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ΕΠΙΒΛΕΠΩΝ ΚΑΘΗΓΗΤΗΣ: ΠΑΝΑΓΟΠΟΥΛΟΥ ΜΑΡΙΑ

ΘΕΜΑ: CLASSIFICATION OF PORTS

ΤΟΥ ΣΠΟΥΔΑΣΤΗ: ΡΙΖΟΥ ΚΩΝΣΤΑΝΤΙΝΟΥ

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Ημερομηνία ανάληψης της εργασίας:
Ημερομηνία παράδοσης της εργασίας:

Α/Α	*Ονοματεπώνυμο*	*Ειδικότης*	*Αξιολόγηση*	*Υπογραφή*
1				
2				
3				
ΤΕΛΙΚΗ ΑΞΙΟΛΟΓΗΣΗ				

Ο ΔΙΕΥΘΥΝΤΗΣ ΣΧΟΛΗΣ :

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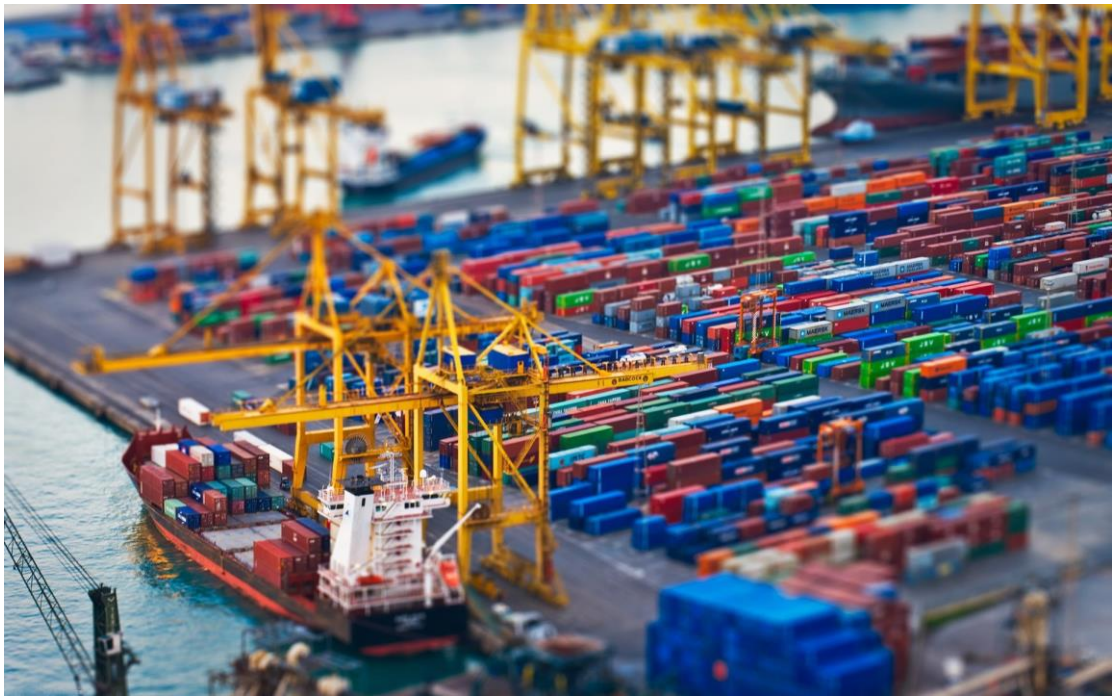
INTRODUCTION



There are 4936 ports in 196 countries in the world, according to the portal, World Port Source. Sea ports are areas where there are facilities for berthing or anchoring ships and where there is equipment for the transfer of goods from ship to shore, shore to ship, and ship to ship. To use more modern jargon, it is a ship/shore interface or a maritime inter-modal interface.

It deserves to be a major area of interest of those concerned with shipping as it is the place:

- where most accidents happen to ship and crew
- where cargo is damaged or stolen
- where repairs are done
- where most costs are incurred
- where delays occur, which will usually involve a large unexpected cost
- where surveys take place
- where most shipping services are situated e.g. Agents, banking, broking, bunkers, provisions, etc.
- where industries are situated
- where cargoes come from
- where customs & government policies are implemented

Unlike ships, ports often have to last a long time, sometimes for centuries. They therefore have to adapt and change over the course of time. Many of the traditional European ports were developed and built over a century ago, which means that many are now faced with a legacy of small antiquated docks, harbors or facilities that are no longer efficient or functional, depending on the services and the environment for which a port is functioning at present.

Many factors can cause ports to change, evolve, or die:

- Changes in the inland transport infrastructure. For instance the coming of railways tended to make large ports like London or Liverpool bigger and small ports smaller. Road transport had the opposite effect though the development of large container ships is again encouraging the growth of large regional ports.
- Changes in trade patterns, such as the UK joining the European Union had a very very negative effect on Liverpool but a positive effect at Felixstowe.
- Changes in financial and logistic thinking. London at its peak was an enormous warehouse for Europe. Since the Second World War the tendency is not to store "things" but to use ports and Industrial Areas, such as Rotterdam. More recently the trend has been to develop "value added activities" and become a sophisticated marketing and distribution center, such as Hamburg or Bremen.
- Changes in ship size with the need for "more water" in the docks and shorter turn round times.

All the above mentioned factors lead us to conclude that classifying a Port depends much on what criteria we choose to classify them, such as their geographic location, the industries it supports, their size, etc. The following is a report of the methods of Port Classification. First, the four generations of ports will be explained. Then, an approach based on the functionality of ports to try to understand various terms used in shipping for classifying ports. The geomorphology that dictates the construction of a port will be analyzed, followed by a report on Harbors and their types. Lastly, various examples of classifications based by size and numbers will be presented, to give an idea of the ways ports are compared in regard of their logistics.

CHAPTER ONE

Generations of Ports

Ports are strategic nodes that facilitate the flow of goods in the international arena, as a part of an extensive logistics network over which trade and exchange of information is established between points and / or distant geographical areas. Within port management the fields of strategic planning, marketing, logistics development and business management have broken through, following the same trend as other productive areas. Thus, ports evolution has changed its management forms, which are turned to be structured into four levels (1st, 2nd, 3rd and 4th generation).

