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► To cite this version:

Ronan Kerbiriou. Baltic and Russian ports in war time: AIS approach. Emilija Pudziute Gallois; Arnaud Serry. Permacrisis & Logistics: From Assessment to Foresight, EMS éditions, pp.83-98, 2023. hal-04427621

HAL Id: hal-04427621

<https://hal.science/hal-04427621>

Submitted on 30 Jan 2024

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Baltic and Russian ports in war time (AIS approach)

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1. Introduction

Trade is the backbone of our globalised economy in which each nation is interdependent. Countries participate in global trade in order to sell what they produce, to buy what they lack or to produce more efficiently (Rodrigue, 2013). International trade has been promoted by international free trade agreements legislated by the World Trade Organisation (WTO) or the International Monetary Fund (IMF). These agreements have led to economic integration between states, trade liberalisation and the reduction of customs duties. The transport of goods and more particularly maritime transport have also contributed to the development of international trade by playing a role in facilitating trade. Maritime transport makes it possible to interconnect the continents. Its importance is indisputable and the development of maritime transport has been one of the factors that have made the expansion of international trade possible (Frémont, 2005). World trade and maritime transport are interdependent and have grown in parallel. This interdependence implies repercussions on each other in the event of a crisis or incident. This was recently the case with the COVID crisis, which led to a decrease in world trade and thus an impact on maritime transport. Another example is the Suez Canal incident, which was blocked by the Evergreen container ship Ever Given for a week and caused disruptions in international trade.

Since 24 February 2022, i.e. for almost a year at the time of writing, the Russian Federation has been at war with Ukraine. Against the backdrop of a new Cold War, diplomatic relations between Russia and its other European neighbours have become strained. The behaviour of the Russian state has led to mistrust and distrust of its objectives and intentions. Russia is therefore diplomatically isolated on the international scene. In order to accentuate this isolation and to constrain Russia, many Western states have imposed economic and trade sanctions. The aim of these sanctions is to show the solidarity of all Western countries with the Ukrainian cause, to weaken Russia economically and thus to reduce the budget available to allocate to military efforts. These sanctions adopted in several stages target members of the government or oligarchs individually (travel bans and asset freezes), involve Russian banks (exclusion from the international SWIFT system, for example), restrict imports of products from or originating in Russia or prohibit exports of certain products to Russia. Various sanctions can thus have an impact on maritime traffic in Russian ports:

- Ban on Russian ships calling at European ports,
- Bans on the import of certain products (sea products, coal, iron, steel, wood, etc.)
- Restrictions on the import of crude oil products (since December 2022) or refined oil products (since February 2023).
- Ban on arms trade
- Ban on the export of certain products (luxury goods, technological products, etc.).

Against the backdrop of imperialism, this war is bringing an imbalance in international trade and more particularly in the Baltic Sea region. Indeed, Russia has two maritime openings in the Baltic Sea offering it access to the European market and, more broadly, a connection with the main world maritime networks. With the start of the war in Ukraine, the Baltic Sea is now at the heart of international geopolitical tensions. It is the meeting point between the Russian Federation and the European Union.

The objective of this chapter will be to study the impact of the war and the economic sanctions taken against Russia on its port traffic of goods in the Baltic Sea and more particularly on the containerised and liquid bulk traffic. For this purpose, we will use the AIS data (see section on method and data) to analyse the calls of merchant ships in Russian Baltic Sea ports by making a comparison over the same two periods of 2020 and 2022, from 11 to 31 May. The objective of this parallel between these two years will be to evaluate the evolution of the calls of the merchant ships studied and thus to know over this period Russia has undergone an impact on its maritime connections and thus on its foreign trade relations.

2. Method and data

The analysis work in this article is based on the processing of AIS (Automatic Identification System) data from maritime ships and a ship database from IHS maritime (<https://maritime.ihs.com/>).

