INTESA SANPAOLO

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The Arctic Route

Climate change impact,
Maritime and economic scenario,
Geo-strategic analysis and perspectives

maritime economy

2020

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1 / Introduction

The Arctic Route may seem a chimera for most people. Nonetheless, the likelihood that by mid-century the iced passages will be opened is not remote and some countries are already in line for taking a bite at the cherry. The issue is not only about the economic potential of the Northern Sea Route or the Northwest or the Transpolar Passage, that cuts straight across the North Pole, but also about the juxtaposition of different interests, such as the imperative attention related to the safeguard of a pristine and unique environment that belongs to humanity.

This scenario has become more plausible given the climate change phenomenon which has stronger and quicker implications in the Arctic region than elsewhere. The environmental challenges, together with the energy and trade related opportunities, could eventually put under pressure traditional shipping routes such as the Suez one. The outcome is highly uncertain and will depend on several factors among which the geopolitical balance between national powers and supranational bodies. A topic not to underestimate especially considering that the recent viral outbreak has stretched the international relations to a new verge.

The Intesa Sanpaolo Group has a forward-looking attitude in business as well as in research, its interest being to detect opportunities and challenges that may shape our social and economic future such as the ones associated to the evolution of the Arctic region.

This report aims to provide a picture of the actual situation and a perspective of future developments under the assumption that, in the aftermath of the Covid-19, activities will go back to normal over time. The proposed research approach has taken advantage of the possibility to mix different source of information with assorted scholars' expertise so to provide a complete analysis of the Arctic Route, looking at it from various angles. Thus, the content of this report is enriched adding to the standard economic perspective, the legal, the environmental and the geopolitical points of views as well as the opinions of academics and practitioners so to offer a deep dive into the complexity of the matter. Two focus (Chapters 7 and 8) contain case studies analyzed by researchers affiliated to the University of Shanghai and of Antwerp. They address specific questions, i.e. the possible effects of the NSR on Hamburg-Le Havre range ports and on the port of Antwerp and a costs analysis of dry bulk carriers on the Arctic Northeast Route and on traditional ones.

We do not intend to anticipate the gist of the research, so to leave the reader the pleasure of the discovery. We highlight hereby few points that need specific attention.

The first one relates to one key issue, that is the environment. Because of the potential increase of the naval traffic and the related increase of the production of energy consuming ice-resistant ship the greenhouses emissions may rise to the point of counterbalancing the CO_2 reduction associated to shorter length of Northern routes. Furthermore, as sea ice and glaciers get thinner the impact on the Arctic flora and wildlife may be massive and the increase in sea level may likely damage not only the regional port facilities but also provoke energy intensive climate events worldwide.

The second point, worthy of attention, is related to the geopolitical balance of power. Over the last decade, Russia, China and, to a lesser extent, the United States have shown an increasing interest in the Arctic Route driven by the huge amount of undiscovered fossil resources and by the implication of the exploitation of shorter shipping lines, linking the Atlantic and the Pacific Oceans. Russia has a logistic advantage meanwhile China wishes to gain not only access to new natural resources but also to integrate the Arctic Route in the infrastructure developments of the Belt and Road Initiative. Differently, the Unites States seems oriented – for now – to mildly contain the Russian and Chinese initiatives. As for the European Union – despite the Arctic location of three member countries (Denmark, Finland and Sweden) – it is not playing an active role in the game whilst it could be of help in finding the proper balance between the preservation of the Arctic environment and the integration of new logistic infrastructures with the new maritime routes.

Both cooperative and competitive outputs are plausible and, given the actual plunge in oil prices as well as the international political tensions associated to the pandemic crisis management, it is not obvious which one will prevail.

Finally, the time horizon of the economic benefits. Under normal conditions, the span to wait so that the passages open for longer periods during the year and the size of the in¬vestment in logistic infrastructure are factors that make measurable economic spillovers unlikely to be seen in a near future.

In the meantime, the passage might exert effects but only for the littoral countries and with limited impacts on other naval routes. This is a key point to keep in mind while reading this report.

Indeed, the Arctic Route is a compelling long-term challenge and it is exposed – now more than ever – to several elements of uncertainty.

This research does not provide the reader with easy takeaways but it offers an updated overview on a complex topic which is relatively unknown and out of the radar of the public discussion. We deemed it important to bring the context out of the shadows, to the public, also to foster a constructive debate that takes into account the relevance of negative environmental spillovers associated with the exploitation of new maritime routes.

2 / The Northern Sea Route: a new economic scenario

Over 80% of world trade by volume and over 70% by value was carried by sea and world seaborne trade volumes - that in 2019 already reached 11.9 billion tonnes[1] - were estimated to grow at a compound annual growth rate of 3.1% in 2018–2026[2]. In a global market that is so competitive and growing, the aim is to look for new routes and new markets in order to increase economic benefits and economic trade. The Northern Sea Route (NSR) becomes a new target because global warming in recent years has accelerated the melting of ice and snow in the Arctic region.

"As economic globalization and regional integration further develops and deepens, the Arctic is gaining global significance for its rising strategic, economic values and those relating to scientific research, environmental protection, sea passages, and natural resources"[3].

In addition, many experts predicted that the NSR, should be largely free of ice in the summers by 2050 if the Polar Ice Cap continued to melt at current rates[4].

In this scenario, "the development of new international trade routes, however, could significantly change existing spatial patterns of freight transport, which would have important implications for global logistics chains and transport network infrastructure"[5].

While traffic on this route until now was light, it will grow in the next future. Experts estimate that during ice-free months, eastward shipments from Northern Range to China through the NSR are estimated to be around 20% faster than the same journey via the Suez Canal; around one week faster than the traditional one. (and about 40% faster from the Northern range to Japan equal to two weeks faster).

[1] UNCTAD.

[2] According to Lloyds latest forecasts before Covid 19 pandemic.

[3] From the official document of The State Council Information Office of the People's Republic of China, China's Arctic Policy, The State Council Information Office of the People's Republic of China, January 2018.

[4] An overview on climate change in the Arctic is provided in Chapter 6 "The Challenge of Arctic Preservation: Environmental And Climatic Framework", at the paragraph "The shape of things to come: an overview of climate change in the Arctic" (Figure 1 and 2), pp. 83-84.

[5] OECD (2019), ITF Transport Outlook.

However, the NSR was not considered as a real competitor for land transportation transit corridors, somehow reminiscent of the historical Silk Road.

A comparison between the NSR and The Suez Route

Figure 1 - Source: SRM

At the moment, the Arctic Ocean has just three ice-free months a year but several estimates suggest that number will increase in coming years, boosting access to vessels and driving up traffic. This route is navigable without icebreakers for around two-four months a year.

The important thing, however, is not only to verify the distance of the routes and the commercial advantages of the latter, but above all the interest of big carriers as well as the development of new possible markets such as the Baltic area and Russian ports. It will also be important to evaluate the possible investments and developments coming from

the exploitation of the energy and mineral resources of the area. On the one hand, the possible exploitation of new deposits could change global energy assets and the balance between states. On the other, it could also have very negative effects on the environment.

The aim of this chapter is trying to understand the possible advantages and disadvantages of this initiative as well as to evaluate the effects on traffic in Europe and consequently in Italy.

As a matter of fact, the question which the chapter tries to address is whether the Mediterranean area of Europe and Italy in particular could see a reduction in traffic or the development of this route could be an opportunity to increase the logistics-infrastructural function of this area by increasing traffic with Russia and the Baltic countries.

1. Different routes and new perspectives of the routes along the Arctic

There are some main routes along the Arctic, thus the use of the Arctic Ocean could become a short-cut between Europe and Asia/North America that until now has been limited. According to J.P. Rodrigue[6], the routes can be identified as follows:

The NSR along the arctic coast of Russia[7]. This is the maritime route that is likely to be free of ice first and thus represents the highest commercial potential. It would reduce a maritime journey between East Asia and Western Europe from 21,000 km using the Suez Canal to 12,800 km, cutting transit times by 10-15 days. Some shipping lines have also run trials, but these have not shown great commercial potential yet.

The Northeast Passage (NEP) is the extension of the NSR along the North European Countries. This is the route linking the Atlantic and Pacific via the various seas to the north of Russia. In legal and geographic terms there is an important distinction between the Northeast Passage and what the Russians call the NSR. From a legal perspective the NEP is governed by international law, treaties, and coastal state legislation consistent with inter-

[6] J.P. Rodrigue, 2017, The Geography of Transport Systems fourth edition.

[7] For an overview on juridical aspects related to the covered area see Chapter 5 “The Law of the Frontier: the legislative framework of the High North” at the paragraph “Definition, scope and compliance with international laws”, p. 67.

national law. In contrast, the North Sea route, shown in Figure 2, has so far been a Russian domestic trade and maritime route[8].

The Northwest Passage (NWP) crossing Canada's Arctic Ocean could become usable on a regular basis by 2020, lessening maritime shipping distances substantially. This route connects the Atlantic and Pacific oceans along the northern coast of North America via waterways through the Canadian Arctic Archipelago. The United States and Canada could be interested in this but effects of traffic decline could be felt from the Gulf to Panama and from Latin America to Scandinavia. The maritime journey between East Asia and Western Europe would take about 13,600 km using the Northwest Passage, a remarkable reduction in distance when compared to the length of the same journey using the Panama Canal (24,000 km). In 2007 the Northwest Passage was open during the summer months for the first time in recorded history, but it remains to be seen how stable this opening will be.

The Arctic Bridge linking the Russian port of Murmansk to Canadian ports could be used, mostly for the grain trade.

There is also a hypothetical route. **The Transpolar Sea Route (TSR)** that would use the central part of the Arctic to link more directly the Strait of Bering and the Atlantic Ocean. This route involves ice-free conditions that are not yet observed.

According to this description **three main passages** were outlined: the Northern Sea Route (NSR) the Northwest Passage and the Trans-Polar route (figure 2)[9].
According to recent studies published by the European Commission[10], the possibility of navigating the Arctic Ocean will increase substantially. In 2019, was open to shipping for 30% of the year[11], whilst in 2040-2059 the predicted probability is between 94% and 98%, depending on the Intergovernmental Panel on Climate Change (IPCC) scenario.

[8] Ibidem note 7.

[9] For an overview on main passages see also Chapter 4 "The Strategic Positioning of Global Players in the Arctic Region" at the paragraph "The Arctic and the Northern Sea Route: geostrategic perspectives", p. 41.

[10] "Science for Environment Policy": European Commission DG Environment News Alert Service, 2013, edited by SCU, The University of the West of England, Bristol.

[11] In 2019, the transits were realized from the end of July to the beginning of November over a period of approximately 14 weeks. Of the 37 transits only 6 (16%) required icebreakers. The possibility of transit along the route without an icebreaker depends on climate and on the polar class of the vessels. On transits see also [https://arctic-lio.com/nsr-shipping-traffic-transits-in-2019/].

The breadth of the route would also expand, providing more possible routes to cross north of the Russian coast.

By 2040-2059 there will be greater potential for moderately ice-strengthened ships to cross the central Arctic Ocean using the Northwest Passage. Again, there will be a northward shift of feasible routes for moderately strengthened ships, meaning that the shortest route becomes possible. The Northwest Passage will also become a possible route for open water vessels. The route using the Northwest Passage is nearly a third shorter than the alternatives. For moderately ice-strengthened ships, the fastest route will go directly over the North Pole.

The findings have important implications for the environmental impacts to this area. If shipping increases, there will be worsened pollution and disruption of ecosystems. Despite the Polar Code (adopted by the International Maritime Organization) being in force since January 2017, there is a pressing need for its actual implementation to ensure environmental protection and vessel safety standards.

We have to consider not only the impact of reductions in sea ice, but also additional factors that may influence the use of these new shipping routes, such as lack of accident-response and search and rescue infrastructure, high insurance fees and poor charting of the area.

After examining the various possible routes through the Arctic, this paper focuses on the NSR that is the most famous and transitable one.

The NSR is the waters off the north coast of Russia - an area extending from Novaya Zemlya in the west to the Bering Strait in the east and outwards to the limits of Russia's Exclusive Economic Zone (EEZ). Russia regulates all traffic on the NSR, which is an integral part of the Northeast Passage, a shortcut between NW Europe and NE Asia through the Arctic Ocean[12].

The Arctic Route has been developing. "Massive Russian resources, including nuclear-powered icebreakers, have now enabled regular navigation. The Northern Russian portion is kept open all year and there are voyages between the Atlantic and the Pacific for three months. The sea route is part of an overall transportation system. Siberian raw materials and delivering goods from Russia transit through coastal ports and the great Siberian river arteries. Although it is seasonal, it is the product that carries the bulk of cargoes to the northern coast"[13].

[12] Businessindexnorth.com

[13] Drent J., 1993, "Commercial Shipping on The Northern Sea Route" in The Northern Mariner/ Le Marin du

The use of the Arctic Ocean as a short-cut between Europe and Asia / North America has until now been limited but recent political and economic changes in Russia have been modifying official attitudes about the international use of the sea route; the authorities are currently encouraging foreign interest in shipping across the top of Eurasia.

Map of the main routes along the Arctic

Figure 2 - Source: SRM on Amsa, Arctic Portal 2018search Service Report, 05-02-2020 [https://fas.org/sgp/crs/weapons/RL34391.pdf]

Nord III, No. 2 (April 1993), 1-17.

2. Investment and perspectives of the NSR

"On June 8 2015, the Russian government released Russia's Integrated Development Plan for the NSR 2015-2030. The plan stresses the importance of providing safer and more reliable navigation on the NSR for maritime export of Russian natural resource materials but also the strategic importance of the NSR for Russian national security. The plan is also to increase international transit cargo transportation on the NSR in partnership with Asian countries and especially with China"[14].

For reasons of strategy and proximity, there could be several countries such as Russia, China[15], Northern European countries and even the US interested in taking the Arctic Route and investing in its ports and among these Russia has been more proactive than others in seeking to exploit the region. The area contains, among other resources, approximately one-fourth of the world's undiscovered oil and gas resources.

The Northeast Passage (an extension of the NSR) above Arctic Russia has long been touted as the most likely viable trade route through the Polar waters as the Arctic shipping season in the region lengthens, but developing the route requires a lot of investment which Russia likely cannot afford alone.

On the Arctic Route Russia is present through ROSATOM – a public Russian company entitled with the responsibility of implementing the Federal Project "The Northern Sea Route" which is part of the Integrated Plan of modernization and broadening of the route infrastructure until 2024[16].

Among the most important projects is that of LNG extraction in the Yamal peninsula.[17] Russia's first large-scale gas extraction project in Arctic waters was realized.

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[14] Gunnarsson B., Managing Director, Centre for High North Logistics (CHNL) Nord University, Norway, 2016 in The Maritime executive, "Future Development of the Northern Sea Route".

[15] For an overview on the interest of China in the Arctic see also Chapter 4 "The Strategic Positioning of Global Players In The Arctic Region", paragraph "A field for cooperation or competition?", p. 43, and Chapter 5 "The Law of the Frontier: the Legislative Framework Of The High North", paragraph "The Ilulissat Declaration and the Arctic Council", p. 65.

[16] For an overview on Rosatom and Russian investments see also Chapter 4 "The Strategic Positioning of Global Players In The Arctic Region", paragraph "The Russian Federation: a (relative) logistical advantage" p. 46.

[17] For an overview on investments and China-Russia cooperation see also Chapter 4 "The Strategic Positioning of Global Players In The Arctic Region", paragraph "A field for cooperation or competition?", in particular Table 1 and 2, pp. 43-46.

This was the first large-scale project for the extraction of liquefied natural gas in Arctic waters that consolidates Russian's pivotal role in the LNG sector. This project was a joint venture of commercial stakeholders, including Russian operator Novatek (owner of 50.1%), French Total (20%), China National Petroleum Corporation (20%) and the Silk Road Fund (9.9%). "The project seemed to be facing a major financial challenge in 2014 when the United States imposed sanctions on Novatek. However, the challenge was surmounted by switching the financing from dollars to euros and, significantly, through the acquisition of $12 billion from Chinese lenders to replace Western investment"[18]. As of January 2020, the project reached a 97.8% completion for a total capital expenditures for a project of nearly $ 30.5 billion at the end of 2019[19]. The Sabetta port takes part in this ambitious project with a year-round export that should reach about 17 million tons per year (construction materials and LNG).

A twin project on the other side of the Ob Bay on the Gydan peninsula was placed: Arctic LNG-2 operated by Novatek, Total, China National Petroleum Corporation and the Mitsui/Jogmec consortium. With a total investment of $ 21 bln and an estimated production of 20 mln LNG tons per year by 2023, Arctic LNG-2 is the largest single project worldwide to have obtained the final commitment from its equity partners[20]. The $ 21 bln-worth plant includes power supply facilities, production wells and quaysides (currently under construction), supported by Novatek's plan to procure up to 42 specialized Arc7 LNG carriers (at least 10 of which from foreign shipyards)[21].

[18] [https://www.aboutenergy.com/en_IT/topics/arctic-route-for-russian-lng-opens.shtml].

[19] A pool of international financial institutions originally sponsored the venture with a $ 20 billion multifacility loan, of which Intesa Sanpaolo Bank committed to € 850 mln ($ 1.08,25 mln), residual € 814,3 mln ($ 882,4 mln).

[20] "Russia ups LNG race with green light on $21 billion Arctic LNG-2 project", Vladimir Soldatkin / Jessica Jaganathan, Reuters 05-09-2019 [https://www.reuters.com/article/us-russia-energy-novatek-lng/russia-ups-lng-race-with-green-light-on-21-billion-arctic-lng-2-project-idUSKCN1VQ0IH] and "Russia advances LNG race with multibillion-dollar Arctic project", Arab News 05-09-2019 [https://www.arabnews.com/node/1550306/business-economy].

[21] "Novatek To order up to 42 new Arc7 LNG carriers totaling $ 12bn", High North News 27-01-2020 [https://www.highnorthnews.com/en/novatek-order-42-new-arc7-lng-carriers-totaling-12bn] Likely bidders will be South Korea's Daewoo Shipbuilding & Marine Engineering (DSME), Hyundai Heavy Industry and Samsung Heavy Industry (SHI). China's Hudong Zhonghua shipyard, a subsidiary of state-company China State Shipbuilding Corporation, is also reportedly vying for the contract offering attractive financing options. DSME constructed the original tranche of 15 Arc7 vessels delivered between 2017-2019 used to export natural gas from Novatek's first Arctic project, Yamal LNG.

Yamal LNG and Arctic LNG-2 projects

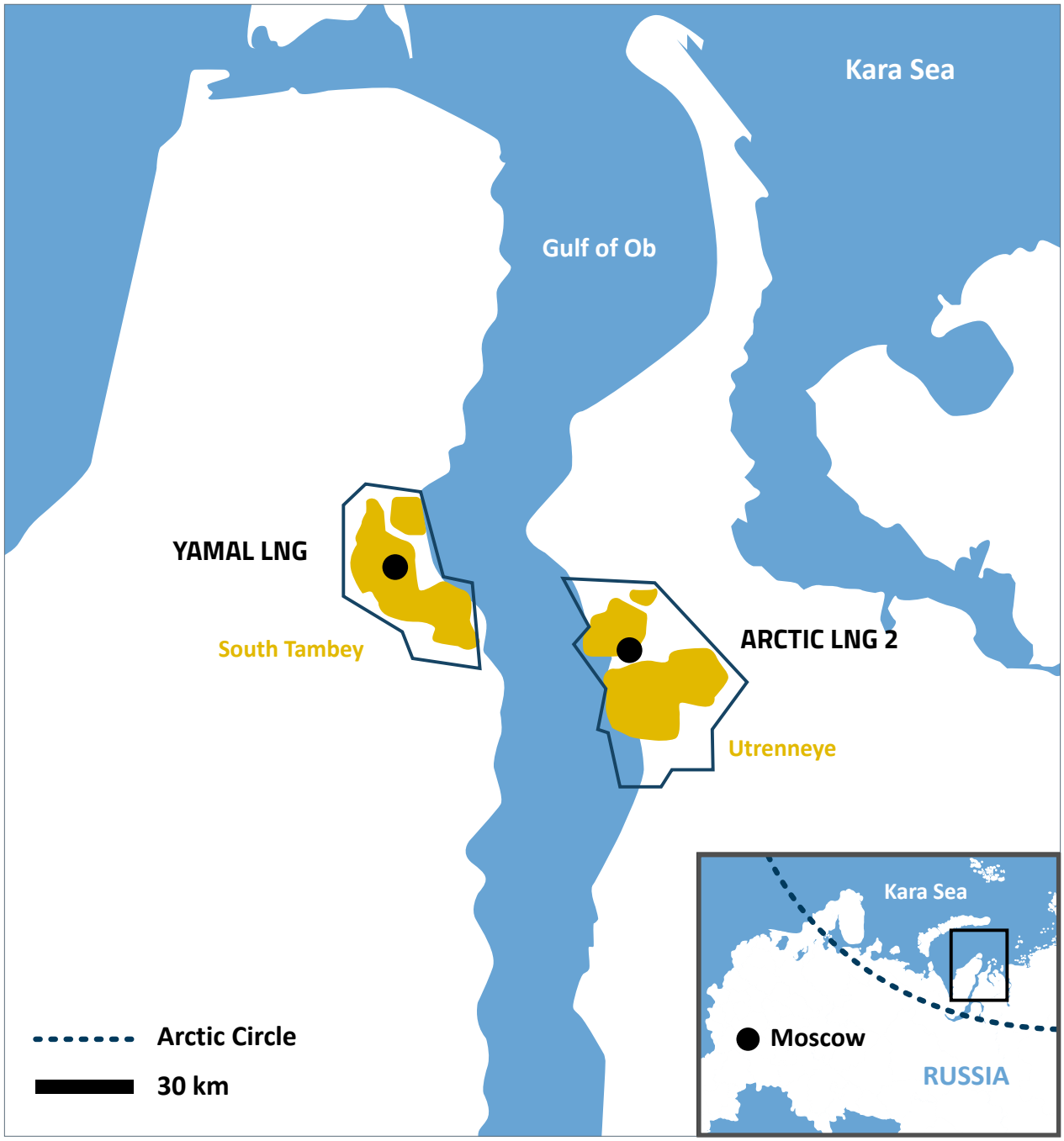


Figure 3 - Source: SRM on A.S. Kovalenko, M.O. Morgunova, V.V. Gribkovskaia (2018) Infrastructural Synergy of The NSR In The International Context

For Russia, the drivers of the Arctic changes could be the development of resource projects, the programs of building nuclear ice-breaking fleet and modernization of seaport and navigation infrastructure which support their dynamics.

NSR cargo flow is expected to increase considerably with further development of Russian Arctic hydrocarbon projects: crude oil from the Novoport Oil Field amounted to 7.26 million tons in 2018 (on a total capacity of 8.5 milion tons)[22]; crude oil from the Payakha Oil Field 7.3 million tons per year by 2024. That estimate might now be increased. As a matter of fact, in June 2019, the China National Chemical Engineering Group and Russian firm Neftegazholding signed a deal on developing the Payakha oilfield, promising investment of $5 billion over four years.

The Payakha oilfield project includes the construction of six crude oil processing facilities, a crude oil port capable of handling 50 million tonnes a year, 410 kilometres of pressurized oil pipelines, a 750-megawatt power station and an oil storage facility. This could become Russia and China's second energy project after Yamal[23].

3. Traffic trends of the NSR: Ships and Cargo

Maritime transport via the NSR is the only delivery route for natural resources originating in the remote Arctic regions. In this paragraph we will consider also traffic sailing through the route between ports along the NSR[24].

Transit sailings (along all the route from east to west) on the NSR fluctuated dramatically between 2010 and 2019. In 2010 transits amounted to over 100,000 tons and reached a peak of 1.35 million tons in 2013 after which they fell to 40,000 in 2015, with another rise to 697 thousand tons in 2019. This fluctuation was mainly due to the price of bunker fuel, geopolitical tensions and EU-USA sanctions against Russia (during the Ukrainian-Crimea crisis) and limited icebreaker assistance to escort transiting vessels[25].

In 2019, 37 transit voyages were made on the NSR, 16 of which were international transits between two non-Russian ports, which is the highest number ever. The most active shipper was the Chinese shipping company COSCO with 7 international transits.

[22] [https://www.gazprom-neft.com/company/major-projects/new-port/].

[23] [https://www.maritime-executive.com/editorials/china-s-arctic-silk-road].

[24] Major of these information and data come from Business Index North Report, 2019.

[25] For an overview on icebreaker Russian fleet see Chapter 4 "The Strategic Positioning of Global Players In The Arctic Region", Figure 2, p. 48.

Transit cargo through the NSR 2010-2019 (1,000 tons)

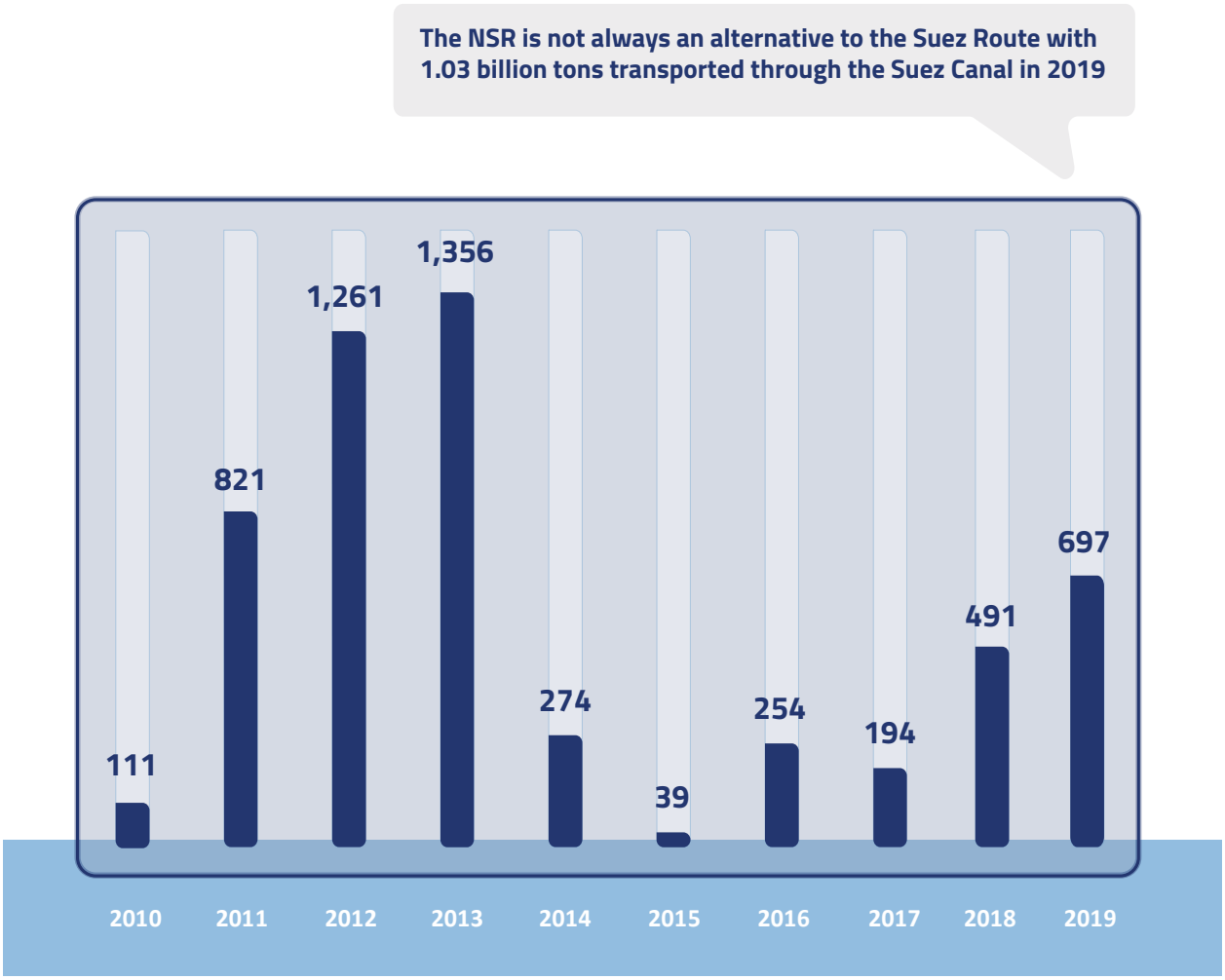


Figure 4 - Source: SRM on CHNL information office, 2020

Also, in 2018, the first containership (3,600 TEUs), Venta Maersk, made an international transit on the NSR, between Busan, South Korea, and Bremerhaven in Germany. However, the NSR can not always be compared to the Suez Route and will not significantly affect the existing schemes of general cargo delivery via traditional routes. It is important to remind that goods in transit through the Suez Canal represent 8-10% of global maritime trade and in 2019 the 18,800 ships that crossed Suez carried over 1 billion of goods stocks[26]. In addition, while megaships larger than 22,000 TEU can pass through Suez, only ships of much smaller dimensions travel through the NSR.

[26] Suez Canal Authority, 2020.

Cargo on the NSR 1933- 2019

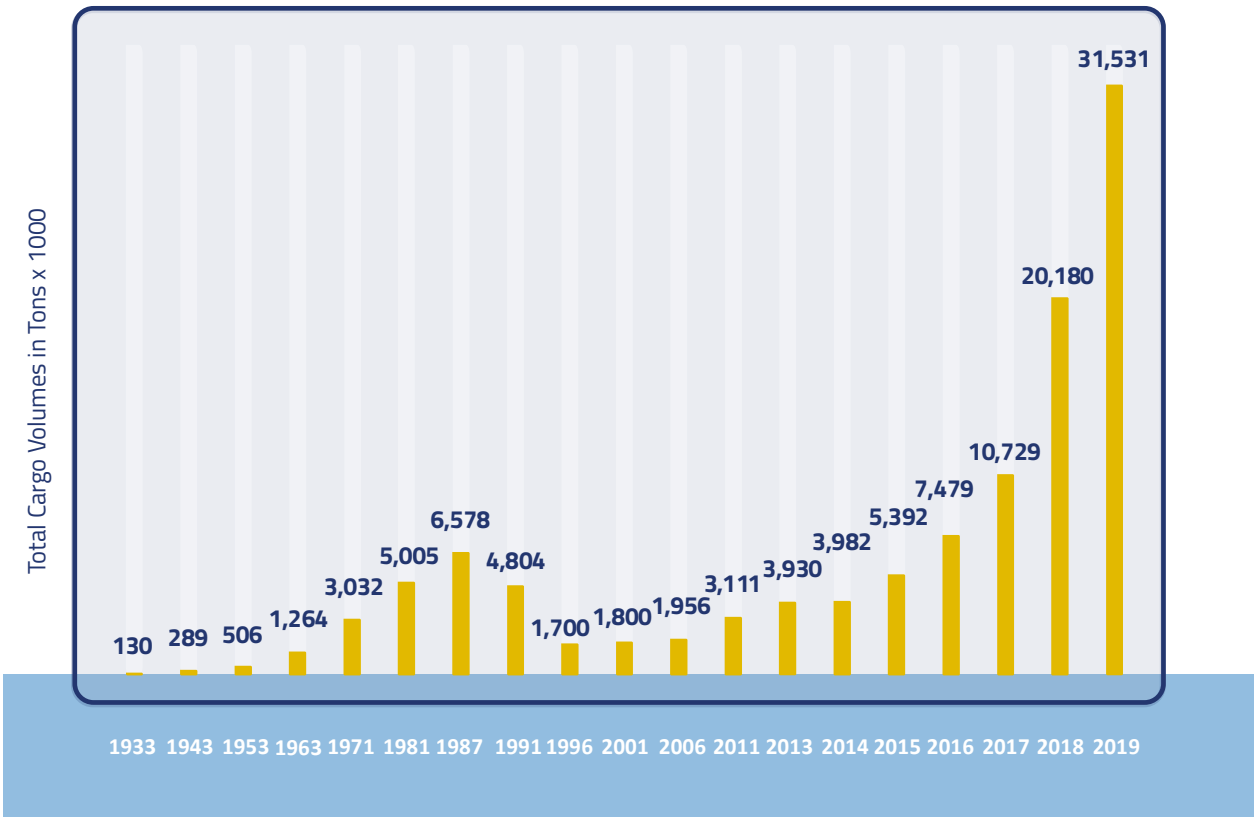


Figure 5 - Source: SRM on CHNL information office, 2020

Furthermore, along the traditional Suez route there are many important ports where ships can stop. As a matter of fact, this route is more convenient especially for megaships because it allows more stopovers in strategic and fast growing areas (starting from Shanghai: India, the Arabian Gulf, Suez, Mediterranean also as a base for stopovers in Europe, USA), while along the NSR vessels have long days of solitary navigation before reaching their destination.

Conversely, the NSR could have an additional role especially if the markets around Russian ports and the Baltic area grow quickly. As a matter of fact, the future of the NSR significance lies in its role as a transport corridor along the Eurasian Arctic Coast and between the Eurasian Arctic and port destinations and markets in the Atlantic and Pacific. But the primary use of Arctic Ocean shipping has been to support other industries heading farther north, like mining and oil drilling.

The total volumes exchanged between the ports along the NSR have increased more than fivefold over the last 10 years.

In fact, volumes began to grow in 2010 due to the increasingly favorable conditions for maritime transport linked to the melting of ice and reached 7.5 million tons in 2016, 10.7 million tons in 2017, increased in 2018 and then touched 31.5 million tons in 2019. The shipping volumes constitute an increase of more than 57 percent from last year. The lion's share of NSR ship traffic is related to the liquified natural gas produced by Novatek.
Russian government officials predict cargo volumes on the NSR as high as 92.6 million tons (in order to provide a comparison, this is equal to 60% of the Italian export) per year by 2024, and by 2030 they hope to add a significant part of international transit to that[27]. Russia expects shipping along the NSR to increase more than fourfold by 2024 compared to 2018 levels.

NSR cargo traffic (million tons) 1987-2030

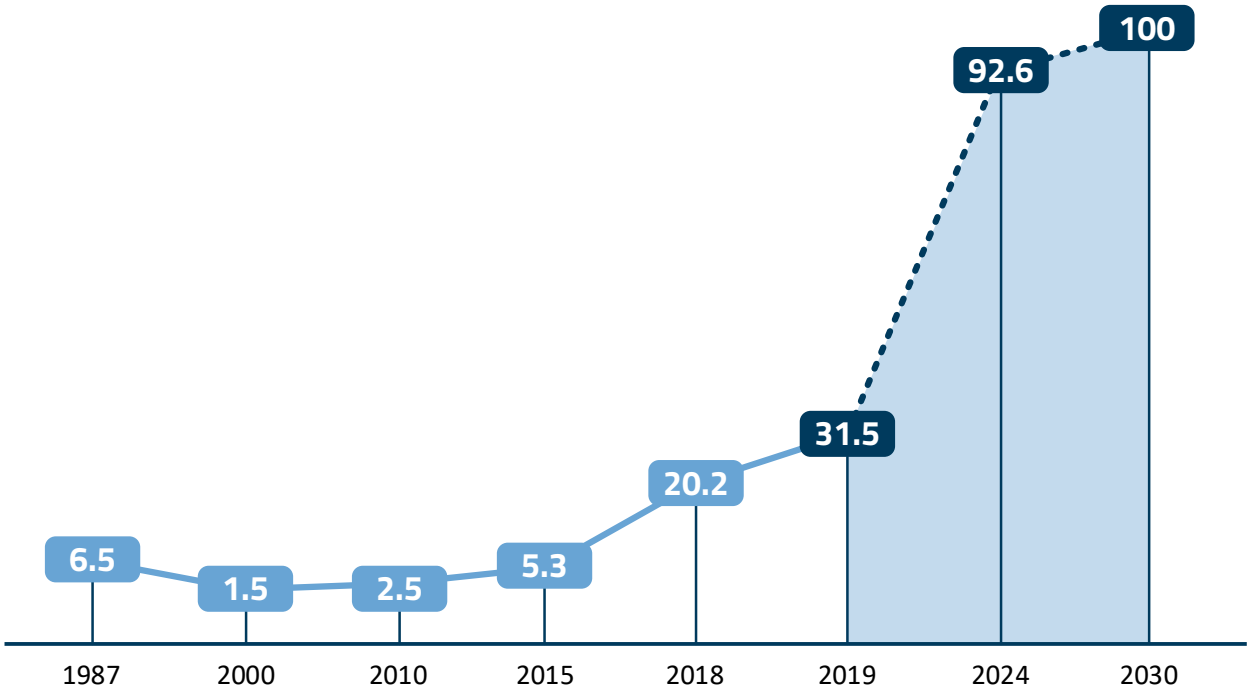


Figure 6 - Source: SRM on roscongress.org

[27] Alexey Likhachev, ROSATOM, April 2019, 5th International Arctic Forum "The Arctic – Territory of Dialogue".

