Analysis of Murmansk as a gateway for the Arctic production

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Abstract

The Western Russian Arctic seabed, due to the huge quantity of oil and gas, is subject to numerous investment and drill like in the Yamal peninsula with the port of Sabetta. Extreme climate conditions and remoteness impact negatively the cost of transportation of raw materials and so the use of ice or polar class vessels due to the ice.

In order to give to Murmansk, the role of transshipment Hub for oil and gas coming from Arctic fields, investment have been made to update existing infrastructure and implement new one.

However, if we are aware of the origin of the cargo, the destination is more complex to define.

The aim of this article is to analyze, the way Murmansk is integrated in the global maritime network.

To do so, we use the Automatic Identification System (AIS) to visualize the different typology of vessel. Even if Murmansk is originally a port mainly dedicated to coal exportation, the coming investment increased the amount of crude oil handled, hence we decided to focus on tankers, container and dry bulk vessels. In order to stress the impact of NSR development on Murmansk, we looked at its input and output evolution since 2010. This evolution is analysed in comparison with the price of commodities.

In conclusion, the future competitiveness of the Murmansk port complex is discussed, considering other comparable investment forecasted on deep-water greenports like Arkhangelsk as well Kirkenes, both promoted as future strategic gateway to Western Russia, Scandinavia and Eastern Europe markets thanks mainly to efficient projected railways & roads networks.

Keywords: *Port System, Tanker, Bulk, Murmansk, Hub, Arctic.*

1. Introduction

In recent years, the Russian government has invested in port infrastructures and more precisely in Arctic port, a region with numerous oil and gas currently exploited. The part of the project receiving most of the investment and attention, Murmansk is one of the examples that represents the renewed interest for these ports.

Within the Russia toward the north, Murmansk appears as being at its inner center. The re-colonization of the north as mentioned by Kinossian (2016) is the corner stone of the NSR development.

Few things to know about Murmansk is that it is one of the few deep-water ports with an ice-free access all year long. Besides, it is connected thanks to a railway to the rest of the Russian railway network. Murmansk is also the largest city in terms of population in the Arctic.

Looking at implemented projects, we could quote the implantation of a free trade zone (Murmansk transport Hub) supposed to handle dry bulk such as coal, liquid bulk and container. Until now, Murmansk is mainly known for, handling coal, being the home port of the northern fleet.

The harsh sailing conditions in the Arctic impose the use of specific vessel able to sail in ice infested waters. However, it may not be relevant to use these ships within warm waters for maneuverability reasons and also because they are smaller than vessels usually used to ship raw materials. Besides, the remoteness of the oil and gas fields increases the cost of transporting crude oil from these fields.

All these parameters posit Murmansk as a potential regional Hub. Yet, if Murmansk is clearly connected to the other Russian ports of the Arctic, the question is which ports located overseas and out of the Arctic Ocean are connected to Murmansk.

The aim of this article is to shed a light on the evolution of Murmansk as a potential hub and to determine the number of dry and liquid bulk calls. The general idea of this article is that because it is complicated to get the amount of cargo transported from the Russian authorities, we will focus on the number of times each type of vessel calls in Murmansk for origin or destination.

The new Russian strategy has been implemented in 2010, so we are going to look at its evolution and impact on Murmansk between 2011 and 2017.

To do so, after a short literature review on this subject, we shall explain the way we extract and manipulate data. The third section deals with the result for dry and liquid bulk. Section four provides prospective approach of the area and the way Murmansk may change. Finally, after a discussion, we propose concluding remarks.

2. Literature review

The development is grounded on the development of ports for mainly safety and economic purposes (Ragner, 2000; Kitigawa, 2001; Gunnarsson, 2014). The ice melting and the oil gas reserves in the western part of the Russian shore (Grigoriev, 2015), explain the numerous academics and professional analysis of this area. Besides, the Arctic region is highly sensitive to Russian development with a production representing 20% of Russia GDP and 22% of its export (Scherbanin, 2013).

Monios et al (2019) conceptualized the idea of second-tier hub based on three examples. If their explanation relies on the port handling containers, they defined a second-tier as a hybrid managing goods coming from other but with also including cargo coming from its own hinterland. Looking at this definition, it appears that Murmansk seems to fit to this definition. The coal exported comes from its hinterland and the oil and gas have for origin arctic ports situated along the Western Arctic Russian shore.

As explained by Monios et al (2018), a second-tier hub has to manage transshipment and be connected to its hinterland. Regarding the hinterland connection, we could quote Scherbanin (2013) who explained that one of the objectives of the Russian transport strategy is to develop the loading capacity of the railroad to ports such as Murmansk by two. Besides, Scherbanin (2013) presents Murmansk as a hub.

Related to the link with the hinterland, Smirnova et al (2016) pointed the importance of Murmansk Transport Hub, defined it as an "anchor project" and one of the main Artic projects, for the Russian Federation. Pavlenko et al (2014) demonstrated the importance of Murmansk within the Russian strategy with a planned capacity of 91 million tons by 2030 far above the 39.2 and 37.5 Million tons of, respectively, Sabetta and Arkhangelsk.

Pahl and Kaiser (2018) highlighted that Murmansk is the biggest port within the Arctic and also shed a light on its ice-free position. The development of the NSR is dependent on the development of Murmansk. Pahl and Kaiser (2018), Bennett (2014) and Scherbanin (2013) clearly pointed the importance of resources extraction, raw materials and cargo shipping for the NSR. In fact, the raw materials such as oil and gas are the pillar of the Arctic economic development and the building and upgrading of proper infrastructures in order to render safer and more profitable navigation within the Arctic (Gunnarsson, 2014).

In order to manage the extraction of Arctic resources, Gunnarsson (2014) considered the development of Arctic ports infrastructures as one of the main elements to take into consideration when dealing with the marine transportation system.

The ice and geographical constraints impose the use of an ice class vessel (Fedi et al, 2018). The presence of ice does not facilitate port access on a year basis and limits the number of vessels able to call in these ports.

Thus, the use of "shuttle vessel" would be necessary as stated by Gunnarsson (2014). He also explains that the implantation of a HUB in the west and the east boarder of the NSR would be necessary and considered that the location of Murmansk is valuable (Gunnarsson, 2014)

Yet as pointed out by (Gunnarsson, 2014), crude oil transshipments also supposed to play a major role within the port activity.

Our analysis focuses on the evolution of Murmansk seaport connection with the rest of the world in function of the typology of vessel between 2011 and 2017. The objective is to demonstrate that Murmansk is clearly a gateway for dry and liquid bulk and that the fishing activity appears as a one of the main levers for growth of the port.