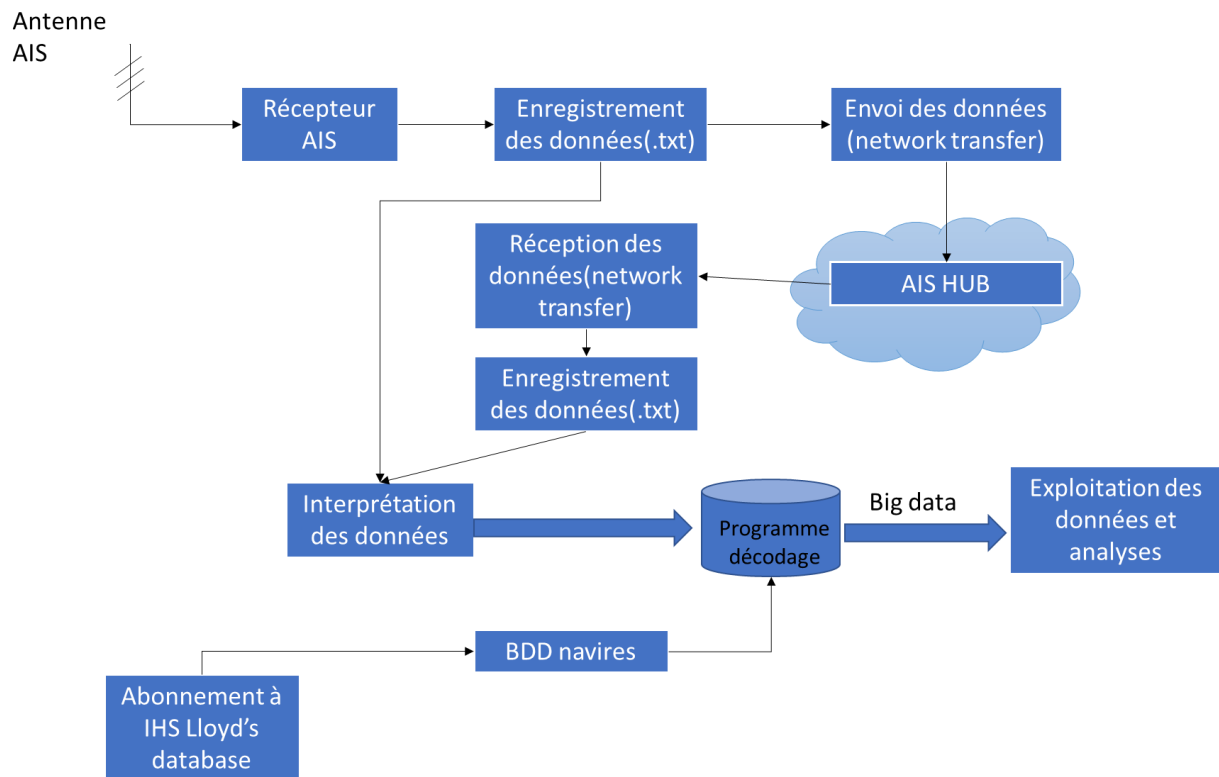
AIS is an on-board vessel location system to provide information to surrounding vessels and shore stations. This system was made mandatory on all major maritime vessels via Annex VI of the IMO (International Maritime Organisation) SOLAS Convention in 2004. The objective of the implementation of this system was to improve the safety and security of maritime navigation as a collision avoidance tool. To this end, ships transmit messages at regular intervals on their locations and also identification information (MMSI number, IMO number). The retrieval of this data and its processing represents an important source of data for scientific research on maritime traffic (Serry and al., 2018). The analysis of AIS data provides an overview of maritime traffic and forms the basis for network analysis. Thus, it can be used to produce improved and optimised information on maritime traffic, such as density maps, to study shipowners' strategies, to analyse port positioning in a maritime network, etc. For our study, AIS data appear as a source of information to know the ship calls and the maritime services actually performed.

As part of the CIRMAR (CIRculation MARitime) project, set up at the Université le Havre Normandie to, among other things, exploit AIS data. To do this, we have set up our own terrestrial antenna on the roof of a university building, enabling us to collect our own data sets off Le Havre. We also contribute to an international collaborative network called AISHUB. We provide our data to this network, which then allows us to receive all the AIS data from the antennas contributing to this network. After interpreting and decoding the data, we can exploit the AIS data and carry out various geo-economic analyses, studies on the environmental impact of maritime traffic, on the safety and security of navigation or on maritime routes.

In order to identify ships and know their characteristics (ship name, ship type, etc.), we connect the AIS data with a "ship" database provided by IHS maritime. IHS is owned by Lloyds, which insures about 80% of the world's maritime fleet. The diagram in Figure 1 illustrates the general organisation of our AIS data collection and processing platform. We are entering the field of Big data, which is rare

in human and social sciences research. We collect about 3GB of AIS data every day, i.e. nearly 100GB per month.

Figure 1: AIS data decoding scheme



Source : CIRMAR, 2020.

