city interface has often been associated with the rehabilitation of old port areas in waterfront development projects. The examples vary, yet in general aim to create a multi-functional district that stages commercial, recreational, and cultural activities.

The transformation of port areas is also used as a way of reconnecting with the local population. Sydney Harbour, no longer used for cargo handling, has been transformed into a leisure area, but has kept its maritime character, thanks to its marinas and old harbour buildings. The transformation of the old port of Genoa has reconnected the city with its port, through new activities such as cultural centres and an aquarium. Creative initiatives to transform the old port infrastructure into cultural spaces include Hamburg’s well-preserved Speicherstadt, a historical warehouse district in the port, which has become one of the city’s most popular tourist attractions since its transformation into several museums. “CRAFTED” at the Port of Los Angeles is another good example, a large-scale permanent craft marketplace located in refurbished World War II-era waterside warehouses. The market hosts hundreds of individual craftspeople, artists, designers and artisanal food makers, and also organises cultural events. A recent example is the J1 site in Marseille, an ancient warehouse renovated as a public cultural space by the Port of Marseille-Fos.

Goodwill projects

To improve the local reputation or image of the port, port authorities can also lead goodwill projects, such as compensation for negative impacts of the port, sponsorships, or volunteer work initiatives. The Port of Valparaíso offers the community social training programmes; in three versions of the programme, 130 beneficiaries have received training in hairdressing, plumbing, nutrition, food handling and entrepreneurship. The Port of Houston Authority sponsors local community programmes, initiatives and activities; Port Commissioners, Port Authority staff members, and representatives of external organisations may request Port Authority sponsorship of events or programmes by submitting a sponsorship application form. The Port of Houston is also engaged in volunteer work initiatives – Port Authority volunteers, known as Port SupPORTers, participate in environmental programmes, helping bag sand for hurricane preparedness and cleaning up the Baytown Nature Centre. The Port of Long Beach awards USD 60,000 in scholarships to Long Beach college students and high school seniors who are pursuing studies in related fields such as international business, global logistics and trade and industrial technologies. As for the Ports of Auckland, it sponsors the Excellence in Exporting Award, to support local businesses and help them expand Auckland's export sector.

For port-cities, providing waterside leisure and recreation activities is not only a good way to attract tourism, but also a way of obtaining public support by consolidating the city's maritime identity. In some port-cities, public beaches close to the port can demonstrate how the port, nature and residents can co-exist. Hamburg's Elbe riverbank offers fine sand beaches overlooking the busy container terminals on the opposite bank of the Elbe; restaurants, hotels, parks, green promenades and natural beaches along the Elbe attract locals and tourists alike, with good views of the harbour and cranes. The Port of Los Angeles contains the Cabrillo Beach Recreational Complex, which offers various recreational opportunities with its public beach, youth sports centre, marina and aquarium.

The port and waterfront provide an arena for water sports and sporting events, and support sailing schools, tour operators, yacht brokers, marinas that bring income to the city and hinterland (Anderson and Edwards, 2001). Several port-cities organise water sporting events or development of marinas. An annual yacht racing event such as the Sydney-Hobart Yacht Race is considered to have a significant impact on tourism and national maritime identity; the event draws international attention and visitors, bringing vitality to the region. Southampton, UK, also enjoys economic benefits from water sports tourism; the Southampton Boat Show, with yacht racing events and free boating, attracts 110 000 visitors, 500-plus exhibitors and contributes more than GBP 11 million to the local economy (Southampton City Council, 2013).

Indicators of effectiveness

The long-term effectiveness of the measures described above has not been subject to systematic research. Specific programme assessments and evaluations are sometimes available that indicate the success of a particular measure and the appreciation rate.[2] There is hardly any information on how a particular campaign or programme affects the overall public perception of ports. A Public Communications and Perceptions Survey

Research Report on the Port of Long Beach, involving 1 000 registered voters, showed that 68% of respondents were satisfied with the port's efforts to communicate with residents through newsletters, television, the Internet and by other means. Other ports are known to have conducted public perception surveys to maintain their image among the local population, and hope to improve their ratings by applying some of the communication strategies described above.

Notes

1. With the possible exception of the super oil tankers.

2. The American Association of Port Authorities holds AAPA Communications Awards, which aim to underline successful communication strategies and their outcomes. The awarded communication projects vary, including advertisements, social media campaigns and special events. Regarding the assessment of social media campaigns, the main indicators are the number of followers on Twitter, Likes on Facebook page, and views on YouTube. When it comes to the special events, the outcome is assessed based on the number of participants, public reaction on the news posting about the event, and online survey results: for example, in case of Port of Long Beach, it organised free community harbour tours in order to build positive awareness for the port and community pride, which attracted 2 500 participants in total; only concerning the event "Specialty Harbor Tours", additional harbour tours to reach specific audiences, a total of 650 passengers boarded for the five tours, and 60 people reacted positively on the postings of the pictures of the event. Moreover, 75% of the participants rated the event as "excellent" on the online survey via SurveyMonkey. In case of Port of Los Angeles, the port authority offered free educational boat tours to students in the local schools in order to nurture a connection and an understanding of the port; the project was evaluated as successful, based on the popularity of the program and the Boat Tour Evaluation form filled out by teachers: it hosted 80 schools with nearly 7 000 students, and the port received 72 forms with a 98% excellent rating, with hundreds of thank you letters from students.

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Chapter 4

Increasing the local benefits from ports

How can competitive ports be turned into engines of urban economic growth? What are the policy options for port-cities and the main policy instruments, and what is their effectiveness? This section identifies three main models for port-based urban economies: maritime clusters, port-industrial development and port-related waterfront development. In addition, a side-option is presented that does not use the port as a source of economic growth but is based on diversification of the urban economy to decrease the dependence on the port economy. A "non-regret" option involves increased co-operation between port-cities. Such policy options are archetypical, as various port-cities have strategies that combine different models.

Table 4.1. Main policy options to increase local port benefits

Policy option	Related sectors	Instruments	Examples
Maritime clusters	Logistics Maritime services Shipbuilding/repair	Developmental support Fiscal incentives/grants Co-ordination/information Human capital matching	Singapore Hong Kong
Industries	Industrial ecology Renewable energy	Spatial planning Investments	Rotterdam
Waterfronts	Tourism/recreation Food Events industry	Master planning Project implementation Incentives/investments Synergies with port	Barcelona
Diversification	Non-port sectors	Similar instruments	London Liverpool Boston

Maritime clusters

Clusters are especially important to the maritime domain, because the shipping and ports industries are highly dependent on subcontracting and various kinds of services, and because they require a very specialised local workforce (De Langen, 2002; Wijnolst, 2006).[1] For firms, participation in maritime clusters is said to generate increasing productivity through the creation of cost-reducing linkages between suppliers and customers, the formation of larger and more qualified labour pools, and through spill-overs of knowledge that work through inter-firm interaction (Brett and Roe, 2010). Particularly for shipping, ports and maritime manufacturing, clusters can facilitate better interactions with a range of ancillary services (finance, brokerage, insurance), and can enable access to information and expertise that might open new markets and provide opportunities for expansion (Weissenberg, 2006).

Successful maritime clusters enhance the port’s contribution to its surrounding city and region. In cities such as London, the growth of high-value-added activities related to the maritime domain has been shown to contribute directly through employment, an increase in GDP, fiscal revenues and overseas earnings, and indirectly through the multiplier effects of wage spending and increases of demand in the supply chain (TheCityUK, 2011). For this reason, the formation of maritime clusters has been seized upon as a policy objective in many parts of the world, and governments now have at their disposal a diverse range of instruments that may help embryonic maritime clusters to emerge and consolidate, and enhance mature clusters. However, many examples of cluster-formation policies have met with mixed success (Doloreux and Shearmur, 2009; Melançon and Doloreux, 2011). The success of a given instrument for encouraging maritime clusters is context-dependent; policy cannot create clusters ex nihilo. In most instances, clusters emerge through path-dependent and market-induced processes, meaning that not all maritime clusters can be encouraged in the same manner, and that not all port regions have the potential to form maritime clusters or should pursue such a strategy (Karlsen, 2005). The role of policy is thus to respond to locally identified needs, and to encourage these tendencies only when this is logical in light of alternative uses of resources (Nauwelaers and Wintjes, 2002). The instruments presented below, and the strategy of maritime cluster formation more broadly, should therefore not be interpreted as a universally applicable panacea.

Cluster composition

A port cluster can be said to consist of "all economic activities related to the arrival of goods and ships" (De Langen, 2004b). Depending on the context, the port cluster can thus be composed of very different sub-sectoral components. Table 4.2 below, based on data compiled by Lam and Zhang (2011), summarises some of the more famous examples of maritime clusters around the world, and illustrates the diverse compositions possible based on the comparative advantages of each cluster:

Table 4.2. Maritime cluster composition in main port-cities

Maritime advantages	Hamburg	Hong Kong	London	New York/ New Jersey	Oslo	Piraeus	Rotterdam	Shanghai	Singapore	Tokyo
Port	X	X					X	X	X	
Marine insurance			X		X				X	X
Financial service	X	X	X	X	X	X		X	X	
Ship registry	X	X	X		X	X			X	
Shipowners, Operators & Managers		X	X		X	X	X		X	X
Ship classification society			X		X					
Ship agency and forwarding			X				X	X	X	
Ship brokers			X		X	X				
Legal services		X	X			X			X	
Ship building & repair	X	X					X		X	
Marine personnel				X			X	X		
Research , education & training	X	X	X		X	X	X	X	X	X
Information and communication technology (ICT) Services		X	X	X		X	X		X	
Regulators: Maritime Organisations / Associations/exchange market, etc.			X		X		X			X
Governmental support	X							X	X	
Maritime culture and heritage	X		X	X	X	X	X			

Notes: Marked boxes indicate comparative advantage in a given sub-sector.

Source: Lam, J. S. L. and W. Zhang (2011), "Analysis on Development Interplay between Port and Maritime Cluster", First International Workshop on Port Economics, National University of Singapore, December 5-6.

Port and logistics

The first and most obvious sub-sector of any maritime cluster is that of the port. The port often increases demand for a sub-cluster of firms that ensure that it performs well.

Port-side logistics firms provide stevedoring services, including loading, discharging and stowing, while other firms specialised in land-side logistics provide services such as trans-loading, warehousing and distribution. Various other firms ensure that the port's infrastructure and operations continue to perform at optimum levels through the provision of dredging, pilotage, mooring, berthing and bunkering services. Of course, port-related logistics do not always necessarily constitute the core component of the cluster, as the cases of London, Oslo and Piraeus illustrate (see Table 4.2).

A given maritime cluster could be composed entirely of firms fulfilling these logistical and port operations functions. An exclusively port-centric cluster would thus base its activities mainly around low value-added logistics activities such as cargo loading, discharging, storage and distribution, as is the case with Dublin, Ireland (Morrissey and O'Donoghue, 2013). Alternatively, the port logistics functions component might be linked to an array of value-added trans-loading and cargo transformation activities (processing, packing, consolidation, etc.), which is the case in ports such as Antwerp or Osaka (Lam and Zhang, 2011). To a large extent, the centrality of the port logistics component in the maritime cluster will be determined by local path dependencies. For example, the Drechtsteden cities in the Netherlands, located on the Rhine-Meuse-Scheldt delta, have built up a significant dredging cluster, in part due to their proximity to the Rotterdam port cluster (De Langen, 2002), but also due to their years of traditional expertise in building levees for urban flood management. The differences in the development of West German maritime clusters also reveal divergences regarding the centrality of the port logistics sub-sector. In Hamburg, the growth of high-value-added maritime service firms (insurance, banking, consulting) has pushed the traditional logistics firms away from the high-cost areas in direct proximity to the port; while in Bremen, largely due to automobile value-added activities, ports and logistics firms remain tightly interwoven within the spatial confines of the city, with back-of-port logistics progressively playing a central role in the cluster (Elsner, 2010).

Shipping and maritime services

In the same way that the ports and logistics services are often tightly interwoven into one sub-sector, the shipping and maritime services sub-sectors often go hand in hand. Ship ownership and management play a key role in the health of the maritime cluster as a whole, increasing demand for a range of services and positioning port-cities such as Singapore, Rotterdam and London as international maritime centres. To an extent, the presence of shipping companies in a given maritime cluster is the product of historical path dependencies. Thus, in Japan, for example, despite the formal dissolution of the Zaibatsu system in the post-war period, the historical privilege and power accorded to shipping companies involved in the Zaibatsu system has helped them retain positions as key players in the Japanese maritime cluster (Shinohara, 2010). With around 80% of world throughput carried by the top 20 shipping lines in 2010 (Notteboom and Rodrigue, 2010), however, the horizontal integration of the global shipping industry – mainly through alliances, mergers and acquisitions – has made shipping lines powerful global actors whose operations are largely unconstrained by any territorial considerations (Slack, 1993).

While the operational mobility of shipping can render maritime clusters vulnerable to sharp shifts in fortune, shipping companies are, however, somewhat constrained in their choice of location for their strategic command and control functions. Headquarters and regional offices for high-level decision making and deal brokering must be located in places that can provide the services without which the shipping industry could not function. Maritime services play many roles for the shipping industry. Shipbrokers, for example, mediate between shipowners and cargo owners who need to charter a ship; they assist with the buying and selling of old ships and the building and acquisition of new ones; and they also play a key role for principals in the freight derivative market. The shipping finance industry includes investment banks, commercial banks and more specialised equity firms, which lend substantial sums to the shipping sector. This is an especially critical service, due to the capital-intensive nature of shipping, but financial actors also provide a range of other key services, such as equity and bond underwriting, merger and acquisition advice, cash management and foreign currency exchange. Due to the risks inherent in the shipping industry, insurance firms also play an important part in many maritime service clusters. Insurers provide protection against a range of liabilities, including risks to hull and machinery, cargo, energy and even piracy. This provides an incentive to locate headquarters in areas with such insurance services. London, for example, is the biggest international centre for protection and indemnity clubs, which provide mutual protection amongst shipowners and operators for risks that many insurers will not cover, including third-party risks associated with cargo, collision or environmental pollution.

Due to its complexity, the shipping industry relies heavily on legal services. Often shipping headquarters and legal firms are clustered together, as in Geneva, Hong Kong and London. On the one hand, they provide solutions and contractual expertise related to a range of fields, including salvage, pollution, shipbuilding, charter parties, insurance, cargo, energy and the environment. On the other hand, law firms assist in dispute resolution. Many disputes in the shipping sector are international in scope, and require cross-jurisdictional expertise both on the side of the legal firm and on the side of the courts. The opening of the Rolls Building, the world's largest dedicated business, property and commercial court, in London in 2011, for example, was heralded as an important move in retaining the city's position as a leading maritime centre. Finally, other services within a typical maritime services cluster include accounting, ship classification and compliance, technical consultancy and research. Different forms of intervention will benefit different aspects of a given maritime services cluster, and it is therefore important to make sure that any cluster-support policies are based on a thorough understanding of exactly which services contribute to the comparative advantage of the cluster.

Shipbuilding and repair

For many decades and even centuries, traditional maritime nations in Europe, such as Britain, Norway, Greece and Italy, built up important clusters connected to the shipbuilding yards that served their fisheries and commercial industries. Many traditional shipbuilding nations, however, could not keep pace with the rapid technological and economic changes that took place during the 1970s and 1980s, involving increasing capital requirements for exponentially larger container vessels, not to mention competition from low-cost manufacturing areas. Consequently, the core of the shipbuilding industry has shifted from Europe to Asia. In 2011, China, South Korea and Japan dominated the contemporary market for shipbuilding, controlling 41%, 33% and 20% of the global shipbuilding capacity respectively, and 94% collectively, according to information from Clarkson Research. Nevertheless, shipbuilding is an industry that naturally lends itself to cluster formation, due to the regional character of shipyards: they are immobile, and must be located near to water and intermediate inputs (Weissenberg, 2006). As a result, some European nations have retained maritime clusters based on shipbuilding activities. Regional specialisation away from large container vessel markets and towards niche markets has been one successful strategy for maintaining shipbuilding activities and putting years of expertise and regional networking to good use (Karlsen, 2005). In Italy, for example, shipbuilding is highly concentrated and highly specialised: the Viareggio cluster remains one of the world's foremost mega-yacht centres, and is connected to an important network of subcontracting producers and service providers (Lazzeretti and Capone, 2010).

Instruments

Governments are increasingly choosing to support and stimulate cluster growth. Table 4.3 summarises the instruments that have been employed in support of maritime clusters around the world. As mentioned above, policies should be tailored to suit the needs of the cluster's specific comparative advantages and needs. Therefore, not all of these instruments will be applicable to every context. Broadly defined, they can be grouped into four different types: *developmental support* instruments that support the emergence and maturation of embryonic clusters through the formulation of broad development strategies and the provision of basic facilitating infrastructure; *fiscal and financial incentive* instruments that seek to spur or renew growth in existing clusters, by providing fiscal relief or financial transfers to strategic aspects of the cluster; *co-ordination and information-sharing* instruments that aim to improve cluster governance and overcome collective action problems; and *human capital matching* instruments that seek to better embed the cluster locally, by improving the match between the local labour pool and the cluster's human capital requirements. Each type of instrument is assessed with notable examples below.

Table 4.3. Main maritime cluster policies

Policy instrument	Scale	Examples
Developmental support		
- National maritime cluster strategy	National	Netherlands
- National Excellency Programmes	National	Finland, Norway
- Incubators and research centres	Local	PortTech Los Angeles
- Venture capital provision	National/local	MCF Business development fund, Singapore;
Spatial planning	Local	Los Angeles, Durban
Fiscal incentives/grants		
- Ship Registry Initiatives	National	Most OECD countries
- Bilateral fiscal agreements	National	Most OECD countries.
- Tax exemption for foreign flag ships	National	Singapore's AISE scheme
- Anti-piracy measures	National	Most EU countries
- Tonnage tax	National	Most OECD countries
- Equity-raising measures	National	KG financing model, Germany
- Targeted wage subsidies	Local	Quebec, Singapore
- Niche shipbuilding	National/local	Italy, Norway
Co-ordination/information-sharing		
- Consultative fora	National/local	South Africa, Port of Brisbane
- Voluntary national associations	National	
- Local networking platform	Local	Deltalinqs Rotterdam
- Shipping exchange	National/local	Copenhagen, Shanghai, Japan; London
Human capital matching		
- Maritime training and certification	Local	Rotterdam, Singapore
- Workplace Initiatives	Local	SEVA-PORT, Southeastern Virginia, US
- Maritime scholarships and grants	National	Singapore
- Research and development	National/local	Canada; Smart Port Rotterdam

Developmental support

Any government strategy to support maritime clusters should take into account the cluster's stage of development, as the needs of the cluster evolve over time (Brett and Roe 2010; Shin and Hassink, 2011). It is possible to distinguish at least four phases in the cluster life cycle. De Langen and Van Klink (2001) have referred to these as development, expansion, maturation and transition, while Menzel and Fornahl (2010) have identified emergence, growth, sustainment and decline as the four stages of any cluster life cycle. Each stage implies different needs, and thus a different role for government (Van Klink and De Langen, 2001). During development, the value chain and strategic relationships are still under construction, so policies should seek to provide information, foster relations and exchange know-how between firms, and create supportive infrastructure. During expansion, while firms are specialising and seeking out new markets, the government should provide risk capital, promote outsourcing and assist with internationalisation; during the maturation phase, the cluster has an established set of products and supplier-producer relationships, and thus the role of policy should be to further professionalise suppliers and seek out links and synergies with other clusters, to avoid stagnation. During the transition phase, changes in the market have brought about decline, new market entries are low and a downward spiral is possible, hence policy intervention should aim to assist with the transition of firms into new configurations or domains, and should seek to retain and reapply local expertise and talent.

Crucially, a cluster does not proceed through these stages in a linear fashion. Policy intervention might facilitate cluster adaptation, allowing it to escape decline and sustain its markets. It also might renew a declining sector by re-invigorating growth (as ship registries helped to achieve in many maritime clusters, described below), and in rare cases, the local know-how and expertise from a no longer active cluster may be transformed to create new markets and products.

During developmental stages of a cluster, the formulation of a broad set of strategies and policies can be a crucial factor in chartering an optimal growth trajectory. These policies set out a vision and a broad, multi-sectoral set of orientations for the implementation of specific sectorally-focused policies and instruments. In Finland, for example, the national government has sought to provide a broad framework for maritime cluster development through its National Maritime Cluster Programme. The programme aims to provide support for all stages of cluster development. It seeks to provide the conditions for the emergence of new clusters through funding innovative initiatives, and helps the cluster identify and pursue new business opportunities (Merk, Hilmola, Dubarle, 2012).

The Netherlands presents a good example of how national policies can support the growth and emergence of maritime clusters. Notably, the Dutch state was able to tailor policy interventions to suite the requirements of the cluster throughout the consecutive stages of its maturity. Throughout the 1980s, the "mainport" strategy constituted the central guiding principle for maritime cluster development (Merk and Notteboom, 2013). Under this strategy, the Port of Rotterdam and the airport of Schiphol were promoted above other ports as the key drivers of the Dutch economy. The strategic vision for a "Netherlands, Distribution Country" (Nederland Distributieland) was enshrined in an overarching policy framework by the same name. In line with this vision, investments in supportive infrastructure were highly concentrated onto the Mainports business environment, and various commercial initiatives sought to attract the headquarters of commercial and logistics firms to the Mainport areas. This vision succeeded in promoting the Dutch maritime cluster, which underwent considerable expansion in re-exporting activities and managed to attract a large number of European Distribution Centers (Kolk and Van der Steen, 2002). As the Dutch maritime cluster has become more complex in its composition and needs, however, the strategic orientation of the government has shifted away from an exclusive focus on Mainports, to one that aims to enhance the competitiveness of the metropolitan region Randstad Holland. This new turn in the

Netherland's maritime cluster policy has sought not only to enhance connectivity through information and transport infrastructure, but has also focused on quality of life in the region. This aspect of the new policy orientation can be seen as a response to the complexification and maturation of the maritime cluster, in that it became necessary to seek high-level headquarters and a high-quality labour pool. The Mainports are now acting as facilitators for the competitive development of Randstad Holland. This new strategic direction is also echoed in several central government documents, including the National Seaports Policy 2005-10, the economic vision on the long-term development of Mainport Rotterdam, but also the Peaks in the Delta programme (2004-10), the Randstad 2040 vision and the Randstad Urgency Programme (2008).

Provided that it is attuned to the life cycle of the maritime cluster, broad national policy support is an essential component in fostering cluster emergence and maturation. Local-level instruments also have an important role to play, however. In clusters concentrated around ports, local government and port authorities can stimulate new cluster growth through the provision of basic infrastructure, such as business premises in proximity to the port. The Port of Los Angeles has implemented successful support instruments through its PortTechLA program. Created in 2010 in direct proximity to the ports of Los Angeles and Long Beach, PortTechLA is a large complex that functions as a business incubator for hundreds of port-related companies and start-ups. It is linked to the Technology Advancement Program, which funds programmes in support of the port's Clean Air Plan and Clean Truck Action Plans. Start-ups that provide innovative forms of environmental port technology are thus supported financially by the port, further embedding the growth of the cluster within the specific local needs of the port community. The success of the programme's cluster-building objectives is evident in the businesses' track records: in 2013, 87% of the incubated start-ups begun in 2010 were still in business. This success rate is perhaps in part due to the access to venture capital facilitated by the incubator facilitates, both through events such as the PortTechEXPO Pitch Competition involving local venture capitalists, and through the various business mentoring programmes set up by PortTechLA.

In Europe, such local-level maritime cluster instruments are undergoing a process of policy transfer, in part driven by EU-level networking initiatives, such as the European Network of Maritime Clusters (ENMC). In Sibenik, Croatia, for example, the Norwegian Ministry of Foreign Affairs has sponsored the creation of a Maritime Innovation Center named CroNoMar, which is meant to function as an incubator for start-ups and development projects in the Croatian maritime sector. Norway, which has extensive experience in the field of maritime cluster development, has thus been able to transfer some of its local-level know-how to its Mediterranean partner. The model of the project seeks to foster the emergence of a local maritime cluster specialised in the shipbuilding sub-sector. Half of the incubator is reserved for established companies, with 25% for services and the remaining 25% intended for use by start-ups. After two years of operation, three shipbuilding firms had begun business there.

Spatial planning for clusters

Port authorities can also use a number of spatial planning instruments to foster their maritime clusters at the local level. Such instruments rely on the landlord function of the port authority, used to plan and develop new infrastructure as well as regulate and steer land-use patterns within the port. Port-based spatial planning instruments can encourage maritime clusters in two main ways.

Firstly, they can optimise land-use *within* the port. This involves land acquisition and the reservation of space within the port for future use in strategic sectors of activity. For example, demand for ship repair and maintenance has increased greatly in recent years, along with the expansion of the world fleet (Senturk, 2008). When coupled with other shipyard activities, such as conversion or shipbuilding, ship repair facilities can generate economies of scale within the port, and thus contribute to the growth of maritime clusters. However, such facilities present enormous land-use requirements that must be planned for. By reserving space for such facilities, ports such as Dubai and Singapore have enabled the growth of strong shipyard clusters. Furthermore, land-use planning within the port can also involve the clustering of complementary activities. Authorities in the port of Los Angeles, for example, created a new Port Master Plan in 2013 that aims to diversify and expand the commercial and academic uses of port land so as to encourage innovative collaboration between port logistics firms and research centres. The plan further aims to reduce the presence of activities on the waterfront that are not water dependent, mandating a 50% decrease in the acreage of such firms on the waterfront by 2017. Port authorities can and should provide spatial frameworks that make the most of the cluster's particular strengths, and that facilitate growth in its most important sectors.

Secondly, port authorities can also foster the maritime cluster by optimising land-use at the interface between the port and its immediate hinterland. In many ports, there is room for improvement in terms of inland depots and distribution centres for value-added logistics, which would better suit the needs of the firms that cluster in the immediate hinterland of a port (trans-loading, warehousing, road haulage, etc.). In Durban, South Africa, for example, a lack of co-ordinated planning between the port authority and the city has led to the creation of an informal logistics cluster in the residential neighbourhood of Clairwood. The cohabitation of such incompatible land uses generates many negative externalities, both for the quality of life of the residents, and for the health of the maritime cluster, which is spatially fragmented. In response to these trends, the port and city have collaborated on a Back of Port master plan, which will create new categories of land use better suited to the existence of a maritime cluster in the city, and will allow for the progressive rezoning of the back of the port area towards an inland depot model. Other ports have taken the principle of interface planning for the maritime cluster beyond logistics, and are using the proximity of the port to the city in order to benefit from the positive externalities that urban agglomerations represent in terms of human capital and infrastructure (Hall and Jacobs, 2012). In the Kop van Zuid and Research, Design and Manufacturing campus areas in Rotterdam, the Speicher area of Hamburg, and the Euro-Méditerranée area of Marseille, for example, the port-city interface has been zoned for hybrid uses that allow for a mix of maritime services, educational facilities and port-related firms.

Fiscal incentives and grants

Once the maritime cluster has been successfully supported and the precedent for further growth has been set, fiscal and financial instruments can provide strong levers for encouraging maritime cluster expansion, and in some cases, can help to renew ailing clusters. The global nature of the maritime industry now makes it possible for market actors to relocate their activity to the business environments that are most amenable. To foster their maritime clusters, governments must encourage market participation, which often means providing competitive tax regimes. A key issue thus lies in ensuring that tax reductions are offset by net gains for the national GDP and labour market.

Fiscal initiatives aimed at encouraging registration in the national fleet have become popular instruments amongst central governments seeking to provide a boost to their maritime cluster. In many states around the world, the problem of declining registered and owned fleets grew severely from 1970-90, as states running open registries with low tax rates ("flag of convenience" states) increasingly attracted shipowners from around the world (Carlisle, 2009). One of the first maritime cluster policies implemented by central governments in many OECD countries has thus been to create low-tax, second registers open to foreign-owned ships, capable of competing with flag of convenience tax regimes. The creation of the Norwegian International Ship (NIS) registry in 1987, for example, was considered instrumental in the turnaround of the Norwegian shipping cluster during the 1990s (Benito et al., 2003).

Besides the low tax rates, which constitute a direct fiscal incentive, the comparative advantage of OECD states with open second registers usually resides in their reputation and credibility with regard to international rules, standards and regulations in the domains of maritime safety, labour laws and environmental protection. Due to the comparatively stringent oversight mechanisms of OECD states, ships that are registered with them are often seen as less risky by insurers, which in turn results in lower premiums for such ships. Thus, because compliance with international standards such as those published by the International Organization for Standardization (ISO), the International Maritime Organisation (IMO), and the ILO increases the attractiveness of the state register, adoption and enforcement of regulations can in fact constitute an important pro-cluster mechanism.[2]

In addition to compliance with international norms on safety and the environment, some states with large maritime clusters have seized upon the issue of maritime piracy to attract and retain shipowners. As the instances of piracy in high-risk areas off the coast of Somalia and West Africa have increased, so too has the demand for new security measures to ensure the transport of cargo. However, major flag states differ in the anti-piracy measures they provide to their registered ships, and some place restrictions on the ways in which ships can be protected. As concern over ship security grows in areas that are at risk, states that offer more leeway on security measures may appear as more attractive flag states to shipowners, particularly to those operating in piracy-prone areas.[3]

Various fiscal measures can be taken to discourage deflagging. One such measure that has been used with success in many states is the tonnage tax. The tonnage tax not only seeks to encourage registration in the state's fleet, but it also seeks to spur employment and productivity in the existing maritime cluster. Under the popular "Dutch model" – introduced by the Netherlands in 1996 and implemented by over 20 states around the world – the normal corporate income tax rates are still applied to shipowners' profits, but their profit itself is calculated differently. The tonnage tax under this model sets a given daily profit per ton, which is applied to the total tonnage capacity of the fleet owned by the company and calculated for a full year. The profit thus calculated is then taxed at the country's corporate tax rate, meaning that shipowners are taxed at a flat rate, irrespective of the company's actual profit or loss.[4] While the tonnage tax played an important role in slowing the decline in flag registers amongst traditional maritime states in the preceding decades, it has since become something of an international norm, and may no longer be sufficient to meaningfully contribute to the maritime cluster. Some states, such as the United Kingdom, however have tailored tonnage tax schemes to suit their own national requirements in ways that push the potential of the tax, rather than simply attempting to reduce deflagging rates.[5] In addition to the regimes described above, governments might undertake bilateral measures to increase opportunities for firms within their maritime cluster. These include reciprocal tax exemption agreements (RTEs), agreements for the avoidance of double taxation (DTAs), and comprehensive DTAs (CDTAs).[6]

Finally, clusters can be fostered through a range of targeted fiscal exemption schemes. Exemptions can target a specific sector, such as Singapore's Approved Shipping Logistics scheme for ship agencies, ship managers, international logistics operators and freight forwarders of shipping groups that provide freight and logistics services from Singapore. Or, they might deliberately target foreign vessels, such as the opening of Singapore's Approved International Shipping Enterprise scheme in 1991. A review of the specific mix of pro-maritime cluster instruments that have helped transform Singapore into one of the world's leading maritime clusters appears in Box 4.1.

Developmental support, easing of flag registration and fiscal relief mechanisms remain key instruments that can be deployed by central governments to support their respective maritime clusters. However, the legitimacy of sectorally focused direct subsidies has been brought into question in recent years, due to concerns over market distortion and trade disputes. Today, governments risk violating international and national trade laws through direct transfers to specific sectors of the economy, and, in certain domains, must seek alternative policy solutions. The shipbuilding sector presents a notable example of such trends. [7]

One option involves so-called industry shifts, whereby know-how and capital from traditional shipbuilding regions are retained and put to new uses. In their analysis of activities at existing and former shipyards throughout Europe, Giovacchini and Sersic (2012) have identified the development of offshore renewable energy sources as a common and successful industry shift that has been set in motion by many Northern European states as a matter of concerted policy. In effect, the development new offshore wind power facilities – not to mention experimental tidal energy generation equipment – has drawn significantly on the expertise of shipbuilders.

Yet, while industry shifts have allowed some port-cities to retain and re-use the capital and know-how of traditional shipbuilding activities, this strategy often represents a move away from – rather than a strengthening of – the rest of the maritime cluster. Alternatively, focusing on "niches" constitutes another strategy that attempts to maintain shipbuilding activities in connection with the broader maritime cluster. The promotion of niches involves focusing investment in research and development on highly innovative and customised products. By comparison with the large-scale, standardised outputs typical of Asian shipbuilding, specialisation and customisation remain competitive advantages of the European shipbuilding clusters. Niches include luxury yachts, offshore support vessels, cruise ships and naval ships. As noted above, Italy has managed to maintain many of its shipbuilding activities by specialising in cruise and luxury ships, mainly in the shipyards of Monfalcone, Marghera and Sestri Levante (Giovacchini and Sersic, 2012). Norwegian shipyards, on the other hand, have specialised in a variety of small vessels, ferries and offshore support vessels. The Norwegian government has assisted in the outsourcing of certain high-cost aspects of the production process to Eastern European countries (such as hull-building), which has supported niche specialisation by allowing the Norwegian shipyards to retain the key value-chain activities while operating at a relatively low cost. Targeted out-sourcing policies might therefore present a viable option for reductions in typically high-cost niche activities, without recourse to subsidies.

However, the reality is that such cost reductions are often achieved through reduction in the labour intensity of production, which translates into a drop in employment in the maritime cluster. Retention of niche activities through selective outsourcing is an instrument that is not without its risks, and should be weighed against alternative development strategies focusing on high-growth, non-maritime sectors, such as offshore energy. Niche strategies are best pursued when few alternative options exist, or where retention of the activity in question is particularly important due to highly dependent supplier industries.

Box 4.1. Singapore's maritime cluster building

In the past, Singapore relied heavily on conventional port functions, providing cargo handling, ship-related services and storage. However, given the need to diversify its business operations and maintain its position as a logistics hub, the government has chosen to set Singapore up as a maritime logistics hub. It now has more than 5 000 maritime establishments, with SGD 28 billion in gross receipts, a workforce accounting for 5% of Singapore's national employment and an output that accounts for 7% of GDP. Singapore has attracted a number of shipping groups to register in its Registry of Ships.

To increase the value added of the port of Singapore, the Singapore government has undertaken a number of fiscal measures and other incentives to attract advanced logistics companies to locate around the port of Singapore and form a maritime cluster. The strategy is to build a maritime business cluster to enhance its position as a logistics hub: a clustering of port and maritime-related activities complementary to the trade in goods and services (linking port operations to international trade) and a one-stop service for customers by providing an integrated maritime logistics services and attaining economies of scale and scope. It emphasises transparency of regulations and aims to provide world-class infrastructure and an adequate supply of skilled logistics professionals. In cultivating environment attractive to foreign firms, it has employed fiscal measures and other generous incentives that have played a major role in achieving the status of a maritime logistics hub. The major tax incentives include the Approved International Shipping Enterprise (AISE) scheme, Approved Shipping Logistics Enterprise (ASLE), tax benefits for ship registration and support for business development. The AISE offers income-tax exemption for 10 years for foreign flag ships, provided that the owner or charterer controls a significant amount of ships and maintains a significant operation in Singapore. In the past, only ships under the Singapore flag were given income tax exemption, which contributed to the substantial expansion of the Singapore fleet in the 1970s and 1980s. However, in many cases there was very little further benefit for Singapore and its economy, since a large part of the fleet was operated, both commercially and technically, outside Singapore. In 1991, to increase the use of Singapore as a base for the management and control of their shipping operations, Singapore introduced a tax incentive under the AISE incentive scheme to exempt shipping lines awarded AISE status from tax on the income from vessels operated by them, whether registered under the Singapore flag or elsewhere. The ASLE provides a concessionary income tax on qualifying incremental income for established ship management, ship agencies, freight forwarders and logistics operators.

To encourage foreign vessels to register with Singapore's Registry of Ships, the profits of a shipping enterprise derived from the operation of a Singapore-registered ship are exempt from income tax. This applies to income derived from the carriage in international waters of passengers, mails, livestock or goods or from towing or salvage operations carried out in international waters by Singapore ships, and it includes the charter of Singapore ships. It also exempts shipping companies registered with Singapore from withholding tax on interest payments with respect to offshore loans to finance ships. Under this incentive scheme, there is also no tax on gains from vessel sales. The government also extends business development support to ship-owners and maritime auxiliary service providers, by providing grants and defraying expenses during initial development on a reimbursement basis.

To foster innovation within the maritime industry, the government established the Maritime Innovation and Technology Fund (MITF) in 2003. In 2002, to address a shortage of supply of skilled logistics professionals, the government established the Maritime Cluster Fund (MCF). The MITF includes the Maritime Industry Attachment Programme, the Joint Tertiary and Research Institutions and MPA research and development (R&D) Programme, the Maritime Technology Professorships and the Platform for Test-bedding, Research, Innovation and Development for New maritime Technologies (TRIDENT). The MCF was established by Singapore's Maritime and Port Authority to support the maritime industry's manpower and business development efforts.

Co-ordination and information-sharing mechanisms

Clusters that are able to co-ordinate interests among participants are better placed to overcome collective challenges and achieve common goals. De Langen (2004a) has argued that co-ordination can lower inter-firm "transaction costs" within a cluster (associated with searching for partners, time and travel expenses, performance monitoring and contract specification) and increase the scope of co-operative efforts (from investments in the labour pool to collaboration on innovative projects, collective marketing and expansion efforts, and knowledge sharing). In spite of these benefits, however, co-ordination does not come naturally to firms within a cluster, for at least three reasons (Olson, 1971; De Langen, 2004b): the risk of "free rider" behaviour by firms that benefit from the co-operative environment without committing their own resources constitutes a disincentive. In situations where benefits from co-ordination will be unequally distributed, firms that are not thriving will seek to inhibit co-operative development; and finally, the uncertainty of co-ordination can constitute a risk, dis-incentivising co-ordination among risk-averse firms.

Without any form of external intervention, co-ordination between firms within a cluster is thus generally more limited than the optimal level. For this reason, it is often necessary for government or "leader" firms[8] (De Langen, 2004a; Nijdam, 2010) to intervene to structure better governance outcomes. Instruments for better cluster governance can range in scope, from the local to national levels.

Governments have used several instruments to introduce better cluster governance, particularly with regard to relations between the port authority and the port community. These may include statutory consultative mechanisms. In South Africa, for example, where ports are nationally owned, the National Ports Act created a port consultative committee (PCC) for each port. The PCCs serve as an interface between the authorities, local government, unions and industry representatives, and help to provide better alignment between the key stakeholders of the ports cluster.

Various public actors in port-cities around the world have also created voluntary networking platforms that bring together representatives from the industries that make up the maritime cluster (shipping associations, import-export associations, cargo handlers, maritime agents, unions, etc.) and from the local institutions (chamber of commerce, municipality, port authority, regional authorities, etc.). In Brisbane, the Community Consultative Committee is run by the port authority, while in Durban, the Port Liaison Committee is run by the chamber of commerce, and in Mississippi, the River Trade and Transport Council runs the local networking platform, the Lower Mississippi Port Cluster. The Community Consultative Committee in Brisbane, like many other platforms of this kind, brings together local environmental groups, the Manly Chamber of Commerce, terminal operators (DP World), and several private actors in the port community. Through this mechanism, stakeholders are able to provide input into the port's plans, enhance co-operative efforts and share information.

Associative initiatives led by the private sector are also important cluster governance instruments, and should be encouraged by policy makers. The Dutch employers' association, Deltalinqs, is a significant example of such a structure, which brings together some 700 firms, mainly of the Rotterdam maritime cluster. Individual firms can be members, and are grouped by industry field (ship's agents, bulk and container stevedores, forwarders, pilots, transport and logistics, and so on). But Deltalinqs also features many associative members, such as the Association of Rotterdam Shipbrokers or the Association of Rotterdam Terminal operators, and thus serves as an umbrella organisation for sub-clusters. Deltalinqs not only lobbies for the interests of the maritime cluster but also maintains a series of important partnerships with the Port of Rotterdam, the City of Rotterdam and several educational institutes. Notable joint projects that such partnerships have enabled include: Port Base, a joint initiative of the Port Authorities of Amsterdam, Rotterdam, Deltalinqs and the customs, which serves as a comprehensive information exchange for hundreds of customers and the authorities; Delta Port Donation Fund, jointly funded by the Rotterdam Port Authority and Deltalinqs, which invests in NGOs working on welfare, culture and sport in the vicinity of the port and industrial area, in order to improve the positive impact of the maritime cluster; and a series of educational and research programmes responding to the needs of the maritime cluster through workplace training and new certifications (detailed below).

It is also important to note that transnational cluster networks are gaining ground. In Europe, for example, the European Network of Maritime Clusters (ENMC) brings together 15 national clusters. The EMNC currently serves two main purposes: internally, it serves as a forum for the exchange of good practices; externally, it serves as a platform for lobbying for the interests of the EU maritime sector. Other examples include the LeaderSHIP 2015 and 2020 initiatives, which have sought to connect various shipbuilding clusters throughout Europe. The initiative brought together several industry leaders to agree on a strategy for lobbying for improved access to finance at the European level.

Finally, shipping exchanges can also constitute private-led, government-supported ventures that enhance the competitiveness and co-ordination of the maritime cluster at the national and regional levels. Shipping exchanges provide important information-sharing mechanisms, especially for those clusters that have strong maritime finance components. For many years, the Baltic Exchange has helped to spur growth in the UK and London maritime clusters, and contributed to the city's transformation into an international maritime centre. The Baltic Exchange is an international source of information on the maritime markets. In addition to its global role, it is a large contributor to the UK shipbroking industry. Some 600 companies were members of the Baltic Exchange in 2013, 400 of which were based in the UK. In light of the success that the Baltic Exchange has brought to the UK maritime cluster, it is little wonder that Denmark, Japan and China now host their own shipping exchanges. The Shanghai shipping exchange, founded in 1996, plays several co-ordinating and information-sharing roles within the Chinese maritime cluster: it helps to adjust freight rates, facilitate trade between the shipping elements of the cluster, collect and publish information on the maritime markets and standardise transactions. The exchange has helped to improve the international standing of the Chinese maritime cluster: some 300 firms were members of the Shanghai Shipping Exchange in 2013, and major shipping firms such as Hapag-Lloyd, Maersk, Pacific Shipping Company, Kawasaki and CMA-CGM have subscribed to its shipping index.

Human capital matching mechanisms

As the firms that compose a given maritime cluster are usually highly specialised, they require specific skills that are often in short supply. Increasingly, governments are seeking to better match their local labour pools with the needs of the maritime cluster, as a way of simultaneously promoting job creation and contributing to the value-added of the port.

Many maritime clusters now feature partnerships between universities, local government and maritime firms. These partnerships help to better match the local labour pool with the maritime cluster in three main ways. First and foremost, they give rise to new degrees and certifications that enable local students to develop skills needed by the maritime cluster. Such mechanisms can serve the long-term aims of the maritime sector, especially in areas that are experiencing shortages of labour in strategic sectors. In the Rotterdam maritime cluster, for example, the Deltalinqs association has created the Maintenance College, in partnership with Albeda College, and the Process College, in partnership with ROC Zadkine and the Shipping and Transport College. The curricula of such programmes are conceived in tight collaboration with the maritime cluster, and respond directly to its labour demands.

Secondly, they provide an avenue for apprenticeships and internships with participating maritime firms. This instrument can provide a very direct mechanism for embedding the maritime cluster within the local context, as it increases the likelihood that skilled workers are retained locally. Such workplace schemes can be especially important in areas that are undergoing changes in their economy and require workforce transformation, and where risk of human capital flight is strong. In southeastern Virginia, which has undergone such challenges, the SEVA-Port Partnership between community colleges and the port authority aimed to create a local workforce skilled in the warehousing and distribution sector through such workplace internship schemes. Crucially, this programme also targeted young talent, through summer programmes with local high schools that included hands-on internships with participating logistics firms. The YoungShip programme in Møre, Norway, has adopted a similar approach, fostering informal contact between young students and key firms of the Norwegian maritime sector. The programme, which includes mentoring and aims to increase female participation in the Norwegian maritime cluster, has met with considerable success, and as of 2013, was active in a number of Norway's port-cities.

Thirdly and finally, educational partnerships in maritime clusters often provide scholarships and grants for maritime education programmes, which extend the breadth of the labour pool by providing greater access to education, and include the added benefit of attracting international talent. The Maritime and Port Authority (MPA) of Singapore offers a host of scholarships in the maritime field, which often lead to career paths within the maritime cluster. Under the Tripartite Maritime Scholarship Scheme, for example, talented high school graduates are granted scholarships of up to SGD 50 000 to complete the Diploma in Nautical Studies or in Marine Engineering at the Singapore Maritime Academy or Singapore Polytechnic. Scholars are co-sponsored by the MPA and a participating shipping company or union, with whom they must spend at least three years as a Marine Engineer Officer in fulfilment of their return of service obligations. The programme thus ensures that students are being trained for specific positions within the maritime cluster and that talent is retained in Singapore.

An offshoot of these forms of collaboration is that the local institutes do not simply provide better-skilled workers to the maritime cluster, but increasingly also research and development (R&D) services for ports and connected small and medium enterprises (SMEs). The Maritime Institute of Quebec, for example, has created its Innovation Maritime research centre within the framework of just such a partnership. Innovation Maritime is recognised as a College Centre for Technology Transfer by Quebec's Minister for Tertiary Education, Research and Technology Sciences, which enables it to benefit from government research grants. For example, any individuals or companies that request research and development projects from Innovation Maritime can apply for tax credits from the Quebec and Canadian ministries of science and development, and the centre is further eligible for grants from the Natural Sciences and Engineering Research Council. In 2013, Innovation Maritime had successfully carried out more than 200 research and development projects for various fields in the maritime cluster. Similarly, the Port of Rotterdam has actively engaged in such R&D development initiatives through its partnership with the Erasmus University. The Smart Port research centre thus aims to meet a growing demand for maritime research and expertise, and collaborates with the port to produce research of direct relevance to the maritime cluster. Such collaborative R&D efforts between universities and ports are increasingly taking on a global dimension. The Singapore Maritime and Port Authority has not only signed MOUs with three of the leading universities in Singapore (the National University of Singapore, Nanyang Technical University and the Institute of High-Performance Computing), but has also begun to invest in joint R&D with the Research Council of Norway – which provides the scope for a range of collaborations between industry and universities in both countries – and jointly organises the International Maritime-Port Technology and Development Conference with the Port of Rotterdam.

Port-industrial development

In many port-cities, industrial development and port development have traditionally gone hand in hand. These forms of port-city industrialisation were more or less spontaneous, occurred during various stages of port-city development and were in many cases determined by urban specificities and land site conditions and availability. In the western Mediterranean before 1919, for example, industrial zones grew up spontaneously in the ports of Marseille, Taranto, Naples, Barcelona, Genoa, Valencia, La Spezia, Piombino, Savona and Palermo (Verlaque, 1981).

Since the late 1950s, a wave of planned industrialisation related to ports has taken place. These policies were in most cases driven by national states supporting national champions as a means of developing economically disadvantaged areas, by restructuring industries and creating new growth poles. The fundamental reasons for their development lie within the sphere of maritime transport, namely the development of very large bulk carriers, which have dramatically reduced the costs of long-distance ocean transport (Vigarié, 1981). This heavy industrial development in coastal areas, frequently referred to as Maritime Industrial Development Areas (MIDAs), was land intensive, with requirements for sites of at least 2 000 hectares. Major MIDA projects in Europe, the United States and Japan all took place in the late 1950s. The Botlek scheme in Rotterdam became operational in 1958, later extended with the development of the Europoort and the Maasvlakte, which created an area of over 10 000 hectares devoted to oil, chemical and shipbuilding industries. Antwerp developed a large site for heavy chemical industries at the same time, whereas Amsterdam and Ijmuiden introduced a major iron and steel complex. Other European examples of MIDAs include Dunkirk, Fos-sur-Mer, Le Havre, Hamburg and the Weser ports, Teeside in the UK, and Livorno in Italy. Also in Japan, ports were considered the lynchpin of regional development in their port policies; the regional development impact of port development projects was considered a sufficient return on port investment. In 1964, an Act on the creation of Special Areas for Industrial Development was approved in which ports served as hubs of development. In line with this, “developer ports” were created in depressed regions as a catalyst of industrial and urban development, as in Kashima and Tomakomai (Olukoju, 2003).

Originally concentrated in heavy industry, policies gradually shifted to lighter industrial activities, after the economic crisis of the mid-1970s. New oil refining capacity and production of primary chemicals and steel in developing countries meant a rationalisation of the industries that underpinned MIDA development, with a refocusing of port development projects. At the same time, increased population pressure in port-cities such as

Rotterdam, Hamburg and Yokohama led to pressure to limit pollution and diversify economic activity. Larger areas in ports became devoted to warehousing, commercial activities and development of light industries. An example is the port of Gioia Tauro in southern Italy, perceived in 1970 as a future MIDA, but transformed into a container trans-shipment port in the mid-1990s after decades of non-existing industrial development and non-realisation of projected steel plant and electrical power plants (Dunford and Yeung). Policies related to MIDAs are special economic zones, often located in or close to ports, which are provided with attractive conditions to attract industrial development.

Port-industrial planning projects like these have had mixed success rates. In many cases, they have led to rapid increases of population, employment and economic growth. They have in some cases increased the industrial potential of nations and facilitated the restructuration of post-war economies. The "developer ports" policies in Japan have facilitated rapid transformation of agricultural areas into industrial and commercial zones, with spectacular growth rates in Kashima (Vigarié, 1981; Olukoju, 2003). At the same time, there have been many partial failures as a result of over-ambitious projects or of a lack of continuity in planning. In southern Italy, no effective MIDAs were developed apart from Taranto (Vigarié, 1981).

One of the main challenges related to port-industrial development is the creation of linkages with the local economy. This often proves challenging, because most of the industries that have invested in MIDAs are multinational companies whose development strategies are often not aligned with those of regions and cities. As noted earlier (in Chapter 2.1), industries within port clusters are not always strongly inter-related and economic benefits often spill over to other regions in the same country – or to other countries. A related challenge is the bottom-up character of these projects, which in many cases ignored the existing regional skills and competences. In Dunkirk, for example, the arrival of heavy industry has replaced diverse competences related to the textile and port industry (such as making fishing nets, sails and other artisanal activities) with low-skilled industrial work with hard labour conditions (Boutillier, Laperche, Uzunidis, 2011).

This lack of economic linkages within the region may enforce vulnerability of regions related to one-sided economic development and path dependency. Port activity in large industrial ports can be largely focused on industrial activity to the detriment of commercial port activities. This is the case in large port-industrial complexes, but also in other ports with strong industrial orientations. In Antofagasta, Chile, all port activity is focused on the copper mining industry, exposing it to vulnerability due to specialisation and a missed opportunity to create an urban logistics sector (Merk, 2013). Various ports with an industrial focus have tried to develop other port functions, such as container terminals, but have not always succeeded, *e.g.* the container volumes in Amsterdam are marginal and present only 3% of total traffic in Dunkirk). Such one-sided development can increase a port's economic vulnerability, cutting off other possibilities for development. In Dunkirk, entrepreneurship has been stymied by the region's dependence on industrial activity, which has led to an accumulation of assets that favour heavy industrial development (Boutillier, Laperche, Uzunidis, 2011).

Some port-cities have tried to tap new and emerging sectors as a way of optimising the human capital and knowledge resources locked into the port and logistics sector. In building institutional linkages, local governments hope to transform their labour markets and reduce the local costs of business. This is the intent of the Southeastern Virginia Partnership for Regional Transformation (SEVA-PORT) (Box 4.2).

Box 4.2. The South-Eastern Virginia Partnership for Regional Transformation

Through the SEVA-PORT partnership, Virginia aims to tether its well-developed port cluster – and especially the industries involved in transport, warehousing and distribution – to the sector of computer modelling and simulation, which specialises in the creation of sophisticated models for use in the fields of gaming, engineering and medicine, and is also crucial to the operational aspects of logistics. In addition to creating this economic synergy, the policy is also intended to work as an inclusive employment mechanism, and to this end has implemented an array of training programmes for youth and dislocated workers. The first step in the project was taken in 2007, when the SEVA-PORT partnership was awarded a USD 5 million grant, created to support regional transitions from traditional industrial or agricultural sectors to innovative information-based sectors. Key to obtaining this funding was the creation of a broad regional partnership, which brings together 24 cities and counties, a number of business and industry representatives, over 10 different educational institutions and several economic development agencies from state and local government. The key mechanisms of the policy focus on upgrading the educational opportunities that will create a labour pool at the nexus of these two industries. This involves integrating certificate programmes for warehousing and distribution, truck driving, and modelling and simulation into the degrees offered by community colleges, and the expansion of internship opportunities in these same sectors through links with the private sector.

