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Transportation in the melting Artic : contrasting views of shipping and railway development

FREDERIC LASSERRE
Professor at Department of geography, Laval University

PIERRE-LOUIS TÊTU
Research Professional, Laval University

UNIVERSITÉ LAVAL

Coordonnées de l'Institut EDS

Institut Hydro-Québec en environnement, développement et société
Pavillon Alexandre-Vachon, local 2045
1045, avenue de la Médecine
Université Laval, Québec, G1V 0A6

Téléphone : (418) 656-2723
Télécopieur : (418) 656-7330

Courriel : ihqeds@ihqeds.ulaval.ca
Site Internet : www.ihqeds.ulaval.ca

Mise en page et édition : Elise-Katrina Perron Jean
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By Frédéric Lasserre and Pierre-Louis Têtu

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| Introduction

In the Arctic, climate change, contrary to popular belief, is a helper, not a driver of traffic expansion for sea transportation. Shipping companies design their strategies around market location and profitability rather than out of consideration of melting of Arctic ice. Moreover, climate change is a serious hindrance for land transportation projects with the melting of permafrost. For several years to come, natural resources exploitation, rather than cargo transit traffic, will likely be the major market for shipping expansion in the Arctic. Shorter routes due to melting sea ice do not appear attractive to most shipping companies. Instead, shipping companies are interested in increased destinational traffic, especially for oil and gas and mining. A factor that could alter this picture is the fact that transportation projects also at times reflect a desire to assert sovereignty over maritime or land expanses.

Expansion of Arctic transportation projects (services and infrastructure) stem from the fact the Arctic has become integrated in the global economy. It is globalization that drives natural resources exploitation. It is the globalization of Chinese and Russian economic ambitions that supports the construction of expensive overland projects. It is globalization, and not necessarily conditions in the Arctic, that has shipping companies questioning the profitability of Arctic shipping

There are different actors, including transport companies and states, involved in these developments in Arctic sea traffic, and they pursue different types of strategies that unfold in parallel in the Arctic. This paper examines the following questions:

- What are the strategies that explain the changing trends in / Arctic sea traffic?
- What can account for the direction of Arctic sea traffic development?
- What drives the new surge in railway projects, especially in Eurasia?

This investigation demonstrates the value of an environmental geopolitics approach because it considers how different actors perceive and pursue political and economic gain through strategic interaction with the physical environment. Additionally, this chapter recognizes that processes at multiple, simultaneous spatial scales may be usefully examined together to create a more complete understanding of a given phenomenon such as Arctic sea traffic. That is, to understand changes in Arctic sea traffic, it is important to look beyond the Arctic and beyond sea traffic as well.

In the next section of the chapter, we provide background on recent trends of climate change in the Arctic. Then we will examine the evolution of maritime traffic, especially the significant growth of destinational traffic. We will later examine the renewed expansion of rail construction, especially in Russia and northern Scandinavia. The growth of both railway construction and marine traffic is then analysed in light of the globalisation of the Arctic.

| The contrasted impacts of climate change on the Artic on sea ice

The impacts of climate change in the Arctic have been widely debated for the past 20 years. The latest, full IPCC report (2014) stated that human activities are estimated to have caused approximately 1°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. An updated IPCC report states that global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate (IPCC 2018). The Arctic region warmed more rapidly than the global mean: positive retroactions, especially because of the decreasing extent of sea-ice, decreased the albedo of the region, thus fueling a stronger temperature increase than the average world increase (Houssais 2010; Miller et al 2010; Walsh et al 2011).

The annual mean Arctic sea-ice extent decreased over the period 1979 to 2012, with a rate that was very likely in the range 3.5 to 4.1% per decade. Arctic sea-ice extent has decreased in every season and in every successive decade since 1979 (IPCC 2014, NSIDC 2018). At its September minimum, Arctic sea ice extended over 4,59 million km^2, or 1,63 million km^2 below the 1981 to 2010 average minimum extent, a drop of 26% below this average value and of 36,3% below the 1979 value[1].

The records suggest that the thickness of ice in the Arctic Ocean has decreased by an average of 1.3 to 2.3 metres between 1980 and 2008 (NPI, 2014). Maslanik et al (2011) underline multiyear ice is gradually disappearing to the benefit of thinner, softer first-year ice. For a long time, despite the signs of decline of the Arctic sea ice, the scientific community did not anticipate the total disappearance of sea ice in summer. Cryosphere specialists realized the evolution of sea ice hinted that if the trend kept going, this possibility had to be factored into assessments. The research published by Stroeve and Maslowski *et al* (2006) and Holland et al (2006) shocked the scientific community as it announced the possible disappearance of the pack ice around 2013. If this model proved overly pessimistic, Gascard (2008, 2017) and Schiermeier (2008) later published scenarios confirming the strong possibility that summer ice could shrink considerably.

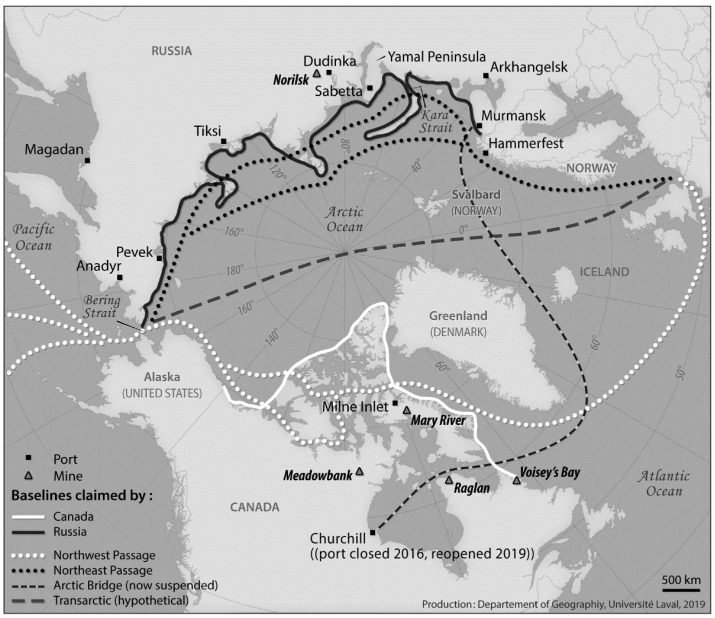
At the same time, research underlined the increasing occurrence of iceberg calving from glaciers and ice sheets, especially around Greenland. These icebergs then break down into growlers that represent a severe shipping hazard (Lasserre and Pelletier 2011; Bourbonnais and Lasserre 2015). Sea ice may also be thinner and younger, but it also moves faster when drifted by winds and currents. For this reason, sea ice can form strong pressure ridges with unpredictable movements. In fact, there is an increasing inter-annual variability and day-to-day unpredictability in the spatial distribution of sea ice (Lasserre 2010a; Tietsche et al 2013), as attested in the heavy ice witnessed during the summer 2018 in the Canadian Arctic, that blocked several commercial and cruise ships (Stieghorst, 2018; Paquin, 2019)

[1] 1979 was the first satellite-recorded value of sea ice for the whole Arctic.

| The evolution of sea traffic: Transit is not off

In this context of rapid sea ice melting, narratives and studies about the advent of rapidly expanding Arctic shipping emerged from the onset of the 21st century. Given the geographically shorter distances between Northern Europe or North America and Asia along Arctic passages, when compared to the classical routes through the Panama or Suez canals, the shrinking of Arctic ice cover nurtured the idea that climate change would be a decisive driver of the development of Arctic shipping routes along the Northeast and Northwest Passages, and then later along the hypothetical Central Arctic route (see Fig. 1).