The main limitation of AISHUB is the geographical coverage which is not global. We cannot have an exhaustive mapping of global maritime traffic. For the purpose of this chapter, which focuses on the Baltic Sea area and more specifically on Russian ports, this area is covered by antennas with the exception of a few white areas, notably in the Gulf of Riga and the Gulf of Bothnia (Fig. 2).

Figure 2: Geographical coverage of AISHUB in the Baltic Sea



Realisation : Ronan Kerbiriou, October 2023.

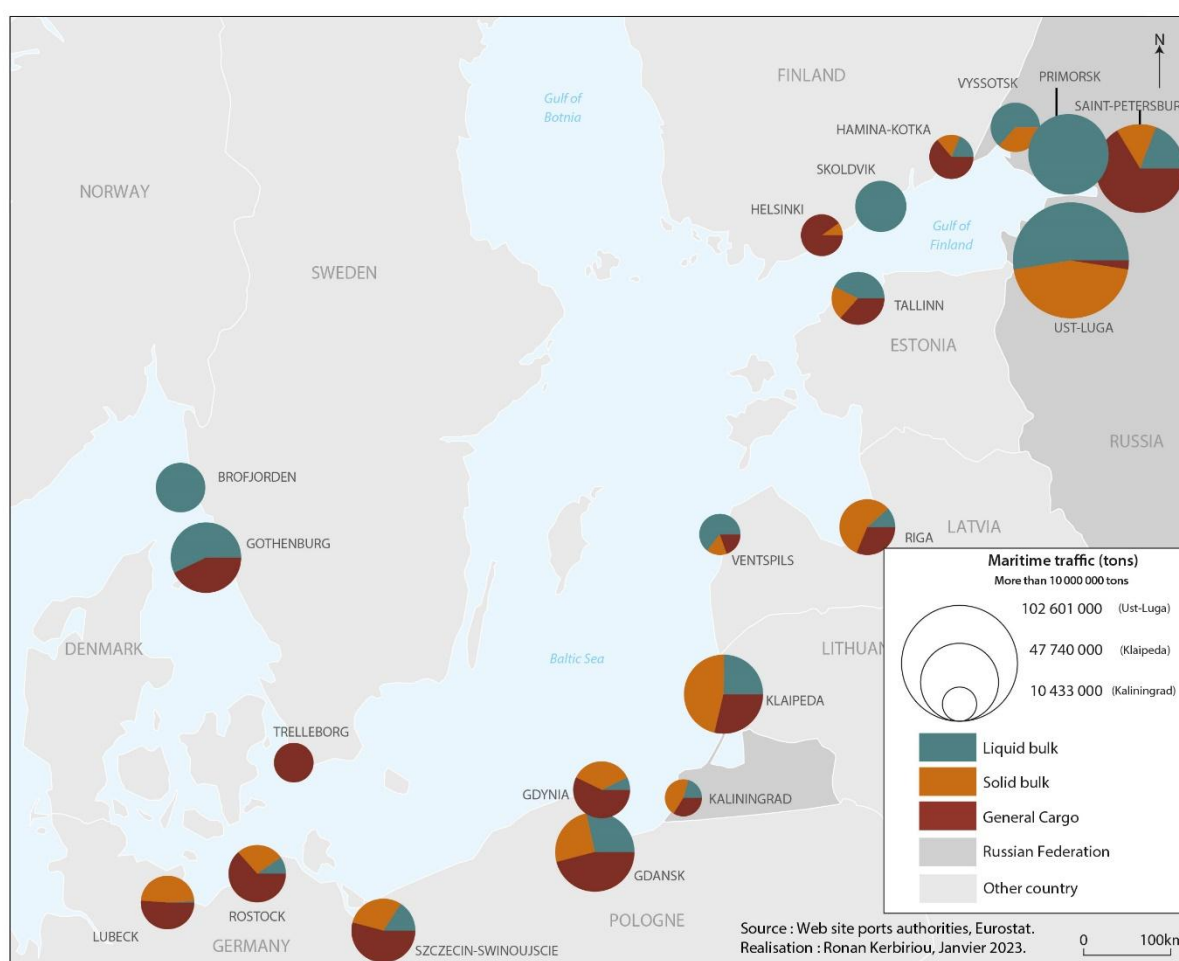
In order to analyse the impact of the sanctions on port traffic in Russian Baltic ports, we will make a comparison of merchant ship calls between 2020 and 2022 over the period from 11 to 31 May. After a general analysis, we will focus on container ship traffic and liquid bulk traffic.

