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Impact of Global Warming on the Arctic Region and World Trade Routes

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Abstract

The Arctic region is increasingly recognized for its environmental changes and geopolitical importance caused by climate change. The Arctic has become a symbol of climate change in recent years, as rising temperatures worldwide have caused significant ice melt. The melting of Arctic glaciers presents opportunities and challenges for many countries in international politics. The environmental transformation experienced in the Arctic region is opening up new trade routes. It is also revealing previously inaccessible natural resources such as oil, gas, and minerals. Melting glaciers may increase global trade, but they also raise concerns about environmental degradation and geopolitical tensions. While melting glaciers create new avenues for trade and resource extraction, they are also causing geopolitical tensions between major powers. As polar ice caps melt and new sea routes emerge, the Arctic has become a focal point for global competition between major powers, particularly the United States, Russia, and China. This study presents the effects of the global melting in the Arctic region on maritime trade routes and the current and future economic and commercial competition between states in this area.

Keywords: Arctic Region, Global Warming, Climate Change, World Trade Routes, New Trade Routes in the Arctic Region
Jel Codes: *Q5, R4, Q54,*

Küresel Isınmanın Arktik Bölge ve Dünya Ticaret Rotalarına Etkileri

Özet

Arktik bölgesi, yalnızca iklim değişikliğinden kaynaklanan çevresel değişiklikleriyle değil, aynı zamanda jeopolitik önemiyle de giderek daha fazla tanınmaktadır. Arktik, son yıllarda dünya genelinde artan sıcaklıkların önemli buz erimesine yol açmasıyla birlikte iklim değişikliğinin bir sembolü haline gelmeye başlamıştır. Arktik buzullarının erimesi uluslararası politikada birçok ülke için hem fırsatlar hem de zorluklar sunuyor. Öyle ki Arktik bölgede yaşanan çevresel dönüşüm, yeni ticaret rotaları açmaktadır. Ayrıca petrol, gaz ve mineraller gibi daha önce erişilemeyen doğal kaynakları ortaya çıkarıyor. Eriyen buzullar, küresel ticareti artırabilecek ancak aynı zamanda çevresel bozulma ve jeopolitik gerginlikler konusunda endişelere yol açmaktadır. Buzulların erimesi bir taraftan ticaret ve kaynak çıkarma için yeni yolları ortaya çıkarırken, aynı zamanda büyük güçler arasındaki jeopolitik gerginliklerinde artmasına neden olmaktadır. Kutuplardaki buzullar eridikçe ve yeni deniz rotaları ortaya çıktıkça Arktik, özellikle Amerika Birleşik Devletleri, Rusya ve Çin olmak üzere büyük güçler arasındaki küresel rekabetin odak noktası haline gelmeye başlamıştır. Bu çalışmada Arktik bölgede yaşanan küresel erimenin deniz ticaret yolları üzerindeki etkileri ve bu alanda devletler arasındaki mevcut ve gelecekteki ekonomik ve ticari rekabet ortaya konulmaktadır.

Anahtar Kelimeler: Arktik Bölgesi, Küresel Isınma, İklim Değişikliği, Dünya Ticaret Yolları, Arktik Bölgesi'nde Yeni Ticaret Yolları
Jel Kodları: *Q5, R4, Q54*

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1. Introduction

The effects of global climate change are felt in various ways all over the world and lead to some alternative consequences. One of these is the new alternative routes emerging in terms of maritime lines in the Arctic region. Global climate change has placed the Arctic at the center of geopolitics; the melting of ice in the region has begun to transform the region from an area of scientific interest into a vortex of competing commercial, national security, and environmental concerns, with profound consequences for the international law and political system. The economic and political importance of the Arctic, which is becoming increasingly accessible as ice melts due to rising global temperatures, should not be ignored. As the region opens up to increased human activities such as commercial shipping, tourism, and oil and gas exploration, maritime vessels will increase the density of commercial work. In this case, as commercial activities increase, the ice cover in the region will become grayer. It will cause more sunlight to be absorbed, further accelerating the melting process of the glaciers.

