

IAPH Port Planning and Development  
Committee (PPDC) Project

# Effects of the Arctic Sea Routes (NSR and NWP ) Navigability on Port Industry



May 21, 2012, Jerusalem

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The International Association of Ports & Harbors  
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May 21, 2012 @Jerusalem

M. Furuichi & N. Otsuka (PPDC)





# Outline

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1. Prospects on Future Natural Conditions in the Arctic Ocean
2. World's Interests in the Arctic Sea Routes
3. Potential Shipping Routes through the Arctic Ocean
4. Scenarios of Future Arctic Shipping
5. Cost Analysis of Arctic Shipping
6. Summary





# Background

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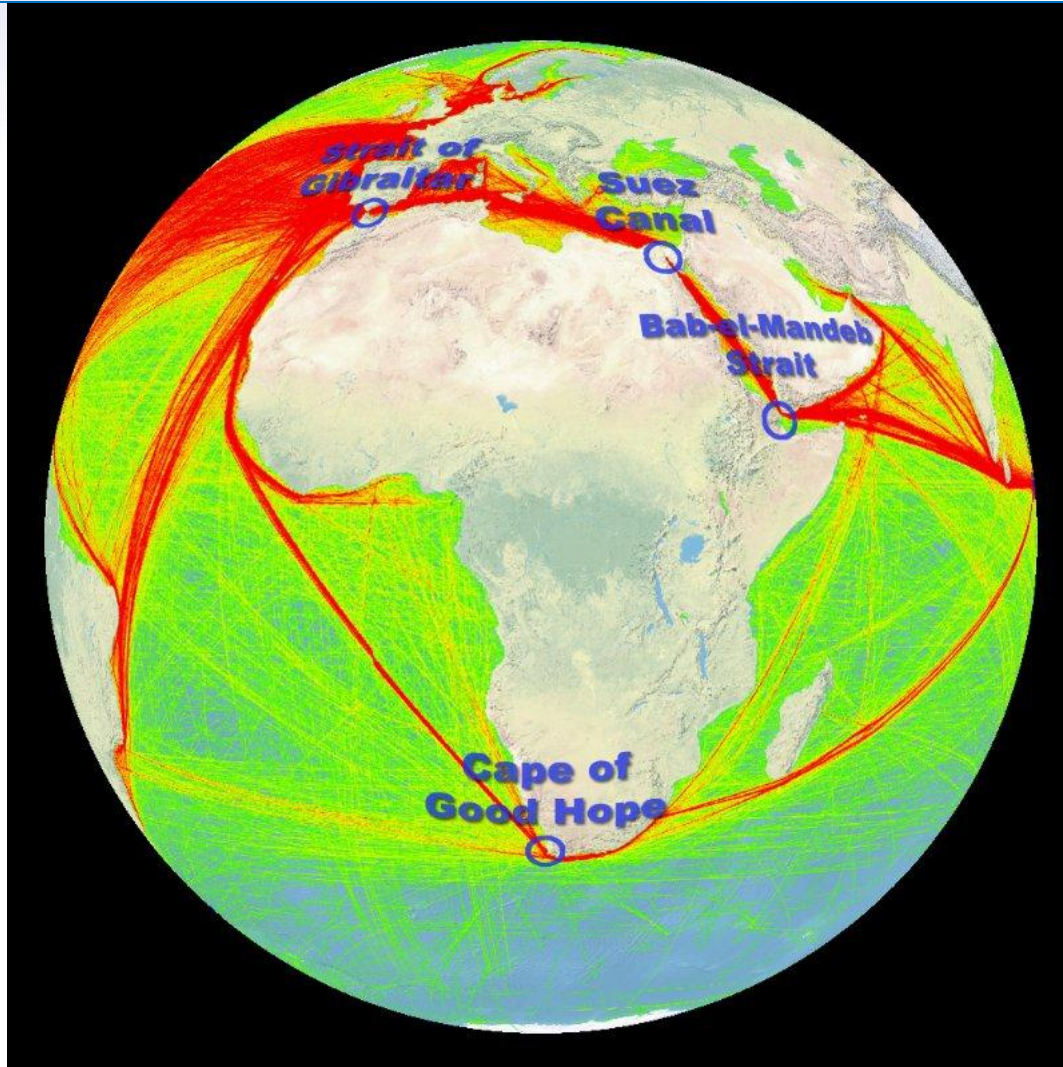
- Global warming?, Climate change?  
arctic sea ice is drastically decreasing!
- New shipping route via the Arctic is now coming into reality ?
- What is the Arctic Shipping Route?
- What are the driver of the Arctic Shipping?
- Is the Arctic shipping feasible ?
- Does this affects to the ports industry in the world?



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<http://sos.noaa.gov/datasets/Ocean/shipping.html>



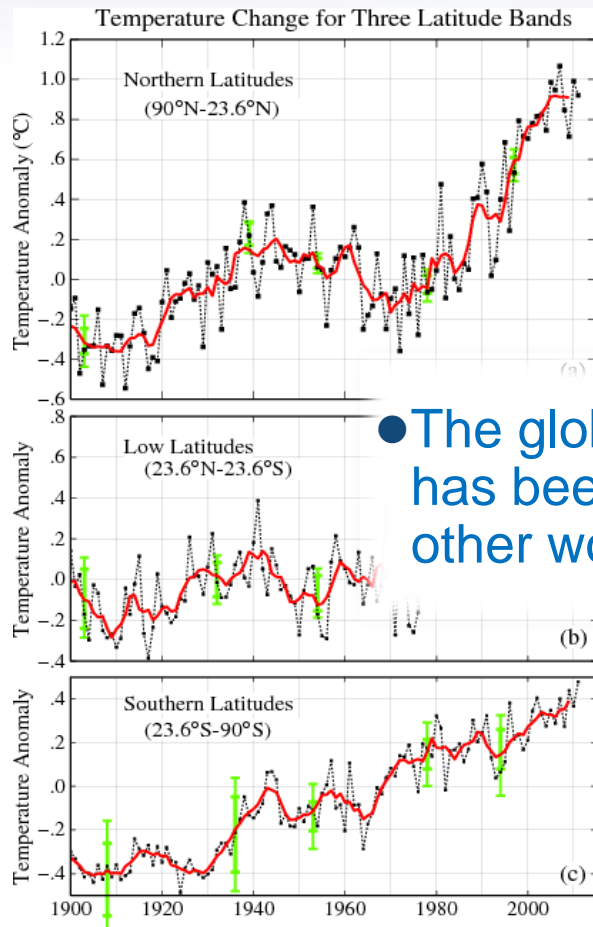
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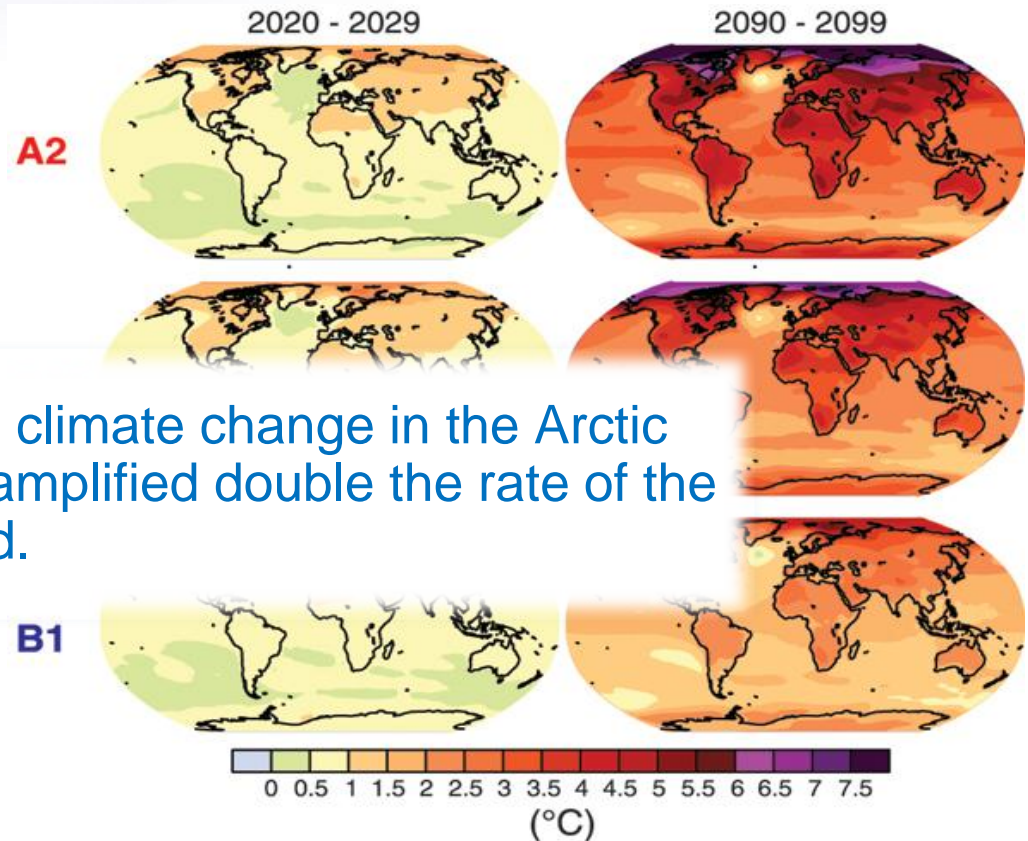