1st Generation Ports

1st generation ports were conceived to transport goods between land and sea and vice versa, through a local or regional hinterland (area near the port that serves as a route for goods sales and distribution), unrelated to the socioeconomic environment of the territory where it was located.

2nd Generation Ports

The 2nd generation ports begin to be seen as a transportation hub and a center of industrial and commercial activity. Services are limited to ships and goods but in its vicinity processing industries are installed. These are called industrial ports.

3rd Generation Ports

The 3rd generation ports incorporate logistics functions related to the distribution of goods in services, data processing and use of telecommunications systems, and help to generate added value.

4th Generation Ports

The 4th generation ports make a step further and are characterized by telematic networks (communication networks based on new technologies) that connect different port areas and allow the collaboration with other ports, with the objective to internationalize and diversify their activity. These are called network ports. These ports are integrated into the international transport logistics chains, door to door services with other logistics operators working in several geographically nearby ports.

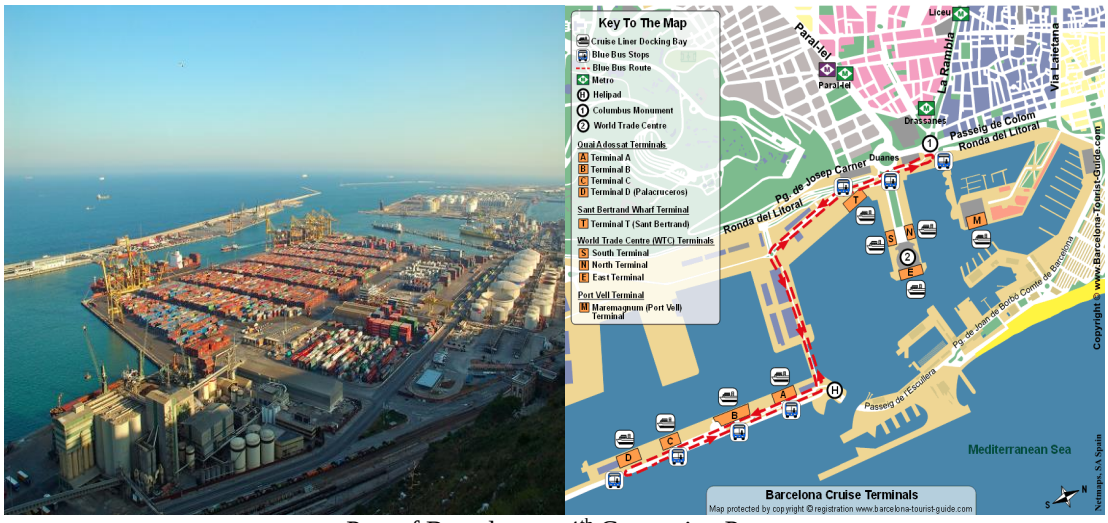
Thus, a 4th generation port is a big magnitude logistics platform. It has inter-modal terminals or dry ports, connected to the seaport, and are situated in

consumer goods environment with regular rail connection and competitive costs, allowing the transportation of large volumes of goods to the distribution chain.

Additionally, the new network economy transforms the classic positions of port logistics chains and gives them value. In this new context, there have been significant changes in port operations, which reduce the time of loading and unloading and door to door transport. In this regard, the 4th generation ports are connected with other ports and are characterized by:

- Development of internationalization strategies and diversification of its activities that allow, for example, the transportation of goods to any place in the planet.
- Provision of a logistics organization that makes its facilities attractive and efficient for the transportation of goods.
- Provision of electronic data interchange (EDI) networks integrated among port areas
- Looking for port areas distributed abroad.
- Cooperation with other port communities.

The 4th generation ports are logistics platforms with security and communications systems at the highest technological level. Also called network ports, are able to integrate into a multi-modal transportation network. They have business and management units, and a growth and expansion strategy in common with other ports that are similar.



Port of Barcelona, a 4th Generation Port

CHAPTER TWO

Classification of Ports by Function

Centre Port

Centre Ports, also referred as Mega Ports or Pivot Ports, are the central ports on a regional scale where, as it's name indicates, is were the main activity of cargo handling and distribution takes place, either seaward to and from other shipping lanes or inward to and from the inland and from smaller ports, which are described below.

Rotterdam, one of Europe's Central Ports

Feeder Port

A feeder port is actually a port that can be in the vicinity of the central port, or anywhere on the region of interest. Usually they distribute cargo to the Central Ports of the region for exporting, or receive cargo from Central ports for importing and distributing inland where the rest of the commercial cycle takes place. A feeder port is a port that large ocean vessels normally don't go to. Partly because the are not adequate means and facilities of storing and handling larger amounts of cargo, whether that is bulk, oil, or containers, or because they are not large or deep enough to handle the large ocean vessels. For instance, Aalborg, Denmark, is a feeder port of

Rotterdam, since it usually supplies or gets supplied by the Central Port, which is capable of handling larger ocean vessels and the cargo they carry.

Transit Port

Also referred in shipping as Entreport, a Transit Port is a port in which the majority of the goods are not intended for the local market, but will be transported to the final destination in the hinterland via other inland modes of transport. Such ports have been set up as a hub within flows of transport. Again, Rotterdam, like Antwerp, are examples of such harbors.

Left Side of Port of Antwerp, Belgium

Inland Port

An inland port is a port on a navigable lake, river (fluvial port), or canal with access to a sea or ocean, which therefore allows a ship to sail from the ocean inland to the port to load or unload its cargo. An inland port is a port on an inland waterway, such as a river, lake, or canal, which may or may not be connected to the ocean. The term "inland port" is also used to refer to a dry port, which is an inland extension of a seaport, usually connected by rail to the docks.

The United States Army Corps of Engineers publishes a list of such locations and for this purpose states that "inland ports" are ports that are located on rivers and do not handle deep draft ship traffic. The list includes familiar ports such as St. Louis, Cincinnati, Pittsburgh, Kansas City, and Memphis. A dense network of inland waterways including ports exists also in Europe (France, Germany, Poland, Russia, the United Kingdom and the Benelux countries), as well as in China and Brazil.