The melting rate of the glaciers in the Arctic has gone beyond being a scenario that can be seen in science fiction movies. Only half of the ice in 1950 remains in the region (Ebinger and Zambetakis, 2009, p.1216). Moreover, since 2013, ice-free arctic summers have begun to appear in certain regions in the last 10 years. The region was opened to global trade for the first time on 21 August 2009, with the announcement that two German commercial ships, accompanied by icebreakers, were heading from Vladivostok to the Netherlands via the Northern Sea Route (Reuters, 2009). Trade routes have played a key role in economic and political developments throughout history. The preservation of existing trade routes and the discovery and implementation of new trade routes have played a vital role in many historical developments. Similarly, today, trade routes have a key role not only geopolitically, but also because they are economical and safe. Because the crowded and long trade routes used in foreign trade are measured by the time gained. To reduce costs in foreign trade, the shortest time and most economical route is sought.

The length of the route used and, salt and food problems of sailors and pirates are still negative factors that make maritime trade risky. These factors contribute to the determination of routes, the construction of shortcuts, and the high reputation of the countries through which the route passes, as well as to the development of maritime trade. Ports, whose development stopped with the development of railways, continue to undertake the function of controlling foreign maritime trade.

The need for any country to lead and direct other countries in the world economy is one of the factors that make maritime trade risky. In recent years, there have been discussions about melting the ice in the Arctic region and whether a shipping channel should be opened that would reduce the distance between the Far East and Europe. The passage that the global war will occur in the new century has been claimed by those who argue that the effects are unpredictable or distant from the effects and that the world is used continentally.

This study aims to reveal the recent changes in maritime trade routes due to global warming. The importance of new trade routes in global trade and their geopolitical effects, especially in the Arctic region due to the melting of glaciers, are analyzed. In this context, the study first reveals the importance of trade routes in the Arctic region in the historical process and emphasizes what the process called the Age Arctic. Then, it shows how global warming melts the glaciers in the Arctic region and the effects of the resulting melting on the seas and glaciers over the years. Following this, the factors that have been effective in making the Arctic region accessible after technological developments have been revealed and the economic effects of this situation and its potential effects on World Trade Routes have been examined. In addition, the geopolitical and economic competition areas experienced in the Arctic region, which has become an important area at the center of global politics in today's world, have been revealed. The regional cooperation and diplomatic efforts in the region were emphasized. The study was conducted using the document review method and was prepared theoretically by using books, articles, scientific reports, and other secondary sources written on climate change and changes in trade routes. This study, which investigates the effects

of climate change on trade routes in the Arctic region in the literature, is expected to contribute to the literature since there are not many studies of this type.

The study generally focuses on the economic and geopolitical effects of climate change caused by global warming in the Arctic region. In this respect, the environmental effects of global warming in the Arctic region and the effects on living and human life in this region are excluded from the scope. In addition, the numerical data and visuals used in the study were taken from reports published by world-renowned institutions.

2. Historical Context of Arctic Trade Routes

The idea of Arctic trade routes dates back several centuries, driven primarily by European exploration during the Age of Discovery. European explorers sought a safe and direct route to the riches of Asia, bypassing the long and dangerous journey to the southern tip of Africa or South America. Early explorations were led primarily by English, Dutch, and Spanish explorers. John Cabot (1497) and Martin Frobisher (1576) are notable figures who made the first attempts to find a passage to the northwest through the Arctic waters of North America (Baugh, 2022). While Western explorers focused on the Northwest Passage, Russian explorers were engaged in discovering the Northeast Passage, or the Northern Sea Route, along the Siberian coast. Russian expeditions, including those led by Semyon Dezhnev (1648) and Vitus Bering (1728), mapped much of the Siberian coastline. These roads were crucial for connecting remote parts of the Russian Empire and facilitating the fur trade. (History of Arctic Marine Transport, 2009).