# 1. Prospects on Future Natural Conditions in the Arctic Ocean

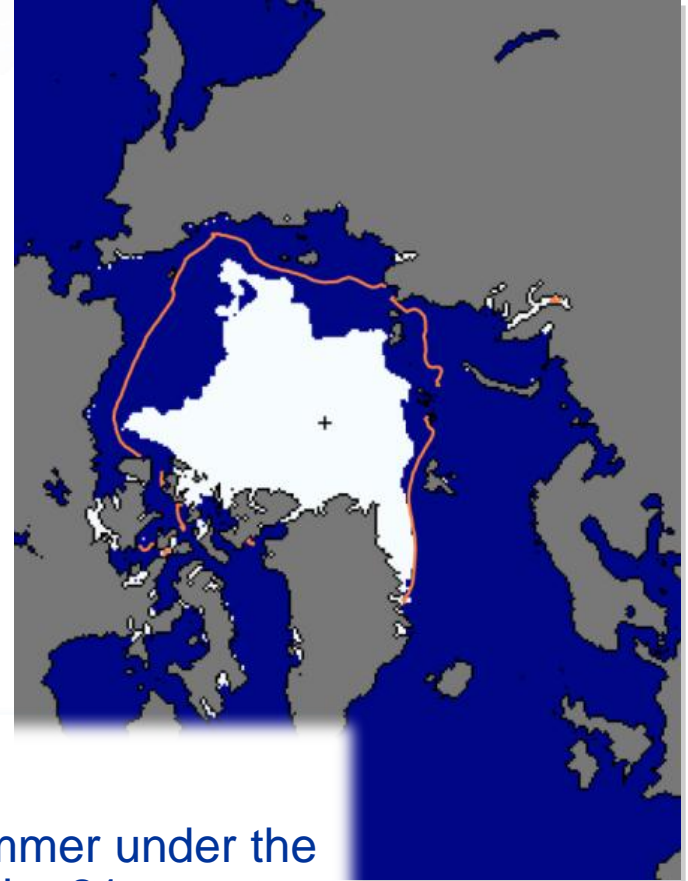
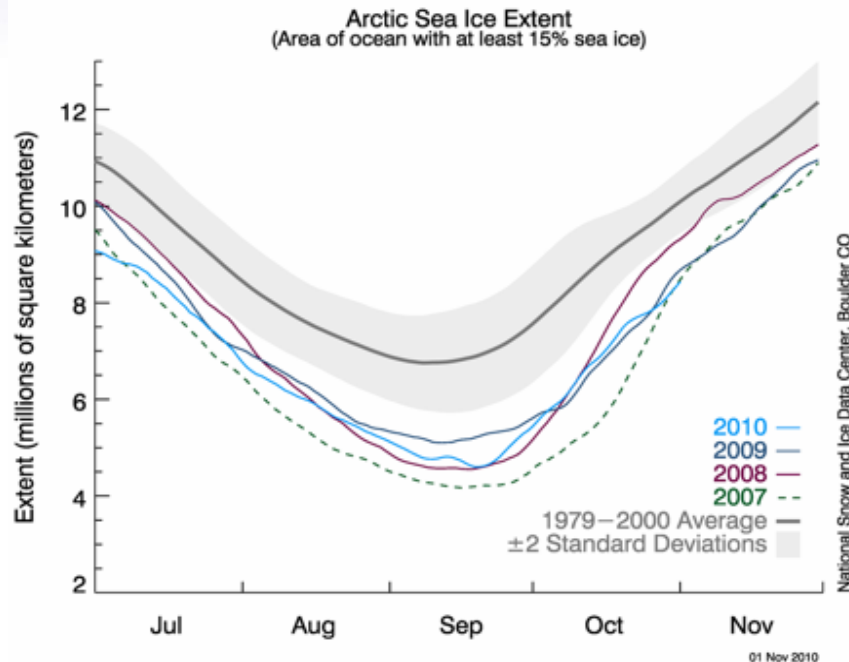


- The global climate change in the Arctic has been amplified double the rate of the other world.





# Arctic Sea Ice Retreat



- The IPCC AR4 :  
the Arctic sea ice will disappear entirely in summer under the high-emission A2 scenario in the later part of the 21st century.