A total of 227 ships transited the NSR in 2018, for a total of 2022 journeys. The number of vessels decreased over 2017, but the number of trips increased. The number of oil tankers and of the general cargo is greater.

Types of vessels and number of voyages for each vessel type on the NSR in 2017 and 2018

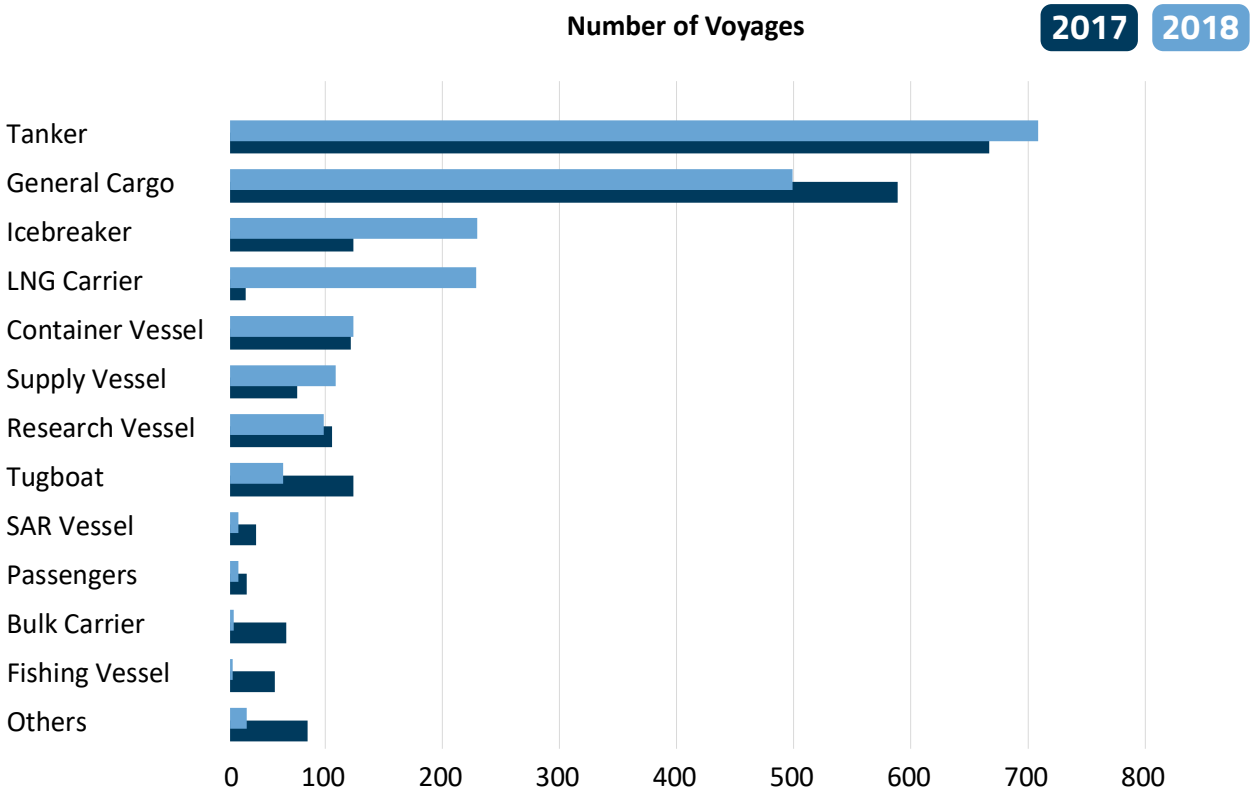


Figure 7 - Source: Business Index North Report, 2019

Of the 2,000 vessel voyages that crossed the NSR, 25% were realised by 53 states that are not part of the Arctic region. Among these there was also Italy, ranking 7th in Europe, 16th among the non-Arctic states and 27th in the world by number of ship voyages.

Non-Arctic countries passing through the NSR

Ranking	Flag	Vessel voyages
1	Panama	48
2	Netherlands	39
2	Bahamas	39
4	Marshall Islands	33
5	UK	31
6	Liberia	30
7	Malta	21
8	Antigua and Barbuda	20
9	Cyprus	18
10	Hong Kong	17
10	Germany	17
12	Singapore	14
13	St-Kitts & Nevis	12
13	China	12
15	France	10
16	Italy	7

Note: Netherlands including Curacao; UK including Gibraltar, Bermuda, Caymans I, Falkland I., France including Wallis et Futuna, TAAF.

Table 1 - Source: Arctic Shipping Summit 2019

4. Comparison between Global Routes

The NSR allows a reduction in transit times of the intercontinental east-west connection between Asia, Middle East, Europe and the east coast of the United States.

This route, usually open between July and November, offers a considerable potential for development due to the large energy resources present in the area. The US Geological Survey estimates indicate that within the Russian Arctic EEZ (exclusive Economic Zone) some 30% of all Arctic recoverable oil and 66% of its total natural gas is to be found. The USGS estimates total Arctic oil recoverable reserves to be about one-third of total Saudi reserves.

However, despite the obvious savings in terms of distance and the recent improvements in infrastructure to support the safety of navigation, the Arctic Route has some considerable operational limits due to the unpredictability of weather. This usually requires a sailing cruise of about 10/15 knots which allows ships and vessels to anticipate problems linked both to the presence of icebergs and to the need for a sudden change of direction in case of uncertainty with respect to the depth of the muddy bottoms – with constant changes depending on the meteorological conditions, often unsuitable to the passage of large ships.

This type of restriction makes the route difficult for the regular container services and it is also complex with respect to the flows of oil products and grains. Even in future scenarios involving a possible extension of the period of navigability, due to higher average temperatures in the area, the Arctic Route will have a very marginal role and will be complementary to the transits in the Suez Canal, unable to be a real alternative for all the main flows that use the Suez route.

Nevertheless, the distance between the ports of north-western Europe and the Far East is reduced by about 40% using the NSR as an alternative to the Suez Canal. If only one of the main routes is considered as the Shanghai-Rotterdam route, the NSR allows for a time saving of around 22%. Therefore, the NSR has attracted the interest of shipowners and shipping companies due to its shorter distance and, therefore, the shorter time spent (table 1) than the other long-haul routes connecting the ports of origin / destination of the 'Atlantic and Pacific.

However, from the table below it is clear that the NSR has some competitive advantages on some routes that originate or travel to the northern areas of China and Northern Europe while it is not competitive for Singapore and Central/Southern Europe. Indeed, for a Mediterranean port such as Genoa, there will not be very big changes, as the routes they use will not really be affected by increased travel in the Arctic.

Analysis of the distance and time of navigation of some routes between Asia, Northern Europe and Canada

The Shanghai-Rotterdam case		
Route	**Distance (in nautical miles)**	**Hypotetical days of Navigation**
Northern Sea Route (NSR)	8,031	22
Suez	10,525	29
Cape of Good Hope	13,843	38
Panama	13,411	37
The Yokohama-Rotterdam case		
Route	**Distance (in nautical miles)**	**Hypotetical days of Navigation**
Northern Sea Route (NSR)	7,010	19
Suez	11,133	31
Cape of Good Hope	14,448	40
The Vancouver-Hamburg case		
Route	**Distance (in nautical miles)**	**Hypotetical days of Navigation**
Northern Sea Route (NSR)	6,635	18
Suez	15,377	43
Cape of Good Hope	18,846	52
Panama	8,741	25
The Hong Kong-Hamburg case		
Route	**Distance (in nautical miles)**	**Hypotetical days of Navigation**
Northern Sea Route (NSR)	8,370	23
Suez	9,360	27
Cape of Good Hope	13,109	37
The Singapore-Hamburg case		
Route	**Distance (in nautical miles)**	**Hypotetical days of Navigation**
Northern Sea Route (NSR)	9,730	26
Suez	8,377	23
Cape of Good Hope	11,846	33

Note: Average speed NSR 8-10 knots other routes 15 knots.

From the analysis on distances with the port of Hamburg, it also turns out that Ho Chi Minh City could be considered a point of indifference (a point at which two alternatives under consideration are the same) since travel times between the German and Vietnamese ports are the same via Suez or the NSR.

Table 2 - Source: SRM on www.sea-distances.com and Didenko 2018

Analysis of the distance and time of navigation of some routes between Italy, Asia and Canada

The Shanghai-Genoa case		
Route	**Distance (in nautical miles)**	**Hypotetical days of Navigation**
Northern Sea Route (NSR)	10,239	31
Suez	8,670	24
Cape of Good Hope	13,619	38
Panama	13,782	38
The Yokohama-Genoa case		
Route	**Distance (in nautical miles)**	**Hypotetical days of Navigation**
Northern Sea Route (NSR)	9,218	28
Suez	9,325	26
Cape of Good Hope	14,271	40
The Vancouver-Genoa case		
Route	**Distance (in nautical miles)**	**Hypotetical days of Navigation**
Northern Sea Route (NSR)	9,096	27
Suez	13,511	37
Cape of Good Hope	18,462	51
Panama	9,232	26
The Hong Kong-Genoa case		
Route	**Distance (in nautical miles)**	**Hypotetical days of Navigation**
Northern Sea Route (NSR)	10,831	33
Suez	7,893	22
Cape of Good Hope	12,837	36
The Singapore-Genoa case		
Route	**Distance (in nautical miles)**	**Hypotetical days of Navigation**
Northern Sea Route (NSR)	12,191	36
Suez	6,433	18
Cape of Good Hope	11,531	32

Note: Average speed NSR 8-10 knots other routes 15 knots.

From the analysis on distances with the port of Genoa, it also turns out that **Yokohama port** could be considered a point of indifference; a point at which the two alternatives under consideration have a very close difference: only 107 miles less via NSR than via Suez.

Table 3 - Source: SRM on www.sea-distances.com and Didenko 2018

5. China's interests in the NSR

Over the past decade, Russia and China have cooperated mainly on oil and gas focusing on the Russian Far East and Eastern Siberia. Also, for this reason, the Arctic, where an important share of these resources is concentrated, has gradually become part of the negotiations.

In July 2017, China and Russia signed the "Joint China-Russia Declaration on further strengthening the global, strategic and cooperative partnership". The declaration includes the North Sea route as a strategic area of cooperation, as a formal part of China's Belt and Road Initiative (BRI) infrastructure. For its part, Russia is investing significant resources in the development of new ports and infrastructure for LNG along the route to serve growing maritime traffic passing through its Arctic territorial waters.

China is increasingly interested in the NSR and the Dragon has entered the Arctic Route in the Belt and Road Initiative (BRI) and COSCO has made several trips across the Arctic sea.

On January 28, 2018, China published the "Vision for Maritime Cooperation Cooperation under the Belt and Road Initiative"[28] as part of the BRI Initiative indicating the Arctic as one of the priorities. The document states that China is gearing up to build a "polar silk road" together with the Arctic coastal countries, especially Russia. The Polar Silk Road is the "3rd way" of connection with the Eurasian Economic Union.

In this official document[29], we can read that China intends to build the "polar silk road" through the development of Arctic sea routes in collaboration with all states that have an interest in the Arctic. It encourages its companies to participate in the construction of infrastructure along these routes and to conduct test commercial trips in accordance with the law in order then to pave the way for their regular commercial operation. As the Chinese Arctic Policy notes, "The use of sea routes, exploration and development of resources in the Arctic can have a huge impact on China's energy strategy and economic development."

[28] For an overview on BRI see also Chapter 4 "The Strategic Positioning of Global Players in the Arctic Region", paragraph "A field for cooperation or competition?" p. 43.

[29] The State Council Information Office of the People's Republic of China, China's Arctic Policy, The State Council Information Office of the People's Republic of China, January 2018.

The three paths of the Chinese BRI

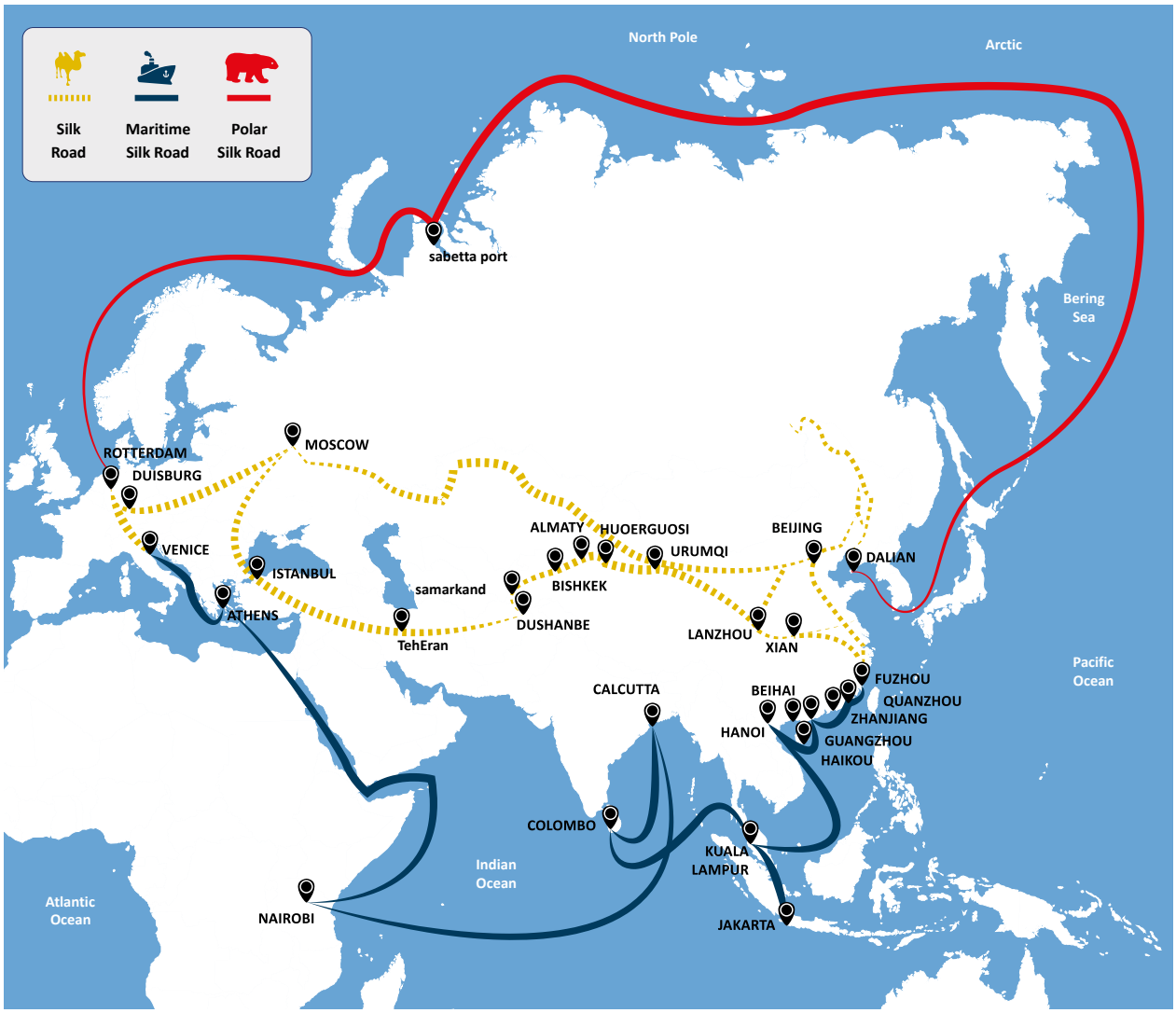


Figure 8 - Source: SRM on China's Development and Reform Commission, The Arctic Institute, National Snow and Ice data Centre, Reuters

The Arctic shipping routes, particularly the NSR, are called "blue economy corridor" due to saving in costs and time for connecting Western Europe and China. In 2013, Chinese shipping company COSCO sailed the first-ever multipurpose ship through the NSR. In addition, in 2015, *five* COSCO vessels sailed through the icy route, which is a record for this company. Furthermore, China has built an Arctic cruise ship for the Polar Silk Road which is the first polar expedition cruise ship built by China Merchant Group and delivered in September 2019[30].

[30] [docksthefuture.eu/chinas-polar-silk-road-a-threat-or-an-opportunity]

In 2015, Chinese banks lent $12 billion to the Yamal liquefied natural gas (LNG) project[31], which lies in the middle of the NSR and is expected to supply China with four million tonnes of LNG a year, according to the state-run China Daily.

China holds a 30% stake in the project of the liquefied natural gas plant at Sabetta on the Yamal Peninsula, Russia. In addition, the first liquid natural gas shipment went to China last summer via the NSR. China is building a second icebreaker able to cruise polar waters.

The Chinese government, as well as government-linked firms and individuals, have invested significant funds in the Arctic. Table 4, adapted from a 2017 CNA report, summarizes overall patterns of Chinese investment in select Arctic countries. Chinese investments in Greenland ($2 billion) and Iceland ($1.2 billion) represent a significant percentage of each country's annual GDP.

CNA Report[32] estimates that China has invested over $1.4 trillion in the economies of the Arctic nations (including Finland and Sweden), $89.2 billion of which was in infrastructure, assets, or projects.

As a matter of fact, there are big projects now for the extraction of oil and gas in the Barents Sea and the Kola Peninsula.

Chinese Investment 2012-17

Target Country	Chinese Investment as percentage of GDP	Total Value of Chinese Investment (billion dollars)	Average Size of Chinese Investment per project (million dollars)
Greenland	11.6	2.0	33.4
Iceland	5.7	1.2	30.8
Russia	2.8	194.4	691.7
Canada	2.4	47.3	442.1
United States	1.2	189.7	340.6
Norway	0.9	2.5	147.9

Table 4 - Source: CNA

[31] For an overview on investments see also the previous paragraph "Investment and perspectives of the NSR" in the same chapter, p. 13.

[32] CNA Corporation (US), Mark E. Rosen, Cara B. Thuringer, 2017, Unconstrained Foreign Direct Investment: An Emerging Challenge to Arctic Security.

6. China-Russia oil traffic

"Only 10 years ago Russia, the world's second oil exporter after Saudi Arabia, was hardly exporting any oil to Asia, with the vast majority of its trade being with Western countries, either seaborne or by pipelines.
As strains between Russia and the European Union mounted, and as the Asian economies expanded, the Russian government decided to diversify oil export routes.
The main element has been the investment in the Eastern Siberia–Pacific Ocean oil pipeline (ESPO) from East Siberian oil fields to the Far East port of Kozmino near Nakhodka. The pipeline was built and operated by Russian pipeline company Transneft"[33].

7. The Russian ports of the Arctic

According to the expert opinion of KPMG, the contribution of the North Sea route to Russia's GDP will be equal to 2% per year (by 2050)[34].
According to recent estimates, 65% of all hydrocarbon reserves in the world are in the Arctic. Most of them (60–65% according to the Ministry of Natural Resources) are located on Russian territory.
In addition, the cost of the development project of the NSR is estimated at 734.9 billion rubles until 2024. Of these, only 274 billion rubles come from the state budget.
Almost all the major ports along Russia's northern coast are experiencing a significant increase in goods volumes. Operators of seaports in the Arctic Basin handled 78.6 million tonnes in September 2019 (+17.5%, year-on-year) equal to 12.3% of total Russian ports. Of the total Arctic basin, 23.5 million tons are dry goods (+4.1%) and 55.1 million tons are liquid bulk goods (+24.2%).
In Sabetta, the new port in the Yamal Peninsula, the year-on-year growth for the first 9 months of the year is as big as 1.9 times.
A total of 20.7 million tons of goods were handled in Sabetta in the period.
"The growth in Sabetta is driven by the shipments of LNG from Novatek's Yamal LNG plant.

[33] Far East Russia Crude Oil Exports: A Legitimate Tanker Play?" dell'Hellenic Shipping News del 17/12/2019 [https://www.hellenicshippingnews.com/far-east-russia-crude-oil-exports-a-legitimate-tanker-play/].

[34] 5st Eastern Economic Forum, 2019

By the end of the year, a fleet of 15 major ice-class Arc7 LNG carriers will shuttle to the terminal to pick up the liquified natural gas.

Also, in Murmansk, the growth in shipping continues. In the first 9 months of the year, the increase was 2.8 percent. In the same period, the ports in the Kola Bay handled 46.4 million tons. That includes coal, construction materials and processed materials produced by the region's powerful mining and metallurgic industry.

The positive development in Murmansk follows a year with major growth. In 2018, the regional terminals had their best year in several decades. More than 60.7 million tons of goods were then handled by the Murmansk port installations, an increase 18.1% higher than the previous year.

Also, the terminal in Varandei experienced growth in the 9 months of 2019. In this period, the infrastructure located on the coast of the Pechora Sea handled 5.4 million tons of goods, an increase of 4.5 percent on 2018. The Varandei terminal is owned by Lukoil and handles exclusively oil from nearby fields in the Timan Pechora area"[35].

Russian Arctic ports

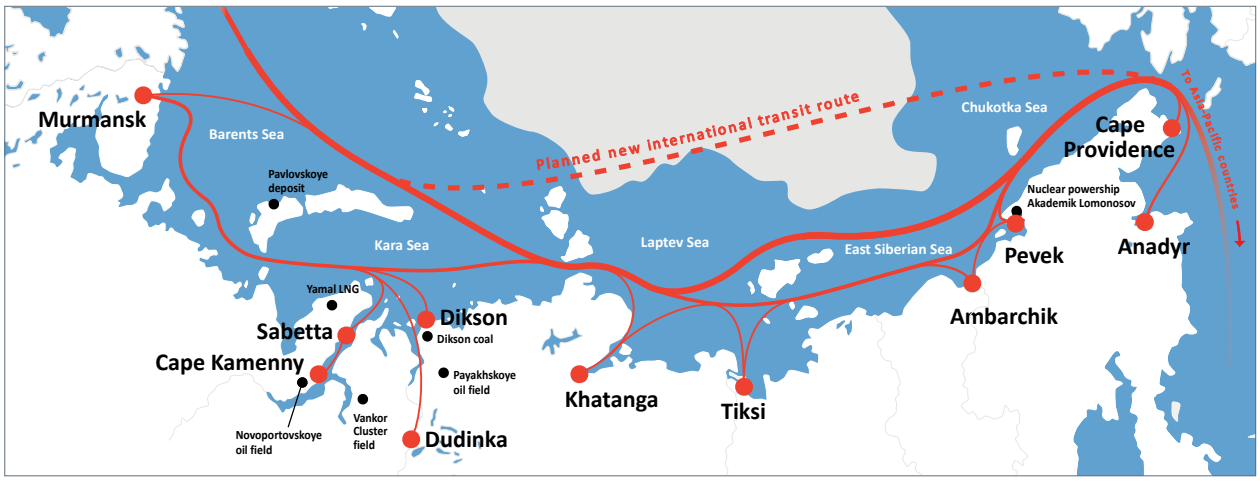


Figure 9 - Source: 5th Eastern Economic Forum, 2019

[35] [https://thebarentsobserver.com/en/industry-and-energy/2019/09/big-growth-russian-arctic-ports].

3 / The NSR in the perspective of Northern Range: Antwerp

From the European point of view, Northern Range Ports are geographically located in a good position to exploit potential benefits deriving from the opening of the Arctic Route while also being well equipped (due to their high level of connectivity and logistic efficiency) to understand if the NSR will change international shipping trade scenarios in the near future.

The economic analysis on the NSR and its growth prospects in connection with the upcoming development mainly linked to climate change and new investments, is important not only to understand impacts on maritime trade but also to see potential evolution in energy trade as a consequence of the estimated huge reserves of liquid gas in the Arctic Region[1].

As illustrated in the following chapters, there are numerous factors that might affect the design of world routes chosen by a carrier, namely costs and times of transit. But it is also clear that new routes could hold a role in shipping, adding new business and new geographic market areas.

For all these reasons, as we normally do for this kind of researches, we decided to integrate and refine the economic analysis of the Arctic Route with a quality survey based on interviews with high-level experts.

For the sake of practicality, we decided to concentrate on the Port of Antwerp as it is one of the most important Northern European Ports, with a huge range of industrial context, rail connectivity, logistic services and (being a North Sea river-estuary Port, bordering The Netherlands) with a trans-national perspective.

In addition, the port, the university and the socio-economic context of Antwerp are at the forefront of technological innovation, organizational model and internationalization in all aspects of maritime sectors.

Finally, geographically speaking, this Port lies midway between the Arctic and the Mediterranean and thanks to its historical and current partnership with Southern Europe,

[1] An overview on resources is provided in Chapter 4 “The strategic positioning of global players in the Arctic Region” at the paragraph “The Arctic and the Northern Sea Route: geostrategic perspectives”, p. 41.

Antwerp experts are well prepared to evaluate the potential impact of the Arctic Route also from the Mediterranean perspective.

Interviews were done during a specific mission in January 2020 involving researchers from SRM and Intesa Sanpaolo and these were carried out thanks to the collaboration with the Department of Transport and Regional Economics (TPR) of the University of Antwerp. The TPR Department has been one of SRM research partners many times in the past, thanks to their well-established expertise in the maritime sector.

The analytical tool used in this stage of the paper consists of meetings and interviews with opinion leaders to gauge their mood and explore Strengths, Weaknesses, Opportunities and Threats of the opening of the Arctic Route, while also exploring geo-economic, legal and environmental aspects.

The analysis provides an overview of the current situation of the route and its possible perspectives and the interviewees were chosen considering the importance of universities, government agencies and industries, the three entities that guarantee research, development, funds and workforce respectively.

Also, being based in Antwerp, our conversations and interviews had a broader view, taking into account all the North European perspective and the international scenario. A common opinion was that the Arctic Route will affect the future relations with Russia and China more than with North America where there is a stable shipping transatlantic route.

As a matter of fact, this analysis is intended as a quick comparison snapshot of the routes and of the strengths and weaknesses of the passage through the Arctic. The paper is aimed at providing insight to sector operators and investors, opinion leaders and those who are directly and/or indirectly involved in the governance of the maritime sector at the national and/or international level.

Although the point of view of the NR and in particular of Antwerp can be considered partial, it is a significant point of view considering that the container ports of the NR reached a market share of about 40% of the Euro-Med area in 2019. In addition, NR ports are advanced in maritime connectivity, as a matter of fact according to the Liner Shipping Connectivity Index (LSCI) 2019 of UNCTAD[2], Belgium, the Netherlands and Germany ranked

[2] The Liner Shipping Connectivity Index (LSCI) is a UNCTAD index that is based on 6 components:
1) The number of ships;
2) The transport capacity in terms of containers of these ships;
3) Maximum tonnage of ships;
4). The number of maritime services;

respectively 7th, 8th and 11th in the world (out of 178 Countries) and in particular Antwerp port ranked 6th (out of more than 900 ports in the world) in the Port Liner Shipping Connectivity Index (PLSCI)[3] 2019. Last but not least, NR countries were leaders also in logistic connectivity as the Logistic Performance Index (LPI)[4] in 2018 of the World Bank indicates

5) The number of shipping companies that use container ships in services to and from ports;
6) The number of other countries that are connected to the country through direct liner shipping services (Note that a direct service is defined as a regular service between two countries; it may include other stops in between, but the transport of a container does not require transhipment).
The index is generated as follows:
The LSCI is generated for all countries that are serviced by regular containerized liner shipping services. For each component, UNCTAD divides the country's value by the maximum value for the component in 2006 and then calculates the average of the six components for the country. The country average is then again divided by the maximum value for the average in 2006 and multiplied with 100. The result is a maximum LSCI of 100 in the year 2006. This means that the index for China in 2006 is 100 and all other indices are in relation to this value.

[3] The PLSCI is generated for more than 900 container ports in the world. It is generated from 6 components:
(a) The number of scheduled ship calls per week in the port.
(b) Deployed annual capacity in Twenty-Foot-equivalent Units (TEU): total deployed capacity offered at the port.
(c) The number or regular liner shipping services from and to the port.
(d) The number of liner shipping companies that provide services from and to the port.
(e) The average size in TEU (Twenty-Foot-equivalent Units) of the ships deployed by the scheduled service with the largest average vessel size;
(f) The number of other ports that are connected to the port through direct liner shipping services. A direct service is defined as a regular service between two ports; it may include other stops in between, but the transport of a container does not require transshipment.
The index is generated as follows:
For each component, we divide the port's value by the maximum value for the component in 2006 and then calculate the average of the six components for the port. The port average is then again divided by the maximum value for the average in 2006 and multiplied with 100. The result is a maximum PLSCI of 100 in the year 2006. This means that the index for the port Hong Kong in 2006 is 100 and all other indices are in relation to this value.

[4] LPI 2018 ranks countries on six dimensions of trade -- including customs performance, infrastructure quality, and timeliness of shipments. The data used in the ranking comes from a survey of logistics professionals who are asked questions about the foreign countries in which they operate.
The components analyzed in the International LPI were chosen based on recent theoretical and empirical research and on the practical experience of logistics professionals involved in international freight forwarding. They are:
• The efficiency of customs and border management clearance ("Customs").
• The quality of trade and transport infrastructure (Infrastructure").
• The ease of arranging competitively priced shipments (Ease of arranging shipments").

that Germany is 1st and Belgium 3rd. The LPI is an interactive benchmarking tool created to help countries identify the challenges and opportunities they face in their performance on trade logistics and what they can do to improve their performance[5].

Thus, the vision of NR is fundamental to understand the trends and prospects that open up to the maritime sector at a global level.

In addition, as was said in Chapter 2, shipping is the backbone of most major economic activity representing 70% of value and 80% of volume transited by sea, from the extraction of natural resources to the manufacturing of goods. Therefore, shipping is the vehicle for this trade, whether it is transporting metals and oil across oceans or bringing manufactured products everywhere, even to remote communities such as the Arctic. In addition, Climate Change and its effects on sea ice are clear, the polar ice caps are melting, and this is offering new opportunities – alongside some risks – of traffic in the Arctic.

Among the others, in Antwerp we met the following key players: **prof. Thierry Vanelslander**, Research professor at the TPR Department of Transport and Regional Economics of the University of Antwerp; **Mr. Guojin Liu**, East Asia Business Manager of the Port of Antwerp; **Mr. Patrick Verhoeven**, Managing Director of IAPH The International Association of Ports and Harbors; **Mr. Marc Beerlandt**, CEO MSC Belgium in Antwerp; **Mr. Geert De Wilde** and **Mr. Laurent Moyersoen**, respectively CEO & Customs Project Manager of *NxtPort*, an innovative company operating in Antwerp in the field of data gathering and organization aiming to make the shipping process more transparent and smooth.

In light of the above, together with these experts we discussed 6 key points:

1. China, Russia and EU geo-strategic interests in **the NSR**
2. The potential **impact of the Arctic Route on Northern Range** and on **Antwerp Port**
3. The reason why **two big carriers like Maersk and Cosco** showed interest in the NSR and have already started to travel on this route, while other big carriers like **CMA, CGM and MSC** declared they will not use route.

• The competence and quality of logistics services—trucking, forwarding, and customs brokerage ("Quality of logistics services").

• The ability to track and trace consignments ("Tracking and tracing").

• The frequency with which shipments reach consignees within scheduled or expected delivery times ("Timeliness").

The LPI uses standard statistical techniques to aggregate the data into a single indicator that can be used for cross-country comparisons.

[5] The LPI 2018 allows for comparisons across 160 countries.

4. Whether the **NSR is a short-term or a long-term challenge**
5. Which **infrastructures** are necessary along the Arctic to develop the shipping business
6. How the **climate change** issues can affect the Arctic Route exploitation

Nowadays, the cognizance that this route is now more feasible could be tempting for shipping lines. From the analysis emerges that there are different aspects to consider and various perspectives to evaluate. The interviewers have mainly underlined and stressed some peculiar aspects that will be examined: the different national interests in the development of the route, the carrier strategies, the current and future perspective of the route, the status of infrastructures and services, the impact on the environment.
These are competitive elements that were taken into account also when SRM studied and analyzed other important routes and strategic points of transits (such as the Suez enlargement or the new Panama Canal)[6].

MSC Antwerp focused on the research of big players of new routes and their different geographical perspective of the world: China and Russia

As a matter of fact, there is primarily a geographical perspective to consider and if we analyze the route mainly from the Chinese or Russian perspective, their focus is to make new economic connections between them and Eurasia. China is looking at the World from a completely different perspective than Europe and from that view, the Arctic is a good opportunity to strengthen relations with Russia. The needs of these two large countries can be considered complementary in regard to the NSR: Russia has the Know-How and control over the route as well as energy resources while China has financial resources and the need to find new routes and new markets for its goods.
Thus, the data show an increasing activity of traffic and investments along the NSR which has indeed affected countries such as Russia and China. Despite its obvious distance from the borders of the Arctic region, China has so much interest in the development of traffic in the area that it has officially included the Polar Sea Route within the Chinese BRI.

[6] For further information: SRM (in cooperation with Alexbank), 2015, The new Suez Canal: economic impact on Mediterranean maritime trade; SRM, 2016, The Economic Effects of the Expansion of the Panama Canal on Maritime Trade.

The aim is to expand global routes and traffic. Obviously, Russia too has an interest, and also know-how, in developing traffic and infrastructure along this route and throughout the Arctic area.

Antwerp port remarked upon the Chinese vision,
that there is also a secondary aspect to consider: creating an alternative route

Through the Arctic and the railway BRI, China expands its interests in new areas, adding other transit modes to the traditional maritime BRI; new paths feed new exchanges and create alternatives for China in the world key and strategic passages.
Connectivity is an important asset and countries aim to make their transport systems and interconnections as competitive as possible. There is also an increasing focus on rail connections that push for sea transport much more than in the past (think of the role that China intends to give the train through the development of the "land silk road"). An alternative to Suez could therefore be found in train connections, especially along the Eurasian route which involves much shorter travel times even though with volumes much lower than the passage by ship.

MSC Antwerp focused on a central element of the analysis;
the future carrier strategies for the NSR, underlining that there are
different approaches to this and even amongst European countries
there is a distinction between the Med and the Northern countries

It must be noted that the future development of this route is closely dependent on the will of the major carriers to use it. In particular, Maersk and Cosco have different interests from other liners and use the route (even if Maersk is only testing it at the moment) differently from CMA CGM and MSC who have openly declared that they will not operate through the route.
On the other hand, if we look at the route from the angle of European ports the vision is different and could be split into: a) Polar European Countries vision (state bordering the Arctic region) and b) other European countries. In cascade, this vision reflects on the behavior of the major world carriers and the market served by them.
We have to consider that four carriers dominate the global container shipping market and capacity deployed on the three major East–West trade routes.

The four companies are: the Danish Maersk with 17.3% of global market share[7], the Swiss-Italian MSC with 14.6%, the Chinese Cosco with 14.2%, and the French CMA-CGM with 12.1%.

Three of them are European companies with Maersk, the first, which is owned by a European polar state (Denmark).