3. Results and Analysis

3.1. Study framework

The Russian Federation has two maritime openings in the Baltic Sea; one in the Gulf of Finland and a second via the Kaliningrad enclave. On the map below, which provides information on the traffic of Baltic Sea ports in 2020 (Fig. 3), it can be seen that Russian ports, and mainly those in the Gulf of Finland, play a major role in the region's maritime traffic. They account for about ¼ of the port traffic in the whole Baltic Sea (241.5 million tonnes). This share rises to 42% in liquid bulk traffic (128.7 million tonnes). The Baltic Sea represents for Russia a major maritime access for the export of hydrocarbons. On its western side, its access to the Sea has been limited since the fall of the Soviet Union (Serry, 2018). Liquid bulk traffic mainly concerns the export of petroleum products (crude or refined), which are mainly carried out by the ports of Primorsk and Ust-Luga. The port of Saint Petersburg has a traffic more oriented towards general cargo with a containerised traffic of 2.1 million TEU in 2020, placing it as the leading port in the region with Gdansk (Poland) for this traffic.

Figure 3: Traffic in Baltic Sea ports in 2020



Source : web site ports authorities, Eurostat. Réalisation : Ronan Kerbiriou, Janvier 2023.

By 2020, Russian ports were fully integrated into the Baltic Sea maritime traffic and occupied a central and major position. In the remainder of this chapter, we will analyse ship calls to study the impact of the war and sanctions on its port traffic.

3.2. General analysis

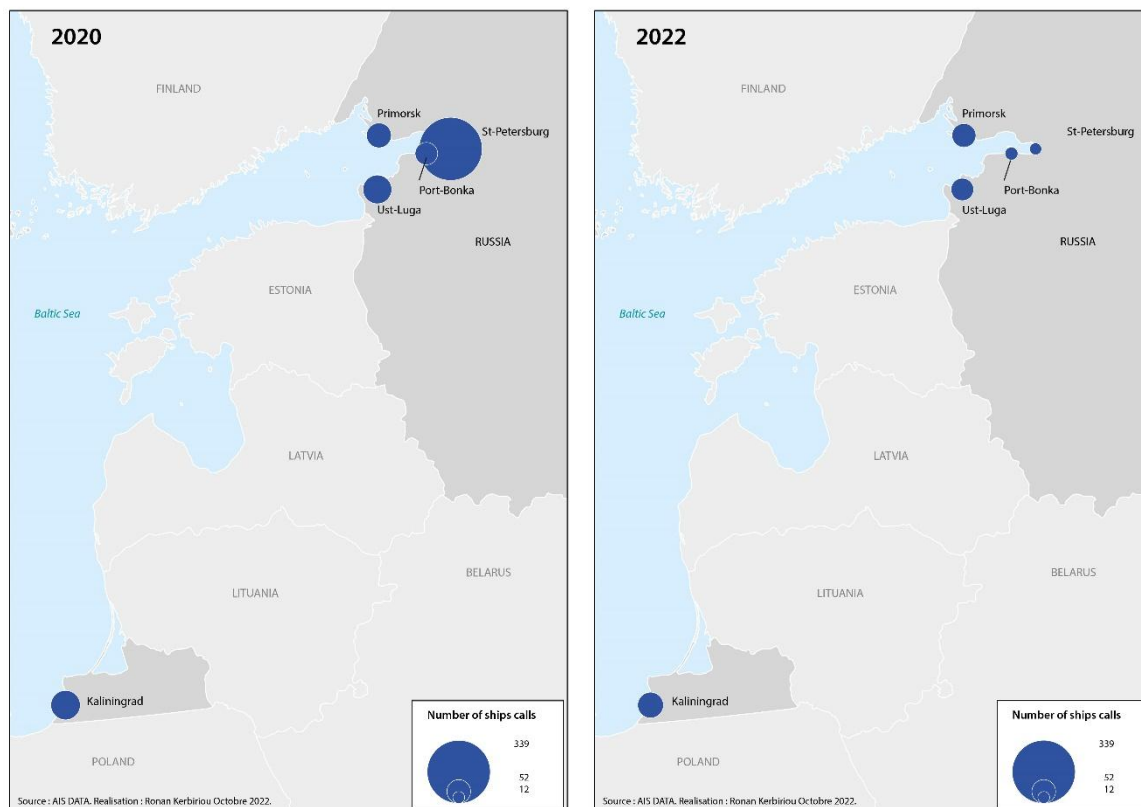
In the following table (Fig. 4), we have counted the number of calls by ship category for all Russian Baltic Sea ports and there is a very significant overall decrease in the number of calls between 2020 and 2022. All categories of ships are affected. But when we look at the evolution of calls by port, we see different impacts (Fig. 5). On the maps below, we can see a considerable impact on the port of St Petersburg. Over the period studied, the number of calls in this port fell from 339 to just 12. For the others, which have very specialised liquid bulk traffic, the number of calls has remained relatively stable. To go further in the analyses, we will look at containerised traffic, which is the dominant traffic for the port of Saint Petersburg, and liquid bulk traffic in a second stage.