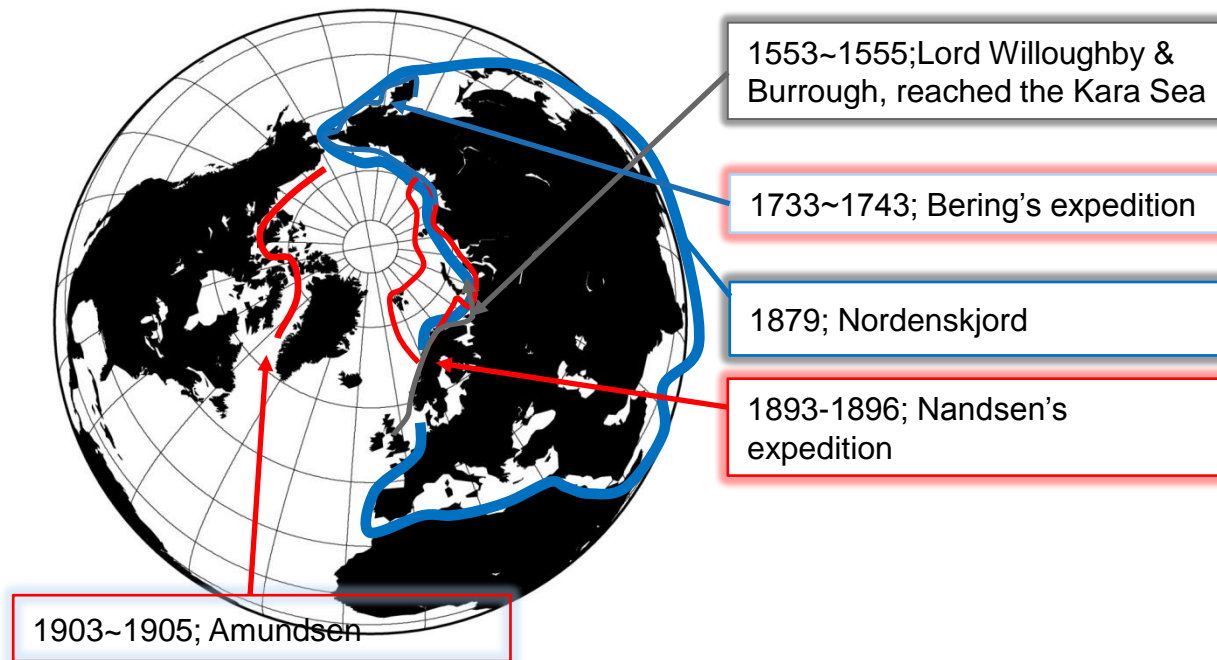


# Historical Challenge toward the Arctic Sea Route

The Age of Discovery: trade route to Siberia

17~18<sup>th</sup> century: whaling and geographical expedition

19~20<sup>th</sup> century: navigating entire route, WW-II and cold war



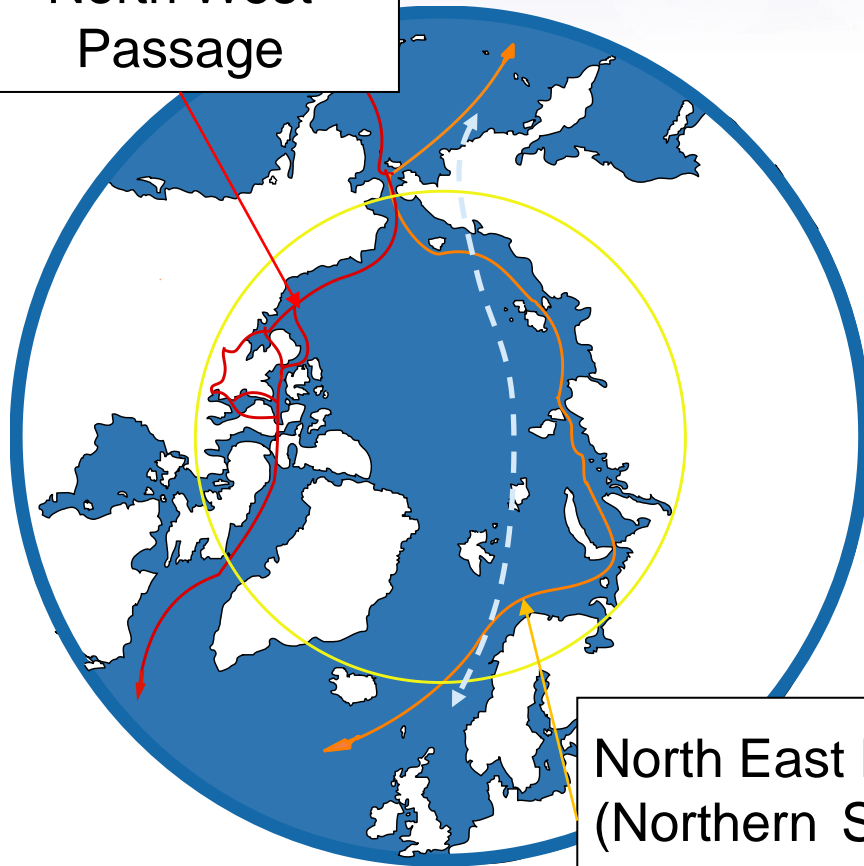
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## 2. World's Interests in the Arctic Sea Routes

North West  
Passage

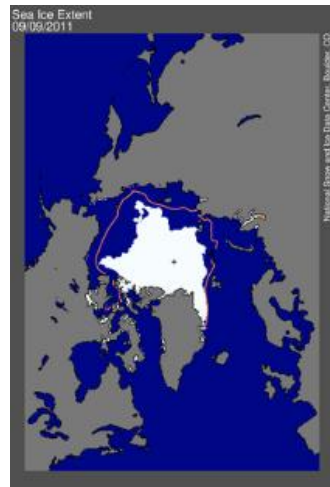
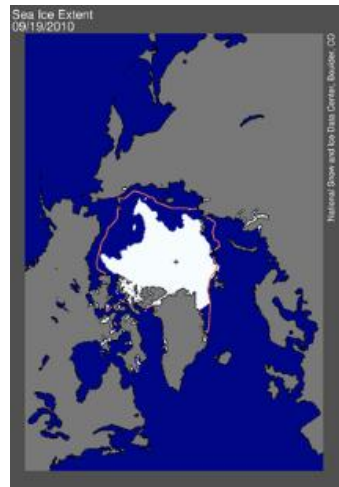
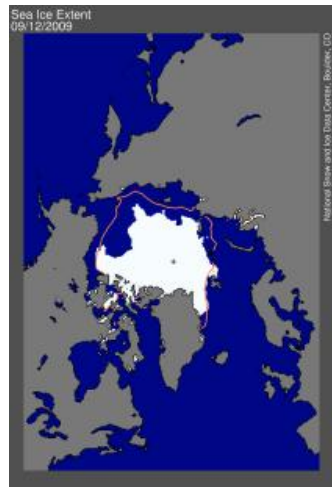
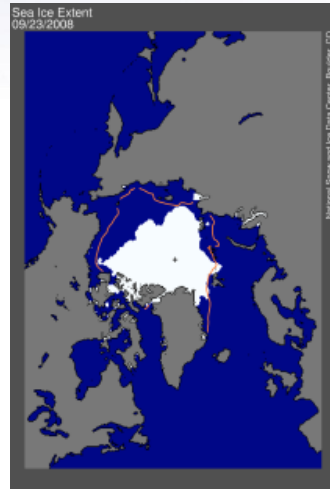
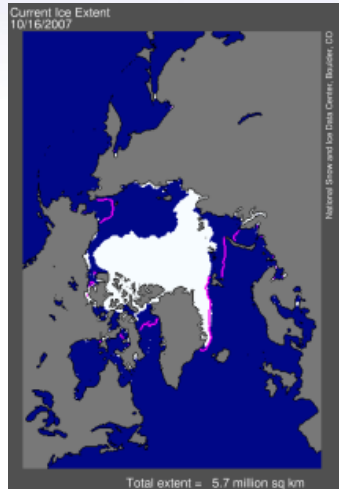
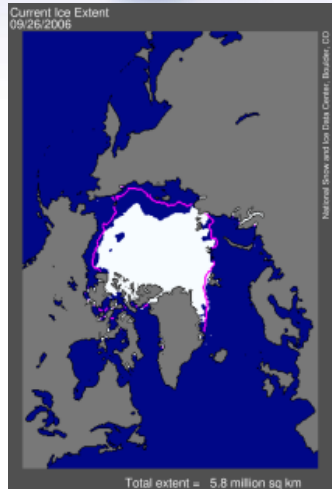


North East Passage  
(Northern Sea Route by  
Russian definition)

- Sea route between the Atlantic Ocean and the Pacific Ocean via the Arctic Ocean.
- The Arctic Sea Route can shorten the current southbound sea route by 30-40%.
- Sea ice and harsh environmental condition have been hampering the navigation for long years.



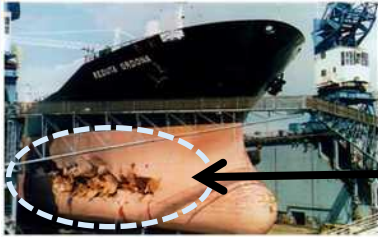
# Recent Sea Ice Retreat Along The Arctic Sea Route



- The ice concentration of the whole route of the NWP became 0% at the first time since satellite measurements started.
- Since 2008, ice along the NEP disappeared in September.



# Navigation in the Arctic



Hull failure caused by sea ice



Russian nuclear ice breaker



Russian ice breaking cargo ship

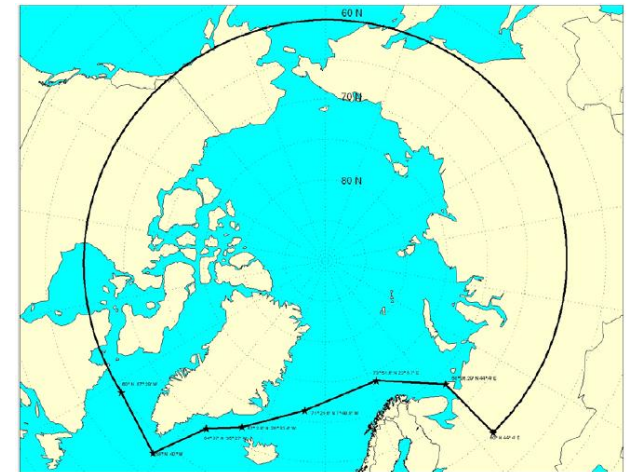
- Hull and machinery must be constructed against ice loads, low temperature and other unique conditions in the Arctic.
- **Icebreaker** : Purposing to provide support and emergency assistance for other ships in ice infested waters.
- **Ice-strengthened ship** : A ship with sufficient durability to withstand the pressure of surrounding ice. In general, ice-strengthened ships are cargo ships designed under milder condition than ice breaker.