Port of Montreal, Canada's second busiest port, is an Inland Port

Dry Port

A Dry Port is an inland intermodal terminal directly connected by road or rail to a seaport and operating as a center for the transshipment of sea cargo to inland destinations.In addition to their role in cargo transshipment, dry ports may also include facilities for storage and consolidation of goods, maintenance for road or rail cargo carriers and customs clearance services. The location of these facilities at a dry port relieves competition for storage and customs space at the seaport itself.

A dry inland port can speed the flow of cargo between ships and major land transportation networks, creating a more central distribution point. Inland ports can improve the movement of imports and exports, moving the time-consuming sorting and processing of containers inland, away from congested seaports.

Comparison of the Terms Inland Port and Dry Port

The term inland port is used in a narrow sense in the field of transportation systems to mean a rather more specialized facility that has come about with the advent of the intermodal container (standardized shipping container) in international transport. Rather than goods being loaded and unloaded in such ports, shipping containers can just be transferred between ship and road vehicle or ship and train. The container may be transferred again between road and rail elsewhere and the goods are only loaded or unloaded at their point of origin or final destination.

Shipping containers allow some functions traditionally carried out at a seaport to be moved elsewhere. Examples are the functions of receiving, processing through customs, inspecting, sorting, and consolidating containers going to the same overseas port. Container transfer at the seaport can be sped up and container handling space can be reduced by transferring functions to an inland site away from the port and coast.

Distribution may also be made more efficient by setting up the link between inland site and seaport as, say, a high-capacity rail link with a lower unit cost than sending containers individually by road. The containers are still collected from their

origins or distributed to their ultimate destinations by road with the transfer happening at the inland site.

An dry port is just such an inland site linked to a seaport. This kind of inland port does not require a waterway. Key features of an inland port are the transfer of containers between different modes of transportation (intermodal transfer) and the processing of international trade. This differentiates an inland port from a container depot or transport hub.

The term inland port may also be used for a similar model of a site linked to an airport or land border crossing rather than a seaport.

The definition of inland port in the jargon of the transportation and logistics industries is:

An inland port is a physical site located away from traditional land, air and coastal borders with the vision to facilitate and process international trade through strategic investment in multi-modal transportation assets and by promoting value-added services as goods move through the supply chain. Inland ports may also be referred to as dry ports or intermodal hubs.

To summarize, the main difference is that a Dry Port needs a connection to a seaport, while inland ports have immediate access to the sea.

Warm-water Port

A warm-water port is one where the water does not freeze in wintertime. Because they are available year-round, warm-water ports can be of great geopolitical or economic interest. Such settlements as Dalian in China, Vostochny Port, Murmansk and Petropavlovsk-Kamchatsky in Russia, Odessa in Ukraine, Kushiro in Japan and Valdez at the terminus of the Alaska Pipeline owe their very existence to being ice-free ports. The Baltic Sea and similar areas have ports available year-round beginning in the 20th century thanks to icebreakers, but earlier access problems prompted Russia to expand its territory to the Black Sea.

Fishing Port

A fishing port is a port or harbor for landing and distributing fish. It may be a recreational facility, but it is usually commercial. A fishing port is the only port that depends on an ocean product, and depletion of fish may cause a fishing port to be uneconomical. In recent decades, regulations to save fishing stock may limit the use of a fishing port, perhaps effectively closing it.

Seaport

A seaport is further categorized as a "cruise port" or a "cargo port". Additionally, "cruise ports" are also known as a "home port" or a "port of call". The "cargo port" is also further categorized into a "bulk" or "break bulk port" or as a "container port".

Cruise home port

A cruise home port is the port where cruise-ship passengers board (or embark) to start their cruise and disembark the cruise ship at the end of their cruise. It is also where the cruise ship's supplies are loaded for the cruise, which includes everything from fresh water and fuel to fruits, vegetables, champagne, and any other supplies needed for the cruise. "Cruise home ports" are very busy places during the day the cruise ship is in port, because off-going passengers debark their baggage and on-coming passengers board the ship in addition to all the supplies being loaded. Currently, the *Cruise Capital of the World* is the Port of Miami, Florida, closely followed behind by Port Everglades, Florida and the Port of San Juan, Puerto Rico.

Port of call

A port of call is an intermediate stop for a ship on its sailing itinerary. At these ports, cargo ships may take on supplies or fuel, as well as unloading and loading cargo while cruise liners have passengers get on or off ship.

Cargo port

Cargo ports, on the other hand, are quite different from cruise ports, because each handles very different cargo, which has to be loaded and unloaded by very different mechanical means. The port may handle one particular type of cargo or it may handle numerous cargoes, such as grains, liquid fuels, liquid chemicals, wood, automobiles, etc. Such ports are known as the "bulk" or "break bulk ports". Those ports that handle containerized cargo are known as container ports. Most cargo ports handle all sorts of cargo, but some ports are very specific as to what cargo they handle. Additionally, the individual cargo ports are divided into different operating terminals which handle the different cargoes, and are operated by different companies, also known as terminal operators or stevedores.

Outport

Outport is the name given in the United Kingdom for a subsidiary port built in deeper water than the original port. The Port of Tilbury from the Port of London is a

good example. Avonmouth for Bristol and, on a smaller and now historical scale, Fordwich for Canterbury are others.