Figure 4: Number of calls by ship type

Ship Type	Number of calls between 11 and 31 may		Evolution 2020 - 2022
	2020	2022	
Bulk Carrier	46	26	-43%
Chemical Tanker/Products Oil Tanker	133	85	-36%
Container Ship (Fully Cellular)	80	9	-89%
General Cargo Ship	210	67	-68%
Refrigerated Cargo Ship	21	0	-100%
Ro-Ro Cargo Ship/Vehicles carrier	17	0	-100%
Autres navires marchands	10	0	-100%

Source : AISHUB.

Figure 5: Number of calls of merchant ships by Russian Baltic Sea ports



Source : AISHUB.

3.3. Containerships calls

Maritime container traffic is the mode of transport that supports international trade and therefore globalisation. Indeed, containerisation interconnects territories at different scales and allows States to exchange manufactured or semi-finished products. The container has allowed a structural reduction in transport costs, contributing to the organisation of sectors on an international scale. The containerised traffic of a port or a country represents the insertion of a State in the world economy. If we observe the number of container ship calls in Russian ports in 2020 and 2022 over the period from 11 to 31 May, we can see a very significant drop, particularly in St Petersburg (-94%). As specified in the study framework, the port of St. Petersburg was, in 2020, a major port in the Baltic Sea with a traffic of more than 2 million TEU. Economic sanctions with the aim of isolating the Russian state economically from the world economy seem to have had a considerable impact on container traffic. According to these data, container traffic is expected to be down sharply.

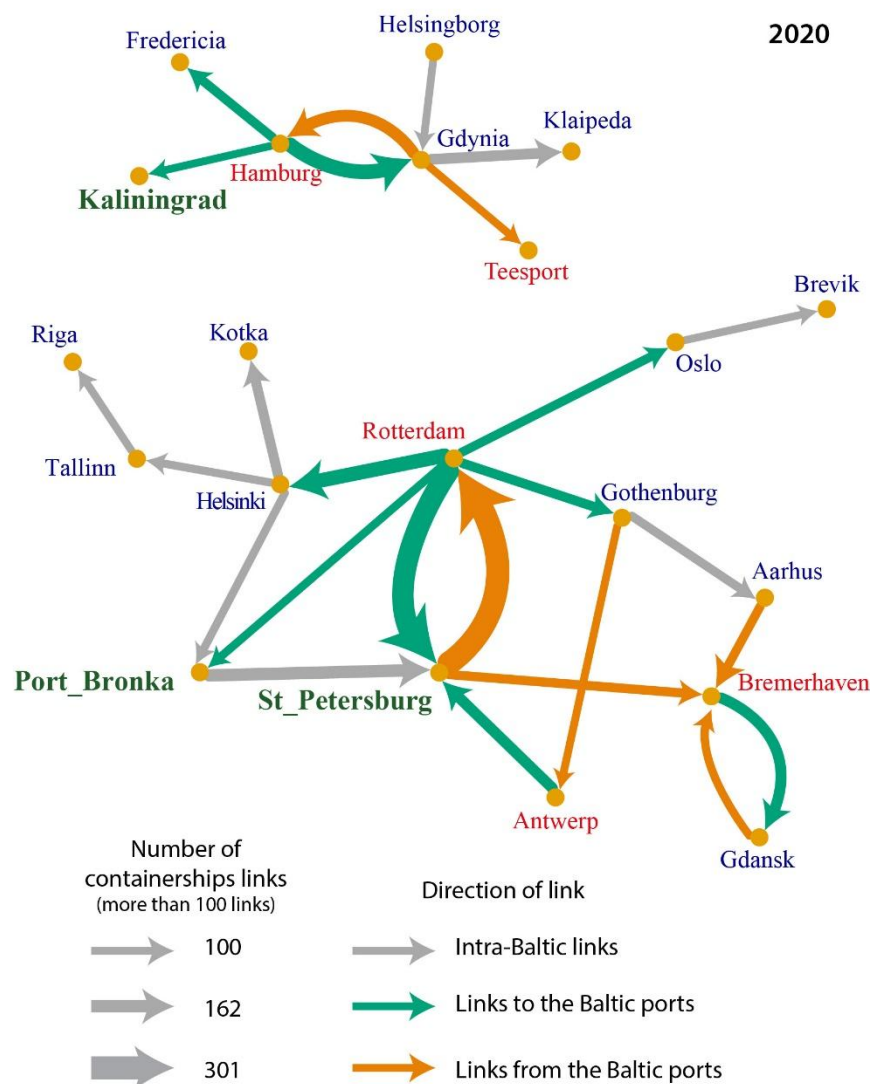
Figure 6: Number of containerships calls by ports