# Maritime Rules in the Arctic

- UNCLOS Part XII Section 8, Article 234
- IMO: “Guidelines for Ships Operating in Polar Waters”
- Russia: “Regulations for Navigating on the Seaway of the Northern Sea Route”
- Canada: Arctic Shipping Pollution Prevention Regulations (ASPPR)

POLAR CLASS	GENERAL DESCRIPTION
PC 1	Year-round operation in all ice-covered waters
PC 2	Year-round operation in moderate multi-year ice conditions
PC 3	Year-round operation in second-year ice which may include multi-year ice inclusions
PC 4	Year-round operation in thick first-year ice which may include old ice inclusions
PC 5	Year-round operation in medium first-year ice which may include old ice inclusions
PC 6	Summer/autumn operation in medium first-year ice which may include old ice inclusions
PC 7	Summer/autumn operation in thin first-year ice which may include old ice inclusions





# 3. Potential Shipping Routes through the Arctic Ocean

Demand of Asian  
Developing Economies

Natural Resource Production  
in the Russian Arctic

Choke Point Problems in  
the existing Sea-lane

Arctic tourism

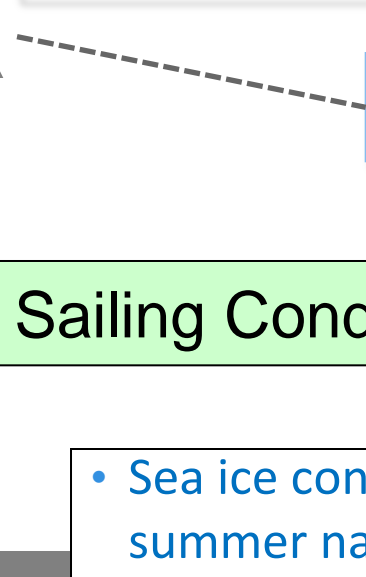
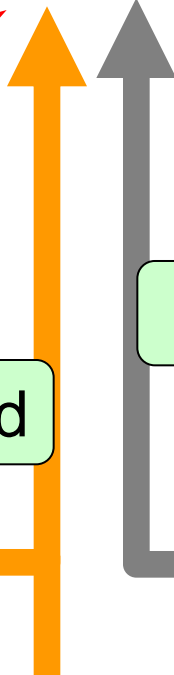
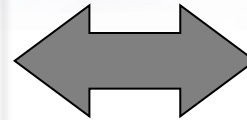
Economic background

Resource Price appreciation  
and procurement

Fuel Price appreciation,  
Shorter transit route via NSR

Sailing Condition

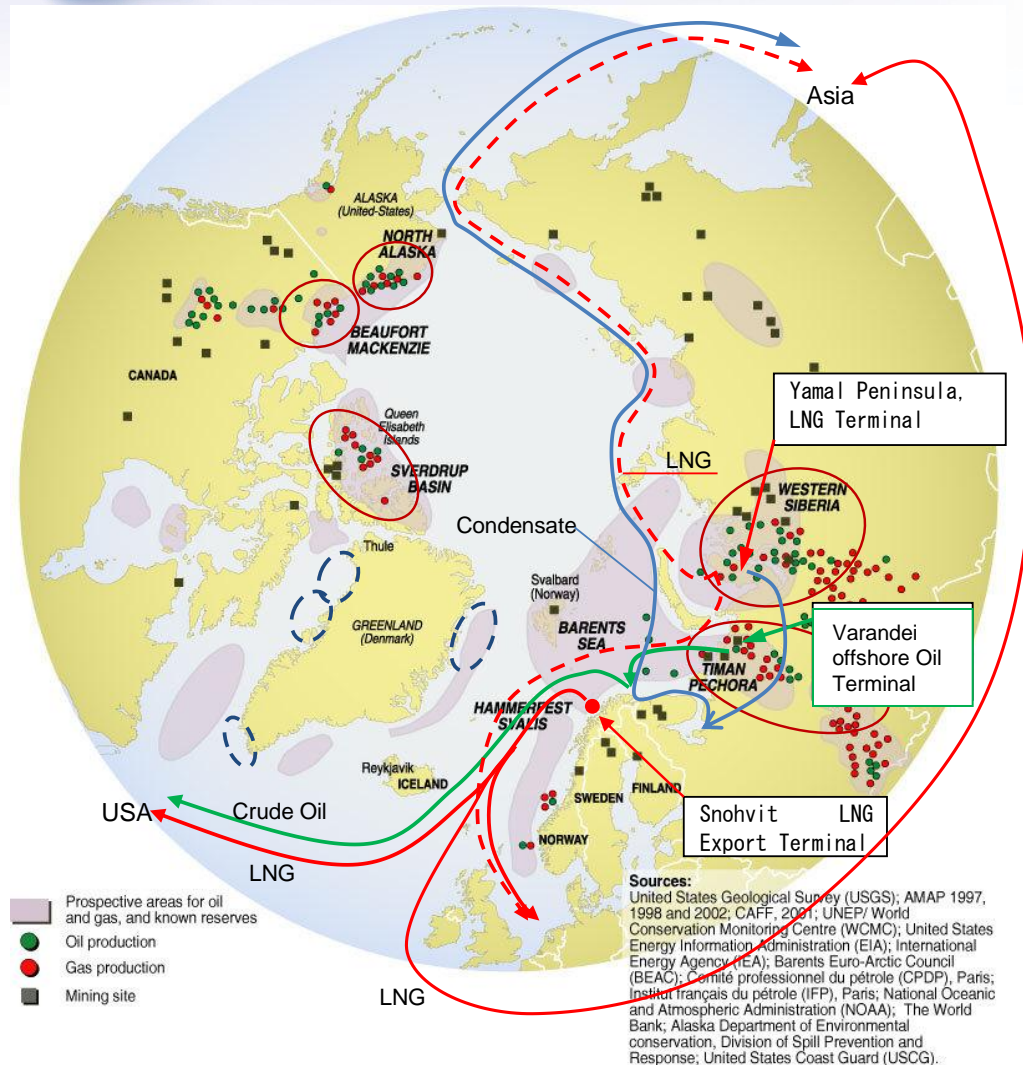
- Sea ice condition and longer summer navigation season
- Satellite Information
- Ice Class Vessel







# Natural Resources in the Arctic



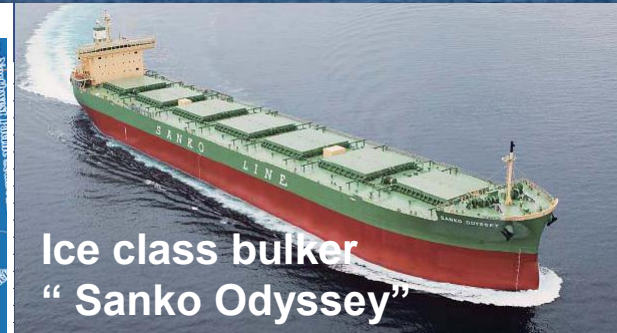
- **USGS Circum-Arctic Resource Appraisal:** Estimates of Undiscovered Oil and Gas North of the Arctic Circle
- **Developments in the Russian Arctic.**
- **Iron ore exploitation in Kirkeness.**
- **Natural resource demand of Eastern Asia.**



Varandei Offshore Oil Terminal



- 
- Nuclear icebreaker
- Ice class cargo ship
- Photo : Tschudi Shipping



# Ice class bulker “Sanko Odyssey”

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## 4. Scenarios of Future Arctic Shipping