3. Methodology

This work is based on a database constructed using the IHS maritime database (https://maritime.ihs.com/) and with collected data from AISHub, a data sharing service which provides access to real time ship positions for vessel tracking systems.

The AIS is a tracking system used on ships to provide information on surrounding traffic situation and supplements marine radar as a collision avoidance device. AIS devices are obligatory on all large vessels according to the IMO SOLAS Convention (SOLAS Convention, 2004). AIS presents advantages for maritime transportation actors: improvements in safety, progresses in fleet management and navigation. The data acquired from AIS systems also constitute a new means of information for the maritime community, or the wider public (See Fig 1).

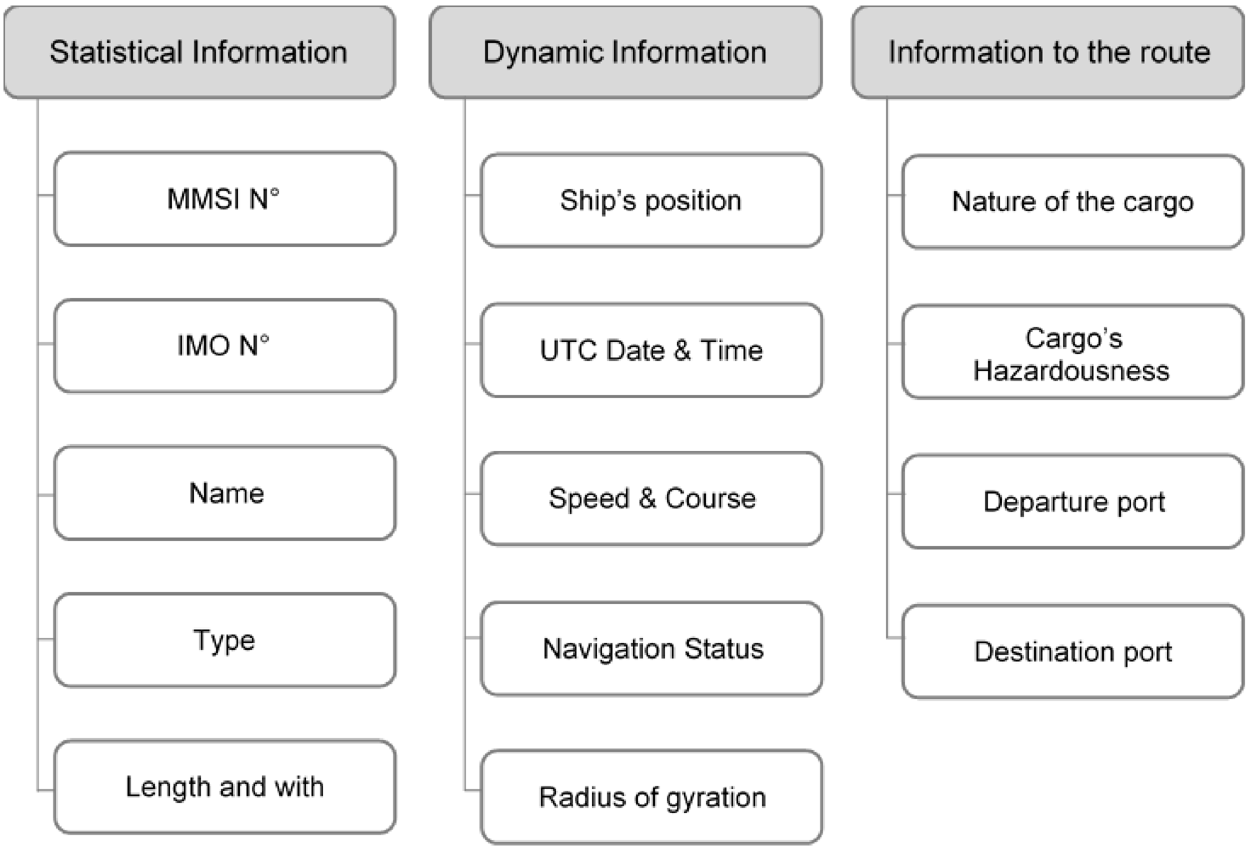

Figure 1: Nature of AIS data

Source: Adapted from Le Guyader, Brosset, Gourmelon, (2011).

Above all, broadcasting AIS data in real-time makes a tangible contribution to the scientific community (Serry, 2017). This data is first used for work mainly based on security or coastal areas. Furthermore, the literature is fragmented between different approaches and subjects like international maritime law, physics, signal processing, geopolitics and many others. The use of AIS data provides the opportunity to study vessel behaviour due to meteorological circumstances or highly refined vessel movement and improved emissions estimation (Perez, 2009). A potential application of archived AIS data is also to extract trip duration statistics for a population of ships (Mitchell et al, 2014).

AIS data improves a network of stations covering more and more areas, providing new possibilities to the mapping of transport activity. "Thanks to the availability of AIS data, it is possible to identify, quantify and map navigation lanes of vessels" (Le Guyader et al, 2011). The automatic character of transmitting vessel positioning signals and its generalisation provide an opportunity to track and analyse the vessels' itineraries. Once this source of information has been properly checked through matching it with external data with regard to vessels and ports, it opens the way to reasoning on a global scale as well as on the scale of port approaches, in real-time as well as long term.

The method, founded on a spatial analysis within a geographical information system (GIS) combined with a database server, makes it possible to reconstruct each vessel's trajectory in such a way as to identify the navigation lanes then to match the daily traffic in its temporal and quantitative dimensions. It is then possible to analyse the maritime networks.

As AIS data can be free of charge, it may raise preoccupations with a confidentiality (Serry et al, 2018). Using of AIS signals request a number of methodological and technical issues, some related to the duration of observation which must be long enough to account for seasonal trends, others related to the geographic scope, which must be comprehensive if you want to account for the economic gap between different regions of the globe. All this requires the accumulation of large masses of data. There is also the question of the intrinsic quality of the data transmitted by the AIS signals.

As AIS data is “Big Data“, it requires specific techniques for data handling and processing which has limited its use. We create a platform (CIRMAR) to develop capacity and methods for better use of this massive source of maritime data. It has to receive, decode, clean, store and analyse AIS messages. During a first phase, AIS messages are received: each message contains position reports from ships, base stations reports... Second, the messages are decoded, made ready to be checked and messages with errors are ignored. As seen in figure 1, the decoded AIS data are human-readable tables containing several parameters such as the date and time when the signal was issued, the identification of the AIS message, the identification number of the AIS transmitter...