FIGURE 1 : ARCTIC SHIPPING ROUTES, ACTUAL AND POTENTIAL



Several dozen papers have been published on the future of Arctic shipping since the turn of the century, mostly focusing on the idea of climate change and shorter distances as the driver for the expansion of shipping. As sea ice retreated and shorter maritime routes became available, Arctic shipping was described as being bound to expand quickly because of the shrinking ice (Borgerson 2008 and 2013; Howard 2009; Maurette 2010; Emmerson 2011; Young 2011; Rahman et al 2014) that would reduce the severe constraint on ship mobility (Stephenson et al 2013 and 2014; Aksenov et al 2017). Several others tried to assess the economic profitability of Arctic sea routes through econometric models, with a relative majority of papers asserting Arctic transit was reportedly profitable (Lasserre 2014; Theocharis et al 2018). A few studies considered the shipping companies could possibly design strategies that were not necessarily based on the shorter distances provided by a receding sea ice (Lee and Kim 2015; Guy and Lasserre 2016; Lasserre et al 2016; Zhang et al 2016).

Interestingly, much fewer papers were written on the impact of climate change on road or rail transport in the Arctic despite the fact that land-based impacts in this region are significant. On land, climate change is severely altering established patterns of permafrost. The gradual melting of the subsoil ice threatens the structural integrity of existing infrastructure such as roads and railways (Corell 2006; Prowse et al 2009; Allard et al 2012) and makes the construction of new ones extremely costly. Yet the lack of attention to implications of climate change for land-based transportation highlights the political dimension of narratives about the advent of Arctic shipping. Both Russia and Canada have claimed that Arctic passage routes are under their sovereignty. However, the United States, the European Union, Japan and China are reportedly bound to challenge the former two to prevent them from controlling the strategic emerging shipping routes (Huebert 2002, 2003; Byers 2010; Lasserre, 2010b; Burke 2018). This is an important feature about the discourses on Arctic shipping: they would often hint at the revolution the advent of transit shipping would represent, after several centuries of dramatic quest embodied in the disastrous failure of the Franklin expedition in 1845; and they would also underline the political battles that expanded Arctic shipping would trigger for the control of traffic. Beyond academic debate, newspaper headlines reinforced these narratives: « Melting Arctic ice opens new route from Europe to east Asia »[2], « The Arctic's fabled passage is opening up. This is what it looks like »[3], « Arctique: fonte des glaces oblige, le passage du Nord-Ouest objet de convoitises »[4]; « La route de l'Arctique, objet de toutes les convoitises »[5]; "Arctic ambition: The race to sail Northwest Passage heats up »[6]; « Race Is On as Ice Melt Reveals Arctic Treasures »[7]; « Arctique: la banquise fond, la route s'ouvre »[8], « Ice melts opening up Northwest Passage »[9]; « Canada well behind Russia in race to claim Arctic seaways and territory »[10]...

Now, nearly two decades after narratives about the soon-to-develop Arctic seaways began to emerge, how has Arctic transit traffic actually evolved? (Table 1 and 2).

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[2] *The Guardian*, 28 Sept. 2018, www.theguardian.com/world/2018/sep/28/melting-arctic-ice-opens-new-route-from-europe-to-east-asia

[3] *Washington Post*, Aug. 7, 2017, www.washingtonpost.com/news/energy-environment/wp/2017/08/07/the-arctics-fabled-passage-is-opening-up-this-is-what-it-looks-like/?noredirect=on&utm_term=.0c2a7ffeb124

[4] RFI, Aug. 20, 2016, www.rfi.fr/ameriques/20160820-arctique-fonte-glaces-rechauffement-climatique-passage-nord-ouest-nasa

[5] *Les Échos*, May 28, 2014, www.lesechos.fr/28/05/2014/lesechos.fr/0202854460715_la-route-de-l-arctique--objet-de-toutes-les-convoitises.htm.

[6] *CNN*, Sept. 8, 2014, http://edition.cnn.com/2014/09/08/sport/arctic-sailing-northwest-passage/index.html.

[7] *New York Times*, Sept. 18, 2012, www.nytimes.com/2012/09/19/science/earth/arctic-resources-exposed-by-warming-set-off-competition.html.

[8] *Le Figaro*, Feb. 3, 2010, www.lefigaro.fr/environnement/2010/01/29/01029-20100129ARTFIG00606-arctique-la-banquise-fond-la-route-s-ouvre-.php

[9] *The Telegraph*, Sept.15, 2007, www.telegraph.co.uk/news/earth/3307052/Ice-melts-opening-up-Northwest-Passage.html

[10] *The Star* (Toronto), Dec. 22, 2011, www.thestar.com/news/world/2011/12/22/canada_well_behind_russia_in_race_to_claim_arctic_seaways_and_territory.html.

TABLE 1: TRANSITS ALONG THE NORTHWEST PASSAGE, 2000-2019

Year	Canadian government ships	General cargo	Tankers	Bulk carriers	Passenger	Tugs	Pleasure-crafts and Adventurers	Research vessels	Foreign government	Others	Total
2019	2	5			5	1	13				**26**
2018	2					1	2				**5**
2017	2	1	1	0	3	0	22	1	2	1	**33**
2016	3	1	0	0	3	0	15	0	0	1	**23**
2015	4	0	0	0	2	0	19	0	0	2	**27**
2014	4	0	0	1	2	0	10	0	0	0	**17**
2013	2	0	0	1	4	0	13	2	0	0	**22**
2012	2	0	1	0	2	2	23	1	0	0	**31**
2011	4	0	1	0	1	0	15	0	0	0	**21**
2010	4	0	0	0	3	2	11	0	0	0	**20**
2009	3	0	0	0	2	2	10	0	0	0	**17**
2008	3	0	0	0	1	0	7	1	0	1	**13**
2007	3	0	0	0	2	0	4	0	0	0	**9**
2006	4	0	0	0	2	2	3	0	0	2	**13**
2005	4	0	0	0	2	0	2	1	0	2	**11**
2004	3	0	0	0	1	0	2	0	0	0	**6**
2003	3	0	0	0	2	6	2	0	1	0	**14**
2002	4	0	0	0	2	2	2	2	0	0	**12**
2001	2	0	0	0	2	0	2	0	0	0	**6**
2000	1	0	0	0	2	0	2	0	1	0	**6**

SOURCE: COMPILED BY THE AUTHORS FROM NORDREG DATA, IQALUIT.