Since the emergence of global alliances, the container shipping industry has evolved into a concentrated industry, especially over the last five years. Whereas the top four carriers in 1998 had a market share of less than 20%, this increased to almost 60% in 2019. Thus, their decisions – based on organizational needs of their business and sometimes also on the country of origin – could influence the maritime sector to a great extent.

Even for the European Union, there is a distinction between the Med and the Northern countries. MSC has more cargo on the Mediterranean route while Maersk has the upper hand on the Northern route, and this contributes to different behaviors on the NSR. As a matter of fact, Maersk will follow the Arctic Route and is studying and pioneering it successfully thanks to suitable ships. Vessels that are among the world's largest ice-class ships specifically designed to operate in cold and icy waters year-round and are capable of operating in unconsolidated ice up to 1 meter thick. The company recently took delivery of the first of seven ice-class feeder container ships: a 3,600 TEUs named Venta Maersk[8]. This vessel is a brand of new generation of seven ice-class 1A feeder container ships.

Travelling along the NSR requires additional investment and thus generates extra costs. Similarly, limits on the size of the vessels that can use the passage compared to Ultra Large Container Vessels on the Suez Canal route increase the relative costs of the Arctic Route.

Nonetheless, the company confirms that it is studying the Arctic option, but at the moment, according to Maersk, the NSR is simply a way for testing new opportunities.

All the interviewees agreed in defining the development of the NSR as a long-term goal, but in particular, it was IAPH that focused on this aspect.

IAPH observed that the NSR is a long-term challenge.
In addition, it was said that Arctic could be considered significant as a destination, in particular for local market and some specific sectors

[7] Alphaliner, 26 Feb 2020.

[8] An overwiew on this issue is provided in Chapter 2 "The Northern Sea Route: a new economic scenario" at the paragraph "Traffic trends of the NSR: Ships and Cargo", p. 16.

According to the International Association of Ports and Harbors the NSR could not be considered a big commercial opportunity at the moment.
They suggested that we should look at the Arctic from a different perspective.
Many global powers are indeed looking at the area from the point of view of resources, and so as a destination, but they are also considering it from the traffic angle, **mainly in terms of the energy and tourism business, which seem to spark great interest. Therefore, the potential of the region itself for either its economic resources or tourism or other factors is significant. The Arctic is important as a destination serving a local market, and also for the cruise sector, not merely as a passage but mainly as a destination.**

The Port of Antwerp added that the NSR may affect the ports in Northern Europe in the future, but at the moment there is not a real influence or an impact

Currently, the core business of the NSR does not include the European ports yet. As Antwerp Port has underlined, they have not received vessels coming along the Arctic Route. Despite Russian efforts, this route is still not very commercial, because there are still many obstacles. In particular, the opening season is too short for shipping lines to keep the business stable, which represents a big issue. Moreover, the season free from ice is usually only two months long, with some means, such as escort by ice-breaking vessels, that can make navigation periods longer but also quite expensive.
These are some of the reasons why it will not have great impact on the Mediterranean traffic. Because the Med Market is too wide, and it involves also the African and Middle East traffic. Thus, for the moment this route (NSR) could be a regional one to link for example the Baltic Area to Asia but this does not generate great expectations in terms of positive repercussions on the economy for the attractiveness exerted by the route on maritime cargo.

The Port of Antwerp added that the NSR will not be a substitute to the traditional routes for certain goods

As highlighted by the interviewee, the appeal of the route depends also on the kind of cargo analyzed. For example, for steel products, which come from northern China, the NSR seems more interesting. On the other hand, if the cargo comes from the southern part of China (for example from Shanghai) and goes to the Mediterranean, shipping lines still prefer the traditional routes.

In any case, there could be changes as a result of the melting of the ice caps. For instance, it might be possible to intensify trade with Russia, a country with which we already have strong energy trade links in Europe, especially via pipelines.

The University of Antwerp underlined the small size of the vessels that at present days can travel through the NSR and underlined also that especially containerships need to have stable regular services

Another key element to understand the lower competitiveness of the NSR that has been strongly underlined by experts, is that vessels travelling along the NSR are small (around 4,000 TEUs) while all the shipping industry is moving towards bigger ship-size, in order to boost economies of scale.

In addition, beyond dimensional problems there are organizational issues to be taken into account. Containerships need to follow an organized and stable shipping line with a regular service. Nowadays, climate aspects (the presence of ice still for a long part of the year) prevent periodical stable service (i.e. a weekly service) with negative economic impact for carriers. In any case, if potential economic benefits are possible in the future, these would be effective for Baltic Sea traffic rather than for the Mediterranean one.

Experts agree in saying that the navigation of the Arctic is at the moment less productive and profitable than other routes.

IAPH observed also that the zone around the NSR is nowadays deprived of good nautical services and advanced infrastructure

The expert interviewed revealed the sense of modest presence felt by the players not only in terms of infrastructure but also of services. Although it is still impossible to predict the size of commercial traffic that will come as a result of the possible practicability, this point could become strategic for carriers, with a view to link logistics, land and maritime transport efficiently.

The improvement of the whole network of existing services is therefore another important goal that the interviews revealed, and not just for local ships and their unitized traffic but also for the other categories in particular energy and dry bulk but also cruises.

An alternative route to Suez through rail or sea could allow China or Russia to further develop their traffic and for this reason these countries are both trying to boost investment.

It has come to SRM's knowledge that growth prospects pushed Russian institutions to design infrastructure to support traffic. Major Chinese and Russian investments were made. The impact of the greater viability of the route will not only concern container traffic but above all the area which can in fact take on a role as energy centre. As a matter of fact, large LNG production projects can be identified within the Arctic Ocean waters where there is also a service of off-taking of tankers that has been underway since 2017 and last January 2019 had exceeded 300 loads. There is also a long-term offtake agreement with Spain[9]. This aspect could be very important because it opens a new perspective of receiving gas for some European countries that do not have direct pipeline services with Russia. Indeed, in Russia there are some oil fields in Siberia and there are already existing shipping services but the majority of these are regional ones.

Thus, European states are also focusing their attention mainly on the traffic and energy resources of this area but there is one last aspect to be considered: environment pollution and connected risks. The Arctic region is in a delicate environmental balance, which should be of great interest to mankind.

MSC Antwerp underlined how they particularly care for environmental and sustainability policies, which is why they do not intend to use the Arctic Route

Even if the melting of ice caps opens up new avenues and opportunities, development in the region could also cause many problems to the environment. Any oil leaks from ships and accidents can cause irreparable damage once the routes of communication with the Arctic are opened. Furthermore, concerns about air pollution are becoming more pressing in this area.

As a matter of fact, some maritime companies want to adopt a specific policy in favor of protecting the Arctic and the climate. For this reason, CMA CGM and MSC have stated that they will avoid using the NSR connecting Asia to Europe through the Arctic in order to protect the fragile ecosystem from the threat of accidents, oil pollution, and collisions with marine wildlife.

[9] https://www.themeditelegraph.com/en/shipping/2018/06/23/news/yamal-lng-ships-first-lng-cargo-to-spain-1.38083487

As IAPC pointed out there are also geopolitical strategies to consider

Above all, there are strategic issues to consider and, as underlined by the interviewee, there are signs of a struggle there between big powers like the United States and Canada, Norway and Russia and China. This is also why they are all looking at that area, mainly from an economic perspective.

A summary of the highlights emerged from the interviews was noted in the following SWOT table:

Strengths	Weaknesses
• Reduced transit time • New energetic resources • Planning of major investments in infrastructure, and in services in support of cargo • New opportunity for business in new areas	• Presence of ice and passages possible only with icebreakers most of the year • Area of transit and not area of destination • Regional passage • Services for shipping to be implemented • Lack of manufacturing activity in the Area
Opportunities	**Threats**
• Container traffic growth • Development of activities related to transshipment which originates revenues and creation of new jobs • Development of new trade, especially in the energetic field • Using LNG for bunkering in the Arctic region • Development of cruise tourism	• Environmental issues • Lack of internal connections • Lack of reliable scheduled container services

The Antwerp Port (one of the oldest port authorities in Northern Europe) summed up the SWOT exercise remembering that wherever business opportunities can be found, shipping traffic tends to follow.

However, every aspect of the shipping business is in evolution and every step ahead affects other fields to some extent. This means that it is necessary to follow these developments attentively.

Antwerp and Norther Range Ports are almost in the middle between the Arctic and Suez. Finally, it might not happen in the near future, but this is a geographical position that could one day turn out to be particularly advantageous.

4 / The strategic positioning of global players in the Arctic Region

This chapter delineates a synthetic comparative analysis of the strategic positioning of Russia, China and the United States in the Arctic and towards the Northern Sea Route, with the aim of explaining each country's interests in the region. Once the asymmetric nature of the Arctic competition has been outlined, the last part will attempt to predict a general macroeconomic development strategy for the region.

1. The Arctic and the Northern Sea Route: geostrategic perspectives

The interest in the Arctic Circle has seen a significant increase in both the academic and business sphere since the release of the U.S. Geological Survey of 2008[1], whose mean estimate of total undiscovered conventional fossil resources in the region amounted to 90 billion barrels of oil, approximately 1,700 trillion cubic feet of natural gas and 44 billion barrels of natural gas liquids[2].

Furthermore, in recent years the economic appeal of the area surged due to the effects of global warming, since the continuous shrinking of the ice caps made navigation in the Arctic not only feasible, but apparently also cost-effective in the long term. In particular, the littoral States of the area started exploring all possible options to exploit shipping lanes linking the Atlantic and Pacific Oceans to complement the conventional trade routes during summer months.

[1] "Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle", United States Geological Survey, May 2008 [https://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf].

[2] At the time of its release, the research appraised those volumes to be roughly 13% of the world's undiscovered oil deposits and 30% of its natural gas reserves. For an overview of the US estimates see, among others, "Arctic region: the new geopolitical theatre of Russia", C. Rekha – Air Power Journal vol. 9-4 2014 [https://www.academia.edu/14295444/ARCTIC_REGION_-_THE_NEW_GEO-POLITICAL_THEATRE_OF_RUSSIA] and "Russian strategies in the Arctic: avoiding a new cold war", L. Heininen, A. Sergunin and G. Yarovoy, Valdai Discussion Club, September 2014 [https://valdaiclub.com/a/reports/russian_strategies_in_the_arctic_avoiding_a_new_cold_war/].

Distribution of the unidscovered Hydrocarbon resources among the Arctic coastal States (%)

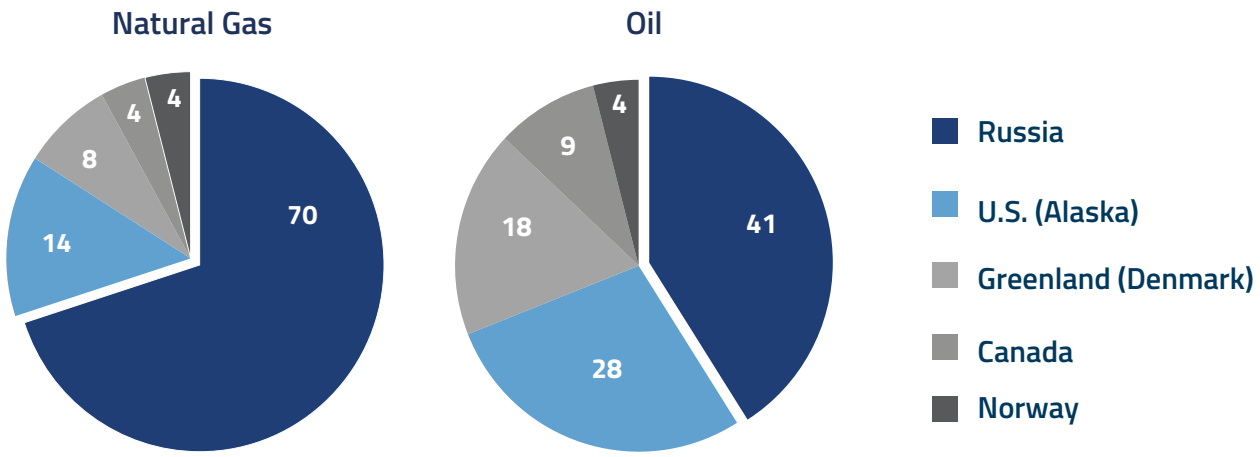


Figure 1 - Source: "The peculiarities of Russian Arctic development", Official site of the Faculty of Distance Learning of Plekhanov Russian University of Economics [http://sdo.rea.ru/cde/conference/3/file.php?fileld=54]

In this respect, three main passages were outlined: the Trans-Polar route cutting straight across the North Pole, the Northwest Passage traversing the Canadian northern archipelago and the NSR, a set of shipping lanes along Russia's northern shores[3]. Among these prospected traffic lanes, the NSR seemed the most promising one due to the slightly less harsh climate conditions affecting its waters, the presence of relatively populated urban sites and facilities along the route and the proximity to fossil fuel resources.

In this context, three major global Powers manifested their interest in playing a role in the governance and economic development of the Arctic and the NSR.

To establish its hegemony in the area, the Russian Federation strongly relies on its logistical advantage and, since it is the largest of the five littoral States of the Arctic Ocean, it has developed a relatively more advanced transport network compared to its direct competitors (namely the United States and Canada) and the vast majority of discovered and untapped energy commodities are located within its territory, territorial waters and exclusive economic zone[4].

[3] An overview on Arctic Maritime passages is proviede in Chapter 2 "The Northern Sea Route: a new economic scenario" at the paragraph "Different routes and new perspectives of the routes along the Arctic", p. 9.

[4] A syntetic overview of the legal framework of Arcticwaters is provided in Chapter 5 "The Law of the Frontier: the legislative framework of the High North", p. 61.

Although far from the North Pole and its waters, the People's Republic of China envisioned a complex diplomatic and economic strategy to gain access to the natural resources sited in Siberia and in the Russian Far East, to increase its international influence through the participation in regional forums like the Arctic Council and to integrate the infrastructure development plans needed in the region within is Belt and Road Initiative (BRI).

Finally, the United States' stance, rather than a direct economic involvement, seems more oriented towards a mild containment of both Russian and Chinese ambitions. In fact, US initiatives focus on endorsing freedom of navigation along the NSR, on the upholding of sanctions against the Russian Federation (that severely hamper its offshore drilling capabilities) and on a constant check of Chinese naval power.

1.1 A field for cooperation or competition?

In order to assess whether competition or cooperation is going to prevail between countries along the NSR and in the Arctic region, a sensible approach might entail understanding what these currently signify for global players.

The consensus[5] converges on the fact that the NSR is – and will probably be in the near future – mainly an energy corridor rather than an economically profitable shipping route for container traffic. This assumption stems from the difficult navigation conditions along Arctic waters which, even in the event of shrinking ice caps due to higher global temperatures, will still be restricted by several factors such as the need for (at least seasonal) ice-breaker assistance and ice pilotage, limited logistic infrastructure, severe and rapidly changing weather conditions and geological restrictions (partly shallow waterway stretches, bottlenecks). All these complications are essentially incompatible with the tight schedule requirements of container shipping which, on the contrary, is based on timing, multiple offloading / onloading points and increasingly larger tonnage capacity of vessels.

Under the perspective that the NSR will initially develop as an energy-extraction project and only later (possibly) evolve into a more product-oriented shipping lane, areas of both competition and cooperation can be identified.

Regarding potential contentions, some areas are highlighted in the following table[6].

[5] Supra note 2 and, among many others, "Geopolitics and the Northern Sea Route", International Affairs, M. Blunden 2012.

[6] For a thorough overview of NSR and Arctic power play, see "The Belt and Road Initiative: A Russian

Areas of potential dispute among States in the Arctic

Field of competition	Relevance	Competitors	Possible system of settlement
Seizing entry points along NSR (port facilities)	Control over energy corridor	Russia / China	World Trade Organization / World Bank
Developing an icebreaker fleet		Russia / China / United States	Joint development agreements
Regime of Arctic Navigation	Trade, security and environmental superiority	Russia / Arctic States / China	Arctic Council / United Nations Law of the Sea Tribunal
LNG supply stability	Support of increasing energy demand	China / United States	Long-term supply contracts / De-escalation of trade war
Funding of Arctic inland infrastructure	Improved logistics	Russia / China	Bilateral development agreements
Development of offshore extraction	Replacement of depleted onshore oil & gas fields	Russia / United States / China	Arctic Council

Table 1 - Source: elaboration of the author based on the documents in note 21

It must be noted, however, that the current market dynamics (oil and gas oversupply) and industrial techniques (fracking) are significantly defusing the risks associated with an Arctic resource race, since drilling operations at such latitudes are still extremely costly. This might encourage a more gradual, cooperative and possibly multilateral approach towards the region, as well as pioneering projects that take into account both economic and environmental concerns.

Undeniably, the Arctic has so far remained an area of peaceful cooperation[7] among States: it has its own governance structures on whose legitimacy a broad consensus has been consolidated throughout the years, plus international diplomacy has satisfactorily settled disputes on maritime borders and hydrocarbon exploitation[8].

Perspective", China's Belt and Road Initiative: Potential Transformation of Central Asia and the South Caucasus, Vinokurov Evgeny 2019, "China as a Polar Great Power", Brady – Cambridge University Press 2017 DOI: 10.1017/9781316832004 and "Northern sea route: an overview of transportation risks, safety, and security", Hill, Lanore and Véroneau, Journal of Transportation Security July 2015.

[7] "The promise of the geoeconomic Arctic: a critical analysis", J. Käpylä , H. Mikkola - Euro Asia Journal, 17-11-2015 [https://link.springer.com/article/10.1007/s10308-015-0447-5].

[8] As in the case of the 2010 Russian-Norvegian agreement on the Barents Sea.

Considering this state of relative stability, despite the expected increased competition for natural resources and shipping lanes, it is safe to presume that at least three main areas of cooperation among States are going to continue in the near future:

a. Scientific research. As it has been pointed out[9], having a high-profile polar science program is an important means for every State to increase their influence in the Arctic and to create cross-field synergies. Several joint research programs have been conducted over the years, covering subjects spanning from water/ice observation to satellite data gathering and shared access to infrastructures (bases and stations)[10].

b. Environmental protection. This is possibly the most solid and established area of collaboration, as all Arctic States have not only engaged in the protection of their respective territorial waters, contiguous and economic exclusive zones, but also committed to a regime of common projects on climate, biodiversity and ecological preservation through regional forums[11].

c. Port technology and logistics. The Russia-China partnership is plausibly going to determine the evolution of the supply chain for all Eurasian countries since, despite significant economic and technical obstacles, the improved connectivity of the region remains a long-term goal that would benefit the two powers. In particular, the northern maritime lanes are officially integrated in the BRI and are already showing examples of industrial synergies as illustrated in the following table[12].

[9] Brady, supra note 21.

[10] For a comprehensive outline of scientific initiatives in the Arctic, "Report of the 2nd Arctic Science Ministerial" 25/26-10-2018 [https://www.arcticscienceministerial.org/files/BMBF_ASM2_Broschuere_V1_A4_barrRZ.pdf].

[11] Thematic work of the Arctic Council [https://arctic-council.org/index.php/en/our-work/environmental-protection].

[12] "China's Huawei signs deal to develop 5G network in Russia", The Guardian 06-06-2019 [https://www.theguardian.com/technology/2019/jun/06/chinas-huawei-signs-deal-to-develop-5g-network-in-russia], "Russia wants to involve Chinese companies in construction of power plants in Far East", TASS 07-11-2019 [https://tass.com/economy/1029765], "Chinese bank invests in Russia's Northern Sea Route", The Barents Observer, 12-06-2018 [https://www.rcinet.ca/eye-on-the-arctic/2018/06/12/china-russia-arctic-shipping-infrastructure-northern-sea-route/].

Areas of potential Sino-Russian cooperation in the Arctic

Field	Activities	Ongoing / completed projects	Potential effects
Port enhancement	Dredging / enlargement of quays	Arkhangelsk and Sabetta port facilities	Increased LNG storage and offtake / Improved intermodal connectivity
Telecoms	Implementation of high-speed communications	Huawei's development of the 5G network in Russia	Improvement of weather forecast and search and rescue services
Bilateral agreements for Chinese investment in Arctic infrastructure	Streamlined co-funding of land and maritime projects	70 initiatives on NSR, Belkomur railway, Murmansk transport hub and Northern Latitudinal Passage	Simultaneous stimulus to northbound and southbound commercial traffic / link with Eurasian economies
Ancillary industries	Construction of commercial / residential buildings, power plants and infrastructure	Several projects on medium-size port cities and industrial zones in the districts of Siberia and the Far East	Inversion of negative demographic trends of remote areas

Table 3 - Source: elaboration of the author based on the documents in note 28

2. Global Powers in the Arctic: a competitive analysis

Although Russian, Chinese and American interests in overseeing the Arctic and the NSR differ significantly on both the economic and geostrategic level, it is nevertheless possible to sketch at least a general framework of what the major stakes are for each of them. In the context of an increasingly interdependent / globalized economy, several exogenous factors are inevitably going to affect the polar regions to various extents: for the sake of simplicity, these influences will be categorized into three main categories, according to their industrial, geographic or political nature.

2.1 The Russian Federation: a (relative) logistical advantage

Russia's northern coastline accounts for approximately 53% of total Arctic shores and the country's population in the region totals around 2 million people (approximately half of the inhabitants dwelling in those latitudes worldwide), while Siberian and Far East districts contribute about 10% to the country's total GDP and cover almost 20% of all Russian

exports[13]. It is therefore not surprising that the Arctic zone has been defined by many official Russian State policies as a "strategic resource base", mainly because of the massive estimated untapped natural resources located underground and under the seabed[14].

At the time of this writing, the most recent plan outlining Russian intentions for the NSR and the Arctic was signed by Prime Minister Dmitry Medvedev on 21-12-2019 and was approved shortly before the end of the year[15]. The strategy covers a wide range of priorities – from the development of infrastructure and the building of new ships to the mapping of natural resources and the launch of new satellites and meteorological equipment – with the main goal of making the Arctic viable for commercial shipping and fossil fuel extraction. As many analysts expected[16], Rosatom (Russia's state nuclear corporation) was tasked with most of the 84 development strategies outlined in the new document. Overall, the government plans to:

a. build at least 40 new Arctic vessels, including nuclear icebreakers;
b. upgrade four polar region airports;
c. construct far northern railways and seaports, and
d. initiate a massive exploitation of natural resources from the Arctic's thawing shores – particularly natural gas, oil and coal.

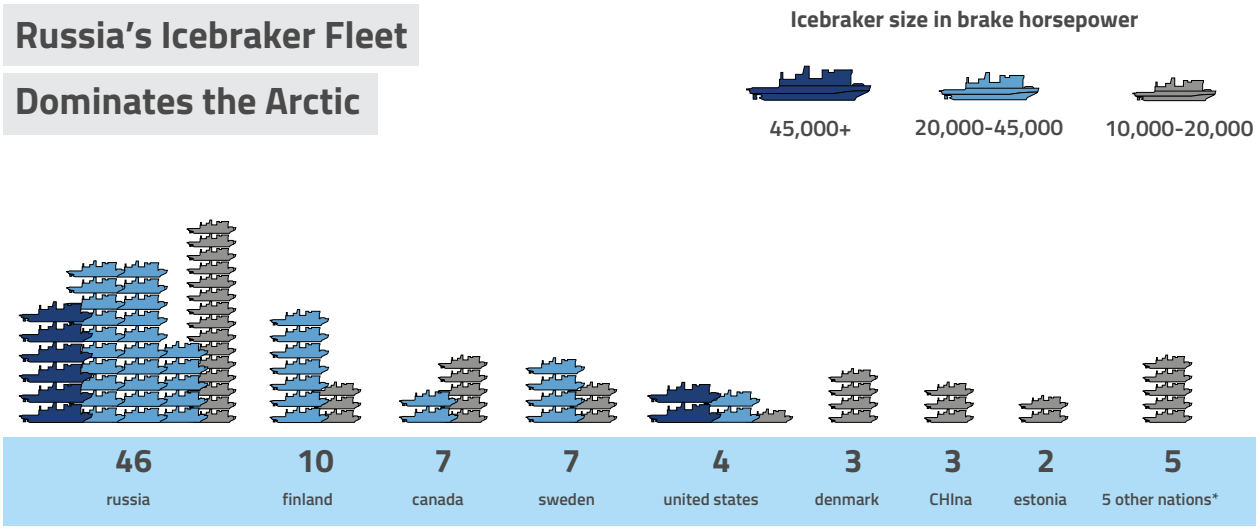
[13] "Russia is dominating the Arctic, but it's not looking to fight over it", Holly Ellyat, CNBC 27-12-2019 [https://www.cnbc.com/2019/12/27/russias-dominance-in-the-arctic.html] and "Russian Arctic Annual GDP to Reach US$ 500 Billion", Russia Briefing, 29-03-2019 [https://www.russia-briefing.com/news/russian-arctic-annual-gdp-reach-us-500-billion.html/]

[14] A review of the main official documents presenting the Russian strategies for the development of the Arctic from 2008 on can be found in "Russia's Arctic Papers: the evolution of strategic thinking on the High North", N. Mehdiyeva NATO Defense College, 19-11-2018 [http://www.ndc.nato.int/research/research.php?icode=567].

[15] "Infrastructure plan for the Northern Sea Route until 2035", Russian Government website, 30-12-2019 [http://government.ru/docs/38714/]

[16] "Russia releases massive official plans for the Northern Sea Route", C. Diggens, Bellona 09-01-2020 [https://bellona.org/news/arctic/2020-01-russia-releases-massive-official-plans-for-the-northern-sea-route] and "Moscow adopts 15-year grand plan for Northern Sea Route", The Barents Observer, 31-12-2019 [https://thebarentsobserver.com/en/arctic/2019/12/moscow-adopts-15-year-grand-plan-northern-sea-route].

Icebreakers' fleets of the northern hemisphere



* Norway, Germany, Latvia, Japan and South Korea. The list includes both government-owned icebreakers, only excluding those belonging to southern hemisphere countries (Chile, Australia, South Africa and Argentina).

Figure 2 - Source: SRM on "Coast Guard polar icebreaker program: background and issues for Congress", R. O'Rourke, Congressional Research Service Report, 05-02-2020 [https://fas.org/sgp/crs/weapons/RL34391.pdf]

Although telling whether these shipping plans will bear fruit in the long term is still matter of conjecture, the Russian government has nevertheless underscored major upticks in traffic along the NSR: in November 2019, Rosatom released figures showing that cargo volumes had already beaten 2018 results by more than 60 percent. When final volumes are tallied, they could crest 30 million tons in 2019 (up from 20 million in 2018), the bulk of it fossil fuels[17].

The substantial investment in the expansion of the (already large) icebreaker fleet is possibly the strongest asset Russia hopes to take advantage of in order to consolidate exclusive control over the NSR in the short term, since currently even ice-class ships can hardly traverse the route without proper assistance, including during the warmer season. It must be highlighted that at present no other country's icebreaker fleet can remotely compare to the Russian one in terms of total size, horsepower and overall technological edge[18]:

[17] A more detailed analysis of the maritime traffic along the NSR is provided in Chapter 2 "The Northern Sea Route: a new economic scenario" p. 7.

[18] "Russia's Icebreaker Fleet Dominates the Arctic", D. Hunkar Top Foreign Stoks, 17-10-2018 [https://topfo-

moreover, this competitive advantage is probably going to last for decades to come, since the construction of new vessels of this kind is extremely costly and lengthy (approximately starting from $700 million a ship, for a building time of no less than 4 years[19]).

Another relevant issue concerning the modernization and widening of Russian port cities along the NSR is the needed electrification of residential buildings and facilities in remote areas. In fact, although those northern urban sites are often reached by the pipelines conveying oil and gas to the storage and offtaking areas of the ports, energy power plants would still be required to convert fossil fuels into electricity. In this case, the Russian strategy is twofold:

a. the abovementioned involvement of Chinese companies in a vast program of joint construction of power plants in the Far East;
b. the implementation of floating nuclear power plants capable of navigating the NSR, anchoring in the proximity waters of port cities and eventually power them.

Yet, despite several advantages, the Russian government's ambitious Arctic development plan is going to face considerable obstacles, some of which not necessarily due (only) to budget limitations.

Firstly, given the heavy operational sea/land conditions along the NSR, the current status of logistics in the area is still considered inadequate to support the economic viability of year-round maritime traffic[20]. With few exceptions, most of the cities, industrial complexes, extraction fields and even navigable rivers north of the economically developed belt along the Trans-Siberian railway are generally poorly connected.

reignstocks.com/2018/10/17/russias-icebreaker-fleet-dominates-the-arctic/] and "Russia Unveils New Nuclear Powered Ice Breaker to Force Open Warming Arctic", J. Loeffler, Interesting Engineering, 30-05-2019 [https://interestingengineering.com/russia-unveils-new-nuclear-powered-ice-breaker-to-force-open-warming-arctic].

[19] "Report to Congress on Coast Guard Icebreaker Program", USNI News, 03-05-2018 [https://news.usni.org/2018/05/03/report-congress-coast-guard-icebreaker-program-2].

[20] On the need for a well-organized and developed logistics, see "Economic and geopolitical aspects of developing the Northern Sea Route", N. Didenko and V. Cherenkov, IOP Conference Series: Earth and Environmental Science, 2018 [https://www.researchgate.net/publication/326959218_Economic_and_geopolitical_aspects_of_developing_the_Northern_Sea_Route].

The network of roads and railroads linking the inland centers to the northern ports require broad maintenance and upgrade: in particular, ore mining cannot rely on pipelines and necessitates nodes where a continuous traffic of commodities might be upheld.

Secondly, it has been rightly pointed out[21] that any large-scale logistic development plan of the NSR must be highly synergic and avoid redundant infrastructure. So far sporadic projects (in most cases connected to the oil and gas industry) proved to be insufficiently integrated into the regional transport network: on the contrary, to facilitate the modernization and future development of the NSR and the Russian Arctic in the short and mid run, initiatives should not be managed singularly, but as a united hub.

As a matter of fact, there are currently two main intra-Russian traffics in the mainstream of the NSR: an outbound one (mineral, hydrocarbons and timber) for exports and domestic use and an inbound one (goods for life support, equipment, construction materials and other capital goods)[22]. The former direction of shipments vastly outweights the latter, thus reducing the NSR to a strongly asymmetric and regional maritime route but, at the same time, also creating the potential preconditions for its evolution into an international and bidirectional lane in the long run.

The Russian Government's plan apparently relies on the notion that the first steps to take will involve the establishment of selected, profitable energy corridors (most of which towards China and Asian economies) to get financial inflows, followed by the heavy investment of such resources (and a substantial State budget) in both land connectivity and transshipment capabilities of port facilities along the NSR. With time, the combined effect of these measures should theoretically strengthen the backbone of the NSR to the point where other types of traffic (bulk and, to a limited extent, container) can be tested.

[21] "Infrastructural synergy of the Northern Sea Route in the international context", A. Kovalenko, V. Gribkovskaia and M. Morgunova, Researchgate August 2018 [https://www.researchgate.net/publication/330643092 _INFRASTRUCTURAL_SYNERGY_OF_THE_NORTHERN_SEA_ROUTE_IN_THE_INTERNATIONAL_CONTEXT].

[22] Supra note 20.

Overview map of terminals and transportation routes along the NSR

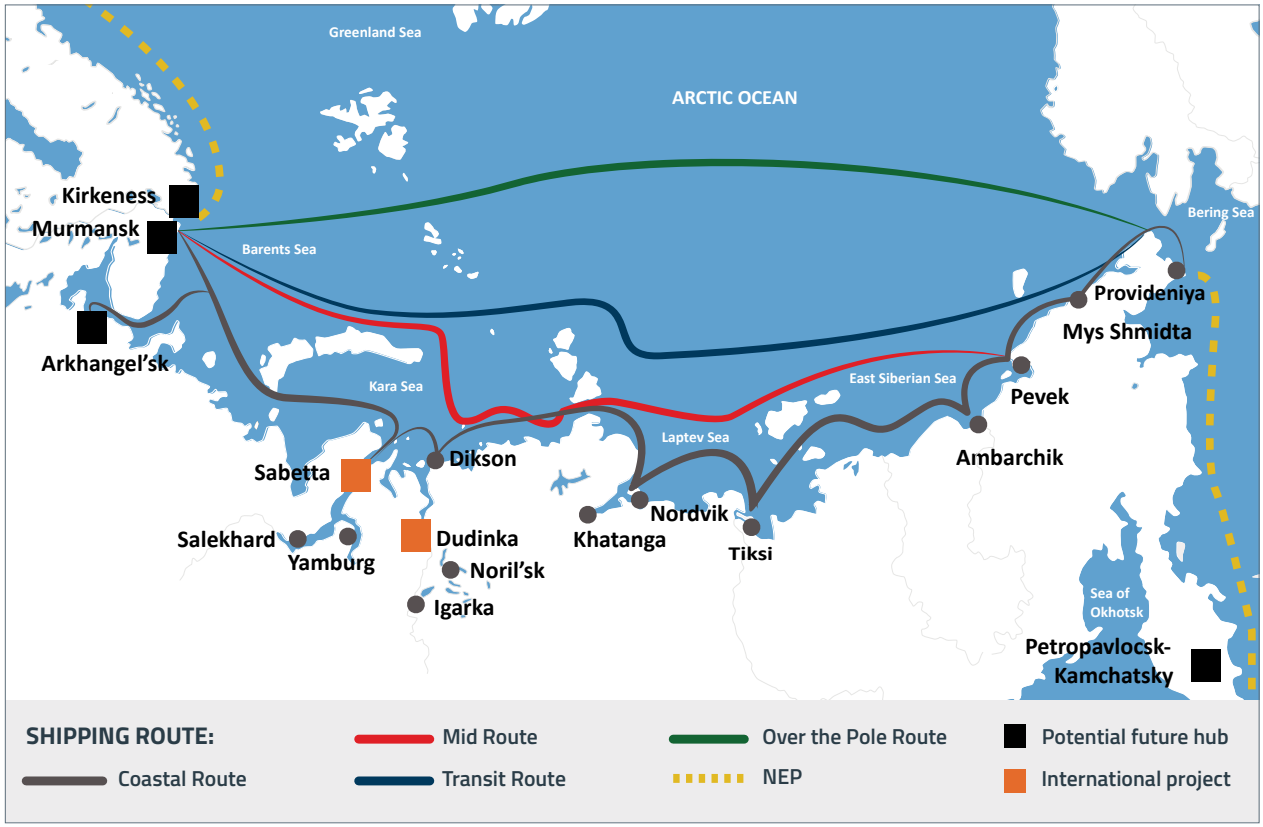


Figure 3 - Source: SRM on "Infrastructural synergy of the Northern Sea Route in the international context", A. Kovalenko, V. Gribkovskaia and M. Morgunova, Researchgate August 2018

It is noteworthy that, before the release of the recent Arctic development plan, in 2014 the Russian Government had already conceived a comprehensive program for the whole northern region ("Social and economic development plan for the Arctic Region of the Russian Federation"), that was later amended to update its goals up to 2025 and is therefore still in force. In addition to conveying more resources to technological advancements in drilling operations, its most interesting feature is the definition of 8 strategic support zones that are going to host complex regional enhancement programs[23].

[23] For a detailed explanation of the relevant projects in the support zones, "The development of the Arctic zone of Russia and the main challenges for its growth" D. Orlov Regnum 25-04-2018 [https://regnum.ru/news/economy/2407690.html]. These 8 support zones are not to be mistaken with the 7 toll areas into which the Northern Sea Route Administration has divided the Northern Sea Route. Whereas the support zones identify specific areas that benefit from governmental funds and development plans, NSRA's toll areas are employed to define the price for icebreaking and ancillary services to be charged to vessels transiting the route.