Port	Number of containerships calls between 11 and 31 may		Evolution 2020 - 2022
	2020	2022	
Kaliningrad	8	4	-50%
Saint-Petersbourg	49	3	-94%
Port Bronka	17	2	-88%
Ust-Luga	6	0	-100%

Source : AISHUB.

The following graph shows the maritime network of container ships for the Baltic Sea ports. The use of graphs allows to simplify a maritime network and to highlight the main structure. Several methods exist to simplify a graph, the objective of which is to remove certain vertices or links. The different methods have been summarised and described in French by César Ducruet (2011). We have chosen the dominant flow method. This method has the advantages of being simple to use, easily understandable by a non-specialist reader and allows the deep structure of the maritime network studied to be highlighted. The principle of this method is to define a threshold and to keep all higher relationships. The R software and the "I graph" package, which are freely available, were used to produce the graphs. On the graph shown, we have retained all links above 100 between the Baltic ports or with external ports. It can be seen that the Port of St. Petersburg has a central position in 2020 with important connections to and from the port of Rotterdam (almost one ship per day in each direction) and to a lesser extent with Antwerp and Bremerhaven. The latter are major ports on an international scale. The port of St. Petersburg, and more generally the Russian Federation, had important trade relations. Its traffic was, like the Russian economy, oriented towards the import of products that it did not produce. The sanctions taken against Russia seem to have had positive results in isolating it from international trade, at least on its western side.

Figure 7: Graph of the container ships network in the Baltic Sea in 2020



Source : IHS Maritime. Realisation : Ronan Kerbiriou, september 2021.

3.4. Tanker calls

Russia is a producer and exporter of oil and gas products. In 2020, it accounted for 10.53% of world oil exports (i.e. production of 10.5 million barrels per day), ranking it as the third largest nation in the world. Russia's weight in the production of black gold is considerable and this is also true for gas production. Russia, for many European countries in particular, was a major energy supplier. This dependence on a single supplier country has led to major negotiations within the European Union. Many nations worried about running out of oil to meet their energy needs and consumption slowed down or even vetoed sanctions for an embargo on the import of oil products. After negotiations and the assurance of being able to diversify their suppliers, the European countries decided to reduce their imports of Russian oil by 90% by the end of 2022. The aim of these oil sanctions is to deprive Moscow of an important source of income. In the period under study, the sanctions on oil imports were not yet officially in place. It can be seen from the table below (Fig. 8) that for the main Russian Baltic Sea ports for liquid bulk traffic (i.e. Primorsk and Ust-Luga), the number of calls only decreased slightly. The impact was more significant on the other ports where liquid bulk traffic was more limited. The trade in oil and its derivatives was able to continue overall in view of the calls made. This

analysis will be repeated in order to study the impact of the embargo on Russian oil put in place between December 2022 and February 2023 on the traffic of the ports of Primorsk and Ust-Luga.

