Chapter 18. Ports

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1. Introduction

Ports are the nodes of the world's maritime transport system. Every voyage of a ship must begin and end at a port. Their size and distribution will therefore both reflect and contribute to the pattern of maritime transport described in Chapter 17 (Shipping). Since the maritime transport system is part of a much larger global transport system, including road, rail, river and canal transport and the interchanges between all the modes, the factors that determine the location and growth (and decline) of ports are manifold, and go well beyond an assessment of the marine environment. These non-marine factors (such as land and river transport connections, location of population and industry and size of domestic markets) will determine, to a large extent, the development of ports and, therefore, the way in which they affect the marine environment. Nodes, however, can become bottlenecks, restricting the free flow of trade. Before the economic crisis of 2008, there were fears that port capacity could limit the development of world trade (UNCTAD, 2008). That problem has receded with the widespread economic slow-down, but could easily re-appear. This would lead to increased pressure for new port developments.

Just as containerization has transformed general cargo shipping from the mid-20th century onwards, so it has also transformed the nature of the ports that container ships use. In the past, ports relied on large numbers of relatively unskilled dockworkers to do the physical work of loading and unloading general cargo, often on a basis of casual labour, with no security of regular work. Containerization and parallel improvements in the handling of bulk cargoes have transformed this situation. Ports now require smaller numbers of much more skilled workers, and even more investment in handling equipment.

2. Scale and magnitude of port activity

Ports can be classified in several different ways. Some ports are dedicated to a single function (such as the handling of oil). Others are general, handling a variety of trades. Some are private, used for the traffic of one trader (or a small number of traders). Others are general, open to shipping in general. Some are designed for bulk traffic, both dry and liquid. Others are for general cargo, which today usually implies containers. And some ports are a mix of these various categories. (This chapter does not deal with marinas and other harbours for recreational vessels: those are covered in Chapter 27 (Tourism and recreation)).

Dry bulk traffic covers the five major bulk trades (iron ore, coal, grain, bauxite/alumina and phosphate rock), together amounting to 2,786 million tons in 2013, and the minor bulk trades (soymeal, oilseed/meal, rice, fertilizers, metals, minerals, steel and forest products), together amounting to 2,300 million tons in 2013. The main tanker bulk traffic (crude oil, petroleum products, and liquefied natural gas) amounted to 2,904 million tons. There is also a much smaller market in bulk tanker carriage of chemicals (UNCTAD, 2013).

The location of ports for handling bulk traffic is usually determined by the location of their sources of supply and demand. A new oil field may well demand the creation of a completely new port, as happened with the creation of Sullom Voe in the Shetland Islands in the United Kingdom in the 1970s at the beginning of the exploitation of North Sea oil and gas (Zetland, 1974). A large iron and steel works may be linked to the creation of new port facilities to receive imports of iron ore, as is happening at Zhanjiang in China (Baosteel, 2008). As a result of geographical or historical factors, some ports for bulk traffic can have awkward conjunctions in their location. For example, in Australia, the coal mines in Queensland need more port outlets, but the likely locations for ports are near the Great Barrier Reef, which gives rise to difficult decisions (Saturday Paper, 2014). In the United Kingdom, the Milford Haven oil terminal grew up gradually over many years in the safe natural harbour of Milford Haven. It is currently the United Kingdom's largest oil port, with a throughput of hydrocarbons in bulk of 40 million tons a year. However, the United Kingdom's first marine nature reserve, Skomer Island, is near the mouth of the harbour (Donaldson, 1994; DfT, 2014).