TABLE 2: NUMBER OF OFFICIAL TRANSITS, NORTHERN SEA ROUTE, 2010–2019.

Ship type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Icebreaker					2	3	2	2	1	2		1
Government ship					1	0	1	1	3	1		
Cruise or passenger ship				1	1	0	1	3	1	1		
Tug, supply vessel	1	1		4	4	5	1	1	4	4	1	2
Commercial ship	1	2	5	6	31	38	64	24	15	11	24	23
Fishing											2	1
Research ship				2	2	0	2	0	0			
Total official transit	2	3	5	13	41	46	71	31	18	19	27	27

*** AS OF OCT. 15. NO BREAKDOWN AVAILABLE FOR 2019. SOURCES: CHNL INFORMATION OFFICE, TRANSIT STATISTICS HTTP://ARCTIC-LIO.COM/?CAT=27, DATA VISUALIZATION HTTPS://ARCTIC-LIO.COM/CATEGORY/DATAVISUALIZATIONS/ AND NSR TRANSITS BEFORE 2011, WWW.ARCTIS-SEARCH.COM/NSR+TRANSITS+BEFORE+2011&STRUCTURE=ARCTIC+SEA+ROUTES, A. DEC. 15, 2019.**

THE NORTHERN SEA ROUTE IS THE SECTION OF THE NORTHEAST PASSAGE BETWEEN BERING STRAIT AND THE KARA STRAIT OR CAPED ZHELANIYA (NOVAYA ZEMLYA), DIRECTLY ADMINISTERED BY THE NORTHERN SEA ROUTE AUTHORITY CREATED IN 1932.

As indicated in Table 1, transits along the Northwest Passage have taken place at low levels for several years; it is also apparent most of this limited traffic is largely fueled by icebreakers and pleasure crafts. Commercial ships, either cargo or passenger vessels, represent a very limited traffic, oscillating between 1 and 5 transits per year, despite a significant increase in 2019 for cargo ships – too early to conclude if this is a trend or not. Even so, these figures underline the small volume of commercial transit traffic through the Northwest Passage.

Along the Northern Sea Route (NSR) , as shown in Table 2,transit traffic began picking up in 2010, expanding rapidly from 46 transits in 2012 to 71 in 2013 only to drop sharply afterwards to 18 in 2015 and 19 in 2016 and then recover slightly at 27 in 2017 and 31 as of Oct. 15, 2019. This decline, and later stagnation at low levels, in transit traffic along the Northern Sea Route, is clearly out of step with the media forecasts announcing the advent of heavy traffic along Arctic routes. This apparent contradiction is due to several factors (Balmasov, 2016; Humpert, 2016; Doyon et al. 2017). First, he decline in oil prices and fuel prices, which makes the search for possible reductions in transit costs less attractive for shipping companies, as well as the decline in commodity prices, which makes Arctic resources less attractive, both for exploitation and for initial investment for transport with specialized vessels. Second, the continuing decline in both bulk and container freight rates, which discourages shipping companies facing overcapacity from investing in new ice-bound vessels. The reorientation of certain export routes for raw materials, including natural gas with the opening of the Russian terminal at Ust-Luga on the Baltic Sea, carrying volumes previously shipped via Vitino in the White Sea (Pettersen, 2014) also limited the potential for expansion of Arctic transit. On the Russian side, one may consider a tariff schedule for the services of the Northern Sea Route, sometimes considered opaque by the maritime carriers, as well as he priority deployment of Russian icebreakers to infrastructure projects, notably the Sabetta port linked to the gas project on the Yamal Peninsula. The lower availability of buildings dissuaded some carriers from hiring their vessels for lack of guarantee escort.

Figures for 2018 and 2019 confirmed that transit traffic did pick up somewhat along the NSR, but it stabilized at moderate levels. It would seem from the data discussed above, that Arctic traffic did not develop up to expectations projected by several observers and media. However, the actual trends are in line with analyses from shipping companies that clearly emphasize how Arctic shipping remains difficult, costly, and risky. Furthermore, Arctic shipping is not necessarily compatible with the integration of containerized shipping in global logistics chains with the constraints of just-in-time industrial management, as attested by several papers (Lasserre and Pelletier 2011, Lee and Kim 2015; Beveridge et al 2016; Zhang et al 2016; Lasserre et al 2016). That is, from the perspective of shipping companies, Arctic sea transit is not highly compatible with the larger trends of the globalized shipping industry. This situation underlines the fact that economic factors such as commodity prices and freight rates, which have nothing to do with Arctic sea ice, have a much greater impact on the development of Arctic shipping – or lack thereof. That is why Arctic shipping transits have not increased at a proportionate rate as Arctic sea ice has been melting.