Arctic support zones

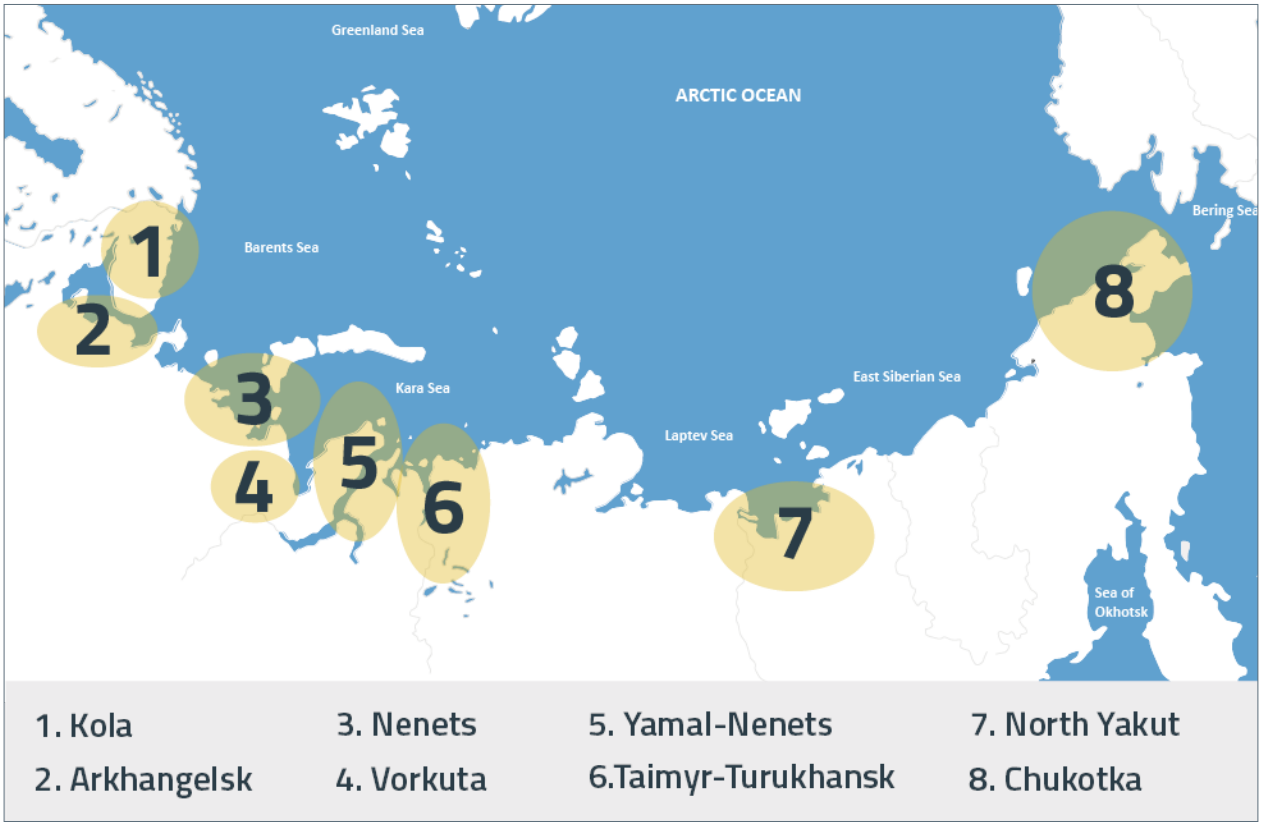


Figure 4 - Source: SRM on Russian Ministry of Economic Development

The set of instruments devised for logistic and urban improvement encompasses a wide range of regional incentives (establishment of territories of priority, free ports / economic areas and special economic zones) and mechanisms for implementing investment projects (legal frameworks for public / private partnerships and international cooperation), mainly in the logistic sector[24].

[24] The 2014 and 2019 strategic plans are also strongly integrated and often focus on the implementation of railway lines and ports / airports facilities. For an overview of the main projects, see Russia Briefing: "New Rail Infrastructure Plans As Russia Signs Off New Northern Sea Passage Developments", 13-01-2020 [https://www.russia-briefing.com/news/new-rail-infrastructure-plans-russia-signs-off-new-northern-sea-passage-developments.html/] and "Russia Upgrades Arctic Airports & Ports As Part Of Northern Sea Passage Infrastructure", 30-12-2019 [https://www.russia-briefing.com/news/russia-upgrades-arctic-airports-ports-part-northern-sea-passage-infrastructure.html/].

2.2 China: a holistic integration of the Arctic

China's current Arctic policy was affirmed in the official "White Paper" released by the State Council Information Office in January 2018[25].

On that occasion, Chinese authorities emphasized their commitment to the creation, in cooperation with other States and within the framework of the broader Belt and Road Initiative (BRI), of the Polar Silk Road (PSR). These guidelines aim to take advantage of the gradual thawing of Arctic frozen waters in order to establish new trading routes (both inland and maritime) and to gain access to the energy resources of the region, in compliance with the provisions of international laws, conventions and treaties to which China is a signatory party. In addition, the document mentions Beijng's observer status in the Arctic Council (obtained in 2013) and defines China as a "near Arctic State". It has been noted that the introduction of this new category in the diplomatic discourse is meant to maintain that, depite not having any coastline or reasonable proximity to the Arctic, China nevertheless holds at least three significant areas of interest in the region:

a. the right to conduct scientific research, resource exploration and exploitation;
b. the legitimacy of implementing maritime trade and security measures;
c. a concern over climate change and its potential consequences on both the North Pole itself and (by extension) the Chinese sovereign territory.

To achieve those goals on an economic and diplomatic level, in recent years the Republic of China has gradually aligned its agenda to Moscow, especially since western sanctions prompted the Russian Federation to rely more on Asian markets in the energy arena[26]. This strategy generated a complex arrangement of cooperation and undercurrent competition between the two Powers in which China:

1. increased its share of orders for goods carried across Arctic waters by ships of the Russian Federation to gain economic influence in Moscow[27];

[25] "China's Arctic Policy", 26-0-2018 [http://english.gov.cn/archive/white_paper/2018/01/26/content_281476026660336.htm].

[26] "Russian perceptions of China in the Arctic", A. Calvo, Asia Dialogue 23-03-2015 [https://theasiadialogue.com/2015/03/23/russian-perceptions-of-china-in-the-arctic-mistrust-feeds-persistent-wish-for-diversification/].

[27] "Why does China need the Arctic?", A. Zapolskis, Iarex 18-06-2018 [http://www.iarex.ru/articles/58795.html].

2. launched a program to build both ice breakers and ice-capable ships so that it will be able to carry more of the goods and raw materials it wants with its own vessels[28];
3. supported national companies in establishing drilling platforms in areas of the Arctic Ocean that Moscow claims as part of its Exclusive Economic Zone (EEZ);
4. invested almost exclusively in selected logistic energy corridors in Siberia and the Far East, while delivering only minor shipment volumes of capital goods and equipment to Russian port facilities.

It is therefore safe to assume that the Chinese Government, while reinforcing the "natural" strategic relation with Russia that stems also from the complementarity of their economies[29], is simultaneously trying to increase its autonomy and freedom of initiative so as to eventually become a fully independent player of the region in the mid term. In order to do so, however, a mutually profitable alliance with Russia remains unavoidable for the time being, due to several reasons. Firstly, because of China's increasing demand for fossil fuels and especially natural gas / LNG, commodities that might prove difficult to obtain from other suppliers in the near future due to political, geographic and economic tensions[30]. Secondly, because a priviledged transit regime along a (mostly) Russian controlled NSR can supplement the more established but heavily operated Southern Sea Route, allowing China's commercial and military fleets to avoid chokepoints like Malacca[31] and Bab El Mandeb Straits.

[28] "Is China's interest for the Arctic driven by Arctic shipping potential?", L. Huang, F. Lasserre and O. Alexeeva, Asian Geographer, 26-06-2014 [https://www.tandfonline.com/doi/abs/10.1080/10225706.2014.928785].

[29] "Russia Update – Commerce and IDE", Intesa Sanpaolo International Research Network, 13-02-2020. From January to November 2019, China confirmed itself as the first trade market for Russia globally for both export (12,9% of total Russian exported goods) and import (22,2%).

[30] "Escalating U.S.-China Trade War Makes LNG Projects Vulnerable Stateside", G. Sharma Forbes, 23-05-2019 [https://www.forbes.com/sites/gauravsharma/2019/05/23/escalating-us-china-trade-war-leaves-lng-projects-vulnerable-stateside/#d47c6702d52d], "World Gas LNG Report 2109", International Gas Union [https://www.igu.org/sites/default/files/node-news_item-field_file/IGU%20Annual%20Report%202019_23%20loresfinal.pdf] and "Chinese demand set to drive oil and gas growth for years to come", Offshore Technology 22-11-2018 [https://www.offshore-technology.com/comment/chinese-demand-set-to-drive-oil-and-gas-growth-for-years-to-come/].

[31] "Effect of The Northern Sea Route opening to the Shipping Activities on the Malacca Strait", Rahman et alt, International Journal of e-Navigation and Maritime Economy 2014 [https://www.sciencedirect.com/science/article/pii/S2405535214000096].

Main shipping lanes along the South China Sea (green) and the Spratly Islands (red)

Figure 5 - Source: Caspian Report, "Geopolitics of the South China Sea", 25-12-2019 [https://www.youtube.com/watch?v=GcFiJwpvmq0]

Finally, because by keeping good diplomatic relations with the Russian Federation, China can plausibly expect to amplify its status in regional fora like the Arctic Council (for instance, by obtaining a full member position) and promote a more multilateral governance of the whole region and related shipping lanes. In view of this, Beijing's commitment to scientific research on climate change in the Polar caps could be instrumental to gain influence and leverage among Arctic coastal States[32].

2.3 The United States: watching the game from a distance

The U.S. Government has articulated its fundamental interest in the Arctic for more than 40 years in a series of official strategies and guidelines[33], the most recent of which are the Reports to Congress from the Department of Defense of 2016 and 2019[34].

[32] "La Chine en Arctique: stratégie raisonnée ou approche pragmatique?", O. Alexeeva, F. Lasserre, Études Internationales vol. 44-1, 2013 [https://id.erudit.org/iderudit/1015121ar] and "The Snow Dragon: China's strategies in the Arctic", O. Alexeeva, F. Lasserre - China perspectives 2012 [https://doi.org/10.4000/chinaperspectives.5958].

[33] For a comprehensive overview of US policies toward the Arctic, "The implications of US policy stagnation toward the Arctic Region", H. Conley and M. Melino, Center for Strategic International Studies, May 2019.

[34] US Department of Defense "Report to Congress on Strategy to Protect United States National Security Interests in the Arctic Region", 2016 [https://csis-prod.s3.amazonaws.com/s3fs-public/event/170124_Ar-

In particular, the latest report appears to take a very firm position on the recognition of the "Arctic status" of other States, acknowledging it only to those having sovereign territory in the region – and thus excluding China's claims of being a "near-Arctic" country[35]. The document also recognizes that the Arctic's physical environment is changing through diminished sea ice coverage, declining snow cover, and melting ice sheets and that temperatures across the region are increasing more than twice as fast as global average temperatures, accompanied by thawing permafrost and loss of sea ice and glacier mass[36].

Yet, despite these significant turns in US policies, many analysts believe that America is falling behind in the race for Arctic governance and presidium, in particular with reference to the increased economic and political cooperation between Russia and China[37]. As a matter of fact, it seems that the two most important drivers of Arctic development (energy resources and shipping routes) are perceived as marginal in the current state of international affairs. Three main factors can provide the basis for such perception:

a. the technological improvements in shale oil and gas extraction and fracturing helped the United States become a net energy exporter in a relatively short span of time, simultaneously lowering operating costs well below those associated with Arctic drilling;
b. the imposition of economic and tech-related sanctions on the Russian Federation since 2014 is already limiting Moscow's drilling and processing capabilities in cold temperatures and especially in the offshore segment.

ctic_Strategy_report.pdf] and "Report to Congress –Arctic Strategy", June 2019 [https://media.defense.gov/2019/Jun/06/2002141657/-1/-1/1/2019-DOD-ARCTIC-STRATEGY.PDF].

[35] A position further reinforced by US Secretary of State Mike Pompeo at the Arctic Council Meeting in Rovaniemi in May 2019, when he openly challenged China's and Russian's Arctic intentions - see "Will China Freeze America Out of the Arctic?", Mark Rosen, The National Interest 14-08-2019 [https://nationalinterest.org/print/feature/will-china-freeze-america-out-arctic-73511].

[36] Contrary to the current Administration's official position of general dismissal, this statement possibly indicates a broader recognition that climate change is a reality. In this regard, an interesting passage reads: "[…] Diminishing Arctic sea ice is opening new shipping lanes and increasing access to natural resources during the summer months. If the warming trends continue at the current rate, Arctic wide sea ice loss may result in nearly ice-free late summers by the 2040s."

[37] "Is America losing out on the Northern Sea Route?", James Gordon 10-09-2019 [https://www.raconteur.net/finance/northern-sea-route] and "10 Big Ideas to 'Up America's Game in the Arctic'", W. Berbrick and R Pincus, The National Interest 22-09-2018 [https://nationalinterest.org/print/feature/10-big-ideas-%E2%80%98 america%E2%80%99s-game-arctic%E2%80%99-31622].

c. the impacts of climate change are generally deemed irrelevant by the present Administration, even though the governmental budget allocated to Arctic science and research has remained largely intact due to bipartisan congressional support[38].

In addition, it must be noted that at present the United States lack adequate infrastructure for Arctic shipping and logistics in terms of a permanent Coast Guard presence and enhanced search and rescue capacity, port improvements, modern water and sewer systems, telecommunications, access to new energy resources, oil and chemical spill prevention and response, and coastal erosion and storm surge protection[39].

From a merely economic standpoint, in US perspective the Arctic is considered as an "emerging market" simply not worth the effort, since it is both difficult / costly to access and where it is hard to measure up to China's competitive advantage. There are two major challenges which seem to prevent the United States from projecting its commercial power in the region:

a. lack of competitive effectiveness so long as Chinese SOEs receive State financing.
   For instance, American firms must collateralize the loans that they obtain from either U.S. trade finance lenders or from international development banks, while Chinese SOEs do not need to comply with this requirement.
b. a vastly smaller industrial sector which has no recent experience of competing in emerging markets.
   The second reason why US participation in Arctic infrastructure projects is likely to be lackluster is that the Chinese have much greater international construction capacity[40].

In conclusion, due to both better investment alternatives and the general perception that the Arctic is currently not a level playing field, the United States is relying more on monitoring the region from a distance while containing Russian and Chinese initiatives via sanctions or tariffs and other trade barriers.

[38] "Changes in the Arctic: background and issues for Congress", Congressional Research Service, 20-12-2019 [https://crsreports.congress.gov].

[39] "Demonstrate leadership in the Arctic", Joint Ocean Commission Initiative, 2019 [https://oceanactionagenda.org/actions/arctic/].

[40] Deloitte's 2017 Global Powers of Construction (GPoC) found that, among global construction companies, Chinese firms "dominate the Top 100 rankings in terms of revenue, with the largest three Chinese groups representing around 30% of the GPoC's total sales." According to the same report, the United States continues to have a good presence in international construction, but Chinese firms are generally much larger and, in total, had sales of €440 bn. US firms had sales of only 20% of that amount during the same period.

3. Longbow: imagining the stages of maritime traffic development in the High North

The development of the Russian Arctic and the NSR is a multifaceted combination of co-operation and competition among global Powers, made even more complex by (only partially foreseeable) State budget, market and climate trends. However, since the maritime route is presumably going to become ice free during summer in 20 to 30 years, even according to the more prudent estimations[41], it cannot be excluded that an adequate land/sea infrastructure can be built within that time framework – provided there's some economic profitability in doing so.

Even without taking into consideration several economic, political and climatic factors – which would inevitably remain speculative for any long-term evaluation – a three-stage industry-led trend can nevertheless be imagined[42]:

a. Phase One – the support line

   A convenient starting point for sino-russian cooperation might focus investments on major Russian cities along the TranSiberian Railroad, since those areas are already more developed and populated than northern ones and most of their centers are also the sites of existing oil & gas / mining plants. From this "support line" two opposite logistic corridors might be financed with mutual benefits: one going south towards China's

[41] "Arctic Climate Change Update 2019", Arctic Council, May 2019 [https://oaarchive.arctic-council.org/bitstream/handle/11374/2353/ccupdate18.pdf?sequence=1&isAllowed=y].

[42] Elaboration of the author based on currently ongoing industrial projects, corroborated by: "4 ways climate change is opening the Arctic up for business", World Economic Forum 27-09-2019 [https://www.weforum.org/agenda/2019/09/4-ways-climate-change-is-opening-the-arctic-up-to-business/], "Gas extraction projects in the Arctic to receive tax preferences", Alexander Kruticov, The Arctic 05-12-2019 [https://arctic.ru/economics/20191205/892641.html], "Draft law on privileges for Arctic companies to be submitted to the State Duma", The Arctic, 18-12-2019 [https://arctic.ru/economics/20191218/893931.html], "The Arctic Route for Russian LNG opens", M. Siddi, About Energy. 09-05-2018 [https://www.aboutenergy.com/en_IT/topics/arctic-route-for-russian-lng-opens.shtml#], "Shipping along the Arctic's Northern Sea Route will be determined by Russia–China cooperation in the region", E. Klimenko, Stockholm International Peace Research Institute, 07-02-2018 [https://www.sipri.org/commentary/expert-comment/2018/shipping-along-arctics-northern-sea-route-will-be-determined-russia-china-cooperation-region], "Northern Sea Route: From Speculations to Reality by 2035", Alexandra Middleton, High North News 07-01-2020 [https://www.highnorthnews.com/en/northern-sea-route-speculations-reality-2035] and "Russia's Untapped Arctic Potential", S. Pritchin, Chatham House, 28-01-2018 [https://www.chathamhouse.org/expert/comment/russia-s-untapped-arctic-potential].

industrial cities (gas/oil pipelines and railroads that are currently being constructed at the present time) and the other going north towards the most important Russian port cities that are still to be developed (railroads, highways and energy/minerals lanes connecting the inland with the coastal districts). That way, as Russia benefits from Chinese investments for its own territorial infrastructure, through public/private ventures, advantageous tax regimes and long-term supply contracts China gains access to oil, gas and minerals extracted from Siberian plants.

b. Phase Two – climate change impacts

   As temperatures rise, drilling operations become cheaper, volumes of commodities' flow increase and generate revenues to upgrade Russian northern ports. Simultaneously, the melting of Arctic ice makes navigation easier and more receptive for international governance, so Chinese tankers can collect oil & gas from those same ports, further quenching the energy needs of their economy. As the energy sea corridor consolidates, further Chinese (and hopefully international) investment helps the drenching of ports and enlargement of their docking areas, making them suitable to host an embryo of container traffic. With time, the NSR shifts from regional (serving only Russian port cities) to international (allowing the transit of Chinese vessels to Europe, with stopovers along Russian ports). It is worth noticing that in southern Siberia many Russian companies are already implementing significant changes to their hard assets in order to adapt them to warmer temperatures, so a steep learning curve can be expected in such field at industry level in the coming decades.

c. Phase Three – the Arctic Ocean opens

   By the time inland fields and mines begin to deplete, the northbound logistic infrastructure is in place to allow for offshore extraction north of Russian coasts up to its national economic exclusive zone, thus prompting the final phase of development of Siberia and the Russian Arctic. In the best-case scenario, the two corridors will balance out and become synergic (since they serve different regional markets), while the bulk of Russian mainland east of the Urals is less energy dependent and can attempt economic diversification.

Longbow: The Trans-Siberian support line, and energy/ore corridors and the NSR

Figure 6 - Source: SRM on authors' elaborations based on "We Build Value Digital Magazine", [https://www.webuildvalue.com/it/infrastrutture/transiberiana-ultima-fermata-tokyo.html]

5 / The Law of the Frontier: the legislative framework of the High North

After a summary of the most relevant sources of law applicable to the Arctic waters, this chapter will focus on the juridical aspects where both potential conflicts and opportunities for harmonization might arise, particularly as regards freedom and safety of navigation along the Northern Sea Route (NSR). An overview of the Russian legislation regulating the NSR (and the federal agency charged with administrating it) will be provided in the second section, followed by insight on the legislative commitment of the European Union for the safety and protection of the arctic environment. The last section will attempt to describe a possible EU strategy aimed at promoting arctic shipping and integrating the NSR with its logistic corridors.

1. Introduction to the international legal framework for maritime activities in the Arctic

Unlike Antarctica, which is subject to a specific and legally binding treaty[1], the waters and seabed of the Arctic are governed by an articulate system of sectorial instruments, the most prominent and comprehensive of which is the United Nations Convention on the Law of the Sea (UNCLOS), designed to provide a framework of rules applicable to any ocean in the world. Adopted in late 1982 after a decade of negotiations at the United Nations, UNCLOS entered into force in November 1994: its 320 articles (plus 9 annexes) defined the provisions all ratifying States must abide by and also established the International Tribunal for the Law of the Sea in Hamburg, with jurisdiction over disputes relating to the interpretation and application of the Convention itself.

[1] Antarctic Treaty, 01/12/1959.

Secondly to UNCLOS, a set of legal sources applicable to the Arctic Ocean mainly derives from:

a. customary international laws, essentially pertaining to general State practices accepted as laws[2];
b. legally nonbinding rules, mainly in the form of conventions seeking to strengthen the official regulatory framework with non-mandatory recommendations, guidelines and practices[3].

Given the rapidly increasing access to Arctic waters due to global warming and the widespread melting of sea ice and glaciers, it is likely that the economic interests of States will intensify in the foreseeable future, requiring further coordination and harmonization of some of the abovementioned provisions, as some academics have debated[4].

1.1 The Arctic region and the Law of the Sea

The United Nations Convention on the Law of the Sea currently provides the primary governing legal regime applicable to the seas of the planet, as it recognizes the sovereignty, sovereign rights, freedoms and obligations of States within several maritime zones: it was ratified by the Russian Federation in 1997, while the European Union became a participant

[2] The Statute of the International Court of Justice acknowledges the existence of customary international law in Article 38(1)(b), incorporated into the United Nations Charter by Article 92: "The Court, whose function is to decide in accordance with international law such as disputes that are submitted to it, shall apply ... international custom, as evidence of a general practice accepted as law".

[3] n this respect, a particularly relevant role has been played by the International Maritime Organization (IMO), a specialized agency of the United Nations dealing with various aspects of shipping. Within the framework of IMO, several conventions were adopted, among which the 1973 *International Convention for the Prevention of Pollution from Ships* (MARPOL, ratified by all Arctic States), the 2002 *Guidelines for Ships Operating in Arctic Ice-covered Waters* (Arctic Guidelines) and the 2009 *Guidelines for Ships Operating in Polar Waters*. In particular, it is worth noticing how the latter recommended the adoption of more demanding standards for ships navigating those sea zones (in terms, *inter alia*, of enhanced communications systems, life-saving appliances and environmental safeguard). Also, these guidelines established a system of polar classes to designate different levels of capability of ships to navigate safely in both Arctic and Antarctic waters.

[4] On the opportunity of a holistic Arctic Treaty that could strike a balance between the freedom of navigation and the law enforcement of NSR, Henri Féron *"A New Ocean: The Legal Challenges of the Arctic Thaw"*, Ecology Law Quarterly 1-2018.

in 1998 on the basis of UNCLOS Article 305(1)(f) which states that the Convention is open for signature to international organizations in accordance with its Annex IX[5].

Finally – and interestingly enough – as far as the United States is concerned, even though at the time of this writing it has not yet ratified UNCLOS (which prevents it from officially accessing the abovementioned system of dispute settling), it still considers the provisions of the treaty as reflecting customary international law and therefore binding on all States[6].

As a general principle, UNCLOS divides the ocean's space into various maritime zones within which distinct freedoms, rights and obligations attach. According to article 5, each zone is measured from the baseline, usually corresponding to the low-water line along the coast.

The partition of the maritime areas according to the baseline criterion creates the following zones:

a. Internal waters, sited landward of the baseline, where the coastal States have sovereign control in the same way as over their land territory. As a general rule, foreign-flagged vessels and aircrafts may not enter such zones without permission unless as a result of distress or *force majeure*.

b. Territorial seas, comprised of the waters seaward of the baseline up to 12 nautical miles (approx. 22,2 km), where the coastal State enjoys sovereignty over the water, seabed and subsoil but must also consent to the navigational rights of:

    1. innocent passage, according to which any foreign-flagged vessel (including warships) may traverse the territorial sea without permission so long as the transit is "continuous and expeditious, not prejudicial to the peace, good order or security of the coastal State and in conformity with UNCLOS and other rules of international law".[7]

[5] Article 1 of Annex XI defines an international organization as "an intergovernmental organization constituted by States to which its members have transferred competence over matters governed by the Convention, including competence to enter into treaties in respect to those matters". It's worth noticing how the key element for the admission to the Convention is the emphasis on the conferral of competence from the member States to the organization, rather than the international body having legal personality.

[6] The United States Oceans Policy Statement of 10/03/1983 officially declares that the United States "[…] recognizes the rights of other States in the waters off their coasts as reflected in the Convention, so long as the rights and freedoms of the United States and others under international law are recognized by such coastal States".

[7] Article 36 confers the coastal State the authority of forbidding innocent passage only when essential to national security, for a limited period of time and in specified areas. The state must also provide appropria-

2. transit passage, applicable only where the territorial sea overlaps straits used for international navigation and allowing foreign ships to engage in the abovementioned "continuous and expeditious" transit in their normal mode of operation without permission.

c. Contiguous zones, extending up to 24 nautical miles (approx. 44,4 km) from the baseline and where the coastal State only has limited sovereign rights, since within those areas it may enforce customs, fiscal, immigration and sanitation laws but can't impede or limit navigation[8].

d. Exclusive economic zones[9], encompassing waters up to 200 nautical miles (a little over 370 km), where a coastal State may exercise both limited rights – related to natural resources – and jurisdiction (essentially regarding artificial structures, marine scientific research and the protection and preservation of the environment), provided they have "due regard" to the rights and duties of other States. Similarly to the contiguous zone, no permission from the coastal State is needed for navigation.

e. High seas, covering the remaining maritime areas where every vessel enjoys full freedom of navigation, with due regards for the interests of other users.

The waters of the Arctic region, in addition to being classified under these five categories like any ocean, are specifically affected by two other provisions of UNCLOS, namely those pertaining to:

1. The outer continental shelf

   Under article 76, coastal States may extend their right of utilization to the continental shelf to up to 350 miles (approx. 648 km) from the coastal baseline, provided that submerged landmass is a natural prolongation of the shelf itself. However, this entitlement to the outer continental shelf (OCS) does not stem from a unilateral act and must instead be reviewed and approved by the United Nations Commission on the Limits of the Continental Shelf (UNCLCS). Canada, Denmark, and Russia currently dispute ownership over the seabed of large parts of the central Arctic Ocean: these quarrels have not been

te notice of the prohibition and can't in any case impose regulations on foreign ships that have the practical effect of denying or impairing the right of innocent passage.

[8] UNCLOS article 33.

[9] UNCLOS article 57.

settled yet and focus in particular on two seabed features: the Lomonosov and Alpha/Mendeleev Ridges[10].

2. The "Canadian clause"

   Under article 234 (also called the "Canadian clause"), coastal States have 'the right to adopt and enforce nondiscriminatory laws and regulations for the preservation, reduction and control of marine pollution from vessels in ice-covered areas within the limits of the exclusive economic zone, where particularly severe climatic conditions and the presence of ice covering such areas for most of the year create obstructions or exceptional hazards to navigation, and pollution of the marine environment could cause major harm to or irreversible disturbance of the ecological balance'. The complexity and relative elusiveness of this norm have been debated extensively[11], but the consensus is that the coastal State's right to enforce potentially restricting laws is not absolute and implies no claim in terms of sovereignty over the waters of the exclusive economic zone.

1.2 The Ilulissat Declaration and the Arctic Council

The official commitment to UNCLOS provisions was confirmed in 2008 by the coastal Arctic States – Canada, Denmark (Greenland), Norway, Russia, and the United States – with the signing of the Ilulissat Declaration[12]. Through the Declaration, the signing States agreed that the law of the sea provides an appropriate legal framework for governing the Arctic Ocean, thus ruling out the need for a new comprehensive international legal regime on the matter. However, recent studies[13] have underscored some deficiencies of UNCLOS in properly regulating, *inter alia*, the protection of the pristine marine environment of the region.

[10] Ridges are underwater features that slope up rather than down, making it unclear whether they should be intended as part of the continental shelf or marking its end.

[11] Sean Fahely, "*Access control: freedom of the seas in the Arctic and the Russian Northern Sea Route Regime"*, Harvard National Security Journal Vol. 9, 2018 and Philip Kastner, *"International legal dimensions of the Northern Sea Route"*, The Northern Sea Route – A comprehensive analysis, 2015.

[12] Ilulissat Declaration, 28/05/2008.

[13] Pierandrea Leucci, *"UNCLOS and the protection of the marine environment in the Arctic Ocean: differences with the Antarctic legal regime and examination of article 234"*.

At the same time, some limitations seem to be complemented by the cited conventions adopted by the International Maritime Organization (IMO) and by the efforts of the Arctic Council, an intergovernmental forum established in 1996 to promote cooperation, coordination and interaction among the Arctic States and communities on common issues, in particular on those related to sustainable development and environmental protection in the region[14].

Contrary to IMO, the Arctic Council is essentially a regional forum. Yet, through its 6 Working Groups it regularly produces comprehensive, cutting-edge environmental, ecological and social assessments. The Council has also provided a site for the negotiation of three important legally binding treaties among the eight Arctic states: the Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic and the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic and the Agreement on Enhancing International Arctic Scientific Cooperation[15], all fully applicable to the NSR.

Understandably, the increased interest in the commercial opportunities of the NSR has apparently introduced various forms of competition among States and organizations even in this hub of cooperation. On the one hand (and despite years of diplomatic efforts), the European Union is not yet recognized as official observer at the Arctic Council due to the opposition expressed by both the United States and the Russian Federation[16], on the other, China gained that status in 2013 and has so far committed to an apparently more assertive role in the definition of Arctic policies[17].

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[14] The Arctic Council is composed of 8 member States (Canada, Denmark, Finland, Iceland, Norway, the Russian Federation, Sweden and the United States, responsible for decisions on all levels), 6 indigenous organizations recognized as permanent participants and thirteen non-Arctic States and 38 intergovernmental and non-governmental organizations contributing as observers. Although the European Union is granted only an *ad hoc* observer status, 3 of its member States (Denmark, Finland and Sweden) are also are members of the Arctic Council, while seven other countries are permanent observers (France, Germany, Italy, the Netherlands, Poland, Spain and the United Kingdom). European Commission, *"An integrated EU policy for the Arctic"*, 27-04-2016 and Icelandic's Arctic Council Chairmanship 2019-2021, *"Together towards a sustainable Arctic"*, May 2019.

[15] Arctic Council, *"The Arctic Council: a backgrounder"*, 25-09-2017.

[16] Luke Coffey and Daniel Kochis, *"Why the U.S. should oppose observer status for the European Union in the Arctic Council"*, The Heritage Foundation, 25/04/2019.

[17] European Parliament, *"China's Arctic policy – how China aligns rights and interests"*, May 2018. It must be underscored that the Chinese Government has officially integrated NSR in its Polar Silk Road initiative

In particular, China seems to be advocating – alongside a certain number of non-Arctic States – the transformation of the current Arctic's governance (provided by the Ilulissat Declaration and the Arctic Council) from regional to global, since that approach would probably better accommodate Chinese commercial, scientific and security interests.

2. The Northern Sea Route in Russian Legislation

The strategic importance of the Arctic for Russia was a well-established reality even in prerevolutionary times, but the legal document that provided a first detailed definition of which areas were to be rightfully considered parts of the Soviet Union is the 1926 Declaration of Lands and Islands located in the Arctic Ocean as territory of the USSR[18]. However, just like its predecessors, the Declaration only dealt with specific offshore water areas sited along the Arctic coastline as Russian internal waters and did not provide for the extension of the States' sovereignty to portions of the Arctic Ocean.

2.1 Definition, scope and compliance with international laws and practices

The most recent definition of the NSR was introduced in 2012 by Federal Law 132-FZ[19] that amended some articles of the 1998 Federal Law 155-FZ on internal sea waters, territorial sea and contiguous zone of the Russian Federation. In particular, the basic principles of Russia's view of the legal status of the NSR and the delineation of its limits are expressed in the new version of article 14 describing the route as *"a historically developed national transport communication of the Russian Federation"*, with navigation in the water to be carried out in accordance with the universally recognized principles and norms of interna-

since mid 2017. Although the idea of developing a new blue economic passage in cooperation with the Russian Federation can be traced back to 2015, it was the *Vision for maritime cooperation under the Belt and Road Initiative* (2017) and the *White paper on Arctic Policy* (2018) that better defined the Chinese agenda for the Arctic.

[18] Issued in the Decree of the Presidium of the Central Executive Committee of the USSR, 15/04/1926..

[19] Federal Law 132-FZ 28/07/2012, whose unofficial translation can (also) be found on the Northern Sea Route Administration website.

tional law, international treaties to which the Russian Federation is a party and the provisions of the national legislation of Russia.

The 2012 Law also amended the Merchant Shipping Code of the Russian Federation, adding to the code[20] a definition of the "Northern Sea Route" as:

> *"a water area adjacent to the northern coast of the Russian Federation that comprises the internal sea waters, the territorial sea, the contiguous zone and the exclusive economic zone of the Russian Federation and is bounded on the east by a maritime demarcation line with the United States of America and by the parallel of the Cape Dezhnev in the Bering Strait, on the west, by the meridian of the Cape Zhelaniya to the Novaya Zemlya Archipelago, by the eastern coastline of the Novaya Zemlya Archipelago and by the western boundaries of the Matochkin Shar, Kara Gate and Yugorski Shar Straits."*

The choice of giving such a broad definition has sensibly been explained[21] by the circumstance that, due to the changing of weather and ice conditions, the route does not have a constant configuration: depending on the severity of climatic elements in some of its segments, a set of alternative shipping lanes (all located within the limits of the Russian exclusive economic zone) may be employed to ensure the safety of traffic. Given that, pursuant to section 4 of article 15 of the Constitution of the Russian Federation, the norms of international law and treaties prevail over Russian national laws, it's crucial to ascertain if and to what extent Federal Law 132-FZ actually correlates with those international sources.

2.2 The regulatory regime implemented by the Northern Sea Route Administration

It has been argued[22] that the expansive definition of the NSR provided by article 5.1 is meant to help streamline Russian governance over the route: still, any national rule applicable in that water area – especially if treated as an indivisible whole for purported practical reasons – must still be compatible with international law.

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[20] Article 5.1.

[21] Viatchelsav V. Gavrilov, *"Legal Status of the Northern Sea Route and Legislation of the Russian Federation: A Note"*, Ocean Development and International Law, 2015.

[22] Zhang Xia, *"From mandatory icebreaker guiding to a permission regime: changes to the new Russian legislation of the Northern Sea Route"*, Advances in Polar Science, 2014.

The level of such compliance can be clarified by analyzing the most relevant amendments to the Russian Merchant Shipping Code introduced by Federal Law 132-FZ which essentially relate to:

a. the establishment of the Northern Sea Route Administration (NSRA)[23], a federal state agency charged with overseeing and administrating navigation along the NSR, whose main targets are to ensure safe transit and protect the marine environment from pollution[24].
b. the wide range of rights and prerogatives with which the NSRA is invested, *inter alia* including:
    1. obtaining and considering the applications and issuing the permissions for navigation through the NSR;
    2. issuing the certificates of the ice conventional pilotage;
    3. researching weather, ice, navigational and other conditions;
    4. providing assistance with the organization of search and rescue operations;
    5. lessening the consequences of pollution from vessels of harmful substances.

