Maritime Society in the Era of Global Warming

– A Message from the Year 2050 –

October 2009

Ocean Policy Research Foundation

Preface

What will become of the global economy and society half a century from now, when the generation that forms the core of today's world will have been replaced by an entirely new one? Will mankind be living in harmony with the earth and the oceans? What will become of the maritime community? In order to maintain a healthy maritime outlook for the next generation, it is essential to provide a vision for the future with an extremely long-term perspective by focusing attention on our relationships with the global economy and society.

Achieving a balance regarding population increase, human safety and protection of the environment presents challenges for mankind to overcome through collective efforts. Regardless of how easily goods, personnel and information can be transported across borders, it will still take a considerable amount of time before all nations can peacefully share the burden of these challenges. People in maritime society, who already share the oceans, may be able to achieve cooperation, collaboration and harmony faster than those in society as a whole.

Our foundation has attempted to visualize what maritime industry will be like in the mid-21st century and to project this vision to actual maritime policies based on the recognition that global environmental problems – especially the risk of global warming – will impose major restrictions on sustainable development. Here, we present two proposals as the fruits of our efforts.

We sincerely hope that these proposals will contribute to discussions regarding sustainable maritime society worldwide.

October 2009

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1. Objective of Proposals

Here at the beginning of the 21st century, the world faces significant changes, including globalization, multi-polarization in worldwide economic activity, diversification of values and serious global environmental problems. There is a need to consider what action maritime society should take toward the mid-21st century to adapt and respond to these drastic changes (in this report, the term *maritime society* is used to refer to all stakeholders involved in maritime transportation).

To this end, we have formulated two proposals with an extremely long-term perspective.

2. Methodology of Proposals

(1) Assumptions regarding the World of 2050

The target year assumed in our proposals is 2050[1]. From among the four major scenarios presented by the Intergovernmental Panel on Climate Change (IPCC) in the Special Report on Emissions Scenarios (SRES[2]), we chose A1B, which is believed to be the most probable scenario for global economic activity before the year 2050.

This scenario states that:

1. The global population will increase from 6.465 billion in 2005 to 8.673 billion in 2050 (by a factor of 1.3 increases). Global GDP is also predicted to increase by a factor of 4.3 from 44.688 trillion USD in 2005 to 193.223 trillion USD in 2050.

2. Per capita GDP will show a increase by a factor of 3.2 during the same period, from 6,912 USD to 22,280 USD per person. The focus of energy consumption will shift from petroleum products to natural gas, and consumption in Btu (British thermal units) will also increase by a factor of 3.0 of the 2005 level by 2050.

3. Focusing on Asia, its total population excluding that of Japan is predicted to increase from 3.443 billion in 2005 to 4.219 billion in 2050 (by a factor of 1.2 increases). Meanwhile, the total GDP of Asia will increase by a factor of 15.5, from 3.785 trillion USD in 2005 to 58.749 trillion USD in 2050.

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[1] We chose 2050 as the most appropriate year for an extremely long-term examination for the following reasons: 1) it is regarded as the target year for global warming prevention; and 2) the world is strongly expected to experience dramatic changes in terms of social structure and values before then.

[2] The report was issued in 1996 for the purpose of predicting future increases in GHG emissions. It includes not only future energy consumption but also economic predictions such as GDP levels, both of which are allocated for individual regions.
http://www.grida.no/publications/other/ipcc%5Fsr/?src=/climate/ipcc/emission/

4. Accordingly, the per capita GDP of Asia will increase by a factor of 12.7 during this period, from 1,099 USD to 13,924 USD per person. Thus, while Asia will experience a smaller population increase than other areas, it will see the highest level of GDP growth in the world.

In these quantitative predictions, we emphasize that such economic growth could be achieved by globalization with growth of individual economic blocks.

More specifically, we assume that East Asian countries will develop more intimate economic partnerships among themselves with fewer restrictions on cross-border economic transactions, resulting in increased international trade. We also assume that companies in Asia will develop efficient supply chain management (SCM) for the distribution of raw materials and semi-manufactured/final products among neighboring countries. We further assume that these companies will place their manufacturing and sales sites in the most suitable locations in association with the development of infrastructure elements such as ports, highways and railways as well as in response to regional demand.