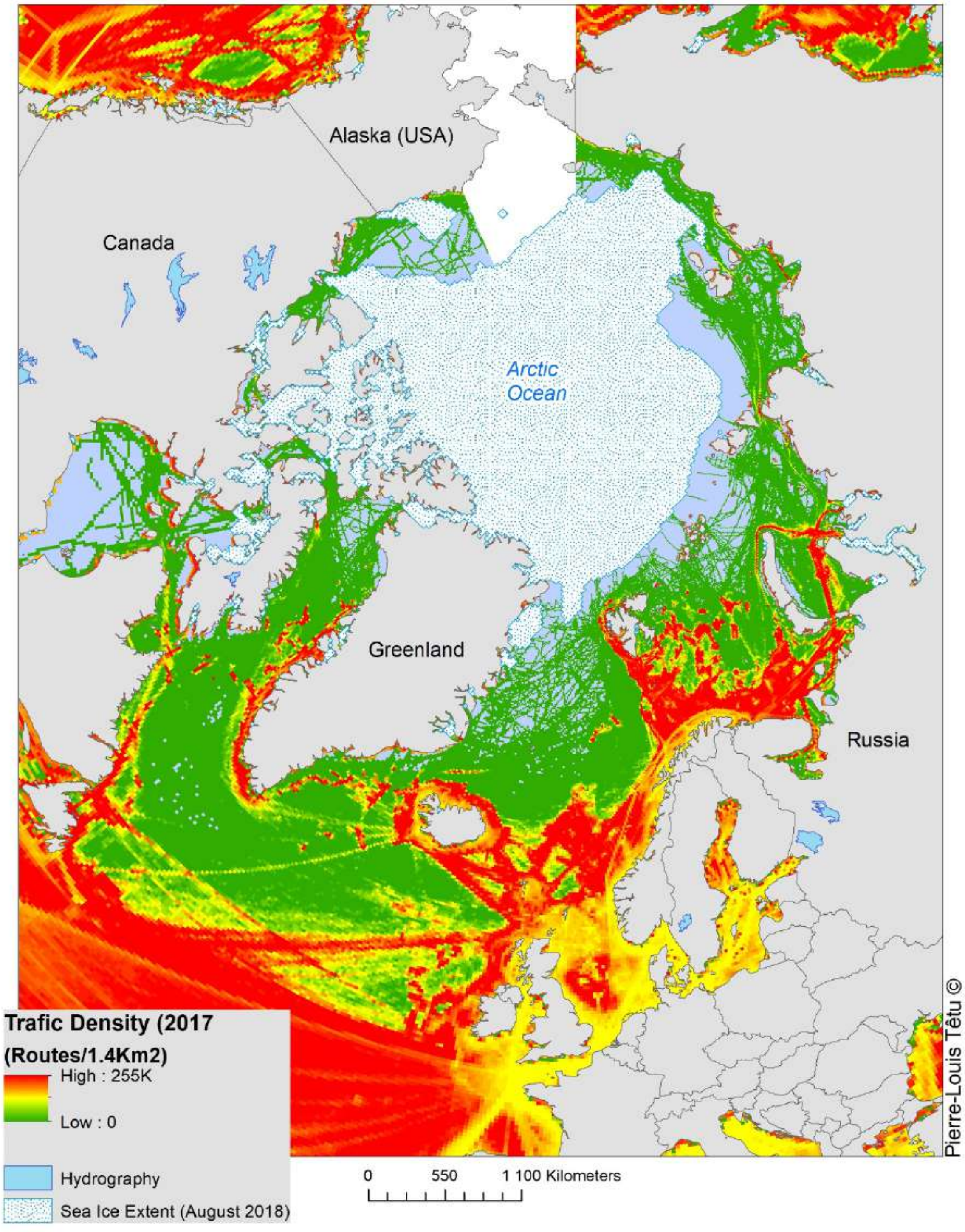
| The growth of Arctic destinational traffic

This does not mean that Arctic shipping does not develop. Quite the contrary, traffic seems to be expanding, especially along the Siberian coast (Table 3 and 4; fig. 2). This kind of traffic to or from the Arctic rather than through or across is referred to as destinational traffic.

Fig. 2 displays traffic density in the Arctic. Centered on the Arctic Ocean, it depicts the density of traffic, which is the number of ships that passed through every area of the sea expanse. The higher the density, the more ships entered a specific area. A high density means many ships crisscrossed the area, while a low density means few vessels ever cross the area. The map shows strong contrasts in Arctic shipping traffic, first between transit, that remains low and destinational traffic that experiences a significant growth: this is apparent as there is little traffic density along the total extent of transarctic routes. The map also underlines contrasts between regions. Some marine regions remain marginal and see little traffic: the western Canadian archipelago, the Beaufort Sea, the Laptev, Eastern Siberian and Chukchi Sea witness little traffic, barely more than the Central Arctic Ocean. However, marine areas like the Bay of Baffin along Greenland's west coast; the Barents Sea, the Kara Sea with corridors linking oil and gas terminals to Murmansk, display significant traffic densities. This attests to the link between the two main drivers of Arctic shipping, community resupply and natural resources exploitation, fishing, mining and oil & gas extraction. In 2005, 20 voyages were carried out in the Canadian Arctic by fishing vessels, as opposed to 139 in 2018. As oil and gas fields began production in northern Scandinavia and Siberia, a significant traffic developed servicing them. Mining sites in the Canadian Arctic and in Siberia also generate a significant traffic.

True, there are now more mining and oil & gas wells than 20 years ago – so it could seem their expansion reflects the melting sea ice. But the history of natural resources exploitation tells another story: mining and oil exploitation experienced a first expansion period in the Canadian Arctic at the end of the 1970s with the opening of the Nanisivik (1976-2002), Polaris (1981-2002), Raglan (1997-) mines, and the Bent Horn oil field (1985-1996), but most of these ventures were closed at the turn of the century, as the melting of sea ice began its effect but also when world prices for resources were depressed. Conversely, what fueled the present expansion of resources extraction across the Arctic is the high prices for natural resources that enables companies to withstand exploitation costs that remain very high. In that sense, sea ice melting is certainly an enabler, but not a driver: it is high prices for resources and the desire, especially for Russia, to develop new fields and mining sites that drive extraction and thus destinational shipping (Lasserre and Têtu, 2020).

FIGURE 2 : SHIPPING TRAFFIC DENSITY



SOURCE: ADAPTED FROM MARINETRAFFIC 2017, WWW.MARINETRAFFIC.COM/, A. DEC. 15, 2019

TABLE 3 : NUMBER OF VOYAGES IN THE CANADIAN ARCTIC, 2005-2019

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ships (voyages) in the Canadian Arctic	121	135	181	209	185	257	317	314	349	301	315	347	416	406	427
of which :															
Fishing vessels	20	26	39	52	44	78	136	114	137	119	129	131	138	139	134
Cargo ships or barges	65	67	101	105	100	124	126	124	127	108	120	147	188	197	222
of which :															
General cargo	16	17	28	30	23	34	38	32	35	32	34	36	50	48	59
Tanker	17	16	24	29	23	28	30	31	28	25	27	23	24	29	28
Bulk	21	17	27	25	27	27	23	26	27	33	36	53	72	89	105
Tugs & Barges	11	17	22	21	27	35	33	35	36	18	23	35	42	31	30
Pleasure-crafts & Adventurers	10	6	9	7	13	13	15	27	32	30	23	22	32	17	19
Cruise/Passenger vessels	12	15	17	20	11	18	11	10	17	11	18	20	19	21	24

Government vessels (Navy, Coast Guard)	9	9	9	10	10	13	20	16	17	23	16	20	22	18	20
Other icebreakers											2	2	2	2	
Research vessels	6	12	9	12	7	11	11	23	20	10	9	6	13	13	8
Others											1	1	4	1	

A VOYAGE IS COUNTED EVERY TIME A SHIP IS ENTERING THE CANADIAN ARCTIC AREA, WHETHER IT TRANSITED OR STOPPED IN CANADIAN ARCTIC WATERS. THUS, A SHIP COMING BACK AND FORTH TO ARCTIC WATERS WILL BE COUNTED AS HAVING MADE SEVERAL VOYAGES.

SOURCE: COMPILED BY THE AUTHORS FROM NORDREG DATA, IQALUIT.

TABLE 4. TRAFFIC ALONG THE NSR, TOTAL AND TRANSIT, IN MILLION METRIC TONS, 2010–2019.

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
NSR, transit tonnage	0,111	0,821	1,262	1,176	0,274	0,04	0,215	0,194	0,491
NSR, total tonnage	2,085	3,225	3,75	3,914	3,982	5,432	6,06	9,737	18
Nb of voyages							1 705	1 908	2 022

SOURCE: CHNL INFORMATION OFFICE, *TRANSIT STATISTICS*, HTTP://ARCTIC-LIO.COM/?CAT=27,, A. APRIL 20, 2019; STAALESEN 2018C, 2019D; HUMPERT, 2019.