We also need to clean the data which will be used in our analysis and to create statistics or maps, for instance, removal of duplicated signals or wrong MMSI signals. The data cleaning is necessary to remove erroneous signals and duplicates. In reality, several problems appear during the treatment. At first, speaking about data treatment, the two major obstacles to produce information for geo-economic issues are the amount of data to process and the quality of data and particularly static data. Even if they are of small size (39 characters for example) the number of AIS messages received, led to the formation of large amounts of data. Regarding data quality, most of the problems relate to information that are manually integrated in the system (port of destination, navigation status, draught of the ship and estimated time of arrival). So, dynamic data (positioning and road) are more reliable than the static ones, therefore, it is interesting to match AIS data with some external databases on ships or on ports (Lévêque, 2016). The next step is to store AIS messages in the database.

In this study, due to the lack of coverage of AISHub in the Arctic area, we mainly used data from IHS Maritime for years 2011 and 2017. As shown in Figure 2, container ships are not calling in Murmansk. So we decided to focus on bulk flows from and to Murmansk.

At least, from a general point of view, as Murmansk is traditionally considered as the beginning of the NSR (Selin et al, 2014), and because it is the largest transportation hub in the Russian Arctic, we decided to have a special focus on ship departing from Murmansk.

4. Results

As highlighted by the Figure 2, the main type of vessel calling in Murmansk are fishing vessels in 2011 and 2017. Fishing vessels, tankers, bulk carrier, general cargo and tug represent representing 80% of calling within Murmansk. Besides, in 2017, the number of calls increased by 34.3 % compared to 2011, reaching 3,758 called. The first results also clearly show that container flows are missing in Murmansk.

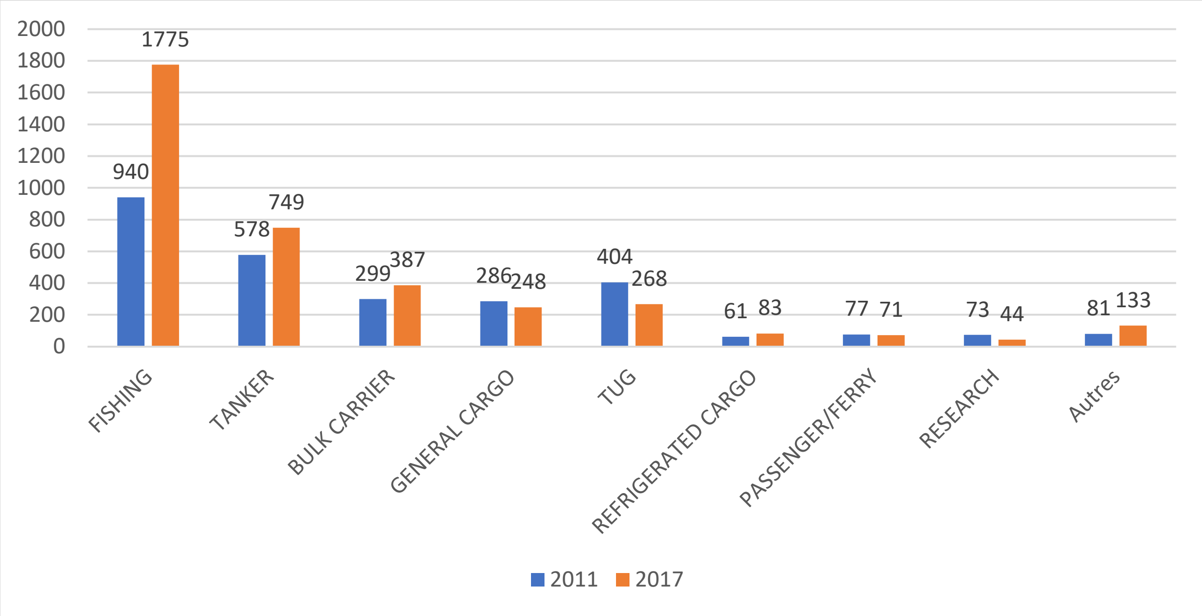

Figure 2: Calls to Murmansk by Vessel type

Source: Authors (2019)

Even if fishing vessels represent the highest evolution in term of number of calls between 2011 and 2017, we assumed to concentrate on tanker, bulk carrier. We made this choice based on the Murmansk's importance for the development of the Russian economy. One of the main growth levers is the exportation of raw materials coming from the Arctic mines and oil and gas fields. Due to its geographical position, Murmansk is the main gateway.

If the number of calls of bulk and tankers vessels increase between 2011 and 2017, their share within the exportation decrease from 39.6% till 36.7% in 2011 and 2017 respectively. Despite the increase of 271 tankers, general cargo and bulk vessels, the additional 835 fishing vessels decrease the global share of commercial vessels.

Regarding tankers, in 2017, Murmansk is still the first with 1,414 calls but Varandey is the second one due to the existing shuttle tanker for the transshipment of additional crude oil coming from the joint venture with Basneft. The second port is Rotterdam with 98 calls. The next non-Arctic and non-Russia port is Antwerp with 35 calls and Hamburg who was the second port in 2011 comes after with 17 calls. In 2011, most of the flows were concentrated between the North-Range and for some of them on the American shore of the Mexican gulf (Figure 2).

4.1. Tankers flows

Figure 3a and 3b demonstrate the position of Murmansk as the main port in term of crude oil management in the Arctic. The Figure 3a and 3b shed a light on the evolution of the connection of Murmansk via the flow of liquid bulk. In 2011, Murmansk main destination is the European Northern range, the rest of the connection being disseminate all around the globe. In 2017, if the Northern range is still present, new point appeared such as in, the Baltic sea, the Bosporus strait. From a Russian perspective, the Arctic Russian ports of Arkhangelsk, Sabetta and Varandey appear. The reason for the emergence of Russia has to be found in the exploitation of oil fields and the implementation of shuttle tankers.