(2) Backcasting from the World of 2050

Based on the A1B scenario, we made our own quantitative predictions regarding global maritime transportation in 2050. Details of our predictions are provided in the Appendix.

We then carefully examined various narrative factors affecting maritime society from the viewpoint of contribution to global economic growth and minimization of risks regarding safety, security and environmental protection.[3]

Based on these examinations, we looked back from the year 2050 (an approach known as “backcasting”) and discussed what action must urgently be taken here at the beginning of the 21st century. From the results, we formulated two proposals for maritime society in the era of global warming.

[3] It should be noted that the main aim of this project is to pinpoint issues with an extremely long-term perspective. Accordingly, in this report we place less priority on issues that are urgent but short- or mid-term in nature such as piracy in the waters off the coast of Somalia and the effects of recent recession conditions on shipbuilding.

3. State of Maritime Society and Related Challenges in 2050

According to our predictions, world seaborne trade will increase by a factor of 2.5 from 29,043 billion ton-miles in 2005 to 72,498 billion ton-miles in 2050. Container shipments will show a particularly sharp rise during this period, increasing by a factor of 5.9 from 490 billion TEU-miles in 2005 to 2,894 billion TEU-miles in 2050. Predictions regarding intra-regional transportation show that shipments within Asia will increase by a factor of 10.7, from 18 billion TEU-miles in 2005 to 194 billion TEU-miles in 2050.

Maritime industry should properly manage these increasing levels of seaborne trade to ensure high economic growth, particularly in Asia, by expanding fleet capacity and enhancing operational efficiency.

However, these increases in global and regional seaborne trade are expected to cause heavy maritime traffic congestion and a shortage of skilled seafarers[4]. Accordingly, there may be a corresponding increase in the number of accidents, posing severe risks in terms of safety and the environment.

Furthermore, international maritime transportation without efficiency improvements will result in the emission of 2.4 billion tons of CO_2 in 2050 – a figure that greatly exceeds current total emissions from on-land sources in Germany and Japan (a combined 2.0 billion tons of CO_2 in 2005). For this reason, international maritime transportation may significantly contribute to global warming.

In addition, such a huge volume of maritime transportation may cause an increase in amounts of air pollutants, noxious and hazardous materials and bio-invasive organisms. As a result, the efficacy of current international frameworks such as those of the MARPOL 73/78 Convention, the AFS Convention, the BWM Convention, etc. may be weakened.

[4] Supposing that the average number of seafarers required per vessel will be the same as at present, 830,000 seafarers will be required in 2050 as a result of an increased number of vessels. If we assume that the supply of seafarers will remain the same as at present, the total will be 364,000 short of the required number.

For contribution to global economic development, increased operational efficiency will be needed in addition to fleet expansion. Stakeholders must also address the following problems, which being left unresolved:

1. Port capacities may be insufficient in Asia, Middle/South America and Africa, where sharp increases in maritime transportation are expected. This may cause delays in transportation due to port congestion in these regions.

2. Worldwide markets for the recycling of steel and other materials and the reuse of ship equipment may not be well established, which may hamper efforts to avoid wasting resources.

4. Proposals for Maritime Society in the Era of Global Warming

Two major principles should be adhered to by all stakeholders in maritime industry in order to achieve sustainability through to 2050. One is that maritime industry should contribute to world economic growth through the provision of stable maritime transportation services. The other is that stakeholders should never pose a threat to the safety, security and environment of the world. To realize these principles, all stakeholders in maritime society should address the various challenges at hand immediately. To this end, the Ocean Policy Research Foundation hereby presents two proposals that it considers to be matters of high priority.

Proposal 1: Development and promotion of the use of Ultra-Low-Emission Vessels and Zero-Emission Vessels

There is a need to achieve an increase in the volume of maritime transportation (by a factor of 2.5 from 2005 to 2050) while achieving a significant reduction in CO_2 emissions. To this end, it is necessary to drastically lower CO_2 emissions per ton-mile[5] for all types of vessels.

To achieve this, those engaged in world maritime activities should promote the following initiatives through international collaboration[6]:

1. Acceleration of the development and commercialization of Ultra-Low-Emission Vessels (ULEVs)[7] and worldwide promotion of their use in the late 2020s

[5] It should be noted that the CO_2 emissions indicated in this report include indirect emissions related to the refining and supply of zero-emission fuels (hydrogen fuels, alternative fuels, renewable fuels and electricity for capacitors).