Finally, based on the same Federal Law, in January 2013 the Russian Ministry of Transport developed and approved the Rules of Navigation on the Water Areas of the Northern Sea Route (RNSR): combined with the ample powers given to NSRA, this detailed and compulsory set of instructions basically directs every aspect of passage along NSR and has therefore raised fears of a *de facto* monopolistic managing of the route itself exerted by the Russian Federation[25]. In this regard, the most sensitive issues can be summarized in two major categories.

2.2.1 Requirement to request permission to enter the NSR

The RNSR prevents all ships from entering the water area of the NSR — which by definition includes significant portions of the Russian Arctic territorial seas and exclusive economic zone — without first obtaining express permission from the NSRA. This requirement is independent of the ship's build, technical configuration, route, or ice class and may theo-

[23] Article 5.1, section 3.

[24] Article 5.1, section 2. The emphasis on the protection of the marine environment appears to embody the spirit of article 234 UNCLOS ("Canadian clause").

[25] Fahely, supra note 14.

retically apply to any vessel traversing the area, even when no icebreaker support is required. The request must include key information about the ship and voyage, together with copies of the vessel's classification certificate and of documents certifying the availability of the insurance. The NSRA will notify the shipowner within twelve days if permission has been granted or, if not, it will communicate the reasons justifying the refusal. At that time, successful applicants will be notified of the proposed route and given information on the need for icebreaker assistance in the various sections of the route.

Given the presence within the NSR of portions of the Russian territorial sea, demanding ships to request permission to enter and navigate its waters might directly conflict with the rights of innocent passage. Secondly, were (at least one of) the straits located in those waters officially recognized as usable for international navigation, the same rule might negatively affect also the right of transit passage. As a third topic of potential dispute, the restrictions on the freedom of navigation would appear even more illegitimate when applied to the Russian exclusive economic zone within the NSR, due to the limited natural-resource related sovereign rights that the coastal State has on those waters.

Although these worries are funded, a pragmatic compromise can be found to mitigate each of them[26]. As reported, the right of innocent passage is not absolute and can in certain circumstances be limited by every coastal State, provided the decision to do so does not have the practical effect of arbitrarily denying or impairing the right itself. It's safe to assume that any restriction aimed at targeting vessels on a purely discretional basis (state flag, polar class etc.) would not only appear obvious and could in any case not be sustained indefinitely at the Tribunal of the Law of the Sea, but would also undermine the Russian economic interests associated with the development of the NSR in the first place. As for the right of transit passage, it is by definition attached to the presence of straits used for international navigation: at the time of this writing, the general consensus[27] is that the straits along the NSR do not meet the requirements set by UNCLOS for the international usage. The rationale behind this conclusion rests on the fact that, when compared to other straits that are used more frequently and regularly, in the past only relatively few foreign ships have passed the straits in question. Lastly, it must be remembered that within its exclusive economic zone the Russian Federation is allowed (like any other coastal State) to

[26] On Russia's need to enact policies favourable to international trade, see *"Arctic security, sovereignty and right of utilizazion"*, M. Keupp 2015.

[27] Philip Kastner, Supra note 14.

exercise the right granted by article 234 UNCLOS and can thus enforce laws for the prevention and control of marine pollution from vessels. The Russian Arctic evidently matches the profile set by the Canadian clause, as not only its waters are currently "ice covered areas" for most of the year, but the climatic conditions in the region are "particularly severe" to say the least. In this regard, the NSRA rule demanding ships to request permission to enter the NSR has at least a general nexus to preventing marine pollution.

However, this framework could rapidly evolve in favor of a more permissive regime of entering and navigating the NSR. In particular, in the near future both the frequency of transit through the straits (affecting the very notion of their international usage and therefore the occurrence of right of transit passage) and the climatic conditions of the Arctic (determining the applicability of the Canadian clause) may be influenced by the effects of climate change. The progressive melting of Arctic ice and glaciers may expose the straits to increasing volumes of shipping (making them of "international usage") and simultaneously reduce the presence of ice for most of the year / mitigate the harshness of the local climate (lessening the rights granted by article 234 UNCOS).

2.2.2 Unilaterally adopted rules on the safety of navigation

According to the RNSR, the regulatory regime within the route is an authorization-based order for ship navigation. Therefore, in case the preventive application is authorized, the ship must abide by the route of navigation prescribed by the Russian authority. This requirement seemingly establishes a *de facto* mandatory routeing[28] system for ships that may potentially conflict with the prescriptions of the International Convention for the Safety of Life at Sea (SOLAS), an international maritime treaty which sets minimum safety standards in the construction, equipment and operation of merchant ships[29].

[28] According to IMO, "ships' routeing" is the practice of establishing "predetermined routes" for ships to follow, primarily for safety reasons. Ships' routeing can take many forms, including traffic separation schemes, the establishment of designated sea lanes for ships to follow in congested areas to ensure the safe and steady flow of maritime traffic.

[29] International Maritime Organization, Convention for the Safety of Life at Sea (SOLAS) 1974. The treaty entered into force in May 1980 and has so far been amended on various instances in order to update its prescriptions to technological developments or prevent past incidents from happening again (e.g. the investigations on 2012 Costa Concordia disaster led to the adoption of stricter rules on the subdivision and damage stability of vessels that entered into force in January 2020).

According to SOLAS, the IMO "is recognized as the only international body for developing guidelines, criteria and regulations on an international level" for ships' routeing and ship reporting systems, as it has the required expertise to evaluate proposed coastal State ships' routeing and ship reporting regulations and collate those comments for review prior to adoption. Given that IMO review helps ensure that such regulations are consistent with international law (including UNCLOS), a hypothetical dispute may stem from the circumstance that Russia has not yet submitted its RNSR to IMO for review and adoption.

Moreover, most ships transiting the NSR are going to require both icebreaker and pilot ice assistance. In particular, such support may be rendered only by the icebreakers authorized to navigate under the State flag of the Russian Federation[30]. This thorough system of seaways guidance implies the continuous supervision of ships from the NSRA (coordination of traffic flows, provision of icebreaker assistance and ice pilots for ships, systematic notification of ice and meteorological conditions[31]), aided by on-board Russian personnel and supported by the whole national infrastructure in the region[32].

Although Russian mandatory ships' routeing and reporting system regulations have not yet been submitted to IMO for an assessment on their compliance with international laws, this doesn't automatically imply that legal quarrels might arise because of that. In this regard, three main considerations are worth mentioning. First, because in signing the Ilulissat Declaration, each of the five littoral Arctic nations made a commitment to collaborate and work through the IMO on existing measures and any new measures for navigational safety, so the Russian delay in presenting the navigation rules for legal scrutiny might just be temporary and based on the relatively limited volumes of foreign ship traffic experienced so far.

[30] For a general overview on the specific features of icebreakers assistance, see ABS, *"Navigating the Nortern Sea Route – Status and Guidance"*, 2014. The standard assistance routine has the icebreaker make a channel in ice, then a convoy of ships follows it and sail through the channel in tow. The fee rate of the icebreaker and pilot ice assistance of a ship in the water area of the NSR is determined by the legislation of the Russian Federation, taking into account the capacity of the ship, the ice class of the ship, the escorting distance and the period of navigation.

[31] Most notably, recommended guidance is also provided for the ships navigating in the NSR areas when no ice is present as well as for the ships that are classified as ice class so that they are able to independently move along the NSR under known ice conditions.

[32] The NRSA coordinates and relies on several supporting services like telecommunications hubs, search and rescue facilities, military bases and a network of 7 main port authorities along the northern coastline.

Plausibly, the growing number of non-Russian vessels expected to navigate the NSR in future years will promote the need for an official harmonization procedure of RNSR at IMO: it's also possible that this necessity might bring about the opportunity for a more comprehensive debate on the rules of navigation in other regions of the Arctic[33]. Secondly because, regardless of how much intrusive Russian regulations might be perceived, so far cooperation among States has prevailed. The adoption of the International Code for Ships Operating in Polar Waters exemplifies that shared commitment. Finally, the NSRS might simply be a sign that regional customary international law could be emerging with respect to the regulation of passage of ships in the Arctic[34]: in that sense, the mere toleration and protracted acceptance of Russian regulations by other States could establish a tacitly recognized *modus operandi* along the route.

It must also be noted how in recent years the Russian legislation on the NSR has shown significant improvements towards a less assertive approach based more on cooperation and mutual trust. For example, the mandatory inspection of vessels upon entry into the NSR has been abandoned as of January 2013 and has not been reintroduced even in the aftermath of the European and American sanctions imposed during the Crimea and Ukraine crises of 2014. Correspondingly the United States, despite being one of few major maritime powers to have formally lodged a diplomatic protest with Russia over the lawfulness of the RNSR, has not conducted a freedom of navigation operation in the NSR in over fifty years.

2.3 Recent developments and future perspectives

In addition to specific provisions of the RNSR, recent legislative interventions also raised questions about the extent to which the Russian Federation may use domestic law to control access to the NSR, possibly in a manner inconsistent with the Law of the Sea. In late December 2017, Russia amended its Merchant Shipping Code[35] to restrict foreign-flagged vessels from transporting certain cargoes (oil, natural gas and coal extracted within the territory of the Federation) along the NSR.

[33] It's worth noticing how at present the Russian legislation may find some support in the practice of two other important actors in the Arctic, namely of Canada and its 1970 Arctic Waters Pollution Prevention Act and of the United States and its 1990 Oil Pollution Prevention Act.

[34] Stepanov, Ørebech and Brubaker, *"Legal Implications for the Russian Northern Sea Route and Westward in the Barents Sea"*, Fridtjof Nansen Institute, 2005.

[35] Merchant Shipping Code, article 4.

As a consequence, besides Russian-flagged vessels already operating along the route, only shipping companies with contractual agreements with Russia specifically authorizing them will be exempt. Though this may provide Russia with better oversight of shipping in its Arctic waters, a proposed ban on international foreign-flagged vessel shipments is thought[36] to be inconsistent with the right of innocent passage, the right of transit passage, and high seas freedom of navigation.

This measure apparently serves protectionist needs and is not without precedents. In fact, it is generally accepted that a coastal State may require foreign-flagged commercial vessels to comply with some of its domestic laws as a condition of entry to its ports. In addition, maritime cabotage laws are generally considered lawful and have been adopted by a number of coastal States. Furthermore, with that amendment Russia (as a flag State) would have greater jurisdiction and control over the manning and conditions of the vessels flying its flag than it would have over foreign-flagged vessels, thus enhancing its role of first responder to any adverse incident, such as groundings, oil spills and search and rescue operations. Such national equities, however, would not justify discriminatory treatment of foreign-flagged vessels aimed at effectively negating crucial rights and freedoms preserved in the law of the sea.

In any case, the imposed restrictions are not absolute and appear to have been introduced mainly with the purpose of gaining some leverage in the definition of the contractual agreements with foreign companies. Moreover, in the past the Russian government clearly stated its interest in transforming its share of the Arctic in a strategic resource base[37] (an occurrence only partially sustainable without foreign funding, technology and expertise) and has recently announced a major infrastructure development plan for the NSR as part of its efforts to make the Arctic viable for commercial shipping[38].

[36] Fahely, supra note 14.

[37] Security Council of the Russian Federation, 2008.

[38] Max Schwerdtfeger, “Russia unveils NSR infrastructure update”, Port Technology, 03/01/2020.

3. The role of the European Union

Since three of its member States – Denmark, Finland and Sweden – are located in the Arctic, not only the European Union is geographically linked to the region, but it can also play a natural and important role in its preservation and sustainable development[39]. Even though the EU's engagement with the Arctic is decades old, that commitment gained greater momentum in recent years, and notably with the increasing economic activity in the area due to the unprecedented rate at with sea ice and snow in the region are melting[40]. In order to seize these opportunities, EU's policies should strike a delicate balance between the need to preserve the Arctic environment and that of being ready to integrate its logistics with the new maritime traffic lanes.

3.1 The EU and the Arctic: a growing legislative commitment

As a general rule, the EU's legal competence varies depending on the specific policy area involved: as far as maritime activities are concerned, that competence is exclusive to the conservation of marine biological resources under the common fisheries policy, but the EU may only support, coordinate, or complement national industrial or tourism policies. Under this light, therefore, the EU has so far acted mostly as an external actor in the Arctic, essentially playing a secondary role compared to other non-Arctic States[41].

However, the EU has continued to develop its policies towards the Arctic in a series of communications, the first of which is from 2008 and sets three main policy objectives: protecting and preserving the Arctic in unison with its population, promoting the sustainable use of resources and contributing to enhanced Arctic multilateral governance. That commitment was later confirmed and increased in 2012, with a second communication stressing the importance of both supporting scientific research to address climate change and ensuring the sustainable economic development of the region.

[39] European Political Strategy Centre, *"Walking on thin ice: a balanced Arctic strategy for the EU"*, July 2019.

[40] Apart from the commercial opportunities of the NSR, also the potentially vast reserves of rare earth elements of the region represent a relevant geo economic factor, since those elements are central to the ongoing global digital and low-carbon transition.

[41] For instance, the EU has not yet been granted the observer status in the Arctic Council.

Finally, in 2016 two high profile documents reaffirmed the EU's strategic interest in the Arctic:

1. the EU's Global Strategy, reaffirming the importance of keeping the region a low-tension area with ongoing cooperation procedures ensured by the Arctic Council, a well-functioning legal framework and solid political and security mechanisms.
2. the "Integrated EU policy for the Arctic" communication, specifically addressing the European priorities regarding the Arctic through three mainstays:
   a. climate change and safeguard of the environment, with a focus on research, climate mitigation and adaptation strategies;
   b. sustainable development in and around the region, with a focus on innovation, investment, space technology and maritime safety;
   c. international cooperation, revolving around international organizations and fora.

As a whole, the joint provisions of the two documents delineated a comprehensive approach that coupled diplomatic initiative with internal EU policies in an attempt to better accommodate them in the context of the new challenges of the Arctic. In particular, the mainstay regarding sustainable development relied on several instruments for the funding of projects like Horizon 2020[42] and InnovFin[43], while the key investments were channeled through various institutions such as the European Investment Bank and the European Bank for Reconstruction and Development. Within this strategy, two investment areas appear to play a significant role for European maritime trade and logistics in relation to the Arctic: space monitoring and navigation (through Copernicus and Galileo networks and the participation in the GEO Cold Region Initiative) and especially the Trans European Transport Network (TEN-T).

[42] Horizon 2020 is the largest EU research and innovation programme ever funded, with nearly € 80 billion of financial resources available over 7 years (from 2014 to 2020). Its goal is to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation.

[43] Innovfin is a wide range of loans, guarantees and equity-type funding made available by the European Investment Bank to small and medium sized enterprises (SMEs), large companies and research institutions. It aims to facilitate and accelerate access to finance for innovative businesses and other innovative entities in Europe.

The Ten-T Network

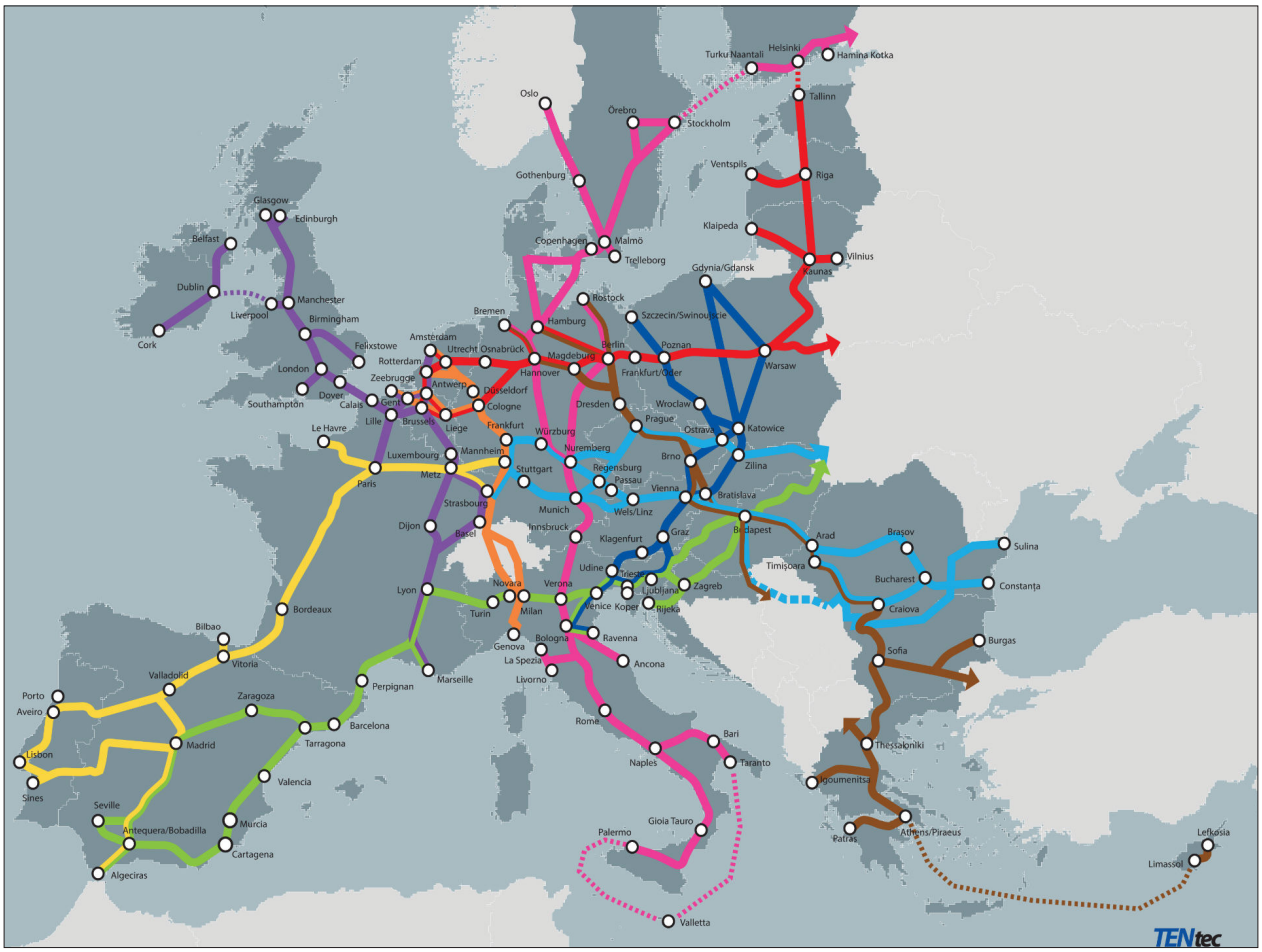

Figure 1 - Source: European Commission website

The Trans-European Transport Network (TEN-T) policy[44] addresses the implementation and development of a Europe-wide network (railway lines, roads, inland waterways, maritime shipping routes, ports, airports and railroad terminals) with the ultimate objective of removing bottlenecks and technical barriers, as well as strengthening social, economic and territorial cohesion in the EU. The initiative focuses on the construction of new physical infrastructure and on the application of new technologies and digital solutions to all existing modes of transport: it further aims to reduce the environmental impact of transport and promote energy efficiency.

[44] The policy is currently based on EU Regulation n.1315/2013.

TEN-T comprises two networks:

1. the Core Network (to be completed by 2030), embracing the most important connections and nodes.
2. the Comprehensive Network (to be completed by 2050) which covers all European regions.

Designed to enhance transportation within the boundaries of the EU, Ten-T also allows for increased and faster handling of goods delivered in ports, and therefore is potentially adaptable to connect with traffic coming from and going to the NSR. In fact, it must be underscored that the European Commission has effectively integrated ports in the corridor work plans foreseen by article 46 of the Guidelines for the development of the Trans-European Transport Network[45] and provided targeted grants and other forms of financial aids to port infrastructure projects. Under this perspective, European port facilities are not the dead end of internal logistic corridors, but rather the *trait d'union* between the transport and maritime policies of the Union: they can therefore work as the "blue extension" of the land network and be the gateway of international sea lanes, including the NSR. Certainly, the caveats to the implementation of such strategy are related to the compliance with EU funding principles[46].

3.2 The long reach: suggestions on how to extend the European logistic corridors to the NSR

As reported, the EU policy on Trans-European Networks for Transport infrastructure (together with its energy and telecommunication complements) aims to connect member States and regions, ensure a sustainable and efficient transport infrastructure, support a connected and interoperable Digital Single Market and a resilient Energy Union. To this end, one of the most important instruments employed to support targeted investment

[45] Supra note 56.

[46] EU regulations on maritime transport focus on the application of the principle of free movement of services and the correct application of competition rules, while ensuring a high level of safety, good working conditions and environmental standards. Article 100 of the Treaty on the Functioning of the European Union (TFEU) is the legal basis, supplemented by the Treaty's general provisions on competition and the freedom to provide services.

across all member States and beyond is the Connecting Europe Facility (CEF)[47], a flagship funding programme enhancing the European Commission's priorities related to smart, sustainable and inclusive growth.

The CEF provides dedicated multiannual financing for infrastructure actions (mainly in the form of grants for studies and works and financial instrument support) so that important investments can be made across the Ten-T, telecommunications and energy network infrastructure. In case the member States' application is successful, the European Investment Bank will be responsible for the implementation of the CEF financial instruments.

Since its first introduction in 2014, the CEF has seen its funds mainly allocated to the transport sector (approx. € 22.8 out of € 26.4 billion), but the transport modality breakdown shows that only less than 5% of the total amount has been conveyed to initiatives related to maritime hauling.

CEF Transport allocation 2014-2019

€ billion (number of actions)

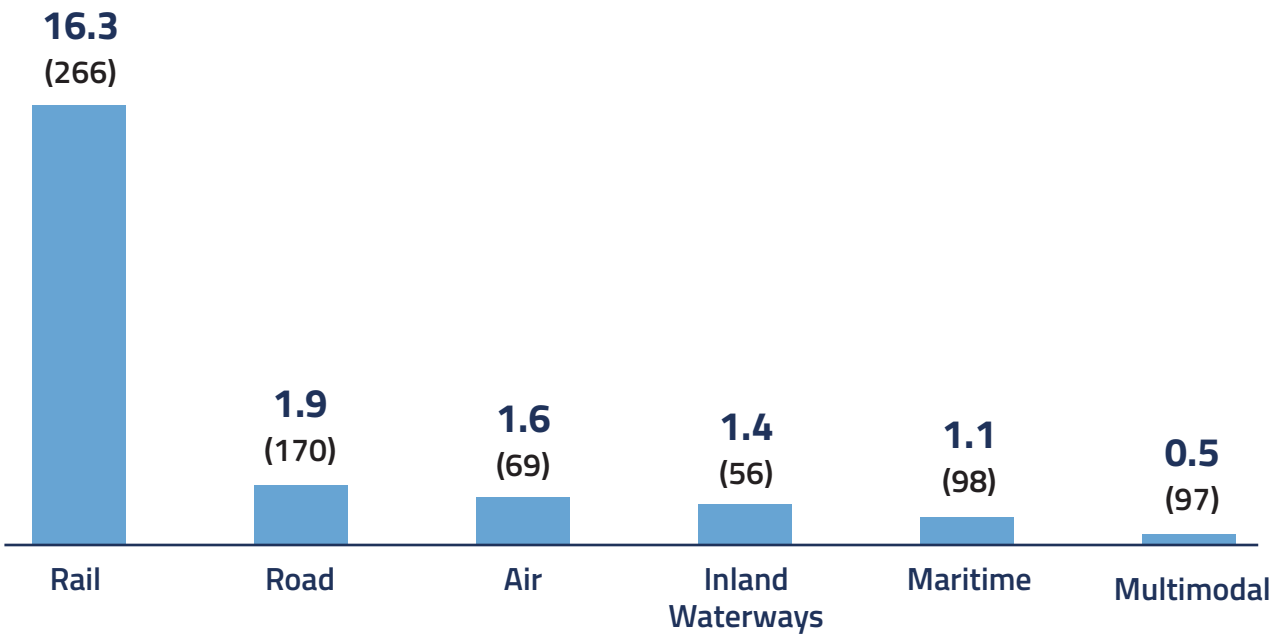

Figure 2 - Source: European Commission - The Connecting Europe Facility

[47] For a detailed description of the CEF and its initial adoption, see European Commission, *"The Connecting Europe Facility: five years supporting European infrastructure"*, July 2019. With an available budget of € 30.5 billion for the years from 2014 to 2020, the programme contributes to strengthening the competitiveness of the EU economy and its transition to climate neutrality.

Also, the resources devoted to the maritime sector have been distributed to a relatively high number of actions compared to the railroads area, leading to a lower average financing per project. Therefore, a possible way of channeling more funds to shipping initiatives would be a slight reallocation in favor of more NRS-related investments. Due to obvious budgetary constraints and to avoid altering the very nature of CEF Transport, such projects should be limited in number and essentially focused on specific goals like:

1. the adaptation of vessels to make them compliant with medium range Arctic navigation (hull reinforcement, low-impact propelling systems) along the NSR. More specifically, those vessels would not necessarily require to be upgraded for the entire transit of the NSR, but only to enter the route from its western boundary (Kola peninsula) and reach the nearest Russian ports on a more frequent basis. Those ships would hopefully feed a "last stretch" segment of sea lanes between the North Sea and the Barents Sea and serve the European ports along these routes with the goods and commodities most traded in the Scandinavian region;
2. the improvement of tankers to facilitate the transfer of energy commodities from floating production, storage and offloading platforms (FPSO)[48] stationed in Russian Arctic waters.

A second scheme to make the European facilities more open to NSR-related trade would require the enhancement of northern ports (e.g. in terms of berths capacity, faster online registration procedures, etc.). In this case the most suitable instrument could be public funding on a State level, provided its compliance with EU regulations. In this regard, it must be noted that in May 2016 the European Commission published a notice on the notion of state aid, which gave guidance on when public investments do not involve market distortion[49]. This strategy could be also helped by the circumstance that in May 2017 the Commission adopted an updated version of the General Block Exemption Regulation: the new regulation gave more flexibility to member States to decide public funding of certain port investments without having to seek prior approval from the Commission[50].

[48] A Floating Production Storage and Offloading (FPSO) installation is a floating facility, usually based on a converted oil tanker hull. It is equipped with hydrocarbon processing equipment for separation and treatment of crude oil, water and gases, arriving on board from sub-sea oil wells via flexible pipelines.

[49] *Commission Notice 2946/206 on the notion of State aid as referred to in Article 107 of the Treaty on the Functioning of the European Union*. An analytical grid for ports infrastructure was published on 02/12/2016 to provide further guidance on the rules and case practice applicable in the port sector.

[50] *Commission Regulation 1084/2017*.

In order for States to properly implement this type of financial support so that fair competition is granted, the most recent legislative intervention at EU level is Regulation 352/2017 of the European Parliament and the Council of Ministers which established a framework for the provision of port services and common rules on the financial transparency of ports. Finally, another mid term measure would involve the extension of Ten-T Scandinavian-Mediterranean and North Sea-Baltic railway corridors[51]. More specifically, the prolongation of the Ten-T to Northern Sweden will potentially create a strategic EU gateway to the Arctic and consolidate the engagement of the EU as a key player in the development of the region. The creation of a more modern and efficient in-land railroad network close to Norwegian ports (prime potential recipients of NRS traffic) would also strengthen the north-south trade flow axis and ease industry complementarities, benefitting the Italian economy as the geographical opposite hub for international exchange[52] .

[51] This proposal was introduced in the Railgate Kouvola conference held on 26/09/2019 in Kuvola, Finland and is line with a suggestion previously submitted by the Swedish Government and supported by the Governments of Finland and Norway. According to the projections attached to the plan, the extension would be vital to accommodate the export-intensive industries in Northern Sweden, which provide large volumes of iron ore, forestry and steel products in north-south and east-west directions.

[52] That way, the Scan-Med corridor would virtually "close the circle" between the southern and northern Belt and Road sea routes.

6 / The challenge of Arctic preservation: environmental and climatic framework

For centuries the Arctic has been a remote region also in the collective imagination, yet it has recently become the object of growing interest for international organizations (namely, the United Nations through its International Maritime Organization agency), regional fora like the Arctic Council and lobbies / NGO concerned about the effects of climate change. The chapter aims at examining the main environmental risks associated with the intensification of maritime traffic and the increased use of natural resources in the area, while also presenting the initiatives taken so far to address such issues.

1. The shape of things to come: an overview of climate change in the Arctic

The North Pole is undergoing a process of profound and rapidly evolving transformation: recent findings from a working group within the Arctic Council[1] show that the region is shifting into a new state, driven by rising temperatures caused by increases in greenhouse gas concentrations in the atmosphere. In particular, the annual average surface air temperature rose by 2.7° from 1971 to 2017, with higher figures during the cold seasons: even more worryingly, in the same period those temperatures rose 2.4 times faster than the Northern Hemisphere average. Such phenomenon has been explained[2] to be driven by a series of "feedback loops" that cause accelerated Arctic ice loss.

[1] "Arctic Climate Change Update 2019", Arctic Monitoring and Assessment Programme, Arctic Council, May 2019 [https://oaarchive.arctic-council.org/bitstream/handle/11374/2353/ccupdate18.pdf?sequence=1&isAllowed=y]. For more details about the Arctic Council and other international entities related to Arctic governance, see Chapter 5.

[2] "Implications of climate change for shipping: Opening the Arctic seas", A.K.Y. Ng, J. Andrews, D. Babb, Y. Lin, A. Becker, Wiley Interdisciplinary Reviews: Climate Change, 9(2), e507 - 2018. DOI: 10.1002/wcc.507

The ice-albedo[3] feedback loop, for example, is a major contributor to Arctic ice loss and can be summarized as follows: reduced sea ice coverage increases the proportion of open water exposed to solar radiation, which lowers the surface albedo and amplifies the absorption of solar radiation in the area; in turn, increased solar absorption warms the ocean surface and leads to augmented melt of the remaining ice pack, thereby exposing more areas of open water and feeding the cycle.

Sea ice-albedo feedback cycle

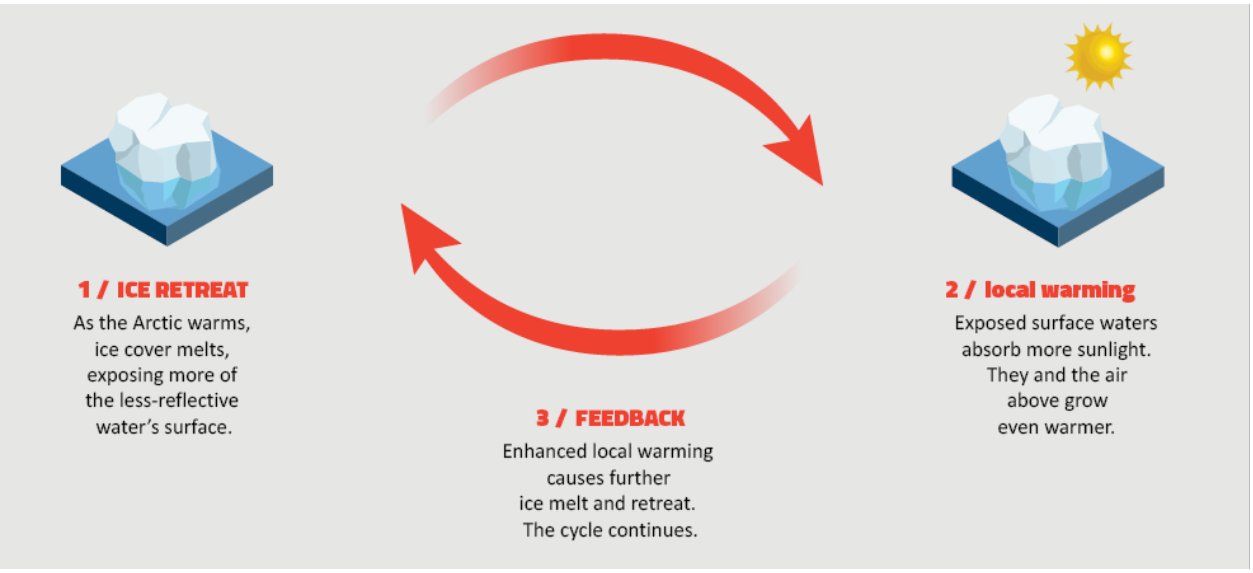

Figure 1 - Source: SRM on University of California, Center for climate science, 2019 [https://newsroom.ucla.edu/topics/environment]

The implications of the retiring of ice are several: not only larger portions of northern seas become relatively frost-free and open to navigation – especially during the warm season and along the NSR – but also higher volumes of fresh water flow into the Arctic Ocean, which in turn affect circulation, nutrient levels, acidification and biological productivity. In addition, since sea ice is the greatest physical constraint on Arctic shipping, the ramifications of its fast-paced melting are ample for both the development of the main maritime routes in the region[4] and the global shipbuilding sector. As a matter of fact, only vessels with some measure of ice strengthening (in terms of hull hardness, design and thickness)

[3] A surface's albedo is a measure of how reflective it is of sunlight: the lower the albedo, the more absorbing of solar rays (and heat) the surface is.

[4] An overview of the main sea routes in the Arctic region is provided in Chapter 2 "The Northern Sea Route: a new economic scenario", p. 7.

can operate within sea ice, thus also orienting the production plans of shipyards around the globe (mainly concentrated in China, Japan and South Korea).

The potential increase of naval traffic in the Arctic and the related expansion of more energy-consuming manufacturing of ice-resistant ship structures entail significant repercussions for greenhouse gases emissions, that some academics argue could counterbalance the reduction in CO_2 associated with navigating the shorter northern routes[5].