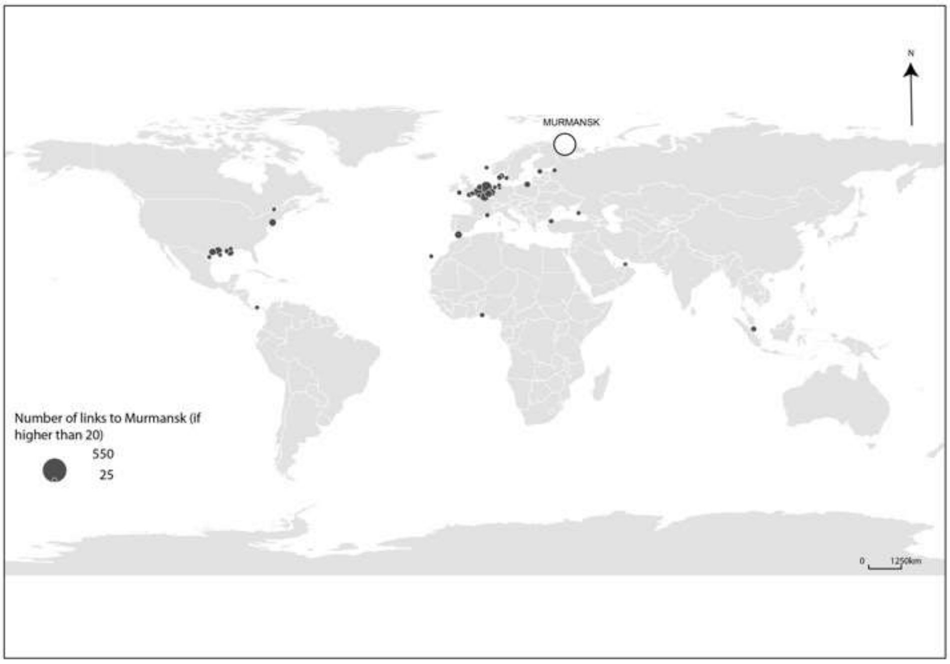

Figure 3a: Connection of Murmansk in 2011 – Liquid Bulk flows.

Source: Authors (2019) based on IHS

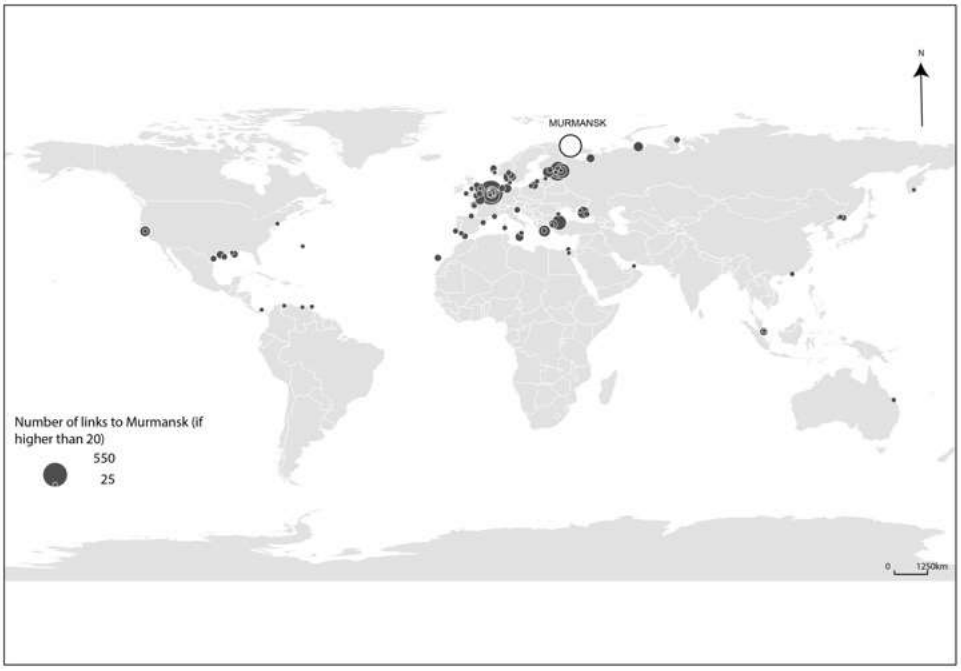

Figure 3b: Connection of Murmansk in 2017 – Liquid Bulk flows.

Source: Authors (2019) based on IHS

At first sight, in 2017, Murmansk increased the number of ports connected but also reinforced its link with ports that have been the main origin or destination.

Table 1a: Number of calls for tankers with as origin (80% of the total calls) in 2011

Port	From Murmansk
Rotterdam	34
Antwerp	11
New York & New Jersey	5
Fawley	5
Corpus Christi	5
Amsterdam	4
Singapore	4
Ijmuiden	3
Dudinka	3
Pevek	3
Sullom Voe	3
Freeport (Bahamas)	3
Mongstad	2
Asnaesvaerkets Havn	2
Galveston	2
Gothenburg	2
Naantali	2
Port Said	2

Table 1b: Number of calls for tankers from Murmansk (80% of the total calls) in 2011

Port	To Murmansk
Rotterdam	25
Antwerp	11
Amsterdam	7
Montreal	7
New York & New Jersey	6
Ijmuiden	6
Fawley	3
Dudinka	3
Pevek	3
Sullom Voe	3
Mongstad	3
Corpus Christi	2
Amderma	2
Hamburg	2
Immingham	2
Skagen	2
Asnaesvaerkets Havn	1
Galveston	1
Botlek	1
Gdansk	1
Kalundborg	1
Le Havre	1
Scapa Flow	1
Slagen	1
Tallinn	1
Wilhelmshaven	1
Algeciras	1

Source: Authors (2019)

In 2011, 3% of ports represented 60% of Murmansk tankers calling (Table 1a and 1b). Exception for Dudinka and Pevek in the eastern shore of Russian Artic zone, no one are Russian. European ports represented the lion share of the flows (5 out of 11) with Rotterdam and Antwerp as, respectively, first and second, ports in number of calls. With the port of new-York, and Corpus Christi in Texas, the USA was connected to Murmansk.

In 2017, the situation is quite different and flows were more concentrated compared to 2011 (Table 2a and 2b). 1% of ports connected to Murmansk represent 60% of calling. 4 out of these 8 ports are part of the North-range (Rotterdam, Le Havre, Antwerp, Wilhelmshaven), the rest being Russian port such as Arkhangelsk, Vorota Arktiki Oil Terminal, and Varandey for the crude oil and Sabetta for the LNG. The high level of connection of the Russian ports can be explained by the Russian strategy to posit Murmansk as a Gateway for the export of raw materials. The management of crude oil is paramount for the Russian economy. In addition, Murmansk as a deep-water ports and ice free all year long provide the benefits to be close to the zone of production and to be able to manage Very Large Crude Carrier or Aframax with no ice-class.