[6] Predictions by the Ocean Policy Research Foundation suggest that halving global CO_2 emissions by 2050 while maintaining global maritime transportation growth will require a per-unit reduction of emissions from individual ships of about 88% from average 2005 levels. Assuming that ships in 2050 will run at speeds 20% lower on average than current levels, it will be possible to achieve this 88% reduction if all ships less than 15 years of age in 2050 (i.e., those built in 2036 or later, accounting for 69% of the total) are replaced by Zero-emission Vessels (those with per-unit CO_2 emissions reduced by 90% or more) and all those between 15 and 25 years of age (i.e., those built between 2026 and 2035, accounting for 22% of the total) are replaced by Ultra-Low-Emission Vessels (those with per-unit CO_2 emissions reduced by 50% or more) by 2050.

[7] Ultra-Low-Emission Vessels (ULEVs) are those with CO_2 emissions reduced by more than 50% per ton-mile (Energy Efficiency Operating Indicator developed by IMO) compared with those from

2. Prompt development and commercialization of Zero-Emission Vessels (ZEVs)[8] and worldwide promotion of their use in the late 2030s

3. Commercialization of onboard carbon dioxide capture and storage (CCS) systems[9] designed for CO_2 emitted from vessels by the late 2030s

Prompt measures should be taken to provide support for the worldwide promotion of ULEV and ZEV usage, including the facilitation of international technology transfer and the securement of an adequate worldwide supply of zero-emission fuels such as those produced from renewable energy sources. Although such a shift toward these new types of fuel may cause a non-negligible increase in fuel prices, the maritime community should accept these higher costs as part of its social responsibility to address global warming.

There is also an urgent need to establish rules and regulations in regard to the risks posed by handling new types of fuel and machinery in view of maritime safety and environmental protection. Moreover, it is crucial to provide training for seafarers and to develop infrastructure including fuel supply facilities for these new types of fuel (i.e., nuclear- or hydrogen-powered systems), which have not yet been commercially used.

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identical ship types built in 2005. ULEVs are built to improve design efficiency (Energy Efficiency Design Index developed by IMO) by redesigning their forms and propulsion systems under speed reduction conditions. Navigation efficiency can also be improved by changing navigation specifications, such as improving the loading rate.

[8] Zero-Emission Vessels (ZEVs) are those with CO_2 emissions reduced by more than 90% per ton-mile (Energy Efficiency Operating Indicator developed by IMO) compared with those from identical ship types built in 2005. ZEVs may be redesigned based on ULEVs with further improvements in efficiency, or may be newly designed to use low- and zero-emission fuels (hydrogen fuels, alternative fuels, renewable fuels and electricity for capacitors).

[9] Onboard carbon dioxide capture and storage (CCS) systems are designed to capture carbon dioxide emitted from vessels and implement seabed or ocean storage. Although both these types of storage were prohibited by the 1996 Protocol to the London Convention, it is necessary to review these prohibitions through international agreement after careful assessment.

Proposal 2: Establishment of an international research institute to support the evolution of maritime society

Maritime industry should assume the following major social responsibilities simultaneously:

- Contribution to global economic development
- Fulfillment of the world community's requirement for risk minimization regarding safety, security and environmental protection

In particular, in relation to the latter responsibility, maritime society should adopt the following two approaches:

1. Improvement of the existing rule making system and process for an international mandatory framework to promptly meet global requirements, which are complicated and deep in nature. Such a framework should be rational to ensure proper implementation, and the related systems and processes should be further optimized and accelerated.

2. Promotion of volunteer initiatives by industries themselves with self-imposed standards for risk adjustment and mitigation that may be stricter than mandatory standards, and incentive schemes and award programs that may be more efficient and effective than those of the international mandatory framework.

An effective way of promoting these two approaches would be to establish a research institute conducting internationally cooperative studies, including data mining and analysis, with expertise and an independent viewpoint. Such an institute could also be expected to promote policy proposals.

To this end, a globally open World Maritime Institute for Rules and Regulations (provisional name) should be promptly established, and should be designed to implement the concrete functions outlined below. It would be appropriate to establish the institute in Japan, which contributes significantly to worldwide shipping and shipbuilding in terms of business, research and study as well as the development of rules and regulations.