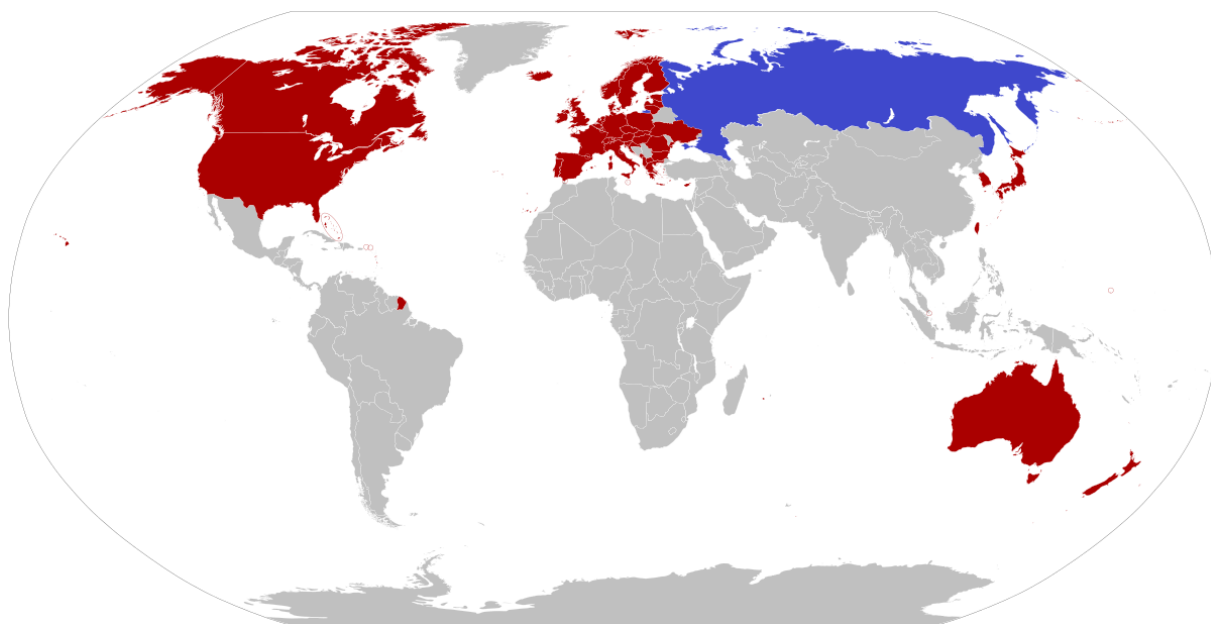
Figure 8: Number of products / oil tanker ships calls (Occidental Russia)

Port	Number of products / oil tanker ships calls		Evolution 2020 - 2022
	2020	2022	
Kaliningrad	24	9	-63%
Port Bronka	24	8	-67%
Primorsk	52	48	-8%
St Petersburg	8	1	-88%
Ust-Luga	25	19	-24%
Total général	133	85	-36%

Source : AISHUB.

Not all nations are aligned to take sanctions against the Russian Federation (Fig. 9). Only the countries in red on the map below have taken economic sanctions. Russia is in a position to pursue trade relations and thus export its products to other partner countries, especially in Asia. Its maritime openness and eastern port facilities offer these possibilities.

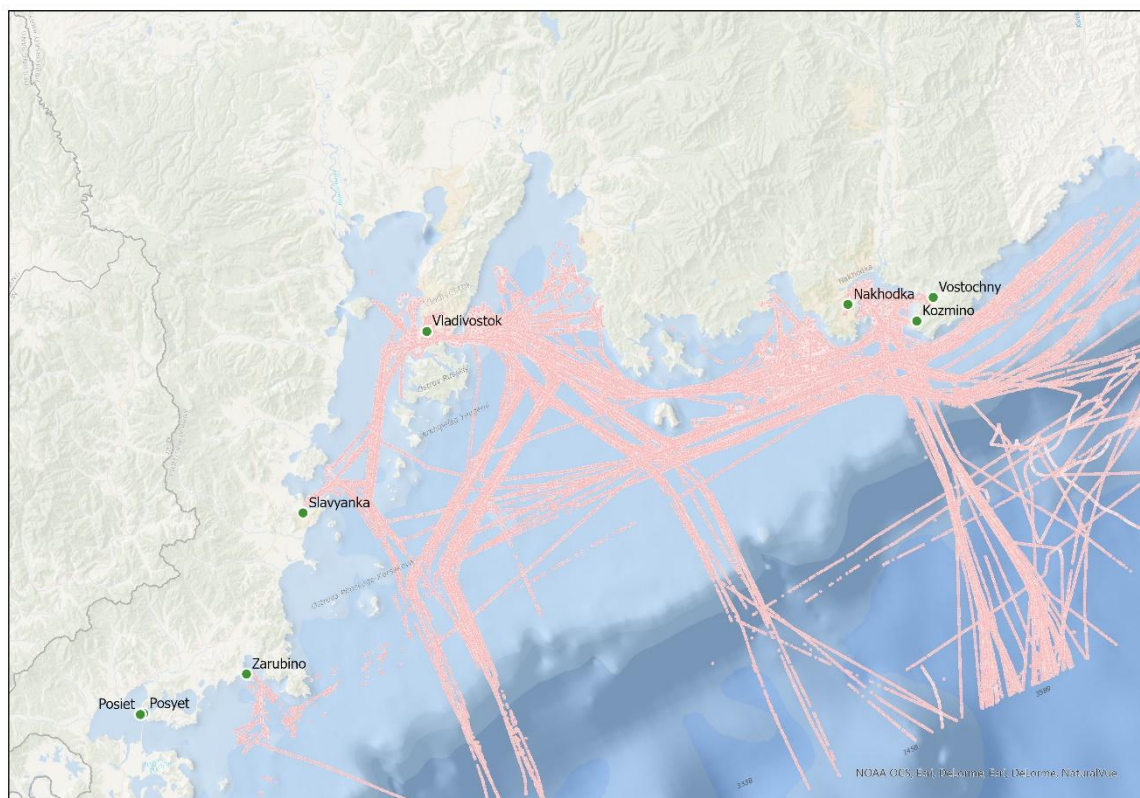
Figure 9: Countries with economic sanctions (in red) against Russia.