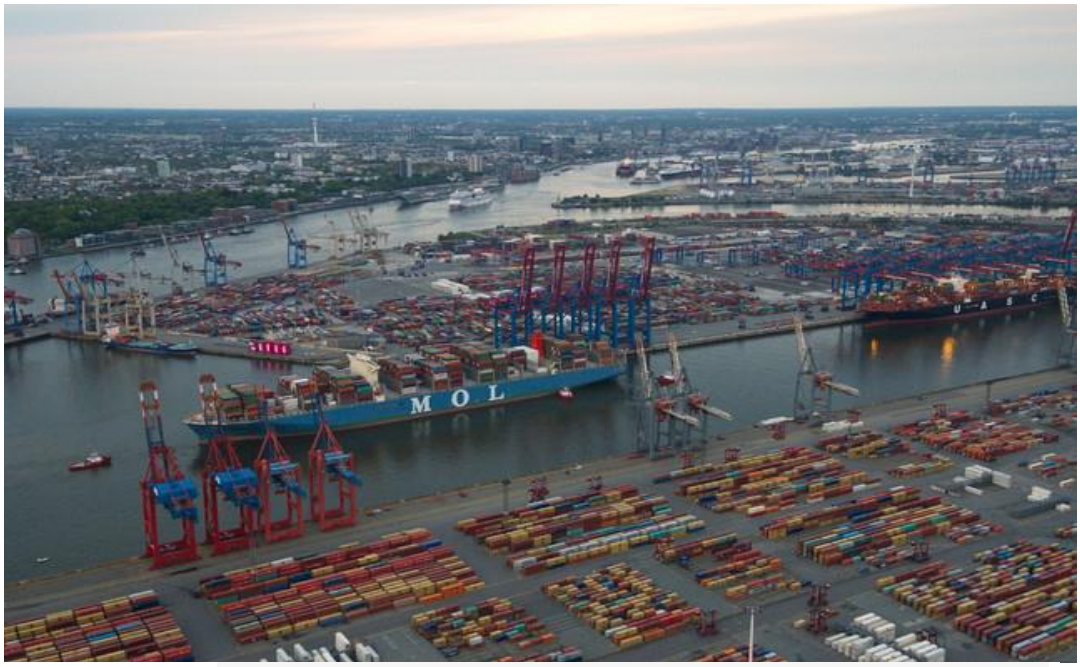
Port of Entry

In general, a port of entry (POE) is a place where one may lawfully enter a country. It typically has a staff of people who check passports and visas and inspect luggage to assure that contraband is not imported. International airports are usually ports of entry, as are road and rail crossings on a land border. Seaports can be used as ports of entry only if a dedicated customs presence is posted there. The choice of whether to become a port of entry is up to the civil authority controlling the port.

Trust Port

In the United Kingdom, a trust port is a port that is administered as a trust by an independent statutory body set up by an Act of Parliament and governed by its own set of rules and statutes. This is in contrast to a private port, which is privately owned, and a municipal port, which is owned by the local municipal authority.
Although there are 52 Trust Ports in England and Wales (according to the Trust ports study: key findings and recommendations (26/05/2016)) the UK Government's web page for Trust Ports has closed. An example of a Scottish Trust Port is Aberdeen Harbour Board.

A number of trust ports have been privatized under the provisions of the Ports Act 1991. The British government is considering further privatizations of trust ports in the future.



Port of Hamburg, around 9,000 ship calls per year, almost 300 berths and a total of 43 kilometers of quay for seagoing vessels.

Ports of Free Economic Zone

The terms related to shipping are the Free Port(Porto Franco) and the Free Zone(Zona Franca).

Most commonly a free port is a special customs area or small customs territory with generally less strict customs regulations (or no customs duties and/or controls for transshipment). Earlier in history, some free ports like Hong Kong enjoyed political autonomy. Many international airports have free ports, though they tend to be called customs areas, customs zones, or international zones.

The advantages of a Free port is that it reduces the time and effort required in customs formalities and avoids having large amounts of money deposited with the customs for duty on goods that are only in transit or being assembled in the area before being exported as a part of a larger product. In 1986 T.F.B. Helm, estimated that 20% of the world's trade was handled in the 478 Free Zones situated in more that 80 countries - compared with only 10% in 1981. Hamburg is perhaps the most famous, being established as such in 1988.

Naval Base

A naval base or navy base (military port) is a military base, where warships (navy ships) and naval ships are docked when they have no mission at sea or want to restock. Usually ships may also perform some minor repairs. Some naval bases are temporary homes to aircraft that usually stay on the ships but are undergoing maintenance while the ship is in port.

CHAPTER THREE

Classification of Ports by Geographical Type

The coasts of New York and New Jersey, evidently affected by the oceanic tides

Tides and their Effect on Port Types

Tides are the rise and fall of sea levels caused by the combined effects of the gravitational forces exerted by the Moon and the Sun and the rotation of Earth.

The times and amplitude of tides at any given locale are influenced by the alignment of the Sun and Moon, by the pattern of tides in the deep ocean, by the amphidromic systems of the oceans, and the form[*disambiguation needed*] of the coastline and near-shore bathymetry. Some shorelines experience a semi-diurnal tide—two nearly equal high and low tides each day. Other locations

experience a diurnal tide—only one high and low tide each day. A "mixed tide"—two uneven tides a day, or one high and one low—is also possible.

Tides vary on timescales ranging from hours to years due to a number of factors. To make accurate records, tide gauges at fixed stations measure water level over time. Gauges ignore variations caused by waves with periods shorter than minutes. These data are compared to the reference (or datum) level usually called mean sea level.

While tides are usually the largest source of short-term sea-level fluctuations, sea levels are also subject to forces such as wind and barometric pressure changes, resulting in storm surges, especially in shallow seas and near coasts.
Tides affect the construction and utility of ports located in coastlines prone to these phenomena. The types derived from tides and their effects are described as below

Coastal submergence

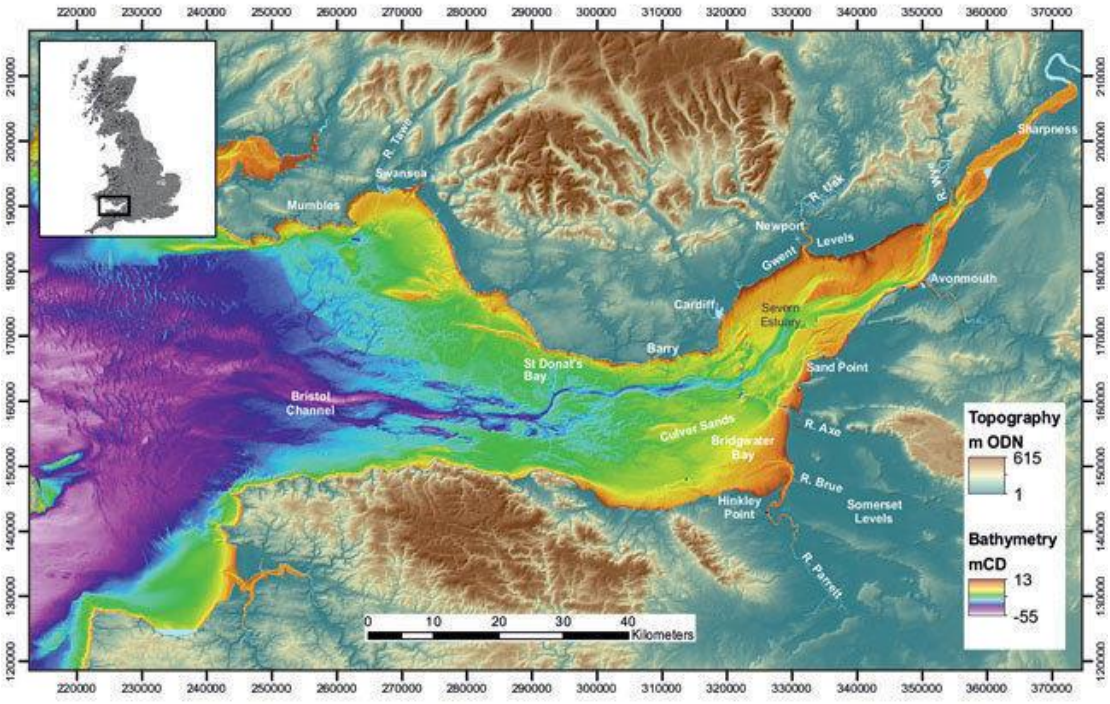
Submergent coastlines are stretches along the coast that have been inundated by the sea by a relative rise in sea levels from either isostacy or eustacy. Submergent coastlines are the opposite of emergent coastlines, which have experienced a relative fall in sea levels. Ports located at such areas are New York and Southampton.