Data on voyages within the Arctic confirm this trend in increased local or destinational traffic. Figures from Tables 3 and 4 demonstrate that traffic is expanding significantly in the Canadian and the Russian Arctic. The number of voyages went from 121 to 427 between 2005 and 2019 in the Canadian Arctic. Along the NSR, total traffic is obviously fueled by destinational[11] traffic since figures show transit traffic remains modest, especially after 2013. Total traffic is witnessing a significant expansion, going from 2 metric tons (Mt) in 2010 to 9,8 Mt in 2017, 18 Mt in 2018 (Humpert 2019) and then 26 Mt in 2019 (Staalesen 2019d), with forecasts of 40 Mt by 2022 according to the Russian Federal Agency for Maritime and River Transport (Safety4Sea 2018) and a government objective of 80 Mt by 2024, an objective set even higher by the Russian icebreaking agency Rosatom at 92,6 Mt for 2024 (Staalesen 2019a). This surge in destinational traffic is also taking place around Greenland or Svalbard (Lasserre 2018a; MarineTraffic 2018). It is largely fueled by the expansion of fishing, by community resupply and by natural resources exploitation for global markets (Lasserre 2010a; 2018a; Lasserre and Pelletier 2011; Lasserre et al 2016; Dawson et al 2018). The same phenomenon is largely responsible for the expansion of maritime traffic in the Canadian Arctic.

As for the Canadian Arctic, there are no statistics reflecting transported tonnage. A proxy can be calculated adding up the capacity of ships that plied Canadian Arctic waters (Lasserre et al 2019). Traffic is now definitely less significant in the Canadian Arctic than in the NSR, for both transit and destination traffic. The increase in destination traffic, all categories combined, is however attested to in the increase and breakdown of the number of trips in the area covered by NORDREG (north of parallel 60): a significant increase in cargo ship and fishing vessels traffic can be noticed (Table 5). These cargo ships come to service local communities and perform the logistics of mining sites, like Raglan (Quebec), Voisey's Bay (Newfoundland and Labrador, out of NORDREG's zone though) and Mary River (Nunavut) mines, the latter serviced by a new port built in Milne Inlet (with 81 ship calls). It is significant in this regard that cargo vessel traffic continued to increase despite the closure of the port of Churchill in Hudson Bay in 2016, before its reopening in 2019 with 4 ships calling.

Witnesses to the efforts to increase service to communities, the project to build a deepwater port in Iqaluit, discussed for decades and relaunched in 2005, has finally come to fruition: the works started in 2018 and should be completed in 2019 or 2020. The new port should allow ships to load and unload consumer goods, construction material and fuel much faster, to shorten their time in port and therefore increase the frequency of service. However, the project to build a ro-ro terminal for a vehicle ferry between Iqaluit and Goose Bay (Labrador) had to be canceled due to the high costs and the economic benefits that were too small (Bell, 2019).

Traffic stastistics underline an increase in general cargo ships voyages. Does that mean that shipping companies like NEAS, NTCL[12] or Desgagnés intended to take advantage of the melting sea ice to increase their offer through the purchase of new ships and the increase of ship calls ?

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[11] Destinational traffic, as opposed to transit traffic, describes ship movements where the vessels go to an area, stop there to load or unload, and they proceed to another point. In transit traffic, ships merely pass by.

[12] Now Maritime Transportation Service, MTS, since it was purchased by the Government of the Northwest Territories in 2017.

Interviews with executives from NEAS and Desgagnés in January 2019[13] led to the conclusion that service frequency increased, but marginally: companies rather opted the increase in ship capacity and the extension of service range up to the Alaska border for NEAS and Desgagnés, thus tapping into a geographically larger market. An increase in capacity and frequency would certainly be welcome so as to improve community supply and the development of economic activities that imply shipments outside the community, like the brewery that opened in Iqaluit in 2018, but shipping companies now appear to opt for larger vessels that service more communities and on the improvement of unloading expertise on barges and beaches in the absence of wharves, rather than on the increase in frequency (Stewart, 2018).

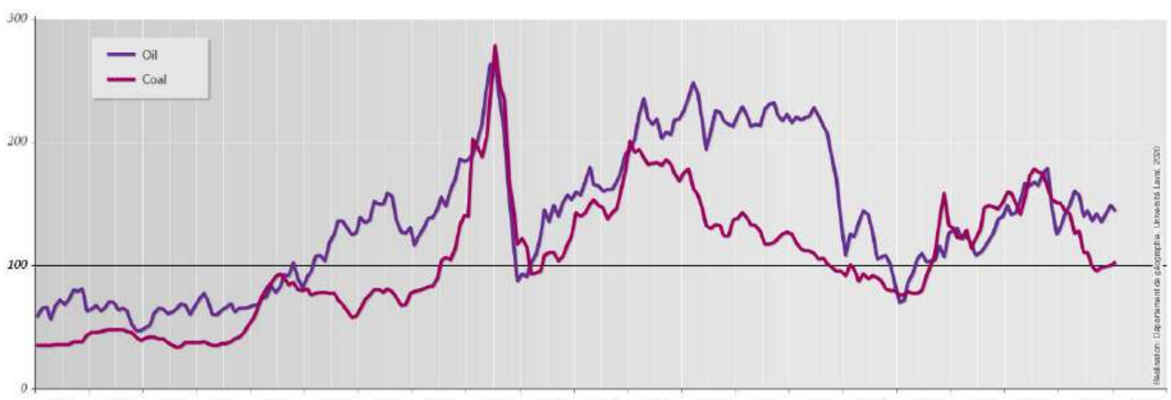
Mining and the oil & gas industry are thus playing a crucial role in the expansion of Arctic shipping. For instance, the huge Canadian iron ore deposit in Mary River (Baffin Island), known since 1962, has been exploited since 2014 and generates substantial traffic of ice-classed bulk cargo vessels. Similarly, nickel mining sites in northern Quebec (Raglan, known since 1932 and opened in 1998; and Jilin Jien (2007), both near Deception Bay) also generate significant shipping activity.