The containerization of general cargo, the consequent reduction of trans-shipment costs and the use of ever larger ships has changed the nature of the demand for general cargo ports over the past half century. Instead of relatively small ships moving directly from the origin to the destination of the cargo, thus minimising the then expensive trans-shipment costs, there is now a hierarchy of ports, with cargoes passing through entrepôts where they are trans-shipped. Rotterdam, in the Netherlands, is a good example of such an entrepôt, with many other North Sea ports receiving the trans-shipped goods. (Haralambides, 2002). The proportion of worldwide total container movements that involve trans-shipment is gradually increasing (25 per cent in 2000: 28 per cent in 2012 (Notteboom et al., 2014)). The nature of this hierarchy shows that there is a major equatorial shipping route linking major ports, with supporting north-south and transoceanic routes. The "trans-shipment markets" identified are the zones within which ports are competing with each other for the long-haul business, which will be trans-shipped for delivery to its final destination by ship, road or rail (Rodrigue, 2010, figure 13). Containerized general cargo amounted to 1.6 billion tons in 2012 – an estimated 52 per cent of global seaborne trade in terms of value (UNCTAD, 2013). The imbalances in containerized exports and imports, the liberalization of trade regulation and transit facilitation are resulting in a growth of containerization of trades previously handled as bulk. Since more containerized imports arrive in some ports than there are exports from those ports to fill the containers, the shipping costs for the return or onward journey using the surplus containers are low. This acts as a form of subsidy on the use of such containers, and thus attracts business from the bulk trades. For example, between 2008, when grain trading was deregulated in Australia, and 2013, the country's containerized wheat export shipments increased tenfold (UNCTAD, 2013).

The world's busiest container port is Shanghai in China, with 33.62 million TEU movements in 2013. Table 1 sets out the numbers of container movements for each of the further five container ports with the heaviest traffic. Outside these areas, there are of course other very large and busy ports – for example (with millions of TEU movements in 2013): Los Angeles, California, USA (7.87), Long Beach, California, USA (6.73) and New York/New Jersey, USA (5.47). In total, the world's 50 busiest container ports in 2013 were spread as follows:

(a) Twenty-four in the west Pacific (ten in China; three in Japan; two each in Indonesia and Malaysia; and one each in Hong Kong, China, the Philippines, the Republic of Korea, Singapore, Taiwan Province of China, Thailand and Viet Nam);

(b) Four in the eastern Pacific (two in the United States of America and one each in Canada and Panama);

(c) Seven in the Indian Ocean (two in the United Arab Emirates and one each in India, Oman, Saudi Arabia, Sri Lanka and South Africa);

(d) Eleven in the eastern Atlantic and adjacent seas (two each in Germany and Spain and one each in Belgium, Egypt, Italy, Malta, the Netherlands, Turkey and the United Kingdom); and

(e) Four in the western Atlantic (two in the United States and one each in Brazil and Panama) (WSC, 2014).

Table 1. The world's busiest container ports in the five major transhipment markets – 2013.

PORT	COUNTRY	TEU MOVEMENTS 2013 (MILLIONS)
World's busiest container port		
Shanghai	China	33.62
North-East Asia		
Busan	Republic of Korea	17.69
Qingdao	China	15.52
Tianjin	China	13.01
Dalian	China	10.86
Keihin ports (Kawasaki, Tokyo, Yokohama)	Japan	8.37
Central East Asia		
Hong Kong	China	22.35
Ningbo-Zhoushan	China	17.33

PORT	COUNTRY	TEU MOVEMENTS 2013 (MILLIONS)
Guangzhou	China	15.31
Kaohsiung	Taiwan Province of China	9.94
Xiamen *(formerly known as Amoy)*	China	8.01
South-East Asia		
Singapore	Singapore	32.60
Port Kelang	Malaysia	10.35
Tanjung Pelepas	Malaysia	7.63
Tanjung Priok	Indonesia	6.59
Laem Chang	Thailand	6.04
Middle East and Indian Sub-Continent		
Jebel Ali, Dubai	United Arab Emirates	13.64
Jeddah	Saudi Arabia	4.56
Colombo	Sri Lanka	4.31
Jawaharlal Nehru Port *(near Mumbai)*	India	4.12
Sharjah	United Arab Emirates	4.12
Mediterranean		
Algeciras Bay	Spain	4.50
Valencia	Spain	4.33
Ambarli *(near Istanbul)*	Turkey	3.38
Port Said	Egypt	3.12
Marsaxlokk	Malta	2.75
North-West Europe		
Rotterdam	Netherlands	11.62
Hamburg	Germany	9.30
Antwerp	Belgium	8.59
Bremen and Bremerhaven	Germany	5.84
Felixstowe	United Kingdom	3.74
South-East USA and Central America		
Colon	Panama	3.36
Balboa	Panama	3.19
Georgia Ports (Savannah, Brunswick)	United States	3.03

PORT	COUNTRY	TEU MOVEMENTS 2013 (MILLIONS)
Hampton Roads (Newport News, Norfolk, Virginia Beach)*	United States	2.22
Houston*	United States	1.47

* Not among the world's 50 busiest container ports.