Rias

A ria is a coastal inlet formed by the partial submergence of an unglaciated river valley. It is a drowned river valley that remains open to the sea. Typically, rias have a dendritic, treelike outline although they can be straight and without significant branches. This pattern is inherited from the dendritic drainage pattern of the flooded river valley. The drowning of river valleys along a stretch of coast and formation of rias results in an extremely irregular and indented coastline. Often, there are islands, which are summits of partly submerged, pre-existing hill peaks.

A ria coast is a coastline having several parallel rias separated by prominent ridges, extending a distance inland. The sea level change that caused the submergence of a river valley may be either eustatic (where global sea levels rise),
or isostatic (where the local land sinks). The result is often a very large estuary at the mouth of a relatively insignificant river (or else sediments would quickly fill the ria). The Kingsbridge Estuary in Devon, England, is an extreme example of a ria forming an estuary disproportionate to the size of its river; no significant river flows into it at all, only a number of small streams.

The south coast of England is a submergent coastline which contains many rias, including Portsmouth Harbour, Langstone Harbour, Chichester Harbour, Pagham Harbour, Southampton Water, Poole Harbour, the estuaries of the Exe, Teign and Dart, then Kingsbridge Estuary, Plymouth Sound in Devon, and the estuaries of the River Fowey, River Fal and Helford River in Cornwall. On the north coast is the River Camel and the River Taw. In Essex is the Blackwater River and River Crouch.
The River Severn also forms a large ria.



The Saefern Sea, or Bristol Channel, connecting the Severn with the ocean, forming a large ria along the coastline.

Estuaries

An estuary is a partially enclosed coastal body of brackish water with one or more rivers or streams flowing into it, and with a free connection to the open sea. Estuaries form a transition zone between river environments and maritime environments. They are subject both to marine influences—such as tides, waves, and the influx of saline water—and to river influences—such as flows of fresh water and sediment. The inflows of both sea water and fresh water provide high levels of nutrients both in the water column and in sediment, making estuaries among the most productive natural habitats in the world.

The most widely accepted definition is: "a semi-enclosed coastal body of water, which has a free connection with the open sea, and within which sea water is measurably diluted with freshwater derived from land drainage". However, this definition excludes a number of coastal water bodies such as coastal lagoons and brackish seas. A more comprehensive definition of an estuary is "a semi-enclosed body of water connected to the sea as far as the tidal limit or the salt intrusion limit and receiving freshwater runoff; however the freshwater inflow may not be perennial, the connection to the sea may be closed for part of the year and tidal influence may be negligible". This broad definition also includes fjords, lagoons, river mouths, and tidal creeks. An estuary is a dynamic ecosystem having a connection to the open sea through which the sea water enters with the rhythm of the tides. The sea water entering the estuary is diluted by the fresh water flowing from rivers and streams. The pattern of dilution varies between different estuaries and depends on the volume of fresh water, the tidal range, and the extent of evaporation of the water in the estuary.

Based on the geomorphology of estuaries, we can colcude to the following categories:

- **Drowned River Valleys**: Also known as coastal plain estuaries, they form In places where the sea level is rising relative to the land, sea water progressively penetrates into river valleys and the topography of the estuary remains similar to that of a river valley. This is the most common type of estuary in temperate climates. Well-studied estuaries include the Severn Estuary in the United Kingdom and the Ems Dollard along the Dutch-German border. The width-to-depth ratio of these estuaries is typically large, appearing wedge-shaped (in cross-section) in the inner part and broadening and deepening seaward. Water depths rarely exceed 30 m (100 ft). Examples of this type of estuary in the U.S. are the Hudson River, Chesapeake Bay, and Delaware Bay along the Mid-Atlantic coast, and Galveston Bay and Tampa Bay along the Gulf Coast.

- **Lagoon-Type or Bar-Built**: Bar-built estuaries are found in place where the deposition of sediment has kept pace with rising sea level so that the estuaries are shallow and separated from the sea by sand spits or barrier islands. They are relatively common in tropical and subtropical locations. These estuaries are semi-isolated from ocean waters by barrier beaches (barrier islands and barrier spits). Formation of barrier beaches partially encloses the estuary, with only narrow inlets allowing contact with the ocean waters. Bar-built estuaries typically develop on gently sloping plains located along tectonically stable edges of continents and marginal sea coasts. They are extensive along the Atlantic and Gulf coasts of the U.S. in areas with active coastal deposition of sediments and where tidal ranges are less than 4 m (13 ft). The barrier beaches that enclose bar-built estuaries have been developed in several ways:

  - building up of offshore bars by wave action, in which sand from the sea floor is deposited in elongated bars parallel to the shoreline,
  - reworking of sediment discharge from rivers by wave, current, and wind action into beaches, overwash flats, and dunes,
  - engulfment of mainland beach ridges (ridges developed from the erosion of coastal plain sediments around 5000 years ago) due to sea level rise and resulting in the breaching of the ridges and flooding of the coastal lowlands, forming shallow lagoons, and
  - elongation of barrier spits from the erosion of headlands due to the action of longshore currents, with the spits growing in the direction of the littoral drift.