Function 1 Information center

- Data mining and analysis of maritime information
- Development of an international maritime information network
- Submission of information to international bodies to assist their development of rules and regulations

Function 2 Promotion of policy proposals

- Development of proposals for international mandatory frameworks regarding safety, security, environmental protection, jurisdiction, etc.
- Development of proposals for volunteer frameworks, e.g., ship ratings, incentive schemes, etc.

Appendix:

Maritime Transportation Predictions
by
The Ocean Policy Research Foundation (OPRF)

1. Assumptions behind predictions

(1) Population

Global population will increase to 1.3 times the level of 2005. While global population will show an increase, the Japanese population will start to decline and will decrease by 10% from 2005 to 2050. Japan will also experience the aging of its population, which will be faster than the global average. Its working-age population will decrease by 15% from 2005, accounting for about 50% of its total population in 2050.

(2) GDP

Global GDP will grow more rapidly than population as a result of increases in work productivity, increasing to 4.3 times by 2050 compared with the level of 2005. Developing countries in Asia and other regions will see particularly rapid increases in GDP as a result of increases in their manufacturing efficiency.

(3) Energy demand

Energy demand will also increase as a result of increases in population and GDP, increasing to 3.0 times the level of 2005 by 2050.

(4) Global economy and trading system

In 2050, the world will be led by a few huge nations or federations of nations. China and India, which will achieve rapid growth in population and economy, and the EU, which will achieve further integration and expand its membership, will have a major influence on the world along with the United States. The BRICs are currently experiencing rapid economic development as individual nations and the Next Eleven (Bangladesh, Egypt, Indonesia, Iran, South Korea, Mexico, Nigeria, Pakistan, the Philippines, Turkey and Vietnam) will also achieve economic growth.

The mid-21st century will see the establishment of a global free trade system within the framework of the WTO. Along with this free trade system, close-knit regional economic partnerships (EPA, FTA, etc.) will develop among neighboring countries. In Asia in particular, a regional free trade economy will be established among the sixteen East Asian countries (ten ASEAN countries (Cambodia, Indonesia, Laos, Malaysia,

Myanmar, the Philippines, Thailand, Vietnam, Brunei and Singapore), Japan, China, South Korea, India, Australia and New Zealand).

Table: World Economic Situation in 2050

		2005	2050	2050/2005	Source
Population (Millions of persons)	World	6,465	8,673	1.3 times	IPCC
	Asia (excluding Japan)	3,443	4,219	1.2 times	IPCC
	Japan	129	123	0.9 times	IPCC
Percentage of working-age population	World	64.4%	63.9%	0.99 times	UN
	Asia (excluding Japan)	65.4%	64.5%	0.97 times	UN
	Japan	66.4%	51.1%	0.77 times	UN
GDP (Billions of USDs)	World	44,688	193,223	4.3 times	IPCC
	Asia (excluding Japan)	3,785	58,749	15.5 times	IPCC
	Japan	3,874	7,981	2.1 times	IPCC
Per capita GDP (USDs/person)	World	6,912	22,280	3.2 times	IPCC
	Asia (excluding Japan)	1,099	13,924	12.7 times	IPCC
	Japan	29,927	64,915	2.2 times	IPCC
Energy demand (Measured in millions of tons of petroleum)	World	10,624	31,372	3.0 times	IPCC
	Asia (excluding Japan)	2,961	10,463	3.5 times	IPCC
	Japan	—	—	—	—

2. Predictions about maritime transportation

(1) World seaborne trade (measured in tons)

World seaborne trade (measured in tons) is predicted to increase to 2.5 times the level of 2005 by 2050. Predictions for different types of cargo show that LNG and container shipments will show particularly marked increases, with LNG shipments increasing 7.1 times and container shipments 7.2 times. Predictions for different regions show that there will be particularly large increases within Asia, with container shipments increasing 10.7 times during the period. Africa and Middle East will also experience large increases in the amount of intra-regional transportation.

Thus, in accordance with the development of regional economies, maritime transportation in 2050 will be characterized by intra-regional transportation growing more rapidly than inter-continental transportation.