The 1981-2010 average maximum (March) and minimum (September) sea ice extent. Three northern shipping routes / regions have been added: the Northwest Passage (NWP), the Northern Sea Route (NSR) and the Transpolar Sea Route (TSR)

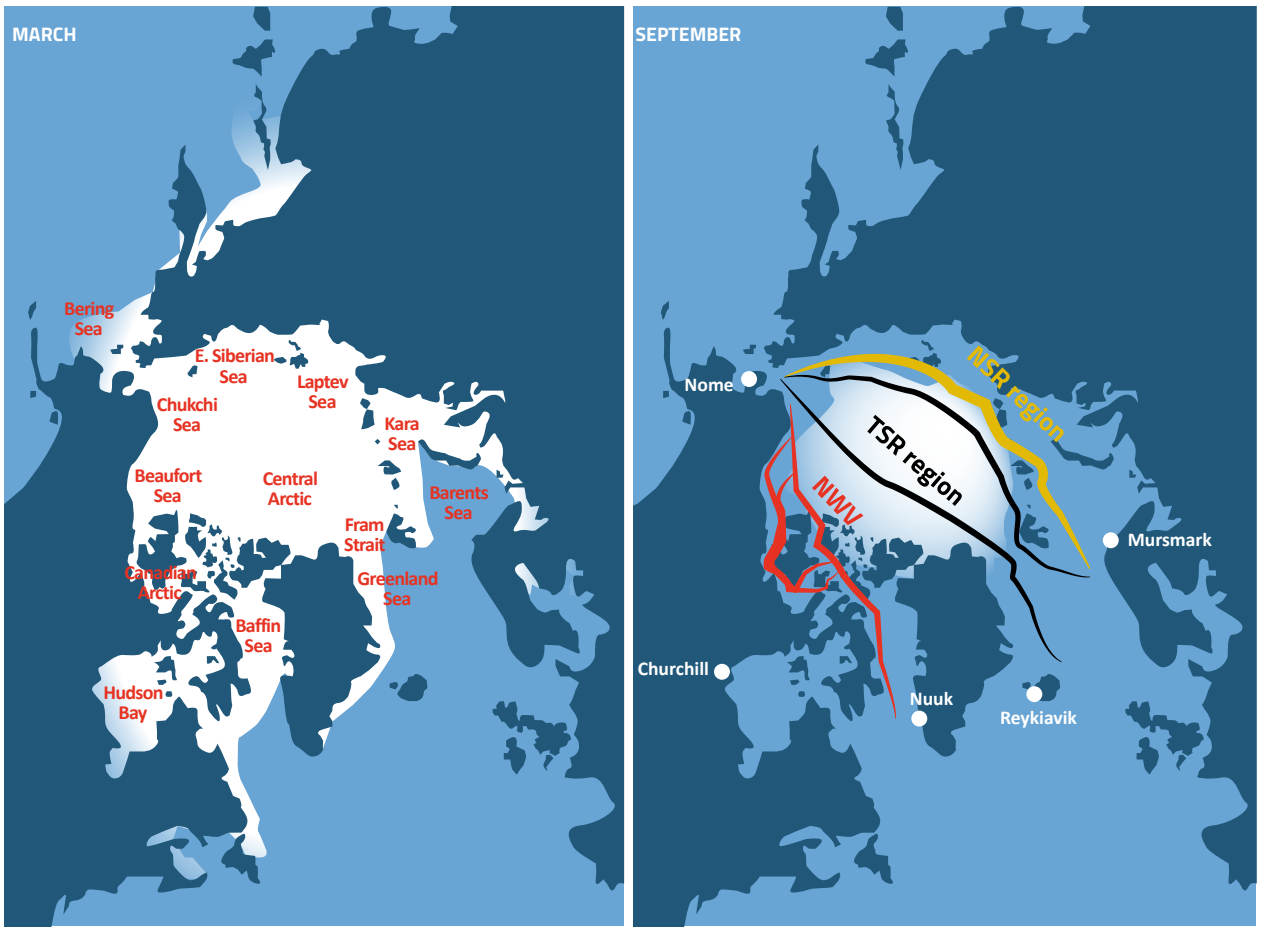

Figure 2 - Source: SRM on U.S. National snow and ice data Center, Arctic sea ice news and analysis, 05-10-2016 [https://nsidc.org/arcticseaicenews/2016/10/]

[5] "Towards a balanced view of Arctic shipping: estimating economic impacts of emissions from increased traffic on the Northern Sea Route", D. Yumashev, K. van Hussen, J. Gille and G. Whiteman, Climatic Change, 2017 doi:10.1007/s10584-017-1980-6

Furthermore, it must be noted that the shipping industry has traditionally relied upon heavy gasolines that belong to some of the most polluting fossil fuels and generate a broad spectrum of emissions, including CO_2 and short-lived climate forcers such as sulphate aerosols and black carbon: although the total emissions from Arctic shipping with a fully operational NSR may be relatively small on a global scale, the impact of these emissions in a climate-sensitive area like the Arctic could be profound. This is particularly relevant for black carbon, which reduces the mentioned surface albedo effect when it is deposited on white ice sheets and snow: the related negative effects are further exacerbated by the stable atmosphere in the Arctic, that increases the lifetime of the sediment and extends the period over which it causes additional warming.

The combined effect of pollutants and non-human related changes in temperature and atmospheric pressure also impacts on two more dimensions of Arctic sea ice:

a. Extent, or the total area with sea ice concentration above a selected threshold (typically 15%), which determines both the width of navigable surface and the length of the ice season;
b. Thickness, defined as the width of ice between the liquid ocean and the atmosphere, whose measurement defines which ice strengthened ships can navigate through it[6].

The coverage, extent and thickness of sea frost are the most relevant factors establishing the possibility for actual navigation in the Arctic in ice-free conditions during the warmer season (from June to October): many studies[7] estimate these conditions may occur for as many as 78 days in 2025 up to 125-192 days by the end of the century. These forecasts positively contribute to the economic feasibility of Arctic shipping in the mid-long run, but also beg questions on the environmental impacts of an intensification of maritime traffic in the high north. The main concerns can be summarized in two categories:

1. Regional impacts.

   An extensive loss of sea ice and glaciers entails dramatic upheavals in the Arctic flora and wildlife in terms of altered food chain and biodiversity, since higher temperatures

[6] The different classes of hull-reinforced vessels are defined according to the international guidelines set out in the "Requirements concerning Polar Class" by the International Association of Classification Societies at the behest of the International Maritime Organization (IMO). The classification encompasses a range varying from open water vessels (capable of travelling in ice up to 15 cm thick) to Polar Class ships that can travel in sea ice several meters thick.

[7] "Transit navigation through the Northern Sea Route from satellite data and simulations", V.C. Khon, I. Mokhov and V.A. Semenov, Environmental research letters, 12(2) 2017.

and increased flows of fresh water will inevitably change the chemical composition of the northern seas. The gradual development of Arctic sea traffic, coupled with fishing and ancillary activities, is going to affect live resources and possibly favor some species at the expense of others. The increase in sea level will cause more damages to offshore platforms, port facilities and energy corridors.

Projected mass loss from local glaciers, ice caps and Greenland Ice Sheet for 2030 and 2080, expressed in millimeters of sea level equivalence under a moderate climate change scenario (RCP 4.5)

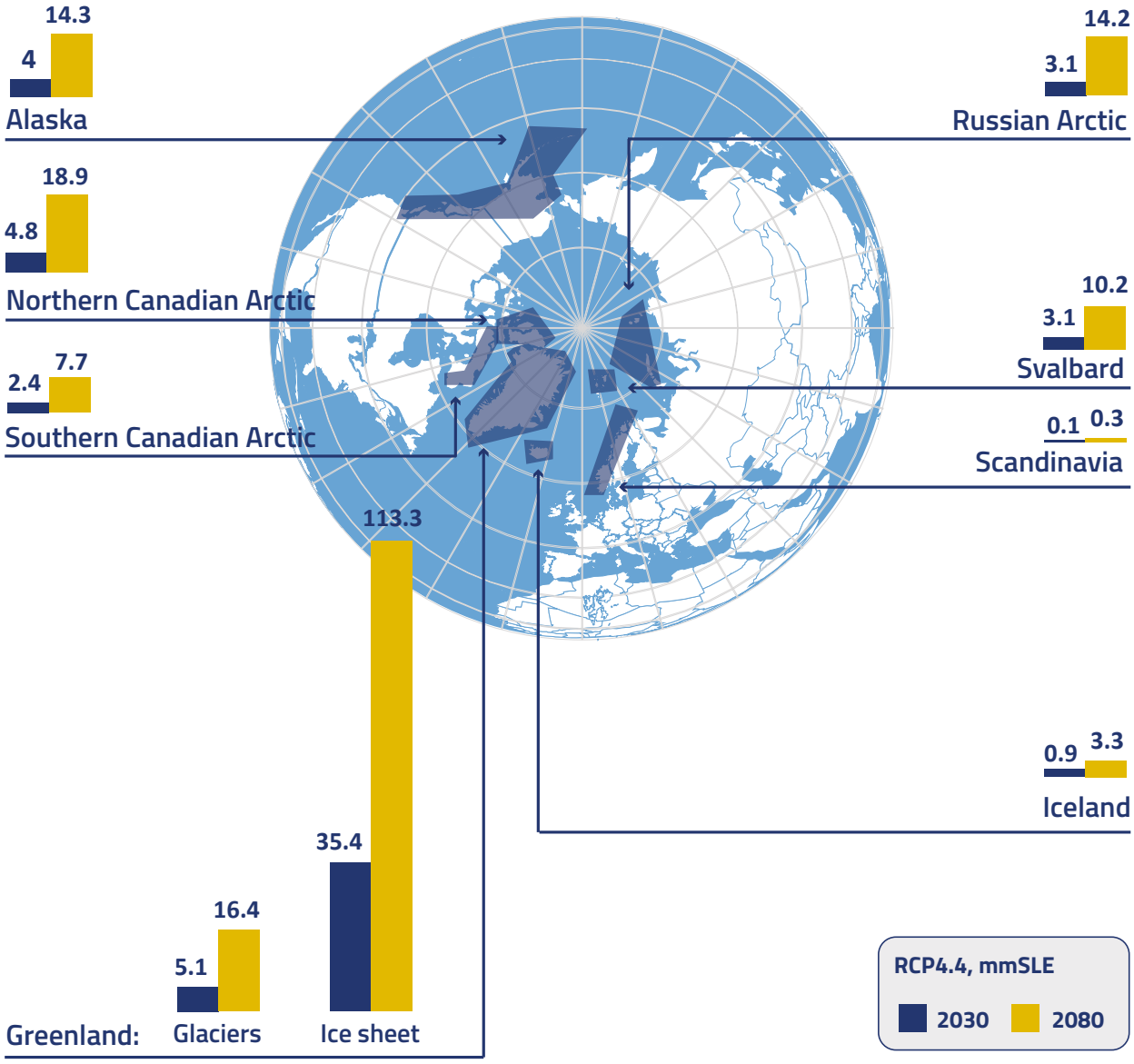

Figure 3 - Source: Arctic Climate Change Update 2019, supra note 1

2. Global ramifications.

   Recent studies[8] show that Arctic glaciers - led by the Greenland Ice Sheet – have been the largest land-ice contributors to global sea level rise (as they accounted for roughly 30% of the total sea level rise that occurred from 1992 to 2017), while other researches indicate that this trend is going to intensify in the future (Figure 3). In addition to storm surges and high tides that will worsen flooding in many regions worldwide, an increase of the water mass of this extent is also going to provoke energy-intensive climatic events like hurricanes.

In this regard it is interesting to notice how, irrespective of the actual accuracy of the various estimates on the matter, several international bodies consider a remarkable change in the shape and composition of the Arctic as inevitable in the next 30 to 80 years, observing that the efforts to reduce greenhouse gas emissions can only limit the extent of climate change even in the most optimistic scenarios. This vison of an unavoidable alteration of the climate in the decades to come is shared also by the United Nations through its "Framework Convention on Climate Change of 2014", a document that adopted a practical approach based more on the concept of adaptation, rather than mere opposition to the environmental challenge[9].

2. Canary in the coal mine: estimating the impacts of global warming in the Arctic

Given the certainty of significant climate variations on a global scale in the mid-long term, a sensible way to look at the Arctic region is by considering it a harbinger of future environmental changes. Higher temperatures are occurring more rapidly in Polar regions, and the magnitude of repercussions is greater than currently experienced in other parts of the

[8] "Mass balance of the Greenland Ice Sheet from 1992 to 2018", Nature, 10-12-2019 https://www.nature.com/articles/s41586-019-1855-2. The study, conducted by NASA and the European Space Agency, also forecasts an approximate 70 to 130 millimeters of global sea level rise by 2100 if the average rate of Greenland's ice loss continues.

[9] For an update on the actions taken since the adoption of the Framework, see "25 Years of Adaptation under the UNFCCC", Adaptation Committee, Climate Change Secretariat of the United Nations, 2019 https://unfccc.int/

world: the Arctic thus functions as a "canary in the coal mine" with respect to direct and indirect responses induced by climate change[10]. In order to provide a general overview of the main threats and opportunities presented by global warming in the region, three levels will be examined: the effects on natural fossil resources, the consequences on the main industrial sectors present in Russian Siberia and along the NSR (with 2 specific focuses on upstream / midstream Oil & Gas operations and maritime shipping) and the potential issues for international relations.

2.1 Natural fossil resources

The combustion of petroleum and, to a lesser extent, natural gas releases carbon dioxide (CO_2) and other greenhouse gases in the biosphere[11] and is currently the major contributor to global warming, as the International Energy Agency reported that in 2017 oil & gas use comprised over 55% of climate-forcer emissions worldwide, with coal covering the remaining 45%. The state of Russian hydrocarbon fields (like any other underground reservoir located in cold regions) is influenced by higher temperatures in that they facilitate the access to previously ice-covered land. However, the reduction of the frost layer on the surface is in part absorbed by the soil through water seeping underground that, in turn, can alter the morphology of the areas where the fossil deposits are sited. This occurrence can result in a gradual modification of the earth's crust in the area (that involves variations in temperature, pressure and moisture) and might also provoke a process of subsidence similar - to a certain extent - to coastal erosion. In the most extreme cases, the increased volumes of water present below the surface can, together with other external factors including seismic waves, heighten the instability of the oil / gas fields and alter the chemical properties of the energy commodities.

2.2 Oil & Gas operations

Although the current debate about global warming generally focuses on how fossil fuels

[10] "The Arctic ecosystem: A canary in the coal mine for global multiple stressors", K. Borgå, Society for environmental toxicology and chemistry, 11-02-2019 https://doi.org/10.1002/etc.4360

[11] "Elements of Petroleum Geology", R.C. Selley and S.A. Sonnenberg 2015, https://doi.org/10.1016/C2010-0-67090-8

use affects the Earth's environment, some studies[12] have explored how the changing climate is likely to affect oil and gas operations both inshore and offshore.

In the Arctic region, the major driver and source of operational risk for onshore extraction plants is the thawing of the permafrost, the portion of ground with a temperature that remains at or below the freezing point. Since most of the existing infrastructures and buildings in those areas were conceived to rest on ice-hardened soil, the gradual melting of permafrost can cause structural tensions that might damage or compromise those facilities, unless adequate repairing / upgrading efforts are put into place. In particular, 4 severe effects may distress the industry:

a. frost heave and settlement of pipelines set on pilings or buried in permafrost, increasing construction and maintenance costs and the potential for leakage and spills;
b. settlement of buildings set on pile of foundations laid directly on permafrost, or a decrease in load bearing capacity of such structures;
c. damage to onshore support facilities, waste disposal sites and roads as coastal erosion and land loss accelerates;
d. hazards associated with the formation of thermokarst lakes in coastal areas (Figure 4) and the stability of shelf and slope sediments.

The increased atmospheric and ocean temperature of the Arctic undoubtedly facilitates the discovery of new deposits under the seabed and the construction of offshore extraction plants, but also constitutes a major threat for three main reasons:

a. it contributes to extensive algal blooms that impact living resources, local economies and potentially also public health. In particular, severe consequences from harmful algae include human illness form ingesting contaminated shellfishes or fish, mass mortalities of wild and farmed fish, loss of seagrasses by reduced light availability and alteration of marine food chains. While these negative phenomena will not directly impact current coastal or offshore oil and gas operations, they could potentially affect the regulatory environment for future exploration and development, as well as the retirement of existing facilities.

[12] "Global climate change implications for coastal and offshore oil and gas development", V. Burkett, Energy Policy, 39(12) 2011 doi:10.1016/j.enpol.2011.09.016 and "Climate change and the oil industry", J.B. Skjærseth and T. Skodvin, Manchester University Press 2003.

Thermokarst lakes in the Nadym-Pur watershed (Russian Federation)

Figure 4 - Source: Photo by S. Kirpotin, 1999 https://www.researchgate.net/figure/Thermokarst-lakes-in-central-part-of-Nadym-Pur-watershed-Photo-by-S-Kirpotin-1999_fig33_278638906. These body of freshwater, usually shallow, are created in depressions formed by thawing ice-rich permafrost.

b. it can propagate into seafloor sediments, provoking the release of methane, the second most important long-lived greenhouse gas in terms of radiative forcing[13].
c. it can hamper the disposal of drilling wastes in onshore in-ground sumps, a practice that relies on the presence of permafrost to prevent the surfacing of exhausts into the surrounding environment.

Another factor that can potentially influence the managing of sea and coastal facilities (including those non-oil & gas related) is the change in precipitation patterns and freshwater runoff from estuaries. The energy development in Siberia could especially be affected by increased restrictions on oil & gas activities in stressed or deteriorating coastal ecosystems, by damage to onshore support facilities (due to extreme rainfall events that flood low-lying coastal areas) and by impairment to roads, bridges and ports in the littoral floodplain due to higher peak stream flows.

[13] In particular, methane clathrate is a solid form of water that contains methane in its crystalline structure and that usually occurs on the continental shelf both in deep sedimentary structures and as outcrops on the ocean floor. Those formations are common in relatively shallow shelf sediments of the Arctic Ocean and the Gulf of Mexico, and their stability is controlled by the combination of pressure and temperature. For a thorough dissertation on the effects of methane clathrate release, see "Radiative forcing of climate change", V. Ramaswamy and others, Climate Change 2001: the scientific basis, 2001 https://www.ipcc.ch/site/assets/uploads/2018/03/TAR-06.pdf

Furthermore, even though most offshore platforms were designed to accommodate a permanent increase in mean sea level, the menace posed by more intense storms cannot be underestimated.

Since an increase in extreme weather events has been observed in areas with higher sea surface temperatures, occurrences like flooding and structural damage to drilling / production rigs and offshore pipelines cannot be excluded[14]. Similarly, also increasing wave heights (created as a secondary effect of the erosion and submergence of coastal lowlands and barrier islands) can cause damage to energy facilities and transportation infrastructure (bridge decks and supports).

Finally, a relevant side effect of climate change is the acidification of Arctic waters due to the absorption of CO_2 by the surface of the sea, a chemical reaction that, even without affecting directly the energy sector, can potentially alter the lifecycle of marine flora and fauna and thus create an unfavorable business environment due to legislative restrictions.

2.3 Arctic Shipping

Due to the mostly pristine state of its ecosystem, the Arctic marine environment is particularly exposed to potential impacts from shipping and naval activities in general. Commercial vessels of every class can potentially harm the regional flora and fauna through a wide range of accidents such as the release of substances through emissions to air or discharges to water, releases of oil or hazardous cargo due to collisions or groundings, disturbances of wildlife's lifecycle or the introduction of invasive alien species[15]. In addition, an intensification of Arctic maritime activity is going to have ramifications on a global scale that are difficult to foresee but that can nevertheless enter three main classes[16]:

[14] The oil and gas industry has been investigating new design of offshore platforms to reduce the potential impacts of changing storm patterns: technologies such as computational fluid dynamics are being used to evaluate the performance of platforms under extreme operating conditions. For an ample overview of those risk-mitigating initiatives, see "Ride the wave", S. Ferguson, Engineering 248 (4) 2007.

[15] "Environmental impact of exhaust emissions by Arctic shipping" C. Schroder, N. Reimer and Peter Jochmann, 24-10-2017, doi:10.1007/s13280-017-0956-0 and "Arctic Marine Sustainability", E. Pongrácz, V. Pavlov and N. Hänninen, 2020 doi:10.1007/978-3-030-28404-6

[16] For a constant update on environmental issues of the High North, see Arctic Council – Climate https://arctic-council.org/en/explore/topics/climate/, while a more technical essay on the implications of global warming, see "Climate Change in the Arctic", Physiscs and Chemistry of the Arctic, A. Kokhanovsky and C.

1. Greenhouse gas emissions

   Among many predictive studies conducted on the impacts of naval traffic along the NSR, a relatively recent one by the University of Rotterdam[17] estimated that the total emissions associated with such regional traffic could fortunately be translated into only marginal increases in global mean temperature and sea level. However, the same analysis indicated that the negative externalities were also going to offset around a third of the expected global gross economic gains associated with NSR over the same period. Noticeably, the study underscored that the gains will mostly occur in Northern Europe and East Asia (as these regions will likely face relatively small climate losses from the additional emissions), while the negative economic impacts of the emission are expected to follow the commonly accepted scenario for climate-induced losses, with poorer regions such as Africa and India set to bear as much as two thirds of the global costs[18].

2. Fisheries

   The fish resources of the NSR play an important role for local communities, but on a global scale live reserves from these Arctic areas are irrelevant, the reason being that the marine fauna is so sparse and difficult to access that no commercial fishing takes place in the open parts of the seas, except from the western Kara Sea and occasionally in the western Chukchi Sea[19]. However, effects of increased shipping and navigation along NSR may be both adverse and positive for fisheries: operational and accidental discharges (such as oil spills) and risks of invasive aquatic species being introduced in the region through ships' ballast water belong to the first category, while the route itself may serve as a mean for transportation of fish products to markets outside the area and also ensure supply of fishing gear and equipment.

Tomasi January 2020, https://doi.org/10.1007/978-3-030-33566-3

[17] A 2017 joint effort of the University of Rotterdam and other private institutions, whose conclusions are included in the document supra note 5.

[18] The most striking picture is for Africa where the losses are comparable to the net gains in Japan and South Korea.

[19] The commercial fisheries of the NSR are mostly restricted to the lower parts of the large rivers and estuaries. "Arctic ecosystems and the impact by shipping activities", K. M. Eger, ARCTIS Database, 2020 http://www.arctis-search.com/Arctic+Ecosystems+and+the+Impact+by+Shipping+Activities

3. Oil spills

As stated in Chapter 2 and III of this paper, the NSR is currently meant to be essentially an energy maritime corridor, with perspectives for a broader use toward cargo and bulk shipping set only in the mid-long term. It is therefore safe to assume that major environmental disasters along the northern shore of Russia might occur essentially in the form of oil spills due to ship collision or grounding. While there has been little research into the effects that these disasters may have on the Arctic environment, some studies have shown that the unique climate of the region poses its own challenges, and nature is slower to respond to such events than it is in more temperate conditions[20]. In particular, it was observed that the activity of oil-eating microbes is slowed down at below-zero temperatures, a conclusion further corroborated by researches that found how low temperatures change the chemical properties of the spilled oil (in terms of higher viscosity) and slow down biodegradation. The lack of waves in the Arctic Ocean constitutes another challenge, since where sea ice is present, fewer waves are created and the oil does not disperse into small droplets. There is also a lower level of nutrients which feed algae and bacteria in the water: without these elements, the bacteria cannot develop at an optimum rate. Finally, one more relevant feature is the long periods of sunlight in the Arctic summer, which can both help and hinder clean-up operations. On the one hand, long hours of sunlight help the microbes to break up oil molecules, but conversely this could make the oil compounds more toxic for aquatic organisms[21].

With the aim of mitigating the risks and costs of environmental shortcomings of this magnitude (as well as the most harmful effects of climate change), several initiatives have been taken on an international level, the most important of which are the introduction of the 2009 Polar Code and the IMO 2020 regulation.

The Guidelines for ships operating in polar waters (Polar Code) defined by the International Maritime Organization (IMO)[22] are intended to cover the full range of shipping-re-

[20] "Oil spills in the ocean: why the Arctic is particularly vulnerable", T. Husseini, Offshore technology 14-10-2018 https://www.offshore-technology.com/features/oil-spills-in-the-ocean-arctic/. During the clean-up operations of the Exxon Valdez spill in Alaska (1989) and Deepwater Horizon in the Gulf of Mexico (2010), only 15% to 25% of oil was successfully removed through mechanical methods, such as physical recovery and burning of the spilled oil. The bulk of the clean-up was carried out by oil-eating bacteria in the water.

[21] Supra note 16. Another weakness is the relatively limited capacity for search & rescue and response operations, although the Russian Government is heavily investing in the development of such infrastructure.

[22] The role of IMO and other international bodies in the protection and governance of the Arctic is treated

lated matters relevant to navigation in waters surrounding the two Poles (ship design, construction and equipment, operational and training concerns and search and rescue activities) and, equally important, the protection of the unique environment and ecosystems of the polar regions. The main provisions of the Polar Code concerning Arctic waters encompass 4 main areas:

a. Oil and oil mixtures

   Discharge into the sea of oil or oily mixtures from any ship is prohibited, and a both a double hull and bottom are required for all oil tankers. Also, ships are encouraged not to use or carry heavy fuel oil in the Arctic and to consider using non-toxic biodegradable lubricants or water-based systems.

b. Invasive aquatic species

   Measures must be taken to minimize the risk of importing invasive aquatic species through ships' ballast water.

c. Sewage

   Except under specific circumstances, no discharge of sewage in polar waters is allowed, with further stipulations specifying the use of approved treatment plants onboard and the safety distances from ice formations at which chemically-sanitized sewage can be ejected.

d. Garbage and chemicals

   No plastic, noxious chemical substances or food wastes can be discharged (the latter benefits from exceptions only if they have been comminuted).

IMO 2020 regulation was another significant step toward environmental protection since, as of January 2020, it enforced a limitation of sulphur content in heavy fuel for ships from 3.50% mass by mass (m/m) to 0.50% m/m. This measure – essentially meant to implement a drastic reduction of sulphur oxides[23] emissions that result from the combustion of naval fuel – also forbids shippers from burning and transporting noncompliant fuel unless appropriate air pollution control devices (scrubbers) are installed on the ship. Before the

in Chapter 5 "The Law of the Frontier: the legislative framework of the High North" at the paragraph "The Arctic Region and the Law of the Sea", p. 62. The most relevant aspects of the Polar Code can be found in: http://www.imo.org/en/MediaCentre/HotTopics/polar/Pages/default.aspx

[23] Apart from being harmful to human health, once in the atmosphere sulphur oxides can lead to acid rain and contributes to the acidification of the oceans.

Installation of a scrubber on a ship in Klaipeda (Lithuania)

Figure 5 - Source: Maritime News, 06-07-2018 https://www.seatrade-maritime.com/

entry into force of IMO 2020, fuel oil with 3.5% sulfur content counted for roughly 33% of total marine fuels demand worldwide, so the positive impacts are expected to be relevant.

In the face of such a radical "game changer", shippers were left with few alternatives[24]:

a. use marine gasoil, easily retrievable worldwide and without compatibility issues, but expensive.
b. use already tested 0.5% fuel oil blends, but taking the risk of operative limitations in their adoption due to compatibility issues and possible constraints in the availability of specific blends in some ports.
c. install scrubbers. Although considered the cheapest choice (as the initial investment is expected to payback in 1 to 4 years depending on the level of the fuel spreads), this strategy has a major limitation in that not all the ships can accommodate scrubbers due to technical constraints. It also entails downtime, in terms of time needed to order and install a scrubber and of the relative loss of revenues while the ship is under modification[25].

[24] "IMO 2020: IP week's takeaways", D. Corsini, Intesa Sanpaolo / Banca IMI Macroeconomic and Fixed Income Research, 06-03-2019.

[25] Further uncertainty is related to regulatory risks, since the "open loop" scrubber category is still not

d. switch to alternative fuels like LNG-powered, electric or new hybrid vessels (those endowed with dual fuel engines). Although being the most expensive strategy, it might offer the best payoff in the long term due to its full compliance with IMO 2020 and the efficiency provided by new generation engines.

2.4 International relations: the ethics of Arctic development

The way that problems and solutions regarding the fossil resources of the Arctic and the development of the NSR are defined and promoted also poses an ethical dilemma of global significance. An important share of the world's as-yet unexploited oil and gas resources is located in Siberia and under the seabed of the Arctic Ocean[26]: as the sea ice keeps on melting, coastal States and energy companies obviously aim at reaching these northern resources. Using them would, however, cause emissions and accelerate climate change, so a debate has started on whether the new Arctic oil and gas reserves should be utilized or left untouched.

In light of the major annual Arctic meetings of politicians, business, academics and NGOs (like the Arctic Circle Assembly and the Arctic Frontiers Conference), there are currently two competing main ways to perceive and communicate about Arctic oil and gas and the shipping lanes set to develop them[27]. In this regard, a pivotal dividing line is whether the development of Arctic resources should be framed as a regional environmental problem or a global climate issue.

The regional approach highlights the risk of oil leaks and contamination from extraction and transportation: from this perspective Arctic oil and gas development becomes a limited environmental problem that can be solved with tools that are readily available: ecological protection and monitoring, scientific standards and advanced extraction technologies. The conclusion from this viewpoint is typically that the use of new Arctic fossil fuel resources is ethically justifiable since it can be done sustainably and in an environmentally-friendly way.

compliant in some major ports like Singapore.

[26] For an overview on the economic development of energy commodities of the region is provided in Chapter 2 "The Northern Sea Route: a New economic Scenario", p. 7; and Chapter 4 "The Strategic positioning of the global players in the Arctic region", p. 41.

[27] "Climate Change and Arctic Security", L. Heininen, H. Exner-Pirot, 2020 doi:10.1007/978-3-030-20230-9

Such vision has however been challenged by a more global viewpoint on the Arctic, that has shifted the attention from the vulnerable Arctic nature to the greenhouse gas emissions that would result on a planetary scale from the utilization of the new under-ice reserves. The key argument is that, since fossil commodities have a climate impact irrespective of their geographical place of origin, it is therefore questionable to promote further development of polluting resources in the Arctic, regardless of how environmentally friendly and safe the extraction and transportation operations might be. The implication surrounding this position is also that that climate change is essentially a global challenge that requires an international response and there is therefore no special responsibility from Arctic States to refrain from using the new resources. Another scientifically sound objection is that it is actually the consumption of fossil fuels (not their production) that matters, as emissions are related to the use of natural resources that mostly takes place outside the Arctic[28].
The debate gradually encompassed other fields like sustainable economics, disputing that the Arctic players benefiting from fossil fuels utilization are basically moving the harms of climate change to future generations or to impoverished people who have little say in global politics. Striking a balance between these conflicting (but not necessarily mutually exclusive) interests is possibly going to become one of the most demanding quests of the century.

3. Promoting the proactive governance and the sustainable development of the Northern Sea Route

In recent years the Arctic has become a complex and multifaceted chessboard for a multitude of players, each with a distinct agenda and priority list on how it should be governed and developed in the near and far future. Also, the peaceful cooperation so far experienced in the region, coupled with the relatively higher costs of operations for the extraction of fossil resources and the slow construction of a logistic infrastructure capable of sustaining commercial maritime traffic, might extend this period of low competition for some decades. Yet, even the most optimistic estimations conclude that this scenario is eventually going to change drastically due to the effects of global warming, begging the question

[28] "The Arctic: opportunities, concerns and challenges", E. Quillérou, M. Jacquot, A. Cudennec and D. Bailly, Ocean Climate.org 2017 http://www.ocean-climate.org/wp-content/uploads/2017/03/the-arctic_07-9.pdf

of what kind of Arctic governance will emerge and regulate private business, public needs and environmental protection.

Many studies[29] have positively assessed the work done so far by international bodies and regional fora in keeping the region a pacific ground for, inter alia, scientific research and international security efforts despite diplomatic and commercial tension erupting in other areas of the world. In this regard, a potentially very effective initiative has been recently put forward: the creation of an Arctic Development Bank (ADB)[30].

Following the footsteps of existing regional and multilateral development banks in successfully implementing large-scale infrastructural projects, a properly endowed ADB would have the capabilities to:

a. raise significant amounts of supplementary financing on international capital markets at relatively low costs to governments;
b. channel collected funds into synergic plans that could host public / private ventures;
c. ease political tensions between funding States and organizations;
d. cover "unfavorable" projects especially in their pioneering stage, like in the case of the construction of logistics hubs in Eastern Siberia and deep-water ports along the NSR;
e. allow the execution of long-term development plans that would also uphold high environmental protection standards;
f. ensure level playing fields among companies from different countries.

Theoretically, the ADB might choose to adopt a governance structure broadly similar to that of the other multilateral entities. For example, in determining its initial member governments it could replicate the membership structure of another Arctic institution (In that case, the Arctic Council appears to be the most logical choice). Alternatively, if the ADB wished to maximize its share capital and access to international capital markets, in addition to the members of the Arctic Council, its membership might be expanded to include non-Arctic governments (for example, Arctic Council observers), which have a demonstrated commitment to promoting sustainable northern development.

[29] "The Arctic: opportunities, concerns and challenges", E. Quillérou, M. Jacquot, A. Cudennec and D. Bailly, Ocean Climate.org 2017 http://www.ocean-climate.org/wp-content/uploads/2017/03/the-arctic_07-9.pdf and "Arctic Meltdown: The Economic and Security Implications of Global Warming", S. G. Borgerson, Foreign Affairs, Vol. 87 No. 2 April, 2008 http://www.jstor.org/stable/20032581

[30] "Sustainable Northern Development – The case for an Arctic development bank", A. Gill and D. Sevigny, CIGI Papers n. 54, January 2015

The voting power of each member could be determined through negotiations to reflect their economic strength and importance in the region. Governing structures could also include a board of governors (which would be responsible for major decisions), a board of directors (with responsibility to oversee the institution's day-to-day activities), and a president who would be responsible for the overall management of the institution.

Finally, the ADB might consider a number of innovative features, like requiring a fixed percentage of its lending to be directed to certain specific types of projects (similarly to the European Bank for Reconstruction and Development). As a measure of further protection of Arctic minorities, it could require that a specific percentage of loans directly benefit indigenous peoples in the region.

7 / Focus / The impact of Arctic Container shipping on the Hamburg - Le Havre Range Ports; a Case Study of the port of Antwerp

Global warming is causing a meltdown of the Arctic ice cap. Consequently, routes going via the Arctic and connecting Eastern Asia to North Western Europe, in a shorter distance, are becoming viable. However, the start of commercial container shipping operations in the Arctic could be a disruptive change for the global container shipping market. The main objective of this chapter is to discuss the possible effects of container shipping through the Arctic (using the Northern Sea Route (NSR)) on the ports in the Hamburg - Le Havre (HLH) range.

Given the uncertainties and frequent new developments surrounding the topic, three scenarios to discuss possible effects of NSR on HLH range ports have been proposed. In link with the proposed scenarios, the present chapter seeks possible impacts of NSR on HLH range ports, then focuses on the port of Antwerp (poA) with a SWOT analysis.

The outcomes of the study indicate that, due to traffic, using NSR will approach the HLH range ports in a reverse order, while poA will have a chance to reposition itself as the southern-most port in HLH range, although accompanied with disadvantages of their own.

Today, the circumpolar North area's geography is changing and offering new possibilities. Although this all attracts a lot of interest, it brings a lot of uncertainty. While almost all the results of global warming have affected the shipping industry negatively (Wright, 2013), voyage planning seems to be benefitting from it. Increased temperatures in the Arctic area have made the ice melt and opened up new routes that had previously been deemed impossible. When geographic conditions change, national interests shift as well. For the shipping industry, these new routes are an opportunity by shortening the Far Eastern Asia to North Western Europe trip both in distance and in time (Bekkers *et al.*, 2015), which will result in a reduction of fuel consumption.

This is a big advantage for the shipping industry to drive fuel costs down and to lower shipping related emissions (Wan *et al.*, 2018) in order to follow the International Maritime Organization (IMO) strategy on reducing Green-House Gases (GHG) emissions, which sets a target of 50% absolute reduction by 2050, compared to 2008 levels (Hughes, 2016).

There are many examples of research papers on the Arctic from a maritime perspective, although little research has been done on the Arctic from a port perspective, particularly in the HLH (Hamburg-Le Havre range). The scope of this chapter will be on possible future container shipping lines crossing the Arctic via the NSR, connecting two major global economic regions, North-Eastern Asia and North-Western Europe. Among all possible shipping types, container shipping was chosen to be in focus, since many ports in the HLH range have big interests and investments in container handling. Ports located in North-Western Europe are responsible for the main flow of importing and exporting goods on the East-West trade route, and the ports on the HLH range are also responsible for handling half of the container traffic in European ports (UNCTAD, 2017). Since the start of commercial shipping operations in the Arctic routes, its possible outcomes (for example: how it will affect the developments of the region) and possible impacts on the ports, have become extremely interesting and debated topics.

The goal of this chapter is to fill the gap in the literature, while focusing on the potential opportunities and threats of Arctic liner shipping in the port of Antwerp. This goal leads us to the following research question for this chapter;

'What is the possible impact of container lines sailing through Arctic Routes on HLH range ports, and port of Antwerp (poA) in particular?'

The process of achieving an understanding of the impact of the opening of the Arctic Route on the HLH range ports requires an in-depth insight into various stated perspectives and components that play a role in NSR. Figure 1 presents the workflow, which takes these different components into account.

Next to the gathered inputs from the literature review, different stakeholders (representatives of shipping lines) are interviewed and get their perspectives on how their business may be affected from the opening of the NSR and how this would affect port-of-call selection in HLH range ports. Given the uncertainties surrounding the topic, three scenarios to discuss possible effects of NSR on HLH range ports have been proposed.