“In the 19th century, explorers wanted to map the Northwest Passage from the Arctic Ocean and find a shortcut over there. This passage would serve as a shortcut between the North Atlantic and North Pacific. Explorers would take ships up Greenland's west coast, then try to weave through Canada's Arctic islands, before going down the Bering Strait between Alaska and Russia. The problem was that the route was mostly blocked by impenetrable ice even in the summer. On one of the best-known expeditions - that of the UK's Sir John Franklin in 1845 - all 129 crew members perished after their two vessels got stuck.” (Murphy, 2018)

On the other hand, in the 20th century, The Soviet Union invested significantly in the development of the Northern Sea Route for strategic and economic reasons. The construction of icebreakers and the establishment of Arctic ports were pivotal in making this route operational. The latter half of the 20th century and the early 21st century have seen significant changes in the feasibility and interest in Arctic trade routes, primarily driven by climate change and technological advancements.

Nowadays, it is seen that global interest is directed towards the Arctic, and especially the expressions “The Age of the Arctic” or “Polar Age” are starting to be used frequently (Hoel and Ravna, 2010, p.158-159). The expression “Arctic Age”, which was first used by Oran R. Young in 1985, stating that it would not be an exaggeration, is a highly predictive conceptualization in that it points to the future of the Arctic during the Cold War and emphasizes its global importance. (Gümrükçü, 2015, p. 7-9). Among the reasons that led Young to use this expression; the topics include natural resources in the region, sea passageways, environmental problems, local people, and industrialization. It does not go unnoticed that he emphasizes that the Arctic, unlike Antarctica, is a border (border geography) (Young, 1985, p. 60-162). Nearly twenty years after Young's findings, the effects of global climate change especially the decrease in Arctic Ocean sea ice, the demand for natural resources in the region, and the increase in global interest in the region are clear proof of his correctness in his assessments (Limon, 2020a, p.120).

The framework of great power competition may be decisive in understanding how future interaction and possible cooperation between Russian and Chinese military activities in the Arctic will work against US national security interests. Military developments and energy issues, the two drivers of competition, may be decisive. Considering the sanctions imposed on Russia due to the Ukraine Crisis, the rising trade wars between the USA and the EU and China, and the increasingly colder relations between the USA, it remains

unclear how the USA will continue its interaction with the other Arctic States. States such as Russia and China, which influence the international security environment, compete with the USA and are close to the USA in terms of military power capacity, are expanding their military, economic, and political spheres of influence in the Arctic by making good use of the sensitivities created by the strategic environment without escalating into armed conflict, while the USA continues to negatively affect its deterrence. Regardless of the final draft of the new strategy document for the USA in the future, it is inevitable that the USA's Arctic policy will turn into a more proactive structure. Despite the United States' desire to purchase Greenland, the United States faces the potential for China and Russia to increase their presence and influence in Greenland (Limon, 2020c, p. 293-294).

3. Climate Change and Its Effect on Melting Ice over Arctic Region

The entire climate system receives power and energy from the Sun. However, almost half of the solar radiation reaching the Earth's surface is reflected from the Earth. The high "albedo"[2] effect of the Polar Regions is important in this. The albedo effect ensures that almost all of the sunlight hitting the sea ice surface is reflected. Thus, the sea surface does not heat up and the high albedo effect helps keep the Polar Regions cold. If climate change warms the Polar Regions and melts the sea ice, the Polar Regions will have a surface that is less reflective of solar radiation, thus more heat will be absorbed in the ice-free seas, and more melting of the glaciers will occur (Gautier, 2014, p. 21-22).