Source: WSC, 2014: http://www.worldshipping.org/about-the-industry/global-trade/top-50-world-container-ports.

3. Socioeconomic aspects of ports

The arrival of containerization of general cargo and the increased mechanization of the handling of bulk cargoes has transformed employment in the dock industry. It has reduced the amount of human physical effort, increased the amount of work done by machinery and reduced substantially the risks of death and injury to dockworkers. As a result, it has also decreased substantially the number of dockworkers required. Negotiations over the change have therefore often been difficult, particularly in the early years of the introduction of containerization. The change has now spread worldwide, and few ports still rely on the handling of general cargo parcel by parcel. However, statistics at global level on the effects of the change are not available (ILO, 2002).

The economic effects on port operations have been no less thoroughgoing. Three main strands of change have been noticeable:

(a) As the economics of ship operation have created pressures for ever larger ships, both for bulk carriage of cargoes and for containers (see Chapter 17 – Shipping), so pressures have developed on ports to create the facilities to handle these larger ships. These pressures have required ports to invest in deeper-water facilities, bigger cranes and navigational improvements in order to accommodate the larger ships. These have all required substantial investment;

(b) The general liberalization of the terms of world trade and consequent growth in shipping have led to ports being placed more and more in competition with each other. Coupled with the development of hierarchies among ports in container traffic, where large ships are used for long voyages between hubs, and the containers are then re-distributed in smaller ships on shorter voyages, this has led to the need for ports to work together to offer shipping lines and (through them) shippers a comprehensive service. At the same time, in many parts of the world there has been a substantial transfer of the operation of ports (and, in some cases, the ownership of the land and equipment of the ports) from the public sector to the private sector. The combined effect of these various trends has been the creation of large commercial groupings of ports around the world. Some of these groupings have sprung from a successful operator of a specific port: the Port of Singapore Authority is the leading example of this type of development, with interests in 25 terminals around the world. Others have sprung from major shipping lines: APM Terminals is controlled by the major Danish maritime shipping enterprise A P Møller Mærsk, and has interests in 71 ports around the world. Another starting point for assembling a chain of ports has been sovereign wealth funds: for example, Dubai Ports World has interests in more than 65 terminals around the world. The final major type of port grouping is represented by Hutchison Port Holdings, part of the Hutchison Whampoa group, which developed from a dock-operating company in Hong Kong; it has interests in 52 ports. These four groups alone therefore have major interests in over 200 ports worldwide. There are a number of smaller similar chains, largely with a regional focus: these include SSA Marine in North America and Eurogate in Europe (privately-owned companies), Hanjin and Evergreen (linked to ocean carriers) and Ports America (owned by financial holding companies) (Rodrigue, 2010). In many countries, however, ports remain under the control of government agencies or chambers of commerce, or are independent public agencies;

(c) The larger sizes of ships have intensified the pressures to handle them in port in the shortest possible time. Ship owners want their capital to be earning money on voyages as much as possible, and therefore dislike the ships being tied up in port – or, even more, waiting at sea until they can get into a port berth. This, coupled with the more stringent requirements arising from growing trade volumes, global value chains, increasingly time-sensitive trade and lean supply chains, has led to increased competition between ports, intensified the pressure on ports to service ships and handle their cargo the shortest possible time and produced an intense focus on the efficiency of ports.

One important aspect of the economics of port operation is security against theft and disruption. In 2002, the International Maritime Organization adopted a new chapter in the International Convention on the Safety of Life at Sea (SOLAS) and promulgated the International Ship and Port Facility Security (ISPS) Code to improve ship and port security. This is supported by the joint IMO/International Labour Organization code of practice on security in ports. These instruments provide a consistent baseline worldwide, by clarifying the desirable division of responsibilities for issues such as access control, cargo and ship stores control, and facility monitoring to prevent unauthorized persons and materials from gaining access to the port. The ISPS Code came into force in 2004. Gaps still remain in some areas to implement these arrangements (IMO, 2015).