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1. Container Shipping (Origin and Destination Pair)
  - i. Far East and N.W. Europe [**NSR** vs. Suez]
  - ii. West Coast U.S. and Canada and N.W. Europe [**NSR** vs. Panama]
  
2. Bulk (Natural Resources [Iron Ore] in the Arctic Region) Shipping (Origin and Destination Pair)
  - i. Kirkenes (Russia) and Dalian (China) [**NSR**]
  - ii. Itaquí (Brazil) and Dalian (China) [Cape, Suez, and Panama]







# Container Shipping

## [between Major Port and Major Port]

[Far East vs. N.W. Europe]

Yokohama - Hamburg

Suez Route (11,585 N.M.) vs.  
**NSR Route (7,356 N.M./-36%)**

[US and Canadian West Coast vs. N.W. Europe]

Los Angeles - Hamburg

Panama Route (7,995 N.M.) vs.  
**NSR Route (7,838 N.M./-2%)**



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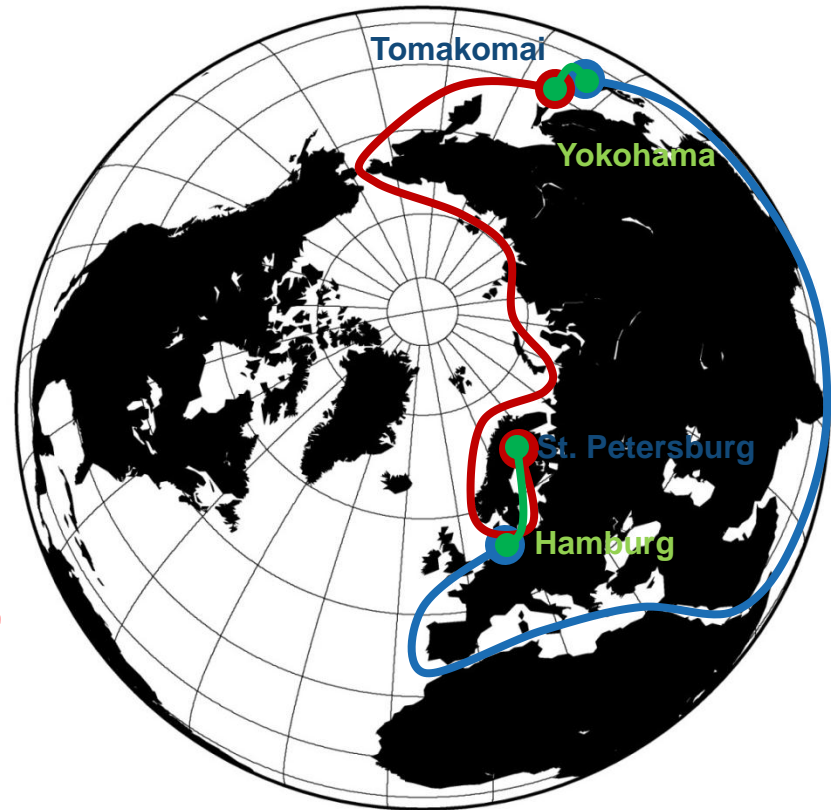
# Container Shipping

## [between Minor Port and Minor Port]

[Far East and N.W. Europe]

Tomakomai -T/S- Yokohama -  
Hamburg -T/S- St. Petersburg  
Suez Route (13,404 N.M.)  
vs.

Tomakomai - St.Petersburg  
NSR Route (7,847 N.M./-41%)



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# Port Distance

Ports	Route	Distance (NM)
Yokohama -> Hamburg	Yokohama – Suez - Hamburg	11,585
	Yokohama – NSR - Hamburg	7,356
Los Angeles -> Hamburg	Los Angeles - Panama Hamburg	7,995
	Los Angeles – NSR - Hamburg	7,838
Tomakomai -> St. Petersburg	Tomakomai -T/S- Yokohama - Hamburg -T/S- St. Petersburg	13,404
	Tomakomai -NSR- St. Petersburg	7,847
Kirkenes - Dalian	Kirkenes – NSR - Dalian	6,633
Itaqui (Brazil) -> Dalian (China)	Itaqui – Cape - Dalian	12,495
	Itaqui – Suez - Dalian	13,071
	Itaqui – Panama - Dalian	11,182
	Itaqui – NSR - Dalian	11,946





# Iron Ore Shipping

## [between the Arctic/Brazil and Far East]

[between the Arctic and Far East]

Kirkenes (Norway) - Dalian (China)

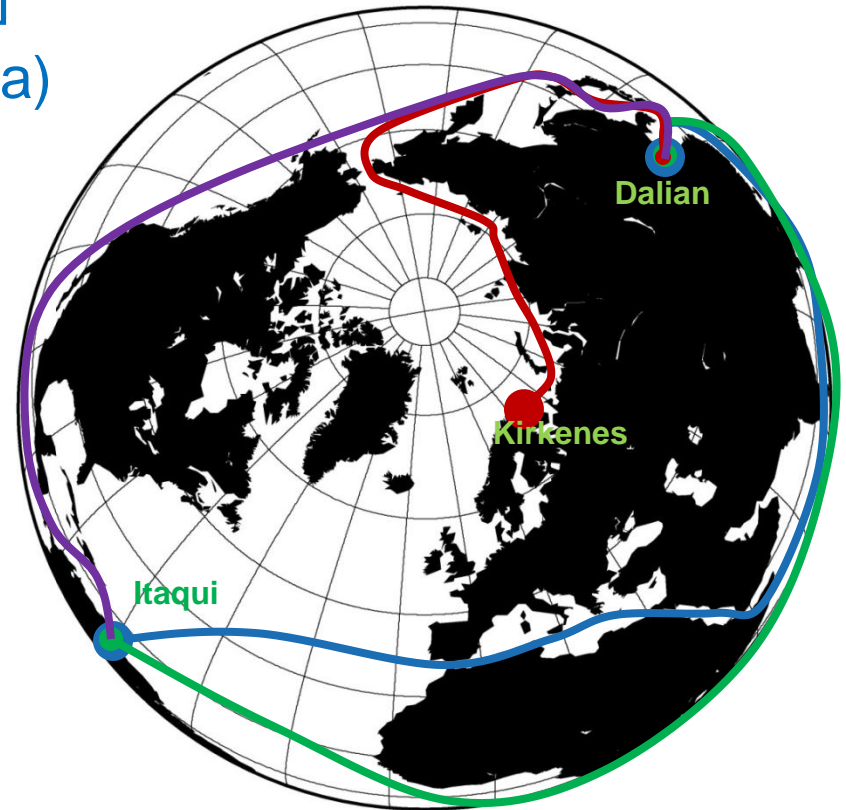
[between Brazil and Far East]

Itaqui (Brazil) - Dalian (China)

Cape Route (12,495 N.M.) vs.  
NSR Route (6,633 N.M./-47%)

Suez Route (13,071 N.M.) vs.  
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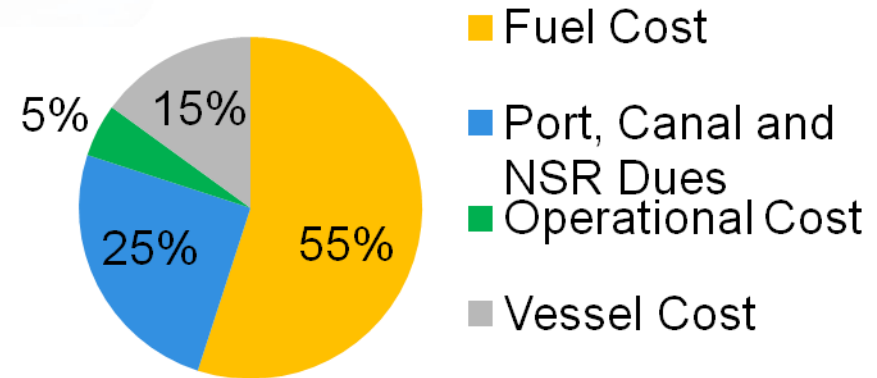