The economic vulnerability of industrial development in ports is underlined by the current global industrial restructuring. Outsourcing of heavy industries from developed economies to emerging economies has led to the closure of many industrial plants on port sites and the need for industrial reconversion. The petrochemical cluster on the port site of Marseilles-Fos is struggling, with various closures of refineries and further closures in sight (Merk and Comtois, 2012). The Port of Rotterdam foresees a large-scale restructuring of the refinery industry and aims at bundling forces with the industrial complex of the Port of Antwerp in order to be the only European location of refinery activity in 2030 (Port of Rotterdam, 2012). With the prospect of industrial rationalisation looming, many ports and port-cities are assessing new industrial opportunities that could build on existing assets and infrastructure. These include industrial ecology and renewable energy, two new options that will be explored below.

Industrial ecology

Industrial ecology, also referred to as circular economy, aims to provide systematic management of material and energy flows, using waste from one process as input for another process. Where this flow of materials or energy is achieved through collaborative relationships between normally unrelated industries, it is referred to as industrial symbiosis. Following the first widely recognised example of Kalundborg in Denmark, other examples of industrial ecology have been developed around the world. The precondition for such cases is the physical proximity of the firms between which interrelations exist or could be created.

Port sites have great potential for industrial ecology projects. Many ports are effectively large industrial estates where various industrial firms are clustered, which provides many opportunities for synergy. Moreover, ports can have substantial influence in siting industries ripe for industrial ecology projects. A recent overview analyses 31 initiatives in 23 different ports world-wide (Mat and Cerceau, 2011). Various motives inspired these projects, ranging from pollution prevention, process optimisation, and waste management to internalisation of environmental costs, local economic development and competitiveness.

While the initiatives in North America were apparently inspired by such motives as pollution prevention and environmental protection, industrial ecology in Europe and Asia is mainly understood as a driver for economic development in port-cities. Initiatives in Dutch ports, including the port of Amsterdam, Zeeland Seaports and the port of Moerdijk, aim at developing industrial ecology to attract and sustain businesses. For instance, since the 1990s, industrial ecology has been developed as a lever for competitiveness and attractiveness in the Port of Rotterdam. The OCAP-project[9] supplies horticultural businesses with residual CO_2 from Shell Pernis located on the port site, using a disused pipeline and a new distribution network of 130 kilometres of smaller pipes. Fostering local economic development was also at the core of projects undertaken in Antwerp, Ghent and Brussels. Several Japanese ports, such as Osaka, Kawasaki and Kitakyushu, have transformed themselves into recycling hubs (OECD, 2013), while eco-industrial parks have been developed in various Chinese and South Korean ports, including Tianjin, Ningbo and Ulsan.

Among the 31 case studies, the main economic sectors in which port industrial ecology projects are implemented are energy, waste, chemicals, petrochemicals, water management, construction materials, maritime industries, metallurgy and the agro-food sector (Mat and Cerceau, 2011). However, this study does not pretend to be exhaustive. In France, a national workshop in 2013 brought together stakeholders of the seven main French port-industrial complexes to highlight the progress of industrial ecology in these areas and encourage networking to share best practices and expertise.

Various drivers can promote industrial ecology in port sites. Many cases involve government pressure for more environmental responsibility. One of the drivers of the effort to promote the use of waste heat capacity in the Port of Rotterdam was pressure from the regional water board, which made it clear that it would no longer accept the emission of heat into surface water (Baas and Huisingh, 2008). Many of the Asian projects originate from the top down, based on national strategies such as the Circular Economy Law (China), the Green Growth Strategy (South Korea), Recycling Ports plan (Japan) and the Eco-town programme (Japan). Important facilitators are knowledge institutes that have helped deliver technical expertise and innovation and facilitate exchange of information and best practices. The University of Delft conducted a study in collaboration with the Port of Rotterdam to explore the possibilities of a methanol-based industrial cluster in the port area (Herder and Stikkelman, 2004). This example of port, industry and university collaboration fits into a larger picture of co-operation in this field (Box 4.3).

Co-siting and clustering can support these exchanges and utility sharing. Ports have the chance to influence this by their zoning regulations in their port master plan, in which they can cluster industries, give them water access or access to railway or inland waterway connections. In addition, they have incentives to attract certain industries, for example through their concessions for port land sites. Although port authorities can play an important role in co-siting, much depends on whether the industrial activity takes place in the port area. The port authorities of Rotterdam and Antwerp, for instance, both act as landlords not only of port terminals but of large industrial estates for the world's largest chemical clusters. This gives them more room to organise co-siting or utility sharing than the port of Tarragona, which is related to a large chemical cluster on land owned by the chemical companies themselves (EPCA, 2007).

Box 4.3. Rotterdam: Co-operation between port and university

Although it has its sights firmly fixed on a global role, the Erasmus University in Rotterdam has shifted its strategy in recent years and is now clearly committed to local and urban development. Its Department of Economics recently created a "Smart Port" Centre, bringing together training, research and consultancy services linked to the port's activities. Erasmus has also joined the "Generation R" Programme and the Rotterdam Climate Initiative (RCIP), with financing for start-ups in the energy and climate sector. The university has been in charge of many impact studies for the Maasvlakte 2 programme and the westward move of the harbour. The university's Institute of Urbanism promoted the idea of the floating city, now in place in the downtown area. Similarly, the Technical University of Delft (TUD) has co-operated with the port authority in the field of computer modelling. It has a common interest with the city and the port in safety and security and transport analysis. In this sense, the metropolitan area and the port can be considered a laboratory for research activities. The Port of Rotterdam has developed on the strength of traditional activities, in particular chemicals and petrochemicals. The port industrial cluster has expanded with new international services, forwarding agencies and multinational company head offices. The fact remains that the majority of small and medium enterprises active in the port are engaged in logistics, transport and trade, and are involved primarily in the carriage of cargoes to and from their port of shipment. These firms have little interest in innovation. It is estimated that only 1% to 2% of the turnover of the port and industrial cluster is devoted to R&D. These are in fact mature industries that show clear signs of becoming ossified in routine activities.

To deal with these risks of "cognitive lock-in", local leaders have sought to reconfigure the city-port interface. Rotterdam University (which specialises in applied sciences) has established a new campus for Research, Design and Manufacturing (RDM) in one section of the old port. An incubator managed by the Technical University known as "Yes! Delft" has been established there. RDM Innovation Dock is part of the campus. Its goal is to connect practical research and entrepreneurship, by creating a degree of integration between higher education institutions, services and private industry. All these initiatives take place within an ambitious plan promoted by the city (City of Rotterdam Council) and the Port Authority, the goal of which is to redesign "Stadhavens Rotterdam" and make it a showcase for water management, by exploiting Dutch expertise in flood control and extending this know-how into the area of climate change. Beyond the RDM, the strategy relies on three other broad objectives: re-inventing delta technology in the context of the Rotterdam Climate Initiative, developing floating communities, and sustainable mobility programmes (the object being to halve lorry traffic). Rotterdam's aim is to become a knowledge port.

In the absence of these drivers, the development of industrial ecology in ports becomes more complicated. Royston (2011) explains the less active adoption of industrial ecology on port sites in the UK by more private ownership, smaller land holdings, a hands-off government policy and the absence of business associations that could have created a facilitating environment.

Renewable energy

Port development strategies are increasingly focused on renewable energy. *E.g.*, Rotterdam's Port Vision 2030, published in 2011, is based on a strategy to link the port to its emerging sustainable energy sector. Like the SEVA-PORT partnership, the Port Vision 2030 envisions this cluster synergy as an agent for industrial transformation. As Rotterdam's port switches to clean fuels and bio-based energy and integrates energy recycling and carbon capture policies into its operations, this should drive demand for transformation in the adjacent energy clusters from its present-day dominance in petrochemicals, to sustainable forms of energy production. Already, Rotterdam is one of the largest European importers of liquefied natural gas (LNG), and the port is equipped with an advanced set of liquid bulk refineries that could be used for biofuels. To oversee and encourage this transition, the port has invested in the development of a synthesis gas (syngas) cluster and has begun construction on carbon capture and storage infrastructure.

Development strategies involving maritime and the new energy sectors appear to be growing in popularity. Several other Dutch cities and ports have based their growth strategies on such links. Groningen port hopes to develop into the Bioport Eems Delta, which would be the main importer and trans-shipper of biomass. It has already developed several partnerships with industry and local authorities, including a shared roadmap with the Northern Netherlands region. The port-city region of Zeeland, between Antwerp and Rotterdam has a well-established agricultural and chemical sector and a set of policies aimed at fostering synergies between the emerging bio-mass activities of these two clusters and that of the port. As part of these policies, the Port of Terneuzen has implemented a project with two local renewable agriculture companies that combine horticulture with carbon-capture.

As one of the key growth sectors in renewable energy, offshore wind energy could bring employment and value added to the ports, by constructing future power-supply systems, clustering related industries in the port areas and thus revitalising the economy of port-cities. It has been estimated that the gross employment in the offshore wind energy sector in selected North Sea countries could be 115 000 jobs, if EU renewable energy targets are met by 2020 (Ragwitz et al., 2007). The methodology of different studies may vary, but all studies assume that the number of jobs per MW will increase as the new installed capacity goes up, because the benefits within the supply chain and export potential will grow with scale (McNeil, Straw and Rowney, 2013). For instance, 18 GW installed by 2020 could generate 22 900 to 43 400 jobs, and having 40 GW installed by 2030 could raise that number to 96 400 jobs in the UK (*ibid*.). Ports are the decisive nodes on the logistics chain for both construction and installation of the Offshore Wind Energy Plants (OWEP), as well as operation and service, which includes maintenance and repair of the Offshore Wind Farms (OWF) and OWEP (Uniconsult, 2013).

Four main functions can be distinguished for ports to engage in offshore wind energy: fabrication and installation; operations, maintenance and service; research and development; and lastly, import and export of onshore and offshore wind energy plants and components (Uniconsult, 2013). In addition to the traditional logistics tasks of storage, stowage and trans-shipment for the components, opportunities for ports to benefit from engaging in the business include related industry clustering and development of infrastructure and research facilities (Uniconsult, 2013). On the other hand, market players in the industry choosing where to locate, including offshore wind developers, component manufacturers and designers, shipowners, operators and energy providers, are evaluating ports in terms of their handling capabilities and capacities. It is critical for ports to be aware of the requirements for the offshore wind energy industry and to position themselves strategically to meet the industry's needs.

Some shared preconditions are critical, including room for expansion, a qualified labour force, and the port's connectivity to its hinterland for logistics transport (Uniconsult, 2013). The production of offshore wind energy turbines is often decentralised and the components produced in different sites in the hinterland, to be transported to storage areas near the ports. Sufficient storage space for pre-assembly or pre-storage activities is key, as is an efficient hinterland connection for transport of the heavy-lift cargo, especially for ports that serve as the consolidation ports in this supply chain, such as the Port of Belfast in Northern Ireland (*ibid*.). Service ports must offer easy accessibility, the ability to accommodate service vessels and sufficient storage space for spare parts (ORECCA, 2012).

In addition to location and infrastructure, strong political commitment from the government is of critical importance to developers as they determine whether to make their investment in a particular port. Offshore wind energy is not only capital intensive; it also requires significant technological resources. Compared to onshore wind energy, the capital cost for offshore wind projects is twice as much as that of onshore, and operation and maintenance costs can even be three times higher (World Bank, 2010). Accessibility to the wind turbines, which is not an issue for onshore wind, could become a barrier. In some northern European countries with a high population density, the limited space for large-scale onshore wind power farms encouraged a push for offshore wind energy in the national energy mix. Wind speed is often higher on the coasts than onshore in these countries. Better power production can to some extent offset the high capital costs and operational costs. On the other hand, in southern Europe, the United States and China, abundant land resources for onshore wind energy production exist, and onshore wind, with its lower costs, is a more competitive option.

In practice, a competitive institutional framework provided by the national government is necessary to support the development of the offshore wind energy industry. As with other renewable energy industries, general policy instruments and approaches like tariff feed-in, quota and tax incentives all can stimulate the sector. As a windy island set in shallow waters, the United Kingdom has a natural advantage in developing offshore wind energy technology (McNeil, Straw and Rowney, 2013). The UK government has introduced a feed-in tariff for renewable energies since 2010. While this is only permitted for energy plants under 5 MW, the offshore wind energy is mainly subsidised through a regulation called the "Renewable Obligation" (Uniconsult, 2013). This determines an obligatory minimum share of renewable energy in the total energy mix, and Renewable Obligation Orders commit UK electricity suppliers to abide by the defined quota. For suppliers that cannot fulfil the quota, a "buy-out" penalty is imposed to pay the fines for every MWH missed for the target set by the government. The fines are to be put into a fund and distributed among the suppliers who have achieved their quota. France's strategy for attracting offshore wind manufacturers involves government strategy and ministerial activism through its approach to procurement and by providing state finance to firms in the private sector (McNeil, Straw and Rowney, 2013). In Asia, China's government is also developing its offshore wind energy system, supported by a discounted corporate income tax or value-added tax, as well as feed-in tariffs or funds (KPMG, 2011). Japan and Korea have also announced plans for investing in offshore wind energy farms and approved feed-in tariffs regulation to boost offshore wind energy production. In the United States, production tax credits (PTC) and investment tax credits (ITC) are the main policy tools used to subsidise renewable energy.

Policy certainty over time is also of critical importance to encourage developers and suppliers to plan for the long term and ensure the continuity for port infrastructure upgrades. In Germany, the *Erneuerbäre Energien Gesetz* (Renewable Energy Law) provides subsidies to support the development of the wind energy industry. German ports are not only being adapted to meet the domestic industry demands, but also to facilitate export to foreign markets (McNeil, Straw and Rowney, 2013). Local municipalities, which own and manage the ports, can make long-term investment decisions that take into account of the potential economic benefits to the local economy. Bremen's state government invested EUR 200 million in offshore wind energy infrastructure and incentives on the banks of the Weser. In addition to its skilled workforce and strategic location, political and regional authorities' pro-active approach has contributed to the success of Bremerhaven's integrated development as the offshore wind energy hub in the

North Sea. Approval for wind turbine construction permits is streamlined, low investment rates are offered and short-term leases are made available to developers and operators. This support has paid off for Bremerhaven, which now has 5 000 workers employed in offshore wind energy, approximately one-third of all employees in the offshore wind energy sector in Germany (Azau, 2012). Major offshore wind-turbine and rotor-blade manufacturers have set up production, and steel foundries and offshore construction companies have also located within the port, as well as research institutes. In Bremerhaven's bid to become a prime construction port for the German offshore wind farms and the base port for the *Nordsee Ost* project, the offshore wind energy cluster is growing strongly. The port is upgrading its specialised infrastructure and developing land space for expansion of the supply base within its complex (Guillen, Wetzeler and Abstoss 2011). The government of Denmark has given continuous financial support to the offshore wind energy market since the late 1970s, along with policy certainty and a stable regulatory environment to bolster the domestic industry. Its focus on building the onshore wind-power supply chain and driving down energy costs has resulted in a mature supply chain, and no wind turbines are imported for the domestic market.

In addition, ports are exploring diversification in their portfolio of industries, such as tidal, wave and marine current energy. Tidal energy projects use the gravitational forces of the moon to generate power, while wave energy is generated by the movement of a device either floating on the surface of the ocean or moored to the ocean floor. The constant movement of marine currents can be used to drive the rotor blades with wind turbines, capturing kinetic energy to generate electric power (FEMP, 2009). Ocean energy is highly dependent on the feasibility of physical environments, and the marine engineering technology required, such as tidal turbines and wave devices, can prove challenging. Although none of these technologies is widely deployed for commercial use, the potential of ocean energy as a credible alternative low-carbon energy resource is still significant, and global potential capacity is estimated to be 748 GW by 2050 (ORECCA, 2012).

Ocean energy industries are still in an early stage of development, with a limited number of operations worldwide, but rapid technological improvement is expected to drive down the high production costs. The tidal resource produces variable, but highly predictable energy, limited to sites that have particularly strong ocean currents. The technology of tidal barrages is relatively more mature than others, but only four tidal power plants are in operation, notably the 240 MW La Rance barrage in France, which has been generating power since 1966 (IEA, 2013). The largest tidal power plant was brought into commission in Korea in 2011, with a capacity of 254 MW. Two other smaller-scale systems have been built in Canada and China. Although most of the technologies for wave energy are still in the research or early development stages, it holds substantial potential with an estimated worldwide potential at 29 500 TWh/year (terawatt hour per year) by the Ocean Energy System (OES) (IEA, 2013). Several prototypes are under review in a context of proliferating technological development (Ernst and Young, 2012). However, the diversity of systematic concepts and uncertainty over market potential make it difficult to assess the costs and schedule for large-scale commercialisation. In addition, the engineering challenges associated with intercepting energy from wave or tidal power efficiently have also limited the growth of the industries.

Ports' layout, design and facilities are critical in installing complex wave and tidal power arrays, which often require a dedicated location to deploy specialised vessels, components and equipment. Supporting infrastructures and grid connections are also critical to ensure the successful and cost-effective transport of electricity output.

Moreover, ports also need to be aware of other issues related to ocean energy development, such as the ecological impact on marine life and the marine environment, as well as on other marine industries like shipping and fishing.

Port-related waterfront development

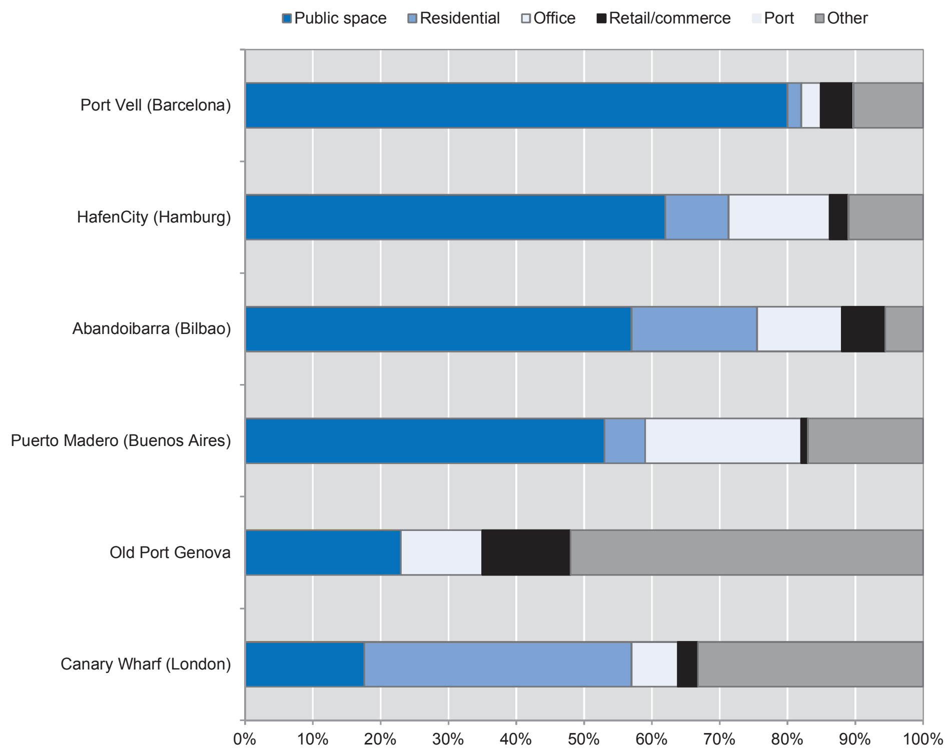
Port-related waterfront development provides a third policy option to increase local economic value from ports. These waterfront development projects, transforming former industrial port sites into contemporary places of consumption, follow similar dynamics all over the world. The emergence of the containing shipping industry accelerated the abandonment of old port areas, mainly due to the fact their piers had too little space to deal with containers. As a result, port functions, especially deep-sea shipping, started moving out of the historic port areas. Ports were faced with the enormous challenge – and opportunity – that surrounds the redevelopment of huge, abandoned land areas, including the old port and the original waterfront in the heart of the urban core (Brown, 2009; Hoyle, 1989). Port-related waterfront development might present an opportunity to create a new image, or marquee, for a city or a region – a new waterfront focal point where citizens can once again enjoy the visceral pleasure of coming to the water's edge, and to share that pleasure with visitors or tourists (Millspaugh, 2001). The many waterfront developments of recent decades have used different ways to reinvent the old port area, including commercialising the proximity to water (with marinas, fisheries and aquariums), using the port function for tourism (cruise ship passenger terminals), promoting a port's maritime heritage (with the preservation of historic buildings), and organising major events to attract people and tourism.

Typology of urban waterfronts

Urban waterfront projects are generally characterised by mixed land use. However, they can also be classified according to their economic or development orientation, whether residential, office, commercial (retail) or recreational (Daamen and Vries, 2013). They may have a principally market orientation, encouraging tourism or business, or create a public space or preservation of historical areas. Lastly, development may be motivated by financial orientation, focusing on the creation of value by intensification of land use.

Alternatively, classification of port land use could involve analysing land allocation of the public space and port terminals, in addition to non-maritime functions such as residential, office or commercial land use (Figure 4.1.). For example, Barcelona's Port Vell waterfront development has focused on creating public space. Residential, office and commercial buildings represent 20% of the land use, leaving the rest for public space (boulevards, promenades) and road infrastructure. Argentina's Puerto Madero has devoted 53% of its surface area to public space, and in Bilbao's Abandoibarra, public space also occupies the largest segment of the land use. Port Vell has focused on retail/commercial function, aiming to encourage economic vibrancy in the area. In Puerto Madero, the office area is the largest after the public space, whereas in Bilbao, the development of Abandoibarra has prioritised residential and office development, more than retail land use. Office areas make up the largest part of HafenCity in Hamburg, while Canary Wharf in London has been converted mostly to residential use.

Figure 4.1. Functional land use in selected urban waterfronts



Source: Own data collection based on data from waterfront development agencies.

The place for port functions in waterfront projects has so far been modest. While there have been increasing attempts to integrate port terminals and the waterfront areas, the most successful waterfront projects have focused land use on non-maritime functions such as residences, offices, or development of a commercial centre, etc. This does not necessarily mean that the identity of the port does not play an important role in waterfront development projects. Strengthening the link with the port can be done in different ways, such as preserving the historical port heritage, transforming the fishing port into a tourist destination, or developing marina facilities to attract pleasure boats. Liverpool's waterfront is well known for utilising its port heritage as a catalyst for tourism; its preservation of port-related heritage played a major role in making it a popular tourist destination. The Merseyside Maritime Museum, part of the World Heritage Site, attracted 1 027 475 visitors in 2010, making it the most visited free attraction in the city (Northwest Research Service, 2012). The Port of Valparaíso (Chile) is ready to start building the urban waterfront of Valparaíso called "Puerto Baron", a 12-hectare space that generates 65% of public spaces, with tourism, cultural and commercial programmes. This project will also convert an old heritage warehouse, the longest in South America and incorporate it into the new buildings. The area will also include a new passenger terminal and community boating marina. In the waterfront areas of San Francisco and Cape Town, the local fishing port attracts tourists as well as businesses; Fisherman's Wharf in San Francisco consists of a long, coast-side row of seafood restaurants and markets, whereas at the V&A Waterfront in Cape Town, equipment for the existing fishing industry is considered a way to attract pleasure boating activity.

Finding the right mix of functions

Successful waterfront projects, in general, have achieved a mix of diversified functions that make the waterfront area economically vibrant. In most cases, the mix of functions that attracts citizens, tourism, and businesses – and thus creates economic value – consists of port functions, developing recreational and cultural activities, and expanding food-related businesses such as food markets or restaurants. Port Vell in Barcelona, which attracts more than 16 million visitors per year, is an exemplary case, where the old port area has been transformed into a successful waterfront area with an interesting mix of functions. Port Vell continues its port function through marina facilities, ship repair dockyards and a cruise terminal. In addition, it offers cultural and recreational activities including its Maritime Museum, Aquarium, water sports facilities, and a variety of events such as the International Boat Show. Its historic former warehouse, Palau de Mar, has been refurbished to accommodate restaurants with terraces on the ground floor, where visitors can enjoy the view of berthed sailing boats.

Cape Town's V&A Waterfront is another example that shows how a mixed maritime activity, surrounded with the quays that are well-equipped with recreation facilities, cafes and restaurants, can make for a unique and busy working waterfront (Charlier, 2009). In addition to the pilot boats, yachts and leisure craft offering water tours, numerous fishing boats are engaged in a real industrial activity that is more active than ever. A ferry terminal has been built in the Clocktower precinct in a mixed-use development completed in 2002, with a 6 000 square-metre tourist centre with retail stores and restaurants. These maritime activities present a working port scenery that is distinctive and attractive, which contributes significantly to the economic vibrancy of the waterfront area. San Francisco's Embarcadero also combines its existing port function with recreational activities and restaurant businesses: the passenger cruise terminal is located near Fisherman's Wharf, which houses historic fishing operations, tourist activities and seafood restaurants. The restoration of the historic Ferry Building is used as a showcase for the best regional produce and has brought vibrant commercial uses and public access to the waterfront.

Since attracting tourism is a crucial factor in stimulating an area's economy, developing a popular recreational function is important in setting up a successful waterfront site. Although many of the exemplary waterfronts possess historical landmarks or port-related heritage, a successful waterfront project does not necessarily require heritage sites if the recreational function is suitably developed. Dongjiang Bay Area in Tianjin, China, is a recent example that demonstrates that a vibrant waterfront area can be created anew without historical background. Dongjian Bay Scenic Area, which houses the largest manmade sand beach in China and Asia's largest cruise port, has become a new destination for the city's tourism and cultural industries, equipped with aquatic sports clubs and leisure facilities, Dongjiang Bay Beach also hosts a variety of festivals and events, such as the Tianjin Harbour Tourism and Culture Festival or Tianjin Sailing Competition. The Dongjiang Bay area attracts 150 000 visitors a year, and 700 000 tourists were expected in the summer season of 2013.

Achieving the right mix of functions can be a challenging task, due to the difficulties in financing a project. The land use of waterfront projects typically includes residential, commercial, tourism and recreational functions; yet the cities or redevelopment agencies are often obliged to include residential developments because low-density land uses – such as park or recreation-based anchorage – do not generate the revenue to cover the cost of buildings or preparation of the sites (Brown, 2009). Finding the right mix is closely related to how the project is going to be financed and the financial capacity of the public sector involved, which must ensure that the waterfront serves local economic as well as social interests. It is crucial to balance the functions that help finance the project (*e.g.* residences) and those that do not, yet are nevertheless essential to develop a vibrant waterfront (*e.g.* leisure or recreational sites). A waterfront development project needs a realistic business plan to achieve the concept in the master plan, based on a projection of market demand and public and private funding (Millspaugh, 2001).

Table 4.4. Main economic functions in selected urban waterfront developments

Waterfront	Port functions	Tourism and recreation	Food
Port Vell, Barcelona	Marina (Port Vell Marina) Ship repair (Barcelona 92 Marina: dockyard specialised in the maintenance of superyachts) Barcelona Ferry Terminal	Barcelona Maritime Museum; Barcelona Aquarium Events (International Boat Show, Barcelona World Race, Swim Across the Port, Catalan Wine and Cava Show) Sports facilities (Swimming Clubs: Sant Sebastià Beach with sports facilities, Barcelona Swimming Club with family activities) Markets: Palau de Mar Craft Fair, Port Antic Antique Market, Port Vell Association of Painters Market; Hotel Grand Marina; W Barcelona Hotel	Restaurants at Palau de Mar, old general trade warehouses transformed into business units on the ground floor, restaurants with terraces
HafenCity, Hamburg	Cruise terminal (Hamburg Cruise Centre HafenCity)	International Maritime Museum Hamburg Speicherstadt (historic brick buildings transformed into museum spaces) Traditional ship harbour Elb-Philharmonic Concert Hall; Hamburg-America Centre (cultural events) Sports facilities (Oberhafen); Stortebeker SV Sports Club 25 Hours Hotel; Stadthaushotel and many other hotels to be constructed Centurion business centre	Plans for public spaces with restaurants, cafes, increasing number of restaurants in Überseequartier
San Francisco Waterfront, San Francisco	James R. Herman International Cruise Terminal Ferry tours operated by different companies Marinas (Pier 39, South Beach Harbor, The Ramp) Fishing port, fish handling facilities (Fisherman's Wharf Waterfront) Ship repair (BAE Systems, San Francisco Ship Repair)	Historic preservation: Ferry Building Events: America's Cup (contest featuring the best sailors on the world's fastest boats) AT&T Park (Baseball/ Sports facility); Swimming clubs Aquatic Park (at Fishermen's Wharf Waterfront); Boating and yacht clubs	Restaurants and seafood Market at Fisherman's Wharf Waterfront
V&A Waterfront, Cape Town	Marina facilities and berths Local fishing industry occupies 60% of the harbour Ferry Terminal in the Clocktower Former commercial berths of the Victoria Basin were converted in the 1960s to cater to the expanding local fishing industry: 1) 160-metre long dry dock (Robinson Graving Dock, located near the New Basin) and 2) a Synchrolift (near the entrance runabout).	Leisure boat/ ferry cruises Cape Town Diamond Museum; Chavonnes Battery Museum Iziko Maritime Museum; Craft Market and Wellness Centre Donald Greig Bronze Art Foundry & Gallery Kids Ahoy Kids Playground Nelson Mandela Gateway & Robben Island Ocean Sailing Academy Diamond Tour; Two Ocean Aquariums	Over 80 restaurants V&A Market on the Wharf (a fresh food market)
Abandoibarra, Bilbao		Guggenheim Bilbao Museum Bilbao Maritime Museum (the Karola crane, used for many years by the shipyards, remains intact) Zubiarte Shopping Centre (commerce and leisure) Memory Lane Sculpture Collection in Ribera Park chronicles the vitality of the area's industrial past Park La Campa de los Ingleses ;Euskalduna Conference Centre/Auditorium	
Puerto Madero, Buenos Aires	Marina of Puerto Madero Yacht Club	Port heritage: 16 refurbished warehouses that house modern offices, restaurants, bars, pubs and other businesses Casino: floating casino, the Star of Fortune, a replica of a Mississippi riverboat Corbeta Uruguay Museum, a gunner boat that pioneered Arctic exploration Fragata Presidente Sarmiento, a 1897 Argentine Navy training boat converted into a museum for children Buenos Aires Yacht Club, with 200 docked sailboats. A nautical school offers classes in sailing, rowing and kayaking. Public art collection of Amalia Lacroze de Fortabat Museum Centre of Buenos Aires in the old Munich Brewery	Over 100 restaurants
Liverpool Waterfront, Liverpool	Prince' Dock area – Liverpool Cruise Terminal Arrival of Royal Navy vessels Pier Head area – Mersey Ferries terminal	Pier Head – cornerstone of the World Heritage Site, including the "Three Graces": the Royal Liver Building, Cunard Building and Port of Liverpool building, and Museum of Liverpool Albert Dock area – Tate Liverpool, Maritime Museum, International Slavery museum and the Beatles Story King's Dock area – ACC Liverpool: BT Convention Centre with 1 350-seat auditorium, 18 break-out rooms and 7 126 square metres of exhibition space, and the interlinked 11 000 capacity Echo Arena	Around 27 restaurants

Effective planning mechanisms

Master plan and implementation process

Most successful waterfront development projects begin with a master plan. This not only guides the implementation process towards the project's initial goal, but also provides common ground that the different actors (*e.g.* the private and public sector, different local authorities) can agree upon. A master plan for land use can blend the values of both old and new structures and uses, and express the desired concept in three dimensions. The plan should provide for public access to and enjoyment of water, with circulation extending from the old city, and planned uses for the water and surrounding land (Millspaugh, 2001).

Depending on the size of waterfront area or local planning conventions, a master plan can contain several plans for different districts in the waterfront area. In the waterfront developments of San Francisco or Liverpool's docklands, plans are established for different districts in the waterfront area. The Port of San Francisco, under its Waterfront Land Use Plan, divides its waterfront area into five different districts: Fisherman's Wharf, Northeast Waterfront, the Ferry Building Area, South Beach/China Basin (adjacent to Mission Bay) and the Southern Waterfront, each with an individual theme and goals. Liverpool Waterfront also has divided docklands, each with its own theme and function: Princes Dock, Pier Head, Albert Dock, and King's Dock. Albert Dock brands itself with its cultural and heritage-based attractions; Princes Dock has a maritime character, with its Cruise Terminal, where navy vessels can be observed. Alternatively, a master plan can initially decide the percentage of the land use function (*e.g.* residential, office, commercial, leisure) of the entire waterfront site, as in Buenos Aires' Puerto Madero and Bilbao's Abandoibarra.

An incremental approach to designing and financing the project is important in the implementation process. A successful waterfront development agency relies on an incremental approach to design, a high degree of political autonomy and the ability to move quickly and flexibly to time individual development projects with market cycles (Brown, 2009). In Cape Town's V&A Waterfront, the development process has been incremental, although the initial master plan covered the entire 123-hectare site. The project first focused on refurbishing historical buildings and architecture in the Pierhead Precinct, which have been converted to new uses, such as restaurants, shops, a theatre and a craft market, etc. (Van Zyl, 2005). Next, the Victoria Wharf Shopping Centre was completed, originally covering 26 500 square metres, but extended several times given its popularity and demand. Initiatives such as V&A Marina luxury housing project and a mixed-use development in the Clocktower Precinct followed, after the success of the waterfront's earlier projects.

Project leading entities and implementation agency

Waterfront projects in port-cities generally involve the old port area adjacent to the city centre, and involve the local port authority and city government. In some cases, the state or national government can also take part in the process. One of the crucial conditions for completing a successful waterfront project is an absence of intra-local conflict (*e.g.* between the local port authority, city government and other interested parties). This can be achieved either through strong support and leadership from the national government or effective co-ordination among the different local authorities or actors. In the cases of the V&A Waterfront and Puerto Madero, the national government strongly backed the project, which facilitated its implementation; the transformation of the old port in the V&A Waterfront was made easier by the fact that the initiative came from the South African government itself. The port therefore had to make room for a redevelopment considered to be of national interest, with no local conflict between the port and the city (Charlier, 2009). In Puerto Madero, the national government established the implementation agency, Corporación Antiguo Puerto Madero S.A. (CAPMSA) with the Buenos Aires city government, and facilitated the process by transferring the territory of Puerto Madero to it.

In the case of Barcelona's Port Vell and San Francisco's Waterfront, the port authority played a leading role in the waterfront development, both in land use planning as well as the negotiation process. In 1988, for the Port Vell waterfront project, the Port of Barcelona set up the Urban Management Port 2000, which is responsible for the operation and management of the port's public spaces. Port 2000 drafted the Special Plan for Port Vell in 1988, and its final version was agreed and approved after a long process of negotiations between the various authorities with responsibility for urban planning. In San Francisco, the port initiated the land use planning process in 1991 and led the negotiations with a citizens' advisory committee, whose 27 members represented maritime businesses, port tenants, labour unions and neighbourhood organisations, etc. In cases where ports play a secondary role in assisting the project, their co-operation is nevertheless valuable. In Cape Town's V&A Waterfront, the local port authority contributed to the process by arranging for an efficient system for controlling the traffic at the common entrance for the V&AW and the commercial port, and by helping to ensure a vibrant working waterfront. Tugs and pilot boats were allowed to remain in this zone and use it as their operational base (Charlier, 2009). In Bilbao's Abandoibarra, the port authority took part in the development by transferring the key land parcels (including the site of the Guggenheim Museum) to Ria 2000 Organisation, an implantation agency that led the waterfront redevelopment.

In the implementation process, a separate agency dedicated to the waterfront project is often established in the form of a corporation. Setting up an independent body facilitates the financing of the project and also plays a role as third-party mediator if conflicts arise among the different stakeholders. HafenCity of Hamburg is co-ordinated by HafenCity Hamburg GmbH, a corporation owned by the city of Hamburg. This separate agency manages relations between the public and the private sector, and also acquires and contracts real estate developers and larger users. While 97% of HafenCity sites are the property of Hamburg, the corporation manages the Special Fund for City and Port, which includes the proceeds of sales of building sites, financing infrastructure, roads, bridges, promenades, parks, site clearance, planning, acquisition of investors, etc. The Abandoibarra Project in Bilbao is managed by a non-profit limited liability company, Bilbao Ria 2000, established in 1992. A private firm of public shareholders, it includes the Spanish government, through the Ministry for Economic Promotion, the Bilbao Port Authority, the national railway companies and the local and regional public authorities. The stakeholders of Bilbao Ria 2000 assign the land parcels they own to Bilbao Ria 2000, which finances the project through sales of land in Abandoibarra. Bilbao Ria 2000 invests in the development of the land by reclaiming the land parcels via private bank loans and reselling them to private developers. In the old port regeneration project in Genoa, establishing a separate agency, the Porto Antico di Genova, helped the dialogue between the municipality and the port, whose relationship is complicated by long-standing feuds over territorial occupation (Marshall, 2001).

Table 4.5. Implementation of waterfront development

Project, City	Implementation Agency	Main shareholders
Abandoibarra, Bilbao	Bilbao Rio 2000	SEPES (land management company, a public body under the Ministry of Development): 25% City of Bilbao: 15% Bilbao Port Authority: 10% National railway companies: 15% Basque and provincial government: 30%
Puerto Madero, Buenos Aires	Corporación Antiguo Puerto Madero S.A. (CAPMSA)	Owned equally by the municipality of Buenos Aires and the national state
Port Vell, Barcelona	The Urban Management Port 2000	Established by the Port of Barcelona
HafenCity, Hamburg	HafenCity Hamburg GmbH	Owned by the City of Hamburg
Old Port Redevelopment, Genoa	The Porto Antico di Genova	City of Genoa: 51% Chamber of Commerce: 39% Genoa Port Authority: 10%
V&A Waterfront, Cape Town	The V&A Waterfront Company Ltd.	Established by Transnet Ltd. (successor of the South African Transport Services), now sold to an international private consortium (Lexshell 44 General Trading Ltd.).

Incentives and public investments

Cleaning and preparation of the sites, building basic infrastructure and creating non-profit oriented sites (public spaces, parks, promenades and sports facilities) are provided by public investments; funding may come directly from a public institution or from the proceeds of land sales. In Port Vell, EUR 51.54 million was invested by the Port of Barcelona; for San Francisco's Bay Trail, the trail system that links parks and points of interest around the waterfront area, the initiative and initial funding were supported by the state of California, which designated a regional planning agency for the planning and management of the trail. In HafenCity, Puerto Madero and Abandoibarra, funding of these basic infrastructure and non-profit sites was prepared with lease and sales of the land parcels. In Puerto Madero, the implementation agency, CAPMSA did not receive any initial budget from the state or the municipality. Lease bidding and sales of the docks were the source of funding for the development of public space.

The private sector can also play a major role in construction of the infrastructure in return for the rights to proceed with profit-oriented private developments, which leads to public-private partnerships or concessions. For San Francisco's Waterfront, the port issued a request for proposals to developers interested in redevelopment of the Ferry Building and Pier 1 as a new commercial office building; the commercial components were required to finance the historic preservation and adaptive reuse of the buildings in exchange for ground rent (Brown, 2009). At Port Vell in Bilbao, the port held concession projects with private investments, such as the World Trade Centre, Aquarium, Imax cinema, Maremagnum (leisure and shopping centre), and the Marina. For these concession projects, EUR 396.52 million was invested by private actors and EUR 158.10 million by the Port of Barcelona.

Hosting mega-events can help pay for construction of infrastructure by attracting attention and investment from public institutions. In Genoa, part of Old Port was redesigned and opened to the public for the International Expo in 1992, which paved the way for the rehabilitation of the extended waterfront area. The Expo was located in the Old Port, and investments by the state made it possible to restore old buildings, build an aquarium and rearrange the open spaces. Hosting events like the G8 summit meeting in 2001 and being designated European City of Culture in 2004 also provided resources for transforming other parts of the Old Port. Barcelona's Port Vell was launched for the Barcelona Olympics in 1992; Marseille is pursuing its waterfront project, Cité de la

Méditerranée, backed by its current designation as the European City of Culture 2013. In San Francisco, the port's waterfront development managed to gain legislative support from the state of California for the 2013 America's Cup international yacht race. A law was passed establishing the America's Cup District as the equivalent of an Infrastructure Financing District, which gives San Francisco the flexibility to finance important waterfront improvements, such as financing for the America's Cup Village and construction of a cruise ship terminal at Pier 27.

As for port-cities, it is advantageous to create synergies with their port functions in developing and promoting the waterfront areas. One of the port functions that show a close link with waterfront development is operating cruise terminals. In many waterfront development projects, cruise activity is considered an important element of port-cities' capacity to develop and reinforce the urban tourism industry, since cruise tourism has now become a new market (CTUR, 2007). According to the European Cruise Council, over 6 million European residents booked cruises in 2011, a 9% increase over 2010; and the direct cruise tourism expenditures directly generated an estimated 153 012 jobs. In North America, the Cruise Lines International Association reported USD 19.6 billion in direct spending by the cruise lines and passengers, creating 356 311 jobs generated by cruise industry expenditure. To capitalise on this opportunity, co-operation between city and port is needed. The formula used to establish co-operation and define actions is often a "Cruise Club" grouping the port authority, the chamber of trade and industry, the municipality, maritime companies, public tourism agencies and tourism companies (CTUR, 2007). In Marseille, the Club de la Croisière Marseille-Provence has been organised by the chamber of trade and industry, the municipality and the port authority, aiming to bring together public institutions and tourism interests to promote the cruise industry. Developing a new cruise terminal in conjunction with other functions of the waterfront is another way of promoting the cruise industry in port-cities. HafenCity of Hamburg is developing a new cruise terminal to combine cruise and hotel facilities in the waterfront area of Überseequartier, where shopping centres and entertainment facilities are under development. In Liverpool, the Princes Dock area was developed with the Liverpool Cruise Liner Terminal, which is surrounded with hotels, restaurants, bars, coffee shops, apartments and office buildings. The cruise terminal contributes to the area's economic vibrancy, since the arrival of cruise ships at the new terminal attracts many thousands of additional visitors.

The development of a marina for pleasure boating can also help establish a vibrant waterfront area. Sailing, yachting and power boating generate income for a city; support services such as sailing schools, tour operators, insurance brokers, maritime financiers, yacht charters, yacht brokers and marinas bring regular income to the city and hinterland (Anderson and Edwards, 2001). Moored yachts add atmosphere to the waterfront area, attracting visitors. Developing marina facilities and promoting water sports has been one of the components that contribute to the success of several waterfront projects. Barcelona's Marina Port Vell, opened in 1992 for the Olympic Games, is now a yachting destination that provides mooring rents and supplementary services, such as refuelling and waste collection. Several yacht clubs are located on the site, offering water sports programmes and activities. San Francisco's Pier 39 waterfront complex, with its restaurants, more than 90 shops and marina, is a major attraction.

Side-option: Urban diversification

Staking the growth of local industry on the performance of the port can be a risky strategy, particularly in smaller port-cities. Over-reliance on the port can render the urban economy vulnerable to the notoriously volatile shipping industry, as the comparison of

London and Liverpool demonstrates (Box 4.4). The advent of containerisation dealt a major blow to both cities' maritime sectors, since technology upgrades were not only economically unfeasible but also fiercely contested by organised labour (Levinson, 2006). In analysing the economic history of Boston since the seventeenth century, Glaeser identifies three periods of structural decline in which Boston had to reinvent itself, one to recover from its decline as a maritime power.

To avoid the fate of Liverpool in the 1980s, some port-cities have tried to reduce their dependence on the port through explicit economic diversification. Other well-established continental European port-cities have managed to encourage activities that increase their appeal. Antwerp has invested in its fashion business, and Hamburg in its local media industries. Rotterdam has benefited from strong public investment in real estate development to become a leading architectural centre (OECD, 2011).

Finally, diversification strategies have also been evident in smaller port-cities at risk of losing market share to their neighbours. The port-city of Ningbo, for example, grew from a simple transit point in the 1980s to a fully-fledged industrial port-city specialised in port-based industries in the 1990s. Since the 2000s, it has come to view this dependency on the port as a potential source of vulnerability, especially in view of fierce regional competition. Ningbo has now made a concerted attempt to diversify its economy as a way of decreasing dependency on the port (Huang and Bao, 2011), by investing in its agricultural resources and in the petrochemical and paper industries.

Box 4.4. Liverpool and London: Two cities dependent on their port economies

During the nineteenth century, port operations at Liverpool handled around 40% of the world's trade. The city's economy, which had expanded rapidly during the Industrial Revolution, was based mainly around the import and export of commodities, with cotton chief among them. By the mid-nineteenth century, Liverpool's cotton market was the largest in the world, supplying textile mills in Manchester and Lancashire to form a major port-dependent economic cluster. However, as demand for Northern England's textiles and other traditional exports fell, so did activity and employment in the port. Containerisation rendered Liverpool's docks all but obsolete, and most of the south end docks were closed by 1975. Since all Liverpool's sectors were dependent on port activity in some way, it was unable to recover from the shock of changing shipping systems, and the city hit its lowest point during the 1980s, with high rates of unemployment, out-migration and political extremism. In many ways, London negotiated a similar transition, with very different outcomes. London too had a strong cluster of economic activity in the city centre, based on the docks of the River Thames. Containerisation requiring ships with deeper draughts relocated London's port activity downstream to the east, resulting in the loss of dock-related employment in the city centre. London, however, was able to rely on a local economy supported by a diverse range of services, most notably in banking, insurance and finance, and negotiated the decline of its port traffic much more successfully. The maritime sector itself was kept afloat through its connections with financial service sectors clusters in the City of London, and is now the world's leading centre for shipbroking, freight derivatives, bank finance, shipping insurance and securities and shipping legal services.

No regret option: Co-operation with neighbouring port-cities

Regional networking between neighbouring port-cities is becoming increasingly common to help them face common challenges. Port-cities require capital to finance state-of-the-art infrastructure, and must increasingly compete for different sources of funding not only nationally, but also at the regional or international level. As political and administrative entities, port-cities are also responsible to their electorates, and must optimise the economic benefits associated with increased maritime activity, while mitigating negative social and environmental consequences. Co-operative networking amongst port-cities is increasingly employed to reach these goals.

Box 4.5. Challenges and opportunities of regional port-city networks in the EU

In response to the challenges of economic development in the post-industrial era, and the funding opportunities proposed by the EU for cross-border co-operative projects, neighbouring European port-cities have begun to represent their interests and steer projects collectively in co-operative fora. Ducruet (2006b) compares two early examples of such port-city networking initiatives: the Normandie Métropole and the South Coast Metropole partnerships, both of which were created in 1993. Normandie Métropole was an associative partnership between the mayors of Caen, Rouen and Le Havre, and sought to unite a broad policy network of actors from infrastructure, education, technology and research. Its aim was to increase the profile of the three port-cities within Europe, to position them competitively vis-à-vis other cities in France and Europe, and to provide a co-ordinated planning framework for projects round the Seine estuary. On the other side of the Channel, the South Coast Metropole was made up of Poole, Bournemouth, Southampton, Portsmouth and the Isle of Wight on the southern coast of England, which have experienced similar patterns of decline in their manufacturing and maritime sectors. The partnership aimed to represent interests collectively and to respond to the funding opportunities for jointly led projects offered by the EU through its regional development funds.

In their two decades of existence, these networks have met with mixed success. In some ways, the Normandie Métropole network can be seen to have failed. Having encountered problems with divergent interests, mismatches between the economic and administrative structures of the respective cities, and a lack of logistical integration between them, it was eventually dissolved (Merk et al., 2011). The South Coast Metropole has been more successful, securing EU funds, which have gone towards regional projects in the fields of tourism and innovation. Furthermore, though they may have lost their initial élan, these two networks arguably set precedents for networking efforts on both sides of the Channel, which have helped to foster further innovative forms of port-city networking. Having met with little success after a first attempt in 1996, the Channel Arc (Arc Manche) network was revived in 2003, bringing together five French and five English maritime regions along the channel. With co-funding from the North-West European Interreg III B programme between 2004 and 2008, the Channel Arc succeeded in producing its Strategic Vision for the Channel Area (the Espace Manche Development Initiative or EMDI), which in turn drove the creation of a EUR 173.5 million Interreg fund specifically for transnational projects in the coastal region surrounding the Channel, one of the busiest stretches of water in the world. With the support of this fund, these port-city regions have gone on to produce the (Channel Arc Manche Integrated Strategy (CAMIS), which has an integrated plan for joint initiatives in the fields of maritime safety, economic development, tourism, environmental protection and innovation. In their own ways, both the Normandie Métropole and the South Coast Metropole set the stage for these subsequent institutional successes in co-operation between neighbouring port-cities.

Co-operation and networking in port-city regions is similar to the port co-ordination mechanisms described above, in seeking to enhance capacities and align the interests of a multiplicity of actors. However, because municipal and regional governments have much wider mandates than port authorities, co-operative measures between port-cities often go well beyond seeking to improve the competitiveness of a given port, and try to respond to collective problems that cannot be resolved on an individual level.

Co-operation between neighbouring port-cities can provide a clear advantage, providing access to regional funding and the opportunity to co-ordinate regional solutions to regional issues. Organising around shared interests can make possible a range of responses sensitive to several policy fields, and help individual port-cities overcome larger challenges, such as environmental management, long-term integrated planning and economic development. Often the impetus for such co-operation emerges in response to specific threats (such as the degradation of collective environmental resources in the Baltic), or to specific opportunities (the creation of funds for pluri-jurisdictional and transboundary projects in the Channel). Maintaining the momentum of such partnerships is not always successful: divergent interests, administrative mismatches and legitimacy deficits of transnational action by sub-national actors can exhaust such efforts. However, the increasing institutionalisation and diffusion of such instruments is to be encouraged, and port-cities should try to institute permanent, resilient frameworks for co-operation.

Notes

1. In recent years, economic development policies in many OECD member states have ceased to focus exclusively on single sectors, and have instead begun to concentrate on the linkages amongst firms within multi-sectoral "clusters". Such clusters are comprised of economic actors from diverse parts of the value chain, and can include producers, customers, suppliers, labour markets, training institutions, intermediary services, industrial associations and government actors (Porter, 1998; Dayasindhu, 2002; Porter, 2003). Clusters are usually defined spatially, as regions or areas that feature higher than average concentrations of value-added activity within a given domain (IT, maritime, agriculture, textiles, etc.). They can be distinguished from industrial districts or simple geographic concentrations of firms in that they are linked through formal networking platforms, and usually benefit from some degree of co-operation and collective governance (Doloreux and Shearmur, 2009).

2. In its attempt to increase its reputation and thus its registrations, Singapore, for example, has adopted all major IMO conventions on ship safety and marine pollution, maintains a "white list" status on most port state control regimes, and is host to no less than nine separate classification societies. Hong Kong has likewise endeavoured to comply with international safety, labour and environmental norms as a way of decreasing credit costs for its registered shippers (CUHK, 2013). Furthermore, both countries have undertaken a range of measures to make registration more attractive. In Hong Kong, these include the removal of registration fees, the introduction of flexible rules for crew nationality, the creation of a 24-hour registration service, free vessel inspections and the creation of a public relations group for the register. Hong Kong and Singapore's registries respectively occupied the fourth and sixth places on the list of the top merchant fleets by tonnage in 2010, according to the IHS Fairplay data.

3. To enhance anti-piracy capabilities in their shipping sector, governments use two main instruments. Firstly, the flag state can provide protection at its own cost through Vessel Protection Detachments (VPDs). VPDs are small teams composed of guards from the government military or navy, and are currently provided by France, Israel, Spain, Belgium and Italy, amongst others. Secondly, states can allow shipping companies to employ private security companies (PSCs). This second measure has proven controversial, resulting in protracted debate in the German parliament in 2013, for example, about the oversight of such PSCs, and whether their operation poses a threat to the exclusively sovereign power to make decisions over the use of force. While PSCs may present issues of training and oversight (Van Ginkel, Van der Putten, Molenaar, 2013), allowing them can also carry several advantages, such as cost-effectiveness and flexibility for shipowners. In nations that allow PSCs, issues of oversight and training should be addressed through the introduction of stringent operational criteria. In Norway, for example, PSCs can only apply for temporary firearms licenses, and cannot engage in the use of force without the approval of the shipmaster. Norway also requires reporting on vetting procedures for any shipping

company wishing to use a PSC, including background checks of the staff. Few public accreditation standards for PSCs exist, however, and it appears important to move toward the formulation of such standards in order to harmonise best management practices across the global private security sector. As of 2013, major European maritime states that allow or were debating approval for PSCs included Italy, Belgium, the UK, Denmark, Norway, Greece, Spain, Cyprus[(i)(ii)], Germany and France.