Workflow of analysing the impact of NSR on the poA

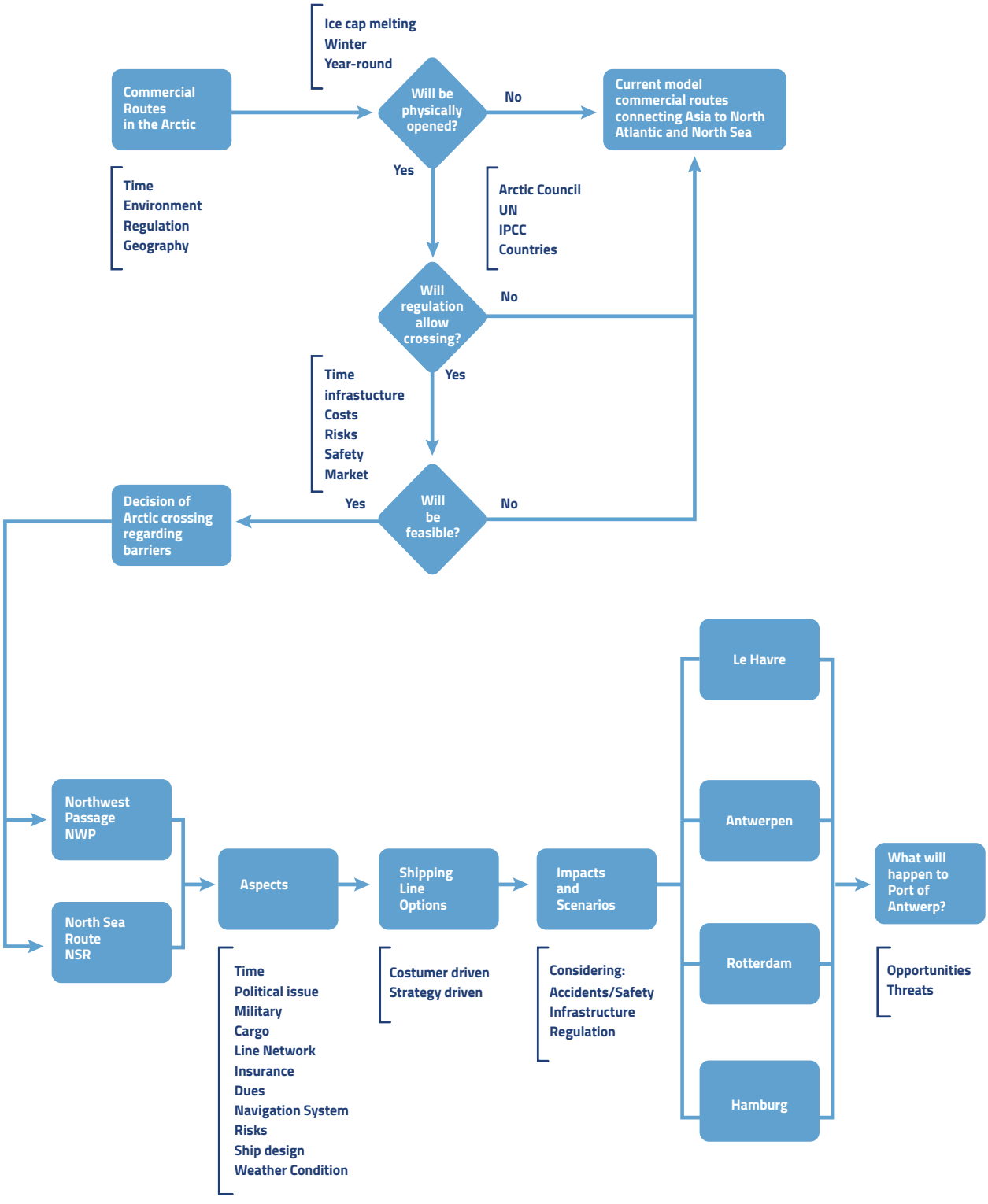

Figure 1 - Source: SRM on authors' elaborations

In the first scenario, NSR will not be viable for the foreseeable future; in the second scenario, NSR has become active in container shipping traffic as a main route. In the final scenario, NSR being used as a supporting route is discussed.

The perspective of this research's goal is investigating and discussing the possible impact of container shipping through the Arctic on HLH range ports (and the poA in particular) due to the drastic change it may bring to the trade route between North-Eastern Asia and North-Western Europe in the future. A SWOT analysis is then applied to illustrate advantages and disadvantages of the NSR for the poA.

A SWOT analysis is a technique to identify the 'Strengths', 'Weaknesses', 'Opportunities' and 'Threats' for a particular business organization. SWOT analysis is used to create a synthesized view of current state of poA, and how it might affect poA if NSR is used for container shipping routes, by demonstrating the opportunities and threats, which point to the possible impacts of container shipping via the Arctic on poA.

This chapter is structured as follows: section 1 presents the literature review. Section 2 gives the results of the interviews with the container shipping lines. Section 3 deals with the scenarios that are developed to facilitate the analysis of possible impacts of NSR. The SWOT analysis is presented in section 4. The chapter concludes with suggestions for future research.

1. Literature Review

1.1 The current situation of the Arctic routes

The downside of the Arctic routes starts with the fact that it is not (yet) possible to use these routes year-round. Nonetheless, increasing temperatures are allowing longer periods of ice-free passage, although it will still take decades until all-year-access is possible. However, with increasing global temperatures, the arctic ice cap is diminishing and enabling longer navigable periods, encouraging shipping companies to utilize northern shipping routes more extensively, particularly using the Russian NSR, which has been developed and promoted by Russia as a new maritime trading route (Chircop, 2016).

The Soviet Union has been working on the development of the NSR by investing in ports and icebreakers, which has gained speed, especially during the 1980s, due to oil and gas industry activities today, which are still mostly 'point-to-point' traffic in the Arctic region (Melia *et al.*, 2016). Consequently, a significant increase in arctic shipping activities has been observed. In this respect, 71 ships sailed using the NSR in 2013, and Russian authorities expect this volume to be 20 times greater by 2030 (Yin *et al.*, 2014 as cited in Zhu at al., 2018).

The commercial use of Arctic routes has the potential to bring massive benefits that are, however, accompanied with disadvantages of their own. The most obvious benefit is the shorter sailing distance, which translates into less fuel burn and a shorter trip time, which will enable an increased frequency for each ship, thus increasing total capacity for the route.

However, the harsh environment and ever-changing ice conditions in the NSR have created technical challenges to ships and ports, where ports along the NSR are not well developed and have poor infrastructure. Hence, if a ship needs repairs along the route, they can only get minimal service at the existing ports, and need to reroute to Murmansk or Vladivostok (Zhu *et al.*, 2018), which means a lengthy diversion from the intended trip route. Ports on the NSR, however, can provide bunkering, provisions and even shelter when this might be needed. For bigger ships, depths in anchorage area and wharfs in NSR ports are yet another problem, and, because current facilities do not meet the shipping companies' fundamental necessities for cargo handling, navigation and rescue, Russia has planned to construct the required infrastructure along the NSR itself (Zhu *et al.*, 2018). Ships will also need to be capable of navigating the rough Arctic sea, which has still not been completely charted. Due to this fact, ships will travel slower compared to the current well-known trade routes. Moreover, ships will need ice-strengthening and they may still need the assistance of ice breakers (Pastusiak 2016, as cited in Zhu *et al.*, 2018). In this respect, sailing in the NSR has always been hazardous due to unpredictable weather conditions and ice in the sea, and the navigable season is always subject to change due to these factors. In this regard, commercial shipping will also be negatively affected from this situation since markets demand goods be delivered on time (Chircop, 2016).

Table 1 provides an overview of NSR for container lines with points for and against derived from the literature review.

Advantages and disadvantages of an NSR for container lines

Advantages	Disadvantages
Shorter distance (North-Eastern Asia to Europe: approximately -40% reduction)	Technical challenges on ships and facilities (changes in ice condition)
Lower risk of piracy (the Strait of Malacca and Gulf of Aden)	Depth of ports in the region are limited (big ships cannot access or secure technical support)
Shorter transit time	Navigation
Fuel-consumption saving	Lack of Search & Rescue infrastructure
Planning and working on sufficient infrastructure along NSR	Effect on a unique ecosystem (unexpected impacts on regional/global environments)
	Infrastructure during the routes
	Transparency (fuel provision)
	Ice-class requirement and escorting icebreakers
	Policy issues
	Complex geographical situation
	Uncertain sea-ice and unfavourable weather conditions
	The length of the sailing season
	Uncertainty in commercial viability
	Waste management in the Arctic areas
	Alternative transport options such as railway
	Differing nature of tramp and liner shipping in container shipping
	High insurance costs

Table 1 - Source: adapted from Pruyn, 2016; Zhu *et al.*, 2018; Bekkers *et al.*, 2015; Melia *et al.*, 2016; Chircop, 2016; Walkowski, 2015

1.2 Hamburg - Le Havre range ports

Having the most economically-developed hinterland regions in continental Europe, HLH range ports facilitate international trade with regions separated by large water bodies. Stopford (2009) states that a port is part of the transport system and is a pivotal interface between land and sea.

Like every other major port in the world, HLH range ports possess crucial importance to the countries they are located in, and the economies of these countries reap the socio-economic benefit that these developed ports bring. In this respect, economic activities are boosted: key infrastructure is developed, jobs are created and other sectors such as banking and insurance are supported indirectly.

Table 2 demonstrates the significance of the container traffic between Asia and Europe in global East-West trade routes. Even though this share of almost 41% includes Mediterranean and Middle East traffic, still a considerable amount of this traffic still has the potential to benefit from a possible NSR in the future.

Advantages and disadvantages of an NSR for container lines

	Trans-Pacific		Asia-Europe		Trans-Atlantic		Total
Year	million TEU	%	million TEU	%	million TEU	%	million TEU
2014	23.2	44.70%	22.0	42.39%	6.7	12.91%	51.9
2015	24.0	45.71%	21.7	41.33%	6.8	12.95%	52.5
2016	25.4	46.35%	22.4	40.88%	7.0	12.77%	54.8
2017	26.6	45.70%	24.0	41.24%	7.6	13.06%	58.2
2018*	27.6	45.70%	24.7	40.89%	8.1	13.41%	60.4

Table 2 - Source: UNCTAD, 2018 (Note by UNCTAD, 2018 data are projected figures, as the report was released in October 2018)

Container throughput in the HLH range ports, destination/origin independent, is led by Port of Rotterdam, followed by Antwerp, Hamburg, Bremerhaven and Le Havre (table 3).

Total tonnage of containers handled in HLH range ports in 2018

Port	TEU
Rotterdam	14,512,661
Antwerp	11,025,696
Hamburg	8,700,000
Bremen	5,483,222
Le Havre	3,000,000
Zeebrugge	1,599,467

Table 3 - Source: Clackson's, 2018

Several researchers seek to model container flows, and, with the results or indications, then suggest possible shifts, trends or conditions among the HLH ports. Tavasszy *et al.* (2011), working with container flows, demonstrate in a scenario in which NSR is used between Port of Rotterdam and Port of Yokohama what the model suggests as the impact on the total container throughput in the Port of Rotterdam. Results suggest that Rotterdam is estimated to gain in 0.65 million TEU traffic. The results for this model show an estimation of 1.5% of the total of container flows would shift to a transarctic route. For this observation, it is verified that the volume handled by considered ports does not change significantly. The estimations presented by Bekkers *et al.* (2015) claim an average 10% increase of trade flows between Asia and Europe, as a result of cost reduction, which needs further research to clearly form a link with demand increase in Rotterdam. It is agreed here that Rotterdam, as the main access point for The Netherlands, a great part of Germany and, substantially, also to other European countries will benefit in the case of an economically feasible NSR, but the dynamic of the operating ports in the vicinity must also be taken into consideration.

2. Shipping line's expectations on possible Arctic crossing

The survey participants consider that container shipping through the Arctic will become a reality, and also expect this crossing to become sustainable around the year 2030. The most important criteria for them, regarding making the decision to start using the Arctic Route, is safety. They have no plans for the Arctic commercial crossing yet, and they do not think the Arctic crossing will affect the current port-of-call selection in which Port of Rotterdam is the first port of call and any port in the HLH range can be the last port of call. Participants consider that the Arctic Route, when it is realized, will be a main route with developed supporting ports and activities along it.

Shipping lines consider available port capacity, port costs and accessibility of the port as the key factors in calling at a port in the future. For ships coming from Asia, Rotterdam is the choice for the first call. However, for the ships returning to Asia to select the last port of call, there is no distinction between the ports in the HLH range. In this regard, small ships will be crossing the Arctic by 2030, medium-size ships by the following decade and large vessels by 2050. A similar thought is expressed regarding route development expectations. By 2030, the infrastructure along the route will be inadequate, while the conditions will

have improved and become somewhat fair and, by 2050, average standards will have been reached. Navigation and the ice cap are the biggest risk factors for the possible arctic crossing; risk imposed to the crew, vessel and local people are intermediate level risk factors, and finally threats towards nature are considered, by the shipping line as a minimal risk factor.

3. Scenario development

Reliably determining how and when Arctic routes will allow container liner shipping operations is not feasible, due to the uncertainties within most of the factors. However, the data obtained with the literature review and conducted surveys can be used to build possible scenarios that can facilitate abstraction on the matter. Evaluation and discussion of these scenarios then give insight into whether container liner shipping operations in the Arctic will become a reality, and how this initiative would affect the ports in the HLH range. As a result of this process, three scenarios are proposed (Figure 2). Scenario A is the current status, in which NSR is not used for container shipping except for trials, thus representing the baseline in this study. Scenarios B and C represent the cases where NSR is viable for container shipping in the foreseeable future.

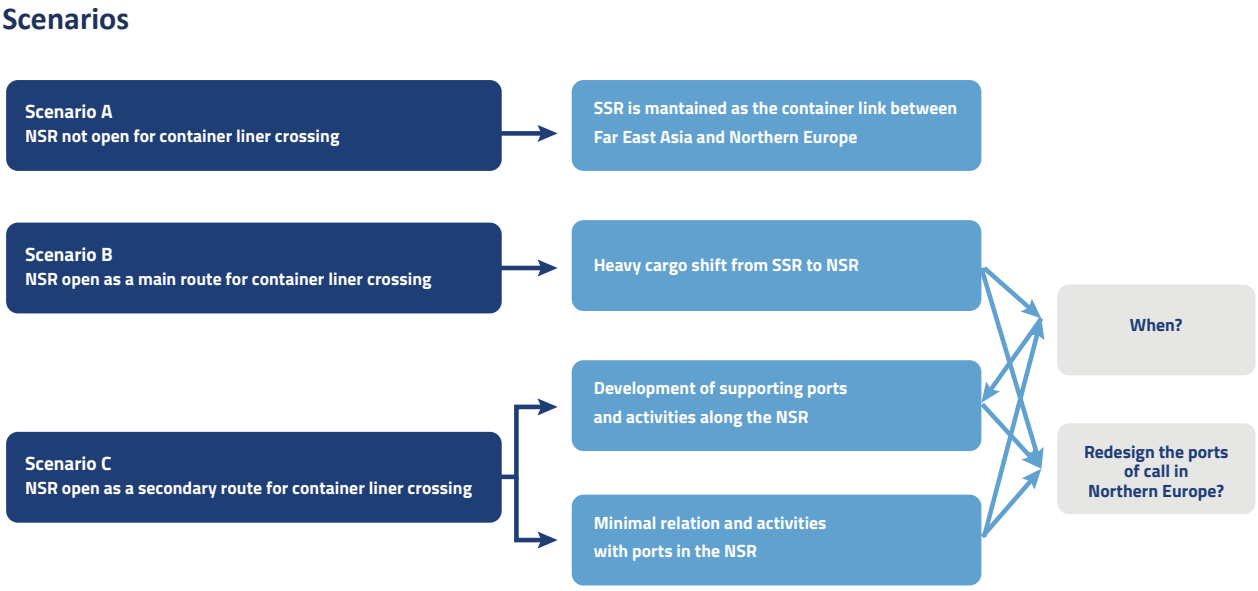

Figure 2 - Source: SRM on authors' elaborations

3.1 Scenario A - current SSR as the main link between Far East Asia - Europe

There are various reasons why NSR may not serve as a container shipping route in the foreseeable future. Humpert and Raspotnik (2012) claim in 'The Future of Arctic Shipping' article that not having enough ports of call along the Arctic routes compared to the existing shipping routes such as SSR, is a big concern. Developing the necessary infrastructure along the NSR is unlikely to be as quick as the global warming that leads to melting of the polar ice cap. For NSR, reaching the same risk and safety standards as existing routes is another challenge. The environmental impact of a possible NSR here is also worrisome.

The ultimate reason why NSR will not attract container shipping is the reliability and punctuality needs of this transport type. "Delays are costly for industry because markets rely on just-in-time delivery of goods (Chircop, 2016)". The navigable season in the Arctic is not predictable. In addition to that, global warming will not only cause the ice cap to melt down, but will also create further adverse weather conditions, free-floating ice and even ice-bergs. A container liner adhering to tight schedules due to business requirements, therefore, would not enjoy the unreliable conditions NSR may offer.

For this scenario, a more environmental approach draws an Arctic where it should keep its current status of navigation for regional purpose and, in this way, maintain the main axis of the Eastern Asia – Northern Europe commerce through the Malacca Straits and Suez Canal. With this configuration, the Suez Canal will maintain the expected growth rate, since an increase of the trade between China and the ports in the Mediterranean Sea is expected.

4.2 Scenario B - NSR as a main link between Far East Asia – Europe

In Scenario B, NSR emerges as the main route for container shipping lines looping between North-Eastern Asia and Northern-European ports. This drastic change does not happen in an instant, but will happen gradually due to the ice cap reduction happening gradually. Bekkers *et al.*, (2015), Comiso, (2012), Rodrigues, (2008) and Rogers *et al.*, (2015) advocate that a navigable window of ice-free sea will be long enough to enable a tremendous shift of container traffic by half-way through this century. With the progressive retreat of the Arctic ice cap, research shows that a considerable amount of polar ice will melt permanently between 2030 and 2050, and main fixed seaways could be drawn in the NSR. However, even if the Arctic ice cap allows Arctic crossing, there are three main obstacles that should be tackled before container shipping operations shift towards NSR.

Since this change will happen gradually, there will still be considerable ice along the NSR in the early phase. Therefore, ships utilizing this route will need to be ice-class vessels, and adequate ice-breaking activity should be present. This aspect is directly influenced by Russian authorities. The NSR today is supported by two operational bases for icebreakers (NSRA, 2018), and a limited number of available vessels. Russia, with the aim of developing NSR, should open the icebreaking pilotage market to more reliable companies, allowing competition and better services that are able to fulfil the growing number of vessels crossing from 2030 to 2050.

A lack of adequate ports of call along the NSR is the second obstacle. Ports along the NSR will therefore need to develop a minimal structure of supporting activities. Today, most of these locations operate with scarce resources, where shipping companies consider security along the route as a top priority. In the case of an emergency or in demand of urgent mooring, a vessel transiting through NSR, with an expected port call only in Europe, will stop at the closest port having enough capacity to receive it. Therefore, an increase in container shipping via the NSR will demand an improvement of the infrastructure in the ports along the NSR.

Finally, the willingness of shipping companies to utilize NSR for container shipping can be considered the final obstacle. Companies with a more stable financial condition and/or driven by regional or local policies tend to take advantage in the quest and, most likely, these companies will be the first ones to inaugurate a fixed loop in the NSR. With Hanjin's bankruptcy and Hyundai Merchant Marine (HMM) having difficulties (Lee and Kim, 2015), the Korean container liner shipping does not present any strong appetite for NSR. The survey participant from Mediterranean Shipping Company (MSC) has stated that the company has no strategic plan regarding the Arctic yet. Conversely, Maersk has been continuously referring to the Arctic in its strategy, where, after demonstrating interest in NSR to the Northern Sea Route Administration (NSRA) last year, a new ice-class vessel was delivered for trials (Humpert, 2018). Along with Maersk, there is also COSCO. In this regard, the Chinese shipping line is already having trials in the last years (Zhao *et al.*, 2016) and following the Chinese government strategy (Huang *et al.*, 2015), the company has had the chance to take advantage of China's interest and desire to assert dominance in the area.

3.3 Scenario C - NSR as a supporting route

In this final scenario, a middle ground between the first two scenarios is expected to occur. NSR here will become a route used for container shipping between South-East Asia and North-Western Europe. However, rather than becoming a main route, it will be a supplementary one. This scenario seems most plausible due to various factors.

In most cases, container shipping requires 'just in time' delivery. The uncertainties here regarding how many days in a year the NSR will allow shipping operations, how the infrastructure will develop along the route, lack of ports to call along the route for transhipment and, last but not least, environmental concerns regarding a fully developed route all support this scenario. Pruyn (2016) reflects that NSR "might not be suitable for container traffic, as there is too much uncertainty to run a sufficiently reliable liner operation".

Nevertheless, the opportunity offered by Arctic crossing via NSR, is too valuable to be missed. A few shipping lines, as suggested by the readiness conditions brought by Lee and Kim (2015) and their analytical framework, will attempt first trials, following the ice retreat forecast between now and 2030. By the time period forecast by the three scenarios built in this study, from 2030 to 2050, most of the above-mentioned reservations, if not all of them, are likely to be resolved. COSCO and Maersk here have already exhibited their interest in NSR among other competitors, in a period of financial instability (Wright, 2017). With NSR becoming a secondary / supplementary route, the expectation is that, along with the Belt and Road Initiative, more advances involving Chinese companies and capital will follow. Moreover, NSR can complement the efforts with other routes the initiative represents (Figure 3).

Verifying the NSR movement data from Centre for High North Logistics (CHNL) (2017), one particular insight becomes evident; as the operation in the NSR will be done by ice-class vessels, with or without ice-breaking assistance, the vessels reaching the North Sea will also be able to sail to the Baltic Sea and the Gulf of Finland, calling at the port of Saint Petersburg in Russia, for instance. This is not common today, where a vessel coming from Far East Asia via the Suez Canal will possibly do a transhipment in the port of Rotterdam, and the container will continue by regional services to its final destination. This opportunity is not inclined to replace usual operations, as happens in the HLH range ports, but can bring a measurable impact, as the representativeness of consumption and production centres in the Baltic are not as large as compared to the Northern Europe ones, but still has meaningful demand.

The East - West links

Figure 3 - Source: SRM on Tavasszy *et al.*, 2011

4. SWOT analysis on port of Antwerp if NSR becomes viable

Based on the literature review, applied survey and critical examination of scenarios, a SWOT analysis is applied to investigate opportunities and threats for PoA.

The strengths of poA mainly come from its geographical location and it being a long-e-

stablished port that is part of the global supply chain (Haezendonck and Langenus 2018). The region in which poA is located and serves is densely populated and urbanized.
It has been a valuable economic asset for Belgium for centuries, and has thus become a key driver to the local economy and built a flexible labour pool (Haezendonck and Langenus 2018). It is a well-developed port, having a high level of terminal operations and container handling productivity. Inland waterway connections and land transport infrastructure (rail and road) complement poA as an intermodal transport hub.
The opportunities of poA are enriched with its attractiveness to related industries, such as petrochemical clusters. Port operations are handled with efficiency, thus customers, shipping companies or terminal operators trust the quality of the service given. In this respect, improving this service quality even further will make poA even more advantageous in HLH range ports. MSC and PSA here has a joint venture terminal investment in poA, which is claimed to be the single largest container terminal in Europe (MPET, 2019). One other opportunity of poA is its good hinterland connections to Northern France. If NSR becomes a viable option, then poA will be the biggest, most southern located port in the HLH, which may create an opportunity and focus on export traffic in order to guarantee port calls for container ships coming from East Asia to the HLH range. The port is also planning to build additional terminal capacity (Saeftinghe dock) to ensure potential further growth of container handlings.
The weaknesses of poA are also mostly related to its geographical location. Container ships need to travel upriver on the Scheldt in order to reach the port, requiring pilotage. Also, there is a limited growth opportunity for intermodal rail freight from the port.
Threats to poA are fuelled by the competition between the HLH range ports: to the North the ports of Rotterdam and Hamburg, to the South the port of Le Havre, and to the west the port of Zeebrugge. If NSR becomes viable, poA may be at a disadvantage, since the ports of Rotterdam and Port of Hamburg are easier and quicker to reach for container ships using NSR. This could impact the potential container handling volume in Antwerp.
Furthermore, even though there is an entirely different transport methodology with railroads, the Chinese Belt and Road Initiative is also threatening poA, since this route will be a direct alternative to the container traffic originating from Eastern-Asian to Northern-European ports, including HLH range ports.
Table 4 summarizes the above in a SWOT table.

SWOT analysis of poA in view of NSR

Strengths	Weaknesses
• Serves a consumption-heavy region • Key driver to local economy • Global supply chain • Container handling productivity • Flexibility of labour pool • Diverse warehouses • Intermodal transport hub	• Accessibility (access via river, pilot is needed) • Limited growth opportunities for rail connection to hinterland
Opportunities	**Threats**
• Attractiveness to other industries • Reposition itself in HLH range as a first port of call for France • Hinterland connection into the main land of Europe	• Competition from other ports (i.e. Port of Hamburg & Port of Rotterdam) which have a shorter sailing distance for the NSR route. • Additional competition might be expected from the Belt and Road Initiative

Table 4 - Source: literature research, scenarios and surveys

The circumpolar North area's geography today is changing and offers new possibilities, all of which has attracted a lot of interest, but also brings a lot of uncertainty. Accessibility is the key factor for Arctic shipping, so collaboration amongst countries, communities and business enterprises is the key in order to enable accessibility within the Arctic.

Throughout this chapter, the authors have sought answers for the research question defined as: "What is the possible impact of container lines sailing through Arctic Routes on HLH range ports, with poA in particular?" Therefore, the authors have constructed a number of potential scenarios and attempted to answer the research question with a critical discussion of them.

Three scenarios have been constructed here in order to study the possible effects HLH range ports can face from having container shipping operations through the Arctic using NSR: scenario 1 deems commercial shipping through the Arctic as an unrealistic option; scenario 2 evaluates NSR as becoming a main route for commercial shipping; scenario 3 finally considers the same route to be a secondary supplement route.

The information collected from existing literature was combined with survey data, where the feasibility of each scenario is evaluated.

Given the economic advantage that the NSR offers, also the geo-political interest from Northern countries will rise. However, existing problems such as lack of legal framework, limited sailing period in the region throughout the year, physical challenges and sustainability goals, will take time to be resolved or tackled. The authors predict that NSR is very likely to start being used by container shipping through the Arctic within the next 20 to 30 years. Thus, the NSR has a large potential to attract trade flows, especially between North-Eastern Asia and North-Western Europe. Such Arctic routes will rather offer alternative supporting routes for container shipping liners in order to complement the existing traditional sea routes in a gradual manner. Countries heavily involved with the Southern Sea Route here risk losing the current trade flow to the NSR and, in return, the countries that will benefit from the NSR will face increased economic and political tension. France, the Netherlands and Germany have gained observer status within the Arctic Council between 1998 and 2000. So, it can be expected that Belgian government joins this organisation in order to support the development of the region, pursue cooperation and support the interests of PoA.

Regarding the research questions, with respect to effects of such an Arctic route becoming available on the ports on HLH range, no major impact is expected by the authors. However, minor changes in call-of-port selection can be expected since ports in the HLH range will have an opposite order when ranked by route length. For the shipping companies involved, the survey data suggests that available port capacity, accessibility of the port and port costs are the biggest factors driving the port of call selection in the future. These survey results indicate that the port of Rotterdam is likely to keep its favourable position, although the port of Hamburg, for example, may possibly gain a competitive edge due to shorter distance advantage and its good hinterland connections. Likewise, the port of Le Havre may lose some ground due being the remotest port on the NSR route, having poor hinterland connections and inflexible labour.

On the other hand, poA may find an opportunity when the port of Le Havre loses ground.

Realizing that it will be the furthest port in HLH range for ships using NSR, when the port of Le Havre is excluded, it could develop a strategy to become more export-heavy and re-position itself as the southernmost port in the HLH range.

Even though there are scientific predictions about the region, many factors, such as the geo-political interest of Northern countries and the dynamics of container shipping routes are still open for debate, some of which are somewhat speculative. New developments related to the topic are happening frequently, so further research is recommended on top of the results of this study. The effects of (de-) globalization, changes in market structure (the Eastern European market gaining importance), a possible production shift in Asia (production moving from China to South-Asian countries such as Vietnam and Bangladesh) are major factors that may affect any Arctic crossing initiative.

8 / Focus / AIS-based Cost Estimation of Bulk Carriers per Voyage on Arctic Northeast Route

Based on previous studies, this chapter compares and analyses the costs of dry bulk carriers on Arctic Northeast Route with those on traditional ones, calculates the fuel oil cost based on AIS data, and incorporates the increased risks on the Northeast Route into cost calculation. With single-voyage cost, average annual cost and necessary freight rate as evaluation indicators, this chapter uses the financial indicator NPV (net present value) to make financial analysis on bulk carrier items on Arctic waterways in order to obtain more objective and comprehensive results.

Arctic waterways are primarily composed of three parts. The Northeast Route, which opened in the 1930s, features relatively straight channels. Presently, the route is navigable for three to five months a year and is covered by ice for the rest of the period when navigation through it requires icebreakers to act as a convoy. The global warming has led to melting of sea ice in the Arctic Ocean, which is expected to become fully thawed in summers in this century. As per current research and studies, Arctic waterways are practical to a certain extent. With the navigable time window widening, the Arctic routes will become safer.

China has seen some success in navigating through the Arctic Northeast Route, such as navigation by Yong Sheng, Tian Xi and Xiang Yun Kou vessels. However, due to the patchy development of Arctic waterways and the various risks involved, current vessels sailing on the Northeast Route are mostly multi-purpose ships and fishing vessels, while container ships and bulk carriers among the three main ship types rarely use the route. Wang Yuqiang and Shou Jianmin designed the China-Europe Route that runs via the Arctic Northeast Route and analyzed its economic significance[1].

[1] Wang Yuqiang and Shou Jianmin. Design and Economic Significance Analysis of China-Europe Route That Runs via Arctic Northeast Route [J]. Marine Technology, 2013, 02, 21-24.

Li Yuwei proposed a ship energy consumption model based on ship motion trajectories[2]. Li Zhenfu and Liu Yiying *et al.* studied the economic significance of container shipping through the Arctic Northeast Route[3,4]. Liu Jianlong analyzed the overall economic significance of the Arctic Northeast Route[5]. Yao Mingyue *et al.* discussed the impact of the opening of the Arctic Northeast Route on Sino-European trade based on the Gravity Model of Trade[6]. Zhang Xiao recorded the whole process of Yong Sheng ship navigating through the Arctic Northeast Route[7]. Cui Jianfeng *et al.* analyzed the key must-pass sea areas along the Arctic Northeast Route[8]. Qian Zuoqin *et al.* proposed the navigation strategy of the Arctic Northeast Route and studied its economic significance[9]. Wang Bin analyzed the oil transportation situation of the Arctic Northeast Route[10]. Dong Jiang *et al.* analyzed the navigation environment of key waters along the Arctic Northeast Route and main ports along the route[11]. Ding Kemao *et al.* analyzed the current navigation status and the maritime support capability of the Arctic Northeast Route[12].

[2] Li Yuwei Study on Statistical Algorithms of Ship Energy Consumption and Carbon Emissions Based on Ship Trajectory, Research Report of Major Discipline Project of Applied Fundamental Research Sponsored by the Ministry of Transport (2014329810120) [R]. Shanghai: Shanghai International Shipping Institute, 2014.

[3] Li Zhenfu, You Xue, Wang Wenya, *et al.* Economic Significance Analysis on Container Shipping Through Arctic Northeast Route [J]. Journal of Jimei University (Philosophy and Social Science Edition), 2015, 18(01), 34-40.

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[6] Yao Mingyue, Hu Maixiu. Impact of Opening Arctic Northeast Route on Sino-European Trade - Analysis Based on Gravity Model of Trade [J]. Marine Economy, 2014, 4(5), 9-15.

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[8] Cui Jianfeng, Liu Dagang. Key Must-pass Sea Areas along Arctic Northeast Route [J]. China Maritime Safety. 2017, 12, 21-23.

[9] Qian Zuoqin, Xu Li, Yan Xinping, *et al.* Navigation Strategy and Economic Significance of Arctic Northeast Route [J], Chinese Journal of Polar Research, 2015, 27(2), 203-211.

[10] Wang Bin. Oil Transportation Analysis of Arctic Northeast Route [J]. Shipping Survey, 2017, 01, 32-35.

[11] Dong Jiang, Liu Lei, Wei Guobing. Navigation Environment of Key Waters and Main Ports Along Arctic Northeast Route [J]. Marine Technology, 2018, 03, 43-46.

[12] Ding Kemao, Liu Lei, Wei Guobing. Current Navigation Status and Maritime Support Capability of Arctic Northeast Route [J]. Marine Technology, 2017, 05, 40-43.

Zheng Lei discussed the interests of the countries located along the Arctic Northeast Route and the freedom of navigation[13]. Based on the previous studies, this chapter calculates the fuel oil cost with the help of the AIS data and estimates the cost of bulk carriers that sail through the Arctic Northeast Route to draw more objective and rigorous conclusions.

1. Analyzing fuel oil costs using AIS data

A ship trajectory can be represented as a combination of multiple legs arranged in chronological order. As long as the energy consumption of each leg is known, we can get the total energy consumption of the ship on this trajectory. The energy consumption of each leg is from the ship's main engine, auxiliary engine and boiler. This chapter selects the fuel oil consumption model in *Study on Statistical Algorithms of Ship Energy Consumption and Carbon Emissions Based on Ship Trajectory* and implements it in Python code with modifications made to the timestamp calculations.

The model is as follows.

1.1 Model validation

1.1.1 Fuel oil consumption of main engine

$$FCRm = LFm * MCR * SFOCm$$

Where:

FCRm - fuel consumption rate of main engine, unit: gram/hour (g/h);

LFm - load factor of main engine, dimensionless;

MCR - rated power of main engine, unit: kw;

SFOCm - the ratio of ships' main engine fuel oil consumption to the main engine work, unit: g/kwh.

MCR is available in ship archives databases and the SFOCm value is available in Table A1-1 of IMO2009.

[13] Zheng Lei. Arctic Northeast Route: Interests of Route-side Countries and Freedom of Navigation [J].International Forum, 2016, 18(2), 39-46+80.

Load factor under general sea conditions and rated draft conditions:

$$LFm = \left(\frac{Vactual}{Vdesign} \right)^3$$

Where:

Vactual - actual velocity, unit: knot;

Vdesign - designed velocity, unit: knot.

1.1.2 Fuel oil consumption of auxiliary engine and boiler

$$FCRa = LFa * MCR * Ra/m * SFOCa$$

Where:

FCRa - comprehensive fuel oil consumption rate of auxiliary engine, unit: gram/hour (g/h);

LFa - comprehensive load factor of auxiliary engine, dimensionless;

MCR - rated power of main engine, unit: kw;

Ra/m - the ratio of main engine total power to main engine SMCR, dimensionless;

SFOCa - the ratio of auxiliary engine fuel oil consumption to auxiliary engine work, unit: g/kwh.

The SFOCa value is available in Table A1-1 of IMO 2009. The Ra/m values of various cargo ships are between 20% and 40%, but the Ra/m values of bulk carriers, container ships, general cargo ships and oil tankers are between 19% and 22%.

Meanwhile, to verify the accuracy of fuel oil consumption data, this chapter refers to the sailing telexes in three voyages of three sister ships owned by COSCO Shipping Bulk Co Ltd to obtain the actual fuel oil consumption, and uses the AIS data of the three voyages to calculate the fuel oil consumption to analyze and compare the actual values against the theoretical ones.

The actual values come from the captains' sailing telexes.