  Barrier beaches form in shallow water and are generally parallel to the shoreline, resulting in long, narrow estuaries. The average water depth is usually less than 5 m (16 ft), and rarely exceeds 10 m (33 ft). Examples of bar-built estuaries are Barnegat Bay, New Jersey; Laguna Madre, Texas; and Pamlico Sound, North Carolina.

- **Fjord-Type**: Fjords were formed where pleistocene glaciers deepened and widened existing river valleys so that they become U-shaped in cross

sections. At their mouths there are typically rocks bars or sills of glacial deposits, which have the effects of modifying the estuarine circulation. Fjord-type estuaries are formed in deeply eroded valleys formed by glaciers. These U-shaped estuaries typically have steep sides, rock bottoms, and underwater sills contoured by glacial movement. The estuary is shallowest at its mouth, where terminal glacial moraines or rock bars form sills that restrict water flow. In the upper reaches of the estuary, the depth can exceed 300 m (1,000 ft). The width-to-depth ratio is generally small. In estuaries with very shallow sills, tidal oscillations only affect the water down to the depth of the sill, and the waters deeper than that may remain stagnant for a very long time, so there is only an occasional exchange of the deep water of the estuary with the ocean. If the sill depth is deep, water circulation is less restricted, and there is a slow but steady exchange of water between the estuary and the ocean. Fjord-type estuaries can be found along the coasts of Alaska, the Puget Sound region of western Washington state, British Columbia, eastern Canada, Greenland, Iceland, New Zealand, and Norway.

- **Tectonically produced**: These estuaries are formed by subsidence or land cut off from the ocean by land movement associated with faulting, volcanoes, and landslides. Inundation from eustatic sea level rise during the Holocene Epoch has also contributed to the formation of these estuaries. There are only a small number of tectonically produced estuaries; one example is the San Francisco Bay, which was formed by the crustal movements of the San Andreas fault system causing the inundation of the lower reaches of the Sacramento and San Joaquin rivers.

The last element of importance concerning estuaries in regard to port classification is the Estuarine Water Circulation. The Estuarine Water Circulation is controlled by the inflow of rivers, the tides, rainfall and evaporation, the wind, and other oceanic events such as an upwelling, an eddy, and storms. Estuarine water circulation patterns are influenced by vertical mixing and stratification, and can affect residence time and exposure time. Based on those effects, are four types of Estuaries:

- **Salt wedge:** In this type of estuary, river output greatly exceeds marine input and tidal effects have a minor importance. Fresh water floats on top of the seawater in a layer that gradually thins as it moves seaward. The denser seawater moves landward along the bottom of the estuary, forming a wedge-shaped layer that is thinner as it approaches land. As a velocity difference develops between the two layers, shear forces generate internal waves at the interface, mixing the seawater upward with the freshwater. An example of a salt wedge estuary is the Mississippi River.

- **Partially mixed:** As tidal forcing increases, river output becomes less than the marine input. Here, current induced turbulence causes mixing of the whole water column such that salinity varies more longitudinally rather than vertically, leading

to a moderately stratified condition. Examples include the Chesapeake Bay and Narragansett Bay.

- **Well-mixed**: Tidal mixing forces exceed river output, resulting in a well mixed water column and the disappearance of the vertical salinity gradient. The freshwater-seawater boundary is eliminated due to the intense turbulent mixing and eddy effects. The lower reaches of Delaware Bay and the Raritan River in New Jersey are examples of vertically homogenous estuaries.

- **Inverse:** Inverse estuaries occur in dry climates where evaporation greatly exceeds the inflow of fresh water. A salinity maximum zone is formed, and both riverine and oceanic water flow close to the surface towards this zone. This water is pushed downward and spreads along the bottom in both the seaward and landward direction. An example of an inverse estuary is Spencer Gulf, South Australia.

CHAPTER FOUR

Harbors and Types of Harbors

A harbor or harbour, or haven, is a body of water where ships, boats and barges seek shelter from stormy weather, or are stored for future use. The term "harbor", referring primarily to a sheltered body of water, is often used interchangeably with "port", which is a man-made facility built for loading and unloading vessels and dropping off and picking up passengers. Ports are often located *in* harbors.
Harbors can be natural or artificial. An artificial harbor can have deliberately constructed breakwaters, sea walls, or jettys, or they can be constructed by dredging, which requires maintenance by further periodic dredging. An example of an artificial harbor is Long Beach Harbor, California, United States which was an array of salt marshes and tidal flats too shallow for modern merchant ships before it was first dredged in the early 20th century.[1] In contrast, a natural harbor is surrounded on several sides by prominences of land. Examples of natural harbors include Sydney Harbour, Australia and Trincomalee Harbour in Sri Lanka.

Below various types of harbors will be explained further.

Artificial Harbors

Artificial harbors are frequently built for use as ports. The oldest artificial harbor known is the Ancient Egyptian site at Wadi al-Jarf, on the Red Sea coast, which is at least 4500 years old (ca. 2600-2550 BC, reign of King Khufu). The largest artificially created harbor is Jebel Ali in Dubai.[2] Other large and busy artificial harbors include:

- Port of Rotterdam, Netherlands;
- Port of Houston, Texas, United States;
- Port of Savannah, Georgia, United States;
- Port of Long Beach, California, United States;
- Port of Los Angeles in San Pedro, California, United States.

The Ancient Carthaginians constructed fortified, artificial harbors called cothons.

Natural Harbors

A natural harbor is a landform where a part of a body of water is protected and deep enough to furnish anchorage. Many such harbors are rias. Natural harbors have long been of great strategic naval and economic importance, and many great cities of the world are located on them. Having a protected harbor reduces or eliminates the need for breakwaters as it will result in calmer waves inside the harbor.

Coastal Natural Harbor

Represents a sheltered site the outcome of a natural profile of the coast, creating a natural barrier such as a cape, a reef or an island. About 2,100 (46.0%) ports are in this category, underlining that the selection of a port site is dominantly influenced by the quality of the harbor.