(i) Note by Turkey:

The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

(ii) Note by all the European Union Member States of the OECD and the European Union:

The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

4. When business is going well, this tax regime often translates into an effective tax rate of <1% for participating companies (PWC, 2009). However, when business is going poorly, the tonnage tax can also constitute a drain on participating companies, which must pay taxes even in situations of negative net income (many tonnage tax regimes require a minimum 10-year participation in the scheme with no opt-out option).

5. In the UK, eligibility for the tonnage tax involves two main requirements. On the one hand, ships must be "strategically and commercially managed in the UK". Several factors are assessed as part of this definition: headquarters and decision-making operations of the company should be located in the UK; activities such as route planning, cargo booking, personnel management, technical vessel management and direction of foreign offices should be carried out in the UK; the overall share of work and number of employees in the UK should outweigh that done elsewhere, vessels should be flagged, classed, insured or financed in the UK, and so on. This ensures that the loss of potential taxation through the implementation of the tonnage tax regime is amply compensated for through increased activity in the UK maritime service cluster. On the other hand, the UK tonnage tax regime includes a "training commitment", which requires participating companies either to train officers and cadets (who must be British or EU nationals), or to transfer funds to the Maritime Training Trust. This requirement effectively builds a human capital matching mechanism into the tonnage tax regime, ensuring tha t the maritime cluster remains embedded in the UK labour market. Since its introduction in 2000, the UK tonnage tax has been credited with reversing the decline in shipowners and operators in the UK, and contributing to threefold and sixfold growth in the UK-owned and UK-registered fleets respectively during the 2000-09 period (MaritimeUK, 2012). The policy has furthermore been credited with contributing an extra 189 700 jobs to the UK economy (direct, indirect and induced), and with more than doubling the shipping industry's GDP contribution, as compared with what it would otherwise have been (Oxford Economics, 2013).

6. The logic behind such bilateral agreements, in which the parties agree to reciprocally exempt ship operators from certain taxes in both countries (RTEs) or in one only (DTAs and CDTAs), is that they foster trade relationships, improve the competitiveness of the maritime cluster and enhance its attractiveness for ship

operators. Maritime and trade-dependent countries often form such agreements. New Zealand, for example, had 37 DTAs in force in 2013, with five signed and not yet in force, and seven more under negotiation. Additionally, Section CV 16 of New Zealand's Income Tax Act 2007 allows for income exemptions for any state in which reciprocal exemptions are made for New Zealand ship operators, meaning that most of its DTAs can also effectively function as RTEs.

7. While output from the shipbuilding sector grew enormously during the late 1960s, the oil crisis of 1973 severely diminished its global output, with supply outpacing demand. Throughout the 1980s and 1990s, this over-capacity led to a drop in profitability that developed countries in Europe and Asia dealt with in part through rationalisation policies (caps on capacity increases) and in part through subsidies (FMI, 2003). The rationale behind subsidisation was to retain capacity and a competitive stance whilst awaiting a new upswing in activity. In 2004, for example, EU-wide subsidies to the shipbuilding sector were in the vicinity of EUR 100 million. However, while the shipbuilding sector did pick up again, profitability did not increase in tandem. Furthermore, concerns over the cyclical tendencies of the shipbuilding sector, coupled with several trade disputes – such as that between Korea and the EU, over which the World Trade Organization ruled in favour of Korea in 2005 – have spurred a global effort to reduce subsidies in the global shipping industry, which has succeeded in the removal of many (if not all) forms of subsidy. In 2013, for example, the European Commission ruled that that tax advantages received by Spanish shipbuilders were unlawful and should be repaid to the Spanish state. While various alternative options for direct and indirect subsidies remain open to the shipbuilding sector in different nations around the world – including the EU, with the non-selective tax scheme approved by the commission in 2012 – other intelligent policy solutions remain open to developed nations seeking to preserve the know-how and sunken capital tied up in their shipbuilding sectors.

8. "Leader firms are firms that have – due to their size, market position, knowledge and entrepreneurial skills – the ability and incentive to make investments with positive externalities for other firms in the cluster" (De Langen, 2004a).

9. Organic CO_2 for Assimilation of Plants.

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Chapter 5

Mitigating the negative impact from ports

Mitigating negative port impacts is essential for the long-term survival of ports and port-cities. Even if ports generate large local economic benefits, building on competitive strengths in services, industrial development or consumer-driven port-related waterfront development, they will not have sustainable future perspectives if they do not mitigate negative impacts related to their development. These negative impacts can be considerable, as illustrated in Chapter 2, and can relate to the environmental impacts – such as pollution of air, water and soil – land use, traffic congestion and risks related to climate change and security. This chapter assesses main policies to mitigate these impacts and risks, building on the experience of port-cities worldwide.

Limiting environmental impacts

Various policy instruments are used to combat the main environmental impacts associated with ports, and are listed below by type of issue and manner of intervention. These instruments can stand alone, but in many cases fit into a wider effort by port authorities and governments to improve the environmental performance of the maritime shipping and ports sectors.

Air emissions

Table 5.1. Overview of instruments emissions policies

Policy types	Instruments	Intervention level	Examples
Regulation	Global emissions cap	Global	IMO MARPOL Annex VI
	Emission control areas	Cross-boundary	Table 37
	Technical standards	Global	IMO: EEDI, SEEMP
Information	Emissions inventories and monitoring	Local	Los Angeles
	Port state control co-operation	National	Antwerp
	Compliance monitoring		United States
Incentives	Bunker tax/emissions trading	Global	
	Fuel switch	Local	Hong Kong
	Slow steaming	Local	Long Beach
	Cleaner ships	Global, local	ESI, Sweden
	Modal shifts	Local	Alemeda corridor
	Truck retirement	Local	Los Angeles
Technology upgrade	Clean bunkering	Local	Rotterdam
	Shore power	Local	Gothenburg
	Electrification equipment	Local	Busan
	Renewable energy	Local	Zeebrugge, Belgium

Regulation

An important global regulatory effort to reduce ship emissions is Annex VI of the Marpol Convention of the International Maritime Organisation (IMO).[1] Emissions caps that entered into effect on 2005 were tightened through the adoption of revisions to the Annex VI in 2008, which entered into effect in 2010. The 2008 amendment reduced the sulphur limit from 4.5% to 3.5%, effective in 2012, and will reduce the limit further to 0.5% by 2020. It also introduced a new "three-tiered" approach to reducing NO_x emissions, in which ships built after 2000, 2011 and 2016 have respectively stricter limits on their NO_x emissions. A key mechanism embedded within the MARPOL legislation is the creation of emission control areas (ECAs), maritime zones where stricter requirements are applied to the contents of bunker fuels in use. Thus, while sulphur is limited by the 2008 amendments to 3.5% of fuel globally from 2012, and to 0.5% from 2020, in ECAs, the limits are 1.0% and 0.1% respectively. The first two ECAs in the Baltic and North Seas set limits on sulphur emissions only (Sulphur ECAs or SECAs), whereas the North American and US Caribbean Sea ECAs cover sulphur, nitrogen and particulate matter emissions. ECAs are located in areas that contain high concentrations of both shipping activity and coastal populations. According to the US Environmental Protection Agency, the North American ECA should save more than 14 000 lives annually by 2020, and improve the respiratory health of some 5 million people in the United States and Canada. It further estimates that the ECA will cost USD 3.2 billion by 2020, but that it will have generated between USD 47 billion and USD 110 billion worth of saving on health costs.

Significant progress has been made operational and technical measures to reduce GHG emissions such as CO_2. However, consensus on global market-based mechanisms – deemed necessary to reduce emissions to levels low enough to impact the pace of climate change – has been elusive within the IMO. The Marine Environment Protection Committee (MPEC) of the IMO amended MARPOL Annex VI in 2011, adding a new chapter on “Regulations on Energy Efficiency for Ships”. It includes two measures that came into force in early 2013 and apply to all vessels over 400 gross tonnage: the Energy Efficiency Design Index (EEDI) for all new ship constructions, and the Ship Energy Efficiency Management Plan (SEEMP) for existing ships. The EEDI phases in progressively stringent criteria into the building standards for different types and sizes of ship. Energy efficiency levels are measured in CO_2 emissions per capacity mile, and are designed to bear upon all production components of a given ship. The SEEMP constitutes a mechanism for benchmarking and improving operable ships, mainly through the Energy Efficiency Operator Indicator (EEOI) instrument. Under the SEEMP, owners and operators are periodically brought to review and upgrade their energy performance, focusing on such measures as engine tuning and monitoring, propeller upgrades, trim/draft improvement and enhanced hull coating. Various states plan to implement these measures through the use of Port State Controls.

An IMO-commissioned study has claimed that, under high uptake scenarios (30%), the EEDI and SEEMP should reduce global emissions below the status quo scenario by an average of 330 million tonnes (40%) annually by 2030, and increase savings in the shipping industry by USD 310 billion annually (Lloyd’s Register and DNV, 2011). Nevertheless, the 2030 model suggests that MARPOL measures will not be sufficient to bring about an overall reduction in emissions relative to 2010 levels. In each of the uptake scenarios tested, projected growth in trade will overwhelm any emissions reductions achieved through the EEDI and SEEMP, even if the upward trend will be reduced compared to status quo scenarios. At least 10 different market-based measures (MBMs) for GHG emissions reductions have been submitted by member-states to the IMO. As of 2013, however, opinion has been highly divided within the IMO about the legitimate use of MBMs to bring down GHG emissions from shipping.

Information

Ports are not only at the forefront of strategies to implement international emissions reductions regulations, but are also themselves the originators of emissions reduction policies. The first and most fundamental step that a port authority should take is to conduct a thorough port emissions inventory. Emissions inventories, such as those in Los Angeles, seek to identify emissions levels that occur within a given area, according to their source (Box 5.1). Sources can be mobile (*i.e.* ships and vessels entering and leaving, cranes, trains) or stationary (*i.e.* energy production facilities). Some ports are increasing their efforts at reporting and monitoring, and integrating emissions inventories into larger sustainability reports that provide measures of a diverse range of environmental impacts and mitigation initiatives. Methodologies employed and main indicators covered vary from port authority to port authority (Table 5.3). For this reason, national agencies, such as the US EPA, for example, published guidelines in 2009 aiming to harmonise best practices across ports.

Table 5.2. Air emissions inventories in selected ports

Port	Main indicators	Since when?
Los Angeles	Port-related GHG emissions (electric wharf cranes, building electricity, building natural gas, port employee vehicles, expanded GHG inventory) Diesel particulate matter (DPM), nitrogen oxides (NO_x), SO_x, CO_{2e} emissions by source category: Ocean-going vessels (OGV), harbour craft (HC), cargo-handling equipment (CHE), heavy-duty vehicles (HDV), rail locomotives (RL). Containerised cargo volume trend Port DPM, NO_x, SO_x, CO_{2e} emissions trend	2001
Long Beach	Port-related emissions (PM_{10}, $PM_{2.5}$, DPM, NO_x, SO_x, carbon monoxide (CO), HC) by category: OGV, HC, CHE, RL, HDV. Port-related GHG emissions (CO_{2E}, CO2, N_2O, CH_4) by category: OGV, HC, CHE, RL, HDV.	2002
Seattle	Total airshed emissions (NO_x, VOC, CO, SO_2, PM_{10}, $PM_{2.5}$, DPM, $CO2_e$) by source category: OGV, harbour vessels, RL, CHE, HDV, fleet vehicles	
New York - New Jersey	GHG emissions (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6) by the category "Port Commerce" (commercial marine vessels, CHE, RL, HDV, buildings, landfill, fleet vehicles) Port commerce emission per TEU handled Total Criteria Air Pollutant (CAP) emission (NO_x, NO_2, PM)	2006
Oakland	Particulate Matter (PM, including diesel), NO_x, SO_2, Reactive Organic Gas (RO), and CO emissions by source category: ships, HC, CHE, RL, trucks.	2005
Vancouver	Common Air Contaminants (CACs): NO_x, SO_x, CO, VOCs, PM_{10}, $PM_{2.5}$, NH_3, GHGs – CO_2, CH_4, N_2O by source group (administration, CHE, on road, rail).	2005
Shanghai	Air pollutant emissions (NO_x, SO_2, PM, VOC, CO) of ships (ships of international shipping lines, ships registered at ports and managed by local maritime authorities, ships travelling along the coast, hotelling, internal rivers).	2006
Gothenburg	GHG emissions by: *Direct emissions: operational vessels, operational vehicles, heating buildings (by fuel usage), fire equipment *Energy indirect emissions: electricity usage, direct heating *Other indirect emissions: business flights gallons per annum, business travel by car gallons per annum, terminals, vessels at the quay/ traffic area, loading of gasoline, leakage of pipelines, carpool	2010
Barcelona	Air emissions at Darsena Sud and Port Vell: SO_2, H_2S, NO_2, C_6H_6, PM_{10}.	2004
Hamburg	Direct CO_2 emissions; Indirect CO_2 emissions CO_2 emissions by equipment type: straddle carriers, OGVs, container/ rail gantry cranes, reefer containers, storage cranes	2011
Houston	Maritime related emissions (NO_x, VOC, CO, SO_2, PM_{10}, $PM_{2.5}$, CO_2) by source category: OGV, heavy-duty diesel-fuelled vehicles, CHE RL, harbour vessels	2007
Melbourne	CO_2 emissions by activity: commercial vessels, cargo handling & Tenants, rail, road	2011
Helsinki	Nitrogen dioxide concentrations, monthly average Sulphur dioxide concentrations, monthly average Vessel waste waters received by Port of Helsinki Vessel waste waters pumped into sewage systems in Helsinki	2010

Source: Own data collection based on information provided by port authorities.

Such efforts at quantification are essential, as they provide a baseline against which subsequent progress and performance can be measured. Various ports have introduced systems for monitoring compliance with clean air regulations. The Port of Tallinn, in Estonia, for example, has installed two automatic stations for measuring concentrations of controlled compounds in the air. If at any point levels exceed predefined limits, operators, inspectors, the harbour master and port authority are automatically warned so that measures can be taken to reduce emissions. Modelling is used to locate the probable source of pollution, and is accompanied by a set of guidelines including actions that can be taken by each operator to reduce emissions. The Port of Helsinki runs a similar programme in co-operation with the authorities, which is managed in real time through an online platform.

Port State Controls play an important role in enforcing monitored standards. In the port of Antwerp, for example, the Port State Control agents have direct access to the information and monitoring system, and use this to target vessels for inspection.

Similarly, the US Coast Guard introduced its Qualship 21 (Quality Shipping for the 21st Century) initiative in 2001, which issues certificates to ships with good environmental track records. Amongst other incentives, certificate-holders are subject to fewer Port State Control inspections for a period of two years, which is particularly advantageous given the intensification of such controls in the United States in the post-9/11 context. Various public and private actors must find ways to comply with these new standards, and some have sought to do so voluntarily as a cost-effective and socially responsible measure. However, there are legal limits for the application of Port State Controls.

Box 5.1. Port of Los Angeles: How to create an air emissions inventory

The Port of Los Angeles and the Port of Long Beach have had an Air Emissions Inventory in place since 2005 to measure port-related air pollution and inform the public about it. This inventory is part of the San Pedro Bay Clean Air Action Plan (CAAP), designed to reduce air emissions and health risks associated with air pollution. The 2005 Inventory of Air Emissions serves as the baseline to measure progress on this action plan. The development of the air emissions inventories was co-ordinated with the US Environmental Protection Agency (EPA), the California Air Resources Board (CARB) and the South Coast Air Quality Management District (SCAQMD). Port tenants and shipping lines also play an essential role in providing accurate activity and operation information. The activity and operational data collected is then used to estimate emissions for each of the various source categories, consistent with the latest estimating methodologies agreed upon by the port and participating regulatory agencies. All the detailed annual inventory reports are available to the public on the port websites.

The inventories evaluate emissions from five port-related mobile source categories: Ocean-Going Vessels (OGVs), harbour craft, Off-road cargo handling equipment (CHE), rail locomotives (RL), on-road Heavy-Duty Vehicles (HDV). For each category, exhaust emissions are estimated for the following pollutants: particulate matter (PM) (10-micron, 2.5-micron), diesel particulate matter (DPM), oxides of nitrogen (NO_x), oxides of sulphur (SO_x), hydrocarbons (HC) and carbon monoxide (CO). The ports started to conduct emission estimates of greenhouse gases (GHG) from port-related operation from the 2006 Inventory, which includes carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). By using the 2005 activity levels as the baseline year, the subsequent inventories also provide the comparisons of main air pollutants between the baseline year and the evaluation year. In the 2011 report, the Port of Los Angeles reported a reduction in cumulative harmful emissions of 76% since 2005. Diesel particulate emissions declined by 71%, NO_x emissions by 51% and SO_x emissions by 76%.

Incentive schemes

In addition to monitoring and enforcing compliance with new mandatory regulations, many port authorities are now employing voluntary incentive schemes to stimulate reductions in emissions from shipping, via slow steaming, fuel shifts, cleaner ships, truck retirement and modal shifts.

Some incentive schemes have sought to encourage slower steaming speeds. Through the Vessel Speed Reduction Programme (VSR), the Port of Long Beach rewards ships that voluntarily lower their speeds within the harbour, through reduced docking fees for vessels that remain within a 12-knot speed limit. The goal of the VSR is to reduce NO_x emissions from ocean-going vessel by slowing their speeds as they approach or depart the port, generally at 20 nautical miles (nm) from Point Fermin. The VSR was first adopted in 2001 with voluntarily participation from the shipping liners, after the two ports signed a co-operative Memorandum of Understanding (MOU) with the US EPA, CARB, SCAQMD, Steamship Association of Southern California and Pacific Merchant Shipping Association (PMSA). The Marine Exchange of Southern California provides the vessel speed data for both ports. Since the 2006 CAAP identified the VSR programme as one of the main control measures for cutting air pollution, the two ports started offering the incentives of dockage rate deduction to participated vessel operators – 15% off for compliance at 20 nautical miles, 30% off (POLA) and 25% off (POLB) at 40 nautical miles. Ocean carriers achieving 90% compliance in a calendar year will receive the incentive for 100% of their vessel calls in that year. As of March 2012, POLA compliance is 94% at 20 nautical miles and 74% at 40 nautical miles, and POLB compliance is 97% at 20 nautical miles and 84% at 40 nautical miles. In 2007, the two ports estimated that the VSR programme has resulted in a reduction of 1 345 tons of NO_x, 832 tons of SO_x, 112 tons of PM, and 52 502 tons of CO_2.

Various ports have introduced environmentally differentiated port dues, based on the environmental ship index (Box 5.2). The Port of Amsterdam gives a rebate on the port dues, ranging from EUR 200 to EUR 1 400 in 2012, depending on the size of the vessel. The Port of Rotterdam announced in 2011 that it would give a rebate on the port dues to the 25 cleanest ships that would call at the port. The amounts of reductions in port dues in Rotterdam related to this were EUR 40 000 in 2011 and EUR 600 000 in 2012, according to the Rotterdam port authority. The effect of these incentives is for the moment fairly small, as the number of vessels that qualify for reduced port dues is limited. Although the reductions in port dues indicated in the previous paragraph are not marginal, the number of vessels that have favourable environmental ship index (ESI) scores remains fairly limited in comparison with the total number of ships calling at the port. As the number of ships integrated in the ESI is steadily rising, the prospective benefits will rise, but the rebates have not so far been financed by a rise in dues for the non-ESI vessels, which will have negative consequences for the budgets of the participating ports.

Box 5.2. The Environmental Ship Index

The Environmental Ship Index helps to determine the environmental performance of ships with respect to air pollutants and CO_2. The aim is to reward ships that score high on the index by offering them lower port dues. The ESI measures a ship's emissions based on the amount of nitrogen oxide, sulphur oxide, particulate matter and greenhouse gas it releases. A voluntary system, it is open to shipping companies, ship-owners and ports. The ESI uses a formula to give ships points for their environmental performance, taking into account current international legislation, mainly promulgated by the International Maritime Organisation (IMO). Currently 1 439 ships have a valid ESI score, and 18 ports are participating, including Rotterdam, Hamburg, Antwerp, Le Havre, Los Angeles and New York/New Jersey. The ESI was developed in the framework of the World Port Climate Initiative (WPCI), committing to reduce greenhouse gas emissions from port activity. The ESI ship database is administered by the ESI Bureau of the International Association of Ports and Harbors (IAPH).

It is also possible not only to reward clean ships, but also to penalise dirty ships. Sweden has applied environmentally differentiated port dues since 1996, following an agreement between the Swedish Maritime Administration, Ports of Sweden and the Swedish Ship-Owners Association to reduce NO_x and SO_2 emissions from ships. This agreement has led to environmentally differentiated fairway and port dues. The fairway dues are mandatory and consist of two parts, one based on the volume of goods loaded/unloaded and one based on the ship's gross tonnage. The latter part is environmentally differentiated and relates to NO_x and SO_2; the differentiation for NO_x is given as a reduction in the first part of the fairway dues and divided into several emission levels. Ships satisfying the strictest requirements are exempted from the dues. A surcharge is added for sulphur, divided into three levels, if the sulphur content of the fuel exceeds 0.20%. Unlike the fairway dues, the environmental differentiation of the port dues was voluntary, but all large Swedish ports have introduced them. The Port of Gothenburg has sulphur charges (divided into three classes) and nitric oxide discounts (also divided into three classes). There are different assessments of these environmentally differentiated port dues. According to Swahn (2002), they have imposed strong incentives for reducing emissions, whereas Kageson (1999) states that the dues were not differentiated enough to present real incentives for ship operators to reduce emissions.

Various ports have introduced truck retirement programmes to mitigate air pollution from old trucks operating in their ports. Emissions inventories conducted in US ports have consistently identified drayage trucks as significant contributors to port-related pollution, accounting for 25%-43% of NO_x emissions. Drayage trucks are typically older and more polluting than the average long haul truck (Norsworthy and Craft, 2013). Examples of mandatory truck retirement programmes can be found in Los Angeles, Long Beach, Oakland and Vancouver, and voluntary truck retirement programmes were introduced in Houston, Virginia and Charleston. These programmes aim to stimulate the replacement of old trucks; the programme in Oakland also encourages diesel particle filter retrofits in addition to truck replacement. In many cases, the programme provides grants or loans. The ports of Los Angeles and Long Beach have provided a total of more than USD 110 million in grant funding to incentivise the replacement of trucks. The Houston Drayage Loan Program combines a traditional grant programme from state funds tied to NOx reductions with low-interest loans from federal funds for drivers seeking to replace their vehicles. The mandatory truck retirement programmes in Southern California have been very effective in reducing emissions; the emission reductions in voluntary programmes have been limited (Table 5.4).

Table 5.3. Effectiveness of port truck retirement programmes

Port	Programme	NOx	PM	CO	BC	HC	Period	Source
Los Angeles	Clean Truck	33%					2008-09	Bishop et al., 2010
Los Angeles	Clean Truck	48%	54%	30%			2008-10	Bishop et al., 2012
Los Angeles	Clean Truck	87%	97%	94%		92%	2005-12	Lee et al., 2012
Oakland	CTMP	41%			54%		2009-10	Dallmann, Harley, Kirchstetter, 2011
Oakland	CTMP		75%				2008-10	
Norfolk, VA	GO	4%	4%					Norsworthy, Craft 2013
Charleston, SC	STACS	1%	3%					Norsworthy, Craft 2013
Houston	DLP	2%	1%					Norsworthy, Craft 2013

Note: Abbreviations in the table stand for Comprehensive Truck Management Plan (CTMP), Green Operators programme (GO), Seaport Truck Air Cleanup Southeast programme (STACS), Drayage Loan Programme (DLP).

Encouraging modal shifts is another method port authorities and transport agencies can use to reduce emissions related to the maritime transport sector. The emissions generated by rail transport are roughly equivalent to a third of those generated by road haulage, and many port authorities are encouraging a switch to rail as a form of hinterland transport, for example by incentivising the use of rail in hinterland moves through tax and subsidies. Since 2004, Spanish ports have been required to give a 20% discount on port dues if a container goes by rail, with little noticeable impact so far (Monios, 2011). Another, more direct solution is to change the port's hinterland infrastructure. The Alameda Corridor, which links the ports of Long Beach and Los Angeles to regional train networks, is estimated to have reduced certain kinds of GHG emissions by up to 35% each year, by comparison with the expected emissions under the status quo. Nevertheless, the overall tendency in emissions along the corridor was to increase in the 2002-04 period, due to growth in traffic.

Modal shifts can also apply to the inter-port transport of empty containers. In the ports of Tokyo bay, for example, empty containers were traditionally transported between ports by road. The government has subsidised and helped with a green partnership programme between the ports that aims to increase the use of barges to transfer the empties. The estimated reductions between the ports of Tokyo and Yokohama are roughly equivalent to 85% (APEC, 2009). However, the project is complicated by the high costs and the unsuitability of barge transport for port facilities. Congestion reduction is another emissions reduction technique related to modal shifts, in an attempt to minimise harmful results. Reducing the time vehicles spend on the road translates into a direct reduction in emissions.

Investment in clean technology

Investment in clean on-port technologies is an effective way both of ensuring environmental compliance and making the port more attractive to shippers. Since shipping companies must comply with increasingly stringent regulations on the type of fuels they can use, ports that offer green services have become more attractive. Some ports situated close to ECAs have been able to leverage their position to become key suppliers of low-sulphur fuel. The Port of Falmouth managed to develop a strong market supplying fuel for low-sulphur oil bunkers, which must be filled before the vessel enters the ECA.

In an approach that may prove more sustainable in the long run, several European ports have begun promoting the use of liquefied natural gas (LNG) as a ship fuel. Bremenports, which is responsible for the management and development of Bremen and Bremerhaven, has decided to actively support the future use of LNG. In addition to the construction of an LNG depot in 2011, one of its main strategies is to use LNG itself, through the creation of ship services powered by LNG in 2012. It is hoped the use of LNG by the service fleet will set a precedent for other users in the port, and Bremenports has a policy of providing technical expertise on these matters to facilitate the popularisation of such technologies. As noted above, the ports of Rotterdam and Gothenburg already run incentive schemes that subsidise the use of LNG by ships. Both ports are also investing in LNG facilities. Rotterdam's Gate Terminal built the first LNG terminal in the Netherlands through a EUR 754 million financing agreement signed with the European Investment Bank and 10 syndicated international banks. Construction on the Gate Terminal was approved in 2008, and it officially opened in 2011. In 2013, the terminal had contracts with five customers, and was handling its maximum start-up capacity of 12 billion cubic metres per annum. Gothenburg aims to have its own LNG terminal operational by 2015. Swedegas and a Dutch tank storage company, Vopak LNG, will run the terminal. Gothenburg and Rotterdam have already begun co-operating on standardisation efforts to ensure that LNG is handled in a uniform manner and to speed up the development and adoption of LNG as a fuel. The push for such technologies will arguably give these ports a competitive advantage over their counterparts, as emissions standards in the surrounding ECAs become increasingly stringent. The EC regulatory proposal on GHG emissions from the maritime transport industry, for example, would mandate that all ports in the EU feature LNG facilities by 2020. The Commission notably recommended EUR 35.5 million in funding for the Gothenburg project.

One important instrument that port authorities are increasingly using to induce cleaner shipping practices is that of "cold ironing", also known as Shore Connection, On Shore Power Supply, and Alternative Maritime Power Supply. Especially in Europe and North America, an increasing number of ports provide shore power to ships that come into their quays, following the lead of Gothenburg (see Box 5.3). Instead of using their diesel-fuelled auxiliary engines, these ships use power generated by the local grid, which significantly diminishes diesel- and other fuel-derived emissions while in port. Shore power not only requires an on-shore power connection, but also ships that are able to connect to this power source. For this reason, shore power is most feasible for point-to-point connections, such as ferries. Increasingly though, issues of compatibility are being resolved, and other ship types are connected to shore power in ports.

Box 5.3. Gothenburg: Shore power in the port

Since the beginning of the 2000s, the Port of Gothenburg (Sweden) has put in place an innovative policy of using on-shore power supply. Vessels that are at the quay typically use their diesel engines to meet energy needs for certain functions, such as lighting, heating and air conditioning. This use of the diesel engine is a source of considerable local air pollution and greenhouse gas emissions. The Port of Gothenburg was the first in the world to propose that vessels be connected to the local energy network, which made it possible for these vessels to shut off their engines during their stay in the port (called "cold ironing").

Since 1989, the Port of Gothenburg has provided electricity to ships calling at the port, but only through several low-voltage cables that did not cover all their energy needs. At the initiative of a large paper-manufacturing company, Stora Enso, which sought to improve the carbon footprint of transporting its products, the port began designing a more efficient system in partnership with several navigation companies and Asea Brown Boveri (ABB), a company specialising in electrical products. Operational since 2000, this newer system uses a single high-voltage cable providing 6.6 to 10KW 50Hz, which can power an entire ship from platforms on the docks. The vessels are therefore able to stop their engines, resulting in a significant reduction in both noise and carbon emissions. The Port of Gothenburg estimated that a vessel not connected to the on-shore power grid emits about 25 tonnes of carbon dioxide, 520 kilogrammes of nitrogen oxides and 22 kilogrammes of particulate matter during its stop. This innovation thus benefits both the environment in terms of climate change, and the quality of life and work of populations on or near the port (residents, dockworkers and ships' crews). Today, one in three ships calling at the Port of Gothenburg uses the connection for shore-side electricity, a proportion that is likely to increase. Roll-on/roll-off ships and ferries are the most frequent users of the new system, because the links they provide are back and forth, but all categories of ships may benefit from this new technology. While connecting to the grid requires vessels to invest in technology to use the new system, costs for retrofitting vessels can be offset by the likely savings in fuel.

Through this programme, the Port of Gothenburg has acquired a first-mover technology advantage in connecting the vessels to shore-side electricity. This system is also in operation in other ports, such as Antwerp, Zeebrugge and Lübeck. However, a significant barrier to technology diffusion is the non-harmonisation of international electricity standards, since some parts of the world using 50 Hz systems and others using 60 Hz systems. This problem complicates retrofitting vessels, although attempts are being made to harmonise them. For its pioneering role in this technology, the Port of Gothenburg was chosen as the leader of the Working Group on onshore power supply created by the World Port Climate Initiative.

In addition to providing clean fuel and energy services for the shipping sector, ports are increasingly investing in cleaner, low-emission technology to drive their own operations. This can be seen in part as a response to legislative changes. The Port of Houston, for example, has implemented several energy-efficiency measures, including improved lighting control systems and the installation of new window systems to reduce dependence on artificial lighting, following the introduction of amendments to the Health and Safety Code. While many ports have implemented energy-efficiency measures due to regulatory pressures, it must also be noted that another incentive consists in the significantly lower costs of energy savings in the long run.

Various ports have upgraded cargo-handling technology, with a shift away from diesel engines. In the ports of the State of Virginia, for example, diesel engines were accountable for around a quarter of port facility emissions in 1999, when it voluntarily undertook to change its equipment purchasing policies in anticipation of impending air quality regulation from the EPA. Under the purchasing policy change, suppliers were instructed to provide only the cargo-handling equipment with the lowest emissions engines on the market. The policy has met with success: despite a 55% increase in cargo from 1999-2005, emissions from cargo-handling activities have decreased 30%, with an additional 35% reduction anticipated by 2015 even under high cargo growth scenarios. This policy, which has also reduced fuel costs while increasing air quality, would appear broadly replicable. For example, the port of Busan, Korea, has switched from fuel-driven Rubber-Tired Gantry Cranes (RTGCs) to electricity-driven RTGCs (e-RTGC) in its cargo-handling operations. Even when accounting for emissions produced through electricity generation, the Busan Port Authority estimates that the switch of 94 RTGCs to electrical systems will reduce emissions by 28 000 tonnes of CO_2 after introduction (OECD, 2011). Larger and higher-volume ports have more opportunities to upgrade or build new terminals. They often replace existing facilities with newer and more energy-efficient technology. At smaller ports with less opportunity and financial ability to build new infrastructure, the tendency is to retrofit old equipment with emission control devices and focus on implementing process improvement, such as reducing idling procedures.

Another clean-technology strategy involves supplementing traditional energy sources with renewable ones. In some ports, this includes the purchase of power from companies specialised in renewable energy production. The Port of Houston, for example, signed a deal with Direct Energy in 2006 to ensure that 5% of its electricity is generated through wind power. In Belgium, the Port of Zeebrugge has concluded a similar agreement with Interelectra, to generate 17 500 MWh of wind-based electricity for the port every year. Many ports are also beginning to generate their own electricity. Solar power is commonly used to light on-port facilities. PSA Singapore Terminals have been using Solatube lighting systems in their facilities since 2008. Some ports are even using clean-energy technologies for other operations. Windpower is used at the Port of Göteborg, for example, to power electricity at the RO/RO terminal.

To a great extent, the impact of renewable energy in port energy consumption appears marginal. Many are still too expensive, or unreliable. Port Kembla, in Australia made news around the world for its wave-energy plant, which was constructed by Oceanlinx, with the purpose of generating electricity at levels equivalent to those required to power 500 houses. However, the generator broke free of its moorings in a storm in 2010, has since lain inactive and rusting in the channel, and is largely considered a failure. If ports are to switch to green electricity-generation methods, strong moral and financial commitments are required from policy makers, as this field demands considerable risk-taking and experimentation.

Water quality

Water is a valuable resource affected by ports and shipping in many ways. In addition to reducing the consumption of water in ports, port authorities must also comply with regulations governing the impact of ships and port activity on the body of water in the port. Currently, shipping activities are responsible for around one-fifth of global discharges of wastes and residues at sea (EMSA, 2013).

Regulation

At an international level, the main instrument for the regulation of discharges from seaborne vessels is Annex IV of the MARPOL Convention 1973/8. Generally speaking, the regulations within the Annex IV concern discharge of liquid wastes within a certain proximity to land. It is considered, for example, that deep oceans can assimilate and nullify the effects of raw sewage through natural bacterial processes. Several measures can be taken by governments and port authorities to ensure that shipping minimises harmful impacts on water quality. Limits on discharge function in two main ways: by regulating where discharge may and may not take place, and by limiting how much may be discharged.

Around 30 states in the United States have created such no-discharge zones (NDZs). Three different mandates for protection are used: protecting aquatic habitats where pump-out facilities are available; protecting special aquatic habitats or species; or protecting drinking-water intake zones to protect human health. In March of 2012, the largest NDZ in the United States was created: the California Marine Waters NDZ, covering over 2 600 kilometres of coastline. When functioning correctly, the California NDZ should reduce the annual discharge of over 76 million litres of sewage by cargo and cruise ships calling in at California’s ports from the status quo level. This is expected to generate significant positive impacts for coastal biodiversity, not to mention public health and aquaculture.

Regulatory limits on how much and which kinds of pollutants may be discharged are often administered through permits and licences. In the United States, merchant vessels and cruise ships are eligible for the Vessel General Permit (VGP), drawn up by the EPA in 2008. The VGP sets general limits covering 26 kinds of discharge, from graywater to bilgewater, various kinds of effluent, lubrication, oil, wet exhaust, and so on. The permit includes operational requirements and a host of best management practices. For example, the VGP recommends that ship operators use shore-power wherever possible, to reduce the seawater cooling discharge generated as a by-product of the vessel’s heat-intensive mechanisms for electricity generation.

Regulation of antifouling treatments is another important regulatory measure for the improvement of water quality in maritime areas affected by shipping and ports. Antifouling describes a range of systems and technologies used to counteract or prevent the build-up of organic or inorganic deposits on marine equipment. Antifouling measures are an important cost-reduction measure in shipping: the build-up of organisms such as molluscs and algae on the underside of the hull can increase friction, slow down the ship and increase its fuel requirements. However, the harmful components used to kill biofouling organisms – such as arsenic, and various metallic compounds included in paints – were discovered during the 1980s and 1990s to have serious residual effects in the aquatic environment, and can even enter the food chain. At the international level, the International Convention on the Control of Harmful Anti-Fouling Systems on Ships – which was adopted in 2001 and entered into force in 2008 – prohibits the use of several harmful compounds used in anti-fouling systems, and created a mechanism for ensuring that future anti-fouling systems would not include harmful substances. Various national frameworks also exist.

Wastewater reception facilities

Port reception facilities play a vital role in reducing the discharges of ships into the sea. Several regulations within MARPOL 1973/78 contain requirements for reception facilities.[2] In the European Union, a specific directive focusing on port waste reception facilities was adopted in 2000 (2000/59/EC). The main aim of the directive was to reduce illegal in-port discharges by promoting better port waste reception services. It includes several requirements for member states, including the formulation and implementation of a waste reception and handling plan (in consultation with stakeholders), and mandatory waste delivery for any ship that does not have sufficient waste storage capacity for its voyage to the next port of call. The Directive also introduces mandatory indirect financing of waste disposal systems, whereby shipowners must pay for waste disposal as part of port dues, regardless of actual disposal. This provides an incentive not to discharge at sea prior to arrival in the port.

With increasingly stringent regulations on ship discharge at international and EU levels, the development of adequate reception facilities can thus be a key component in increasing the attractiveness of a port to shippers and in improving environmental conditions.

Some ports have collaborated with local authorities to handle waste water from ships. In the ports of Trelleborg, Sweden and Kalundborg in Denmark, black and grey water is pumped directly from the berths to the municipal sewage treatment plant. In the Port of Kapellskär, Sweden, the port itself built a sewage treatment plant that was subsequently sold to the city. In larger ports, such as Rotterdam, more complex systems are required. With over 20 waste water-disposal service providers operating in the Rotterdam port, the authority has put into place information-sharing mechanisms and acts as an interface between ship agents and waste collectors.

Sewage, sludge and oil spills

In addition to waste water discharges from vessels, ports must also develop strategies to cope with a range of potential consequences for water quality resulting from their own activities and physical layout.

Bunkering often poses a range of pollutant risks, not the least of which are oil spills. A series of important measures can be taken in bunkering ports to ensure that the risk of oil spills is drastically reduced. The Port of Gothenburg, which around half of Sweden’s oil imports pass through, has undertaken a range of measures to ensure that gases and oils are not inadvertently discharged into the environment during bunkering. As part of its “Green Bunkering” project, the port of Gothenburg introduced a stringent set of rules in 1999 that encompasses a wide range of activities, requiring the installation of electronic overflow alarms, the carriage of at least 50 metres of oil booms with absorptive material, and the vetting of all bunker barges by the port authority, amongst other things. The port has also mandated oil-spill prevention equipment for bunker installations and that all bunker operators attend training programmes to learn safe bunkering techniques. Gothenburg has argued for the expansion of green bunkering practices to the rest of Sweden, supporting a 2011 bill to require regular pressure testing in Swedish bunkers to prevent oil spills.

Storm water is another risk factor for in-port water quality. Runoff from storm water can carry many pollutants, including petroleum products from vehicles, litter, construction materials, sand and other sediments, heavy metals, livestock effluent, fertilisers and pesticides, and various other aspects of the urban system. As part of the National Pollutant Discharge Elimination System (NPDES), most US ports require Standard Urban Stormwater Mitigation Plans (SUSMPs), indicating a range of measures for effectively dealing with storm-water run-offs. The Port of San Diego's SUSMP, for example, integrates several design concepts into any new commercial and industrial development projects larger than one acre in dock and maintenance areas of the port. Requirements under the SUSMP include the use of pervious surfaces (permeable pavements and surface structures), and the planning of land slopes and gradients to ensure drainage or retention in designated zones.

Issues with water management can be particularly pressing in dry bulk ports, which require regular cleaning. In the Port of Nantes-Saint-Nazaire, an extensive water treatment plant has been built to deal with run-off from the dry-bulk docks. Water is first filtered before being treated chemically, in a process that significantly reduces pollutants in the run-off water. The plant was co-financed with the regional water authority.

Biodiversity

Without proper mitigation mechanisms in place, shipping and ports activities can have disastrous consequences for the biodiversity of regions where activity takes place. Consensus on the adverse impacts exists, but solutions at international and national levels have proven elusive. Ports should help to make sure that growth does not come at the expense of biodiversity. The main instruments, discussed below, are set out in Table 5.6.

Table 5.4. Overview policy instruments for biodiversity

Policy types	Instruments	Intervention level	Examples
Regulation	Ballast water management	Global	IMO
	Nature compensation	Local	Antwerp
	Integrated coastal and river management	Regional	
Technology upgrade	Ballast water treatment	Global	IMO

Ballast water management

Ballast water is an essential component of seafaring: water pumped into the vessel helps to reduce hull stress, replaces weight lost through fuel and water consumption while at sea, optimises vessel manoeuvrability and improves propulsion. However, practices of taking on and emptying ballast water can have far-reaching consequences, because the water that is carried in this manner contains a host of microbes, small invertebrates, larvae and bacteria that constitute aquatic invasive species (AIS). While relatively harmless in their eco-system of origin, AIS can prove devastating in the eco-system into which they are introduced. They can cause serious harm to biodiversity through habitat loss and mass species kills, damage national economies through bio-fouling and adverse impacts on coastal aquaculture, and even imperil human health.

Well-known examples of species invasions due to ballast discharge include: the cholera epidemic of Peru in 1991, thought to have been introduced into three separate ports by ballast water from Bangladesh, which spread throughout South America, killing more than 10 000 people by 1994; the introduction of the zebra mussel to Ireland, the Baltic Sea and the eastern half of the United States, which is estimated to have caused between USD 750 million and USD 1 billion in damages between 1989 and 2000 to the United States alone, primarily through fouling of infrastructure (blockage of intake pipes, sluices and irrigation ditches); and the global spread of toxic algae, which can kill populations of ocean life on a vast scale through oxygen-depleting algal blooms, and can contaminate farmed shell-fish that cause illness and death when eaten (paralytic shellfish poisoning) (Globallast, 2004). Measures to manage ballast water are vital in reducing the biodiversity, health and economic consequences associated with the growth of global shipping.

At an international level, the UN Convention on the Law of the Sea requires that governments work to “to prevent, reduce and control human-caused pollution of the marine environment, including the intentional or accidental introduction of harmful or alien species to a particular part of the marine environment.” The first specific guidelines for managing the problem of aquatic invasive species were introduced in 1991 by the Marine Environment Protection Committee, recognised at the UN Conference on Environment and Development in Rio de Janeiro in 1992, and finally adopted by the IMO assembly in November 1993. Steps toward mandatory ballast control were finally taken with the signature of the International Convention for the Control and Management of Ships’ Ballast Water and Sediments (BWM Convention) in 2004. As of June 2013, the convention was still not in force, its 37 signatories falling short of the ratification threshold of 35% of the world’s merchant shipping tonnage. Excepting the Marshall Islands, Liberia, Norway and France, many of the major flag states, such as India, Japan, China and Panama, have held back from ratification. Their reluctance appears to reflect concerns about the technical challenges involved with compliance (IHS, 2013).

Port states that have already ratified the BWM convention require shipping companies to undertake at least three kinds of measures in order to achieve compliance. Firstly, under Regulation D-1 of BWM 2004, vessels must perform ballast water “exchange”. This involves the replacement of water taken in at the beginning of the journey at the port or coastal area with water from the open ocean. Not only does open ocean water generally contain fewer organisms, but also those that it does contain are less likely to survive in the coastal environment of the regulating state. It is worth noting that even states that are not party to the convention, such as New Zealand, have long required mandatory exchange measures. New Zealand’s *Import Health Standard for Ships’ Ballast Water from All Countries*, introduced in 1998, requires all water taken up in a foreign port to be discharged and replaced mid-ocean prior to arrival in New Zealand waters.

Secondly, Regulation D-2 of the BWM Convention of 2004 requires that ballast water be treated to remove or nullify invasive species. To be compliant, shipowners must implement systems that have been granted approval. For techniques that use chemical treatment, the active substances must be pre-approved, before receiving “type approval”. Most states use independent classification societies that issue type-approval, which is reviewed by the IMO. As of mid-2013, some 29 systems had received type approval. The approved systems use a mix of three main kinds of treatment technology (IHS, 2013): mechanical (including filtration and cyclonic separation); chemical treatment and biocides (chlorination, residual control, advanced oxidation, etc.); and physical disinfection (ultraviolet, heat, cavitation, electrolysis, ozonation, etc.). One of the first treatment systems, for example, was designed by the Swedish company Alfa Laval, and uses a mixture of UV treatment and filtration during both ballasting and deballasting to remove organisms. Current barriers to implementation of treatment systems include: cost (which has been brought down by increasing competition as approvals are granted);

system footprint aboard (including both space and energy requirements); and the risk of explosion (IHS, 2013).

Thirdly, there are measures associated with production of information on ballast water and planning of ballast water management (BMW). Canada, for example, published its non-binding "Canadian Ballast Water Management Guidelines" as early as 2000, and transformed them into binding regulations in 2004. All vessels must now submit BWM plans for review by the national Administration, although only Canadian vessels are subject to approval processes. The master of any ship destined for Canadian ports must provide a ballast-water reporting form to the Minister of Transport prior to entry into Canadian waters, detailing whether or not ballast water is carried, the nature of the vessel's BWM Plan (including certification by classification society or flag administration), whether BWM procedures have been carried out, and various other pieces of information. Non-compliant vessels are subject to inspection and detention.

Preservation and conservation

In addition to enforcing compliance with ballast water management protocols, authorities may also use offsets to mitigate the increased emissions associated with port development projects. Sometimes this simply involves a change in land-use frameworks, stipulating that a certain percentage of developed land must include green spaces. This is a policy employed at the Port of Brisbane, where all new developments must allocate at least 5% of the new port land to green areas, and where 9% of the current land use plan is occupied by green spaces, including 150 hectares of wetlands. Similarly, the Port of Durban has declared some 20 hectares of its port area, which mainly includes sensitive mangrove swamps, a natural heritage site. Such measures can increase the visual attraction of such ports, and help to limit the often highly destructive effects of ports on local biodiversity.

Integrated coastal and river management

Given that ports are located on the water's edge, their activity is very often subject to the regulatory framework set up to govern the coastal or riverside areas in their respective jurisdiction. Integrated coastal and river management frameworks increasingly include port actors in their biodiversity policies.

Since at least the mid-1990s, policy makers have worked towards "integrated" approaches to the management of coastal and river environments. Both such approaches fall under the notion of integrated water resources management (IWRM). Although human societies have arguably managed their water resources in an "integrated" fashion for millennia, IWRM was first popularised as a policy concept at the international level during the UN Conference on Water in Mar del Plata, Argentina, in 1977 (Rahaman and Varis, 2005). The term was defined in 2002 by the Global Water Partnership "as a process which promotes the co-ordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". Integrated coastal management and integrated river basin management continue in this same vein, though each emphasises slightly different aspects that affect port operations in different ways. Indeed, whereas both focus on the protection of water as a resource, the former focuses more on the marine environment as a whole, while the latter emphasises water as a consumable resource used by individuals, industry and agriculture.

Turning first to integrated coastal management (ICM), the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) in 1996 provided a definition that has, for all intents and purposes, become the paradigmatic one: "Integrated coastal management is a process that unites government and the community, science and management, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal ecosystems and resources". Integration is thus meant here not only in reference to the holistic approach that is adopted when managing water resources (including coastal flora and fauna, as well as social systems and economic factors), but also refers to the range of actors involved. ICM is thus intersectoral and interdisciplinary.

The extent to which a given port will be affected by ICM norms depends on the stringency of the national regulatory framework. In New Zealand, for example, ICM was implemented as part of the Resource Management Act (RMA) of 1991. The RMA contains a mandatory set of coastal development objectives, referred to as the New Zealand Coastal Policy Statement, with which all future coastal development must demonstrate compliance, including ports.

In the case of Integrated River Basin Management (IRBM), water is treated more as a resource that is subject to conflicting patterns of usage, including environmental conservation, transport, industry, domestic consumption and agriculture. In such cases, IRBM is often used as a conflict management tool, to arbitrate between upstream and downstream conflicts over water levels during the dry season, for example. To the difference of ICM, IRBM is often pluri-jurisdictional. For the ports sector, this is especially important in water bodies that serve as corridors to inland ports. The Rhine river basin, for example, covers some 185 000 square kilometres of northwestern Europe, crossing nine different countries and serving as an important waterway for the transport of goods. Ocean-going vessels can navigate as far as Mannheim, Germany, and barges as far as Basel, Switzerland (Philip, Anton and Schraffl, 2008). At the international level, the principles of IRBM are upheld along the length of the Rhine by the International Commission for the Protection of the Rhine (ICPR), established in 1963 by France, the Netherlands, Switzerland, Luxembourg and Germany. Various ministers from the member states are represented on this body, including the transport ministers.

Solid waste

Solid waste management in ports involves the collection, transport, processing or disposal, planning and monitoring of unneeded material by-products generated through port activity. Solid waste can have many sources in a port, from on-port facilities to vessels and the treatment of cargo itself (*i.e.* oil refinery). Typically, the management of waste is carried out in three main strategies, applied to different phases of the life cycle. First, upstream measures try to cut down on the amount of waste generated in the first place. Secondly, downstream measures seek to recycle and reuse waste that has been produced. Thirdly, end-of-stream measures seek to improve upon the final disposal and treatment of waste that can neither be recycled nor reused.

Reception facilities

Just as with waste water, the reception and management of solid waste in ports is often best undertaken through co-ordination with the municipal authorities or local sub-contractors. In some ports, this leads to innovative collaborations that make use of the particular specialisation of the port.

In partnership with the Flemish Region, for example, the Port of Antwerp has begun experimenting with ways to recycle the filter cake produced through the mechanical dewatering of dredging soil. The AMORAS project thus produces clean water from the solid by-products of dredging, while the VAMORAS project seeks ways to reuse it, in line with a so-called "cradle-to-cradle" policy. The potential applications of de-watered dredging soils include the creation of bricks, concrete aggregate, clay granules and road foundations.

In a similar move, the Port of Aalborg in Denmark has used its specialisation as an organic dry bulk port to recycle solid by-products of its activities. Every year, 300 tonnes of organic waste are produced in the port, due to spillage of bulk goods such as soya, corn, pulp and sphagnum. Rather than dispose of this, the organic materials are sent to a local biogas plant and used to generate electricity.

Marine debris

Marine debris is a serious environmental problem in which port authorities might play a more pro-active role, particularly in fishing ports. Marine debris is often land-based, reaching the ocean via run-off, but is also produced by shipping and fisheries. Several species are threatened with extinction due to its debilitating effects. In the ports of Groningen, the authority houses and supports the KIMO foundation, which runs a "Fishing for Litter" programme. Under the programme, fishing boats are provided with large bags for the deposit of litter found at sea. The bags are collected for disposal at the port when full. By involving key stakeholders, such as fishermen, ports may provide platforms for such net positive environmental action, rather than simply seeking to mitigate their own impacts.

Impact of port noise

There are various legal frameworks for port-related noise. The IMO specifies a noise limit of 70 dB(A) at listening posts of ships.[3] In addition to the IMO resolution, there are International Organization for Standardization (ISO) codes for vessels and there may be national and regional legislation on noise limits in the port area, as well as regulations in municipal codes. Many European seaports and their surroundings are covered by the Environmental Noise Directive of the European Commission.[4] The Directive requires noise mapping for industrial port areas near agglomerations (a territory with more than 100 000 inhabitants with typical density for urban areas). Other key provisions in the directive are that information on environmental noise and its effects should be available to the public, that action plans should be made based on the noise maps, a process in which the public should be consulted. Many countries require for new port development projects that an Environmental Impact Assessment (EIA) be made, which usually includes a Noise Impact Assessment (NIA).

Noise measurement is a prerequisite for noise management by ports. Various ports have invested in noise measurement. The Port of Valencia has three noise meters distributed around the port that can take measurements every second and 24 hours per day (Rizzutto et al., 2010). Noise maps can determine priorities for policy intervention. Noise impacts and noise management have been the subject of various co-operative projects between European ports. The NoMEPorts-project dealt with noise pollution related to ports, delivering Strategic Noise Maps for six pilot ports: Amsterdam, Hamburg, Livorno, Copenhagen/Malmo, Valencia and Civitavecchia. The HADA-Project designed an acoustic monitoring network for the Port of Bilbao and the definition of an evaluation methodology of the noise levels produced by port activities. The Sympic Project aimed at creating tools for environmental policies for port authorities and municipalities (Badino, Schenone and Tomasoni, 2010). These projects have generated useful information for measuring noise impacts and good practices for port noise management. Three types of measures have been identified to reduce noise impacts of ports: technical possibilities for source mitigation, port design and barriers, and adaptations in residential areas.