Table: Predictions about World Seaborne Trade (Measured in tons)

	World (millions of tons)			Within Asia (millions of tons)		
	2005	2050	2050 /2005	2005	2050	2050 /2005
Petroleum	2,279	2,855	1.3 times	63	36	0.6 times
LNG	138	979	7.1 times	56	64	1.1 times
Coal	710	1,140	1.6 times	158	121	0.8 times
Iron ore	652	1,109	1.7 times	96	218	2.3 times
Grain	251	322	1.3 times	12	11	0.9 times
Mineral phosphate, aluminum and bauxite	104	129	1.2 times	—	—	—
Containers	1,099	7,878	7.2 times	171	1,775	10.7 times
Containers (million TEU)	84	599	7.2 times	13	135	10.7 times
Other goods	1,488	2,262	1.5 times	—	—	—
Total	6,720	16,674	2.5 times	—	—	—

Note: Converted assuming that 1 TEU = 13.15 tons

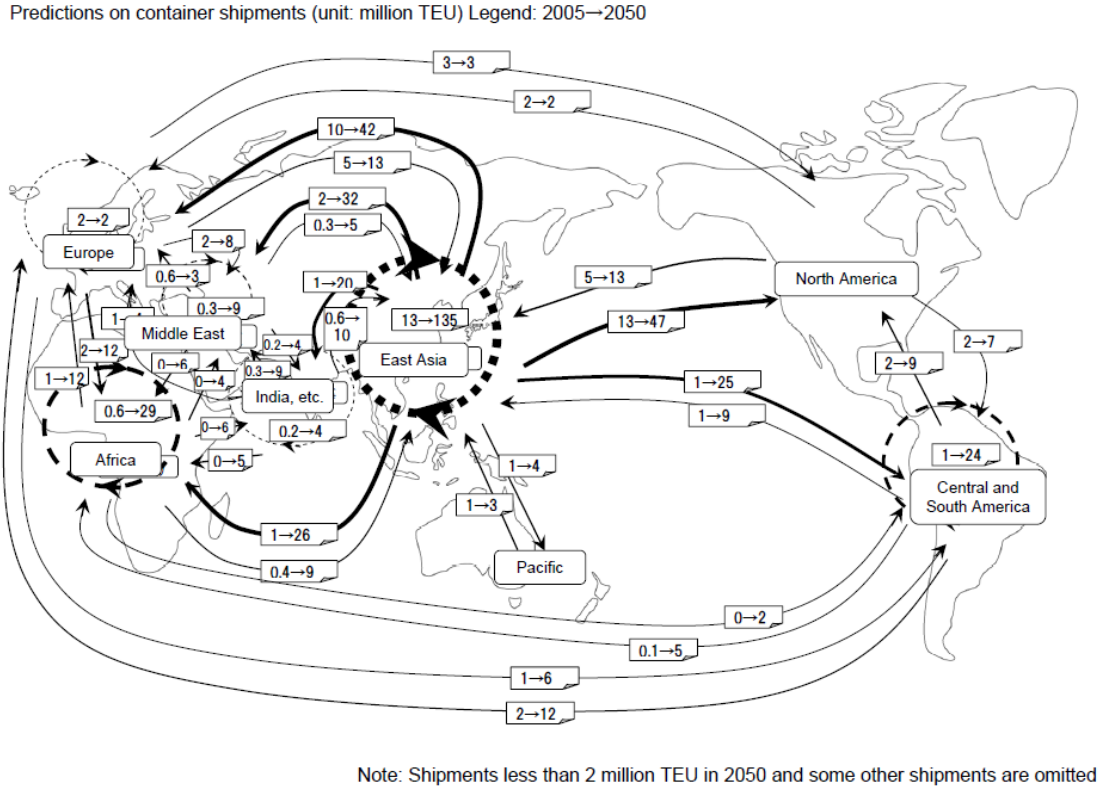

Figure: Predictions by OPRF about Container Shipments

(2) World Seaborne Trade (measured in ton-miles)

World seaborne trade (measured in ton-miles) is predicted to increase to 2.5 times the level of 2005 by 2050. As was the case with world seaborne trade measured in tons, LNG and container shipments will show particularly marked increases among different types of cargo, with LNG shipments increasing 10.4 times and container shipments 5.9 times. Predictions for different regions suggest that there will be significant increases in the amount of transportation within Asia, with container shipments increasing to 10.7 times the level of 2005. LNG shipments measured in ton-miles are predicted to increase more rapidly than those measured in tons, with long-distance transportation, including inter-continental transportation, accounting for a larger percentage. Meanwhile, short or middle-distance transportations, are predicted to account for a large percentage of container shipments with the growth of inter-regional transportation..