Coastal Breakwater

A harbor lying behind an artificial breakwater construction, built from scratch or built to add to an existing natural shelter. It is particularly the case for harbors exposed to dominant winds, waves or the sea currents. About 810 ports (17.6%) are in this category.

Coastal Tide Gates

A harbor behind a set of locks or other mechanical devices built to insure sufficient water levels in the harbor for all tide levels. In many cases ships can enter or exit the port only at certain times of the day when water levels are adequate. Only 39 (0.8%) such ports exist, such as Mumbai, India.

Open Roadstead

A harbor with no natural or artificial protection. They are often built to accommodate very large ships (such as oil tankers) or are in a setting where there are limited tides, implying that sheltering infrastructure are much less required (Persian Gulf, Red Sea, Gulf of Mexico). 580 (12.5%) ports are in this category, including Ra's at Tannurah, Saudi Arabia, a major oil port in the Persian Gulf.

River Natural

A harbor located along a river where water is not retained in any artificial means. The harbor often consists of quays or wharves parallel to the river banks. Piers may also extend into the river. About 850 (18.5%) such ports exist, such as Jacksonville or Montreal.

River Basins

A river harbor where basins have been excavated to accommodate ships, often parallel to the flow of the river. This confers the advantage of additional berth space without impeding fluvial navigation. 77 (1.6%) such ports exist, including Bremen.

River Tide Gates

A river harbor behind a set of locks or other mechanical devices built to insure sufficient water levels in the harbor for all tide levels. Such harbors tend to be located close to the ocean, such as in a river delta or estuary for the case of Antwerp (Scheldt estuary) and Bremerhaven (Weser estuary). Only 47 (1.0%) such ports exist.

Ice-free Harbor

For harbors near the North and South Poles, being ice-free is an important advantage, especially when it is year-round. This term is similar with the Warm-water port term, the one referring to the port, the other to the harbor.The world's southmost harbor, located at Antarctica's Winter Quarters Bay (77° 50′ South), is potentially ice-free, depending on the summertime pack ice conditions.

Murmansk seaport, one of the largest ice-free ports in Russia, is the backbone of the economy of the city.

Canal or Lake

A harbor located along an artificial canal or by a river accessible through a navigable waterway. 67 (1.4%) such ports exist, including Balboa in Panama and Brugge in Belgium.

Inland Harbor

An inland harbor (or inland harbour) is a harbor that is quite far away from the ocean or sea, such as Berlin, Germany or Paris, France. Inland harbors are connected to a large body of water by an important river or canal passing near the center of the city.

The Danube in Europe, the Mississippi River in the United States, and the Yangtze River in the People's Republic of China are transportation routes for many cities in each case.

Inland harbor should not be confused with an inland port which is a transport hub connected by rail or road to the ocean rather than by a water connection.

CHAPTER FIVE

Classification of Ports by Size

A really satisfactory statistic for measuring the size or productivity of a port for comparative purposes does not seem to exist. The following however are some of the more popular ones:

1. The total weight of cargo handled in a year. This statistic gives a tremendous advantage to the oil ports where cargo is handled in thousands of tons per hour.

2. The total value of cargo handled. Ifthis fugure is used Dover becomes the largest port in the UK. This is an almost impossible figure to assess globally.

3. The total number of ships that enter and leavethe port each year. This enables ferry ports such as Dover and Southampton to exaggerate their importance. Singapore seems to be the largest on this statistic. Japanese ports also score well due to the large fishing fleets using many of their ports.

4. The number of berths available

5. The size of the largest ship that can use the port's facilities.This would make Bantry Bay one of the largest ports in the world.

Major World Ports Cargo Traffic in Millions tons & Number of Ships in 1993

Port	Liquid	Dry Bulk	Container	Other	Total	Rank	Ships
Rotterdam	134	80	35.7	29.3	279	1	27,170
Singapore	124	7	127(FT)	16 (FT)	273	2	92,655
Hong Kong	14	23	36	22	96	9	?
Long Beach	35 (RT)		35 (RT)	2.5 (RT)	72.5	1st USA	5,036
Hedland Port	48		.002	.012	48	2nd Aus.	617

Source ISL Bremen October 1994

However, the undisputed overall champion, with high score on all the first four of these creteria and able to take 200000 ton dwt tankers is Rotterdam's Europort.

Europort, Rotterdam is one of the world's busiest ports and considered a major entry to Europe. The port handled 12 million containers in 2015.

Although the size of the largest ship that can use a port's facilities is not a very meaningful statistic when comparing the size of various ports, it is a very important criterion from the ship operator's point of view and for those concerned with post planning and designing the ship of the future. The usual limiting figure and the one that is usually the most expensive and dificult to overcome is the draft or depth of water available. Because pf this it is perhaps necessary to explore this area with rather great detail.

The approximate correlation between the ships draft and her deadweight tonnage:

Dead Weight Tonnage	Draft in Feet	Draft in Decimeters
10000	26	79
20000	30	91
50000	38	116
100000	48	146
200000	60	183
300000	72	219
500000	90	274

Naturally enough there are experimental designs for special "reduced draft" large vessels.Nor is it enough just to have sufficient water to float the ship. When large fast ships get into shallow water they both slow down and squat(increase their draft at one or both ends).

Finding ports with sufficient depth or water to be able to accept loaded 200000 ton deadweight tankers is difficult. In 1970(the early days of VLCCs) there were only eight ports in Europe that could accept such ships and none on the East Coast of North America. Energetic dredging operations have improved on this so by 1975 there were

22 such ports in North Western Europe(of which nine are in the UK), 15 in the Mediterranean, four in North America, 16 in Japan, four in South America, one in South and East Africa and one in South-East Asia. Since this initial surge of improvement the numbers of ports with sufficient depth of water has only increased gradually.

It is not only a question of finding sufficient depth of water at the port and in the port but also in getting to the port, and many of the continental shelf areas of the world present real problems for the larger ship.