Technical possibilities such as silencers on the diesel generator exhaust can reduce noise from ships. If noise persists after the exhaust tack has been installed, it can be very cumbersome and expensive to resolve because of space limitations in the casing. Another solution is to use the main engine exhaust silencer in port for the diesel generator exhaust, by rerouting the exhaust. Standard methods for reducing noise from ventilation systems on board a ship include adding mineral wool to fan rooms, and more expensive solutions such as cylindrical silencers, baffle silencers and noise-reducing louvers. Onshore power supply is another solution, eliminating the need for power generation on board and thus the noise from the diesel generator, and reducing the need for engine room ventilation. Other sound sources in ports can also be mitigated by silent equipment, silent exhaustion pipes, insulation of sound-intensive components, quiet asphalt and sound-absorbent building materials. Much of the moving equipment in ports uses diesel; electrification would reduce noise and emissions. Electrification of rubber-tyred gantry cranes in Busan Port has reduced noise levels from 85 dB to 65 dB (OECD, 2011). Using cooling water instead of air cooling could also reduce the noise of port equipment.

Port layout and design can reduce the sound impact on an urban area. This includes overall port design and the planning of residential areas, roads and railways. A new approach to the passenger terminal in Livorno was modelled to reduce noise levels in the urban area with 5 dB-6 dB (A), due to a reduction of tourist traffic mingling with the regular road traffic (Morretta, Iacoponi and Dolinich, 2008). Measures within ports could include enforcing speed limits and reducing transport distances within the port. Other measures could include relocating the noisiest activities, such as entrance gates, and more drastically, berths or whole terminals. Port planning schedules could also take noise impacts into account. The noise generated by ships is sometimes asymmetrical, and it could make sense to berth a ship with the noisy side facing away from sensitive areas in the port. Ships could also be required to provide data about the noise they generate before calling the port, so that the noisiest ships could be berthed away from residential areas. This could be combined with financial incentives, charging ships higher berthing fees if they have high noise impact or do not provide noise impact information. Noise limits could also be part of port licensing schemes, as in Denmark, which encourages high-speed ferries that generate low frequencies in ports. Barriers between the noise and urban residential areas can also be used, including container racks in terminal yards and new non-residential buildings and trees. Such measures are most effective when the acoustic barriers are located near the source or the receiver. However, this is not always easy, as the barrier can interfere with the source, or because the urban population can object to barriers that are too close to residential areas.

Finally, measures can be taken to mitigate sound in urban residential areas. They can include insulating houses, sound-insulating windows, communication and neighbourhood groups. HafenCity, the urban transformation project in Hamburg located close to core port areas, provides one example of demand for mitigating noise emissions. In the areas immediately adjacent to HafenCity, a scheme of noise control has been introduced, capping night-time noise (between 10 p.m. and 6 a.m.) at three different levels, between 55 dB(A) and 63 dB(A), depending on the intensity of the land use. In addition, soundproofed windows and specific noise-accommodating alignment of buildings have been mandated to limit the impact of noise. These public regulations are complemented by a tolerance clause in property purchase agreements to avoid complaints or legal issues from residents who move to HafenCity (Merk and Hesse, 2012).

Such measures are most effective as part of an integrated action plan. This might include monitoring noise impacts and training for port workers to improve their sensitivity to noise. An integrated port noise management plan can have significant benefits: in Amsterdam, noise reduction of more than 30% could be achievable by implementing the action plans developed for the NoMEPorts project. There is no universal solution, as every port has its own characteristics, such as the position and height of noise sources, the distance from surrounding urban residential areas, orientation toward potentially affected areas, operation hours, distribution of buildings and screening elements and the volume of activity in the port.

Other impacts

One of the traditional ways of limiting other negative impacts from the port has been to create buffer zones. This restricts urban development to within a certain distance of the port area, because of its noise, emissions, visual impact or dust. These buffer zones can consist of nature compensation (in many European ports, this is incorporated in new port development), golf courses (as in Helsinki) or areas with mixed development, such as creative workplaces (as in Amsterdam) or maritime training institutes (as in Rotterdam). In practice, many ports have experienced urban encroachment that has limited the port's expansion. A new urban area may appear not to limit the physical space of new port development, but does in fact given the noise and air quality concerns and regulations.

Another approach is to allow the co-existence of port and urban functions, but to somehow find measures to mitigate the direct impact for citizens. This can be either on the port areas through measures such as dust covers, sound wall exhaust filters, and in urban areas, for example through building codes requiring double-glazed windows. Several ports in the United States have provided citizens living in communities close to the port with some form of monetary contribution, by means of compensation for negative impacts and in order to finance home improvements that could limit the impact of port activity. An alternative form of such a measure is the Amsterdam Covenant Fund, financed by housing projects close to the port area, to enable port-related companies to reduce the nuisance of noise, odour, and air- pollution. In several instances, the port also acts as a sort of urban redevelopment agency, helping to transform port-city buffer areas.

Trans-boundary co-operation

Trans-boundary issues such as pollution and climate change are often dealt with in international venues such as the United Nations and the IMO. However, in many maritime regions of the world, ports and port-cities are co-operating across national borders to develop regional responses to collective challenges. Co-operation between local authorities such as port authorities and municipalities can provide solutions tailored to the scale of the impacts, regional trans-boundary co-operation can provide a new scale for action in the attempt to regulate the relationship of ports and shipping and their environment.

Transboundary co-operation and networking can help port-cities respond to environmental problems that cannot be resolved without the participation of all parties concerned. This has proven important, for example, in environmental protection in the

Baltic Sea region, which has a history of ministerial and sub-national co-operation that preceded EU involvement. In response to the fall of the Soviet Union, the Council of the Baltic Sea States was created in 1992. It was around this time that ministers from Baltic Sea states began co-operation on the VASAB (Visions and Strategies in the Baltic Sea Region), initiated by the Swedish government at the Karlskrona Conference in 1992. This proposal, which was incorporated at the EU level through the European Spatial Development Perspective (ESDP) in 1999, provided a set of shared visions for developing the region looking towards 2010, and it set the stage for the creation of a regional fund in 1997 (Interreg IIC), whose three main priorities were the promotion of inter-urban networking, improvement of transport and communication links, and integrated maritime management. The European Commission developed its first strategy specifically aimed at fostering transnational co-operation in the Baltic Sea region in 2009, following a mandate issued by the Council in 2007. This strategy and subsequent rounds of funding for the Baltic sub-region have given rise to a plethora of co-operative initiatives amongst neighbouring Baltic port-cities. Many of these have sought to align interests around collective resources. The Baltic Metropoles Network, for example, has implemented the Clean Baltic Sea Shipping project, involving a clean shipping strategy and six pilot projects, and various initiatives aimed at financing and promoting innovation and SMEs.

At the European level, the exchange of best practices by environmentally forward-looking ports is facilitated by the Eco-Ports Network, set up through the European Seaports Organisation (ESPO). Eco-Ports features two main instruments that facilitate information sharing and monitoring amongst European ports that aspire to lead the way in terms of environmental impact. First, the Self Diagnosis Method (SDM) is a methodology used by all the member ports to identify environmental risks and develop action plans. The SDM provides port authorities with an easy-to-use, comprehensive checklist for comparing their performance with European and international benchmarks. Secondly, the Port Environmental Review System (PERS) is a recognised environmental management standard specific to the port sector. It incorporates the main requirements of widely used environmental management standards such as ISO 14001, and allows for independent certification.

Land use

Mitigating negative land use impacts is of crucial importance in modern port-cities. As cities grow, alternatives to port land use emerge, often leading to conflict over the extent to which prime urban land should be used for port functions. Solutions for these land use conflicts can be summarised under three headings: increasing ports' land productivity, port relocation and alignment of port and city land use plans.

Ports' land productivity

Land productivity rates among ports differ widely, indicating the potential that many ports have to become more land productive. The average number of TEUs per hectare per year was 49 005 in Southeast Asian container terminals run by international operators and only 9 303 in North America (Drewry, 2010). Our own calculations indicate that the land productivity in Hong Kong might be approaching 60 000 TEU per hectare per year. Such statistics may be deceptive, because container terminals in some regions include certain functions that would not be counted in other regions. For example, many US container terminals have devoted large shares of their land to rail yards or ancillary facilities that would not be counted in Asian or European terminals; corrected for this, average land productivity rates could double (Tioga Group, 2010). However, even taking a net terminal area, the scores of North American terminals are far lower than those of Hong Kong and Singapore.

Higher land productivity for ports can be achieved through planning, regulation and relocating non-essential functions. Higher densities can be reached by changing the design and layout of terminals, sometimes using landfill, to create longer quays and a larger terminal surface that makes the terminal exponentially more productive. Certain container terminals manage to stack containers more than five high in their transfer area, thanks to superior yard planning. In Hong Kong, multi-storey warehouses have been erected to rationalise space. Such an approach requires changes in local regulation and building codes; and even in Hong Kong, the boundaries of what is legally allowed have been reached. Another approach would be to de-localise functions that do not need quay access; in various ports non-port-related firms have been granted land with access to water. As urban port land becomes scarcer, the port may reserve future land for purely port-related functions, while relegating other functions to other areas.

Port relocation

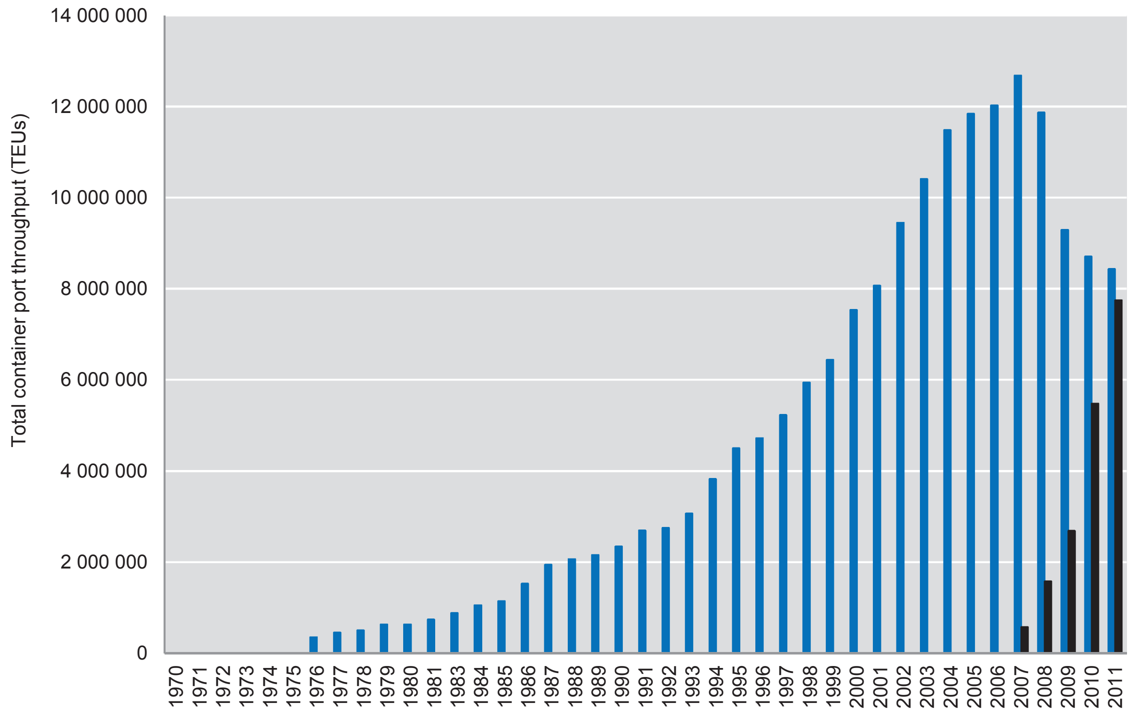
An important part of port modernisation is relocating ports to new sites. This is to some extent inevitable if both the city and port are growing, which leads to new assessments of the ideal location of the port. A location that might have been excellent a few decades ago can be constrained by ongoing urbanisation, facing resistance to negative impacts on the one hand and opportunity costs of port land use on the other hand. At some point, both the port and the city have an interest in relocating at least part of the port to a site with less opportunity costs that offers the port more possibilities for expansion.

This process is complicated by sunk investments and long-term contracts with private operators. It can take place gradually, with port activity gradually shifting towards newer facilities, or radically, if announced far enough in advance (as in Singapore). Table 5.7 provides an overview of ports that have created a new port site, in addition to the existing city-port; in practice many of these new port sites, located away from city centres, manage to capture a lot of the port traffic from the city-port site, as illustrated in the case of Busan (Figure 5.1). A radical re-location is evidently also easier to decide if the old port is no longer very active or if terminal equipment has been written off, as was the case in Helsinki (Merk, Hilmola and Dubarle, 2012). Relocation of ports can be facilitated by land swaps, with ports giving up some of their land in urban cores in exchange for new land for port development. This can become a source of conflict if urban and port interests are not aligned, and if the port fears that current industries might move to other sites than the new port sites.

Table 5.5. Multi-site ports

Old city port	New port site
Busan	Busan New Port
Shanghai	Yangshan
Rio de Janeiro	Sepetiba
Marseille	Fos
Kolkata	Haldia
Bremen	Bremerhaven

Figure 5.1. Busan: The relationship between the old and new ports



Alignment of port and city planning

Alignment of planning is essential to resolve the port-city mismatch. It guarantees that port and city mutually reinforce rather than oppose each other, and can be expressed in common master plans and aligned land use planning. Policy alignment depends on different variables: the role of port authorities, functions of cities, the involvement of cities in their ports, the role of the national government, the involvement of the port in urban development and finally, the way in which strategic planning is used to involve stakeholders.

A common master plan for port and city

To ensure cohesive and mutually beneficial growth, some port-cities have adopted visions, strategies and plans jointly drawn up by the port authorities and local government. Common master plans can cover various scales, from the project level, to the city, to strategies for much larger regions. The main advantage of such plans is that they provide parameters for long-term decision-making that are visible and clear for all parties concerned.

A port-city is a complex territorial, social and industrial organisation, whose developmental trajectory is determined by a number of actors. These range from local to national scales of government, and including private and public actors, each of which has a different set of interests and motivations (Jacobs, 2007). On the one hand, a coalition of actors and decision-makers seeks to provide for and plan the city, which entails the provision of quality public services, such as housing and transport, as well as support for inclusive economic growth and job creation. On the other hand, another coalition of actors and decision-makers plans and provides for the port, which entails development of infrastructure with sizeable land-use demands, helping to expand international trade through commercial incentives, and increasing the competitiveness of the port globally by capital investments in efficiency.

Because these two broad agendas are pursued in the same jurisdiction and space, competing for the same resources (land, transport networks, tax revenues and the environment), tensions may result. This is likely to arise when the institutional distance between the port governance and city governance is large, as when the port authority is fully national or private. In such contexts, joint master planning efforts help to avoid problems down the road. In providing a joint vision of the respective development of the port and the city, problematic areas can be identified and dealt with early on. Joint master planning often sets a new precedent for collaboration, facilitating future joint efforts. The Port of Valparaíso (Chile) has developed a Master Plan that has been incorporated in the UNESCO nomination document for the historical city centre of Valparaíso, which became a "World Heritage Site" in 2003.

It is possible to distinguish between two types of joint port-city planning exercises: ad hoc plans that last for the duration of a given project or initiative (Box 5.4); and institutionalised plans that provide a broad, multi-sectoral framework for future interactions (Box 5.5). Port-city master plans often coincide with a window of opportunity in which the ports and city's interests become unexpectedly aligned. Such master planning efforts should be distinguished from classic port-city interface trade-offs, in which the port agrees to cede some of its land to the city for waterfronts or docklands, often in exchange for the acquisition of new land from the city (see Waterfront development). Such waterfront trade-offs constitute a momentary deal, in which land is exchanged, but the interests of the port and city are ultimately kept separate. In joint master planning efforts, the city and the port engage in a more serious and lasting collaboration, often in recognition of their interdependence, and often with the city deliberately helping to facilitate the operations of the port, rather than simply reclaim land for its own commercial or electoral purposes.

Box 5.4. Oakland: A common port-city Master Plan to restore the waterfront

In 1999, the decommissioning of the Oakland Army Base (OAB) resulted in the loss of 7 000 local jobs and the dismantling of a significant economic asset. This dealt a serious blow to the urban economy. However, the closure also freed up 130 hectares of land at the cusp of the port-city interface, which was divided up and transferred to the Port of Oakland and the City of Oakland in 2003-06. For both parties, this initial transfer of land thus represented numerous opportunities. The port sought lands adjacent to the main rail connection, hoping to improve hinterland connectivity. For its part, the city sought land on the waterfront and in the northern portion of the former Army site. Many different options for this land were considered by the city, including the typical private-led waterfront redevelopment ideas (from a casino, to a shopping mall or film centre), which would have in no way benefited the port on an operational level. However, in recognition of the significant economic asset represented by its port, the city formulated an industrial development strategy in co-operation with the port, a logistics park developer (Prologis) and a real estate developer (CCIG). In 2011, this collaboration resulted in the common Master Plan for the Oakland Global Trade and Logistics Centre. The Master Plan, revised in 2012, aims to provide the Port of Oakland (the main export gateway for the Northern California region) with a world-class intermodal centre. To this end, the port land will feature a new intermodal rail yard, and the city's land will play host to 70 acres of logistics and trade facilities.

The results of the 2011 Master Plan have been positive for both port and city. Because the common planning and implementation of this project involved the pooling of resources and the sharing of costs between the port and the city (as opposed to the zero-sum exchange typical of waterfront trade-offs), the two parties have been able to leverage significant funding from both the federal and state levels that would not have been available had they applied individually. Moreover, the collaboration has set the stage for weekly project team meetings between city and port actors, increasing their capacity for working collectively. Finally, the Port of Oakland is governed by a board of commissioners nominated by the City Council, so the scope for port-city conflict is already reduced considerably.

Box 5.5. Durban, South Africa: Creation of a common vision for the port-city

In the port-city of Durban, the historical absence of co-ordinated planning for infrastructure has created a less than optimal spatial allocation for the links in Durban's logistical chain. The RORO facility is in the far north of the port, while the main manufacturing basin that contains South Africa's largest automobile plant (Toyota) is in the far south of the city, requiring intensive usage of the North-South artery by automobile shippers that competes directly with commuter traffic.

For many years, interactions between the port authority and the municipality in Durban were strained. Ports in South Africa are owned and operated by a state-owned enterprise, Transnet, and as a result, ports, are often managed and run independently from the cities in which they are located. In Durban, conflicting interests would most often become apparent when the port or the city attempted to implement projects that crossed one another's jurisdictions. For instance, the municipality would use statutory mechanisms such as urban zoning regulations to constrict the port's plans for truck movements around the port, using such regulations to force concessions in port-owned areas adjacent to the port.

As traffic increased, such tensions appeared untenable and provided growing momentum for a new approach to port-city relations. Coupled with a change in leadership, this impetus was institutionalised through the signature of a Memorandum of Understanding (MOU) between the city and port in 2003, which gave rise to what is now known as the Transnet and eThekwini Municipality Planning Initiative (TEMPI). The MOU established a Port-City Forum, whose purpose is to "develop a sustainable and pro-active planning and co-operative framework between the National Ports Authority (Port of Durban) and the eThekwini Municipality."

In 2010, the Durban International Airport was closed in favour of the new King Shaka International Airport, built to coincide with the FIFA World Cup. As in the Port of Oakland, this constituted a window of opportunity for the port and the city, freeing up a substantial amount of land in an area that was prime for brownfield development. Pressure from speculative developers became a catalyst for more joint action under the TEMPI framework, and in 2010, eThekwini and Transnet published their ambitious "2050 Vision" for a long-term development of the Durban-to-Gauteng Freight Corridor. The Vision provides a broad and long-term master plan with an integrated framework for the development of a new dig-out port at the former Durban International Airport site, and the provision of an extensive road and rail corridor between Durban and the Gauteng Industrial Basin. By providing a conjoint framework for long-term decision making, the 2050 Vision has helped align planning between the port and city. It was largely in response to this Vision that the City has formulated its new Back of Port Area policy, which lays out a new zoning framework in the urban areas directly behind the port, to better rationalise this space and improve the port's performance. For its part, the port has sought to remediate the problem with the location of the RORO terminal in its plans for the new dig-out port: a new automobile terminal will be built in the south of Durban, in direct proximity to the Toyota plant, which should help the city hold onto this crucial economic asset.

Port land-use planning

With many of the world's major ports under pressure from intense urban growth (Hall and Jacobs, 2012), land is a vital resource in port-cities. Port authorities endeavour to keep a tight watch over the land resources at their disposal, including assessments of its real estate value, the potential for land exchanges with the city, and, of course, possible acquisitions. Furthermore, land-use plans allow the port authorities to guide development: re-zoning can be used to rationalise port use by grouping similar activities; certain strategic sectors can granted privileged locations or advantageous lease structures; environmental compliance can be outlined and integrated into land use; and sectors that do not fit into the port authority's strategy can be gradually zoned out. Finally, land-use plans can constitute an important consultation mechanism for ensuring that stakeholders agree on the direction of future port developments. This can be particularly important for the urban planning department in the city, which must plan land use in the zones directly adjacent to the port perimeter. Used in this manner, land-use plans are often integrated into port development frameworks detailing capital expenditure projects. Although they are not always positioned as such, land-use plans are thus highly strategic instruments at the disposal of port authorities, and are reflective of a particular port's strategy.

Reducing road congestion in the port-city

Road congestion hinders a port's competitiveness, and is also a major nuisance to urban residents. The hinterland strategies indicated in Chapter 3 can help to reduce urban congestion, and their goal to provide for smooth traffic flows will also benefit citizens. The section below focuses on traffic flows within port-cities, in particular those at the interface of port and city. Two sets of policies are discussed below: port gate strategies and modal-shift strategies for hinterland traffic (Table 5.8).

Table 5.6. Overview of measures to reduce congestion

Policy strategies	Instruments	Examples
Gate strategies	Terminal appointment systems	New Orleans, Georgia Ports Authority
	Extending gate hours	Los Angeles, Long Beach
	Virtual container yards	Southern California
Hinterland modal shifts	Incentives	Germany, Switzerland
	Dedicated infrastructure	Valparaíso
	Competition hinterland modes	Germany

Gate strategies

One of the main port-related traffic mitigation measures concerns reduction of idle trucks at port gates. This is a challenge in many port-cities, leading to urban congestion. Possible policy instruments include terminal appointment systems, extending gate hours and virtual container yard systems. The section below assesses these instruments as applied in ports and port-cities. Simulation models have been attempted, but most have represented gate strategies as shifts in demand and have not combined those demand shifts with actual gate operations, so their results will not be discussed here.

Terminal appointment systems

The goal of appointment systems is to reduce road congestion at port terminals by giving preferential treatment to trucks that schedule an appointment. Appointment systems are intended to allow terminals to spread truck movements more evenly through the day. Terminal gate appointments are usually voluntary, but have in a few cases also been imposed by law. In 2003, the state of California passed California Assembly Bill (AB) 2650, requiring 13 terminals at the ports of Oakland, Los Angeles and Long Beach to create an appointment system or face a charge of USD 250 for each truck idling more than 30 minutes.

The results of terminal gate appointment systems can be positive. The Gate Entry Management (GEM)-system in the port of New Orleans and the WebAccess system of Georgia Ports Authority (GPA) are considered successful. Both are Web-based applications that allow dispatchers to schedule appointments and provide information for pre-clearance prior to truck arrival at the terminal. WebAccess allows customers 24-hour access to updated data on container shipments. These applications have improved traffic flow, increased terminal throughput and improved productivity for trucking companies and terminal operators, with a reduction of truck turn-around times by 30% on average in the case of GPA (US EPA, 2006).

The terminal appointment system in the ports of Los Angeles and Long Beach, however, is generally considered ineffective. The majority of the terminal operators did not view appointments as an effective operational strategy, and they did not facilitate their implementation. Only a small percentage of trucks used the appointment systems, and these appointments were not given priority, so queues were not reduced. In addition, terminals were not able to enforce appointments, drayage operators were not willing to participate in the programme, dedicated appointment lanes were lacking and the system was opposed from the outside. Similar truck idling bills have been introduced in Illinois, Rhode Island, Connecticut and New Jersey. For such systems to work, a large proportion of trips would need to use appointments and priority would need to be given to trips with appointments in order to realise significant time savings (Giuliano and O'Brien, 2007; Giuliano et al., 2008).

Extending gate hours

Extended gate hours attempt to redistribute the arrival times of trucks to port terminals throughout the day. Offering incentives to use off-peak hours is intended to reduce congestion at port terminals and on nearby roadways. The best-known example of extended gate hours is the PierPASS programme in the ports of Los Angeles and Long Beach, which includes a Traffic Mitigation Fee (TMF) for drayage transactions made during peak hours, with exemptions for off-peak hours.[5] The TMF fee is USD 50 during peak hours (originally USD 40), with exemptions during off-peak hours and for empty containers and intermodal transport using the Alameda corridor.[6] The Beneficial Cargo Owners (shippers, consignees or their agents) are responsible for the payment of the fee. Neither the trucking community nor the ocean carrier is assessed a fee under this programme. In addition to providing an incentive for the shippers to divert cargo to off-peak time periods, the TMF also serves to defray the additional costs incurred by the terminal operators for keeping terminal gates open at night and on weekends. Extended gate hours were also part of trial programmes in the Port of New York/New Jersey.

The instrument was effective in Los Angeles/Long Beach, but not in New York/New Jersey. The PierPASS programme was successful in reducing daytime truck arrivals from 90% to 66% within a few months after introduction (Cambridge Systematics, 2009), and it reduced daytime traffic on a nearby freeway by 13%. The average share of off-peak cargo from July 2005 to September 2006 was 40%, with an average rate of increase of about 8% per week. Little sensitivity to the fee itself was found, which suggests that adjustment costs, such as additional opening hours, more storage space for cargo etc., are the key factor in cargo scheduling (Giuliano and O'Brien, 2008). The programme was also received positively: drayage operators felt that extended operating hours of terminal gates had a positive impact on the overall efficiency of drayage operations, according to a survey (cited in Cao and Karafa, 2013). The only drawback of the programme was that ports experienced heavy queues just before the opening of the off-peak hours, due to a flaw in the design of the programme: a variable pricing scheme would alleviate this side-effect. In contrast, the pilot programmes carried out in the Maher Terminals and the Port Newark Container Terminal at the Port of New York/New Jersey were not considered to be a success. Only very few truckers were utilising the off-peak hours (7% of daily truck moves at Maher Terminals), despite the much shorter truck turnaround times (Spasovic, Dimitrijevic and Rowinski, 2009).

These differences in effectiveness could be explained by different market and political conditions. The Port Los Angeles/Long Beach was subject to persistent political pressure from the environmental lobby, and the port terminals were run by large shipping lines, which have more power to co-ordinate along the whole logistics chain. Cargo was predominantly handled for large national shippers, requiring less co-ordination efforts than the more fragmented customer base in New York. Moreover, few customers in New York are open at night and inland port distribution centres are limited, leaving truckers nowhere to go after picking up a container from the port at night (Spasovic, Dimitrijevic and Rowinski, 2009). Other conditions that contributed to the success of the programme in Los Angeles/Long Beach were the pressures of off-dock rail and congestion, as well as inter-port competition, with the risk that cargo could be diverted if terminal operations were inefficient (Cambridge Systematics, 2009).

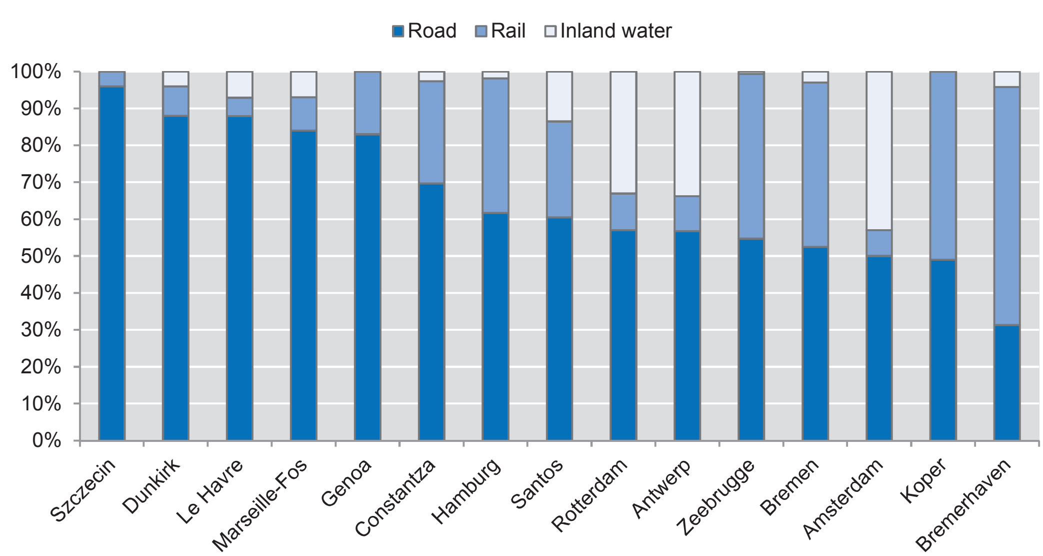
Virtual container yard systems

A virtual container yard system is a Web-based approach to matching tractors with trailers as they head back to the port, rather than returning empty. Returning with a load is called a street turn (Thompson and Walton, 2011). The typical rate of street turns in Southern Californian ports was estimated to be 2%, meaning that 98% of tractors return to the port without a load (Tioga Group, 2002). It is estimated that a virtual container yard system can increase the rate of street runs to 5%-10%, but not much higher, due to mismatch of location, timing, owner and commodity type. This means that even if the system is cost-effective as a tool to reduce emissions at ports, the maximum penetration of this strategy is likely to be low.

Modal shifts of hinterland traffic

Port-related road congestion can be reduced by shifting to other hinterland transport modes, such as rail, inland waterways, pipelines and short-sea shipping. In practice, the hinterland traffic of most ports is dominated by trucks (Figure 5.2). Even the ports with the highest shares of non-truck hinterland traffic rarely manage to achieve more than half of their traffic by means other than trucks. However, it is truck traffic that causes most of the congestion in and around port areas; and it is truck traffic that generally generates most external costs. Many ports have formulated targets in their strategic plans for a modal shift of hinterland traffic towards rail and water. This is not easy, because not all ports are connected to a well-developed system of inland waterways or of railway lines. As a result, the modal split shares of most ports tend to remain fairly stable. A variety of instruments might be applied, including incentive schemes, dedicated infrastructure and competition in hinterland modes.

Figure 5.2. Modal splits of port hinterland traffic



Incentive schemes

Port authorities and governments can apply a range of incentives to achieve modal shifts of hinterland traffic, to make port-related truck traffic relatively less attractive and other modes of hinterland traffic more attractive. Negative incentives can include tolls for trucks, and positive incentives include reduced port fees for cargo trans-shipped on barges.

Although various port-cities have introduced urban congestion charges, none of these were primarily aimed at reducing port-related truck traffic. The most widely cited urban congestion charges are those in Singapore, Oslo, London and Stockholm, all of which are considered to be effective in reducing urban congestion, and in facilitating the use of public transport (in the case of Singapore and Stockholm). Although trucks were included in these charges, no information is available on the extent to which these trucks were port-related. This means that it is not clear to what extent the urban congestion charge has resulted in a modal shift of port hinterland traffic or more evenly distributed port truck traffic over the day. It can be assumed that the effects are marginal. Some port authorities with a large set of responsibilities, in some cases including bridges and tunnels, have introduced tolls. In 2001, the Port Authority of New York /New Jersey introduced a new pricing structure for six bridges and tunnels, with tolls that varied according to time of day and payment technology. Assessment of this scheme indicates that 7.4% of passengers and 20.2% of trucks changed their behaviour in response to the time of day pricing: a significant shift in weekday peak-period traffic has been reported in the hours just before or after the peak toll rates are in effect (Holguin-Veras, Ozbay and De Cerreno, 2005). The new pricing scheme has helped to raise additional revenue for the intermodal investments of the port authority (Muriello and Jiji, 2004).

Various toll systems for trucks exist, some of which have the explicit aim to achieve modal shifts and increase the efficiency of truck traffic. Germany's truck tolling system (LKW-Maut) charges heavy trucks driving on the motorways based on distance, the number of axles and vehicle emissions (not weight). The system is considered successful in the more efficient use of truck trips, in addition to generating revenue and encouraging purchase of lower-emission vehicles. Switzerland has a truck toll, the LSVA, which charges trucks weighing over 3.5 tonnes, with rates varying by vehicle class and emissions. The fee is charged per tonne-kilometre, on the assumption that all trucks are fully loaded. This provision has encouraged trucks to take advantage of their capacity and operate more efficiently (McKinnon, 2011). The "Eurovignette" could also be considered a toll for trucks. This is a common system of user charges of heavy goods vehicles above 12 tonnes, operational in the Netherlands, Belgium, Luxembourg, Denmark and Sweden. This system allows hauliers, after paying a specified fee, to use the motorways of the participating member states for a given period (whether a day, a week, a month or a year). Unlike distance-based truck user fees such as the LKW-Maut, it is not related to the actual use of the road. Since the adoption of the directive 2011/76/EU of the European Parliament and the Council of 27 September 2011, it is possible to internalise externalities in the Eurovignette, *e.g.* by imposing a surcharge in peak hours, which might mitigate truck congestion in port-cities. However, the effects on modal shifts remain to be seen. Inter-operability between these different truck tolls (including the more traditional highway tolls in countries such as France, Spain and Portugal) will remain a challenge (Viegas, 2003) but increase the potential impact of truck tolling on modal shifts of port-hinterland traffic.

Various ports use incentive schemes to stimulate modal shifts. This can take the form of reduced port fees or handling fees for cargo trans-shipped to barges or railways, usually embedded in a context of broader national support for inland waterways or freight railway transport. Various ports also negotiate modal-split targets with terminal operators as part of terminal concessions, giving the operators and the shipping lines behind these an incentive to organise or accommodate more sustainable hinterland transport.

Dedicated infrastructure

Port authorities can influence the hinterland modal split by providing dedicated infrastructure. Some ports have developed dedicated short sea terminals, to promote short sea shipping as a sustainable hinterland mode. This will give short sea shipping-vessels more priority than is typical in common user terminals. Various ports have inland barge and river terminals, effectively connected to deep-sea terminals, to guarantee smooth trans-shipment between ocean-going vessels and barges. Finally, ports can plan for effortless connection between quayside and railway lines within the port, so that additional handling – which might be prohibitively expensive – can be avoided. The provision of this dedicated infrastructure for sustainable hinterland transport is far from obvious in many ports. In Le Havre, the new container terminal Port 2000 was constructed without adequate consideration of its links with inland waterways and railways (Merk et al., 2011; European Court of Auditors, 2012). Dedicated infrastructure for trucks will not lead to a modal shift, but might still be effective in reducing port-related congestion in port-cities. Since 2009, the Port of Valparaíso has been connected to a distribution centre via a dedicated tunnel for trucks, de-congesting major arterial roads in the city.

Competition in hinterland modes

Sustainable hinterland transport modes are in many countries constrained by lack of competition within these sectors. Short-sea shipping from one coastal location to another in the same country is often subject to restrictive cabotage laws, prohibiting this kind of cargo from being carried by foreign-flagged ships, vessels with foreign staff, vessels that were not constructed in the country, or a combination of these. Such laws have had a deterrent effect on short-sea shipping. The railway sector has been privatised in many countries, but wide differences prevail, even in EU countries subject to the same EU railway packages; it appears that countries with more liberalised railways also tend to have higher shares of rail in their port hinterland modal split (Merk et al., 2011).

Climate change adaptation in ports

Increasing awareness of the environmental context of maritime transport does not pertain solely to the impacts of transport on the environment, but increasingly includes awareness of the ways in which the environment impacts maritime transport. Strategies for adapting to the potential consequences of climate change are gaining traction, particularly given that the maritime frontier is at the forefront of many of the changes anticipated in climate-change scenarios (Becker, Fischer, Matson, 2010).

Seaports are particularly vulnerable to climate change, because of their location in coastal zones, low-lying areas and deltas. They can be particularly affected by rising sea levels, floods, storm surges and strong winds. In its Fourth Assessment Report, published in 2007, the IPCC estimated that the global average sea level would rise from 18 to 59 centimetres by the last decade of the 21st century (US EPA, 2008). Assuming a sea level rise of half a metre by 2050, Lenton, Footitt, Dlugolecki (2009) estimated that the value of exposed assets in 136 port megacities might be as high as USD 28 trillion. Ports will also have to consider anticipated sea levels not only for economic reasons, but also to prevent leaching of contaminants (US EPA, 2008). The severity of these impacts, however, will vary widely by geographical location and will be modulated by a number of contingent variables.

This uncertainty renders adaptation measures difficult, as public decision makers are most likely to act on conditions that they can already observe or easily foresee. One of the major impediments to the implementation of adaptation strategies resides in the discrepancy between port authorities' planning frameworks and the time span of climate change. The highly competitive nature of ports requires that they adapt quickly to changing business circumstances, whereas adaption to climate change requires planning on a time span of up to one hundred years. The typical lifespan of major port infrastructure, including docks and port terminals, is around 40 to 50 years, and many port authorities' planning horizons are even shorter, at 5 to 30 years (Becker, Fisher, Matson, 2010).

To cope with these challenges, many ports have begun to design adaptation strategies that attempt to plan on a longer timeframe. Some plans feature new land-use zoning frameworks, which have to be co-ordinated with authorities in charge of zoning, when the port does not have the competences to plan its hinterland (for flood risks, for example). Another strategy involves the co-ordination and training of agents involved in managing the port sector. The Office of Ocean and Coastal Resource Management of the US National Oceanic and Atmospheric Administration's (NOAA) has developed "Adapting to Climate Change: A Planning Guide for State Coastal Managers" to help federal and state coastal managers develop adaptation plans. Other plan-based strategies of this sort include data storage plans, emergency responses and recovery plans, and work-to-ID funding streams. These plans often involve practices such as drills and event reconstructions, simulation of post-storm actions, and storm preparations.

Design upgrades constitute another major adaptation strategy. These entail the elevation of structures and port lands above flood levels, or the reinforcement of structures on port land. Measures can also be taken off port land with breakwaters, flood barriers, or, in very extreme circumstances, the port can even be relocated (this is being considered by the Port of New Orleans as a retreat response [US EPA, 2008]). This aspect of adaptation is particularly emphasised in small island developing states, such as those in the Caribbean or Mauritius, where higher quays are required to avoid flooding (Barbeau, 2012). Adaptation measures can thus feature a mixture of protection, adaption or retreat.

All such adaptation efforts require research, including damage assessments, risk/vulnerability assessments, improvements in forecasting abilities and cartographic studies of flood-prone areas. Such tools enable ports to formulate better strategies ahead of the fact, rather than on the basis of traditional after-the fact analysis. The Port of Miami, for example, participates in the Miami-Dade Climate Change Advisory Task Force (CCATF), which recommended the creation of detailed elevation maps of the county (US EPA, 2008). Finally, ports may consider designating a single point person to manage and distribute information on climate change. This is not a technical answer, but it can help improve the efficiency of adaptive strategies.

Finally, it is worth noting that a spatial mismatch exists between climate change impacts and port jurisdictions. The impacts of climate change will occur at global and regional scales, while ports are traditionally responsible only for their own infrastructure.

Adaptation measures will therefore most likely require broader co-operation with multiple jurisdictions.

Today, most ports do not have comprehensive plans of adaptation strategies, and the international institutions such as the United Nations Framework Convention on Climate Change (UNFCCC) underline the urgent need to build common knowledge and take adaptive measures. Some ports, having taken stock of the issue, have begun co-ordinating regional-level responses. Port authorities should seek to co-ordinate with local, regional, and national bodies to address climate change adaptation, as these actors may help ports to define specific research gaps, produce the studies and data that they need, and possibly help with planning adaptation responses. Co-ordinated study efforts can lead to better response efforts. For example, the Port of Vancouver is part of a working group of the Climate Advisory Team (CAT) of the state of Oregon. Co-operation is thus not limited to local or regional co-operation, but can be extended to international circulation of ideas and best practices, as the UNFCCC projects aims to do (UNCTAD, 2011).

Mitigating security risks

Risk and the associated strategies for dealing with it (precaution, preparedness, resilience, adaptation, etc.), are increasingly important aspects of port policies. Increasingly, port operators must change their modus operandi to comply with new regulatory frameworks aimed at managing risk. Sometimes compliance involves a change in customs security procedures and protocols, which may directly affect throughput rates; sometimes compliance means that port actors must undertake the formulation of new internal "risk management" guidelines and security plans. This may require changes in port governance, such as the creation of oversight committees. The management of various kinds of risk in port-cities involves a complex set of interactions between local, national and international authorities, between the public and private sphere, and between geographically distant actors. As a result, the networks of actors with whom port actors must interact are widening as they attempt to recognise, assess and respond to various kinds of risk. Recent phenomena of worldwide significance have led to the introduction of new risk governance logics in port systems. All of these go beyond or expand upon the traditional focus on supply chain security in the maritime sector.

Firstly, a number of regulatory changes and new policies have been introduced in response to the terrorist attacks carried out against the United States on the September 2001, whose direct consequences for port operations worldwide are still making themselves felt. Some of these are specific to the operation of container ports and customs procedures. The November 2001 Customs and Trade Partnership Against Terrorism (C-TPAT), the 2002 Container Security Initiative (CSI), and the 2006 Security and Accountability for Every Port (SAFE) Act, for example, were part of a range of supply-chain security policies introduced by the United States after the attacks. These were widely adopted through multilateral agreements by states around the world in the months that followed their introduction. At an international level, the International Maritime Organisation (IMO) drastically sped up development of the 2004 International Ship and Port Facility Security Code (ISPS) in reaction to the attacks. Many countries (including the EU member-states, the United States and the United Kingdom) have already taken major steps towards implementing this legislation, which details a range of specific security requirements for shippers, port authorities and governments. Moreover, individual port authorities are increasingly seeking to comply with international risk management standards published by the International Organization for Standardization.

Most ports in New Zealand and Australia, for example, have put in place internal risk-management systems that are aligned with the Australian/New Zealand Risk Management Standard AS/NZS ISO 31000:2009.

For many ports, the implementation of new national and international risk management policies brings a range of challenges. For example, relations between public and private actors can be delicate: sometimes the formulation of security standards is left to the discretion of private operators, making harmonisation difficult. Moreover, compliance can be an issue, because it comes at a cost: new exigencies concerning container scanning, manifest forwarding, tracking and the security environment of the container all involve initial and ongoing burdens for shippers and operators. Nevertheless, the costs of non-compliance are potentially greater: regardless of whether non-compliant actors actually put their supply chains at greater risk, they are perceived as more risky by other potential business partners, and may severely jeopardise their trade relationships by refusing to adopt new security standards. While many studies have sought to assess the costs and benefits of increased supply chain security, the full effects of such policies are only now becoming apparent.

Some of the effects of this new risk climate on the port sector, however, have been more immediately felt. In 2006, for example, the US Congress blocked a deal in which P&O sought to hand over terminal operations at six US ports to the United Arab Emirates-owned Dubai Ports World (DPW). Even though this agreement had received approval from the executive branch, Congressional actors introduced legislation to delay the sale, citing gaps in intelligence surrounding the operations of DPW as a potential source of risk to the security of US ports. After much debate, DPW eventually ceded the sale to AIG, which bought the operation contracts for an undisclosed sum. This is only one example of how the emergence of a new risk environment is altering the dynamics of the ports and shipping industry.

In addition to new risk-management policies that are specific to the maritime and ports sector, the regulatory framework governing port operations has been further altered by a set of trans-sectoral policies introduced in the aftermath of 9/11. So-called Critical Infrastructure Protection (CIP) policies are one such example. Introduced in many OECD states around the world during the period 2001-10, CIP policies seek to integrate a range of sector-specific security initiatives into one unified national (or even supra-national, in the case of the EU) protection strategy. In contrast to "public utilities" denoted through reference to concrete objects (bridges, roads, dams, pipelines, etc.), "critical infrastructure" tends to be defined in the negative, in terms of the material and immaterial systems without which society and the economy could not function. In nearly every CIP policy – from the EU's European Programme for Critical Infrastructure Protection, to Australia's Critical Infrastructure Resilience Strategy, Germany's *Nationale Plan zum Schutz Kritischer Infrastrukturen* and the United States' National Infrastructure Protection Plan – ports are included as a vital part of a broader infrastructure sector, variously referred to as the "maritime transport system", "freight and logistics", the "shipping and postal sector", and so on. Such policies have generally focused on the trans-sectoral and trans-jurisdictional interdependencies between infrastructural systems. In the EU, for example, critical infrastructures such as energy grids and rail-based freight networks span multiple countries: failure in one sector or in one national jurisdiction can "cascade" into others. Canada's CIP policy has pointed to ports as a site in which infrastructure failures could cascade or be amplified, due to sectoral interdependencies such as intermodal transfers to road networks, or the concentration in the port of petrochemical facilities that service the energy needs of the economy. Given the preeminent economic role of maritime ports in facilitating the import and export activities upon which the economic health of many nations depends, port actors are increasingly included in the formulation, implementation and review of such policies.

The concrete instruments that are used by government and port actors to implement new risk governance policies of course vary greatly according to the kind of risk that is being dealt with, and the institutional context of the given state. Nevertheless, it is possible to trace several prevailing trends in the kinds of instruments employed as part of risk governance strategies at the international, national and port levels.

The first and most obvious set of instruments used to bring about changes in the risk governance in the ports of the world is the modification of the regulatory framework that sets the rules for actors' behaviour in port environments. This has involved the promulgation of new standards focusing on ports, such as the International Ship and Port Security Facility (ISPS) code. More recent standards have focused on the resilience of the supply chain as a whole. The 2011 ISO 28002:2011 (Security management systems for the supply chain – Development of resilience in the supply chain – Requirements with guidance for use), for example, reflects a new trend proceeding beyond "risk prevention" towards enhancing the organisation's "capacity to manage and survive any disruptive event and take appropriate actions to help ensure its viability and continued operation".

The reform of customs procedures worldwide has also functioned as a key instrument for instituting new risk-governance norms. Some such reforms have visibly altered the rules governing the behaviour of port actors around the world. New Advanced Manifest rules – such as the 2002 US Customs 24-hour Advance Vessel Manifest Rule, Canada's 2004 24-Hour Advance Commercial Information Rule, China's 2009 Customs Advance Manifest regulation and the 2011 EU Customs Advanced Manifest Rule – make it incumbent upon shippers to provide detailed reports of container contents sometimes up to 24 hours before the goods arrive at their port of destination. In US ports, failure to comply with this rule can result in penalties, fines and even supply chain disruption in order to unload non-compliant cargo.

In addition to such regulatory instruments, a mix of voluntary schemes has been used to implement new risk governance policies in ports. So-called "secure trading schemes" are one such instrument. The New Zealand Secure Exports Scheme (SES), for example, is a partnership offered by the public customs authorities, into which various private stakeholders can enter in order to benefit from less customs intervention and higher export priority. In return, shippers must commit to co-operation on data sharing and certain security standards. Private-led initiatives include the Transported Asset Protection Association (TAPA), an association bringing together professionals from the security sector as well as shippers in order to produce standards and certification relating to supply chain security, and the Business Alliance for Secured Commerce (BASC), a voluntary co-operative measure between US Customs and the private sector, aiming at combating the use of legal trade to undertake smuggling and trafficking.

The creation of information-sharing networks is increasingly being used as an instrument for the implementation of risk governance frameworks in ports and beyond, especially in countries that have formulated so-called CIP policies (the United States, the EU and Australia have all created such networks). Networks for sharing information on threats and disruptions between private and public actors at multiple scales are seen as a crucial platform for co-ordinating the many different interests that must be brought together to increase risk-governance capacities in and around port infrastructure. These networks also promote planning for adverse events across sectors, involving increasing co-operation between port authorities, national security agencies and private operators, in order to put in place response strategies and contingency plans.

Finally, the recognition of ports as “critical infrastructure” has increasingly led to the prioritising of resources towards such infrastructure. For this reason, competitive grant programmes constitute one key instrument for implementing new risk governance policies in port zones. The United States, for example, created its Port Security Grant Program (PSGP) in 2005. Administered by the Federal Emergency Management Agency (FEMA), the PSGP is an example of so-called “risk-based funding”, whereby 48 port areas have been grouped into different categories of risk, and receive differential priorities for funding on this basis. The seven ports that fit into Group 1, for example, are eligible for funds that many other ports (deemed less risk-prone) are not. The budget of the PSGP has been around USD 300 million every year, and aims to “support increased port-wide risk management; enhanced domain awareness; training and exercises; expansion of port recovery and resiliency capabilities; and further capabilities to prevent, detect, respond to, and recover from attacks involving improvised explosive devices and other non-conventional weapons.”

Notes

1. These “Regulations for the Prevention of Air Pollution from Ships”, adopted in 1997 and entered into effect in 2005, plays the most direct role in regulating the emissions of the shipping sector globally. With 72 contracting parties as of 30 June 2013, Annex VI covers 94.3% of the world’s tonnage.
2. Annex I: regulation 38; Annex II: regulation 18; Annex IV: regulation 12 (12bis); Annex V: regulation 8; and Annex VI: regulation 17.
3. IMO Resolution A.468 (XII), “Code on noise levels on board ships”, 1981; IMO Resolution A.343 (IX), “Recommendation on methods of measuring noise levels at listening posts”, 1975.
4. Directive 2002/49EC.
5. Peak hours are 3 a.m. to 6 p.m. (Monday through Friday); off-peak hours are 6 p.m. to 3 a.m. (Monday through Thursday and 8 am to 6 p.m. on Saturday).
6. Other exemptions include domestic containers and trans-shipments to other ports.

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Chapter 6

An effective policy mix for port-cities

The appropriate policy mix for a specific port-city depends on its local assets and characteristics. Despite the need for tailor-made policy design, a few generic lessons can be identified. An assessment of port-city policies shows the effectiveness of transport-related port-city policies, provided that policy coherence is respected.

Choosing an effective strategic policy must be informed by a clear assessment of existing local assets. Economic history is to a large extent determined by path dependency, and heroic, if not always successful, attempts to change existing trajectories. Not every port-city or every maritime nation can or should stake its economic development on the growth of its maritime cluster, if only because there can only be a few leading global maritime clusters in the world. Various port-cities have invested in heavy industrial development, which provides them with certain assets but also involves sunk investments that can limit alternative economic development. Similarly, not all port-cities can develop a successful waterfront, because success is defined by how well it can divert visitors, high-earning residents and investors away from other urban waterfronts. Only rarely, as in Bilbao and Bremen, have radical conversions of the economic destiny of a port-city had unqualified success. Looking for an effective policy mix is a delicate balancing act between building upon existing strengths and developing new assets and capabilities.

The typical port-city does not exist; rather, there is only a collection of port-cities with various characteristics and heterogeneous opportunities. Concrete impacts and implications differ depending on local circumstances, on the character of the port-city interface and the functional composition of the port and its city. Large-scale industrial development on or close to port sites requires a huge amount of bulk goods, generally associated with fairly limited job intensity, a variety of environmental impacts and strong local economic linkages. Container traffic has similar low job intensity, fewer local economic linkages and environmental impacts related to shipping and hinterland traffic, but overall less polluting impacts, because the connected economic activity is less industrial. Maritime business services generally generate high value added and limited environmental impacts, but are connected to large ports or large metropolitan areas. Cruise shipping is less space intensive than most other port functions, but the economic value it generates is fairly limited unless it is linked to a port-related waterfront. However, it can have relatively severe environmental impacts (emissions, noise) especially if terminals are close to city centres, which is frequently the case.

What makes a port competitive?

Recent studies have emphasised how important ports are in global supply chains. Their effectiveness depends ultimately on how they link up with these chains both by sea and by land, and also how port operations are aligned with shipping and hinterland transport. Four complementary areas competitive ports can pursue have been presented here: maritime connectivity, effective port operations, strong hinterlands and cultivating local goodwill. Ports with good practices in one domain tend to perform well in others, as in the case of Rotterdam. The continuing increase in ship size calls for better hinterland connectivity, whilst the trend towards port concentration makes local goodwill an important part of sustaining ports' functions close to cities. However, much depends on local circumstances. Some factors are exogenous, such as geographical location and to some extent nautical access, but even these are subject to change for example in the case of the future navigability of the Arctic seas. Port authorities have an important role to play in improving ports' competitive position, with the help of other actors, including national governments and cities. The area is relatively well researched: the determinants for competitive ports are known and identified, even though it is not always clear what this should mean in terms of concrete policies. Our study indicates that, in general, port policies have a positive impact on value added and economic performance.