[13] Interviews conducted January 23rd, 2019 with Ms Nadine Blacquière, Deputy Director Sales & Operations, Desgagnés Transarctik and Ms Suzanne Paquin, President & CEO, NEAS; Georges Tousignant, Vice-President, Operations, NEAS on April 4, 2019.

| Economic drivers push for the expansion of natural resources exploitation, a major shipping driver

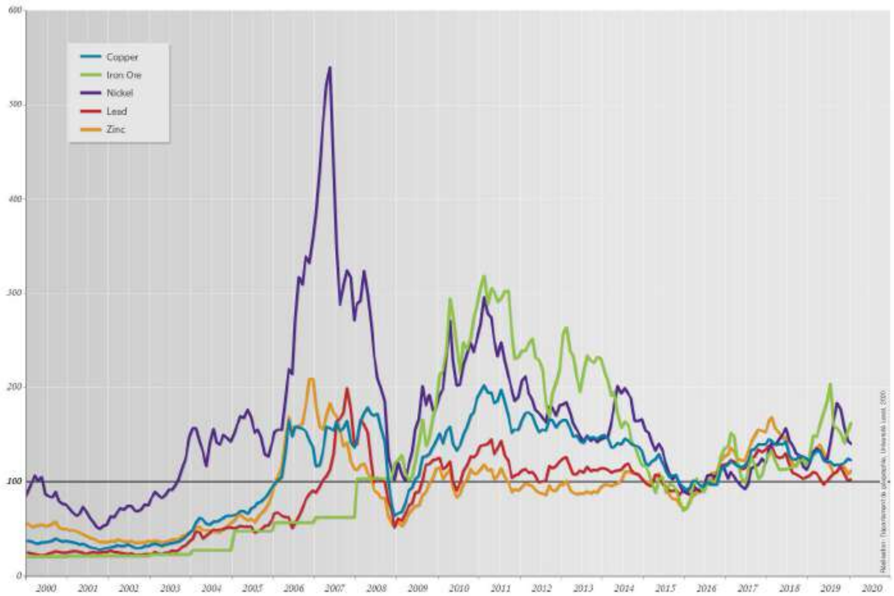
In Russia, Arctic oil and gas production is on the rise since LNG shipments began in 2017 from the gas terminal of Sabetta on the Yamal peninsula where gas was discovered in 1971 (Kontorovich 2015); and since oil shipments began at Varandei (2008), Prirazlomnoye (2013), and Mys Kamenny/Arctic Gate (2016). Oil shipments are likely to keep growing with the recent discovery of the large Paykha oil fields (1,2 billion tons) in the Ienissei delta, north of Dudinka (Staalesen 2019c). The Norilsk nickel mine, through the port of Dudinka, ships about 1,3 Mt of ore to Murmansk annually for transhipment elsewhere. The port of Dickson is set to see a strong expansion of it traffic as the new coal mine of Malolemberovskoye run by VostokCoal is about to enter exploitation in 2019 or 2020 (Safety4Sea 2017; VostokCoal 2018). On Novaya Zemlya, a new port is being built to service the future zinc, lead and silver mine of Pavlovski that should begin operation in 2020 (Maritime Executive 2018). Coal and ore production is also on the rise on the Kola peninsula, and this production and the transhipment from other Arctic ports accounted for a significant growth of throughput at the port of Murmansk, where traffic reached 51,7 Mt in 2017 (up 54,5% from 2016) (PortNews 2018). What drove the opening of these mining ventures was not the opening up of seaways due to climate change. If that was a significant driver, then the Nanisivik and Polaris zinc mines, opened in 1976 and 1982, would likely not have shut down in 2002 just as talk of ongoing climate change was on the rise. Instead, declining world metal prices caused those zinc mines to close down. Similarly, it is the current, higher world prices for metals and minerals than triggered the wave of exploration and new mining exploitation after 2006 (Lasserre 2010c; Lasserre and Têtu 2018). It is apparent that, if indeed prices went sharply down after 2009 and the financial crisis, they remained at higher levels than before the upsurge in 2005-2006, thus supporting the most interesting mining sites (Table 6) and enabling sites like the iron mine Mary River or Malolemberovskoye coal mine to go ahead despite the high costs of Arctic exploitation.

FIGURE 3: EVOLUTION OF WORLD PRICES OF OIL AND COAL, 2000-2020



SOURCE: IMF, PRIMARY COMMODITY PRICES, FEB. 2020

FIGURE 4: EVOLUTION OF WORLD PRICES FOR SELECTED INDUSTRIAL METALS, 2000-2020



SOURCE: IMF, PRIMARY COMMODITY PRICES, FEB. 2020, <HTTPS://WWW.IMF.ORG/EN/RESEARCH/COMMODITY-PRICES>

TABLE 6. EVOLUTION OF WORLD PRICES FOR SELECTED COMMODITIES, 2002-2020

($/tonne)	Jan. 1st 2002	June 2 2008	Jan. 2, 2014	Dec. 5 2018	April 5 2019	Jan. 15 2020
Nickel	6 699	22 150	13 928	10 604	12 131	12 771
Copper	1 705	8 657	7 155	5 840	6 784	5 691
Zinc	775	1 980	1 964	2 467	2 825	2 225
Lead	488	1 763	2 095	2 007	1 904	1 898
Iron Ore	12,68	190	128,12	72,3	91,49	96
Oil ($/bbl)	24,36	138,5	96,29	61,49	63,5	57,68
Coal	33,12	104,97	82,35	101,12	88,45	72,27

SOURCE : WWW.INFOMINE.COM; HTTPS://WWW.MARKETINDEX.COM.AU/IRON-ORE; TRADING ECONOMICS, COAL XAL1, HTTPS://TRADINGECONOMICS.COM/COMMODITY/COAL; *BP STATISTICAL REVIEW OF WORLD ENERGY* 2019.

In this perspective, the integration of the Arctic into the globalized market of natural resources supports exploration and the opening up of new exploitation sites, albeit at a slower pace than between 2006 and 2008. This expanding Arctic natural resources exploitation in turn fuels a growing demand for destinational sea transport. The impact of climate change does not directly support the expansion of destinational traffic; it is an enabler, not a driver.

| Economic drivers also largely explain the development of railway projects

The analysis of traffic figures and transit geography underlines that climate change in itself did not trigger the expected boom in Arctic shipping. Traffic is indeed developing, but it is destinational shipping and concentrated in specific marine areas. Land transportation is also experiencing contrasted developments, with large-scale projects going ahead in Siberia while often remaining delayed in North America, but these are happening despite climate change as the melting of permafrost adds costs to infrastructure construction. Most land transportation projects involve rail development. In Russia, the construction of new Arctic railways is unfolding with the development of the Yamal project, but there are several other schemes under way. Projects have blossomed in Scandinavia as well.

Railway construction in the Arctic is associated with the exploitation of natural resources. The Alaska Railroad between Anchorage and Fairbanks was developed between 1903 and 1923 to facilitate the development of economic activities and especially mining (Wilson 1977). In Canada, the railroad to Hay River on the Great Slave Lake was completed in 1964 largely to service the lead and zinc Pine Point mine, closed in 1991. Hay River now serves as a transhipment point for goods bound for Arctic communities as they are loaded on barges that run down along the Mackenzie River to the Beaufort Sea. The railway to the port of Churchill was opened in 1931 for the export of grain to Europe during summer shipping through Hudson Bay. Elsewhere, iron ore exploited from Kiruna (1898) and Malmberget (1888) in northern Sweden is largely shipped by rail to the Norwegian port of Narvik, and then by sea. The port of Narvik is ice-free all year long and this access represents a strategic, economic advantage (Lasserre and Têtu 2018).