Source : Wikipedia

On its eastern seaboard, Russia has several ports, particularly around Vladivostok (Fig. 10), which provide it with a maritime opening towards East Asia and the Pacific Ocean. With the implementation of economic sanctions and embargoes on certain Russian products, we can wonder about a possible impact on the calls to these ports? Did tanker traffic increase or decrease during the period under study? We will therefore analyse tanker calls in the ports of Vladivostok, Kozmino, Vostochny and Slavyanka. However, due to a problem of access to the 2020 data, we will compare the calls from 11 to 31 May in 2018 and 2022.

Figure 10: East Russian ports and AIS tracks



Source : AISHUB. Realisation : Ronan Kerbiriou, septembre 2022.

If we analyse the calls of vessels specialising in liquid bulk (Fig. 11), we can observe an overall increase in the number of calls, particularly in the port of Vladivostok. This port has seen a significant increase in the number of calls (+267%). These initial results suggest that the development of traffic in the ports of this region responds to a market logic by taking advantage of the development of commercial relations with other nations, particularly Asian ones, which are not unfriendly. For example, China does not condemn the invasion of Ukraine and continues to maintain trade relations with Russia. China is an energy-intensive nation with a considerable need for oil and gas imports and Russia is able to meet this need. The development of trade relations prevails over morality. To confirm these initial results, it will be interesting to continue and deepen the analysis over time.

Figure 11: Number of products / oil tanker ships call (Oriental Russia)

Port	Number of products / oil tanker ships calls		Evolution 2018 - 2022
	2018	2022	
Nakhodka	39	7	-82%
Slavianska	4	10	150%
Vladivostok	12	44	267%
Vostochny / Kozmino	14	18	29%
Total général	69	79	14%

Source : AISHUB.

4. CCL

In this chapter, the impact (or not) of the war and economic sanctions on the traffic of the Russian Baltic Sea ports was highlighted. Container traffic, which was concentrated in the port of St. Petersburg, was strongly impacted with a decrease of more than 90% in the number of calls. On the contrary, calls for liquid bulk were maintained over the period studied. This can be explained by the fact that the sanctions on oil products and its derivatives have only recently come into force. At the same time, calls for liquid bulk in Russia's eastern ports have increased (mainly in Vladivostok and Slavianka), favoured by the probable development of new commercial relations with China among others. The exploitation of AIS data and this method of analysis have the advantage of being able to study the impact of an event on maritime traffic instantaneously, such as a maritime accident, a strike in a port, a cyber attack on a terminal or, in our case, a war and economic sanctions against a State. The data we collect therefore offers the possibility to perform different multiscalar analyses on both maritime traffic and port passage. The information and data created from the AIS can be considered reliable, unlike some port statistics which may question their veracity. The analyses and results presented relate to a short period given the recent situation of events. These results would need to be refined and developed over a longer period of analysis and also by studying the evolution of the place of Russian ports in the maritime networks and therefore of the commercial relations of the Russian state.

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