Detailed Parameters of Ship

Name of ship	**QING QUAN SHAN**	**Call Sign**	**VRPL7**
Owner	CHINA SHIPPING NAUTICGREEN BULK 03 LIMITED. Address: 32/f, tower 2, Kowloon Commerce Centre, 51kwai Cheong Road, Kwai Chung, New Territories, HongKong		
Operator	CHINA SHIPPING BULK CARRIER CO., LTD. Room 402,NO.11 of 56 Jin Gang Da Dao, Nansha District, Guangzhou, P.R.C.		
Builder	CHINA SHIPPING INDUSTRY (JIANG SU) CO., LTD		
Date of delivery	30 N0V 2016	**Date of keel laid**	24-ott-15
Flag	HONGKONG CHINA	**Port of Registry**	**HONGKONG**
Official number	HK-	**IMO Number**	**9741530**
Classification	**CCS**	**MMSI**	**477854900**
Type of vessel	BULK CARRIER	**Light Ship**	11753.97MT
LOA	**199.90m**	**LBP**	194.50m
Breadth	**32.26m**	**Depth**	18.50m
GRT	**36388**	**NRT**	**21647**
Engine Power	8050KW	**Service Speed**	14.4Knots
Allowance for fresh water	301mm	**Distance from keel to highest point**	50.04m
Distance from bridge to bow	172.94 m	**Distance from bridge to stern**	26.96 m
H. Cover Type	ELECTRIC HYDRAULIC FORE & AFT OPENING	**Grain Capacity**	78642.4 m^3

DRAFT	**DISPLACEMENT**	**DEADWEIGHT**	**FREEBOARD**	**TPC**
13,577 m	76958	65240	4951mm	62.5
13,300 m	**75226.7**	**63472.7**	5228mm	62.4
13,023 m	73497	61743	5505mm	62.3
13,601 m	75226.7	63472.7	4927mm	62.5

Hold No.	**Hold Capacity**	**Hatch Capacity**	**Sub Total**	**Hatch Sizes**	**Ship's crane SWL X Grabs capacity**
1	**13252.5**	669.16	**13921.7**	**19.68*18.26**	No.1 30 mts X 15 cub
2	**16780.2**	880.48	**17660.7**	**22.96*18.26**	No.2 30mts X 15 cub
3	**14546.7**	754.93	**15301.6**	**22.96*18.26**	No.3 30mts X 15 cub
4	**15060.2**	754.91	**15815.1**	**22.96*18.26**	No.4 30mts X 15 cub
5	**15182**	761.33	**15943.3**	**22.96*18.26**	
	74821.6		**78642.4**	Max allowable Tank top	Hold no.1.3.5 25T/m2 Hold no.2.4: 20T/m2

Ballast pump rate	900cub/h × 2 sets	**Total ballast capacity**	17786.7+ 15301.6M3
Total fuel oil cap.	2012.1M^3	**Total diesel oil cap.**	241.5M^3
Total drink water	61.7M^3	**Total fresh water**	508.0M^3
Port consumption (PER DAY)	FO/2.5, CRANE WORKING FO/5.5, FW/12	**SUEZ GT/NT** **PANAMA NT**	30120
TYPE OF M/E	YMD-MAN B&W 5S60ME-C8.2	**MANUFACTURER**	Yichang Marine Diesel Engine Co., Ltd

Table 1 - Source: Authors' elaborations

1.1.3 Measurement and calculation results

(1)

Ship: Qing Ping Shan

Period: July 1-August 1, 2018

Route: Transpacific

Main engine fuel oil consumption as per model: 509.03 mt

Auxiliary engine and boiler fuel oil consumption as per model: 25.48 mt

Actual heavy fuel oil consumption: 507.57 mt

Actual light fuel oil consumption: 1.5 mt

(2)

Ship: Qing Yun Shan

Period: July 1-August 1, 2018

Route: Transatlantic

Main engine fuel oil consumption as per model: 517.24 mt

Auxiliary engine and boiler fuel oil consumption as per model: 24.29 mt

Actual heavy fuel oil consumption: 545.35 mt

Actual light fuel oil consumption: 23.4 mt

(3)

Ship: Qing Hua Shan

Period: July 4-July 31, 2018

Route: Transpacific

Main engine fuel oil consumption as per model: 235.61 mt

Auxiliary engine and boiler fuel oil consumption as per model: 24.21 mt

Actual heavy fuel oil consumption: 258.41 mt

Actual light fuel oil consumption: 1.4 mt

The above real ship validation shows that the AIS-based fuel oil calculation model has high accuracy and is applicable to actual fuel oil calculation. Yet after a comparison between the theoretical data and the actual data, we discover a problem that, though the total heavy oil consumption error in a voyage is not large, the daily errors are relatively signi-

ficant. Besides, the light oil consumption in actual voyages is extremely small and even zero in some cases. Consultations with experts show that the low light oil consumption is generally due to the following factors: (1) air conditioning, garbage incineration, and ship cranes; (2) entry into the low-sulfur oil zones. These factors should be taken into account for model revision.

1.2 Model application

Based on the theoretical basis of this model, this chapter selected a ship named Xiang Yun Kou to roughly figure out the fuel oil consumption for sailing through the Arctic waterways while identifying the legs that are more fuel-consuming. However, the detailed fuel oil consumption data of this ship is temporarily unavailable and the data is for reference only.

Voyage Information

Port of Departure	**Port of Qingdao**
Port of Destination	**Port of Sabetta in Russia**
Ice Class	**ICE1**
Main Cargoes	**Yamal Project Modules**
Ice Conditions	**1-2**
Icebreaking Time	**0.8 days**
Range Saved	**7.455**
Shipment Period Saved	**24 days**

Table 2 - Source: Authors' elaborations

Main Parameters of Xiang Yun Kou Ship

Hull No.	**413055620**
Length (meters)	**216**
Width (meters)	**43**
Port side distance (meters)	**22**
Back range (meters)	**188**
Draft (meters)	**9.1**
Gross tonnage of ship (DWT)	**35,569**

Table 3 - Source: Authors' elaborations

1.2.1 Velocity analysis

The AIS database provides the AIS data for the ship from 12:00 midnight on August 29 to 22:00 p.m. on September 21, 2016. With the data, we can work out the ship's sailing trajectory by extracting the latitude and longitude coordinates, timestamps and velocities of the ship in the AIS and arranging the data in chronological order. Specifically, with the observation points along the trajectory connected by straight lines, the trajectory includes a total of 2,215 observation points and 2,214 legs extending 5,912 nautical miles in total.

Velocity Analysis Based on Ship Trajectory

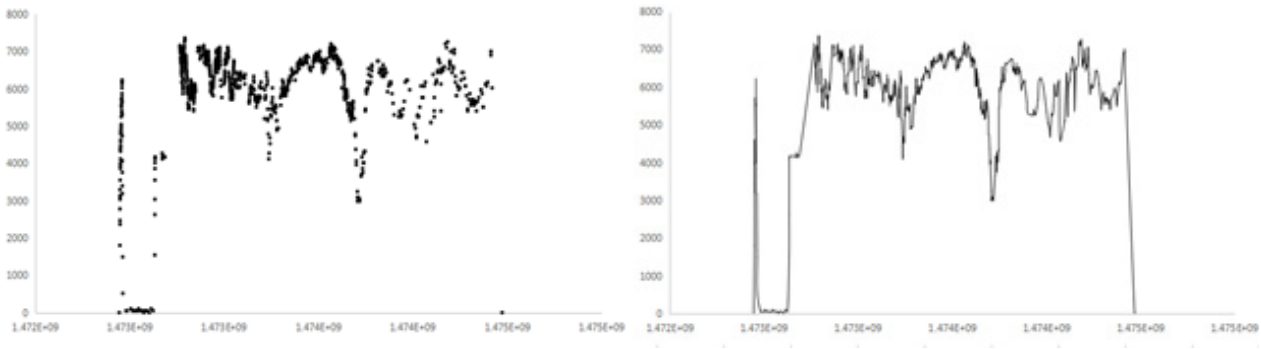

Figure 1 - Source: Authors' elaborations

1.2.2 Fuel oil consumption and navigation status analysis

Tracks of Fuel Oil Consumption

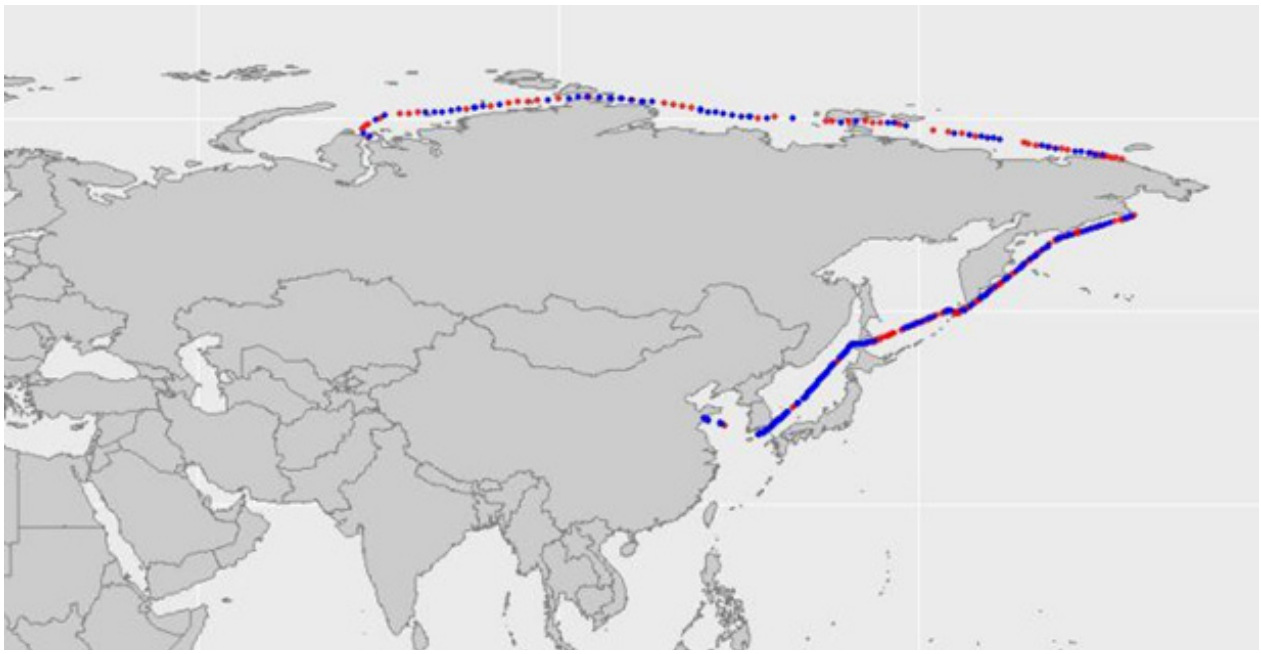

Figure 2 - Source: Authors' elaborations

The figure shows the fuel oil consumption tracing points of the ship, where red points stand for the points where the fuel oil consumption is higher than the voyage's average, and blue ones stand for the points where the fuel oil consumption is lower than the voyage's average.

Tracks of Navigation Statuses

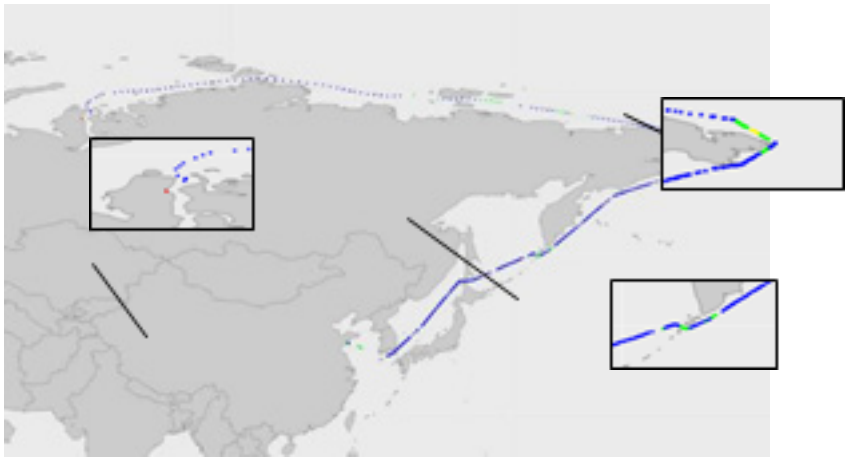

Figure 3 - Source: Authors' elaborations

The figure shows the five navigation statuses of the ship. Red, orange, yellow, green and blue points stand for berthing, anchoring, maneuvering, low-velocity sailing and normal sailing.

By adding the data up, we can work out the main engine fuel oil consumption to be 422.3 tons and the auxiliary engine fuel oil consumption to be 19.2 tons.

2. Cost estimation

2.1 Major costs

2.1.1 Cost for icebreaking and piloting

A large part of the Arctic Northeast Route is on the Russian NSR, which is governed by the Russian Northern Sea Route Administration (NSRA) to ensure the safety of the ships on the NSR and protection of the Arctic environment. Currently, Russia adopts a flexible convoying charge system which allows independent sailing of ships without the convoying of icebreakers or ice piloting services during periods of good ice conditions, such as late August and September.

According to relevant fee act provisions of the Government of the Russian Federation in 2014 regarding the rules for charging icebreaking and convoying services in waters along the NSR, the Arctic Northeast Route icebreaking and navaids charge CI is determined by the total tonnage of navigating ships and the ship's ice class. The NSRA has divided the NSR into seven toll areas, as shown in Figure 4. The sailing periods are divided into the summer and autumn sailing period (July 1-November 30) and the winter and spring period (December 1-June 30).

Seven Toll Areas of Northern Sea Route

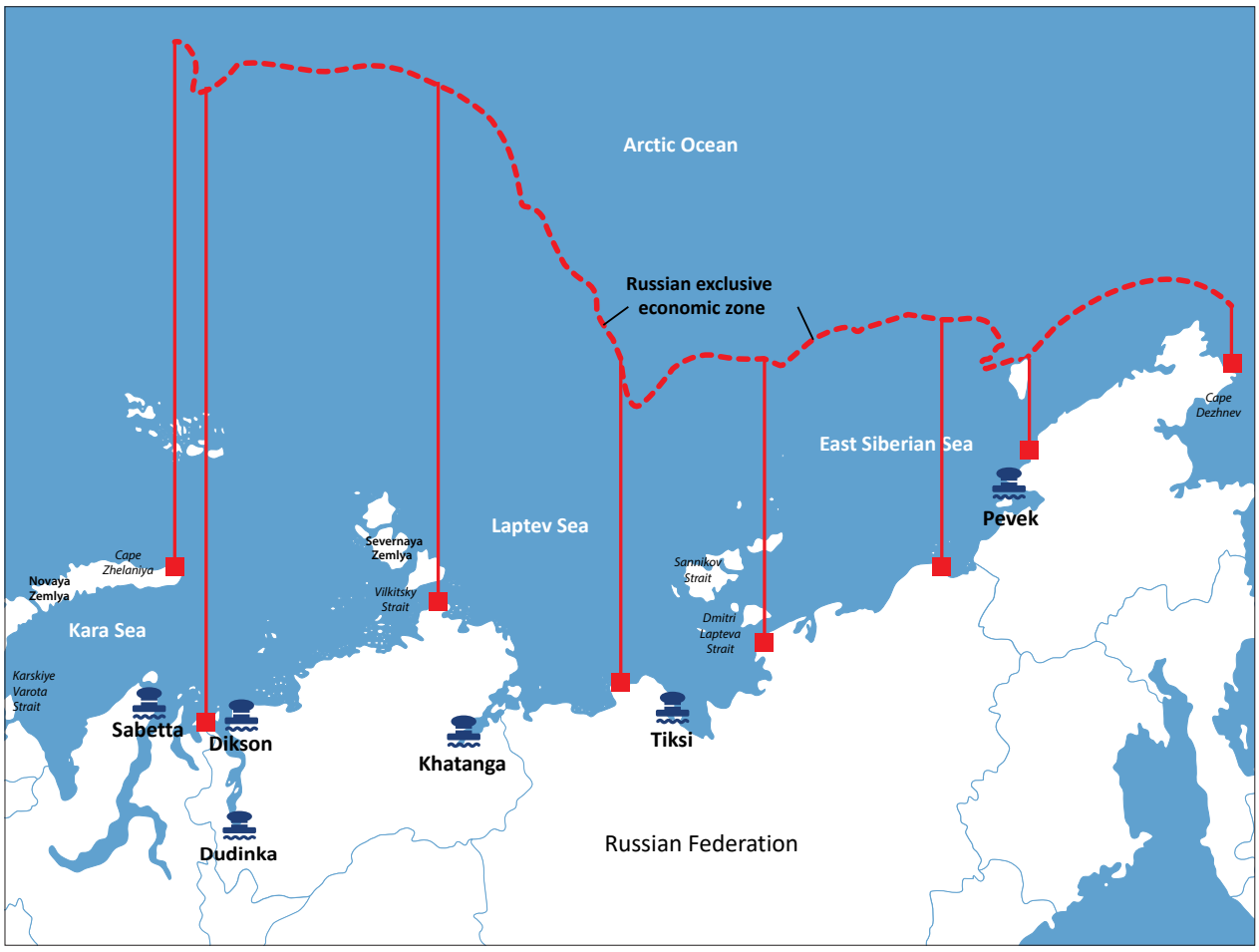

Figure 4 - Source: SRM on authors' elaborations

2.1.2 Crew wages

Staffing is generally independent from routing, but considering the tough conditions in Arctic sailing, the crew wages are 110% more of those on regular routes. This chapter uses the manning scheme of COSCO Shipping Bulk Co Ltd as the reference for calculations, to-

taling 22 crew members including the captain. When the amounts are added up, the total wage of the bulk carrier crew members comes to US$62,920/month.

2.1.3 Other expenditures

Other costs include fuel oil cost, port charges, and ship operating costs, and ship operating costs include insurance premiums and ship repair and maintenance expenditures.

2.2 Cost per voyage estimation

Bulk shipping earnings formula:
Freight revenue - Variable cost = Revenue per voyage

Freight revenue = freight rate * actual cargo volume
Variable cost = port charges + fuel oil cost
Revenue per voyage = freight rate * actual cargo volume – port charges –
– fuel oil cost + other revenues – other costs

Evaluation indicators: cost per ship voyage and net present value (NPV)

Based on the above formulas, we can use the financial indicator NPV (net present value) for financial analysis of the bulk carrier items for sailing on Arctic waterways.

Ship selection: Handy-size bulk carriers, with Qing Quan Shan vessel in the previous section of this chapter as an example.

Shipbuilding cost: This chapter selects Handy-size bulk carriers as reference. According to the Clarksons Shipping website, the present cost of a general-purpose Handy-size bulk carrier is $24 million. For ice navigation, with various demands posed on ships' materials, structures, functions, etc. taken into account, studies claim that with the same deadweight, ice-class ships are 20% more expensive than ordinary ships. In this calculation, we assume that an Arc5 ice-class ship, which costs about 30% higher than an ordinary vessel of the same type, is used. It is therefore assumed that the shipbuilding cost is US$31.2 million.

Depreciation method: straight line depreciation method.

Depreciation life: 20 years, assuming a salvage value of 10% after the depreciation life elapses.

Revenue per voyage: freight rate * tons.

With regard to freight rate determination, as there are an excessive number of variable factors in bulk shipping contracts which are also non-standardized, differences exist between different shippers, terms and clauses, ship types and ship owners.

Therefore, we can only refer to the freight rates for grain cargo types of the last six months (higher freight rates and larger scales) on traditional routes and make a hypothesis of the freight rate on the Arctic routes with relevant factors taken into consideration. The freight rate is determined to be 15 USD/T.

Tons: Take Qing Quan Shan ship as an example. We assume it is fully loaded. With the ship's deadweight tonnage subtracted by the fuel oil weight, fresh water weight, constants, ballast water weight, etc., and by consulting with ship companies, we reached the conclusion of 54,000 tons (chock-a-block yet not fully loaded).

Port of call selection: Shanghai Port to Port of Rotterdam.

Round-trip time of ship: total mileage/ economical velocity + average stay in port. Specifically, the total mileage from Shanghai Port to Port of Rotterdam is 15,592 nautical miles. The economical velocity of the selected ship is 12 knots at zero load and 11 knots at heavy load, reconciled at 11.5 knots. The average stay in port (Shanghai Port and Port of Rotterdam) is seven days, and the other time is one day. So the total round-trip time is: 15592/11.5/24+14+1=71.5 days.

Fuel oil cost: Based on the AIS data, we can calculate that the fuel oil consumption of the selected ship is 14T/day during anchoring, and 27T/day during sailing at the economical velocity. The round-trip voyage time is 57.5 days and the stay in port is 14 days. If it is an ice-class ship, the consumption will become 30% higher. In January 2019, the IFO380 price in Europe was about 350 USD/T, and that in Asia was 400 USD/T, which was reconciled at 375 USD/T.

Icebreaking and convoying charges: The ARC5 ice-class ship needs icebreaking and convoying services in four sea areas as per the inquiries on the aforementioned official website and the total cost is USDRUB 15.45 million, equivalent to US$233,897. Ordinary ships icebreaking and convoying services in seven sea areas total USDRUB39.02 million, equivalent to US$606,022.

Port charges: Some ports collect port charges in the form of lump sum charges at expressly marked prices, some collect the charges based on the actual implementations by the port authorities, and some charge the fees based on the net tonnages of operating ships. Cargo handling charge refers to the expenses incurred by ships' loading and unloading car-

goes at terminals. To facilitate calculation, this chapter refers to the calculation methods of Qiang Meng *et al.* for port charges and cargo handling charges, that is, the port charge rate of Arctic Northeast Route or a traditional shipping route is 0.184 ($/GT/port of call) and the cargo handling charge rate is 0.244 ($/GT/port of call).

The total tonnage of the selected ship is 36,388. We suppose that the port charges of an ice-class ship is 5% higher than those of an ordinary ship, so we can work out the port charges of a ship per round-trip voyage to be US$32,706.

Fixed cost: including crew wages and operating cost per voyage

Crew wages: US$62,920/month

With regard to the operating cost per voyage, this chapter refers to other relevant research results and concludes that the daily operating cost on Arctic waterways is about 25% higher than that on a traditional route. The operating cost of the same type of ship on a traditional shipping route is about 8,000 USD/day, while that on Arctic waterways it is around US$10,000/day.

Based on the above data, we can calculate the NPVs of this item for 20 years, with the following two scenarios assumed:

Scenario 1:

Build an ARC5 ice-class Handy-size bulk carrier that requires convoying service in four ice areas along Arctic waterways. The ship is used on Arctic waterways only and becomes idle during non-navigable periods. We set the inflation rate i to 3%, the social discount rate to 8%, the corporate income tax rate to 25%, and the navigable periods to 150/300 days.

Computing model:

$$NPV = \sum_{n=1}^{20} \left(\left(P * (1+i)^{n} * T - K + D \right) * \frac{1}{(1+n)^{t}} \right) + R$$

Where ***P*** is the freight rate, **i** is the inflation rate, **n** represents the year, ***T*** represents the tons, **K** stands for the sum of various costs, **D** stands for the depreciation for tax credits and ***R*** is the salvage value of the ship.

Scenario 2:

Rent a regular Handy-size bulk carrier that requires convoying service in seven ice areas along Arctic waterways. This scenario only serves to calculate the revenue per voyage. The rent is set at US$15,000/day.

As per calculations, the NPV of the ship's continuous operation in Scenario 1 when the navigable periods are 150/300 days, respectively, are: US$-22,324,585 and US$-17,559,809. In Scenario 2, the net revenue per round-trip voyage is US$-1,234,375.

Analyzing the results, we can intuitively find that the sailing costs of bulk carriers on Arctic waterways in scenarios 1 and 2 far exceed the revenues per voyage, and the economic effectiveness is negative, indicating a lack of feasibility. When the freight rates in Scenario 1 reach 23 USD/T and 19 USD/T for the navigable periods of 150 and 300 days, respectively, the NPV value becomes positive, that is, the freight rates should be increased by 53% and 27%, respectively.

Navigation through the Arctic Northeast Route indeed enjoys a time advantage over that of traditional routes. However, due to the restrictions on navigation conditions, there exists a threshold size for navigable ships. A traditional shipping theory has it that the larger the ship, the lower the unit shipping cost. But when this theory is applied to Arctic waterways, various limitations will emerge. In the cost estimation, we have drawn the following conclusions through analysis:

(1) The high fuel oil and icebreaking costs as well as the lack of profitability of bulk carriers are the main reasons for the negative revenue per voyage.

(2) When the revenue per voyage is negative, the duration of navigation time does not make any changes to the loss.

(3) Due to water depth restrictions of some straits, it is not feasible to simply increase ship size to improve the profitability.

9 / Conclusions

Throughout the centuries the Arctic Route has been a merely fascinating challenge, a passage evocating unspoiled glacial and polar nature, hard to dominate.
Nevertheless, new technologies from one side and climate change on the other, are currently triggering potential developments that will have implications on the maritime trade, energy supply as well as on geo political aspects.
As has been noted, three main passages along the Arctic Ocean could become a short-cut between Asia, Europe and North America: the Northwest Passage, the Trans Polar Route and the Northern Sea Route (NSR) which is likely to be free of ice sooner and thus represents the highest commercial potential.
The first containership test along the NSR was done in 2018: Venta from Maersk, a vessel of about 3,600 TEUs, made the international transit between Busan in South Korea to Bremerhaven in Germany through the Arctic. The transit was 40% faster than on the same journey through the Suez Canal. A similar journey from China to Northern Europe was 20% faster (one week).
A shorter way means lower costs and higher economies of scale for shipping industry and this may foster a growing interest to exploit the potentialities of the new route.
In fact, in 2019 the route was open to shipping for 30% of the year from July to the beginning of November over a period of approximately 14 weeks during which only 16% of ships required icebreakers. The deliveries to ports (transit cargo) in the water area of the NSR amounted to almost 700,000 tons of goods.
If we consider the overall volumes traded along the NSR the number is impressive: more than 200 ships in over 2,000 voyages travelled on the NSR – especially tankers and general cargos – transporting 31.5 million tons in 2019, a more than threefold growth over the last 10 years. A trend expected to reach 92.6 million tons by 2024 with an increasingly significant international traffic.
These figures are not only important to understand the impacts on maritime trade but also to analyze potential evolution in energy trade because of the estimated huge reserves of oil and liquid gas in the Arctic Region, analyzed in Chapters 2 and 4. The interest to develop the Arctic Route is now for real, there are many key questions that need to be addressed to fully understand the impact of the NSR on maritime economy and for shipping industry.

Is the regular opening of this Route a short term or a long run challenge? If some big carriers have already tested regular transit through the Arctic, why have other big players clearly stated they will not?
Which infrastructures are necessary to expand the shipping business and how can climate change issues affect the Arctic Route exploitation? What are the geo-strategic implications for China, Russia, US and UE and what are the potential effects for the Mediterranean and the Suez Canal?
The Report does not provide a final reply to each question.
Nonetheless, some insightful outcomes can be summarized as follows.

1. The Arctic Route has great potential as a transoceanic route, but this will probably become more apparent in the long term rather than in the near future.

Opportunities have been highlighted clearly through the chapters: shorter transit times between Asia and Europe, huge local oil and gas resources, development of cruise sector and the perspective of the Arctic becoming a touristic destination. At the same time, it has been distinctly stated that there are still huge limits and constraints that prevent to exploit these opportunities for now.
As matter of fact traveling along the NSR requires additional investment and thus produces extra costs that can counterbalance the advantages. Similarly, the limited size of the vessels that can navigate the Arctic Route (because of the ice and icebreakers tracks) compared to Ultra Large Containers Vessels passing through the Suez Canal increase the relative opportunity cost of using the NSR.
These elements together with the fact that containerships need to have stable regular services to be rentable and that the area around the NSR is nowadays deprived of good nautical services and advanced infrastructure, prevent full and immediate exploitation of the new route for commercial purposes. Additional problems are also posed by the lack of accident response, search & rescue infrastructure, high insurance fees and poor charting of the area.

2. Climate change and the environmental impact are critical issues for the exploitation of the Arctic Route both for shipping and energy extraction.

On the one hand, climate change is the primary cause for de-icing and the reason why the Arctic Route is becoming a viable option but, on the other, it also indicates global warming

and sea level rise.

At world level, the public opinion is increasingly more sensitive to and aware of environmental consequences. A point also related to the social responsibilities of companies, shipping carriers, big energy players and banks. These issues are looked at in detail in Chapter 6, which is devoted to the challenge of Arctic environment and climate preservation. It is a fact that as the global shipping increases, this will worsen pollution and bring about a disruption of the local ecosystems. The potential increase of naval traffic in the Arctic and the related expansion of more fuel-consuming icebreakers and ice-resistant ships entail significant repercussions for polluting emissions, which could offset the reduction in CO_2 associated with the shorter northern routes.

Climate change and environmental impact are expected to remain limits (both in terms of reputation and costs) for the ordinary use of Arctic as a transoceanic global shipping route. However, it is less obvious whether these elements will restrain local cargo traffic and regional energy exploitation especially if one considers the transparency of politics and the weight of the public opinion of some countries.

3. The Arctic is currently a maritime energy corridor rather than a global cargo route.

Since 2008, when huge total undiscovered oil and gas reserves in the Arctic were estimated, strategic interest for the region has grown sharply especially from the five littoral countries.

If we consider that 70% of Natural Gas and 41% of Oil undiscovered reserves belong to Russia it is clear why this country is trying to fix its hegemony in the area using its logistical advantage. Russia is the largest littoral state of the Arctic Ocean and has developed a relatively more advanced transport network also thanks to the largest icebreaker fleet in the World. Many exploitation projects are on the table and some important extraction activities have completed the preliminary phase and are now close to starting the production, as Russia's first large-scale gas extraction project in Yamal Arctic peninsula, which reached 97.8% completion in January 2020 for a total cost of nearly $30.5 bn.

In the coming years, these developments are expected to encourage cargo traffics and collateral maritime transportation services, especially along the NSR, with a boost in ports infrastructures in Russia.

Although the analysis clearly points out that, in the near future, the Arctic will not become an alternative to the Suez route for Europe-Asia trade – due to reasons involving costs, le-

gal framework and environment – the NSR could still have a strong local and regional role. This is particularly true if the markets around Russian ports and the Baltic area continue to grow as quickly as they have in the last 10 years.
At the beginning, the NSR importance will probably lie in its role as a local transport and energy corridor along the Eurasian Arctic Coast and between port destinations and markets on the Atlantic and Pacific adjacent sides.

4. The international and complex legal framework need to be harmonized to avoid drawbacks.

From the juridical and legal point of view – that has also direct implications on the economic and business side (i.e. shipping insurance) – freedom and safety of navigation along the Arctic and the NSR depend on the harmonization of different sources of law applicable. Waters and seabed of the Arctic are governed by a complex system of sectorial instruments deriving from customary international laws, some legally nonbinding rules, mainly in the form of conventions seeking to strengthen the official regulatory framework with non-mandatory recommendations, guidelines and practices.
Chapter 5 is devoted to a full overview of the international law and legislative framework of the Arctic, also including the Russian legislation on the NSR and the European Union legislative commitment for the safety and protection of the Arctic environment.
The EU tried to design a strategy for promoting an integration of the NSR with its logistic corridors, namely through the extension of Ten-T Scandinavian-Mediterranean and North Sea-Baltic railway corridors. More specifically, the prolongation of the Ten-T to Northern Sweden would potentially create a strategic EU gateway to the Arctic and consolidate the engagement of the EU as a key player in the development of the region. The creation of a more modern and efficient EU inland railroad network, potentially recipient of the NSR traffic, would also strengthen the North-South trade flow axis, a benefit for the Italian economy for being the geographical opposite hub for international exchange.
It would be important also for Mediterranean countries to develop a EU strategy over the Arctic region, but until now Europe is far from being an active player in the Region especially if compared with the political and legislative activism of the other countries.
It seems clear that the complex legal framework, described in Chapter 5, with overlaps between international conventions and treaties, national and local rules, some of which customary other mandatory, do not favor the exploitation of the potential business oppor-

tunities in the shipping and energy sectors.
At the same time, enforcing legislative activity is a clear way to try to exercise geo-political influence and control over the Region. This is particularly true for States – i.e. littoral countries who want to strengthen their territorial sovereignty – but also for International Organizations which have a wider interest revolving around environmental preservation and protection of the Arctic uniqueness.

5. A geo-political context still in balance between competition and cooperation. Will the Covid-19 pandemic change the game?

Due to its natural and geographical characteristics, the Arctic Region (and the NSR) is the field of an active and geo-strategic positioning of three main players: Russia, China and the United States.
The Russian Federation is the largest Arctic State and, as shown in this research, it strongly relies both on its logistical advantage and huge energy off/on shore resources.
The People's Republic of China, not as a littoral country but being a global player, officially fixed its Arctic policy in a "White Paper" released by the State Council Information Office in January 2018. Since then it has been promoting a complex diplomatic and economic strategy to gain access to the natural resources of the area and to increase its international influence. This has also been done through the participation in regional forums, like the Arctic Council, and with the integration of the infrastructure development plans needed in the region within its Belt and Road Initiative (BRI).
The United States' stance has not so far included direct economic involvement but has appeared to be more oriented towards a mild containment of both Russian and Chinese ambitions.
As has been observed, the NSR could initially develop as an energy-extraction project and only later evolve into a more product-oriented shipping lane. This might encourage a gradual approach from business venture, with the need for international consortia to better distribute higher costs and risks of operating in the Region. As a result, this might also support a multilateral and cooperative approach towards the Region, as well as towards projects that consider both economic and environmental concerns.
Also, considering that the Arctic has so far remained an area of peace and stability, despite the expected increased competition for natural resources and shipping lanes, it is safe to assume that at least three main areas – scientific research, environmental protection and

port and logistics – will be fields of cooperation among States with a likely Russia-China partnership to develop and carry on.

But if the pendulum between cooperation and competitions was the context we described until now, how will this pandemic change the game?

The global economic crisis and dramatic drop in World trade due to the Covid-19 are expected to strongly affect the economies of the key players in the Arctic – China, Russia, US and the EU – reducing, at the same time, cargo shipping trade and oil and gas global demand.

These circumstances will probably result in a momentary lower interest in the Arctic Route, at least in the short term and especially from non-littoral countries.

As noted by The Economist last April 18th in its cover, one of the key questions is whether China will manage to go through the pandemic supported by its international care aid, the so-called mask diplomacy, or the blame game will prevail. It might also be the case that accusations of scarce transparency and delayed information about the virus will gain so much ground that China's reputation will be hit dramatically and for a significant period of time with negative consequences for its trade flows and for the implementation of the BRI projects.

A further point to consider regards how severe the crisis will be in America and the timeliness of economic recovery alongside the next presidential elections in November.

Whatever the answer to these questions, it seems likely that – in the near future – the US and China will be more focused on their national core issues than on the Arctic. On the other hand, differently from the other players, Russia, being a littoral country, might be tempted to take advantage of the situation.

Finally, the Covid-19 pandemic will probably increase the global public opinion's level of attention towards air pollution and environmental issues (as French President Macron pointed out in an interview to the Financial Times last April) and this will lead international organizations to show greater commitment to the preservations of areas like the Arctic. Indeed, most of the World population has been able to make an unthinkable sacrifice to stop the curve of the pandemic and could well be ready to accept restrictions in the name of a better environment.

It is precisely in this context that a more active European Union, able to play a balanced and strategic role to blend economic development of the Arctic with high standards for the preservation and defence of this unique environment, could make a difference.

Without the European “voice” the risk is that competitive approaches will prevail over co-operative attitudes but to avoid this, the EU will need to reach a more united and assertive political stance.
Will this be a positive legacy of the Covid-19 pandemic for the Arctic future?

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