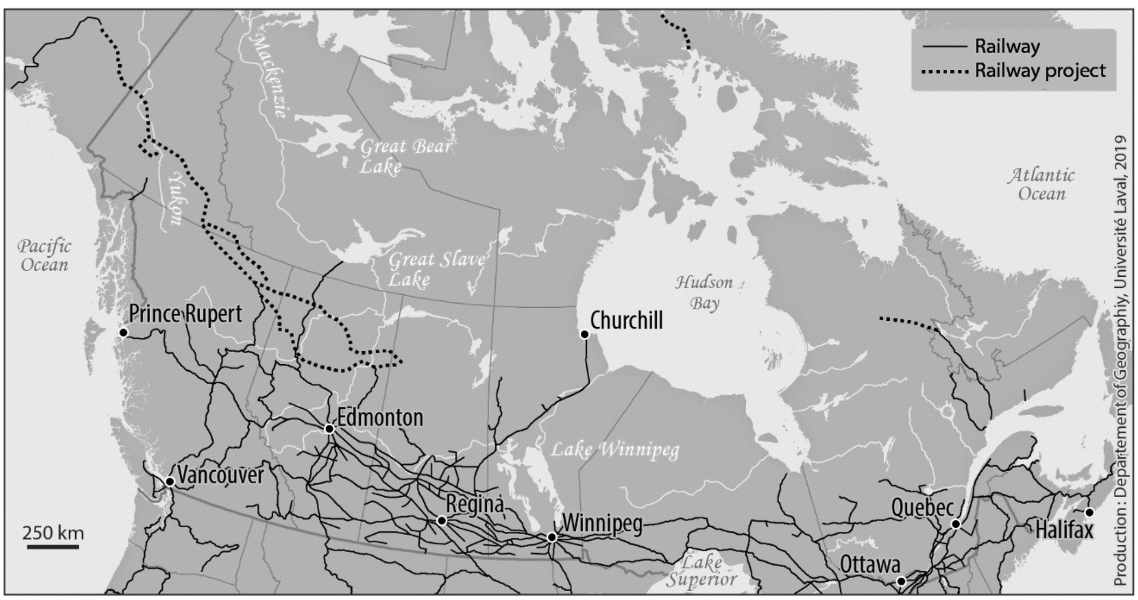
In Russia, the rail line to Murmansk was completed in 1917 to facilitate the exploitation of natural resources in Karelia and the Kola Peninsula through the port of Murmansk, which is kept ice-free for most of the year by the Gulf Stream. The Northern railway was developed in the late 19th century and extended to the mining town of Vorkuta in 1941 with gulag labor. The town of Norilsk boomed after 1935 thanks to the exploitation of the nickel mine nearby, which was serviced by a railway to the sea port of Dudinka on the Yenissei River. In 1947, the Soviet government began the construction of a railway line between Obskaya, on the Ob River, towards Igarka (the Transpolar Railway) with a view to connecting several mining developments in Siberia and improving transportation connections in these remote and vast lands. Rivers flowing northwards were connected to the Northern Sea Route through a series of ports, Pevek for the Kolyma, Tiksi for the Lena, Dudinka, Igarka and Dickson for the Yenissei, Yamburg and Novi Port for the Ob (Smolka 1937; Pastusiak 2016; Goble 2018)[14]. The addition of a railway after the failure of the canal construction was intended to strengthen control over the vast territory. Here, strategic objectives of territorial control mixed with economic drivers to promote the exploitation of Siberian lands. The projected railway, built with gulag workforce, was abandoned in 1953.

[14] A canal had been built between 1882 and 1891 to link the Ob and the Yenissei, but proved too shallow and narrow to compete with the Trans-Siberian Railway and was abandoned after the Civil War in 1921.

FIGURE 5: RAILWAY PROJECTS IN EURASIA

SOURCES COMPILED BY THE AUTHORS

FIGURE 6: RAILWAY PROJECTS IN NORTH AMERICA



SOURCES COMPILED BY THE AUTHORS

Railway development experienced a second impetus recently (Figures 5 and 6).

In Canada, speculations about a projected connection between the Alaska railway and the Canadian network has been circulating since at least 2000 (Metz and Taylor 2012). Several earlier proposals had been floated including a 1956 project for a link between British Columbia and the Yukon and eventually extending to Alaska (Taylor 2012). The urgency to find an outlet for the oil exploited in northern Alberta convinced the provincial government to reactivate this project, which was estimated to cost about 28 billion C$ (20,8 billion US$) (CBC News 2016).However, given this very high cost, the likelihood of its being built appears slim at the present moment. A local rail project connecting the Mary River iron mine on Baffin Island to the port of Milne Inlet is making progress in the environmental review process (Bell 2018).

In Scandinavia, economic conditions encouraged increased production from existing mines and the opening of new ones in northern Sweden and Finland. Baltic ports being saturated, several railway projects were considered to link northern Sweden and western Finland to Arctic ports in Norway or to Murmansk (Nordic Investment Bank 2018) since these ports are, as underlined above, ice-free most of the year and could be connected to the developing Northern Sea Route. Here, the conjunction of local economic drivers, the opening up of new mines that would generate a heavy traffic, with Arctic perspectives, the possible use of Arctic seaports to connect to Asia, leads to a business plan that could justify the huge required investments. It appears the proposed connection between Rovaniemi and Kirkenes is preferred by regional governments (Karijord 2017, 2017b) despite not being the most affordable at about 1,3 billion euros (Norconsult 2018) and its questionable profitability (Ministry of Transport and Telecommunications 2019). However, this plan reportedly offers higher development potential for interconnection between natural resources exploitation sites and higher transit traffic between the Baltics, Central Europe, Finland and a port hub connected to the NSR (Rautajoki & Lakkapää 2018; Sør-Varanger 2018), in a context of growing iron prices that led to the likely reopening of the Sydvaranger iron mine near Kirkenes (Staalesen 2019b). The profitability of the scheme thus rests on the development of natural resources at higher prices and of the accessibility of the NSR made possible by climate change.

Several old Russian rail projects have been revived since the beginning of the 20th century. In Russia, Arctic oil and gas generate growing shares of economic activity and of the federal budget (Hedlund 2014; Sabitova and Shavaleyeva 2015; Lee and Lukin 2016). Arctic natural resources contribute to economic activity even more significantly when mining is included. The Russian government thus tries to promote the coming online of Arctic oil and gas projects that may be marginally profitable given their high costs but that provide revenues for the State. As mentioned above, the Yamal LNG terminal was inaugurated in December 2017, and several oil terminals are now producing. Other oil and gas fields are to be exploited in the area, but the logistics of the development are complex. Exploitation could be made easier with the development of railway infrastructure that could benefit the mining industry in addition to oil and gas exploitation, and such a railway could also help promote the Northern Sea route, a geoeconomic project dear to the Russian government (Lasserre 2018b).