Besides, when looking at the number of calls in both directions, they are quite balanced with only a difference of 30 calls between these 8 ports. The difference being explained by Antwerp, Le Havre and Wilhelmshaven.

Table 2a: Number of calls for tankers vessel with as origin (80% of the total calls) in 2017

Port	From Murmansk
Varandey	87
Rotterdam	58
Archangel	29
Antwerp	28
Le Havre	19
Sabetta	18
Vorota Arktiki Oil Terminal	17
Pointe-a-Pierre	11
Gladstone	10
Fawley	8
Mamonal	7
Immingham	6
Kalundborg	6
Pevek	6
Brofjorden	6
Hamburg	4
St Petersburg	4

Table 2b: Number of calls for tankers from Murmansk (80% of the total calls) in 2017

Port	To Murmansk
Varandey	87
Rotterdam	55
Archangel	31
Vorota Arktiki Oil Terminal	16
Sabetta	12
Antwerp	10
Wilhelmshaven	9
Le Havre	8
Immingham	8
Skagen	8
Sydney (Australia)	6
Sines	6
Hamburg	5
St Petersburg	4
Botlek	4
Melbourne	4
Liverpool (United Kingdom)	4
London	4
Milford Haven	4
Fawley	3
Kalundborg	3
Pevek	3
Mongstad	3
Vlissingen	3
Amsterdam	3
Bilbao	3
Cork	3
Suez	3
Gladstone	2
Novorossiysk	2
Gothenburg	2
Piraeus	2
Finnart	2
Townsville	2

Source: Authors (2019)

4.2. Dry-bulk flows

This section focuses on the connection of Murmansk with other ports when dealing with dry bulk carrier whether Murmansk is the destination or the origin. Figure 4a and 4b point out the importance relation linking Murmansk to the North-range, the American coast of the Mexican

Gulf and the Baltic sea. In 2017, the north-range and the Mexican gulf and the Baltic sea were still highly connected to Murmansk but some new area appears or enhanced their level of connection such as Gibraltar Strait, Aegean Sea, Malacca Strait and the African West-coast.

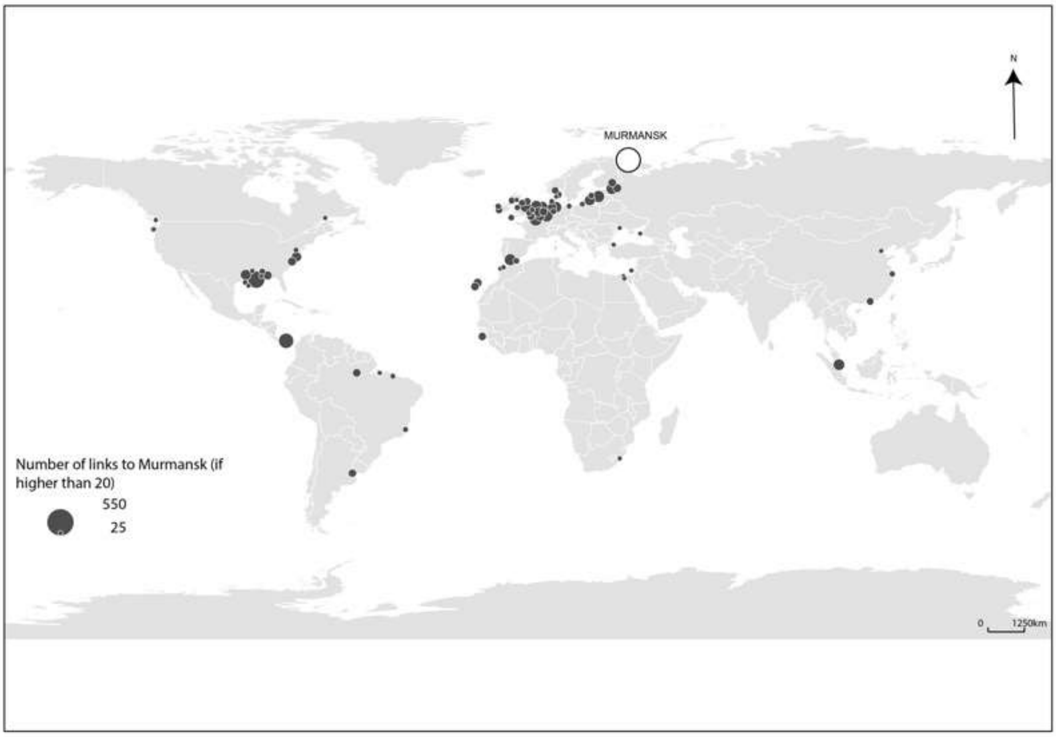

Figure 4a: Connection of Murmansk in 2011- Dry bulk flows.

Source: Authors (2019) based on IHS

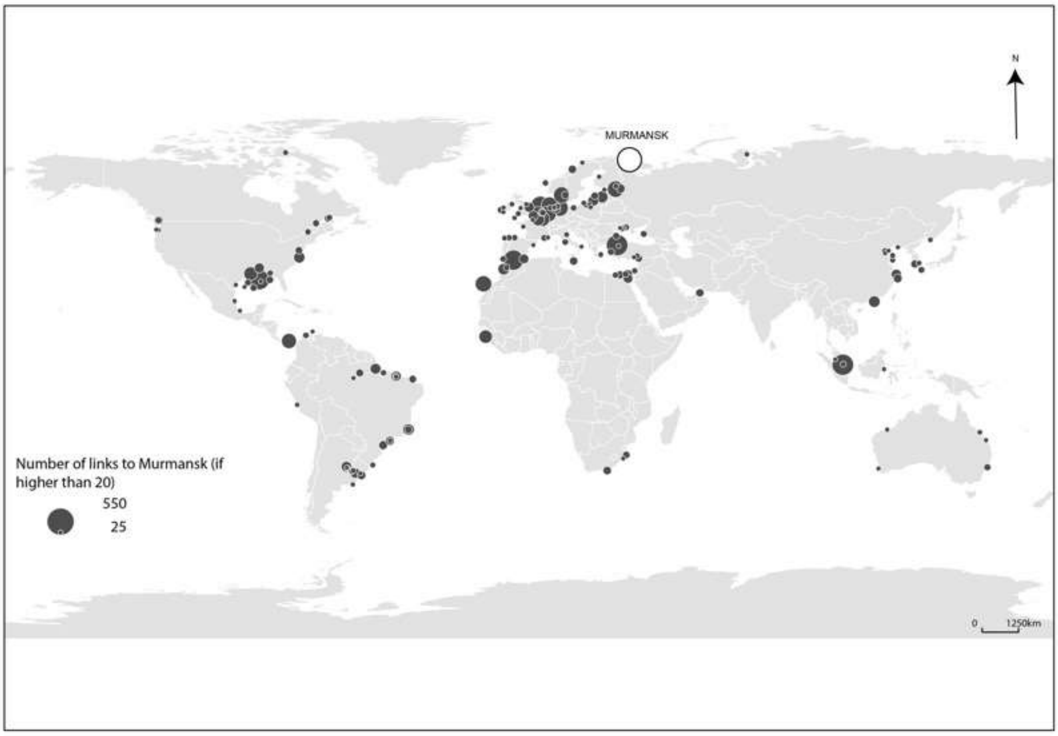

Figure 4b: Connection of Murmansk in 2017 - Dry bulk flows.
Source: Authors (2019) based on IHS