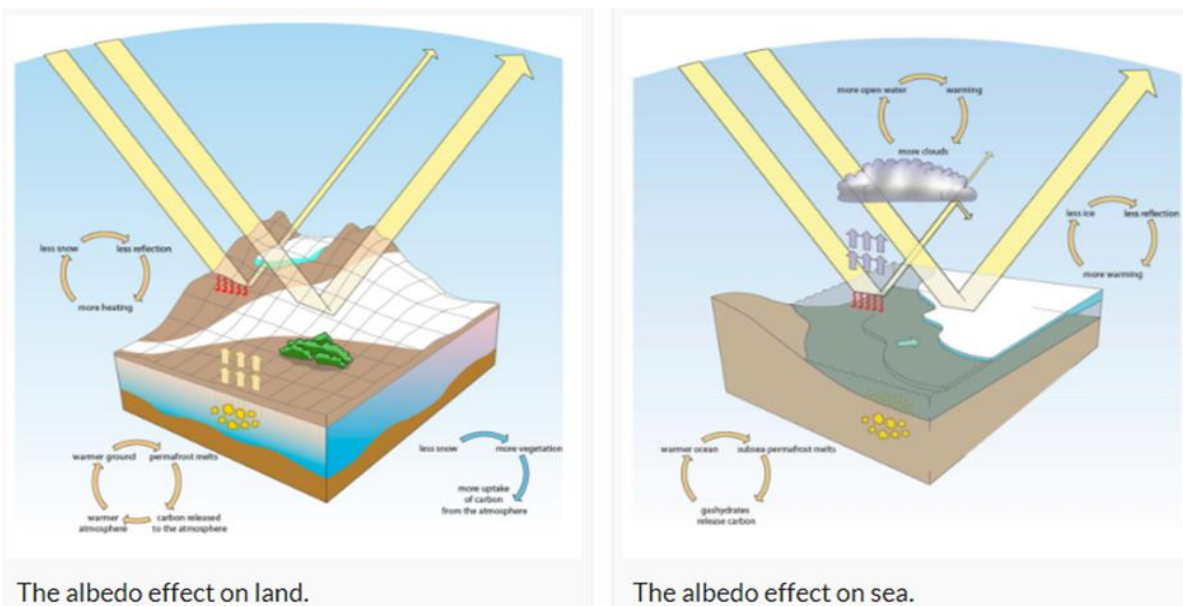


Figure 1. Albedo Effect on the Land and Sea

Source: NPolar (2024)

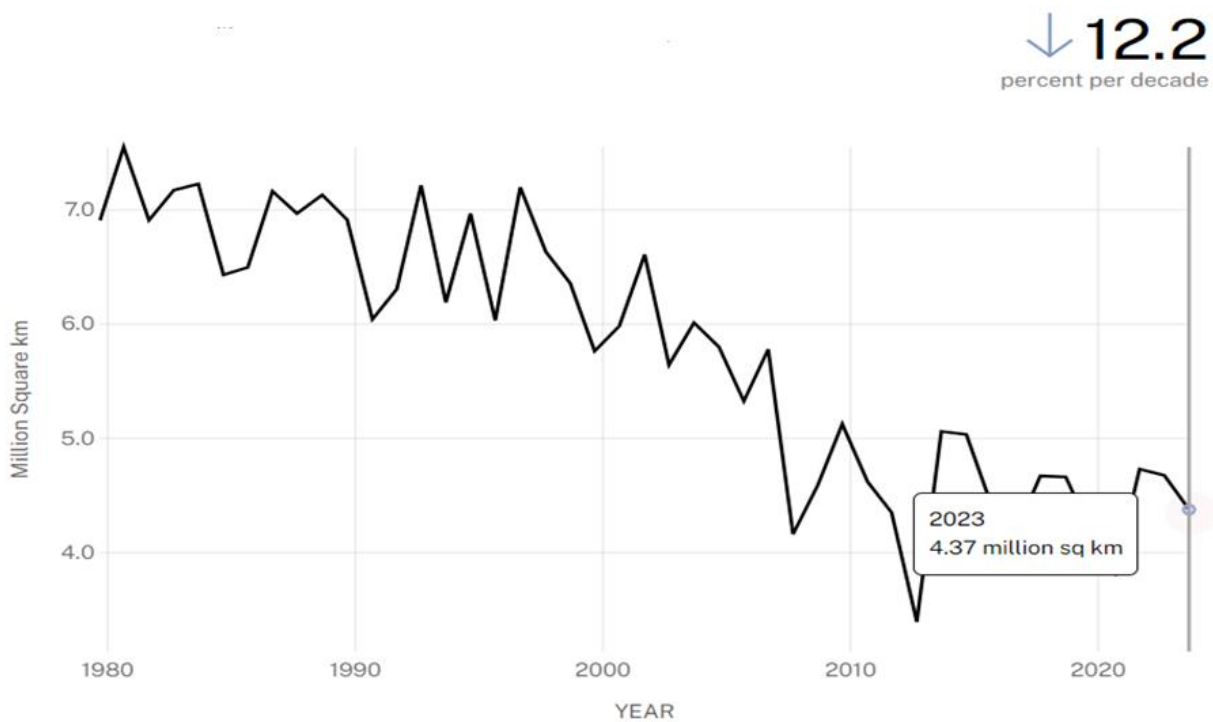
Many glaciers around the world have been melting rapidly since the early 1900s. Since the industrial revolution, carbon dioxide and other greenhouse gas emissions have increased temperatures in the poles, causing the glaciers there to melt rapidly, causing sea levels to rise and land to emerge.