## 5. Cost Analysis of Arctic Shipping

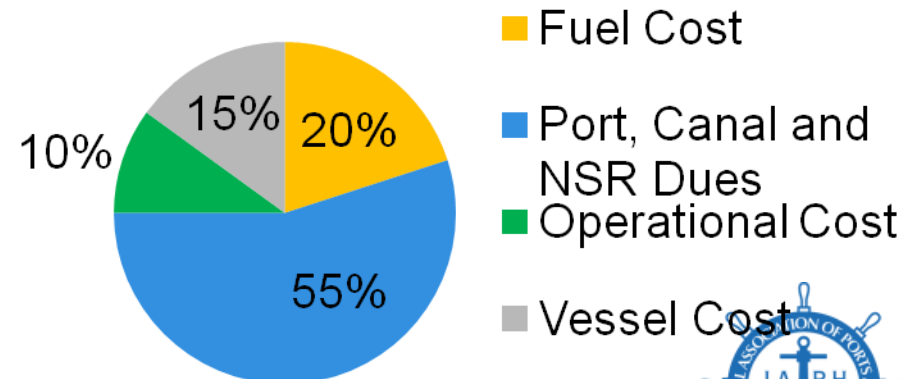
### Cost Composition of Maritime Shipping

- i. Fuel Cost
- ii. Port, Canal, NSR, and Risk Dues
- iii. Operational Cost
  - a. Insurance
  - b. Crew
  - c. Maintenance
- iv. Vessel Cost (Depreciation)

### Suez Route (Example)



### N.S.R. Route (Example)



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# Fuel Cost

1. Fuel cost (USD600/ton) usually dominates cost composition for a long distance maritime shipping.
2. Engine power and actual navigation speed may play a crucial role to determine fuel consumption.
3. Arctic navigation requires relatively slower speed (approx. 12 Kn), which may result in significantly efficient energy consumption.

Items	Value	Unit
Fuel Price	600	USD/ton
Engine Power (2000TEU - 7226TEU)	20,000 — 68,000	KW
Navigation Speed	12 - 20	Knot





# Port, Canal, NSR, and Risk Dues

1. A set of port dues per call is defined due to vessel-size within a range of 35,000 and 100,000 (USD/port call), which consist of entry due, berthage, demurrage, etc.
2. A maritime route with transshipment (T/S) includes T/S charges at T/S ports.
3. Routes through N.S.R., Suez Canal, and Panama Canal need compulsory charges.

Items	Value	Unit
Port Dues	35,000 - 100,000	USD/call
Trans-shipment Handling Charge	50	USD/TEU
NSR Fee	674	USD/TEU
Suez Canal Fee	1 <sup>st</sup> 5000*7.88 + 2 <sup>nd</sup> 5000*5.15 +3 <sup>rd</sup> 10000*4.12 +4 <sup>th</sup> 20000*2.88 +5 <sup>th</sup> 30000*2.6 +70000(+)*2.11	SDR/GT
Panama Canal Fee	74	USD/TEU



# Operational Cost

1. Operational cost consists of i) insurance, ii) crew, and iii) maintenance.
2. Crew and maintenance cost dominate operational cost.
3. A group of per-vessel crew consists of 23 - 24 members, which may cost approximately USD 1 Million per year.
4. Maintenance cost is defined as same amount as crew cost for approximation.

Items	Value	Unit
Insurance	250,000 - 450,000	USD/vessel *year
Crew (24 members)	1 Million	USD/vessel *year
Maintenance	1 Million	USD/vessel *year





# Vessel Cost

1. Large-scale container ship building (2000 TEU - 7,000 TEU) is a huge investment (USD 50 Million - USD 100 Million).
2. Depreciation of large-scale container ship is estimated in a range of USD14,000/day and USD28,000/day.

Items	Value	Unit
Vessel cost (New ship-building)	50Million - 100 Million	USD/vessel
Depreciation	14,000 - 28,000	USD/vessel* day







# Container Shipping

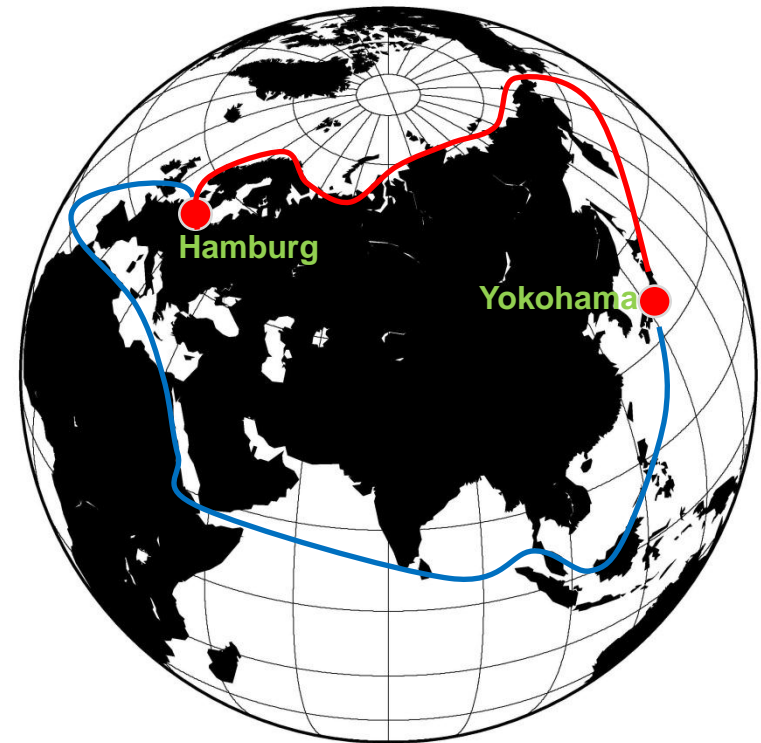
## [between Major Port and Major Port]

[Far East vs. N.W. Europe]

Yokohama - Hamburg

Suez Route (11,585 N.M.) vs.

**NSR Route (7,356 N.M./-36%)**



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# Transport Time (Yokohama - Hamburg)

Transport Time (Suez Route)

Distance = 11,585 N.M.

Ports of Call

Yokohama-Le Havre-  
Felixtowe-Zee Brugge-  
Rotterdam-Antwerp-  
Hamburg

Vessel size = 4,000TEU /  
6,000TEU / 7,300TEU

Nominal Vessel Speed = 25 Kn

Actual Vessel Speed = 20 Kn

Navigation Period = 30.4 day

Transport Time (NSR Route)

Distance = 7,838 N.M. (68%)

Ports of Call

Yokohama-N.S.R.-Hamburg

Vessel size = 2,000TEU (Ice-  
Class)

Nominal Vessel Speed = 22 Kn

Actual Vessel Speed = 12.2 Kn

Navigation Period = 20.7 day  
(67%)



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# Transport Cost (Yokohama - Hamburg)

Item	N.S.R.			Suez Route		
	Yokohama-Hamburg (Ice-Class 2,000TEU)	Yokohama-Hamburg (Ice-Class 2,000TEU)	Yokohama-Hamburg (Ice-Class 2,000TEU)	Yokohama-Hamburg (4,000TEU)	Yokohama-Hamburg (6,000TEU)	Yokohama-Hamburg (7,226TEU)
Capacity Occupancy Rate	70%	70%	70%	70%	70%	70%
Discount Rate of NRS Fee	No Discount	50%Discount	100%Discount	---	---	---
Transport Cost (USD/TEU)	1,797 >	1,460 >	1,123 << Competitive	1,366	1,364	1,292
Distance (N.M.)	7,356	7,356	7,356	11,585	11,585	11,585
Annual Transport Volume (TEU/year)	14,000	14,000	14,000	36,400	50,400	60,698
Voyage Period (days/voyage)	20.7	20.7	20.7	30.4	30.4	30.4
# of Voyages (Voyages/year)	10	10	10	12	12	12