Table 3a: Number of calls for bulk vessel with as origin (80% of the total calls) in 2011

Port	Destination Murmansk
Hamburg	19
Rotterdam	12
Immingham	10
Terneuzen	10
Amsterdam	9
Antwerp	8
Shannon Foynes Port	7
Hull	6
Liverpool (United Kingdom)	5
Botlek	5
Newcastle upon Tyne	5
Hunterston	3
Dunkirk	3
Grenland Harbour	3
Ijmuiden	3
Santa Cruz de Tenerife	3
Ghent	3
Wilhelmshaven	3
Nordenham	2
Leith	2
Ashdod	2
Esbjerg	2
Teesport	2

Table 3b: Number of calls for bulk vessel from Murmansk (80% of the total calls) in 2011

Port	From Murmansk
Hunterston	12
Immingham	10
Dunkirk	8
Klaipeda	8
Hamburg	6
Terneuzen	6
Grenland Harbour	6
Jorf Lasfar	6
Nordenham	5
Las Palmas	5
Singapore	5
Amsterdam	4
Antwerp	4
Liverpool (United Kingdom)	4
Hadera	4
Donges	4
Puerto Cabello	4
Botlek	3
Newcastle upon Tyne	3
Gibraltar	3
La Coruna	2
Plaquemines	2
Port Nador	2
Santander	2
Suez Canal	2

Source: Authors (2019)

Table 3a and 3b stress the ports representing the origin of 80% of vessels calling in Murmansk and the destination of 80% of bulk vessel coming from Murmansk and the numerous varieties of port trading with Murmansk. Furthermore, they point out the existing imbalance of flows. If the main destination is exactly the same as the main origin in the case of tankers, it is clearly not the same for bulk vessels. Besides, the number of time ports receiving vessels coming from Murmansk are not the same number as the number of times vessel coming from these ports call in Murmansk.

Table 4a and 4b stressed the strong imbalance between the flows coming in and leaving Murmansk in 2017. Firstly, 80% of calls in vessel calling in Murmansk come from 37 ports and while 80 % of bulk carriers leaving Murmansk are calling in 28 ports. 11 ports that are part of the main destination are not in the main list of the main origin and among them Jorf Lasfar and Singapore respectively the first and eighth destination and 18 new ports appear within the list of main origin. Besides, Sabetta is the only Russian in this list the next being Dudinka with one origin.

Table 4a: Number of calls for bulk vessel with as origin (80% of the total calls) in 2017

Port of destination	To Murmansk
Rotterdam	29
Amsterdam	26
Hamburg	24
Immingham	16
Klaipeda	14
Ghent	13
Ijmuiden	12
Dunkirk	10
Sabetta	8
Antwerp	6
Eemshaven	6
Gibraltar	5
Terneuzen	5
Elbeharbour	5
Kandalaksha	5
Bremen	4
Botlek	4
Dikson	4
Aughinish	4
Liverpool (United Kingdom)	4
Shannon Foynes Port	4
Gijon	3
Mo I Rana	3
Teesport	3
La Coruna	3
Nordenham	3
Wilhelmshaven	3
Grundartangi	3
Sunndalsora	3
Vlissingen	3
Las Palmas	2
Belfast	2
Gothenburg	2
Port Elizabeth	2
Aarhus	2

Table 4b: Number of calls for bulk vessel from Murmansk (80% of the total calls) in 2017

Port of destinaton	from Murmansk
Jorf Lasfar	27
Hamburg	19
Klaipeda	18
Antwerp	18
Ijmuiden	17
Hadera	13
Rotterdam	12
Singapore	12
Amsterdam	9
Sabetta	9
Bremen	9
Gijon	7
Nemrut Bay	7
Dunkirk	5
Las Palmas	5
Algeciras	5
Plaquemines	5
Port Said	5
Toros	5
Mo I Rana	4
Teesport	4
Nantes-St Nazaire	4
Gibraltar	3
Terneuzen	3
La Coruna	3
Istanbul	3
Porto Torres	3
Immingham	2

Source: Authors (2019)

5. Prospective

5.1. Energy analysis

Murmansk connect the Russian port of the Russian Arctic shore with the rest of the world by playing the role of gateway for the Arctic production (figure 5). Figure 5 stressed the importance of Murmansk as a regional hub for the Arctic ports mostly dedicated to the exportation of crude oil and LNG as explained above with the figure 3b. Figure 5 also shows the use of shuttle doomed to deliver crude oil extracted and shipped in Varandey. Murmansk in 2017 was also used as a transshipment hub for the LNG produce in Sabetta.

Based on British Petroleum report (2018), most of energy resources comes from oil and gas industry and may represent 60% of the total energy consumed. One explanation is based on the development of India and China. As an example, China aims to increase its consumption of

LNG in the coming years. This objective may be one reason explaining the growth of 3% in LNG consumption.

If we consider the current volume of energy consumed worldwide with the forecasted economic growth of the most energy-intensive economies (China, USA, Russia, India, European Union, etc.), the emblematic threshold of 15 000 Mt of equivalent oil could be exceeded before 2030 (SEFACIL Foundation, 2018).