Today, temperatures measured on land and at sea on Earth for more than a century show that the global average surface temperature is increasing. While the global average temperature in the 20th century was +13.9 °C, the average temperature on global land and ocean surfaces during 2019 was +0.95 °C above the 20th-century average. Earth's temperature has risen by an average of 0.06 °C per decade since 1850, or

[2] Albedo is an expression of the ability of surfaces to reflect sunlight (heat from the sun). Light-coloured surfaces reflect most of the sun's rays back into the atmosphere (high albedo). Dark surfaces absorb the sun's rays (low albedo). Albedo is the ability of a surface to reflect solar energy. See, (NPolar, 2024)

about 2 °C in total. In addition to that 2023 was the warmest year since global records began in 1850 by a wide margin. The 10 warmest years in the historical record have all occurred in the past decade (2014-2023) (Lindsey and Dahlman, 2024).

All of these developments are human-induced and are essentially the result of the capitalist mode of production. Even if states significantly reduce carbon emissions in the coming decades, more than a third of the world's remaining glaciers are expected to melt before 2100 (although there is no consensus yet). Today, approximately 10% of the land area on Earth is covered by glaciers. Almost 90% is in Antarctica, with the remaining 10% in the Greenland ice cap. When it comes to sea ice, 95% of the oldest and thickest ice in the Arctic has already disappeared. Glaciers around the world can range from a few hundred years of ice to several thousand years of ice, providing a scientific record of how climate has changed over time. Thanks to their work, we gain valuable information about how rapidly the planet is warming. They provide scientists with a record of how the climate has changed over time (Hancock, 2023).