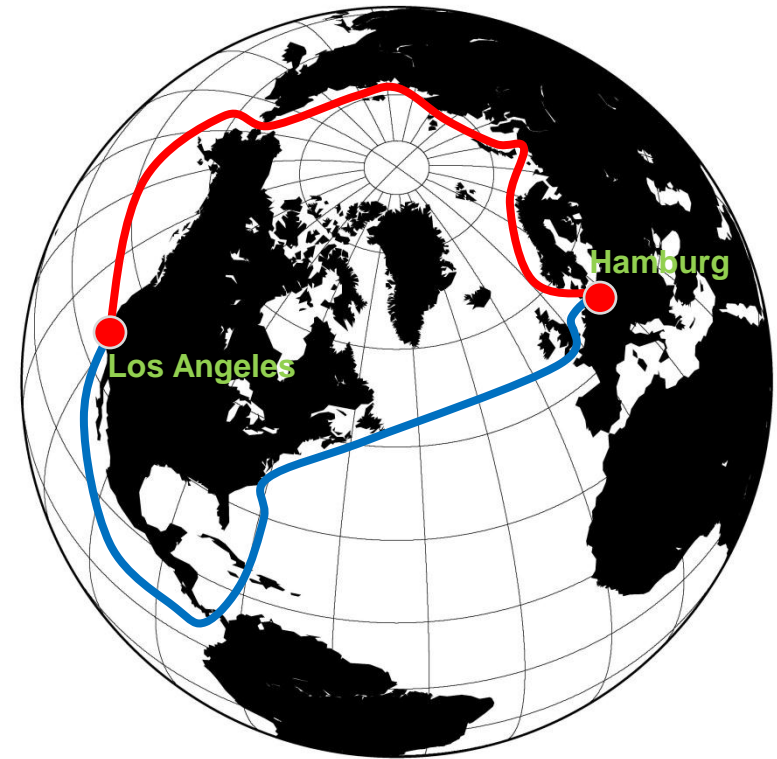


# Container Shipping

## [between Major Port and Major Port]

[US and Canadian West Coast  
vs. N.W. Europe]

Los Angeles - Hamburg  
Panama Route (7,995 N.M.) vs.  
NSR Route (7,838 N.M./-2%)







# Transport Time (Los Angeles - Hamburg)

Transport Time (Panama Route)

Distance = 7,995 N.M.

Ports of Call

Los Angeles-Panama-  
Savannah-Norfolk-New York-  
Halifax-Antwerp-Thamesport-  
Hamburg

Vessel size = 2,000TEU /  
4,000TEU (Panamax)

Nominal Vessel Speed = 25 Kn

Actual Vessel Speed = 20 Kn

Navigation Period = 21.7 day

Transport Time (NSR Route)

Distance = 7,838 N.M. (98%)

Ports of Call

Yokohama-N.S.R.-Hamburg

Vessel size = 2,000TEU (Ice-  
Class)

Nominal Vessel Speed = 22 Kn

Actual Vessel Speed = 12.2 Kn

Navigation Period = 21.7 day

(100%)

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# Transport Cost (Los Angeles - Hamburg)

Item	N.S.R.			Panama Route			
	Los Angeles-Hamburg (Ice-Class 2,000TEU)	Los Angeles-Hamburg (Ice-Class 2,000TEU)	Los Angeles-Hamburg (Ice-Class 2,000TEU)	Los Angeles-Hamburg (2,000TEU)	Los Angeles-Hamburg (4,000TEU)	Los Angeles-Hamburg (6,000TEU)	Los Angeles-Hamburg (7,226TEU)
Capacity Occupancy Rate	70%	70%	70%	70%	70%	---	---
Discount Rate of NRS Fee	No Discount	50%Discount	100%Discount	---	---	---	---
Distance (N.M.)	7,838	7,838	7,838	7,995	7,995	7,995	7,995
Transport Cost (USD/TEU)	1,857 >	1,520 >	1,183 =< Slightly Competitive	1,301	952	---	---
Annual Transport Volume (TEU/year)	14,000	14,000	14,000	22,400	44,800	---	---
Voyage Period (days/voyage)	21.7	21.7	21.7	21.7	21.7	---	---
# of Voyages (Voyages/year)	10	10	10	16	16	---	---



# Container Shipping

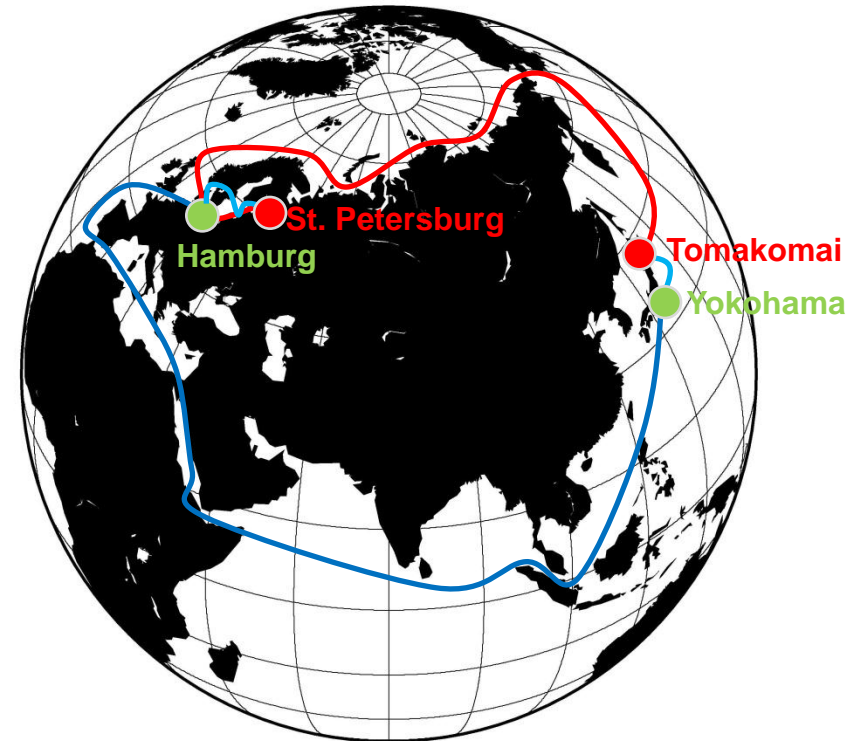
## [between Minor Port and Minor Port]

[Far East and N.W. Europe]

Tomakomai -T/S- Yokohama -  
Hamburg -T/S- St. Petersburg  
Suez Route (13,404 N.M.)

vs.

Tomakomai - St.Petersburg  
NSR Route (7,847 N.M./-41%)



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# Transport Time (Tomakomai-T/S- Yokohama-Hamburg-T/S-St. Petersburg)

Transport Time (Suez Route)

Distance = 13,404 N.M.

Ports of Call

**Tomakomai**-Yokohama  
(T/S)-Le Havre- Felixtowe-  
Zee Brugge-Rotterdam-  
Antwerp-Hamburg (T/S)-**St.  
Petersburg**

Vessel size = 1000TEU(feeder)  
/4000TEU/ 6000TEU/7300TEU

Nominal Vessel Speed = 25 Kn

Actual Vessel Speed = 20 Kn

Navigation Period = 37.1 day

Transport Time (NSR Route)

Distance = 7,847 N.M. (59%)

Ports of Call

Yokohama-N.S.R.-Hamburg

Vessel size = 2000TEU (Ice-  
Class)

Nominal Vessel Speed = 22 Kn

Actual Vessel Speed = 12.2 Kn

Navigation Period = 21.7 day  
(58%)







# Transport Cost (Tomakomai - St.Petersburg)

Item	N.S.R.			Suez Route		
	Tomakomai-St.Petersburg (Ice-Class 2,000TEU)	Tomakomai-St.Petersburg (Ice-Class 2,000TEU)	Tomakomai-St.Petersburg (Ice-Class 2,000TEU)	Tomakomai-St.Petersburg (4,000TEU)	Tomakomai-St.Petersburg (6,000TEU)	Tomakomai-St.Petersburg (7,226TEU)
Capacity Occupancy Rate	70%	70%	70%	70%	70%	70%
Discount Rate of NRS Fee	No Discount	50%Discount	100%Discount	---	---	---
Transport Cost (USD/TEU)	1,854 = < Slightly Competitive	1,517 < Competitive	1,180 << Fairly Competitive	1,917	1,913	1,843
Distance (N.M.)	7,847	7,847	7,847	13,404	13,404	13,404
Annual Transport Volume (TEU/year)	14,000	14,000	14,000	36,400	50,400	60,698
Voyage Period (days/voyage)	21.7	21.7	21.7	37.1	37.1	37.1
# of Voyages (Voyages/year)	10	10	10	12	12	12