Synergies between ports and cities

The interaction between ports and their cities is complicated by a series of policy dilemmas. Port authorities and city governments do not necessarily have the same interests, goals and perception of challenges and policies needed (Table 6.1). Typically, port authorities are concerned with cargo handling and ways to grow in this respect. Their priorities for transport investments are freight transport networks, efficiency of port labour, and land use dedicated to cargo handling and port-related industries. From the environmental perspective, their interest is to limit negative impacts. An urban government is not principally interested in port volumes, but in the value added it generates for the city; not in efficiency of port labour, but in the number of jobs that it can generate, preferably high value added jobs. Cities will generally have a wider set of challenges to address, including housing and urban transport, both issues of relevance to their constituencies, so they tend to prioritise urban passenger transport and have an interest in redeveloping urban waterfronts into housing areas. Environmental policies they favour extend past merely limiting impacts, toward marketing quality of life as one of their city's competitive advantages, as in Copenhagen, which promotes the swimming facilities in its harbour. The challenge for port-cities is to find synergies between the two perspectives, for example by introducing smart, selective goals for port growth, attracting high value added port employment, using the port as a site for green businesses and developing mixed urban waterfronts with room for port functions. This report has referred to numerous examples of such policies and related instruments.

Table 6.1. Policy aims for typical ports and cities

	Port	City	Port-city
Economic	Port volumes	Value added, diversification	Smart port growth strategies Maritime clusters
Transportation	Freight	Passengers	Dedicated freight corridors or smart co-existence of freight and passenger traffic
Labour	Efficiency	Employment	High value added port-related employment
Environment	Limit impacts	Quality of life	Green growth
Land use	Cargo handling, industry	Urban waterfront as opportunities for housing	Mixed development, with a role for port functions
Structural logic	Closed industrial cluster	Open networks with pure agglomeration effects	Mix

Increasing local economic benefits from ports

The three main economic policy models for port-cities that we have identified (maritime clusters, industrial development and urban waterfronts) have different orientations, but are often simultaneously pursued in the world's largest port-cities. Some of these functions are easier to combine than others. Maritime clusters and urban waterfronts can reinforce each other, as both models are being pursued by increasing urban attractiveness; urban amenities for maritime professionals, tourists and local population could be complementary and synergetic. However, a successful marriage between industrial development and maritime clusters is not as easy to achieve, thanks to the fundamentally different logic that informs them: industrial clusters are networks that are generally only open to suppliers and industry-related actors, whereas the agglomeration effects necessary for a thriving maritime cluster will benefit from a larger extent of openness (Box 6.1). However, port-cities such as Singapore and Hamburg have managed to combine the three strains, through a judicious choice of policies.

Box 6.1. The different clustering effects in ports and cities

Spatial clusters, where companies in a given economic sector decide to locate in proximity to one another, can be classified into three different groups, with different characteristics of relations between firms and knowledge spill-overs (McCann and Sheppard, 2003; Iammarino and McCann, 2006):

- **Pure agglomeration:** Metropolitan areas can be considered engines of growth thanks to economies of agglomeration. The assumption is that people and firms tend to cluster in metropolises because of the positive knowledge spill-overs that result from interaction between individuals. Firms in such a constellation typically have no market power, and will continuously modulate their interactions with other firms and customers in response to market arbitrage opportunities, leading to intense local competition. Loyalty between firms, and long-term relationships, are difficult to establish in these circumstances. The cost of the membership in this cluster is the local real estate market rent. There are no free riders, access to the cluster is open and the price that local real estate can command is a benchmark for the cluster's performance.
- **Industrial clusters**: These typically involve stable and predictable relations between the firms in the complex, involving frequent transactions. To become part of a cluster, firms each undertake significant long-term investments, particularly in physical capital and local real estate. Access is restricted by high entry and exit costs: the rationale for clustering is that proximity will minimise transport transaction costs between firms. In this context, a few large firms dominate the market. These often feel that outflows of knowledge to their industrial rivals can be costly in terms of lost competitive advantage. Such firms prefer to locate in industrial complexes with stable, planned and long-term relationships.
- **Social networks**: This third type of spatial cluster relies on mutual trust. Such relationships are manifested in a variety of ways, including joint lobbying, joint ventures, informal alliances and reciprocal arrangements. Relations of trust are assumed to reduce inter-firm transaction costs, because they minimise the problem of opportunism.

These models are theoretical ideal types, not intended to represent any particular location, but such classifications can clarify the challenges facing ports and port-cities. Large ports, especially those connected to heavy industries and specialised in containers and oil products, mostly fit the industrial complex model, with an oligopolistic firm structure, high entry and exit costs and a relatively closed character, which prevents leakage of strategic knowledge. Major port-cities like New York, Singapore and Hong Kong can combine these two imperatives, but the situation is more complicated in smaller port-cities such as Le Havre, and also to a certain extent in Rotterdam. Rotterdam has introduced economic diversification but struggles with relatively negative perceptions of its urban attractiveness. The challenge for cities like Le Havre is to compensate for its relative "closedness" due to the port cluster by building regional networks, with Paris among other places, to develop a larger mass of "pure agglomeration" effects.

The room for manoeuvre for public policies should not be overestimated in the market-driven environment of global shipping. Many of the linkages between producers, customers, suppliers, labour markets, training institutions and intermediary services that compose a maritime cluster or other port-related development form through necessity and a response to market signals that governments can hardly foresee or influence (Uyarra and Ramlogan, 2012). It is not certain that policy intervention is always an effective or necessary component of maritime cluster growth (Doloreux and Shearmur, 2009; OECD, 2009).

Moreover, not every declining sub-sector can be saved. While renewal of declining maritime clusters has been possible in countries such as Norway, where niche specialisation and cost-reduction through targeted outsourcing helped to breathe new life into an ailing shipbuilding sector, policy focus on declining sectors is not always desirable. This is of particular relevance to industrial development policies. Many port-cities in developed countries have been confronted with outsourcing of heavy industries and refineries. A proper understanding of needs and possible transitions is thus a prerequisite for any policy formulation.

Policy initiatives can be effective if their underlying rationale is grounded in a response to a real and problematic deficiency in the status quo. Underinvestment into emerging markets, where potential for growth has been identified but is not being exploited due to private sector reluctance, might indeed be remediated by the provision of public funds for R&D. An obvious lack of qualified labour in industries could be at least partially resolved by publicly promoted partnerships between training institutions and maritime firms. Firms with similar needs that do not interact or represent their interests collectively as part of shared marketing or lobbying strategies, might collaborate more effectively through complementary spatial planning frameworks or publicly created networking platforms. When a key component, such as the registration of shipowners, of the maritime cluster is in decline and this is bringing down with it the firms dependent on the demand generated by that component, targeted regulatory or fiscal intervention at the national level may slow down or reverse such a decline. Successes include Quebec's "Innovation Maritime", which has carried out 200 R&D projects for the maritime sector with government grants; and publicly sponsored educational partnerships through the industry-led Deltalinqs platform that have helped to turn Rotterdam into a leading centre for maritime expertise; the UK's tonnage tax has been credited with contributing to the growth in UK-registered and -owned fleets, not to mention the employment opportunities linked to the in-built training requirement of this policy.

Policy initiatives must be adapted to the maturity of the sector. Developmental support, such as incubator infrastructure or the provision of venture capital, can be vital for emergent clusters, as in the case of Los Angeles' PortTech industrial park, which has helped set up a clean port energy cluster. However, this cannot help clusters that have already matured or are in decline. Similarly, it might make sense for countries with large maritime clusters to engage in expensive measures to protect their fleets from competition by other flag states, such as the provision of Vessel Protection Detachments to protect at-risk vessels, but this expense cannot be justified by maritime nations that do not stand to gain from increased vessel registries (or to lose from deflagging). Similarly, it can make sense to assist with internationalisation of markets where clusters have matured, or to institutionalise inter-sectoral interactions where such linkages have begun to emerge, but global competition can imperil markets that are not mature enough to handle expansion, and interactions between sectors with little need of collaboration cannot be forced.

The composition of economic functions is highly relevant to all three strategic policy options. The most successful maritime clusters, such as London, Singapore and Hong Kong, are those that have developed into well-rounded and diverse clusters. Their diversity attracts new businesses because they can be guaranteed to find high-quality services in any maritime-related branch. Some maritime clusters, such as Rotterdam, have developed policies to benefit strong sub-sectors within that cluster, but need to expand into underdeveloped sectors in the cluster (Merk and Notteboom, 2013). Development of new industrial functions in port areas is hugely dependent on the existing industrial infrastructure that determines the potential for exchanging residual products. Mapping current and potential links can help identify gaps in commodities or infrastructure that can help create new economic opportunities. The mix of economic functions is also key in determining if urban waterfronts can attract visitors and create economic wealth.

Mitigating negative impacts

A variety of types of policy instruments can mitigate negative port impacts, from regulation to market-based incentives, information and technology upgrades. Many of the policy choices made will depend on the local situation, but the most convincing examples of policy performance involve a coherent package of inter-related instruments, such as those used in Southern California for the San Pedro Bay Ports Clean Air Action Plan (Box 6.2). Mitigating negative port impacts requires the interplay of different levels of intervention, ranging from the local on up. Given the nature of the shipping industry, some environmental impacts of shipping are best tackled at the global level. Self-regulation of ports can work, but in most cases, external pressure is needed. Some port-city policies entail join benefits. For example, reducing port-related traffic congestion has positive environmental effects; and modal shifts of hinterland traffic not only improve environmental performance but can also reduce traffic within the city. Policy trade-offs, for example between security and commercial concerns must also be taken into account.

Box 6.2. San Pedro Bay Ports Clean Air Action Plan

The San Pedro Bay Ports Clean Air Action Plan (CAAP) is a comprehensive strategy to reduce air pollution emissions from port-related cargo movement. The two San Pedro Bay ports, the largest seaport complex in North America, are also the single largest source of pollution in Southern California, according to the South Coast Air Quality Management District (SCAQMD). In 2005, the twin mega-ports of Los Angeles and Long Beach generated approximately 25% of the diesel pollution in the region (O’Brien, 2004). The CAAP aims to address the problem of the ports’ growing operations and their increasing environmental impact. Its goal was to dramatically reduce emissions and associated health risks for the region without upsetting the continuous port development. The plan was first approved in 2006 and updated in 2010. Near-term plans through 2014 and long-term goals include reducing port-related emissions by 59% for NO_x, 93% for SO_x and 77% for DPM by 2023 and meeting standards to lower the residential cancer risk in the port area from diesel particulates. Under the plan, the twin ports have developed annual emission Inventories, which are made public, to track progress in achieving CAAP standards. The CAAP uses a combination of regulations, fees, grants and incentives to the cargo industry to promote cleaner technology and operational systems, such as the Clean Truck Program, the Vessel Speed Reduction Program and the Alternative Maritime Power Program. To support the development and demonstration of clean-air technology, the ports have also jointly created a Technology Advancement Program that has provided more than USD 9 million in funding to the industry since 2007.

The latest analysis in 2011 indicates that the two ports have substantially reduced the key air pollutants from port-related sources since 2005, including a 71% and a 75% reduction in airborne diesel particulates, respectively. Several pillar programmes have significantly contributed to reducing air pollution at the two ports, including the Clean Truck Program (CTP) and the Vessel Speed Reduction Program (VSR).

The CAAP marks a milestone for the port industry in mitigating the environmental impact of maritime operations. The plan was a co-operative venture, and the two ports initiated the concept and brought along industry stakeholders and agency leaders (Giuliano and Linder, 2011). The key factor in its success is the co-operation of port users, including terminal operators, truckers and shippers, as well as the support of federal, state and local regulatory bodies and local communities (Mongelluzzo, 2012). The ports were also under considerable social pressure. Community concern over the health risks of port-related diesel emissions had grown after a series of air quality studies was published on the correlation between cancer and respiratory disease rates and proximity to freight-movement corridors. Cargo volumes rose through 2004, in an expansion of capacity at the two ports, and public opposition, including a series of lawsuits, made plans for expansion difficult if not impossible. Political pressure for increased regulatory oversight also prompted the ports to respond to public dissatisfaction over air quality. This ultimately led to the adoption of a comprehensive plan. The CAAP was portrayed as a solution to build the credibility of the ports to obtain agreements on future projects as they engaged all the key stakeholders. One study describes the CAAP as “a response to the loss of social legitimacy and to social and regulatory pressures that were restricting the ability of the ports to expand” (Giuliano and Linder, 2011). The two ports’ market influence also played a role in the mitigation efforts, since their gateway location gave them more room to impose fees on the industry and generate the revenue to implement environmental policies.

Assessment of policy effectiveness

What is striking in most of the current literature on port-cities is the absence of description and assessment of port-city policies. There are only a few assessments of specific policy instruments. There is some literature on port pricing policies, but most of this literature is theoretical rather than practical. There are articles on port labour markets, but these focus more on institutional mechanisms rather than public policy tools. However, there are exceptions, all documented in the chapters above; *e.g.* the effectiveness of port gate strategies and truck retirement programmes in US ports have been well analysed and documented; the effectiveness of some maritime cluster policies has been assessed, as well as environmental port dues, onshore power and waste reception facilities. However, most reports on port and port-city policies are not coming from the academic domain, but have been written by international organisations, such as World Bank (The Port Reform Toolkit), ILO, IMO, European Union and OECD. It is within this context that we have tried to provide an overview of existing policies in preceding chapters. In addition, we have attempted to quantify the effectiveness of these policies (Merk and Dang, 2013).

We have attempted to measure the effectiveness of port-city governance by *i)* identifying the links between port and city on the basis of quantifiable outcomes; *ii)* assessing policy effectiveness in achieving such outcomes; and *iii)* highlighting emerging patterns of various policy instruments taken as a whole. Governance is here broadly defined, so it includes policies and institutions. We have conducted this analysis in Merk and Dang (2013) by using the principal component analysis (PCA), an appropriate methodology to explore these issues. It allows to measure key correlations for a set of indicators, shows the direction of the correlations, and summarises the various indicators into a limited number of interpretable factors. As such, this technique helps to derive good summary indicators to address the multidimensional aspect of port and city outcomes, identify ports which are performing along these factors, highlight policy effectiveness by comparing port performance to port policy scoring, explore the links between policy scores across different policy areas.

For the purpose of that study we build a database of main port-city instruments and port-city outcome indicators. Policy instruments were identified (Table 6.2) on the basis of a series of place-specific case studies that were conducted within the framework of the OECD Port-Cities Programme, as well as additional port-city profiles collected for this purpose. For each port-city, scores were assigned to each policy, ranging from A (best practice) to D (policies that in comparison to those of peer port-cities lag with respect to effectiveness, seriousness, comprehensiveness and variedness). In addition, policy outcome indicators were identified, covering port development, port-city development, transport, research and development, spatial development, environment and communication as described in Table 6.3.[1] The collection of the policy outcomes and policy scores was conducted for a selection of 27 large world port-cities from OECD countries, plus Singapore and China, in order to represent the major ports and port-cities of the world.

Table 6.2. Main port-city policy instruments

Policy areas	Policy instruments
Port development	Long term strategic port planning Modernisation of port terminals Port information systems Industrial development policies on port site Development of new port functions Port labour relations Upgrading port workers' skills
Port-city development	Creation of maritime clusters Attraction of port-related headquarter functions Economic diversification policies Creating synergies between port and other clusters Co-ordination between ports Co-operation with neighbouring port-cities
Transport	Intermodal access of hinterlands Modal shifts of hinterland traffic Dedicated freight lanes/corridors
Research and innovation	Innovation policy to improve port performance Fostering local research related to the port sector Attraction of port-related research institutes Attraction of innovative port-related firms Logistics related innovation systems
Spatial development	Port land use planning Common master plan for port and city Waterfront development Urban regeneration of old port and industrial sites Integral coastal/river management
Environment	Emission reduction policies Climate change adaptation policies Renewable energy production in the port Energy efficiency policies Waste reduction policies
Communication	Port communication and information Maritime museums Waterside leisure and recreation Cultural projects related with port Port as part of global city-brand

Source: Merk, O. and T. Dang (2013), "The Effectiveness of Port-City Policies: A Comparative Approach", *OECD Regional Development Working Papers*, 2013/25, OECD Publishing, Paris, http://dx.doi.org/10.1787/5k3ttg8zn1zt-en.

Table 6.3. Main port-city outcome indicators

Policy areas	Outcome Indicators
Port development	Port throughput 2009 (million tonnes); Port throughput containers 2009 (million TEUs) Growth port throughput (1971-2009); Growth port throughput TEUs (2001-2009) Value added port area (million USD) Efficiency index Maritime connectivity (degree of centrality); Maritime connectivity (clustering coefficient) Diversity maritime connections (diversity in vessel movements)
Port-city development	Metropolitan GDP per capita 2008 (USD, constant real prices, year 2000) Growth metropolitan GDP per capita 2000-08 (USD, average annual growth) Metropolitan population 2008 Metropolitan population growth Port related employment (including direct and indirect port-related employment) Port-related labour productivity (ratio of port related employment and value added port area) Unemployment rate (2008)
Transport	Motorway network density (km/1 000 km^2); Railroad network density (km/1 000 km^2)
Research and innovation	Total patent applications in region (TL3, 2005-07) Patent applications in shipping sector (2005-07) Number of articles in port research journals (1995-2011)
Spatial development	Land surface of port (km^2) Urbanised area (km^2)
Environment	CO_2 emissions per capita (tonnes per inhabitant, 2005) Population exposure to $PM_{2,5}$ (annual average 2005)
Communication	Number of Twitter followers (31/1/2013)

Source: Merk, O. and T. Dang (2013), "The Effectiveness of Port-City Policies: A Comparative Approach", *OECD Regional Development Working Papers*, 2013/25, OECD Publishing, Paris, http://dx.doi.org/10.1787/5k3ttg8zn1zt-en.

On the basis of these data, using the principal component analysis, the effectiveness of port-city policies was assessed by confronting policy outcomes with policy instruments in five different policy areas: port development, port-city development, transportation, environment, and a last category that includes R&D, spatial development and communication.

The results of our study confirm that port-city policies are key determinants of success. Sound policies can make a difference to port-cities, but in some areas more than others. The most effective port-city policies are transportation and R&D-policies. Port policies are effective in stimulating high port traffic performance. Performance in this context is characterised by high standards in traffic volumes, port efficiency, and port connectivity as a central and diversified node. Policies focused on transport and research and development (R&D), are found to be effective in stimulating port growth and port-city development. Port-city prosperity mostly relies on high value-added and employment level generated by the port. Such features are likely to be prone to high transport density network and innovation, but also to negative externalities as CO_2 pollution. Policies aimed at creating port-city synergies are found to be relatively ineffective in achieving both high port performance and city prosperity. City prosperity seems to be directly fuelled by port activity via port-related value-added activities and employment, but not so much by port-city policies. Spatial and communication policies also have mixed results in this respect (Merk and Dang, 2013).

Our analysis on the policy mix is confirmed by findings from the instruments for which policy evaluations exist. Our inventory and assessment of port-city policy instruments (Merk, 2013) reveals that various policy instruments related to transport have proven to be effective, which is often not the case for policy instruments in other fields where the perception of policy effectiveness is often based on anecdotal evidence and selective observation. Examples of transport policies with sound scientific evidence on effectiveness include programmes to replace old port trucks and extended port gate hours, to redistribute the arrival times of truck to port terminals throughout the day.

Our studies thus suggest that policy effectiveness in port-cities could possibly be increased by focusing even more attention to transportation policies, one of the most effective policy areas. Port-cities with average to least performing policy packages would benefit from moving their policy efforts towards the benchmark within the policy areas where they are the least performing, or focusing on the policy areas where public intervention is most effective, such as port development, transportation and R&D. Although there are limits to the generalisations for policy that one can make, one generic recommendation covers the desirability of policy coherence.

Towards policy coherence

The policy mix should be coherent: policy instruments should neither overlap nor work at cross-purposes. Networking mechanisms can generate overlap: too many different networking platforms can result in intra-sectoral competition and the fragmentation of available financing. If the effects of one policy on another have not been carefully gauged, instruments can cancel one another out. States that have chosen to implement a tonnage tax to attract shipping should also make sure that fiscal policies are aligned with their aims. In India, benefits to the shipping sector from the introduction of the tonnage tax in 2004 were largely nullified by increases in indirect taxation through the services tax in 2007, which reduced prior gains in foreign direct investment in India's shipping sector. Co-ordination between instruments is closely related to co-ordination between actors. Stakeholders in the maritime sector must be clear about their priorities and intentions, and policy makers must seek to incorporate these priorities through a consultative process.

Alignment between local and national policies is particularly important in this regard. Much depends on the situation in a specific port-city: some ports are owned and controlled by their cities, whereas others are owned by a national government, and yet other ports completely privatised. These ownership patterns evidently change the dynamics between the city and its port. Whatever these institutional differences, port-cities are generally faced with a need for policy alignment on at least two levels; between the port administration and the city administration; and between the city and higher levels of government (central and regional/state).

Notes

1. For an overview of sources of these policy outcome indicators, see Merk and Dang 2013.

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Annex A

Port growth patterns 1970-2009

Figure A.1. Average container volume (in thousands TEUs), 1970-1979

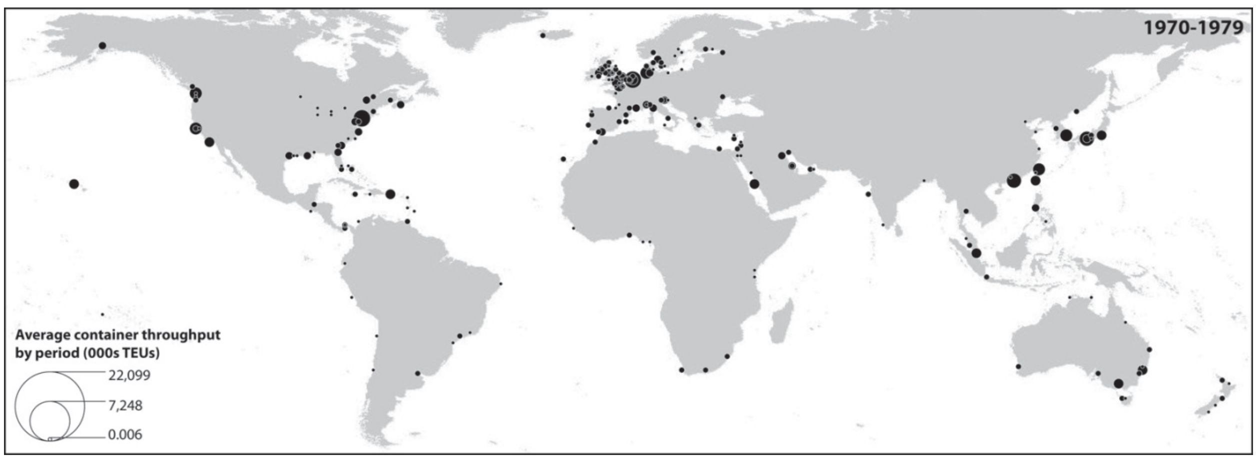


Figure A.2. Average container volume (in thousands TEUs), 1980-1989

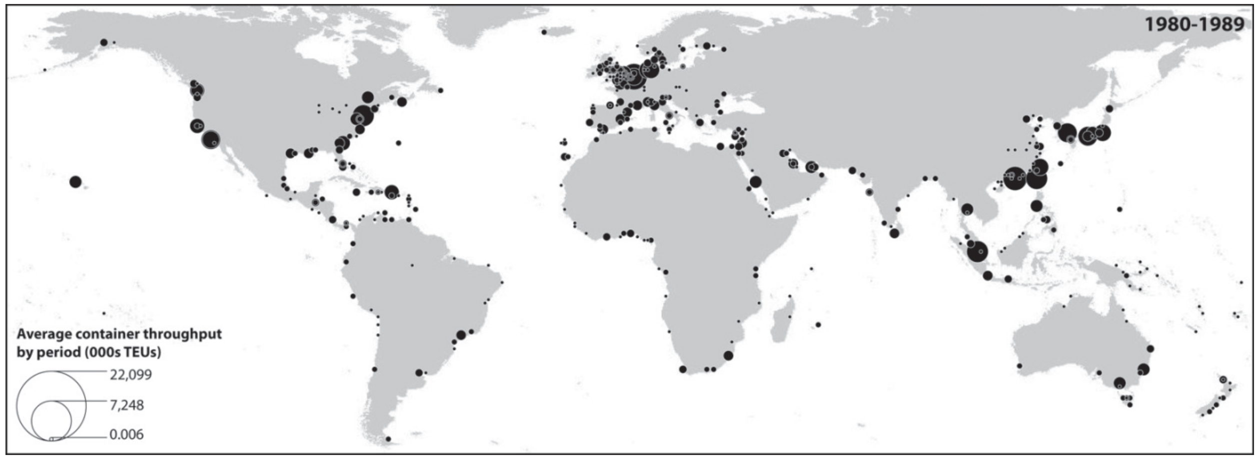


Figure A.3. Average container volume (in thousands TEUs), 1990-1999

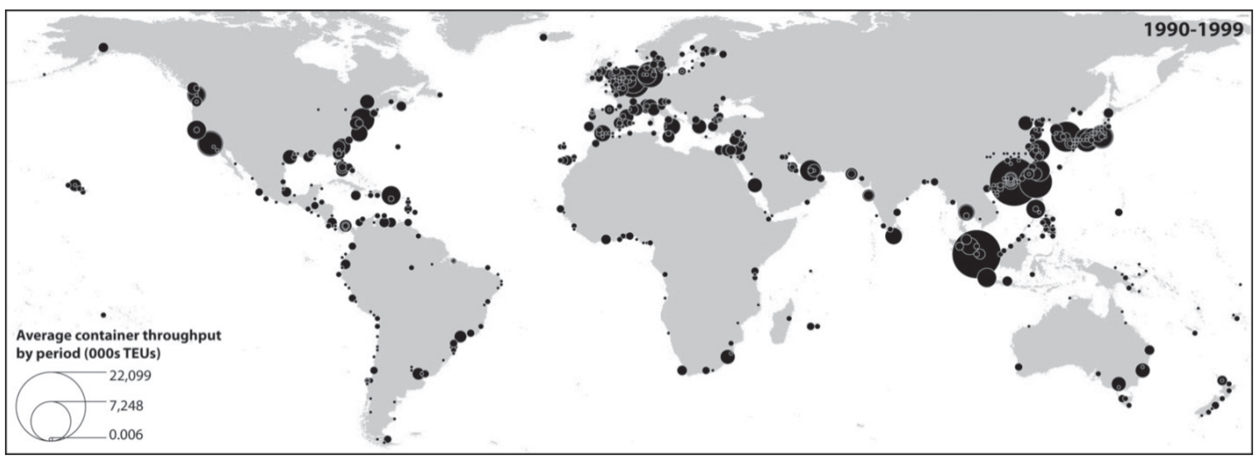
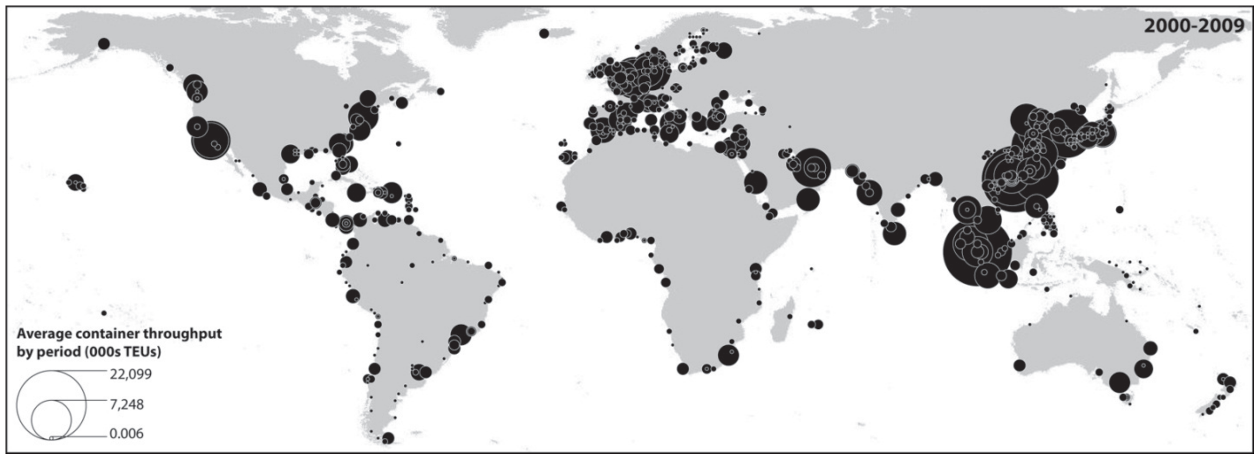


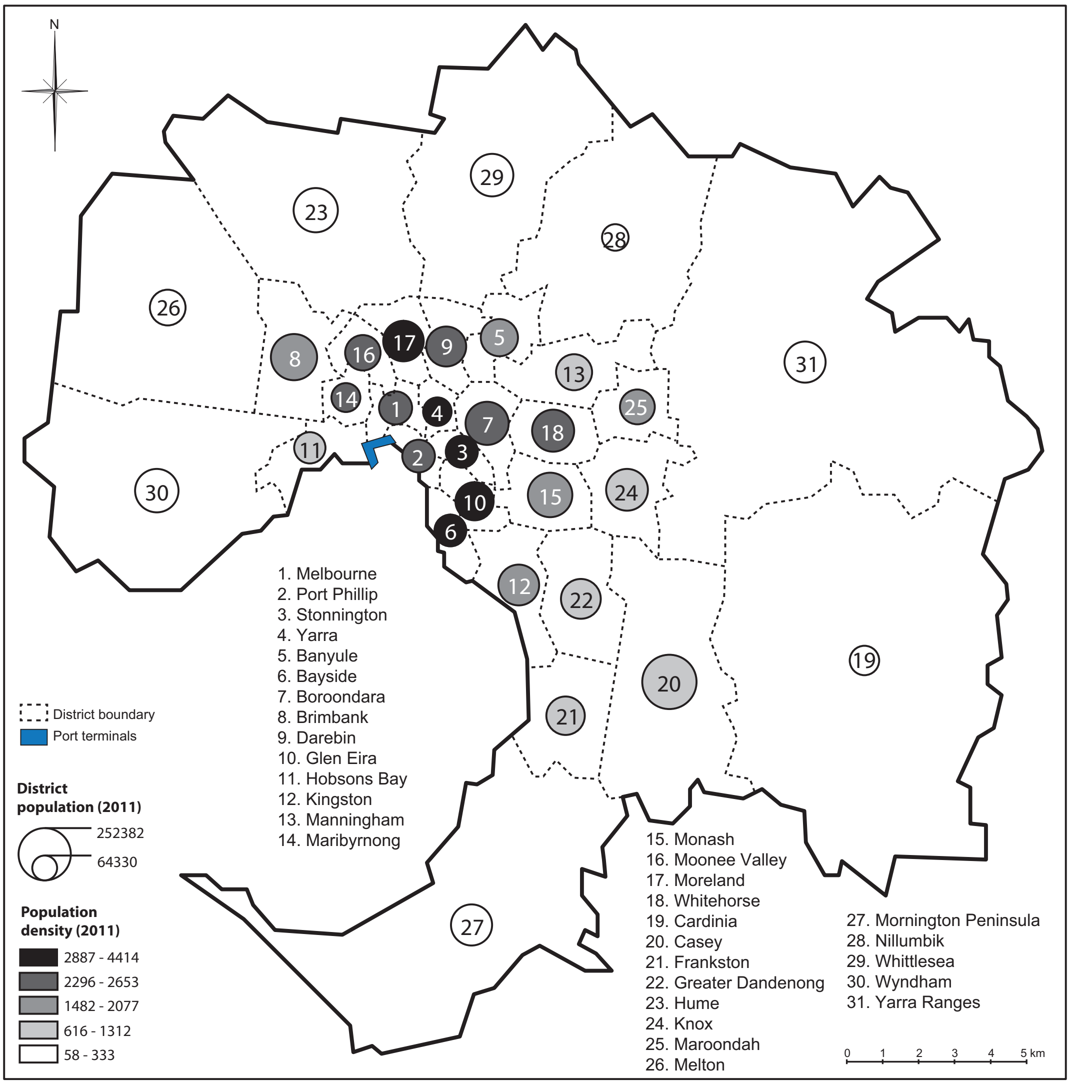
Figure A.4. Average container volume (in thousands TEUs), 2000-2009



Annex B

Port-city profiles

Australia – Melbourne



Main indicators

- Port volume: 86 million tonnes in 2013; 2.5 million TEUs in 2013
- Port growth: 57% over 2003-13 (tonnes); 45% over 2003-13 (TEU).

Main characteristics

- Largest container port of Australia, located very close to the city centre.

Main accomplishments

- ***Integrated transport planning***. Victoria's 2010 Transport Integration Act provides a common transport vision and a set of operative principles for a number of transport actors, including the Port of Melbourne Corporation. The port has undertaken several initiatives to promote better transport integration, primarily focusing on rail. It has supported the development of on-port rail terminals and the provision of rail links with the external network at the terminal boundaries.
- ***Port communication strategies***. The port is involved in a series of initiatives to promote local goodwill, including educational projects at the port, a port information centre and public access to the port area.

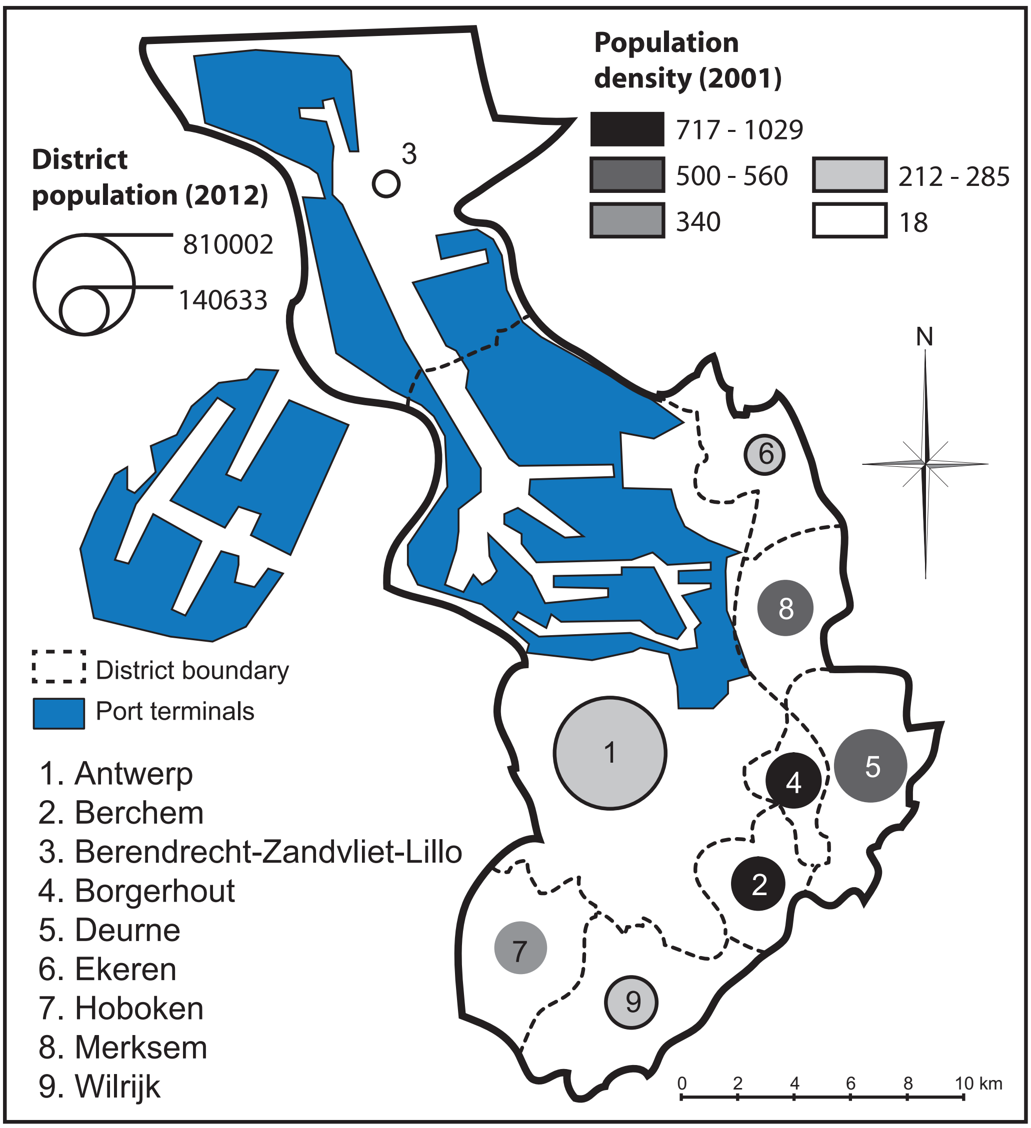
Main challenges

- ***Port-city governance***. The governance of the city of Melbourne is shared between the 26 municipal councils that comprise the Melbourne metropolitan area and the state government of Victoria. The municipal councils are charged with local planning but do not have much power; the state government is broadly responsible for all other government services, including the different ports, including Melbourne and Hastings. In this context, strategies are rarely articulated in terms of a port-city dynamic, but are rather framed in a port-regional context.
- ***Space constraints***. The port is located close to the densest part of the metropolitan area. Although expansion of port capacity in the short term is possible, via the planned development of a new container terminal on the Webb Dock, other solutions will have to be found to accommodate the cargo volumes forecast for the longer term. One of the ideas floated is the development of a new port in the west of Port Philip Bay.

Main opportunities

- ***Cargo growth***. Container throughput at the Port of Melbourne is expected to quadruple over the next 25 years. Part of this growth will be accommodated by the third container terminal at Webb Dock, recently awarded to a consortium led by global terminal operator ICTSI, with the terminal expected to be operational in 2016.
- *Privatisation.* The Port of Melbourne is the only large port on the east coast of Australia that is still owned by the state government. Other ports in the state of Victoria, the ports of Geelong and Portland, were sold in 1996. At that time, the government intended to privatise the Port of Melbourne as well, but withdrew its proposal after strong opposition. Following recent privatisations and announcements to privatise by the government of New South Wales (Port Botany, Port Kembla, Newcastle) and Queensland (Brisbane, Abbott Point), the government of Victoria has announced privatisation again, which might provide the private investment required in container terminal extensions in Melbourne.

Belgium – Antwerp



Main indicators

- Port volume: 191 million tonnes in 2013; 8.6 million TEUs in 2013
- Port growth: 34% over 2003-13 (tonnes); 58% per year over 2003-13 (TEUs)
- Main cargo types: container (54%), dry bulk (8%), liquid bulk (31%), break bulk (8%)

Main characteristics

- An estuary port, connected via the River Scheldt to the North Sea, Antwerp is one of the largest ports in the world in terms of area (130 square kilometres), covering more than a third of the city.

Main accomplishments

- ***Local port-related value added***. The port is well embedded in the local economic structure. Industries at the port site produce considerable value added and also generate synergies, thanks to a cluster effect.
- ***Green port policies***. Antwerp has been at the forefront of various green port policy initiatives, including hinterland modal shifts (to barges), liquefied natural gas (LNG) bunkering and sustainability reporting.
- ***Hinterland accessibility***. Antwerp has managed to guarantee access to its hinterlands, thanks to its extended gate strategy, a system of dry ports in Belgium that extends into Netherlands and Germany.
- ***Port communication***. The Port of Antwerp has invested in pro-active communication intended to generate local goodwill. Examples of this include the Lillo Port Centre, the MAS Museum and port educational programmes.

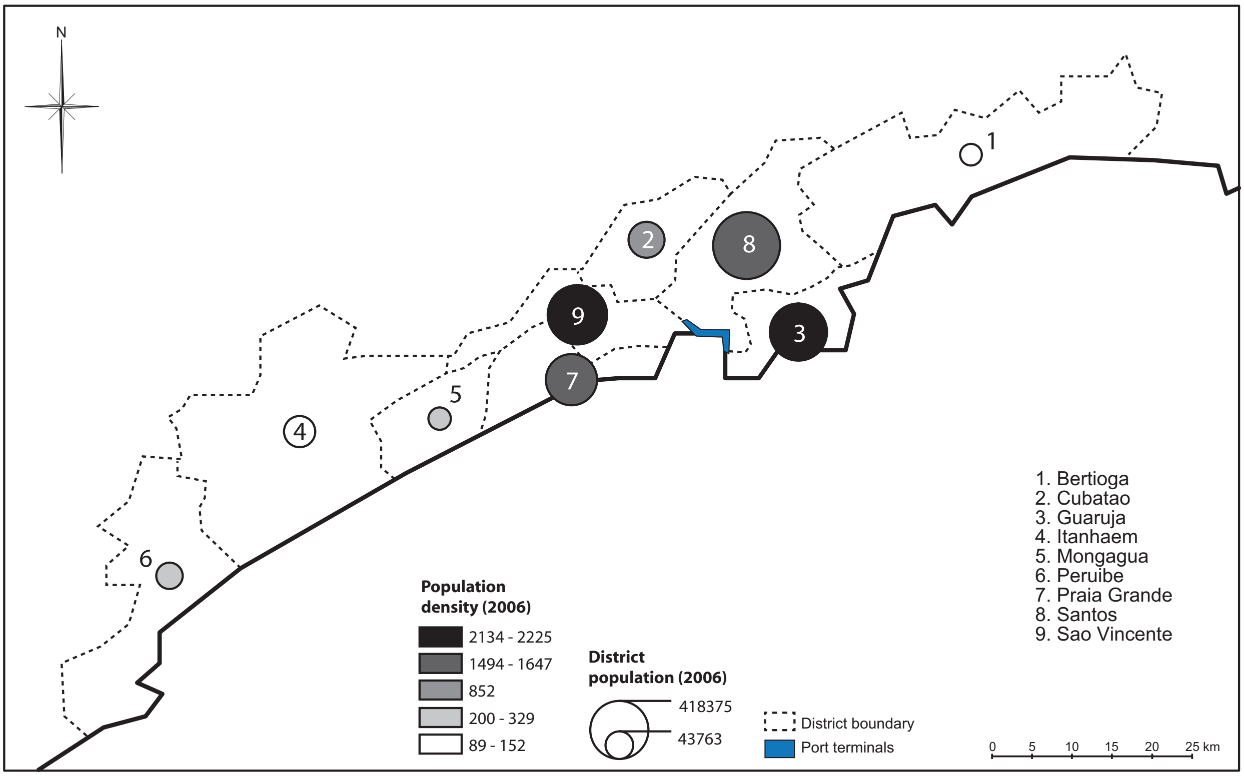
Main challenges

- ***Road congestion***. Roads and highways in and around Antwerp are heavily used, with considerable congestion costs as a result (EUR 100 million per year in direct congestion costs for freight traffic). Road intensity increases and is expected to increase further. Declining hinterland connectivity will be a key competitive disadvantage for the port. Current initiatives include the closing of the ring-road around Antwerp (Oosterweel junction), a project that is controversial, politicised and that has been subject to debate for several decades.

Main opportunities

- ***Cross-border co-operation***. Rotterdam, the largest European port, is located only 75 kilometres from Antwerp. Both ports have large industrial areas dedicated to the petrochemical sector. The Port Vision 2030 of Rotterdam encourages co-operation with Antwerp to ensure the long-term viability of these two petrochemical sectors, which are already largely interdependent possibly yielding further synergies.

Brazil – Santos



Main indicators

- Port volume: 105 million tonnes in 2012; 3.4 million TEUs in 2013
- Port growth: 74% over 2003-13 (tonnes); 121% over 2003-13 (TEUs)
- Main cargo types: general cargo (36%), dry bulk (49%), liquid bulk (15%)

Main characteristics

- Santos is Brazil's main port and serves a hinterland that generates 55% of Brazil's GDP. It is located 65 kilometres from São Paulo, Brazil's largest metropolitan area.

Main challenges

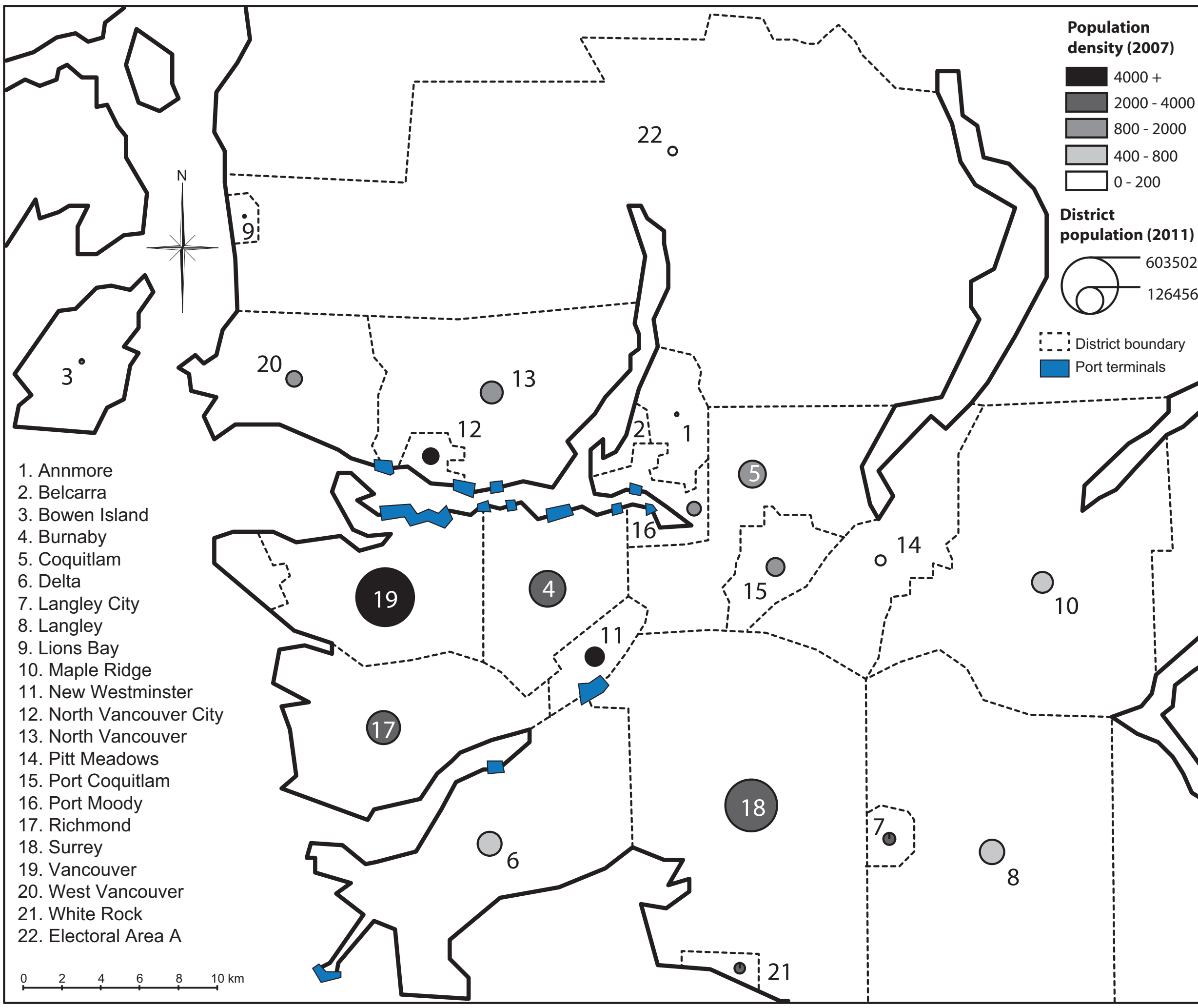
- ***Port congestion***. Vessels lining up to enter the port are subject to long waiting times, and truck congestion is chronic at the port gate and in the city itself. This is particularly damaging for perishable goods, such as agribulk exports, a problem compounded by the lack of storage facilities for grain, for which Santos is one of Brazil's main export ports.

- ***Port capacity***. Inadequate port infrastructure has been a drain on Brazil's economic development. Port utilisation rates are very high and expected to rise in the coming years. In addition, Santos has a reputation for excessive bureaucracy, complex hiring procedures, poor service and corruption. The Brazilian Growth Acceleration Programme prioritises infrastructure, including port infrastructure, and the 2013 port reform package aims to attract private finance for port investment, but it will be a few years before the effects of these investments can improve port performance.
- ***Hinterland connectivity***. The ports are poorly connected to the hinterland, with insufficient road and rail access to the port area.

Main opportunities

- ***Port privatisation***. Legislation was passed in 2013 to facilitate private investment in ports and to allow private terminals to handle third-party cargo. The first package of leases, which includes terminals in Santos, should be available from 2015; with a second package by 2017.
- ***Urban redevelopment***. The port-city interface in Santos is covered in the Porto Valongo project, which is to convert eight former port warehouses in the historic city centre to tourist-related use. It includes the construction of a passenger terminal and a tunnel designed to divert the traffic of heavy goods from the port away from this future tourist centre. Construction of the tunnel is expected to start in 2015.

Canada – Vancouver



Main indicators

- Port volume: 135 million tonnes in 2013; 2.8 million TEUs in 2013
- Port growth: 102% per year over 2003-13 (tonnes); 84% over 2003-13 (TEUs)
- Main cargo types: container (18%), bulk (69%), break bulk (13%)

Main characteristics

- The largest Canadian port; one of the main cargo gateways for North America. The port closely co-exists with the city, and most terminals are located in the most densely populated areas.

Main accomplishments

- ***Port merger***. Metro Port Vancouver (MPV) was created in 2008 through the amalgamation of the Fraser River Port Authority, the North Fraser Port Authority and the Vancouver Port Authority, as a way of matching the increasing consolidation in maritime industries.
- ***Greening port initiatives***. Port Metro Vancouver has introduced a range of green port policies. Vessel operators that use clean fuel, for example, receive rebates on their harbour dues. The port published its first sustainability report in 2011 and is co-operating with the US ports of Seattle and Tacoma on the North West Ports Clean Air Strategy.
- ***Hinterland connectivity***. As part of the federal Asia-Pacific Gateway and Corridor Initiative and the "Gateway Program" of the government of British Columbia, the connectivity of the Port of Vancouver with inland destinations in its hinterlands in Canada and the United States has been improved. New programmes have been initiated to further increase connectivity. The Deltaport Terminal Road and Rail Improvement Project consists of a new overpass and configuration of the rail tracks on the existing Deltaport Terminal and associated rail lines.

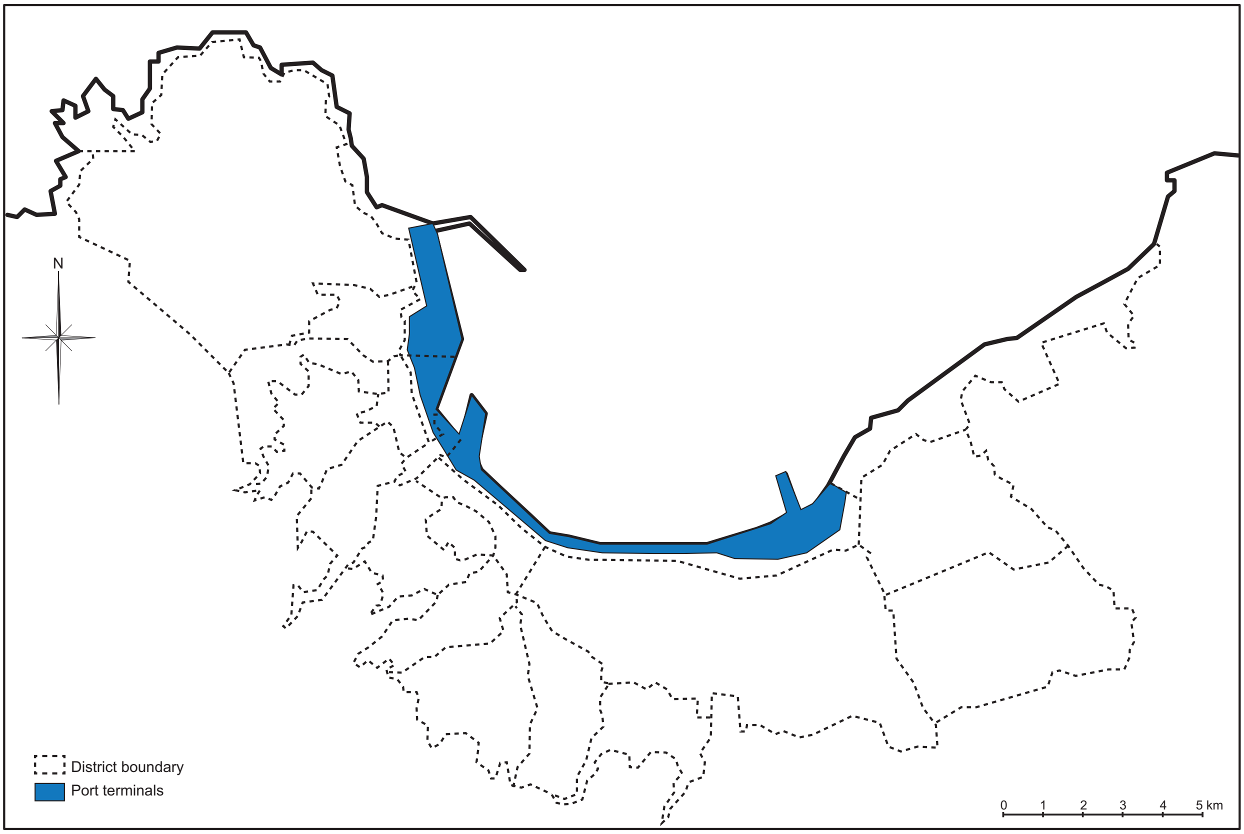
Main challenges

- ***Local support***. The co-existence of a working port and one of the most liveable cities in the world creates tensions that can sometimes be difficult to resolve. Recent conflicts have emerged over Vancouver's coal exports, intensification of land use for bulk goods and the expansion of the Roberts Bank container terminal.