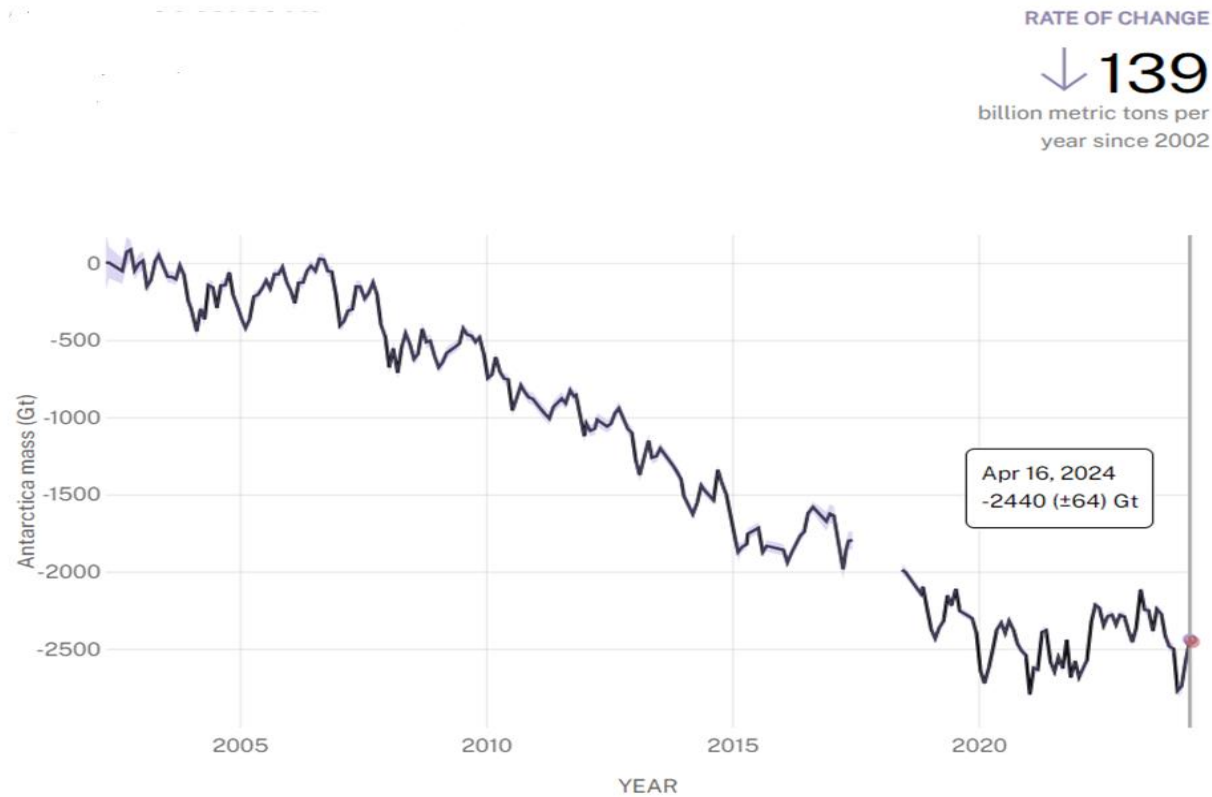


Graphic 1. Decreasing Amount of Ice in the Arctic Region by Years

Source: NASA (2023)

As seen in Graphic 1 above, it can be seen that the glaciers in this region have gradually decreased since 1979, when records began to be kept by NASA, and until today. Accordingly, Arctic sea ice reaches its minimum size every September. September Arctic sea ice extent is decreasing by 12.2% per decade due to rising temperatures, compared to its average extent from 1981 to 2010. In addition, the amount of sea ice in 2012 represents the lowest level in satellite records (NASA, 2023).

On the other hand, as a result of this melting, Antarctica loses an average of 150 billion tons of ice mass per year. Greenland, on the other hand, loses approximately 270 billion tons per year, contributing to sea level rise (NASA, 2024). The loss of Arctic ice is contributing to rising sea levels and further accelerating global warming, creating a cycle that could have catastrophic consequences worldwide.



Graphic 2. Mass Change in the Arctic Region between 2002 and 2024

Source: NASA (2024)

As seen in Graph 2 above, the sea areas in the Arctic region and the land ice sheets in Greenland have lost great mass from 2002 to the present. Essentially, this situation brings up a very serious danger. Because the ice sheets in Greenland and Antarctica store approximately two-thirds of the fresh water on Earth. "They are losing ice due to the Earth's surface and ocean warming. Meltwater from these ice sheets is responsible for approximately one-third of the global average rise in sea level since 1993" (NASA, 2024).

Sea ice cover in the Arctic region declined rapidly in July 2024, reducing daily ice cover by the end of the month to the third lowest level in the 46-year satellite record. The average Arctic sea ice extent for July 2024 is 7.89 million square kilometers, the sixth lowest in the 46-year passive microwave satellite record. "As of August 1, 2024, daily sea ice extent is the third lowest behind 2019 and 2020 and just below the record low year of 2012. Sea ice extent in July was 1.58 million square kilometers below the 1981-2010 average and 600,000 square kilometers above that of 2020; this was also the record low in July" (National Snow and Ice Data Center, 2024). Worryingly, melting all the ice in Greenland would cause global sea levels to rise by as much as 6 meters. Although the melting of glaciers in the Arctic region as a result of global warming causes global climate change and sea level rise, especially in the Atlantic Ocean, this will not only make it an accessible region shortly, especially during the summer months, but also become one of the new routes of international trade.