3.1 Efficiency

In 2012, the Organization for Economic Cooperation and Development (OECD) published a study on port efficiency that it had commissioned (Merk and Dang, 2012). This study sought to compare the efficiency of ports around the world, in the different fields of containers, grain, iron ore and oil, looking at proxies for the inputs of each type of port to the handling of cargoes and the throughput achieved, measured in terms of the dead-weight tonnage (dwt) passing through the port. For container ports, the study concluded that, with the exception of Rotterdam in the Netherlands, the most efficient ports were mostly located in Asia. The most efficient container ports were not necessarily the largest ports. Among most efficient ports are some of the largest global container ports (for example, Hong Kong, China; Singapore; and Shenzhen and Shanghai in China) (handling from 20 to 60 million dwt per port per month), but also medium to small size ports. For bulk oil ports, it concluded that, with the exception of Galveston, Texas, in the United States and (again) Rotterdam in the Netherlands, the most efficient oil ports are mostly located in the ROPME/RECOFI area[1], but not all ports in that region are operating efficiently. In this case, size does matter: the most efficient terminals are largely those with the largest throughput. In the case of bulk coal ports, the study concluded that a group of coal ports in Australia and China were clearly more efficient than nearly all the rest of the sample, although Velsen/IJmuiden in the Netherlands, Banjamarsin in India and Puerto Bolivar in Colombia were equally good. In the case of iron-ore and grain ports, the study concluded that, in both cases, larger ports were more efficient. It also concluded that, for grain ports, the least efficient terminals tend to be found in developed OECD countries. It should be noted, however, that the methodology of the study inevitably tends to rate a port as less efficient if, for historical reasons, its past investment has provided more facilities than is required for current levels of traffic.

It is instructive to compare the results of this study with the ranking published by the World Bank of the quality of the infrastructure of ports in different countries. This is based on a questionnaire to members of the World Economic Forum, which has been running for some 30 years. Recent rounds of the survey have included around 13,000 respondents from around 130 countries. Although subjective, the views expressed are likely to influence trade and investment decisions. The classification runs from 7 (efficient by international standards) to 1 (extremely underdeveloped). In 2012, the best-regarded ports were those in the Netherlands and Singapore, both being ranked at 6.8. Table 2 shows the countries whose ports are regarded as being in categories 6 and 5.

[1] Regional Organization for the Protection of the Marine Environment (ROPME) Members: Bahrain, Iran (Islamic Republic of), Iraq, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates. Regional Commission for Fisheries (RECOFI) Members: Bahrain, Iran (Islamic Republic of), Iraq, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates.

Table 2. Quality of Port Infrastructure

Category 6:	Bahrain, Belgium, Finland ↓, Germany ↓, Hong Kong, China ↓, Iceland, Netherlands↑, Panama↑, Singapore, United Arab Emirates↑.
Category 5:	Australia↑, Barbados↑, Canada↑, Chile ↓, Cyprus ↓, Denmark ↓, Estonia, France ↓, Ireland↑, Jamaica ↓, Japan, Lithuania↑, Malaysia, Malta↑, Namibia, New Zealand, Norway ↓, Oman↑, Portugal, Qatar↑, Republic of Korea↑, Saudi Arabia↑, Seychelles, Slovenia, Spain↑, Suriname↑, Sweden, United Kingdom↑, United States of America↓.
Those countries marked ↑ had a higher ranking, and those marked ↓ *a lower ranking, in 2012 than in 2009.*	

Source: World Bank, 2012.

The message from both these sources is that well-equipped and well-managed ports can be found in all parts of the world – as can less well-equipped and less well-managed ports. Given the importance of port effectiveness for world trade, improving capacities both in the planning and construction of ports and in their management could have beneficial effects. The facilities for the provision of accurate and timely navigational information to ships using ports is an important element of the equipment for the efficiency and effectiveness of ports, particularly in view of the adverse impacts on the marine environment from ships' casualties.

3.2 Charging

Charges for the use of ports raise some important issues. First, there is how to charge for services rendered. The normal recommendation of economists is that charges should only be levied if a service is delivered: economic theory argues against cross-subsidization between services. In the case of ports, however, there is a strong argument that ships' operators should not normally be able to opt out of paying for port waste-reception facilities. If they can opt out, they have an economic incentive not to pay for the disposal of their waste and to retain it on board until they can throw it into the sea, thereby aggravating the problem of marine debris. The European Union has adopted legislation requiring its ports generally to apply the rule of no separate charge for waste-reception facilities (EU, 2000). Whatever form a charge takes, it is important that the money is applied towards the environmentally sustainable disposal of the waste (see Chapter 17).