Main opportunities

- ***Growing Asian markets***. With the third berth added to the Deltaport Terminal, the container capacity of Vancouver is now 3.2 million TEU. In order to accommodate further growth related to Asian trade, new port developments (such as the new Roberts Bank facility) are planned, scheduled to be opened in 2015. The Container Capacity Improvement Program is anticipated to meet the demand for container capacity through 2050.

Chile – Valparaíso



Main indicators

- Port volume: 10 million tonnes in 2013; 0.9 million TEU in 2013.
- Port growth: 100% over 2003-13 (tonnes); 185% over 2003-13 (TEUs)
- Main cargo types: container (82%); break bulk (18%)

Main characteristics

- The port of Valparaíso is located just next to the historic city centre, recognised as a World Heritage Site in 2003 by the UNESCO. The city, built on forty hills, forms some sort of a natural amphitheatre overlooking the port; this visibility of the port in the cityscape poses challenges on new development. Valparaíso is the main port for Santiago, where Chilean population and economic activity is concentrated.

Main accomplishments

- ***Dedicated port access and logistics centre***. Port-related congestion in the city centre has been reduced by creating a new dedicated access route to the port (South Access), via a tunnel leading to a logistics centre, called Extension Area for Logistical Support (ZEAL). ZEAL has been in operation since 2008 and has contributed to increased logistical efficiency: one year after introduction cargo processing time was reduced by 60%.

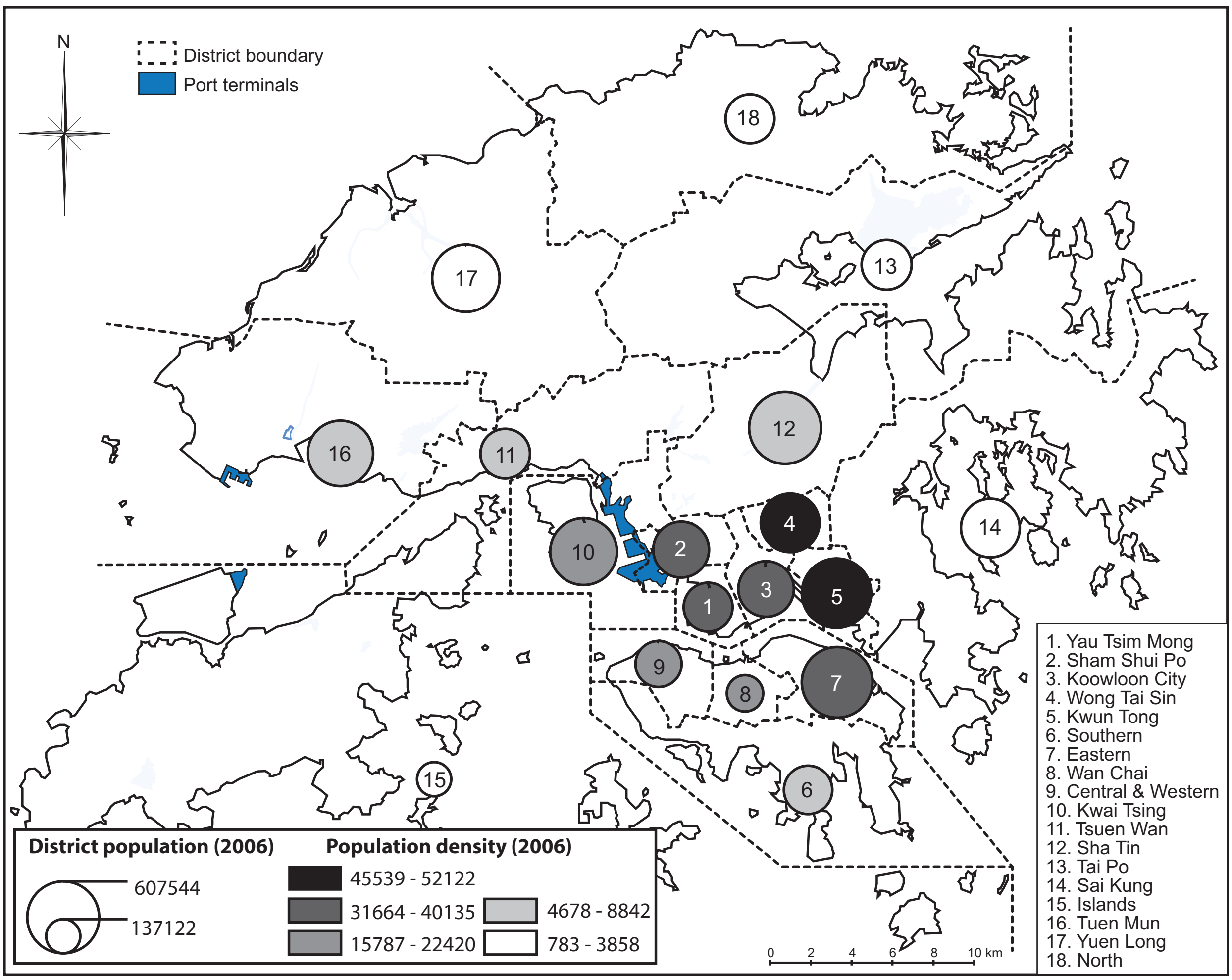
Main challenges

- ***Opposition over Puerto Barón development***. There is wide-spread opposition among academics, civil society and trade unions to real estate development (a shopping mall) on part of the port site, at Puerto Barón. A UNESCO report released in 2014 warns against the destruction of the city-scape that would be caused by port expansion and the mall at Puerto Baron.

Main opportunities

- ***Cruise shipping***. The port of Valparaíso had 38 calls of cruise ships in the 2012-13 season, representing 88 thousand visitors. Considering the attraction to tourists of Valparaíso and the close-by Viña del Mar, there is potential for further development of Valparaíso as a main cruise port in South America.
- ***Intra-port competition***. The monopoly on container traffic by terminal operator TPS was terminated in 2013 when a 30-year concession for Terminal 2 was awarded to OHL. This increase of competition will provide an opportunity for increased efficiency and better services. It will also allow the port of Valparaíso to double its capacity by 2017 and reach capacity of 22 million tonnes and 950,000 TEUs. Considering that the two container terminals of the main competing port, San Antonio, have different operators, there are now four main container terminals for central Chile.
- ***New port development in central Chile***. According to studies commissioned by the Chilean Ministry of Transport and Telecommunications, at some point in the first half of the 2020s central Chile will need additional container handling capacity, as a result of underlying demand growth. The ministry is currently engaging in preparations for a public tendering of a new container port for central Chile, labelled *Puerto de Gran Escala* (PGE), for which two potential locations currently seem most feasible: one in San Antonio, located a few hundred metres to the south of the current terminals, and one in Valparaíso, located approximately two kilometres to the north of Terminal 2, in an area commonly known as Yolanda.

China – Hong Kong



Main indicators

- Port volume: 276 million tonnes in 2013; 22.4 million TEUs in 2013
- Port growth: 33% over 2003-13 (tonnes); 9% over 2003-13 (TEUs)
- Main cargo types: container (73%), dry bulk (16%), liquid bulk (6%), break bulk (5%)

Main characteristics

- Hong Kong is the gateway to the world's manufacturing centre, the Pearl River Delta, which includes Guangdong province in China.

- Ranked as the fourth-largest container port in the world in 2013, it is located in close proximity to the third- and eight-largest container ports, namely Shenzhen and Guangzhou.

Main accomplishments

- ***Land productivity***. Hong Kong is one of the ports with the highest throughput per hectare: approximately 60 000 TEU per hectare per year, more than six times the average for North American container terminals. This is achieved by multi-storey warehouses, container stacking of more than five containers high and superior yard planning.
- ***A leading maritime cluster***. Main factors underpinning this cluster are regulation and taxation favourable to global business, an active maritime community and incentives to attract and train manpower in the maritime sector. Competing ports, such as Shenzhen, have not been able to match this, but Shanghai has started to develop a similar maritime cluster.
- ***A regional leader in green port policies***. A voluntary fuel switch programme, the Fair Winds Charter, was initiated by the shipping industry in 2010. The government followed up with environmentally differentiated port dues in 2012, giving rebates for ships switching to low-sulphur fuel. The government is currently introducing legislation that will require all ocean-going vessels berthing in Hong Kong to switch to low-sulphur fuel (<0.1%). The goal is to create an Emissions Control Area (ECA) for the Pearl River Delta.

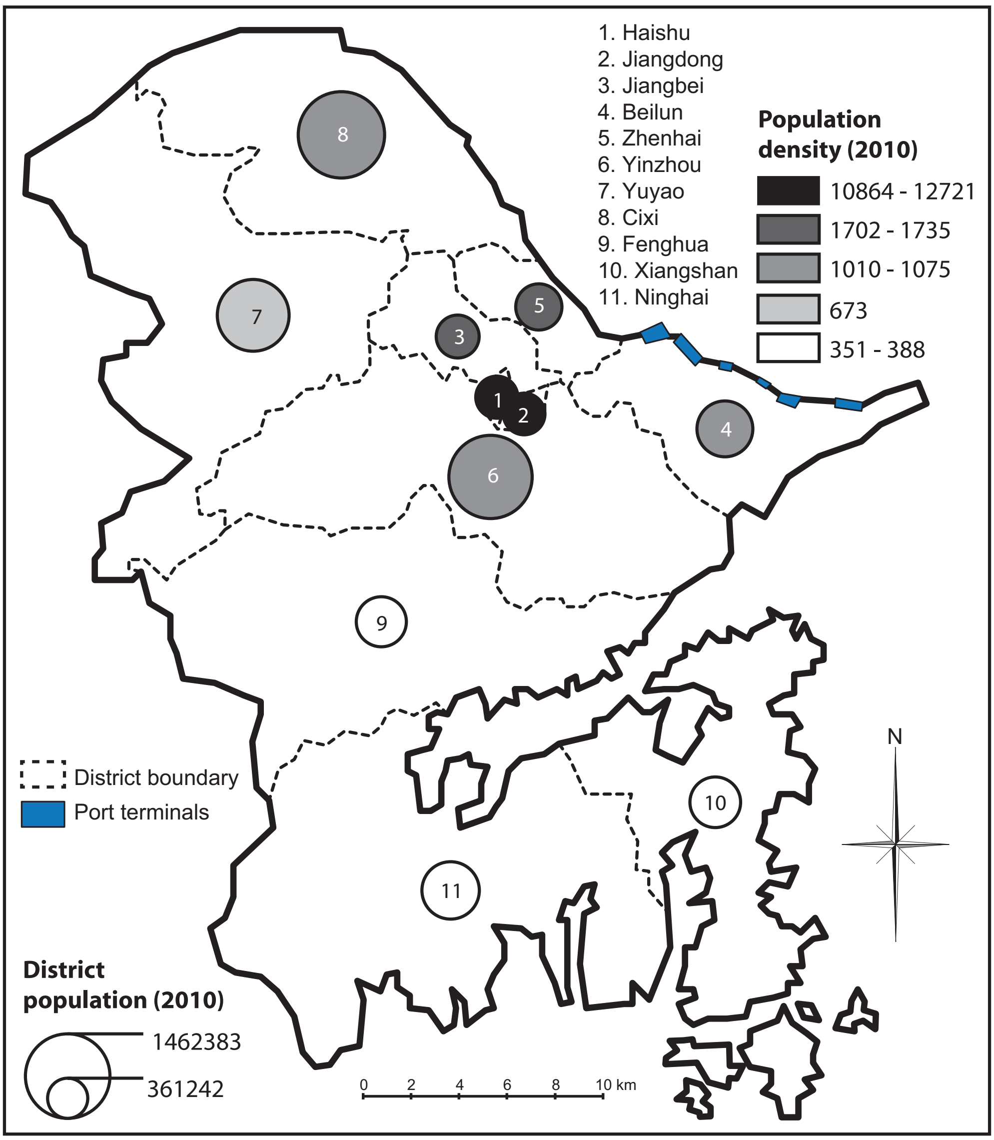
Main challenges

- ***Port competition in the Pearl River Delta***. Hong Kong has lost market share, due to phenomenal growth rates in competing ports such as Shenzhen and Guangzhou. In the last decade, the former differences in quality have disappeared, with ports in mainland China spectacularly increasing their efficiency. At the same time, price differences remain: the Port of Hong Kong is relatively more expensive.
- ***Sustaining the port hub position***. The focus of the port has shifted slightly towards trans-shipment functions. In this respect, Hong Kong is advantaged by the Chinese maritime cabotage law, which restricts domestic cargo handling to Chinese vessels, but from which Hong Kong is excluded. If this cabotage law was liberalised, other Chinese ports might capture part of Hong Kong's current trans-shipment cargo.
- ***Hinterland accessibility***. The costs of cross-boundary trucking between Hong Kong and mainland China are the single biggest element in the cost difference between Hong Kong and other regional ports in Guangdong.

Main opportunities

- *Regional governance*. Co-operation between Hong Kong and the Guangdong province has been increasing. Intensifying this co-operation and improving regional governance could be a source of great opportunities for Hong Kong. It could result in policy harmonisation and a level playing field, for example by installing an emission control area for the whole Pearl River Delta.

China – Ningbo



Main indicators

- Port volume: 809 million tonnes in 2013; 17.3 million TEUs in 2013
- Port growth: 337% over 2003-13 (tonnes); 526% over 2003-13 (TEUs)

Main accomplishments

- ***Environmental policies***. These include replacing port trucks by LNG-fuelled trucks and electrification of rubber-tyred gantry (RTG) cranes. The port has also applied onshore power to various berths, as well as solar-powered and wind-powered street lights and traffic signals.
- ***Regional co-operation***. The ports of Ningbo and Zhoushan merged in 2005. Ningbo Port Group has a co-operative relationship with the Port of Shanghai and the other ports in the Yangtze River Delta region. The ports of Ningbo and Shanghai jointly own the Shanghai Port & Shipping Equity Investment Company, which invests in various projects, ranging from shipping, logistics and warehousing to real estate.

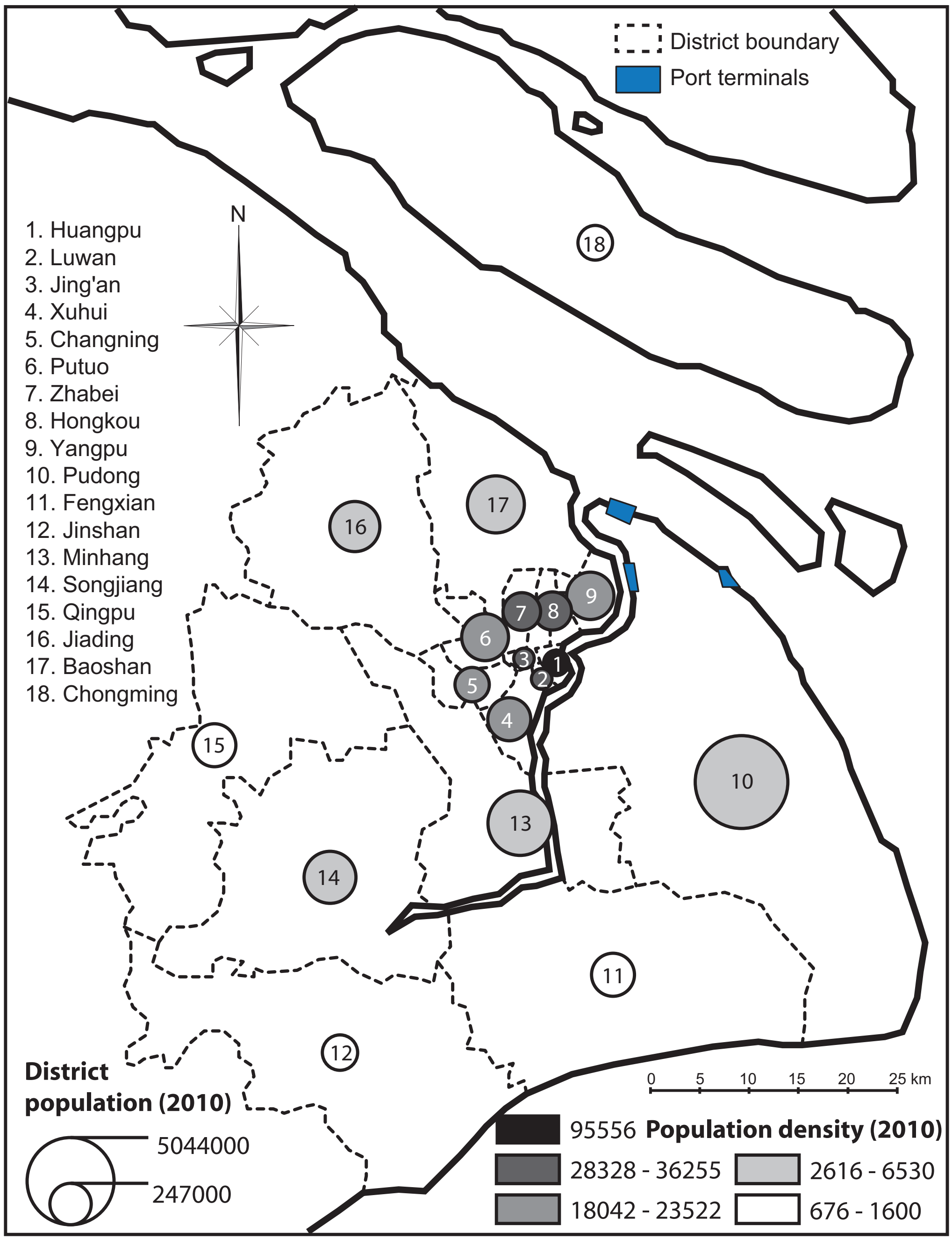
Main challenges

- ***Relationship with Shanghai***. Both China's and Ningbo City's 12th Five-Year Plans position Ningbo as a constituent part of the Shanghai International Shipping Centre. Shanghai's new port, Yangshan, is in the Zhoushan archipelago, where the Ningbo-Zhoushan port is located. Not surprisingly, Shanghai captures part of the natural hinterland of Ningbo-Zhoushan port, the province of Zhejiang. At the same time, Ningbo-Zhoushan port is engaged in the extension of container terminals, which is due to raise annual container capacity to 20 million TEU in 2015. Whether this capacity can be put to optimal use will to a large extent depend on the development of Shanghai and its port.

Main opportunities

- ***Demand for bulk commodities***. One of the strategic goals of the Port of Ningbo is to become a distribution centre for bulk goods. Already the largest crude oil port in China, Ningbo has various projects under way that are intended to expand its role as a major bulk port and trade centre. The Chinese State Council has designated Ningbo as the gateway for the storage, transportation and processing of bulk commodities. In addition to the extension of the Meishan Container Terminal and the Chuanshan container terminal, new terminal development is planned for bulk goods, including via the Daxie oil terminal, Beilun general cargo terminal and Zhenhai liquid chemical terminal. The newly state-approved Comprehensive Bonded Port Zone in Zhoushan port will further serve as a warehousing and distribution centre for regional bulk commodities.

China – Shanghai



Note: The map does not include the Yangshan port area, which is also part of the Port of Shanghai.

Main indicators

- Port volume: 776 million tonnes in 2013; 33.6 million TEUs in 2013
- Port growth: 146% over 2003-13 (tonnes); 198% over 2003-13 (TEU)
- Main cargo types: container (77%), dry bulk (15%), liquid bulk (6%)

Main accomplishments

- ***Spectacular port growth***. After impressive port growth rates in recent decades, the Port of Shanghai has been ranked as the world's largest container port since 2011.
- ***Port relocation***. A new port site is located in Yangshan, an offshore port connected by a 31-kilometre bridge. This has eased port-related urban congestion and freed up old port land for urban redevelopment.

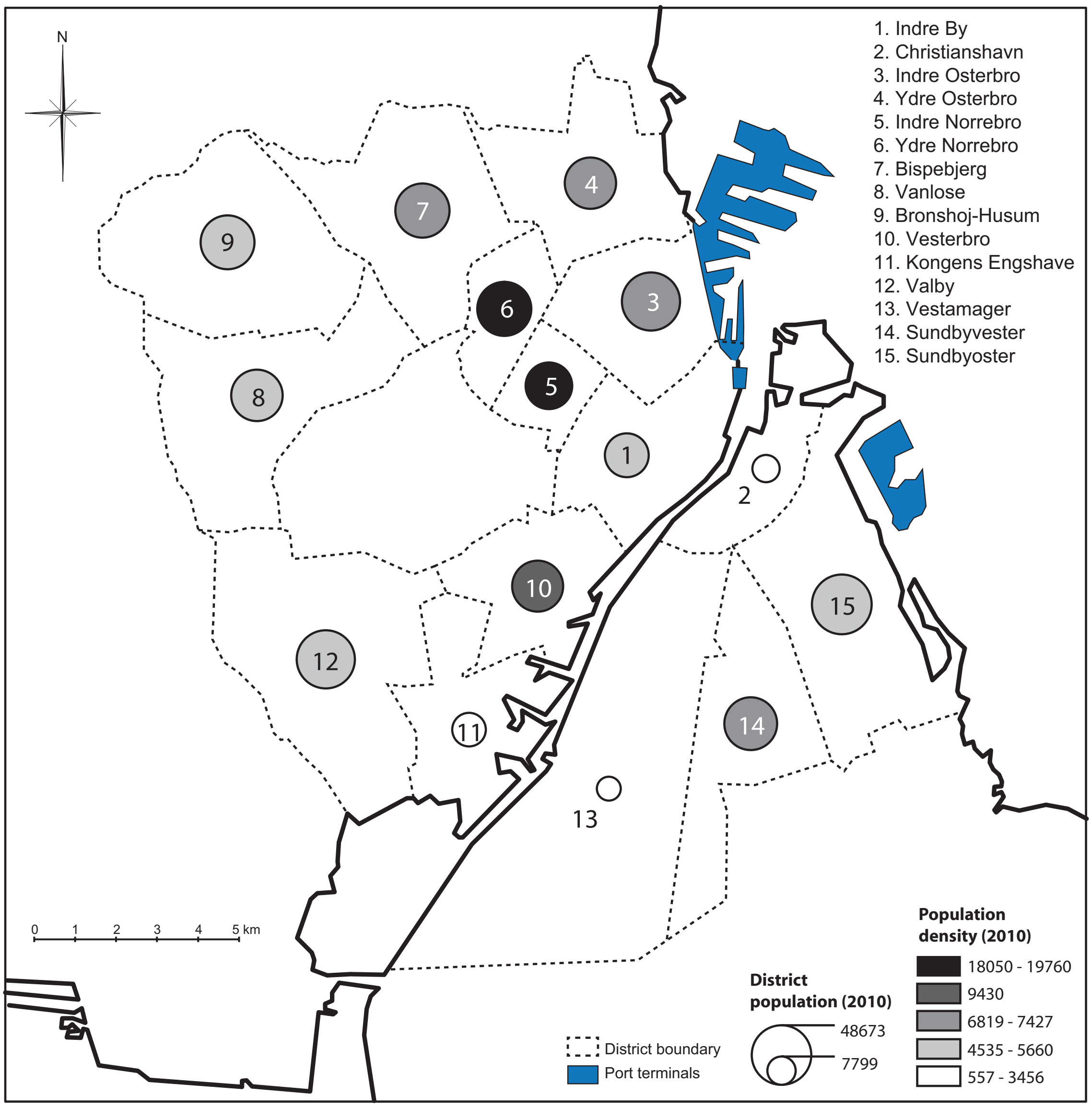
Main challenges

- ***Environmental sustainability***. The port has targets for reduction of CO_2 emissions, energy consumption, waste and waste water. Measures that should help to achieve these targets include retrofitting equipment (such as RTGs) and implementation of onshore power. Considering cargo projections, and their associated environmental impact, an intensification of green policies may be needed to improve Shanghai's quality of life.

Main opportunities

- ***International maritime services centre***. The goal of becoming a world leading maritime cluster is part of a larger strategy of the Shanghai government, the "Four Centre" initiative, launched in 2009. This aims to develop Shanghai as an international centre for finance, trade, shipping and headquarters. Policies to promote Shanghai as a shipping centre include preferential tax and customs policies, shipping education and research, as well as the Shanghai Shipping Exchange, established in 1996, and the Shanghai Containerised Freight Index, launched in 2009. Maritime businesses are encouraged to locate in the various free zones related to the port.
- ***Trans-shipment hub***. Although it is the world's largest container port, Shanghai is not the best-connected port; Singapore and Hong Kong are more central and could be considered the main global port hubs. This is related to the relatively limited share (one-fifth of the port volume) of ship-to-ship trans-shipment in Shanghai. One of the pillars in the port strategy is to develop Shanghai as the trans-shipment hub in Northeast Asia. The port area of Yangshan is well positioned for trans-shipment; reaching a capacity of 25 million TEU by 2020. Lifting the national cabotage restrictions would help to develop Shanghai as a trans-shipment hub.

Denmark – Copenhagen



Main indicators

- Port volume: 6 million tonnes in 2013 (Copenhagen); 0.1 million TEUs in 2013 (Copenhagen/Malmö)
- Port growth: -13% over 2003-13 (tonnes); 4% over 2003-13 (TEU)
- Main cargo types: general cargo (46%), dry bulk (22%), liquid bulk (34%)

Main characteristics/accomplishments

- ***Urban redevelopment***. The spatial development strategy in Copenhagen has been to locate new port development away from the city centre and to redevelop former port sites. This has resulted in new waterfront development with residential and mixed uses.
- ***Cross-border port merger***. Copenhagen offers a successful example of a cross-border port merger, with the Port of Malmö. This merger, which took place in 2001, has allowed the new Copenhagen Malmö Port (CMP) to avoid duplication of investment, increase efficiencies through better utilisation of facilities and offer a wider range of services.
- ***Cruise traffic***. Copenhagen has managed to develop a successful cruise port and is expanding its capacity to accommodate cruise traffic with a new cruise terminal with 1 100 metres of quayside in the North Harbour area.

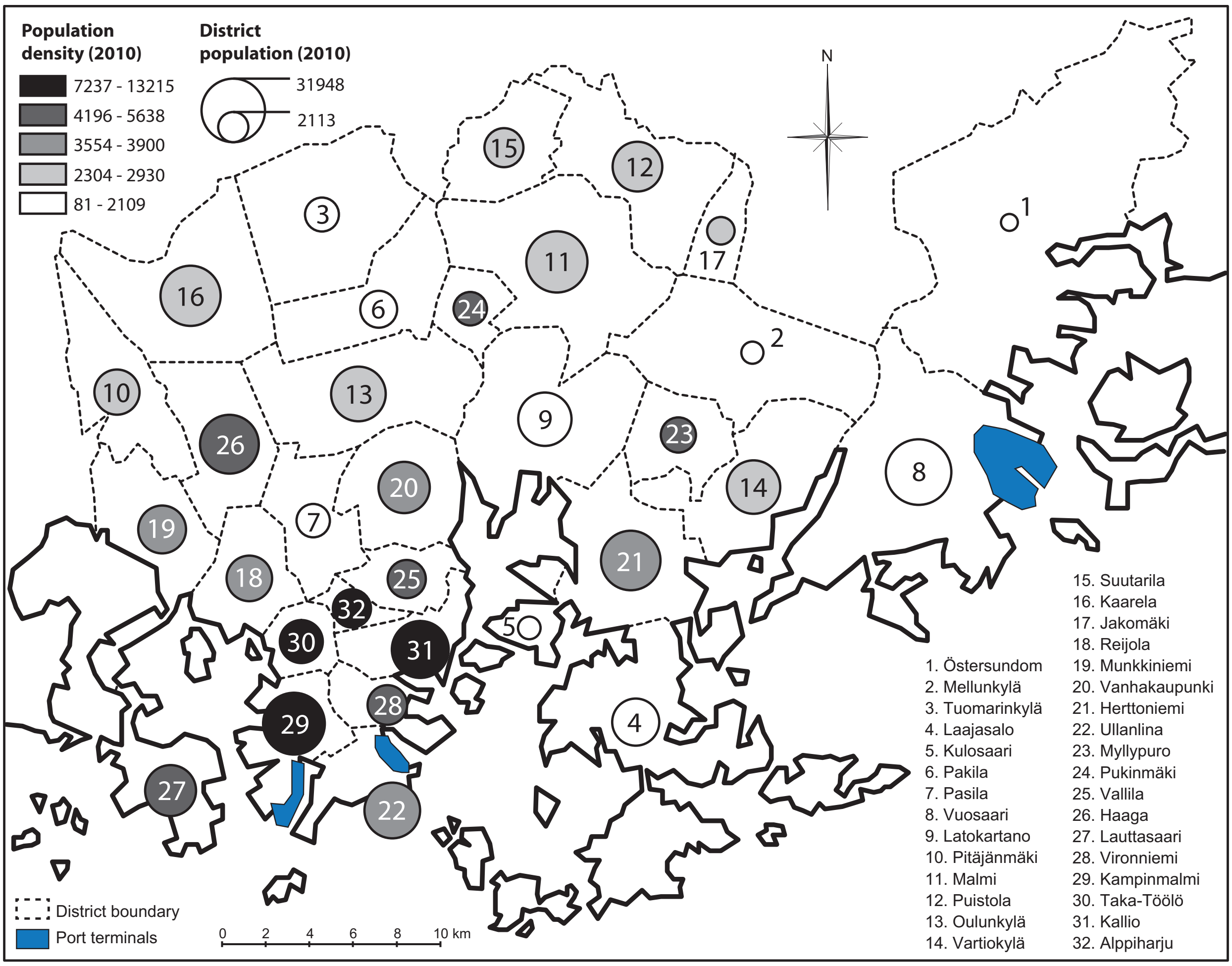
Main challenges

- ***Dependence on a single dominant shipping firm***. Although it has a relatively small port, Copenhagen is one of the world's shipping leaders, thanks to the headquarters of Maersk, the world's largest container shipping line. Maersk has brought a high value added maritime-related services economy to Copenhagen, but this cluster is highly dependent on Maersk's sustained presence in Copenhagen. This cannot be guaranteed: the headquarters of its terminal operations-affiliate, APM Terminal, is situated in in The Hague (Netherlands) and the headquarters of the 2M-Alliance, formed by Maersk and the shipping line MSC, is situated in London.

Main opportunities

- ***Green maritime industries***. In addition to a strong maritime cluster, Copenhagen (and Denmark as a whole) also hosts a concentration of firms in renewable energy and clean technologies. Given Copenhagen's profile as a green city, these sectors could potentially provide synergies with respect to green economic development on port sites.

Finland – Helsinki



Main indicators

- Port volume: 10.5 million tonnes in 2013; 0.4 million TEUs in 2013
- Port growth: -10% over 2003-13 (tonnes); -14% over 2003-13 (TEUs)

Main characteristics

- Helsinki is specialised in roll on/roll off-traffic (i.e. trucks and semi-trailers), which represented 57% of total cargo in 2010.

Main accomplishments

- ***Port relocation***. The Port of Helsinki has relocated most cargo traffic away from the centrally located South and West terminals to a new port area in the Vuosaari area, on the periphery of the city. This has opened up space in the city centre for urban development.
- ***Efficient ferry services***. Ferry traffic between Helsinki and Tallinn has created a “twin city”, with spectacular increases in commuting between the two cities.

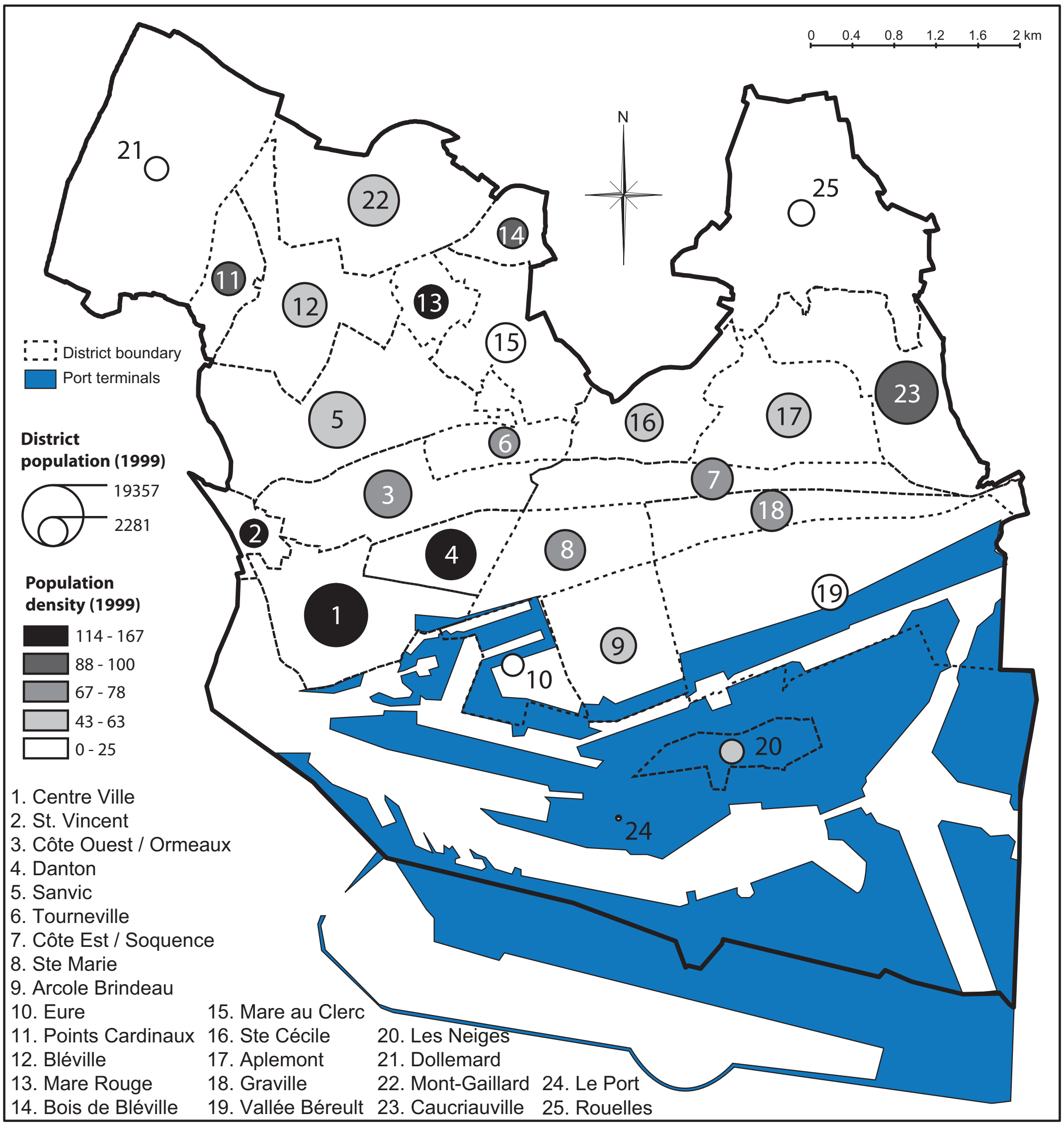
Main challenges

- ***Truck traffic from ferries***. Despite the relocation of the cargo port to Vuosaari, a considerable share (around 25%) of the cargo traffic by truck continues to use the South and West terminals.
- ***Limited rail share in hinterland modal split***. Rail carries only 5% of total hinterland traffic.

Main opportunities

- ***Expanding the port and maritime cluster***. Helsinki has a relatively high share of shipping patents. It also has a niche shipbuilding cluster, and government programmes have encouraged a maritime cluster in Finland. These initiatives, in combination with a port more actively connected to economic development opportunities, could form the basis for an expanded port and maritime cluster.
- ***Port co-operation and mergers***. More critical mass could be generated, which might be necessary for railway hinterland traffic, common marketing, operational issues such as empty container handling, strategic planning and co-ordination of port specialisations.
- ***Trans-shipment***. Helsinki is a safe port of call for traffic destined for Russia, given the relatively smooth railway links from Helsinki to Russia.

France – Le Havre



Main indicators

- Port volume: 68 million tonnes in 2013; 2.5 million TEUs in 2013
- Port growth: -7% over 2003-13 (tonnes); 25% over 2003-13 (TEUs)
- Main cargo types: container (37%), dry bulk (4%), liquid bulk (56%), RORO (2%)

Main characteristics

- Le Havre is a small city of approximately 250 000 inhabitants with a large port, serving the greater Paris area and a large part of France.

Main accomplishments

- ***Improved reputation***. The port is regaining credibility, thanks to port reform and intensified international marketing efforts. The reform of French ports, instituted in 2011, which transferred cargo-handling personnel to the private sector, has managed to reassure the shipping world. Since the implementation of the reform, growth in the container sector has compared relatively favourably with that of Le Havre's main competitors.
- ***Increased regional co-operation***. Joint efforts with Rouen and Paris in the Haropa organisation (Harbours of Paris) are building on the synergy between the three ports, and has resulted in a common long-term development strategy.

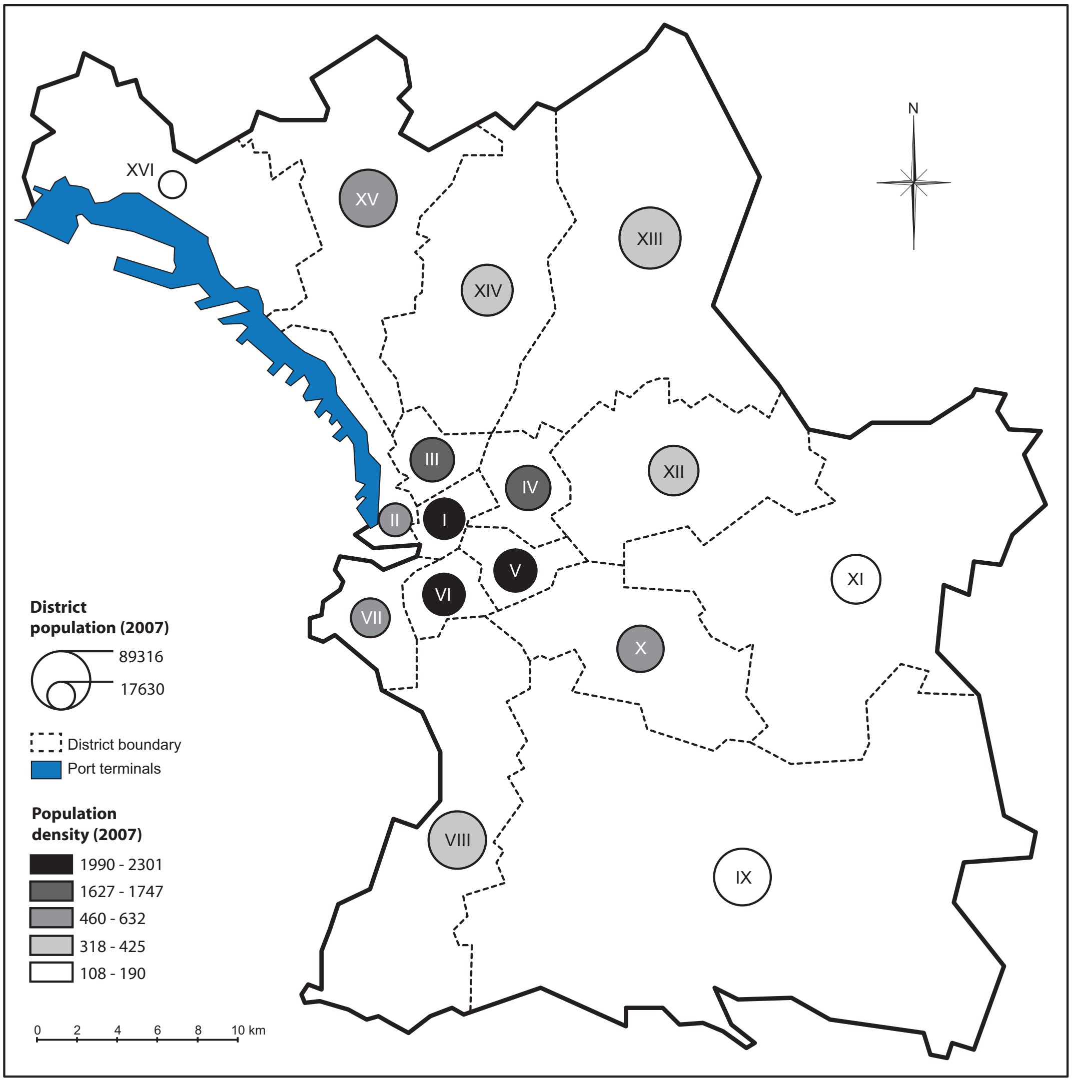
Main challenges

- ***Limited local value creation related to ports***. Most of the industrial development on the port site is not linked to port activities or Le Havre's local economic structure. Many of the high value added maritime services are based not in Le Havre, but in Paris. The multiplier of port activities is substantial, but almost none of this economic activity takes place in Le Havre.
- ***Limited development in the energy sector***. Le Havre is one of Europe's main energy ports, but new development that could enforce this function has to a large extent been located elsewhere. There will be developments in offshore wind farms, but these will be dispersed along the French Atlantic coast. New LNG terminals will built in Dunkirk and Bordeaux, but not in Le Havre.
- ***Hinterland modes other than road traffic remain problematic***. Trucks represent almost 90% of total hinterland traffic. The new container terminal, Port 2000, is poorly connected to railway and river routes.

Main opportunities

- ***Industrial ecology***. A combination of port infrastructure, industrial processes and the commodities it handles makes the Port of Le Havre a promising location for industrial ecology, and for creating value from residual products from industry, such as heat and industrial waste. Some initiatives have been started, but there is considerable potential for expansion of such processes.
- ***Canal Seine-Nord***. Plans for this canal, which would connect the Seine with the Scheldt river system and its canals – and thus with the Europe's main inland waterways – were put on hold, but have been re-launched in October 2014. It is in Le Havre's longer-term interest to be connected via the Canal Seine-Nord, so that it can compete for cargo in the north of France and the Benelux countries.

France – Marseille



Note: The Port of Marseille also includes a port site on Fos and the surrounding municipalities, which are not shown on this map.

Main indicators

- Port volume: 80 million tonnes in 2013; 1.1 million TEUs in 2013
- Port growth: -16% over 2003-13 (tonnes); 32% over 2003-13 (TEUs)
- Main cargo types: container (13%), dry bulk (16%), liquid bulk (62%), Ro/Ro (5%)

Main characteristics

- ***A multi-site port***. The Port of Marseille-Fos has two main sites: a site in the city of Marseille (East Basin), and one in the West Basin, 50 kilometres from the city of Marseille. The sites face different challenges: the East is a relatively small port in a large city, whereas the West is a large port that covers a series of small municipalities.
- ***A limited economic function***. The port is highly dependent on the petrochemical sector, and crude and refined oil products represent more than 70% of the cargo handled.

Main accomplishments

- ***Ambitious development of the port-city interface***. As part of the *Euro Méditerranée* urban redevelopment project, the relationship between the City of Marseille and the port and the waterfront has been restored. One example is the *Terrasses du Port* retail development, with a public roof terrace above one of the ferry terminals, overlooking the terminals of the East Basin.

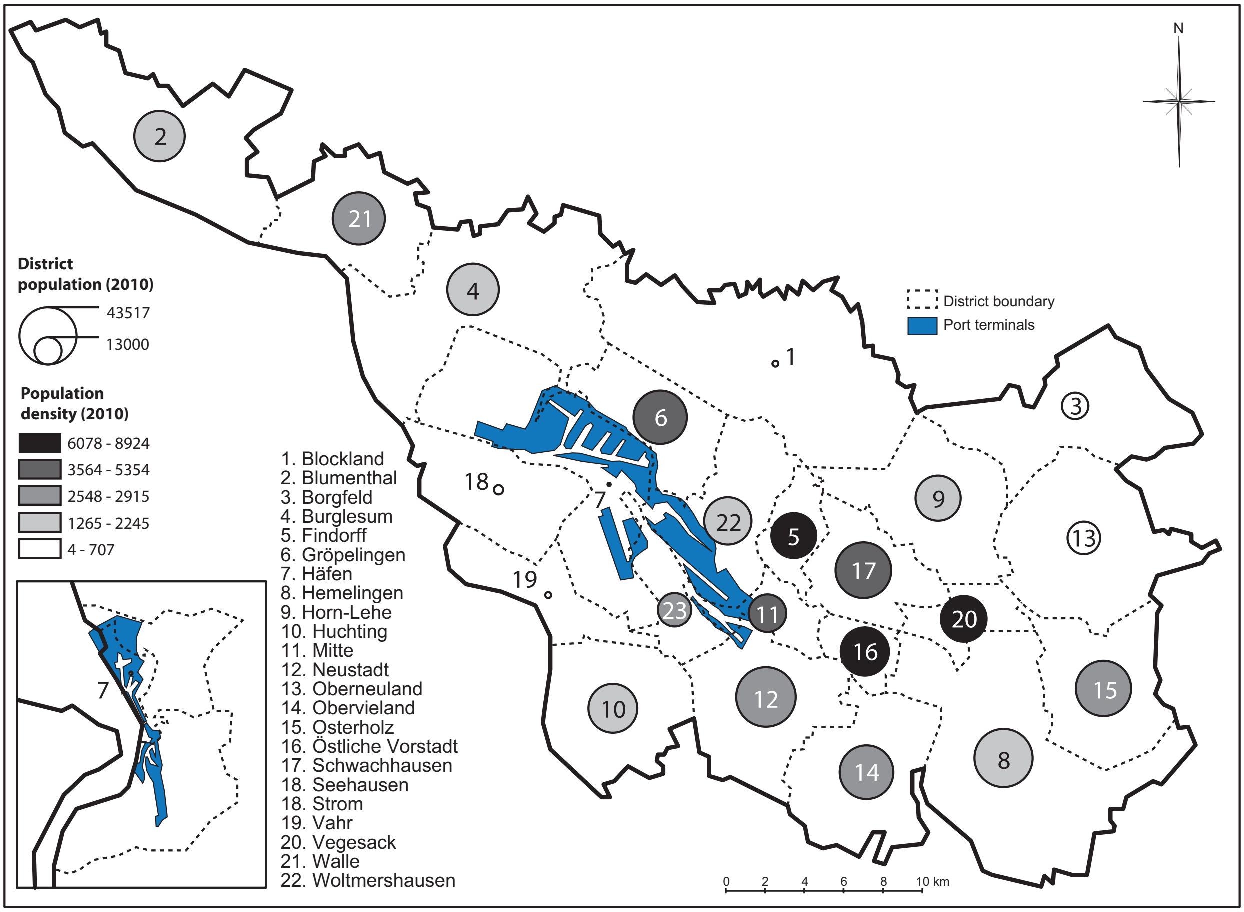
Main challenges

- ***Long-term decline in market share.*** Marseille's port stagnated from 1990 to 2011, and it dropped from Europe's second-ranked port in 1970 to its fifth-ranked in 2011, due to its declining reputation and a quasi-monopolistic position.
- ***Hinterland connectivity***. Le Havre, Antwerp and Barcelona have been competing for what was once Marseille's natural hinterland. The port's decline can only be halted by resolving port hinterland obstacles and opening up new hinterlands (e.g. a rail bypass around Lyon, and the Saone-Rhine canal).
- ***A lacklustre reputation and conflict-ridden local situation***. The French port reform, implemented in 2011, has restored some of the confidence of the shipping lines. Soft governance measures, such as more transparent information and external communication policies, have been relatively little explored in Marseille, but could help to mitigate conflictual situations.

Main opportunities

- ***Maritime cluster building***. As the home of a diverse maritime community and the headquarters of the world's third-largest container shipping company, CMA CGM, Marseille has the potential to become one of Europe's main maritime service centres.
- ***Industrial transition***. The petrochemical and refinery sector is in decline, with various refineries closing. The port-industrial sites could instead be reoriented towards green energy cluster development.

Germany – Bremen/Bremerhaven



Main indicators

- Port volume: 79 million tonnes in 2013; 5.8 million TEUs in 2013.
- Port growth: 61% over 2004-13 (tonnes); 83% over 2003-13 (TEUs)
- Main cargo types: container (77%), bulk (11%), break bulk (11%)

Main characteristics

- The city-state of Bremen has twin cities and twin ports: Bremen and Bremerhaven. Bremerhaven is located downstream at the river Weser, at a distance of 60 kilometres from Bremen that has a more upstream-location, so a lower port depth. As a result, port functions have gradually been transferred from Bremen to Bremerhaven, where more than two thirds of the total port traffic is now concentrated, including the container and car traffic. Bremerhaven is a large port in a fairly small city. Most of the maritime high value added services are located in Bremen, not in Bremerhaven.

Main accomplishments

- ***Economic diversification***. After a deep economic crisis throughout the 1980s and 1990s, in which the iconic shipbuilding industry in Bremen disappeared and unemployment rates attained record levels, Bremen has been able to recover. The city-state's Economic Policy Action Plan, which commenced in 1984, stimulated the reconversion of Bremen as an industrial port-city towards a modern city of science, by attracting research institutes and stimulating advanced technological sectors, such as aerospace, that need access to a seaport. Old port areas have been reconverted in projects such as "Overseas City", which started in 2001. In Bremerhaven, development projects such as *Hafenwelten* (Harbour Worlds) have successfully revived the city by developing research centres, such as the German Emigration Centre and the Climate House, that build upon the local maritime tradition.
- ***Off-shore wind energy cluster in the port***. Thanks to strong and pro-active policies, Bremen/Bremerhaven has developed into one of the European hub ports for off shore wind energy. Specific infrastructural investments, availability of land, fiscal and financial support for developers and efficient permit procedures have facilitated the location of wind energy-related manufacturers, service providers and research institutes close to the port area.