# Iron Ore Shipping

## [between the Arctic/Brazil and Far East]

[The Arctic Region to Far East]

Kirkenes (Norway) - Dalian (China)

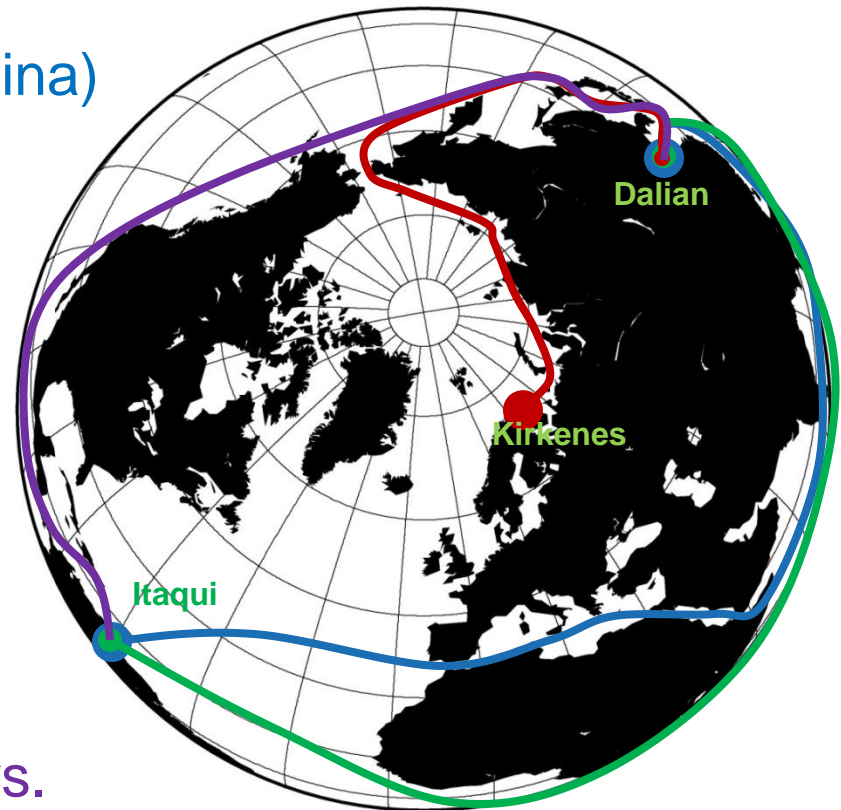
[Brazil to Far East]

Itaqui (Brazil) - Dalian (China)

Cape Route (12,495 N.M.) vs.  
NSR Route (6,633 N.M./-47%)

Suez Route (13,071 N.M.) vs.  
NSR Route (6,633 N.M./-49%)

Panama Route (11,182 N.M.) vs.  
NSR Route (6,633 N.M./-41%)



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# Transport Time (**Kirkenes-N.S.R.-Dalian**) vs. (**Itaqui-Cape-Dalian**)

Transport Time (NSR Route)

Distance = 6,633 N.M. (53%)

Ports of Call

**Kirkenes-N.S.R.-Dalian**

Vessel size = 75,000DWT (Ice-Class)

Nominal Vessel Speed = 14 Kn

Actual Vessel Speed = 12.2 Kn

Navigation Period = 25.2 day (62%)

Transport Time (Cape Route)

Distance = 12,495 N.M.

Ports of Call

**Itaqui-Cape-Dalian**

Vessel size = 175,00DWT

Nominal Vessel Speed = 15.3 Kn

Actual Vessel Speed = 14 Kn

Navigation Period = 40.7 day





# Transport Time (**Itaqui-Suez-Dalian**) vs. (**Itaqui-Panama-Dalian**)

Transport Time (Suez Route)

Distance = **13,071 N.M.**

Ports of Call

**Itaqui-Suez-Dalian**

Vessel size = **175,00DWT**

Nominal Vessel Speed = 15.3  
Kn

Actual Vessel Speed = **14 Kn**

Navigation Period = **43.9 day**

Transport Time (Panama Route)

Distance = **11,182 N.M.**

Ports of Call

**Itaqui-Panama-Dalian**

Vessel size = **75,000DWT**

Nominal Vessel Speed = 14 Kn

Actual Vessel Speed = **14 Kn**

Navigation Period = **38.2 day**







# Transport Cost (Kirkenes - Dalian / Itaqui - Dalian (Cape, Suez, and Panama))

Item	N.S.R.			Conventional Route		
	Kirkenes-Dalian (Ice-Class 75,000DWT)	Kirkenes-Dalian (Ice-Class 75,000DWT)	Kirkenes-Dalian (Ice-Class 75,000DWT)	Cape Route Itaqui-Dalian (175,000DWT)	Suez Route Itaqui-Dalian (175,000DWT)	Panama Route Itaqui-Dalian (75,000DWT)
Capacity Occupancy Rate	70%	70%	70%	70%	70%	70%
Discount Rate of NRS Fee	No Discount	50%Discount	100%Discount	---	---	---
Transport Cost (USD/TEU)	39 >	35 = > Break-even	31 < Slightly Competitive	34	41	52
Distance (N.M.)	6,633	6,633	6,633	12,495	13,071	11,182
Annual Transport Volume (ton/year)	285,000	285,000	285,000	665,000	665,000	285,000
Voyage Period (days/voyage)	25.2	25.2	25.2	40.7	43.9	38.2
# of Voyages (Voyages/year)	8	8	8	8	8	8



# Summary: Implications of Cost Analysis (1)

1. **NSR** of container shipping may be estimated **competitive** for major ports pair between Far-east (Yokohama) and N.W. Europe (Hamburg), if NSR fee is discounted by 100%.
2. **NSR** of container shipping may be estimated **slightly competitive** for major ports pair between U.S. West coast (Los Angeles) and N.W. Europe (Hamburg), only if NSR fee is discounted by 100% and Panama canal is not expanded.
3. **NSR** of container shipping may be estimated **competitive** for minor ports between Far-east (Tomakomai) and N.W. Europe (St. Petersburg), if NSR fee is discounted by 50%.
4. **NSR** of Iron ore shipping from Kirkenes to Dalian may be estimated **slightly competitive** against Cape route from Brazil to Dalian, if NSR fee is discounted by 100%.





## Summary: Implications of Cost Analysis (2)

5. **NSR** is defined **available only for 210 days per year** (2030 at earliest), which may suffer **significant dis-advantage** as liner shipping services.
6. Cost analysis may heavily depends on changes of **bunker oil** and **ship-building prices** as well as **NSR**, **Suez**, and **Panama fees**. Thus, the shipping scenarios including navigation conditions would be a key factor to the cost analysis here. Severe competition will be expected among NSR, Suez and Panama Canals in the near future.
7. Port industry will need to pay special attention to the newly evolved competitions.





# Summary: Implications of Cost Analysis (3)

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8. NSR can shorten the transit time, and reduce fuel consumption and GHG emission in many cases.
9. This project will continue and complete by L.A. conference in May, 2013.
10. A wider variety of origin and destination pairs of container and bulk shipping can be further studied on the request basis of PPDC members, if necessary.







# Summary: Issues of NSR to be discussed

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1. Ice Breaker must be renewed.
2. Ice information and forecast services need to be developed.
3. Crews to be trained for ice navigation.
4. Search and rescue, and oil spill and other environmental risk are to be further studied.
5. Russian regulations and escorting fees need to improve their transparency.
6. Social/economic impact to indigenous community