Secondly, there is the question of how far the port operator should be expected to cover the costs of providing the port. This applies both landward and seaward. In the landward direction, it is important that ports have adequate road, rail or inland-waterway connections to the port's hinterland. Otherwise, any efficiency gains in the port are cancelled out by the inefficiencies of transport into the hinterland. This can be very important for the economic viability of the port, since competitors may be able to offer a better deal overall. There is then the question of how far the costs of such adequate connections should be financed from the port charges rather than from government revenues or charges on the users of the connections. Decisions on this can only be taken for each port in the light of the policies of its possible competitors.

A parallel situation arises in the seaward direction, where there is often a need for dredging to maintain the access channels. In some countries, port operators have pressed governments to fund all or part of the costs of deepening and widening navigation channels, since they find themselves faced with competition from neighbouring ports which have natural deep-water harbours.

3.3 Landlocked countries

Because of the large proportion of international trade that is transported by sea (see Chapter 17 – Shipping), landlocked countries have particular difficulties from their lack of seaports. The 31 landlocked developing countries (LLDCs), 16 of which are among the least-developed countries (LDCs), face serious challenges to their growth and development, derived in substantial part from their problems in accessing maritime transport. In general, LLDCs face a 45 per cent higher ratio of freight charges to total value of exports and imports than the average of the developing countries through which their exports and imports must transit (LLDCs, 2011). This is a further aspect of capacity-building gaps to improve the efficiency of ports in the transit countries.

4. Impacts on the marine environment from port operations

The direct impacts on the marine ecosystem from ports take three main forms: first, the concentration of shipping, secondly, the demand for coastal space and, thirdly, the need for deep water. Chapter 26 (Land/sea interaction) considers other impacts that result from the transformations caused to the shoreline by the creation of ports and harbours.

4.1 Concentration of shipping

The concentration of shipping is generally an inevitable result of a successful port. Where a port takes part in a general market for port services, the more successful the port is, the greater are the size and number of the ships that it will serve. This means that discharges and emissions from the ships will be higher and have a more concentrated effect on the marine environment around the port. Even if each individual ship maintains the best practicable level of control over its impact, increasing levels of shipping to and from a port will result in increasing overall impacts, unless the best practicable means of control can be improved. Chapter 17 (Shipping) discusses the impacts from ships, particularly chronic oil discharges, garbage, sewage, anti-fouling treatments, air pollution and noise. All these can be controlled, but that control is more in the hands of the ships' masters and owners than in the hands of the port authority. Port authorities and governments can, however, influence these aspects through their charging policies and their enforcement of international standards. Because many ports have competition from their neighbours, effective action is likely to require agreement at a regional level.

For this reason, the regional memorandums of understanding on port-state control have an important role in managing the impact of ports on the marine environment. Other effects, such as the turbidity caused by ships' propellers disturbing sediments, are more site-specific, and can to some extent be controlled by port navigation rules. Nevertheless, such turbidity (and the subsequent re-settlement of sediment) can have adverse impacts on sensitive habitats, such as corals and sea-grass beds (Jones, 2011).

In all these cases, port authorities and port operators have some important roles to play in managing the impacts of ships. Adequate waste-reception (and especially for cruise ships) sewage-reception facilities are important for preventing marine debris and eutrophication problems. Likewise, adequate land-based electricity supplies ("cold ironing") for ships that need to run equipment while in port (especially refrigerator ships) are essential to reduce air pollution, since otherwise they must run the ships' generators while they are in port.

The IMO has set up a system whereby ships' operators can report inadequacies in port reception facilities. This can be found at https://gisis.imo.org/Public/PRF/ReportedCases.aspx. It enables ships to report the problems that they have encountered and port authorities to offer (if they wish) explanations for such shortcomings and information on steps that are being taken to resolve them. Since the beginning of 2005, 279 inadequacies have been reported. States have responded in only 76 cases (although there are several where the port State had not been notified).

4.2 Coastal space

The demand for coastal space in ports is tied up with the growth in container traffic. Space is needed next to the berths for the containers to be off-loaded. In step with the development of container traffic, there has therefore been a substantial growth in the land needed for container ports. Rodrigue (2010, in figure 3) shows the current scale of coastal space occupied by container ports. These are particularly demanding of coastal space because they have to have level space to hold the containers until they can be forwarded into the hinterland: bulk cargoes are normally transferred directly to less space-demanding storage.