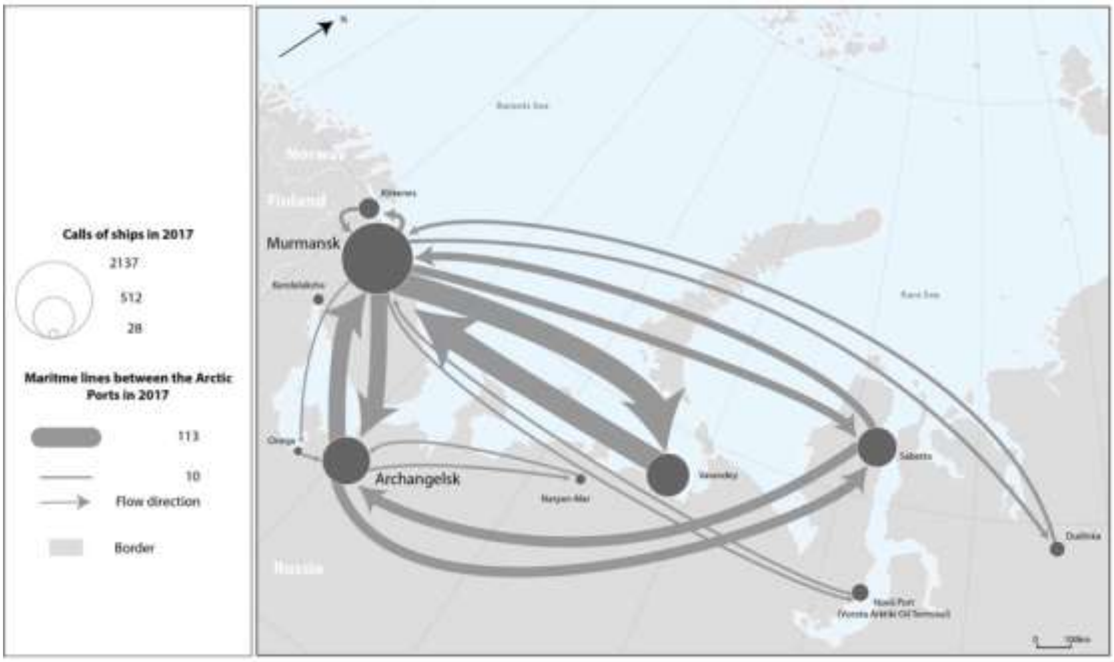

Figure 5: Murmansk connection with Arctic ports

Source : Faury et al (2019)

That perspective also includes the fact that 2017 has seen a growth of 2.2% of the world total of energy, a best ever since 2013 to be injected into a ten-year growth which stands at 1.7% (BP Energy, 2018). It should also be reminded that China is, for the 17th consecutive year, the country with the highest growth in energy consumption with 3.1% in 2017 making China as the most interesting destination market in the short and medium term. It appears obvious in the light of the projection of the future Chinese energy mix defended by Beijing whose plans to convert the most polluted heavy-industries fueled with dirty coals to ever cleaner energy (natural gas and electricity). A remarkable increase of 15% in its natural gas consumption has already been recorded for the sole year of 2017, which weighs for one third of the net worldwide growth (96 Bcm).

As mentioned, Beijing is currently leading the most ambitious energy conversion ever experienced with millions of private homes which have to be equipped for natural gas. In stake is the purification of the air, especially in the largest cities located in the northwestern part of the country. From a purely geographical and strategic point of view, Chinese LNG Port & industrial infrastructure investments are carried out everywhere on the coastal fringe and not only focused on the northwestern areas. Two important facts to be bear in mind: a twentieth

LNG terminal has been confirmed in 2018 whereas the opening of the LNG infrastructure market to the private sector should stimulate healthy competition with public historical actors. For instance, the ENN Group terminal in Zhoushan, Zheijang province (capacity of 3 Mt per year) is expected to reach 10 Mt with nearly 1.5 billion investments (Xin, 2018). Those perspectives are built on Chinese projected imports of LNG to be continued to grow at an amazing pace. A spectacular increase of 47.3% has been tracked between 2016 and 2017 to reach a total of 39.1 Mt and the first 6 months of 2018 looks as even more promising with another 50% increase in volumes!

On the European perspective, still the dominant market destination for Russian natural energy resources, the trend is towards a slowdown in net consumption of petroleum products despite an increase in 2017. Europe "only" accounts for 15% of the world's crude oil consumption. With an increase of 5.5% in 2017 the Russian natural gas looks quite much more attractive for European market, both fed by pipelines and LNG shipped by specialized ships and stored and transformed on industrial complex such as Zeebrugge in Belgium, Montoir in France and various Spanish terminals. Those ports are in fierce competition to impose as Western European port gateway as well as international hub for LNG ship-to-LNG ship transshipment activities.

And a final word to include the fact that the full relevance of an energy strategic prospective depends on the genuineness of relevant data on potential oil and gas reserves in the Arctic areas. In 2008, the US Geological Survey estimated that "only" 10% of the oil reserves and 29% of the gas reserves could be found in the Arctic which represent 90 billion barrels of oil and 47,261 Bcm of natural gas. These real volumes, how huge they may be, weight about “only” three years of the current world oil consumption and no more than seven years for natural gas (Lasserre, 2014). For Russia alone, the largest country of the World, the Arctic territories cover 15% of the total national territory and account nowadays for 20% of the GNP with just over one million inhabitants (Zarudnitskiy and Chvarkov, 2018). Noteworthy, according to Zarudnitskiy and Chvarkov "up to 90% of recoverable hydrocarbons of the entire Russian continental shelf are deposited and up to 80% of Russia's explored gas reserves are produced here" (Zarudnitskiy and Chvarkov, 2018).

Incidentally, the same glitches apply to mining potential, with the endless equation to be found between the ever more complex Arctic exploitation surcharges and remuneration by an increasingly volatile global market. This will not prevent the launching of huge extraction projects and therefore the development of maritime segments from the Russian Arctic. With respect to import inputs, real traffic opportunities are based on the provision of all the "supply stuff" needed for the development and production of future mining sites. Heavy lift for machinery, ro-ro flows for rolling stock, containerized manufactured products: a whole range of Arctic flows will probably continue to grow in the coming years, activating ports’ infrastructures nearby mining extraction sites. Consequently, on the exportation output, some new ports intensities will emerge like the ones at the Taimyr-Norislsk zone with the development of specialized infrastructure in Dudinka and Dikson for the massive export of nickel and coal in particular. In a longer-term perspective, Yacoutie's proven reserves of raw materials (energy, of course, but also mineral resources with, for example, interesting high value-added deposits such as diamonds) could support the development of new infrastructure in addition to those already active. However, these perspective in Yacoutie ties to a very different climatic temporality, keeping in mind the complexity of organizing an integrated supply chain including reliable shipping services.