Container Ports

This is a categorization of Ports handling containers, that segregates Container ports in three Categories:

Minor ports	Handling < 50,000 TEUs annually, Multipurpose ports, feedering + coastal Examples: Mazatlan (Mexico); Bar (Montenegro)
Regional ports	Handling between 50,000 and 300,000 TEUs annually Feedering + direct regional (short sea) calls Examples: Oran, Bejaia (Algeria), Tripoli (Libya) in the Mediterranean
Major regional or national gateways	Handling >300,000 TEUs annually Feedering + direct inter-continental (longer haul) trade Examples: Tg Priok, Surabaya (Indonesia)

This is a list of the world's busiest container ports (ports with container terminals that specialize in handling goods transported in shipping containers) by total number of actual twenty-foot equivalent units (TEUs) transported through the port. Data listed in thousands of TEU.

Container Traffic (in thousand TEUs):

Rank	Port	Jurisdiction	2015[1]	2014[2]	2013[3]	2012[4]	2011[5]	2010[6]	2009[7]	2008[8]
1	Shanghai	China	36,516	35,268	33,617	32,529	31,700	29,069	25,002	27,980
2	Singapore	Singapore	30,922	33,869	32,240	31,649	29,937	28,431	25,866	29,918
3	Shenzhen	China	24,142	23,798	23,280	22,940	22,570	22,510	18,250	21,414
4	Ningbo-Zhoushan	China	20,636	19,450	17,351	16,670	14,686	13,144	10,502	11,226
5	Hong Kong	Hong Kong SAR	20,073	22,374	22,352	23,117	24,384	23,532	20,983	24,248
6	Busan	South Korea	19,469	18,423	17,690	17,046	16,185	14,157	11,954	13,425
7	Qingdao	China	17,323	16,624	15,520	14,503	13,020	12,012	10,260	10,320
8	Guangzhou	China	17,097	16,160	15,309	14,744	14,400	12,550	11,190	11,001
9	Jebel Ali (Dubai)	United Arab Emirates	15,585	14,750	13,641	13,270	13,000	11,600	11,124	11,827
10	Tianjin	China	13,881	14,050	13,010	12,300	11,500	10,080	8,700	8,500
11	Rotterdam	Netherlands	12,235	12,453	11,621	11,866	11,877	11,146	9,743	10,784
12	Port Klang	Malaysia	11,887	10,736	10,350	10,000	9,604	8,870	7,309	7,970
13	Kaohsiung	Taiwan	10,264	10,593	9,938	9,781	9,636	8,872	8,581	9,677
14	Antwerp	Belgium	9,654	9,136	8,578	8,635	8,664	8,468	7,309	8,663
15	Dalian	China	9,591	10,128	10,860	8,060	6,400	5,242	4,552	4,503

This is a list of the World's busiest transshipment ports ranked by their total containerised transshipment cargo handled:

Rank	Port	Country
1	Singapore	Singapore
2	Hong Kong	Hong Kong, China
3	Shanghai	China
4	Busan	South Korea
5	Tanjung Pelepas	Malaysia
6	Rotterdam	Netherlands
7	Dubai	United Arab Emirates
8	Gioia Tauro	Italy
9	Algeciras	Spain
10	Hamburg	Germany
11	Salalah	Oman
12	Klang	Malaysia
13	Colombo	Sri Lanka
14	Port Authority of Jamaica	Jamaica
15	Antwerp	Belgium
16	Sines	Portugal
17	Los Angeles	United States
18	New Jersey	United States
19	Port Authority of Jamaica	Jamaica
20	LACONA	Panama

Cruise Ports

This is a list of the busiest Cruise Ports by Passengers, on 2014:

Annual cruise passengers

Rank 2014	Port	Country	2014
1	Port of Miami		4,850,000[1]
2	Port Everglades		4,160,000[2]
3	Port Canaveral		4,001,000[2]
4	Port of Nassau		3,412,000 (2012)[3]
5	Port of Cozumel		2,700,000[4]
6	Port of Barcelona		2,364,292[5]
7	Port of Civitavecchia		2,140,039[5]
8	Port of The Virgin Islands		2,083,890 [6]
9	Port of Saint Martin		2,000,864 [7]
10	Port of Venice		1,733,839[5]
11	Port of The Balearic Islands		1,587,064[5]
12	Port of Southampton		1,529,000 (2013)[8]
13	Port of Marseille		1,311,284[5]
14	Port of Naples		1,113,762[5]
15	Port of Piraeus		1,055,556[5]
16	Port de Genoa		1,051,015 (2013)[9]
17	Port of Savona		1,018,794[5]
18	Port of New Orleans		1,014,325[10]
19	Port of Galveston		901,000 (2013)[11]
20	Port of Dubrovnik		894,216[5]

The following is a list of the world's busiest seaports by cargo tonnage, the total mass of actual cargo transported through the port. The rankings are based on AAPA world port ranking data.

The cargo rankings based on tonnage should be interpreted with caution since these measures are not directly comparable and cannot be converted to a single, standardized unit. In the Measure column, MT = Metric Tons, HT = Harbor Tons, FT = Freight Tons, and RT = Revenue Tons.

The table refers to the 2012-2014 period.

Rank	Port	Country	Measure	2014 kiloton[1]	2013 kiloton[2]	2012 kiloton[3]
1	Shanghai	China	MT	678,376	696,985	644,659
2	Singapore	Singapore	FT	581,268	560,888	538,012
3	Guangzhou	China	MT	500,975	472,760	438,000
4	Qingdao	China	MT	465,055	450,111	407,340
5	Port Hedland	Australia	MT	446,922	488,000	288,443
6	Tianjin	China	MT	445,780	477,399	477,000
7	Rotterdam	Netherlands	MT	444,733	440,464	441,527
8	Ningbo	China	MT	429,912	399,250	364,612
9	Dalian	China	MT	337,366	320,843	303,000
10	Busan	South Korea	RT	335,411	313,295	298,689
11	Hong Kong	China	MT	297,737	276,055	269,282
12	Qinhuangdao	China	MT	261,702	253,293	233,235
13	South Louisiana	United States	MT	242,578	216,445	228,677
14	Port Klang	Malaysia	MT	217,289	198,928	195,856
15	Houston	United States	MT	212,561	207,973	216,082
16	Nagoya	Japan	FT	207,621	208,241	202,556
17	Antwerp	Belgium	MT	199,012	190,849	184,136
18	Shenzhen	China	MT	192,093	201,546	196,458
19	Xiamen	China	MT	184,604	171,885	155,131
20	Dampier	Australia	MT	172,802	177,528	180,366

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