The connection from the Baikal-Amur Magistral railway in southern Siberia, to Yakutsk should be completed in 2021. The train already goes up to Nijni Bestiakh on the other side of the Lena River, the connection to Yakustk demanding the costly construction of a bridge over the river. Traffic has already increased to Yakutsk, leading to a better supply of cheaper consumer goods[15]. In Siberia, there are several, simultaneous efforts to diversify the connections between mines and oil and gas fields in the region to river and sea ports. These connections will accomplish several objectives: facilitate the logistical servicing of these ventures, offer transportation alternatives, and help develop and diversify the Northern Sea Route with

[15] According to Daryana Maximova, head of the Northern Forum; interview in Iakutsk (Russia), Sept. 29, 2019.

diversified cargo that will come only if Arctic ports are connected to the hinterland (PortNews 2013; BNE Intellinews 2018). The ports would thus facilitate the enlargement of the hinterland of Arctic ports, in the hope connections will develop between river traffic and small Arctic ports that could then act as stopovers for traffic along the NSR.

FIGURE 7: THE PORT OF IAKUTSK ON THE LENA RIVER, SEPT. 2019

CREDIT F. LASSERRE

Economic take off of the Siberian hinterland cannot rely on Arctic transit shipping alone. Construction of rail connections should begin in 2019 and be completed in 2025 (Railway Gazette 2018) at a cost of between 2 billion $ (BNE Intellinews 2018) or 3 billion euros (3,41 billion $) (Staalesen 2018). This sum largely exceeds the capacity of the cash-strapped Russian government given the lower prices of oil and gas on the world markets. To cover these costs, Moscow turned to a private-public partnership between RZD, Gazprom, the Yamal-Nenets Autonomous region and is actively trying to attract other private investors (Staalesen 2018a). Gazprom, a partner in the railway venture, tried to sell its stake to RZD but failed to get rid of what is likely to be a very expensive scheme to build and run (BNE Intellinews 2018).

Moscow is also actively promoting the revival of the Belkomur project, which was first launched in 1995 and aimed at connecting Arkhangelsk to Perm and thus to the TransSiberian mainline. The goal is to diversify the export of natural resources exploited in the area-- ore, coal and timber-- and to diversify and augment sea traffic through a new, deep-water port that remains to be built and that would be fed through the development of the NSR (PortNews 2013). The

Arkhangelsk and the neighboring Komi Republic are actively promoting the project with the Eurasian Development Bank as well as Chinese investors (Staalesen 2017, 2018b). Similarly, the Murmansk Transport Hub is a project designed to expand the shipping capacity of the port of Murmansk. This port presents the strategic advantage of being ice-free most of the year. This is the reason why it was chosen as the main transshipment hub for oil and gas exploited in Yamal and the Kara Sea. It is also serviced with a major railway that was electrified in 2005. The transport hub project includes the extension of the railway on the western bank of the Kola Bay to service industrial projects planned in the area as well as new harbor facilities. However, it is a costly endeavor and Rosneft reportedly considered abandoning its planned oil terminal in the area (Staalesen 2016). These very ambitious Russian rail projects attest to Moscow's strong will to develop transportation infrastructure to support resources exploitation. Some authors pointed to the technical difficulties and high cost of these endeavours (Goble 2018; Staalesen 2018a), forcing the Russian government to resort to the concession financing mechanism (Tass 2017).

Thus, several Arctic land transportation projects are currently being promoted. The Northern Latitudinal Railway, the Belkomur Railway, the port of Sabetta, the Murmansk Transport hub are considered part of the Arctic Transportation Corridor, a large set up of transportation infrastructure projects aimed at developing transportation capacity between the Russian Arctic and the world (PortNews 2013). Finland and Norway are also keen on developing rail infrastructures to the Arctic to foster the development of northern mining projects and to promote the integration of their northern regions into large logistical schemes that could diversify their economies. Projects have also emerged in Canada and Alaska but their prospects are less rosy as in Russia. Other Canadian infrastructure projects, like the road between the Izok mining corridor and the Coronation Gulf, have been struggling with financial difficulties for the past ten years (George 2019; Bell 2017).

Conclusion

Arctic region is experiencing serious impacts of climate change that lead to a rapid melting of sea ice. This shrinking of sea ice led to the renewal of the idea of expanding Arctic maritime traffic, in particular since distances are shorter between the North Atlantic and Asia along Arctic routes than through the Suez or Panama canals.

To understand patterns of shipping expansion in the Arctic, one must actually look beyond the Arctic to ways in which resources of the Arctic region are becoming integrated into the global economy. It is also important to note that transit shipping is not actually expanding as much as the media-drawn picture might induce. Just because those waterways are more accessible does not make them safe and affordable to ply, and there is more to shipping logistics such as overall costs of shipping and strategic logistical constraints like just-in-time, especially for shipping companies that largely reason on the global market.

What the region is witnessing is expanding destinational or local traffic in support of fishing, oil, gas, and mineral exploitation development. It is also the quest for resources that spurs the construction of new railway lines, especially in Siberia, but also in Arctic Scandinavia. Traffic is also expanding because of the development of tourism with cruises and pleasure crafts, and because of an expanding community resupply, as villages appreciate cheaper consumer and construction goods delivered by sea rather than by airlift. If sea access improved because of climate change, however land access became more problematic. Railways are expanding indeed, but this is despite the fact that climate change and permafrost instability makes these projects much more complex and expensive. From a geopolitical stance, railway expansion and Arctic marine traffic control represent important means of exercising sovereignty over these remote areas. This demonstration of State power is happening despite the added expense of railway construction in areas where melting permafrost makes infrastructure projects more expensive, and where the remoteness and sparsely populated land make port development projects poorly profitable, unless supported by an active resource-producing site.

This research exemplifies environmental geopolitics as it examines the assumption that increasingly open Arctic waters will lead to more marine shipping. In fact, melting sea ice and climate change are enablers of increasing traffic, but not drivers. Rather than short distances that did not prove strong an incentive for the development of transit shipping, it is the integration of the Arctic region into the global market of natural resources that largely drives the expansion of shipping in the area. It is only when we closely examine the role and meaning of natural resources (oil, gas, and minerals) that we can understand the nuance of patterns of actual Arctic marine traffic. However, States definitely saw in this expanding natural resource market a reason to expand their control over lightly controlled territories, as they could simultaneously develop valuable resources and their political control over long-claimed but weakly controlled territories and maritime expanses.

Thus, to understand what is happening in the Arctic marine region, it is important to be aware of both the context of the global economy and regional geopolitics. Examining these multiple, simultaneous spatial scales of activity and processes is key to understanding the unfolding and imminent activity in the Arctic Sea region.

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