5.2. Murmansk positioning

Due to its geographical position, Murmansk has an open access all along the year providing the possibility for non-ice class ships to call. Besides, if the other Russian ports have a limited draft, it is not the case of Murmansk who can handle AFRAmax or even bigger vessels with a result to improve its potential connectivity.

Regarding transshipment, Murmansk attract crude oil flows coming from Novy, Prirazlomnoye platform and the Varandey terminal which represent almost the whole crude oil exported from the Arctic fields and the production of mineral leaving Dudinka.

As part of the numerous projects planned, the MTH and the connection of the Lavna coal terminal financed by SUEK group, via the 46 km railway *(Staalesen, 2018a)* shall provide 9 million tons of dry bulk dedicated to the exportation by 2019. When complete, the new project capacity shall reach 25 million tons per year reinforcing the link of Murmansk with its hinterland.

The coal terminal is not the only one included within the MTH. Facility for the exportation of 6 million tons is also planned (Staalesen, 2018a).

Yet as specified Monios et al (2018), the position of second-tier hub is not static and can be challenged by other ports and Murmansk is not an exception. The Kola bay port is facing the competition of two other ports, Kirkenes and Arkhangelsk (Figure 6).

Smaller than Murmansk but with the same advantages (ice free all year long and deep-water port) Kirkenes has already managed transshipment of crude oil coming from Varandey oil terminal. Yet, aware of its quite small hinterland, for the moment, compared with Murmansk the Norwegian and Finnish government agreed to connect Kirkenes to the Arctic Corridor Railway (ACR). This r-project provide a railway connection between Kirkenes and Rovaniemi in Finland. This railroad is the first step of a much larger project doomed to connect Rovaniemi to Berlin via Helsinki which is part of the Barents Euro-Arctic Transport Network connecting Northern Europe, Scandinavia, the Baltic and the Russian railway network. If the ACR would provide finished goods for exportation, it shall offer the possibility for Kirkenes to export raw materials coming from the Kevitsa, Sakatti and probably the Sokli mine thanks to its 500 km for an estimated investment between 2.5 and 3 Billion Euros (Eilertsen, 2018a). We could add the timber from the Finnish forest.

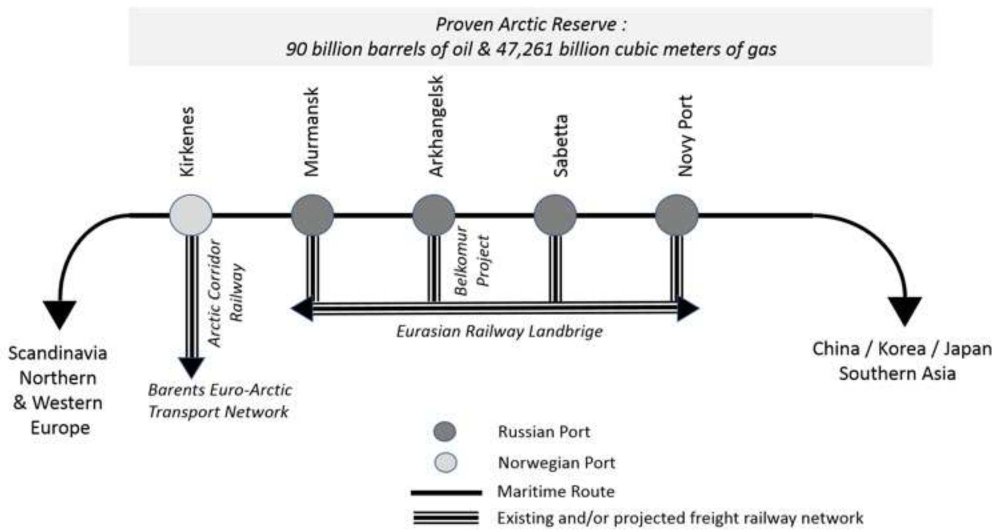

Figure 6: Prospective vision of the Arctic Range

Source: Alix (2018)

Arkhangelsk is already a serious challenger for Murmansk despite an ice blanket covering its access involving the use of an icebreaker. If the MTH is considered as a main project, so is the Arkhangelsk Transport Hub (ATH).

The dredging of the port till 14.5 m port 55 km away from port city of Arkhangelsk will occur between 2023 and 2028 (Nilsen, 2016) and the upgrade of the Belkomur railway financed by the Chinese group, Polytechnology shall provide the possibility for Arkhangelsk to increase its flows through connection to the Kusbass coal mine and container handling. According to Bambulyak et al. (2009), the update of this 1,161 km railway, with 715 km newly built, should cost around 4.8 billion USD and supply 22 million tons of cargo per year to Arkhangelsk (Khomiakova, 2011; Nilsen, 2013). More than an opportunity, this railroad appears to be a prerequisite for Arkhangelsk port development (Chernov, 2014) in order to reach the 30 million tons of output per year. Kokin (2018) shed a light on the investment of coming from Poly Group dedicated to the dredge of the port till -14.5 m and appears as a strategic point for the future Ice Silk Road in western Russia.

To conclude on this prospective part, Murmansk's position as a regional hub may change in the coming years with the upgrade of ports such as Arkhangelsk and the building of others like Sabetta. However, Murmansk must maintain a leading position due to its ability to be ice-free all year round and to manage a larger vessel without dredging its berth.

6. Conclusion

This analysis made it possible to draw a picture of the Murmansk connection level in 2011 and 2017 based on dry and liquid bulk flows. We may think that this analysis could be complemented by additional work also based on AIS data such as the calculation of shipping time between Arctic ports or the efficiency of ports in handling operations.

The article analyzed how Murmansk’s connection with the rest of the world evolved between 2011 and 2017 and demonstrated the importance of this port in Russian strategy. Most of the flows from Murmansk are definitely raw materials coming from an area representing 20% of the national GDP.

Despite these assumptions, our analysis highlighted four main points. Firstly, fishing activity is growing over the years with an 89% increase between 2011 and 2017. This evolution demonstrates the importance the fishing industry can have in the future of Murmansk.

Secondly, liquid bulk flow are quite concentrated and balanced when looking the main destination and origin. This result points out the position of Murmansk as a Regional Hub for transportation of crude oil and LNG coming from the Arctic fields.

Thirdly, the bulk is a product coming from the Murmansk hinterland with very different origin and destination very different from those of liquid bulk.

Finally, the position of Murmansk as a regional hub is challenged by two others ports, Arkhangelsk and Kirkenes. If both do not provide the same level of services as Murmansk, they have some arguments that has already made the difference in the past and may continue in the future.

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