Further growth in port throughput will inevitably result in further demand for container storage space at ports. This demand is rarely going to be able to be met from land that is not part of the coast, because around most ports this land is already committed to other forms of development (such as housing or industry) which are also essential for the growth of the port. As discussed in Chapter 26 (Land/sea physical interaction), this demand has therefore often been met by land reclamation – often from mangroves or salt marshes (for the pressures on which see Chapters 48 (Mangroves) and 49 (Salt marshes). These pressures are likely to continue. There is therefore a need for further investigation on how ports can handle increasing numbers of containers without increasing their demands for coastal space.

4.3 Deep water

The third pressure generated by ports is for deep water access channels. This normally means that dredging is used to deepen and widen the channels through sedimentary deposits, although in some cases it can involve blasting a channel through rock or (in rare cases) through coral reefs. Lack of available dredging services may constrain what can be done to provide deep-water access, and thus affect a port's competitiveness. Dredging can also affect the hydrodynamics of an estuary with consequences for adjacent beaches and seabed stability over broad areas (Pattiaratchi and Harris, 2002). Where dredging is used on areas not previously dredged, the impact on the bottom-dwelling flora and fauna may have to be balanced against the advantages of the improved access for ships. Where blasting is the only method available for providing the necessary deep-water access, the judgement is even more difficult, because it may mean the destruction of ecosystems based on a rocky or coral reef substrate. The quantities of material to be lifted by dredging can be immense (see Chapter 24 – Disposal of solid waste) and difficult judgements may have to be made about where the disposal should take place (Brodie, 2014). Where the dredging has to be done in the estuary of a river with a history of heavy industrial development, even more difficult judgements may have to be made about whether the dredged material should be re-introduced to the sea at all, given the risk of remobilising hazardous substances that have been sequestered in the sediments (see again Chapter 24 – Disposal of solid waste). The effects of elevated turbidity from dredging operations can have negative impacts on seagrasses (Erftemeijer and Lewis, 2006) and other benthic communities (Newell et al., 1998).

5. Integrating environmental, social and economic aspects

Port development is a special case of the issues raised by integrated coastal-zone management. Economically, it is always of high importance for the coastal State (and for the landlocked States that depend on transit through the coastal State). The pressures from ports will grow in step with the growth in international trade between coastal States, except to the extent that it is possible to improve the performance of ships and port installations. Port development also focuses together a large bundle of difficult trade-offs: increased benefits from trade, increased impacts from shipping, increased demand for coastal space and increased demand for creating or maintaining access channels. The growth in port throughput will therefore nearly always be accompanied by increased pressures on the environment. Social effects will be less pressing, because the changes needed as a result of the changeover to containerization are now largely in the past, and the social adjustments have been made. They will, however, need to be taken into consideration for those ports that have not yet joined the global consensus on containerization. A careful review of the different interests will therefore always be essential if port development is to be sustainable.

6. Information and capacity-building gaps

6.1 Knowledge gaps

Since ports constitute a significant economic sector, much information is available about them and their operations. What seems to be lacking is systematic information bringing together worldwide the operational aspects of ports and their impacts on the local marine environment, and their contribution to economic activity.

6.2 Capacity-building

Since the operation of a port can significantly affect both the successful operation of ships and the economic performance of the countries it serves, some ports need capacity-building in the operational skills needed for successful port operation. This is particularly important for ports that are serving as transit ports for landlocked countries, since the landlocked countries rely on the quality of port management in the transit country or countries, and are not in a position to insist on improvements.

It is important to develop (and then maintain) the capacities of port States both to implement the International Ship and Port Facility Security Code and related instruments and to carry out port-State inspections of ships, so as to enforce the internationally agreed standards for ships. Capacities to provide ships with good, real-time information on local navigational issues are also important.

Since the delivery to shore of garbage from ships in general is an important element of combating marine debris problems, ports which do not have adequate and easily used port waste-reception facilities need to have their capacities in this field improved. The same applies to sewage-reception facilities for cruise ships in relation to eutrophication problems.

Where ports which need dredging to maintain or improve navigation adjoin bays, rivers or estuaries with a history of industrial discharges, there is a need for them to have the capacity to examine the dredged material to decide whether it can safely be re-deposited in the sea.

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