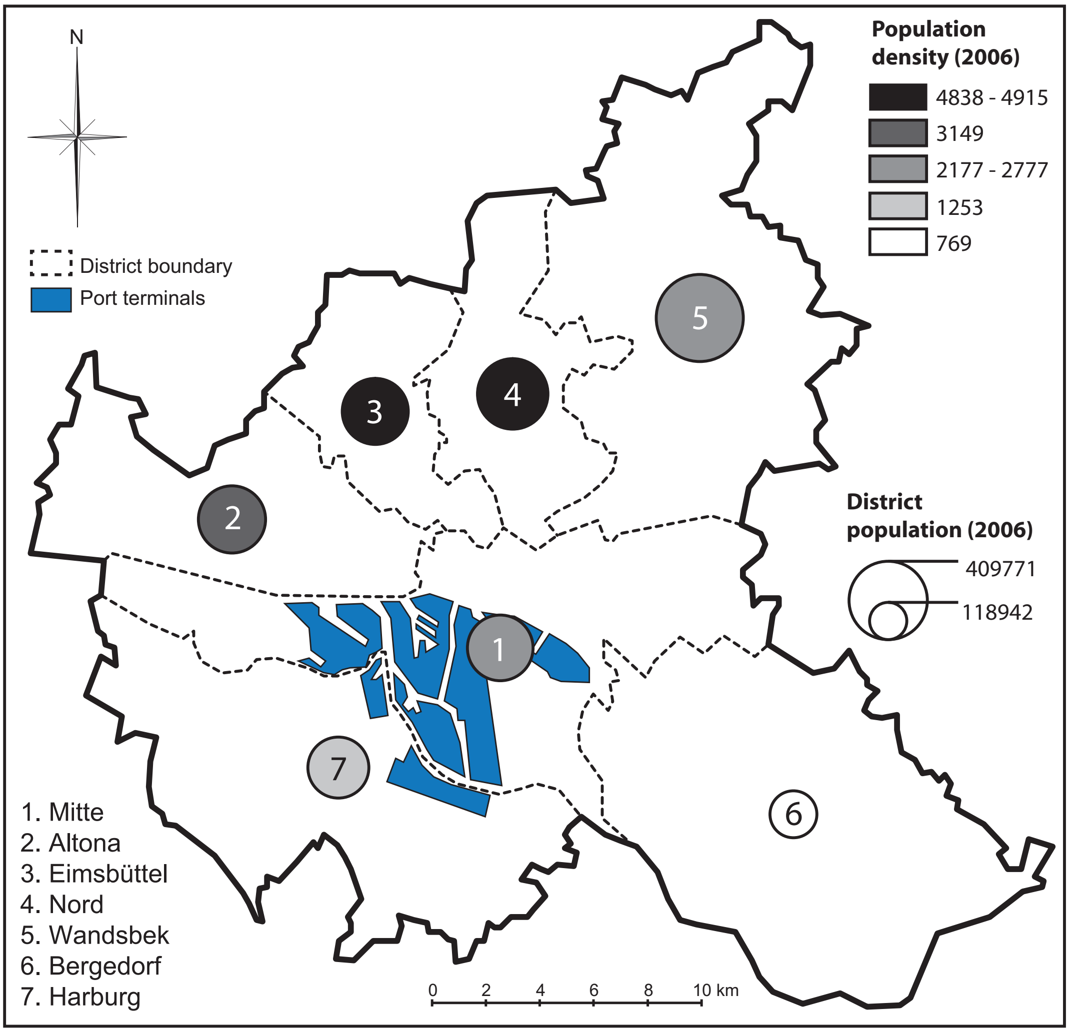
Main challenges

- ***Governance.*** The city-state of Bremen is the smallest state in Germany and consists of the two cities of Bremen and Bremerhaven, located a 60 kilometres distance from each other, and but surrounded by the state of Lower Saxony. This peculiar situation poses various challenges. Bremerhaven is the largest port, but it is owned by the city of Bremen where more high port-related high value activities are located. The port economic linkages extend beyond the boundaries of the city-state, and most of the sub-urban development has taken place outside the city of Bremen, which means that most of the fiscal benefits from port-related activity do not accrue to Bremen itself, which has exacerbated its public debt and financial deficits. This combination of elements has resulted in a more or less constant need for lobbying the federal government, e.g. for improving hinterland connections, constructing a ring road around Bremen and dredging of the river Weser to keep the port of Bremen accessible.

Main opportunities

- ***Consolidation of container shipping***. The State of Bremen has a 49.9% stake in the new Jade-Weser Port, located 40 kilometres west of Bremerhaven, that started operations in 2012, but that did not yet manage to attract large cargo flows. This can be explained by container terminal overcapacity in North-West Europe and fairly unexpected inclusion of Baltic Sea ports in service loops of large container carriers. Consolidation in the container shipping industry, such as via currently planned vessel sharing agreements might change the fortunes of the Jade-Weser Port, as well as Bremerhaven.

Germany – Hamburg



Main indicators

- Port volume: 139 million tonnes in 2013; 9.3 million TEUs in 2013
- Port growth: 31% over 2003-13 (tonnes); 52% over 2003-13 (TEUs)
- Main cargo types: container (68%), dry bulk (18%), liquid bulk (11%)

Main characteristics

Located right in the centre of the city, the Port of Hamburg is the main hub for traffic from and to the Baltic Sea and a gateway for cargo to Central Europe. The creation of HafenCity is the largest on-going transformation in Europe of a historical port site.

Main accomplishments

- ***Centrality***. Hamburg is one of the main European centres in maritime services, with a high concentration of regional headquarters, maritime consultancies and ship finance. It also benefits from an elevated quality of living.
- ***Hinterland rail connections***. Hamburg has a high share of rail in its hinterland modal split (37% in 2010). This share has gradually increased in the last decade from approximately 28% in 2000.
- ***Local goodwill***. The port enjoys considerable support from the local population, facilitated by pro-active port communication policies, which include port events (port anniversary, cruise days), public access to the port and Port TV.

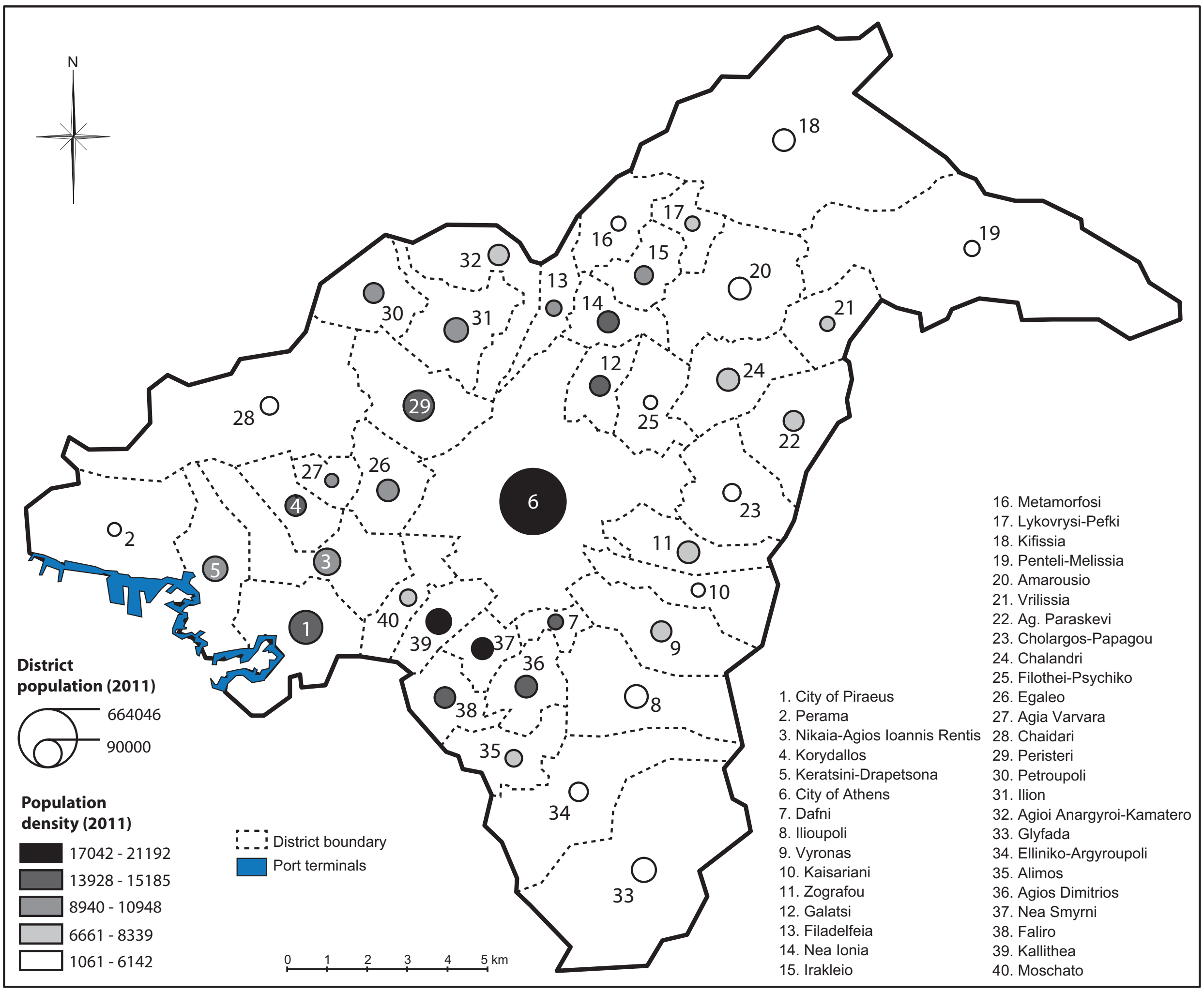
Main challenges

- ***Nautical access***. Hamburg is an estuary port, and the largest ships can only call at the port if they respect restrictive tidal conditions. Dredging of the river Elbe will be needed to sustain port growth, but this is controversial and currently under review.
- ***Relative lack of competition***. The lion's share of container handling services is conducted by two terminal operators, both German. An attempt to open up the market for competition has so far stalled. The city is shareholder not only of the port authority, but also of terminal operator HHLA and shipping line Hapag-Lloyd.
- ***Space constraints***. Logistics has migrated beyond Hamburg itself. Logistics functions are increasingly handled outside the city-region of Hamburg, sometimes in municipalities that have no interest in or experience with distribution centres.
- ***Mitigation of the impact of cruise traffic***. Cruise shipping to Hamburg is increasing, and new cruise terminals have been set up close to urban residents. In the case of the HafenCity, planning regulations have to some extent mitigated the impact of noise and pollution from cruise ships, but more measures may henceforth be necessary.
- ***Intergovernmental relations***. The Port of Hamburg serves the whole of Germany, and is dependent on the governments of other states that exercise jurisdiction over the River Elbe, which connects Hamburg to the North Sea. Hamburg is also dependent on the federal statefor dredging the Elbe and replacement of the locks in the Kiel Canal.

Main opportunities

- *Synergies with Bremen/Bremerhaven*. Bremen is oriented towards North American markets, whereas Hamburg has traditionally had strong connections with Asia. The overlap of their maritime hinterlands is the lowest among the main multi-port gateways in the world.

Greece – Piraeus/Athens



Main indicators

- Port volume: 35 million tonnes in 2012; 3.2 million TEU in 2013
- Port growth: 65% over 2003-12 (tonnes); 97% over 2003-13 (TEU)

Main characteristics

- Piraeus has large maritime- and tourism-oriented sectors; Athens has a world leading maritime cluster, with many ship-owners.

Main accomplishments

- ***Spectacular growth rates in recent years***. The largest share of Piraeus's container terminals is since 2010 operated by Cosco Pacific, which has greatly improved terminal efficiency and attractiveness of Piraeus to global shipping lines, despite concerns over local labour standards. As a result container throughput at Piraeus increased from 0.8 million TEUs in 2010 to 3.1 in 2013.

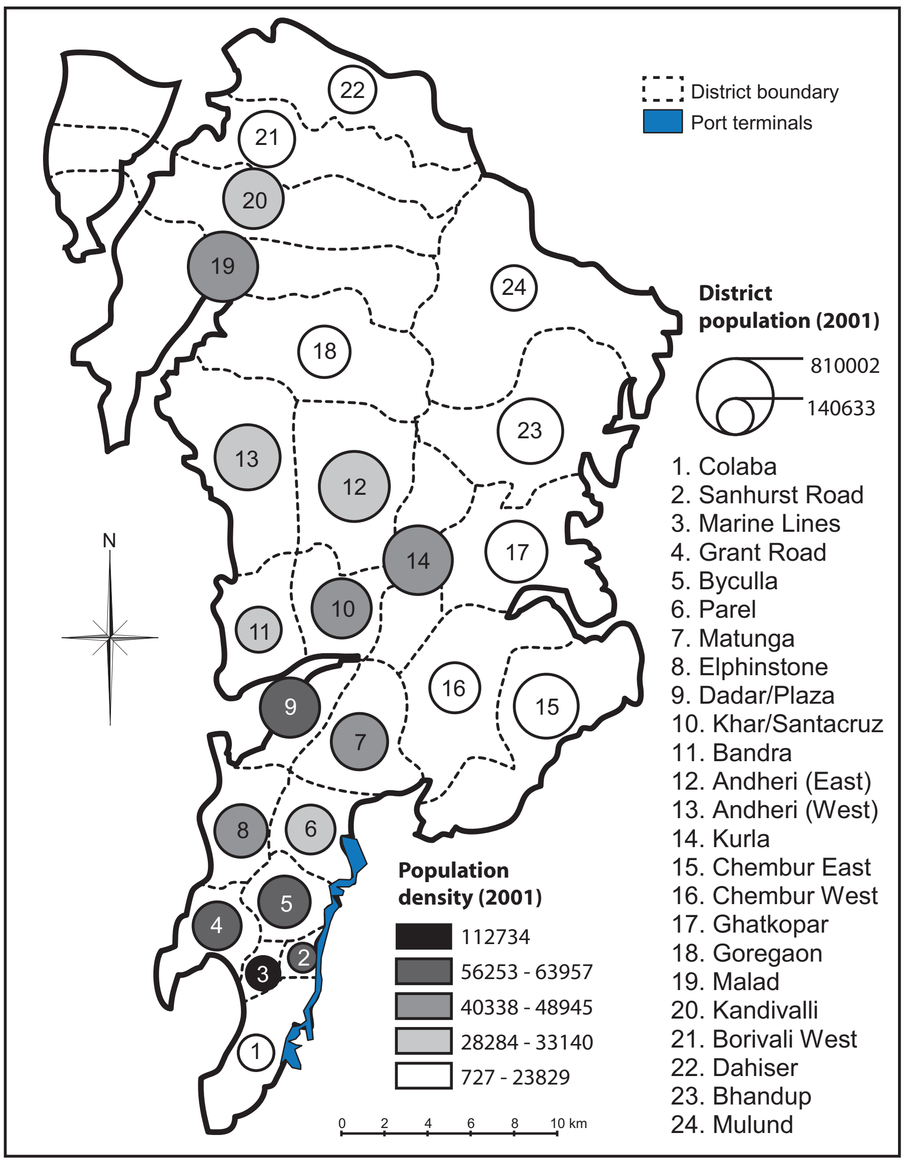
Main challenges

- ***Manage local impacts of port expansions***. Various expansions of the port are ongoing or planned which will add to the already fairly adverse environmental and traffic impacts: almost 1,600 port-related trucks per day through Piraeus and metropolitan Athens in the peak year 2007, and up to 1000 coaches on the road in case of full capacity at the cruise terminals. Mitigating measures would include an uptake of the train connection of the port to the Thriassion plain, and a proposed monorail around the cruise and passenger berths.
- ***Local economic value creation***. The direct and indirect port-related value added in Piraeus port has been estimated at EUR 4.2 billion in 2009 by the National Bank of Greece, with estimated port-related employment of 94,000 jobs. Arguably most of these economic impacts spill over to the country a whole, as well as other Eastern Mediterranean countries.

Main opportunities

- ***Privatisation***. The privatisation of main Greek ports forms part of the policy package designed to deal with public debt reduction in Greece. The main political choice is between privatisation of the remaining operations of the port via concessions, or the sale of the shares currently owned by the government (74.1%), which would imply privatisation of both operations and port authority functions, with the latter often of a more regulatory nature. Although a sale would bring immediate revenues, it would also complicate the port-city interface as the port would then principally serve private interests. From a context of regional policy alignment, privatisation of port operations - via new concessions and the development of the PPA into a public "landlord port" - appears more promising.
- *Regional co-operation*. Political commitment to sale of the government shares of PPA could unblock the proposal to create a regional port organisation for the ports of Attica, which would include Piraeus, Lavrion, Rafina and Eleusis. Such a regional regrouping of ports could help to reap regional synergies and complementarities between regional ports. It could also open a window of opportunity for considering more local participation in port governance, in addition to the current local board seat for the mayor of Piraeus. Considering the joint local and national interests, a more hybrid share-holdership of the PPA might be considered.

India – Mumbai



Note: This map does not include the Jawaharlal Nehru Port (JNPT).

Main indicators

- Port volume: 4.2 million TEU in 2013
- Port growth: 83% over 2003-13 (TEU)

Main characteristics

- Mumbai has two main ports the Mumbai Port Trust (MPT) and the Jawaharlal Nehru Port (JNP), also known as Nhava Sheva port. The MPT is located on the crowded Mumbai peninsula, and JNPT port just opposite, on New Mumbai, where it has been operating since 1989. JNPT, the largest port in India, handles around 65% of India's containerised cargo; the share of MPT is marginal.

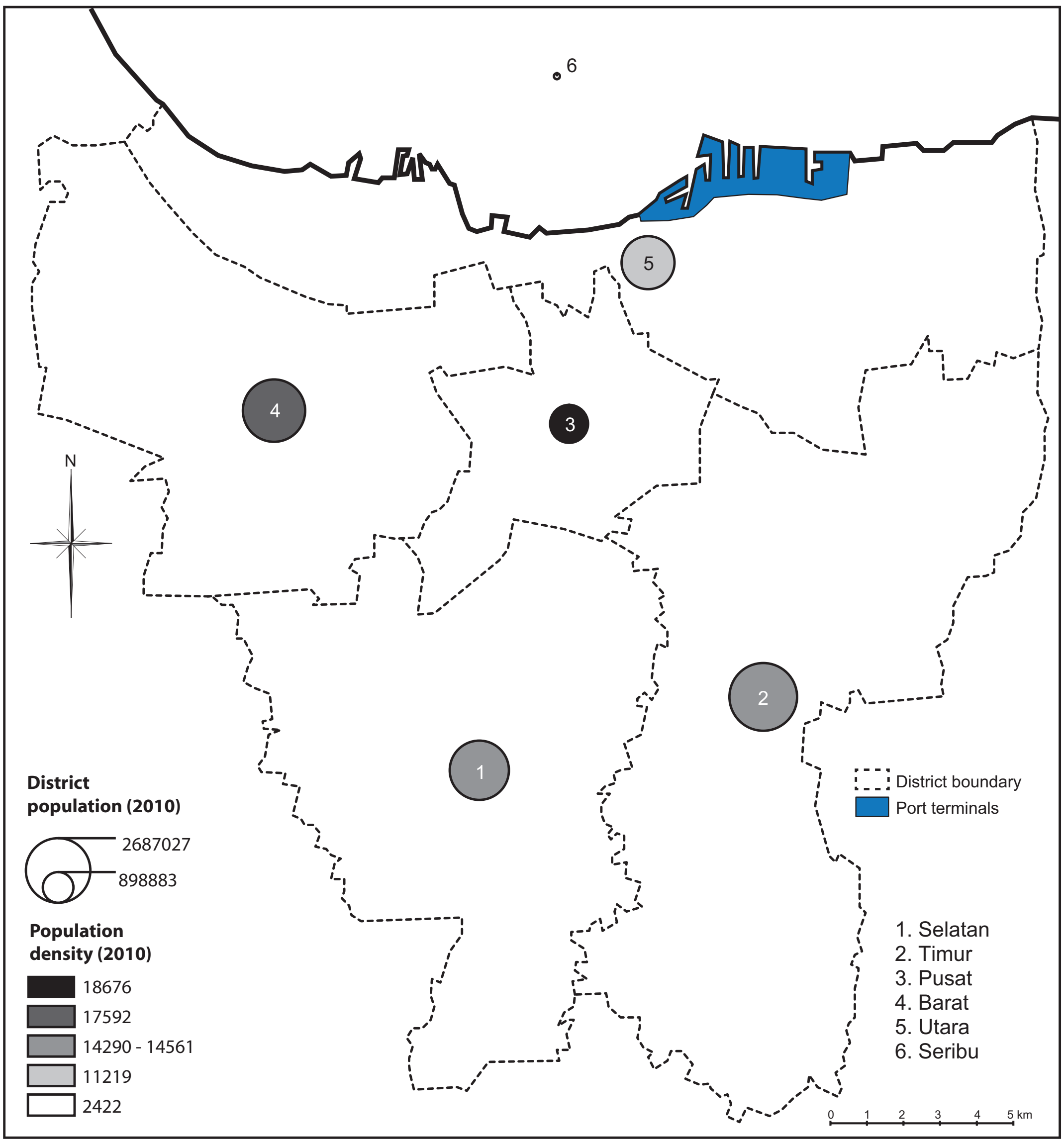
Main challenges

- ***Port capacity***. India lacks port infrastructure, hence the concentration in JNP.
- ***Trans-shipment hub***. Despite India's convenient location on the Asia-European shipping route, it has little direct port calls; most of the cargo is trans-shipped via Singapore, Colombo, Dubai or Salalah. JNP is not particularly suited to becoming a trans-shipment hub, given its draft limitations.
- ***Port congestion***. Vessel turnaround time in the port has improved over the last decade, but is still relatively poor by comparison with other ports in India. As a result, there are long vessel waiting times and substantial port-related truck congestion.
- ***Port inefficiency***. The Mumbai Port Trust employs approximately 30 000 workers, which is considered a source of the port's inefficiency. To improve the port's performance, the Asian Development Bank (ADB) recommended cutting the labour force by 85%. Labour union mobilisation has made this impossible, but hiring has been frozen and a Volunteer Retirement Scheme has been introduced.
- ***Regulation***. Indian ports in general suffer from heavy regulation; this includes tariff regulation via the Tariff Authority for Major Ports (TAMP) and the involvement of multiple ministries for the clearance of port projects. Some of the world's largest terminal operators have not been able to work in Mumbai for this reason: HPH was not allowed to bid for a JNP Terminal 3 for security reasons and PSA withdrew from its involvement in JNP Terminal 4 in 2012 for bureaucratic reasons.

Main opportunities

- ***Delhi-Mumbai Industrial Corridor***. This mega-project aims to create an industrial and transport corridor between Delhi and Mumbai. It could both improve hinterland connectivity for JNP and create value-added activities linked to the port.
- *Urban redevelopment*. Part of the MPT site could be transformed for urban development and generate more value added to the port-city than at present.

Indonesia – Jakarta



Main indicators

- Port volume: 6.2 million TEUs in 2013
- Port growth: 110% per year over 2003-13 (TEU)

Main characteristics

- Tanjung Priok, the seaport of Jakarta, is the country's main gateway, handling approximately 65% of the external trade volumes of Indonesia.

Main challenges

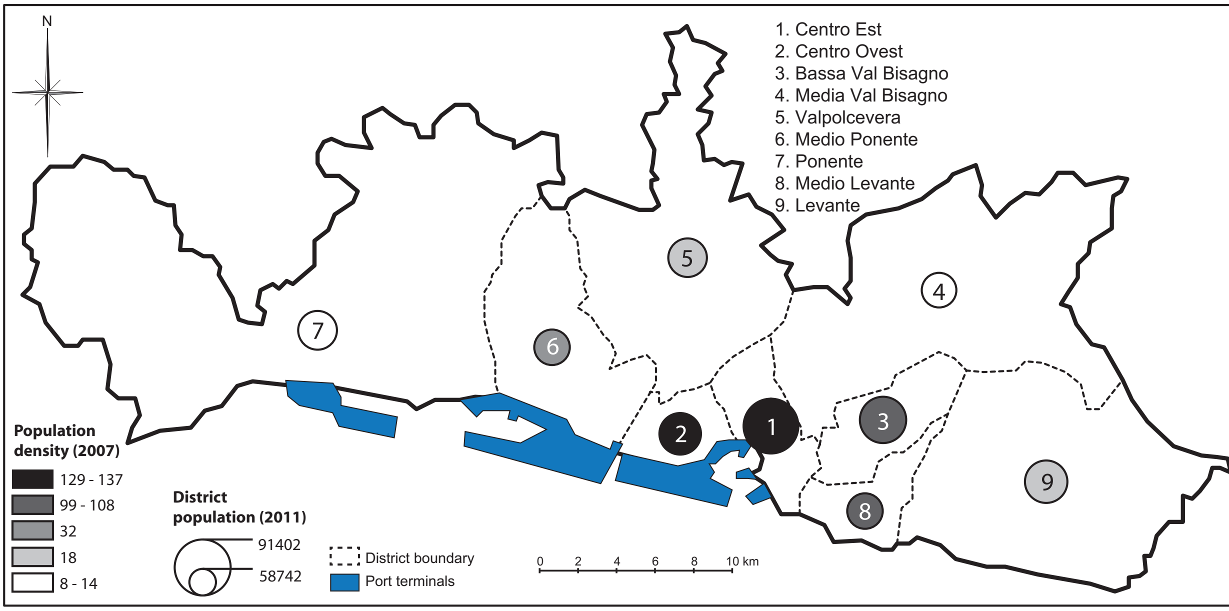
- ***Port congestion.*** There is huge congestion in and around the port, with frequent queues before the gates of several kilometres long. This is related to under-capacity and operational inefficiencies: the average import container dwell time at Tanjung Priok Port has increased from 4.8 days in 2010 to 6.4 days in 2013, leading to high logistics costs for businesses. According to the World Bank, the main cause of the delay is the pre-clearance stage, accounting for 58 percent of dwell time. A faster removal of the containers after the customs clearance would require larger investments that would entail road improvements, and possibly transformation of the trucking industry.
- ***Lack of competition***. The two main container terminals in Tanjung Priok, Jakarta International Container Terminal (JICT) and Koja, are both operated by a joint venture of Hutchison Port Holdings (HPH) and the regional port state operator Pelindo II, which means that there is hardly any intra-port competition. Considering the dominance of Tanjung Priok in Indonesian container traffic (70% of the volumes), it is not subject to much competitive pressure. An active strategy of encouraging port competition could be adopted, including allowing private terminals to handle third-party cargoes, competitive allocation of port service licences and restricting bidding for new opportunities from dominant operators. More competition could be the result of new ports currently under construction, including one in North Jakarta (Kalibaru). Competition could also be introduced through the process of port expansion at Tanjung Priok and by having different operators for JICT and Koja when lease agreements expire in 2019 and 2020 respectively. Restrictive cabotage rules have kept inter-island shipping expensive; liberalisation of cabotage would present a growth opportunity for Tanjung Priok.

Main opportunities

- ***New port development and expansion***. The port extension project at Jakarta's Tanjung Priok Port will triple the annual capacity of the port to 18 million TEU of container capacity upon its completion in 2023. A new port development project, the Cilamaya seaport in West Java, is one of the priorities in the national government's MP3EI-plan[1]. New port development could ease congestion at Tanjung Priok; the development of multiple freight gateways could also make Jakarta more resilient, as it has a high vulnerability to natural disasters including floodings.

1 The Master Plan of Acceleration and Expansion of Indonesia Economic Development (MP3EI). The port development project is also part of the Master Plan for Establishing Metropolitan Priority Area (MPA) for Investment and Industry.

Italy - Genoa



Main indicators

- Port volume: 49.5 million tonnes in 2013; 2.0 million TEU in 2013.
- Port growth: -8% over 2003-13 (tonnes); 24% over 2003-13 (TEU)
- Main cargo types: container (40%), dry bulk (9%), liquid bulk (35%), Ro/Ro (16%)

Main characteristics

- Since ancient times, the economic development of Genoa has been inextricably linked to its harbour. Over the years, the port expanded westwards, culminating in the technologically advanced container terminal in Voltri, creating an uninterrupted port area along the coast with a length of 20 kilometres.
- Genoa ranks as the premier maritime gateway to Italy. Although the Port of Gioia Tauro handles larger container volumes, it is a hub port which caters for transhipment cargo, whereas Genoa is one of the top Southern European gateway ports.

Main accomplishments

- ***Waterfront development***. The urban transformation of the old port of Genoa (Porto Antico) can be considered a success story, integrating remaining port functions (cruise and ferry terminals) with a new site along the waterfront accommodating major public attractions, whilst stitching together the old port basin and the historic city centre. The redevelopment of the waterfront, conceived as a pedestrian vehicle-free zone, included the renovation of old industrial buildings and the introduction of new features which conjure up maritime imagery. The organisation of large events, including Expo '92 to mark the 500th anniversary of the discovery of America and the European Capital of Culture in 2004, has been the driving force behind this regeneration. As a result, Porto Antico now ranks as one of the city's top visitor attractions.

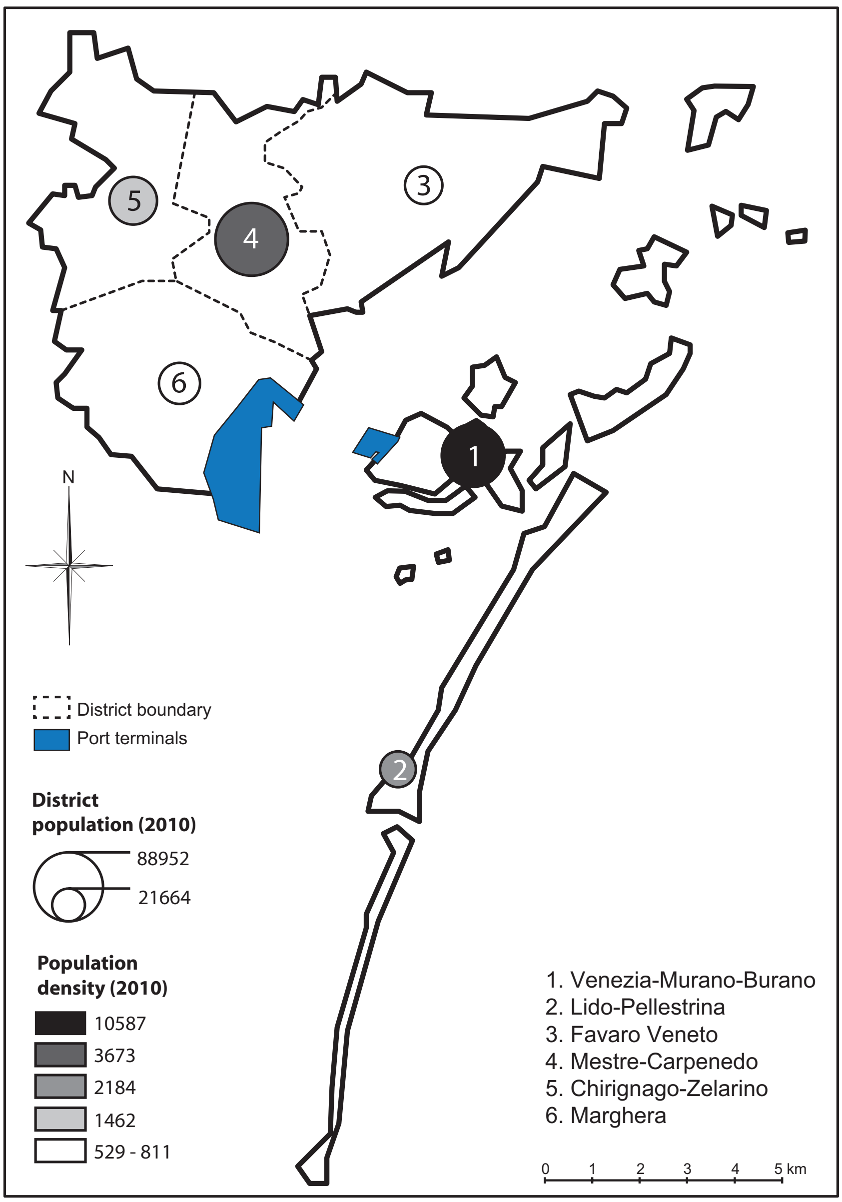
Main challenges

- ***Port-related congestion***. It is estimated that on average 3,600 port-related trucks cross the city each day; as the port is located in the city centre, these trucks flow directly into urban arteries mixing with urban traffic flows, leading to high congestion rates. The share of rail in the hinterland modal split of Genoa is approximately 20%, above the average for Italian ports, but below various other large European ports. The rail share could be increased by liberalisation of freight rail, optimisation of resources and modernisation of infrastructure. The Italian policy to stimulate national short sea traffic with subsidies has not resulted in considerable modal shifts.
- ***Hinterland connectivity***. The hinterland of the port of Genoa comprises, above all, the major industrial and consumer centres of northern Italy, but the port community is also firmly committed to capitalising upon Genoa's strategic location in proximity to the primary manufacturing regions of Central Europe, specifically, southern Germany and Switzerland. Policies are geared towards regaining the market shares in these areas, which could be considered natural hinterlands for the port of Genoa, but which over the years have been acquired by ports such as Rotterdam and Antwerp. The encroachment can partly be explained by geographical barriers (the Apennines and the Alps) that limit hinterland connectivity, and a recent dearth of investment in major rail infrastructure projects. Nevertheless, to date, the European railway corridor 24 (Genoa-Rotterdam), and in particular the third railway line across the Apennines, currently under construction and part of the TEN-T Programme, should help improve the inland connections of the port of Genoa with North Italy and the rest of Europe.
- ***Administrative burdens***. Despite promising projects in the port of Genoa to reduce red tape, e.g. by pre-clearing and by wider use of ICT applications, the maritime industry has indicated that further progress is possible. Administrative procedures related to port cargo involve 18 different entities with often overlapping jurisdictions. Solving the inefficiencies related to this could take the form of a Single Window for all administrative procedures, to be extended to the whole port hinterland, including the extensive network of dry ports connected to the port of Genoa, such as Alessandria.

Main opportunities

Port reform. This could solve the fragmentation of the Italian ports system. In addition to Genoa, there are two other relatively large ports in the Liguria region, namely Savona and La Spezia. Co-operation between these ports already takes place in joint marketing and co-ordination of logistics, but co-operation could go much further. Port reform plans included the merger of the 24 main ports in Italy into larger entities. Transforming Genoa and Savona into a combined port could enhance their overall competitive position. In addition, an increase in the financial autonomy of the port authorities could give them more flexibility to undertake strategic investments.

Italy – Venice



Main indicators

- Port volume: 24 million tonnes in 2013; 0.4 million TEU in 2013
- Port growth: -16% over 2003-13 (tonnes); 57% over 2003-13 (TEU)
- Main cargo types: general cargo (32%), liquid bulk (41%), dry bulk (27%)

Main characteristics

- The Port of Venice is located on the former industrial site of Porto Marghera, in the Venice Lagoon, while the cruise terminal is located in the historical city centre.

Main accomplishments

- ***Regional co-operation***. The North Adriatic Ports Association (NAPA), established in 2010, brought together the Italian ports of Venice and Trieste, the Slovenian port of Koper and the Croatian port of Rijeka. Venice is one of the leaders in building regional co-operation and promoting the Adriatic ports as an alternative to North-West European ports to service hinterlands in central Europe, Switzerland, Austria and southern Germany. This has been achieved by joint marketing and research showing that carbon emissions can be reduced by using Adriatic ports.

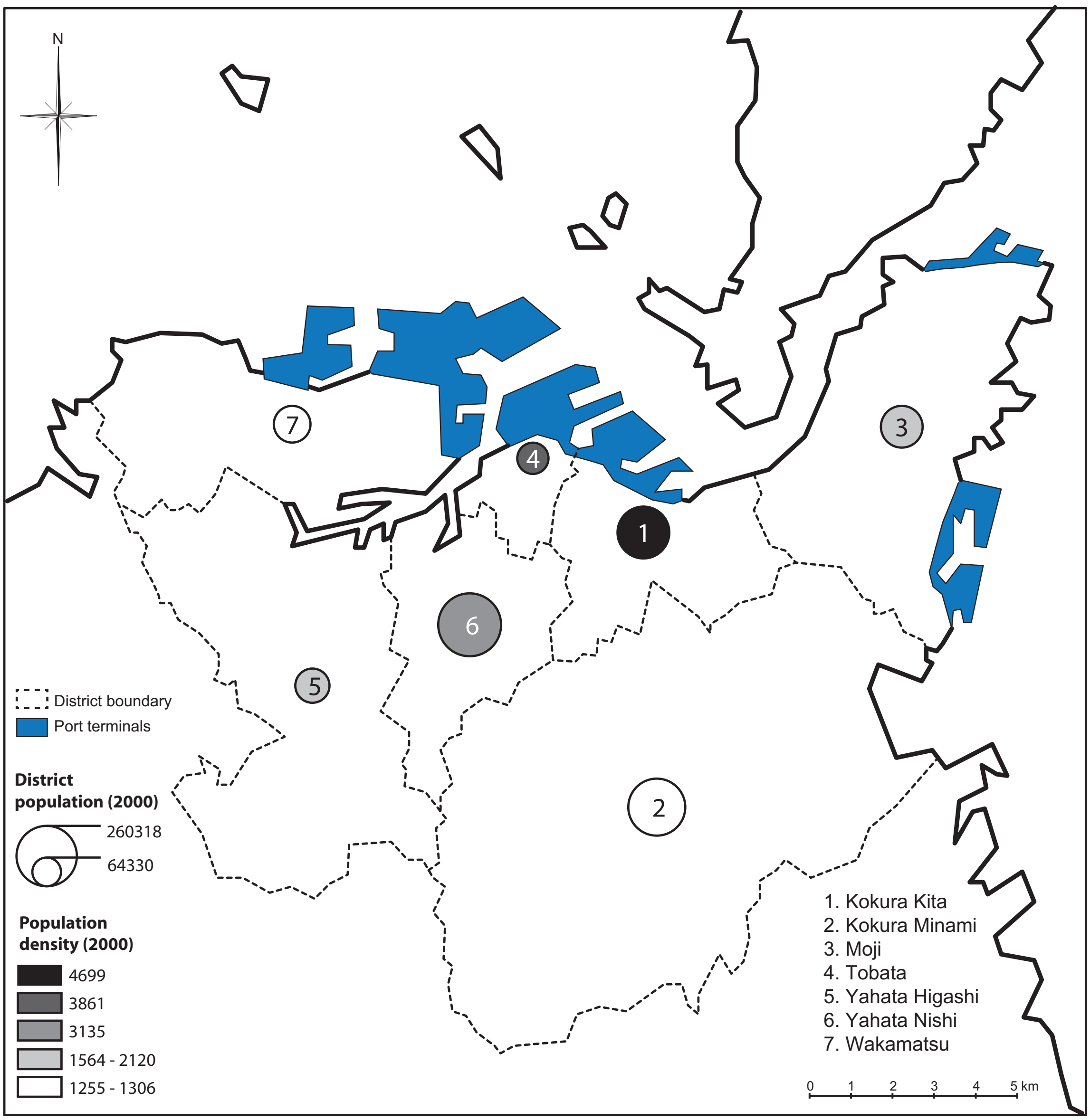
Main challenges

- ***The impact of cruise ships***. In 2012, 1.8 million cruise tourists visited Venice, almost six times as many as in 2000. This explosive growth has generated public opposition to cruise shipping and its negative aspects, such as pollution, its visual impact and the erosion of the Venice Lagoon. The Italian government passed a decree to cap the size of cruise ships allowed in Venice, provided that alternative routes could be used instead of the current approach route via the Giudecca and San Marco canals. However, this decree has so far not be implemented, given the complexities and controversies surrounding alternative approach routes.
- ***Fragmentation***. Italy has a large number of cargo ports and public investment in ports has been fragmented: none of the Italian gateway ports has the size and hinterland connections needed to play a role beyond its direct hinterland. The Port of Venice would benefit from a more sustained national strategy for ports.

Main opportunities

New offshore container port. In 2010, the Port of Venice proposed to build an offshore container terminal 15 kilometres from Venice, to be connected by barges with Port Marghera, the current location of the Port of Venice. The European Union is willing to contribute EUR 770 million and the Italian government EUR 100 million, but the main challenge will be to find private parties willing to finance the remainder (EUR 0.5 billion). The new container port would create container-handling capacity of 1.4 million TEU in the first phase of the project.

Japan – Kitakyushu



Main indicators

- Port volume: 101 million tonnes in 2013; 0.5 million TEU in 2013
- Main cargo types: containerised cargo (7%), break bulk (45%), Ro/Ro (47%)

Main characteristics

- Kitakyushu is currently Japan's sixth-largest port.

Main accomplishments

- ***Port efficiency***. Kitakyushu is one of the most efficient ports in the world. The average vessel turnaround time in the port is one of the lowest in the world, according to our calculations.
- ***Green policies.*** Kitakyushu port has applied onshore power electricity, and the city is actively engaged in changing the modal split of the hinterland traffic towards a more sustainable mode (with more rail and fewer trucks). The Kitakyushu Seaport and Airport Bureau administering the port has developed the concept of "Green Energy Port Hibiki", clustering environmental and energy industries in the waterfront area and promoting the location of renewable energy facilities, such as wind energy, solar and biomass energy.

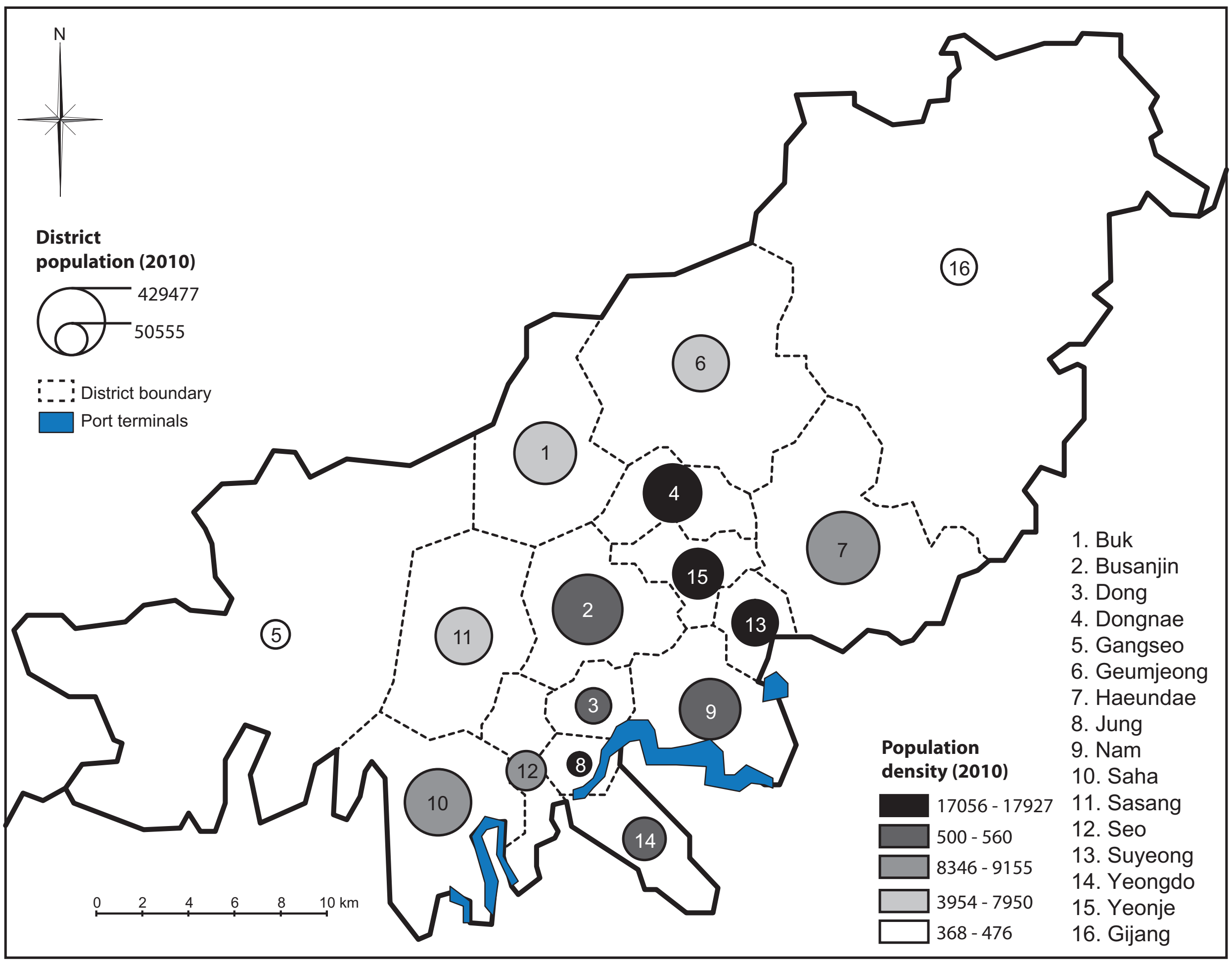
Main challenges

- ***Limited port growth***. The Port of Kitakyushu has almost exactly the same cargo volumes in 2009 as in 1972, whereas the metropolitan population of Kitakyushu-Fukuoka increased by 70% over the period, and other Japanese ports, such as Nagoya and Osaka, experienced comfortable growth rates in these decades.
- ***Modest international port profile***. The cargo at the Port of Kitakyushu is more than 70% domestic, a higher share than in most Japanese ports. In Japan's largest ports, such as Nagoya, Chiba and Yokohama, 35%-40% of the cargo is domestic and 60%-65% international. This limited international exposure is confirmed by calculations of hub functions and foreland diversification, where Kitakyushu trails behind most Japanese and many world ports. Moreover, the international connections of the Port of Kitakyushu have become more focused on the main Chinese and Japanese ports and less on other international ports. An explanation for the limited international share of cargo can be found in the port specialisation pattern in Kitakyushu. It has limited shares of container traffic, which has become the main transport mode for international trade, but high shares of roll on/roll off (Ro/Ro) traffic, which are subject to stringent restrictions in Japan. Foreign-made truck chassis are not allowed on Japanese roads.

Main opportunities

- ***Regional connectivity***. Kitakyushu promotes itself as a major node for combined sea and rail traffic from China to Tokyo. This could not only attract more port traffic, but also extend the number of port connections and strengthen its hub position. The national government could help Kitakyushu by easing restrictions on foreign-made chassis, to stimulate truck flows between Japan, China and South Korea.
- *Expansion of green policies*. In various aspects of green policy, including tidal energy, different actors in the city have conducted research and feasibility studies that could now be put into effect.

Korea – Busan



Main indicators

- Port volume: 271 million tonnes in 2013; 17.7 million TEU in 2013
- Port growth:70% over 2003-13; 72% over 2003-13 (TEU)
- Main cargo types: container

Main characteristics

- The Port of Busan has two different port sites: the North Port and the New Port.

Main accomplishments

- Formidable growth rates, even during the global economic crisis and slowdown in Asia.

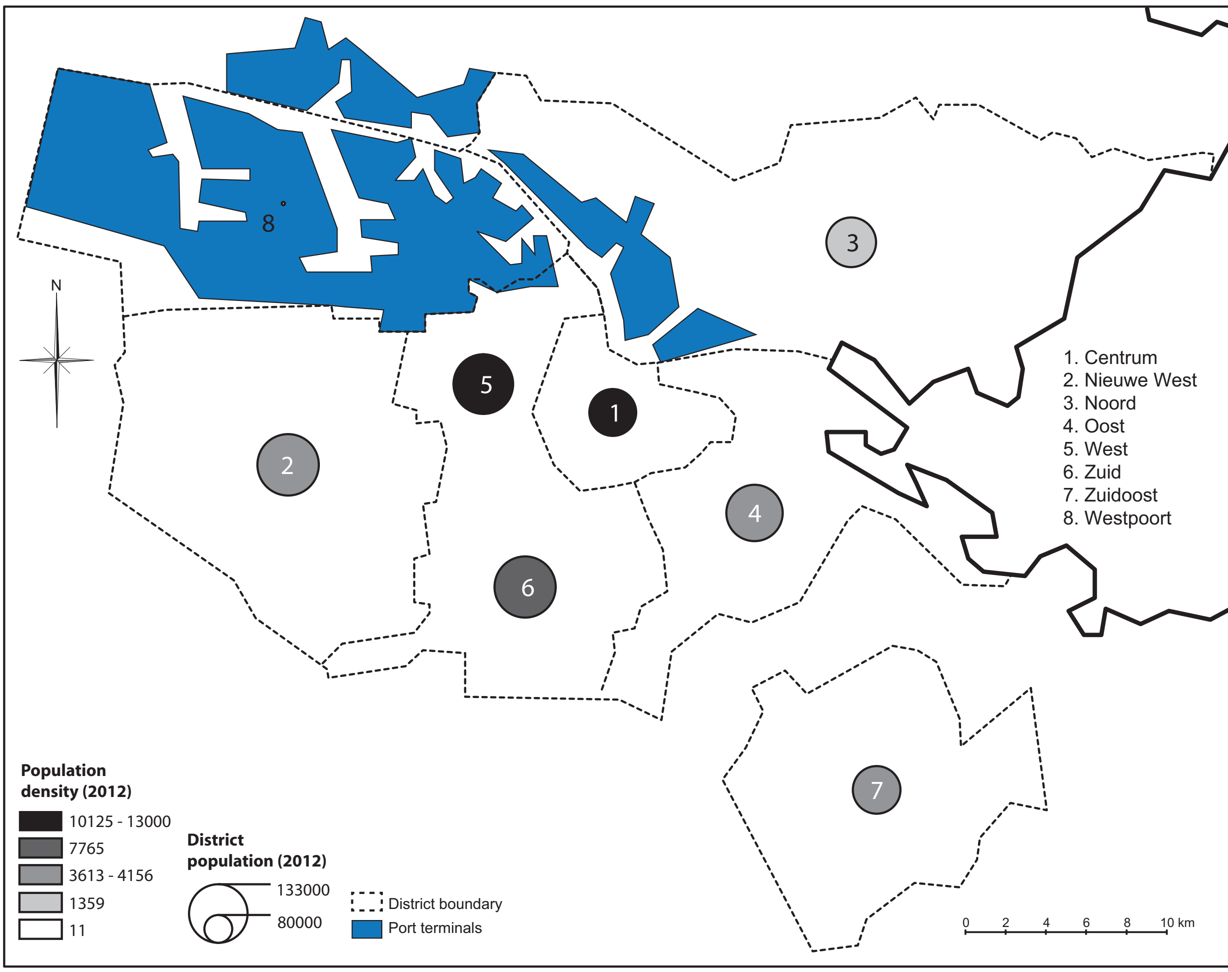
Main challenges

- ***Local economic value creation***. The Port of Busan used to have relatively limited economic value creation connected to its port. Space constraints of the city-port limited possibilities for value added activities, such as logistics services. Both the New Port development and North Port redevelopment could change this dynamic. The New Port expansion involves the construction of three logistics parks that could accommodate value added activities, including assembly, packaging, storage and manufacturing. The North Port redevelopment opens the prospect of more consumer- and tourist-driven economic development. The challenge for both developments will be to design and attract activities of a unique character that will not be easy to replicate in the competing port-cities.
- ***Road congestion***. In the past decade, the Port of Busan has increased its share of trans-shipment traffic, which was 45% in 2011. The largest vessels carrying this trans-shipment cargo use the New Port, whereas the smaller feeder vessels that transport the transhipment cargo to ports in the region predominantly use the North Port. As a result, there is lot of truck traffic between the New Port and North Port to facilitate the connection between transhipment and feeder traffic. The Busan North Bridge construction, completed in 2014, is expected to mitigate this traffic congestion. Further increases could be realised by transferring larger shares of container traffic from North Port to the New Port.

Main opportunities

- ***Port-city development***. Some of the cargo traffic has moved from the North Port to the New Port area, and the North Port area is being redeveloped, which will include an urban waterfront with housing, industrial, cultural and recreational uses. This waterfront development, covering 1.5 million square metres and costing over USD 8.5 billion, will include a new International Cruise Terminal, operational in 2015 and designed to receive 2.7 million passengers per year. Other public facilities will include a marina and a convention centre.
- ***Trans-shipment***. The increasing trans-shipment traffic to Busan has been one of the drivers of its strong port growth, and the expectation is that the trans-shipment share will continue to grow, from 45% in 2011 to 60% in 2020. This expectation is based on Busan's geographical location (between China and Japan), good weather conditions and the expansion of free trade agreements by the Korean government. The rise of intra-Asian container traffic could also benefit the Port of Busan. Its trans-shipment ambitions are supported by the expansion of the New Port, the final phases of which are planned for 2020. A further impetus to Busan's trans-shipment position could arise if there were a rapprochement between North and South Korea. This would make it possible to link Busan by rail to the Eurasian land mass.
- *Corporatisation*. Busan Port Authority confirms that it has the permission of the South Korean government to act autonomously as a public enterprise. This would give the port authority sole responsibility for its budget, management and workforce, which could facilitate the ongoing port extension projects.

Netherlands – Amsterdam



Note: Due to land use changes in Amsterdam over the last decade, the map approximates the land use of the port of Amsterdam, without being completely aligned to a representation of the actual situation in 2014.

Main indicators

- Port volume: 96 million tonnes in 2013
- Port growth: 46% over 2003-13 (tonnes)
- Main cargo types: dry bulk (48%), liquid bulk (43%), break-bulk (8%)

Main characteristics

- ***High share of bulk traffic***. Approximately 95% of port tonnage in Amsterdam is connected to liquid and dry bulk, which distinguishes it from other large European ports. Unlike most other large European ports, Amsterdam has no container traffic to speak of.

Main accomplishments

- ***High integration with local industrial structure***. Most of the commodities handled by the port serve local industries, including the refinery and food industry (cocoa).
- ***Urban transformation of former port areas***. These areas, located on the eastern side of the former port, are now internationally recognised as benchmarks for urban transformation of old port sites.
- ***Dedicated freight corridor***. The Betuweline is a double-track dedicated freight rail link to Germany, serving both the Port of Rotterdam and Amsterdam.