Table: Predictions about World Seaborne Trade (Measured in Ton-miles)

	World (billions of ton-miles/billions of TEU miles)			Within Asia (billions of ton-miles/billions of TEU miles)		
	2005	2050	2050 /2005	2005	2050	2050 /2005
Petroleum	1,1749	13,053	1.1 times	170	95	0.6 times
LNG	448	4,673	10.4 times	122	131	1.1 times
Coal	3,124	5,240	1.7 times	316	250	0.8 times
Iron ore	3,711	6,458	1.7 times	96	220	2.3 times
Grain	1,385	1,799	1.3 times	59	54	0.9 times
Mineral phosphate, aluminum and bauxite	395	489	1.2 times	—	—	—
Containers	6,448	38,069	5.9 times	237	2551	10.7 times
Containers (TEU)	490	2,894	5.9 times	18	194	10.7 times
Other goods	1,783	2,717	1.5 times	—	—	—
Total	29,043	72,498	2.5 times	—	—	—

Note 1: Calculated assuming that 1 TEU = 13.15 tons.

Note 2: Shipments for maritime transportation within Asia were calculated for each type of cargo for the routes between the locations shown below:

Petroleum: Japan and other Asian countries – South East Asia

LNG: Japan, South Korea, China and other Asian countries – Other Asian countries

Coal: Japan and other Far Eastern countries – China and Indonesia

Iron ore: Japan, China and other Far Eastern countries - Asia

Grain: Japan and other Far Eastern countries – Other countries

Containers: East Asia – East Asia

Other goods: The figure for 2005 represents the difference between the amount of global maritime transportation, which was 29,043 billion ton-miles (Maritime Report issued by the Ministry of Land, Infrastructure, Transport and Tourism of Japan), and the total amount of transportation for all types of cargo examined in this paper. The figure for 2050 was calculated assuming that the increase rate is the same as the average of all types of cargo excluding containers.

(3) World fleet required (measured in deadweight tons and number of vessels)

World fleet (measured in deadweight tons) required for maritime transportation in 2050 will be 2.0 times the amount of ships available in 2005. Predictions for different types of vessels suggest that while the amounts of tankers and bulk carriers required in 2050 will be nearly the same as in 2005, the amount of LNG carriers required will increase 8.1 times and that of container ships 7.7 times from 2005.

The total number of ships required for transportation in 2050 will increase 1.7 times from 2005. Predictions for different types of ships suggest that while the number of tankers and bulk carriers required in 2050 will be nearly the same as in 2005, the number of LNG carriers required will increase 7.2 times and that of container ships 3.7 times from 2005.

In these predictions regarding the amount of ships required for transportation, we assumed that the size of ships will become larger.

Table: Predictions about World Fleet Required in 2050

	Total DWT (millions of tons)			Number of ships			Average ship size (DWT)	
	2005	2050	50/05	2005	2050	50/05	2005	2050
Tankers	317.6	297.0	0.9	3,210	2,950	0.9	98,954	100,671
LNG carriers	12.3	100.0	8.1	185	1,328	7.2	50,542	75,246
Bulk carriers	341.0	337.3	1.0	5,980	5,087	0.9	57,030	66,318
Containers	97.3	748.2	7.7	3,562	13,179	3.7	27,260	56,795
Total	768.2	1,539.4	2.0	12,937	22,544	1.7	-	-

(4) Global CO_2 emissions

Global CO_2 emissions generated from international maritime transportation throughout the world will be 2.4 billion tons in 2050, 4.1 times the level of 2000. CO_2 emitted from container ships will account for nearly half these emissions.

Table: Estimated CO_2 Emissions from International Maritime Transportation by Typed of Cargo

CO_2 emissions (millions of tons)	2000	2010	2020	2030	2040	2050
Petroleum	117	147	174	201	175	149
LNG	16	51	106	161	204	248
Coal	46	63	74	85	91	97
Iron ore	47	74	84	95	107	119
Grain	29	33	36	39	41	42
Containers	127	259	396	634	941	1,234
Other goods	201	290	373	456	485	514
Total	583	917	1,243	1,671	2,044	2,403