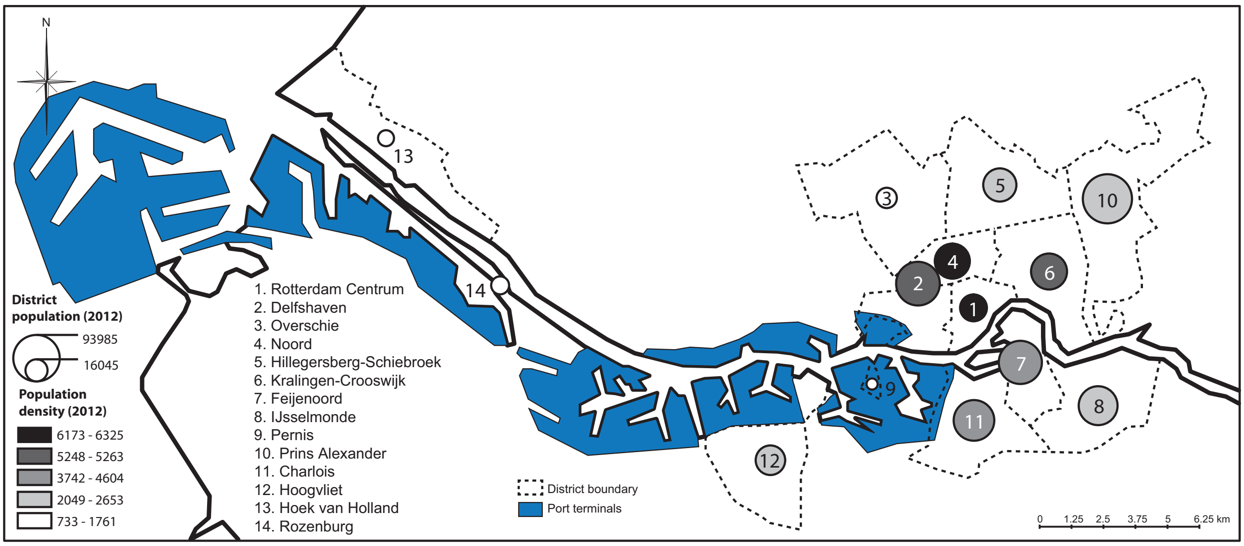
Main challenges

- ***Nautical access***. As an estuary port, Amsterdam is highly dependent on the depth of the North Sea canal between the sea and the port, and the modernisation and enlargement of its lock system. This is anticipated for 2019, but remains controversial.

Main opportunities

- ***Regional port development***. There is strong pressure caused by urbanisation to convert parts of the current port to urban functions, such as a mix of housing and firms. Sustaining the growth of the Amsterdam port could only take place westwards, to other municipalities along the North Sea Canal. This will necessitate a regional port strategy, as expressed already in the Regional vision for the North Sea Canal region, which forms the basis for future port expansions for the mid long term and sustaining the growth for the short term by intensifying land use.

Netherlands – Rotterdam



Main indicators

- Port volume: 441 million tonnes in 2013; 11.6 million TEU in 2013
- Port growth: 33% over 2003-13 (tonnes); x% over 2003-13 (TEU)
- Main cargo types: liquid bulk (47%), containerised cargo (28%), dry bulk (20%),

Main characteristics

- ***Industrial functions***. The Port of Rotterdam is not only a port but an industrial estate, including a large petrochemical cluster. Our research suggests positive economic clustering effects within the port area. The port has gradually moved out of the city, with the last stages of port development on reclaimed land in deep sea.

Main accomplishments

- ***Long-term strategic planning***. The Port of Rotterdam has engaged in sustained long-term planning since the 1990s, most recently with Port Vision 2030, adopted in 2012.
- ***Port expansion***. The port has managed an ambitious port expansion programme (Maasvlakte 2) to add container capacity of around 9 million TEU. This expansion has been accompanied by an active public relations campaign.
- ***Green port policies***. The Port of Rotterdam has implemented various green port policies, including shore power for barges, renewable energy production in the port, the environmental shipping index, subsidies for clean tech innovations and the greening of vehicles and ships used by the port authority. The concession process for the Maasvlakte 2 has incorporated various green indicators.

- ***Extended gate development***. The Port of Rotterdam co-operates with inland ports in the Netherlands, such as Moerdijk, Dordrecht and Tilburg, as well as foreign ports, such as the German inland ports of Duisburg. Some of these ports can be considered the extended gate of the Port of Rotterdam. This development is facilitated by the large share of river transport in Rotterdam's hinterland modal split.
- ***Dedicated freight corridor***. The Betuweline is a double-track dedicated freight rail track towards Germany, serving both the Port of Rotterdam and Amsterdam.
- ***Port co-operation with the university***. This co-operation is expressed in the Smart Port Centre of the Erasmus University in Rotterdam, the Port Research Centre TU Delft, the Rotterdam Mainport University of Applied Technology and the location of a new university campus for research, design and manufacturing (RDM) in the old port. Rotterdam is the leading city with regards to published articles in maritime studies.
- ***Urban redevelopment***. Various parts of the old port areas have been converted to urban use, including the Kop van Zuid area and the city-ports area, Stadshavens.

Main challenges

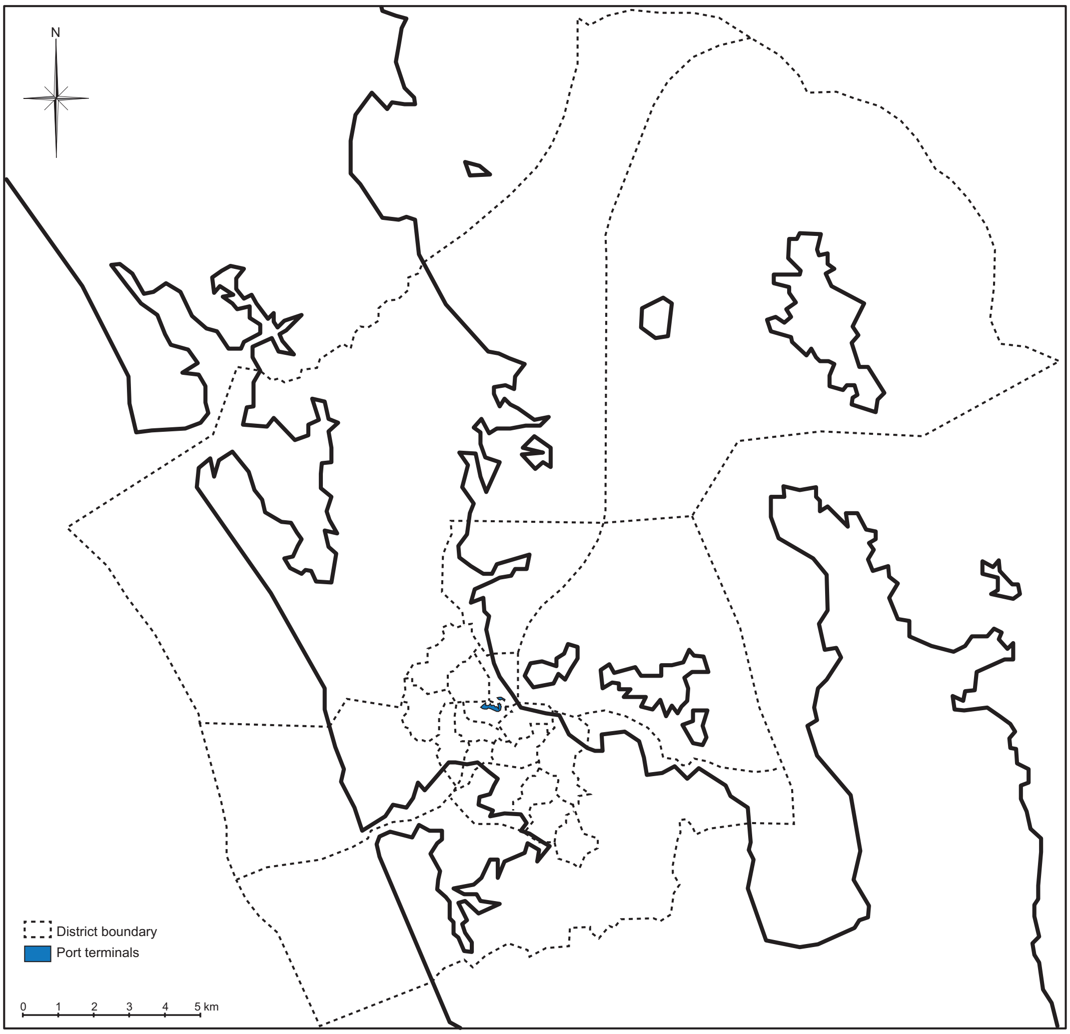
- ***Competition.*** A large chunk of new port capacity will become available with the start of operations on Maasvlakte 2 in 2014. Considering the economic prospects following the global economic crisis, and the port capacity that has recently become available in northwest Europe (Jade-Weser port, Le Havre's Port 2000, London Gateway), there will be strong competition to attract cargo.
- ***Congested hinterlands***. Increase port traffic will lead to considerable congestion in the direct hinterlands of the Rotterdam region. Ambitious targets have been formulated for non-truck traffic, but it is far from certain that these will be reached.
- ***Transformation into a leading global maritime services centre***. Despite its competitive maritime sub-sectors, Rotterdam cannot be considered an international maritime services centre in the same league as London, Singapore or Hong Kong. It could benefit from a more aggressive and holistic maritime cluster policy, in addition to generic measures to increase the urban quality of life and business climate.

Main opportunities

- ***Economies of scale in shipping***. The Port of Rotterdam, in particular its newest terminals, will be perfectly suited to handle the largest container ships. Unlike its main competitors, such as Antwerp and Hamburg, the Port of Rotterdam has the deep-sea access with the required berth depth and new capacity to handle large peak volumes.
- ***Industrial ecology***. The combination of industrial processes, commodities handled and port infrastructure makes the Port of Rotterdam a promising location for industrial ecology processes that create value from by-products of industry, such as heat and industrial waste. Various projects have been initiated, but there is potential for far more.

  Cross-border co-operation. Rotterdam, the largest European port, is only 75 kilometres from the Belgian port of Antwerp, both home to large petrochemical sectors. The Port Vision 2030 favours co-operation between these two petrochemical sectors, promising synergies.

New Zealand – Auckland



Main indicators

- Port volume: 5.7 million tonnes in 2013; 1.0 million TEU in 2013

Main characteristics

- Auckland is one of the two large ports in New Zealand, together with Tauranga. It serves the metropolitan area of Auckland, which contributed 35% of the country's GDP in 2010, but also has important hub functions, with a trans-shipment rate of 20%.
- Auckland is a multi-site port-city, broadly divisible into three parts: mixed-use marina, petro-chemical storage and fisheries in the west, dedicated passenger terminals and downtown CBD linkages in a small urban port in the centre, and a large commercial

port to the east. Since 1989, the strategy has consisted in a progressive consolidation of freight and cargo activity towards the east, offset by sale of large sections of port land in the west for alternative use and redevelopment.

Main accomplishments

- ***Metropolitan governance***. The creation of the Auckland Council in 2010 has streamlined metropolitan governance. Instead of one regional council, 3 district councils, 4 city councils and 30 community boards, there is now one single council co-ordinating waterfront development, with one single strategy, the Auckland Unitary Plan.
- ***Port communication***. The port supports a wide range of events, provides free port tours and has an active information and media policy, including via social media. In addition, the port has established a Community Reference Group, which provides an opportunity for representatives of local community groups, to engage with the port.
- ***Productivity lift***. The port started restructuring in 2011 with the aim of lifting productivity, particularly in the container terminals. The reforms have resulted in increases of 30% in of annual crane rates and 44% in vessel rates.

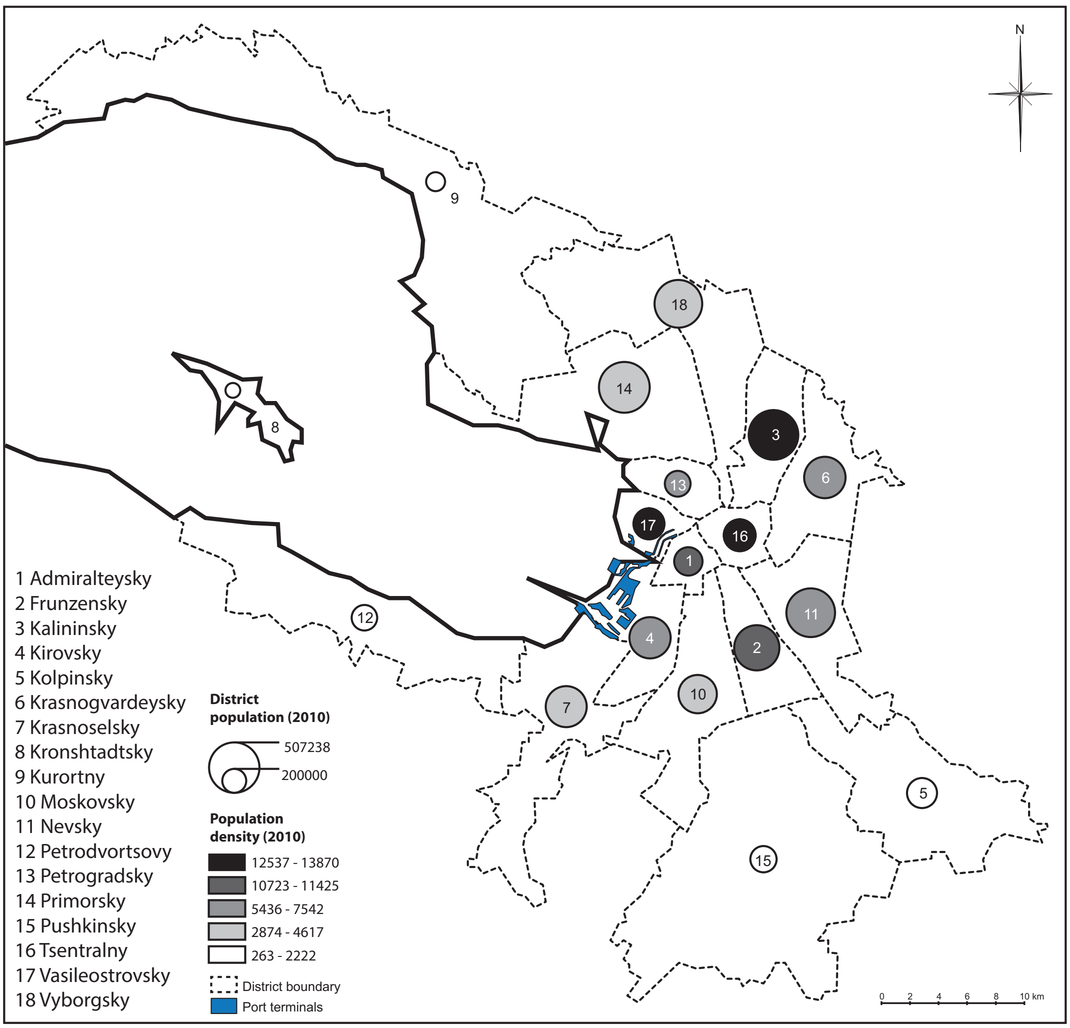
Main challenges

- ***Labour relations.*** Following a damaging period of industrial unrest over the introduction of a flexible shift and roster system in 2011, POAL lost a significant portion of the container trade to Tauranga. The dispute remains unsettled, but around 60% of the workforce now works the flexible system. In 2013 the company recaptured business lost to Tauranga.
- ***Hinterland transportation***. In order to increase its hinterland transport capacities, POAL is working with the KiwiRail and Auckland Transport to fully exploit the capacity of rail connections to the port. This resulted in a 50% lift in rail volumes in the second half of 2013..

Main opportunities

- ***Port expansion***. POAL is in the final stages of a multi-year project to expand Fergusson Container Terminal by 10.4 hectares. The next stage, construction of a new wharf on the northern boundary of the reclamation, has not yet been programmed. Full implementation of the 2012 port master plan would push up handling to over 3 million TEU by 2040.
- *Local economic value creation*. The city considers the commercial port as an integral part of its economic development strategies. It has planned investments in waterfront conversion projects for 2012-22, as well as the creation of a cruise ship facility. The western Wynyard Quarter, a former industrial port site, will be turned into an innovation cluster for marine and associated businesses.

Russia – St. Petersburg



Main indicators

- Port volume: 58 million tonnes in 2013; 2.5 million TEU in 2013
- Port growth: 23% over 2003-13 (tonnes); 287% over 2003-13 (TEU)

Main characteristics

- A fifth of Russia's foreign trade flows through the Port of St Petersburg.

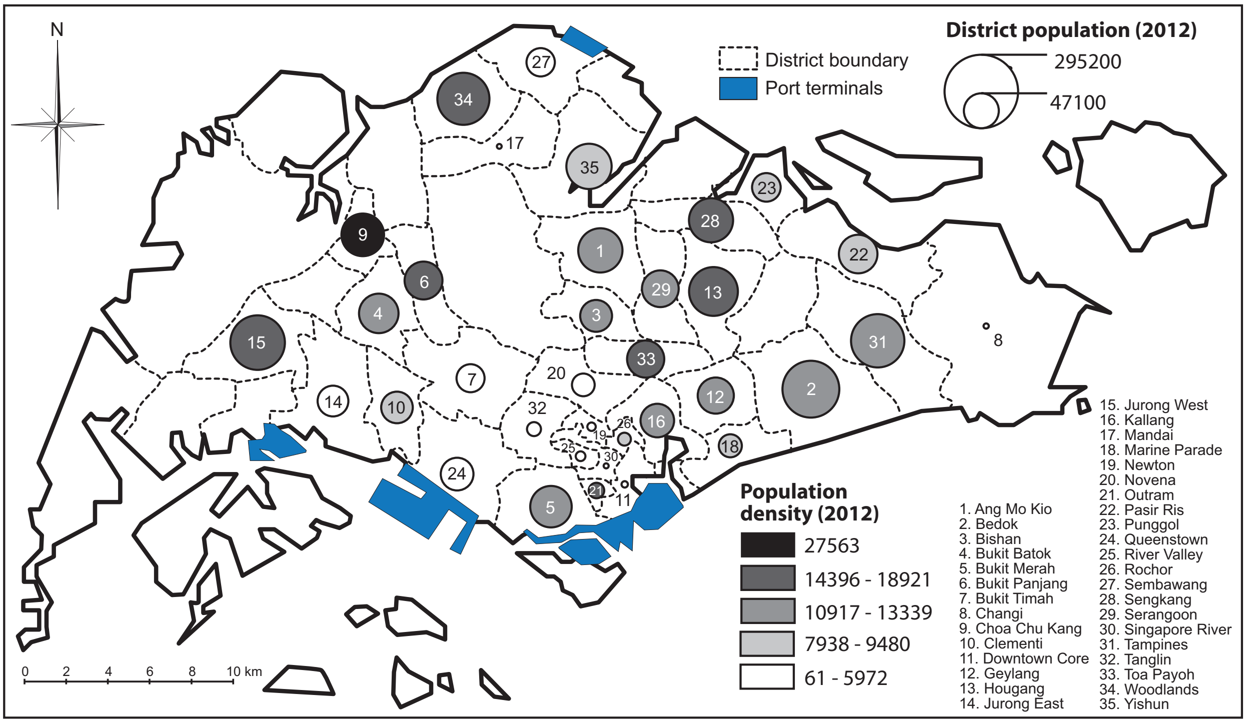
Main challenges

- ***Nautical access***. Both depth and ice constrain the port's maritime connectivity. Like many Baltic Sea ports (with the exception of Gdansk), St. Petersburg has limited berth depth, which limits its possibilities for port calls from large vessels. Despite icebreakers that keep the access channel to the port open all year, the port can only take ice-class ships in the winter, and often even closes for a few weeks.
- ***Port competition in the Baltic Sea***. Around 1 million imported containers to Russia arrive every year via Finnish and Baltic ports, resulting in substantial revenue losses for the Port of St. Petersburg. One of the reasons for this is the lack of up-to-date port capacity in St. Petersburg.
- ***Space constraints***. The Port of St. Petersburg is a real city-port, constrained by the urban area encroaching on the port.
- ***Air emissions***. Russia has not ratified the IMO convention installing a Sulphur Emission Control Area (SECA) in the Baltic Sea. In this SECA, the sulphur content of ship fuel has been reduced to 1.0% from 2010 and will be further reduced to 0.1% in 2015. These regulations have reduced shipping-related air emissions in other Baltic Sea port-cities, but not in Russia.

Main opportunities

- ***Projected cargo growth***. According to the Sea Port Infrastructure Development Strategy to 2030 developed by Rosmorport, the Russian state ports company, cargo volumes through Russia's seaports could double between 2012 and 2030, and containerised transport might increase more than fivefold. The strategy defines the North West Basin, which includes St. Petersburg, Ust-Luga and Kaliningrad, as the main gateway for refrigerated and containerised cargo, as well as for hydrocarbons and mineral fertilisers.
- ***Public and private port investment***. One of Russia's largest ongoing infrastructure projects is the Port of Ust-Luga in the Baltic Sea, operational in dry bulk since 2001 and with a container terminal that started in 2011. This will become fully operational only in 2025. This project might decongest the Port of St. Petersburg and allow it to specialise in containers and cruise traffic. Current upgrades in the Port of St. Petersburg would increase its performance, as well as the new investments by APM Terminals, one of the largest global terminal operators.

Singapore



Main indicators

- Port volume: 561 million tonnes in 2013; 32.2 million TEU in 2013
- Port growth: 61% over 2003-13 (tonnes); 75% over 2003-13 (TEU)
- Main cargo types: container (59%), oil (32%)

Main characteristics

- ***Central hub***. Singapore is the most central port in global port networks, based on our calculation of port centrality indices, as explained in this report.
- ***High trans-shipment rates***. Among the world largest ports, Singapore has the highest trans-shipment rates (85%). Ports of similar size generally have more gateway traffic, whereas ports with similar or higher trans-shipment rates are generally smaller.

Main accomplishments

- ***Maritime cluster building***. Singapore has managed to transform itself from the world's largest port into a leading global hub for shipping, trading and finance. This has been the result of a focused and long-term ambition, facilitated by a range of instruments. These instruments include fiscal incentives, a shipping registry, training and education, as well as innovation programmes. Major fiscal incentives include the Approved International Shipping Enterprise (AISE) scheme, the Approved Shipping Logistics Enterprise (ASLE) scheme, tax benefits for Ship Registration and Business Development Support. Education and innovation programmes include the Maritime Innovation and Technology Fund (MITF) and the Maritime Cluster Fund (MCF).

- ***Waterfront development***. Singapore has managed one of the most spectacular recent waterfront developments, the Marina Bay, which manages at the same time to pay tribute to the maritime heritage and diversify the urban economy.
- ***Long-term strategic planning***. Singapore has meticulous port planning, in particular with respect to its long-term developments. As part of this forward-looking planning, the relocation of the port has been announced and planned ahead.

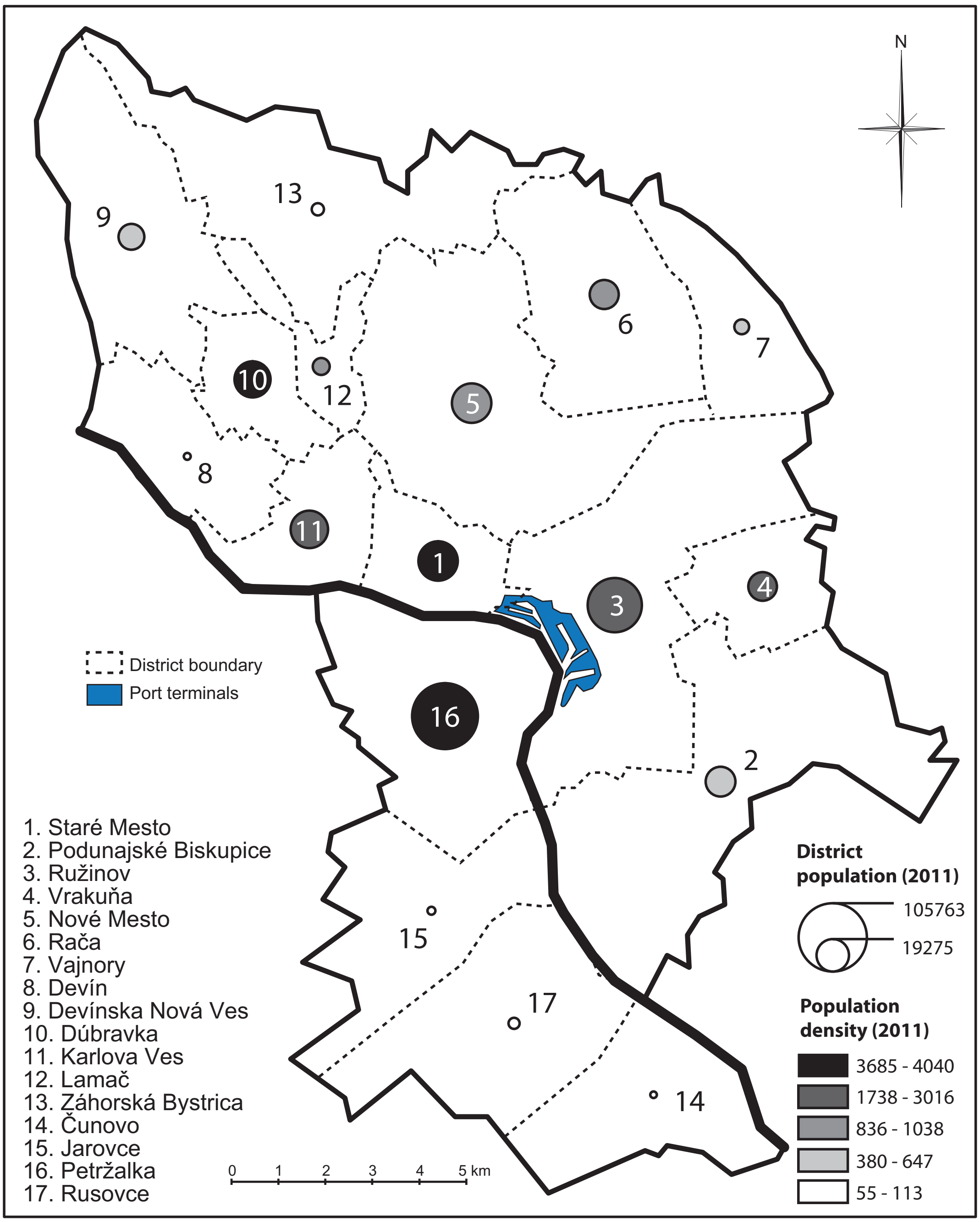
Main challenges

- ***Soft governance***. The governance culture of the port of Singapore is relatively closed. The extent of pro-active communication with and consultation of citizens, community groups and other stakeholders is less developed than in other large ports. With an increasingly vocal local population, the challenge of the port and port-city of Singapore may be to combine rational long-term strategic policy making with more consultative and open decision-making processes.
- ***Regional challengers for the transhipment position***. Singapore is highly dependent upon trans-shipment traffic. Its dominant position in this area is based on its geographical location close to main east-west shipping routes, using the Malacca Straits, but also on the relative incapacity of challengers (such as Tanjung Pelepas in Malaysia) to capture shares of this regional market. Part of this incapacity is based on regulatory constraints that could potentially be lifted in future. If Indonesia abolished its cabotage restrictions, some of its ports could challenge Singapore’s trans-shipment hub position.

Main opportunities

- ***Long-term port relocation***. The Singapore government has announced the long-term relocation of the port of Singapore to Tuas, an industrial centre at the southwestern tip of Singapore. This relocation, planned to start in 2027, would free up centrally located port areas for the construction of the “Southern Waterfront City”.

Slovak Republic – Bratislava



Main indicators

- Port volume: 2.3 million tonnes in 2011

Main characteristics

- ***Stagnant port volume***. The Port of Bratislava handled 2.3 million of tonnes in 2011, a volume more or less flat over the last decade. Volumes before 1988 were considerably higher, linked to the communist-planned economy, in which water transport played a more important role. Public port capacity is consequently under-utilised.

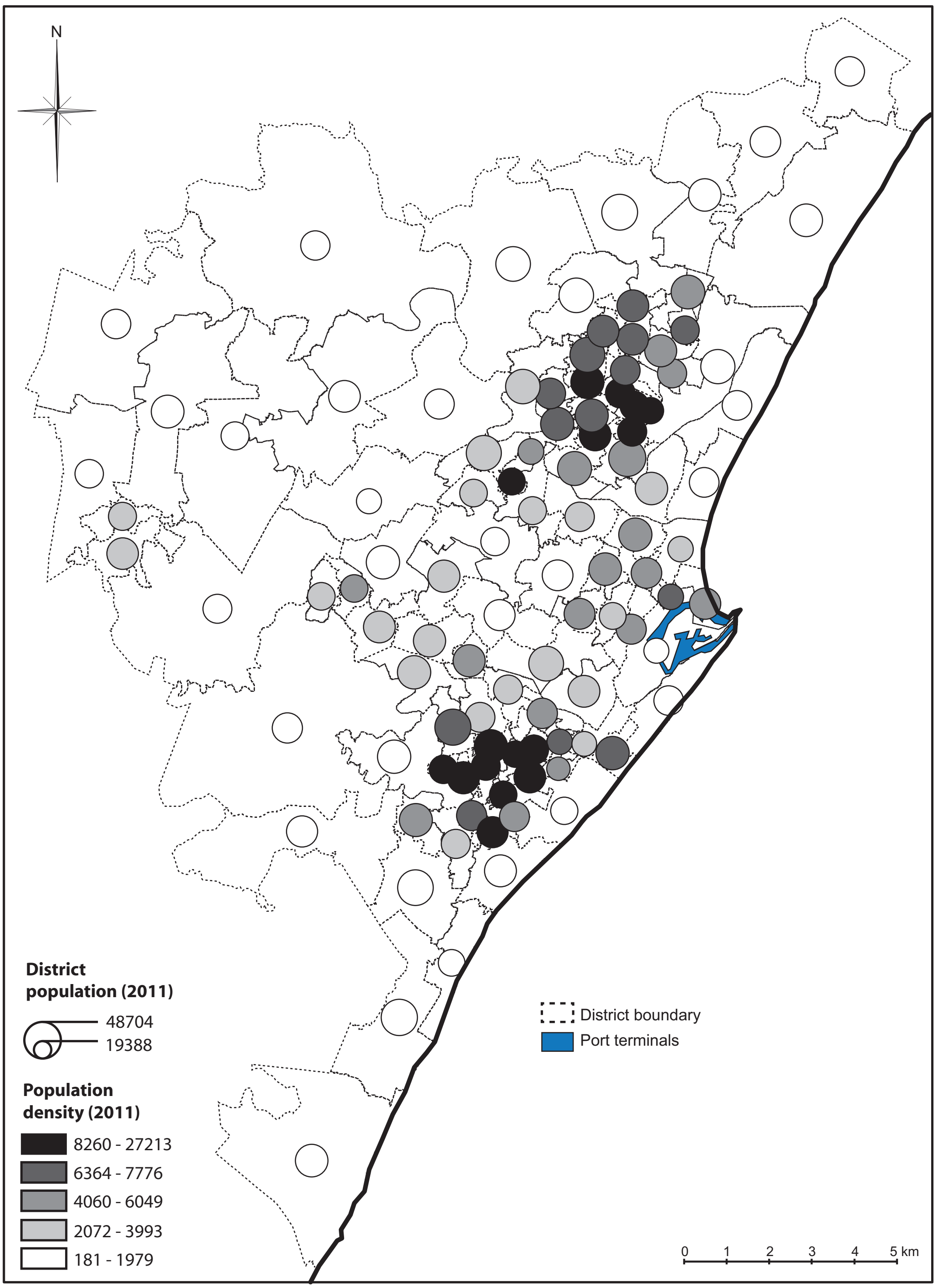
Main challenges

- ***Navigability of the Danube***. There are various bottlenecks along the Danube, connected with depth, bridge height, locks systems and ice during the winter.
- ***Reliability and frequency of service***. Transport volumes are currently too low to guarantee reliable and frequent river transport. This lack of frequent services in turn makes it difficult to convince companies to use river transport.
- ***Inter- and intra-port competition***. Slovakia lacks both types of competition, and as a result, there is little incentive for efficient use of public port infrastructure.
- ***Limited appetite for water transport***. Only a few companies use river transport, and most firms do not consider it a viable transport mode at present.

Main opportunities

- ***Geographical location*.** Bratislava has a favourable geographical location, at the core of Central Europe and at the crossroads of Western and Eastern, as well as north and south Europe.
- ***Danube strategy***. The European Union strategy to promote the Danube as an economic and transport axis, has also provided the possibility of increasing navigability along the Danube. Growing awareness at the different government levels in the Slovak Republic of the potential of river transport could help to acquire joint support for river services and facilities, better co-ordinated port and economic development and better integration of port development in spatial planning.

South Africa – Durban



Main indicators

- Port volume: 45 million tonnes in 2013; 2.6 million TEU in 2013
- Port growth: 10% over 2003-13 (tonnes); 64% over 2003-13 (TEU)

Main characteristics

- ***Major gateway***. Durban is the main gateway port to Africa. It is not only the largest, but also the most central African port, carrying more than two-thirds of South Africa's container traffic.
- ***Strategic location***. It is located just next to the central business district of Durban.

Main accomplishments

- ***Joint long-term port-city planning***. The development of a new port site in Durban and a freight transport corridor between Durban and Johannesburg has become a presidential priority, thanks to constructive co-operation between city and port in formulating these projects.

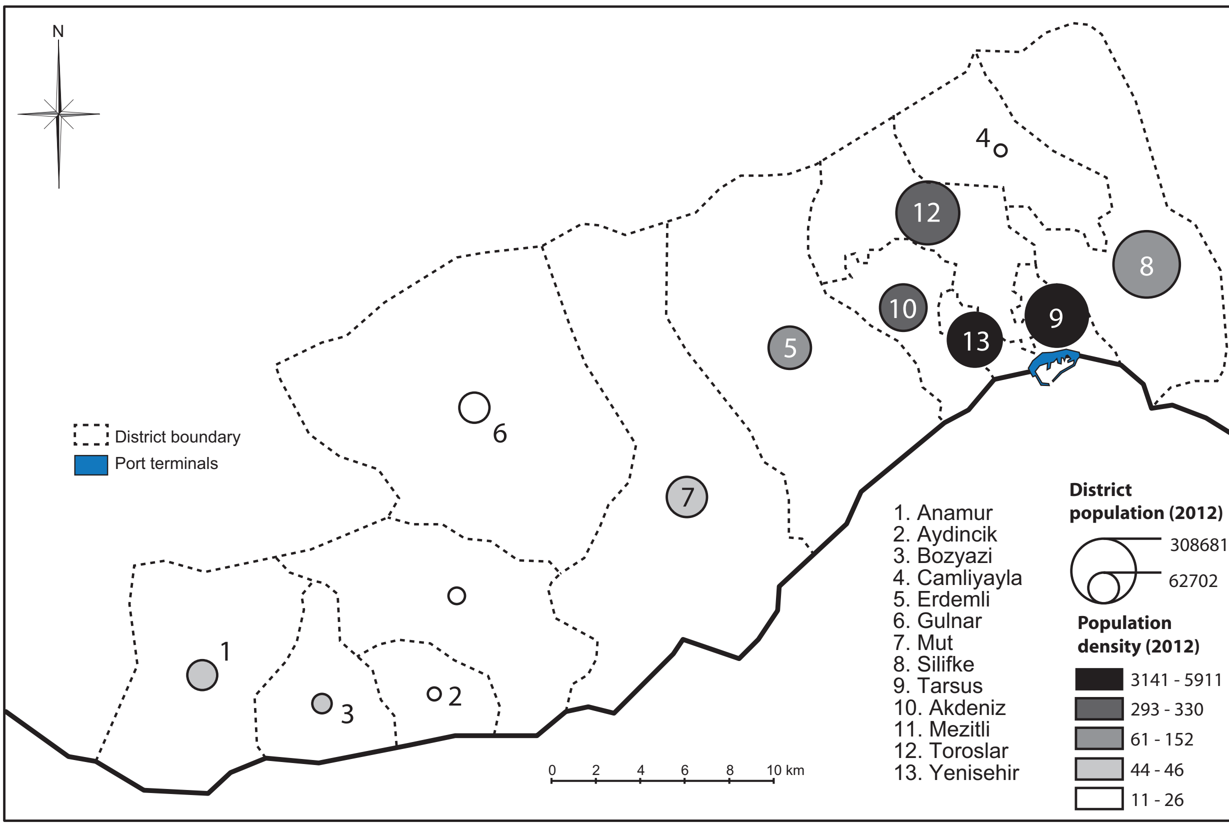
Main challenges

- ***Lack of competition***. The Port of Durban is a quasi-monopoly; its main terminal operations and port authority functions in South Africa are in the hands of the state-owned company Transnet. Financial benefits generated in Durban are used to finance railway operations and other ports in South Africa, with very high cargo dues for Durban as a consequence.
- ***Congestion***. Approximately 690 million tonnes of port-related cargo are transported on the major roads of the metropolitan area of Durban. This is associated with congestion, pollution, delays, road damage and accidents.

Main opportunities

- ***New port development***. A new port at the site of the former airport has been planned for Durban, scheduled to be operational from 2020. This port, also called a dig-out port, could have important implications for the South African institutional landscape. It provides an opportunity to introduce port competition in South Africa, resolve the combination of operational and regulatory roles of Transnet and tackle the limited autonomy of Transnet National Port Authority (TNPA). It could also liberate space on the current port site for other functions.

Turkey – Mersin



Main indicators

- Port volume: 25 million tonnes in 2011; 1.4 million TEU in 2013
- Port growth: 195% over 2003-13 (TEU)
- Main cargo types: container (52%), dry bulk (20%), liquid bulk (17%)

Main characteristics

- Second container port of Turkey, located in the south of Turkey, in the east of the Mediterranean.
- Privatised in 2007; concession won by the global terminal operator PSA in partnership with the Turkish conglomerate Akfen.

Main accomplishments

- ***Strong growth***. Volumes have grown an average of 6.5% per year, since the privatisation of the port in 2007, despite the global economic crisis.
- ***Strong links to the local economy***. Maritime transport is highly interlinked with trade and manufacturing in Mersin and the wider Çukurova region, in particular with respect to food products and textiles. According to our calculations, EUR 1 of extra output in the port results in additional economic output of EUR 1.20.

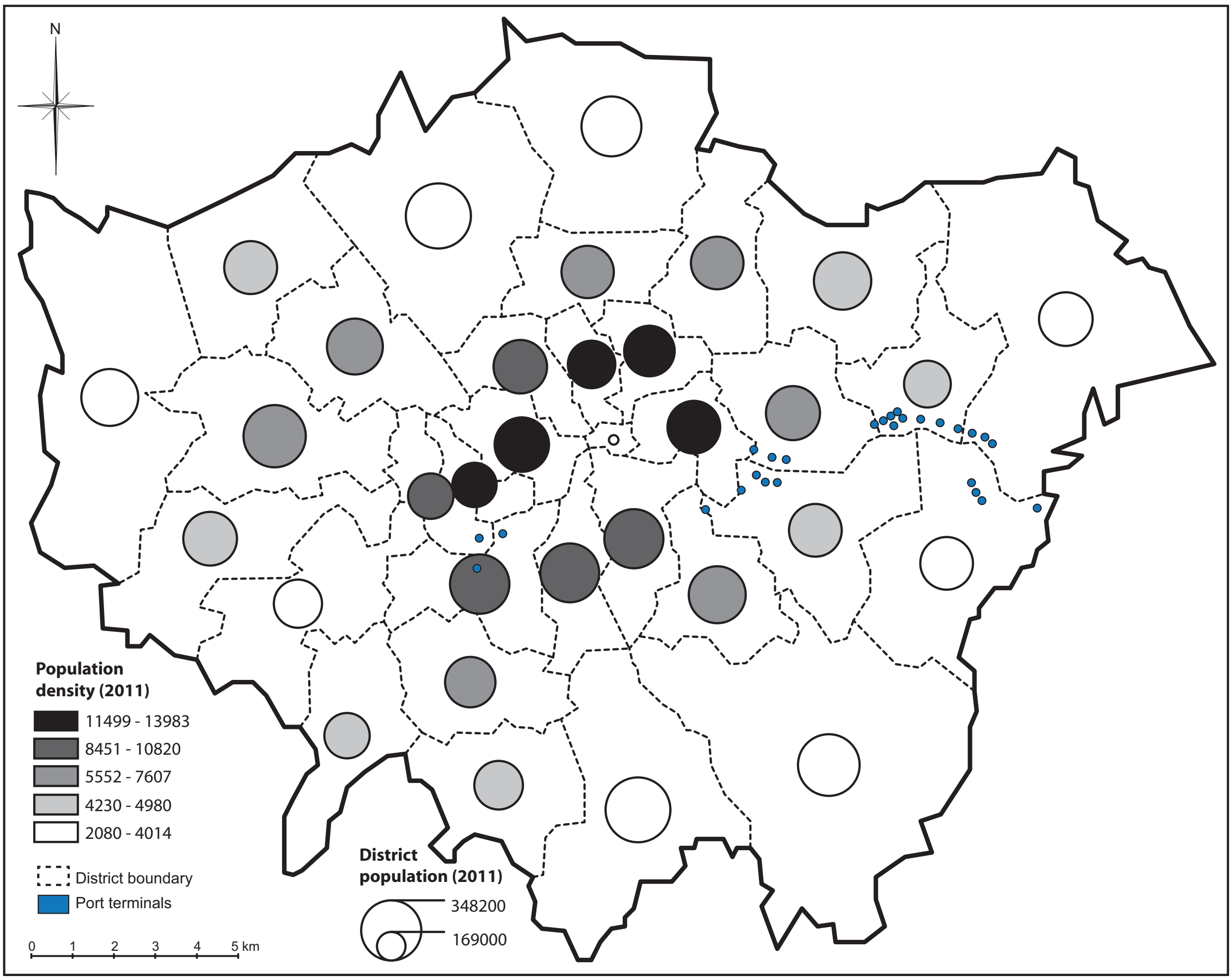
Main challenges

- ***Maritime connectivity***. Mersin has not so far often been included in intercontinental routes of the large global container carriers, and has maritime connections that are less diverse than most Mediterranean ports.
- ***Creation of public port authority***. Extensive port privatisation policies in Turkey have created an institutional void; the public port authority that in many countries acts as a liaison between private terminal operators, port clients, the port-city and the ministries responsible for ports does not exist in Turkey. Such a public port authority could help bridge the various interests within the port-city.
- ***Legislative change***. Liberalisation of freight rail transportation and maritime cabotage is needed to attract the interest of the private sector and to increase the non-truck shares in hinterland modal splits.

Main opportunities

- ***Development of distribution centres***. These centres, including the Yenice freight village, are currently being developed in Mersin and could decongest the port area.
- ***New container port development***. The Turkish government has announced the creation of a new container terminal in Mersin, next to the current port facility. Although this typical mix of port privatisation and port development ambitions by the central state will have to be elaborated in practice, a new container terminal would increase port competition in Mersin and might have beneficial effects for local firms.
- ***Instability in the Middle East***. Political instability in Egypt, Syria and Lebanon has increased the prospects of Mersin as a stable regional hub port.

United Kingdom – London



Note: the London Gateway port is not included on this map

Main indicators

- Port volume: 43 million tonnes in 2013
- Port growth: -15% over 2003-13 (tonnes)

Main characteristics

- ***Decline in port functions***. London is one of the world's largest port-cities without a large port. Unlike many of the large historic or current port-cities, it has lost most of its port functions and transformed its docklands into urban or business centres. The current port of London is a collection of fairly small port terminals. The London Gateway port, operational since the fourth quarter of 2013, reintroduces major port operations in the London metropolitan area.

Main accomplishments

- ***The world's leading international maritime services centre***. London has the most complete and comprehensive cluster of high value added maritime services, related to finance, law and consulting.

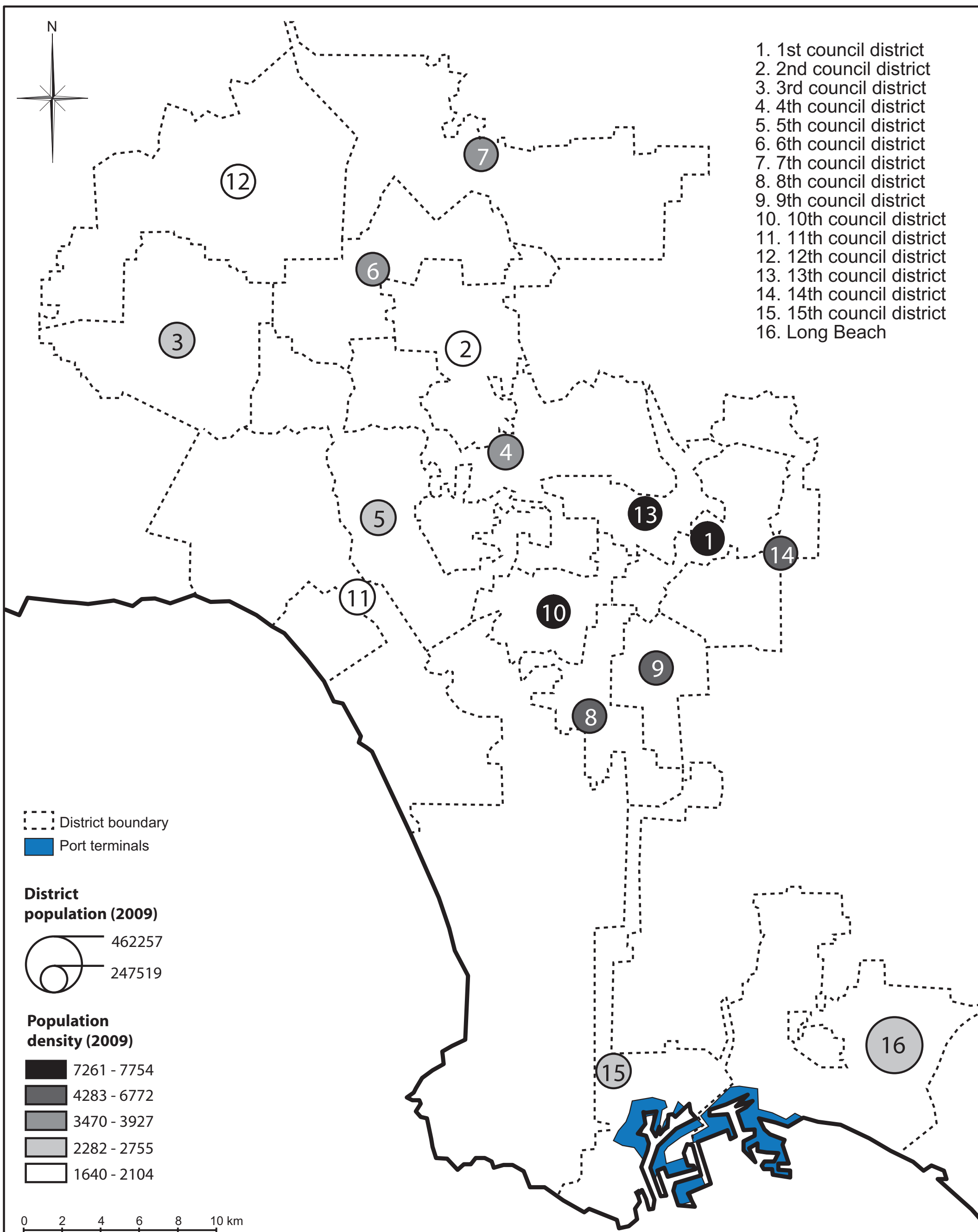
Main challenges

- ***Geostrategic power shifts***. With more of the economic and political power shifting to Asia, the question arises how long London can remain the world's leading maritime service centre. Singapore, Hong Kong and Shanghai are all formidable challengers, with strong ambitions to take over London's position.
- ***Maritime connectivity***. The new London Gateway port has a depth of 14.5 metres, which is sufficient at present for calls from the largest ships, but may not be enough for the vessels that will be built in future; port depth at the Maasvlakte 2 in Rotterdam, for example, is 23 metres.

Main opportunities

- ***Port-centric logistics***. The new London Gateway port aims to bring a new logistics model to the United Kingdom, with a new port closer to the London market. As such, it poses challenges to the main ports that covered the London hinterland, Southampton and Felixstowe. Although London Gateway port is further away from shipping lanes, has more limited railway connectivity and will be dependent on congested highways (M25) for its hinterland transport, it will also provide new opportunities. Its business model is built on a combination of port and large warehouse and logistics facilities, which could prove attractive for many customers.

United States – Los Angeles/Long Beach



Main indicators

- Port volume: 69 million tonnes in 2013 (Los Angeles), 44 million tonnes in Long Beach; 7.9 million TEU in 2013 (Los Angeles), 6.7 million TEU (Long Beach).
- Port growth: 70% over 2003-13 (tonnes) for Los Angeles. 0% for Long Beach; 10% over 2003-13 (TEU) for Los Angeles, 44% for Long Beach
- Main cargo types Los Angeles: general cargo (95%), liquid bulk (5%); Long Beach: containerised cargo (76%), liquid bulk (18%), dry bulk (6%)

Main characteristics

- Two ports that could be considered one functional port (8th largest container port in the world), considering that they are located just next to each other. The Port of Los Angeles is far from the downtown area, whereas the Port of Long Beach is located just next to the centre of Long Beach.

Main accomplishments

- ***Air emissions policies***. The ports of Los Angeles and Long Beach have one of the world's most comprehensive air quality programmes in the San Pedro Bay Ports Clean Air Action Plan (CAAP). This combines various policy instruments: information, regulation, incentives and technology upgrades. Both ports have annual air emissions inventories. Both have gradually banned polluting trucks in the Clean Trucks Program (CTP), promoted slow speeds close to the ports through the Vessel Speed Reduction Program (VSR) and promoted onshore power for ships and other technology upgrades in the Technology Advancement Program. Thanks to the CAAP and its components, port-related air emissions in both ports have been substantially reduced.
- ***Congestion mitigation***. Both ports have introduced the PierPASS programme to redistribute arrival times of trucks to port terminals more evenly over the day. Part of this programme is a Traffic Mitigation Fee (TMF) of USD 50 during peak hours, with exemptions for off-peak hours, reducing day-time truck arrivals from 90% to 66% immediately after introduction.
- ***Dedicated freight corridor***. The Alameda Corridor is a 32 kilometre-long freight rail cargo facility, connecting the transcontinental rail lines near downtown Los Angeles to the ports of Los Angeles and Long Beach. The aim of the Alameda Corridor is to consolidate train traffic, eliminate at-grade conflicts and reduce traffic congestion at rail crossings. This has cut train transit time and eliminated conflicts at 200 at-grade rail crossings.

Main challenges

- ***Competition***. The ports of Los Angeles and Long Beach face competition from other West Coast ports, such as the Metro Port Vancouver (MPV), whose hinterland connections with all North America have been improved by Canada's federal freight strategy. No such policy exists in the United States. Moreover, thanks to the deepening of East Coast and Gulf ports and the expansion of the Panama Canal, these ports now have more possibilities of calls from Asian destinations.

- ***Finance***. Part of the income generated by US ports goes to the Harbor Maintenance Trust Fund, which spends less on ports than it receives. For Los Angeles/Long Beach, by far the largest port complex in the United States, this represents a significant amount of income forgone.

Main opportunities

- ***Local economic value creation***. The ports have major economic impact, but most of the value added leaks away to other US states. However, the ports show great promise for local value creation, in terms of maritime services, industrial development and waterfront activities. Both ports have started to exploit this potential for economic development, for example by reserving space for cleantech development, marine research and maritime services cluster development.
- ***Port co-operation***. Intensive port co-operation has resulted in many common policies. The next step in this trajectory could be to merge the two ports. This could avoid duplication of functions while creating critical size that would counterbalance the consolidation in the shipping and terminal business. It would not restrict competition, which is mainly created by the multitude of port terminals, but it would require a political balancing act.
- ***Short-sea shipping***. The US maritime cabotage regulations under the Jones Act are so restrictive that short-sea shipping is fairly marginal. Liberalisation of this market would create new opportunities that Los Angeles and Long Beach are well placed to exploit.

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Ports and cities are historically strongly linked, but the link between port and city growth has become weaker. Economic benefits often spill over to other regions, whereas negative impacts are localised in the port-city. How can ports regain their role as drivers of urban economic growth and how can negative port impacts be mitigated? These are the questions that this book aims to answer.

Contents

Consult this publication on line at ***http://dx.doi.org/10.1787/9789264205277-en.***

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