While the earth was subject to extensive initiatives and changes by human beings in the past, today climate change is a new element for human beings. The combined effects of global resource depletion, climate change, and technological progress mean that the natural resource base in the Arctic, such as fisheries, minerals, oil, and natural gas, is now increasingly abundant and available. This has begun to add economic value to the Arctic natural environment. Apart from the hydrocarbon resources of the Arctic, potentials such as geothermal, wind, and hydroelectricity are emerging, an increasing number of tourists are coming

to the region, shipping activities are expanding, and intercontinental shipping is developing, although it may take a few more decades to approach the scale of the current main shipping routes. Uncertainties about future environmental conditions are compounded by uncertainties about the size and accessibility of new energy basins in the Arctic, the pace of technological developments, oil, and natural gas prices, the future shape and demands of the global economy, and the political preferences of Arctic States (Limon, 2020b, p. 236-237)

4. Technological Advancements in Arctic Navigation

In recent years, several technological developments have emerged that enhance navigation and maritime operations in the Arctic region, particularly in the context of global warming and the resulting changes in ice coverage. These technological advancements not only improve navigation and operational safety in the Arctic but also contribute to the sustainable development of the region as it becomes more accessible due to climate change. Here are some key advancements:

Icebreakers: "The gradual erosion of sea ice in the Arctic region is the natural and most visible feature of the warming climate. The consequences of ice loss are a major concern for the world's marine infrastructure. Ice-free Arctic summers bring new challenges and opportunities for shipping companies to develop modern technologies that can confront the gradual disappearance of seasonal long-lived sea ice" (Arctic Portal, 2024a). Icebreakers are specialized ships designed to navigate and break through sea ice. They are crucial for maintaining and expanding Arctic trade routes. The need for icebreaking ships arose because of the opportunities to navigate arctic ice-covered waters and keep the trade route open in all seasonal or permanent ice conditions. Newer icebreakers are equipped with more powerful engines, reinforced hulls, and advanced icebreaking technology. These ships can operate in thicker ice and harsher conditions than older models. Current ships, whether powered by gas turbines, diesel-electric, or nuclear energy, are extremely difficult to operate due to their thick, rounded keels and lack of stability-providing protrusions that cause constant movement, causing annoying noise and vibration. The design and construction of ice-class ships have evolved, with stronger hulls and enhanced capabilities to operate in icy waters. These vessels can withstand harsh conditions, reducing the risk of accidents and enabling year-round navigation. Russia has developed nuclear-powered icebreakers such as the Arctic class, which can operate for long periods without refueling and break ice up to 3 meters thick. It is possible to say that Russia has a relatively pioneering technology in this regard. "Already the first icebreaker to go to the Arctic was the Russian nuclear-powered ship Arctic, which reached the Arctic in August 1977. In 2007, the Murmansk Shipping Company provided management of state-owned Russian nuclear icebreakers. NS 50 Let Pobedy has completed its sea trials" (Arctic Portal, 2024a). In addition to Icebreaker, the development of autonomous shipping technology allows for remote-operated vessels to navigate the Arctic safely. These ships can be equipped with advanced sensors and AI-driven systems to assess ice conditions and optimize routes.

Navigation Systems and Communication: Once a frozen frontier, the Arctic is now an increasingly accessible region due to melting sea ice caused by climate change. This transformation has created new possibilities for shipping routes, presenting both challenges and opportunities for global trade. In this regard, reliable navigation and communication systems are critical for safe and efficient operations in the Arctic. Global Navigation Satellite Systems (GNSS), including GPS and GLONASS, provide accurate positioning and navigation information (Grewal, 2011, p.383; Dow, John M., Neilan, R.E. & Rizos, C., 2009, p.191). These systems are essential for route planning and navigation in the remote Arctic. In addition to that Arctic operations benefit from Advanced Communications Networks that provide reliable voice and data services even in remote areas. This ensures constant contact between ships and shore support.

Advanced Weather Forecasting and Ice Prediction: Accurate weather forecasts and ice forecasts are crucial for planning safe Arctic journeys. In this context, Improved Numerical Weather Prediction (NWP) models provide more accurate weather forecasts, including wind, temperature, and precipitation. These

models help predict and avoid severe weather conditions. Moreover, advanced ice forecasting models predict the movement, growth, and degradation of sea ice. These models combine satellite data, in situ observations, and numerical simulations to provide reliable ice forecasts. The integration of environmental monitoring systems helps in tracking changes in the Arctic ecosystem, including ice melt and wildlife patterns. This information is vital for making informed decisions about maritime operations.

Satellite and Remote Sensing Technologies: Satellite technology plays a vital role in Arctic navigation by providing real-time data on ice conditions, weather, and sea state. High-resolution satellite images help track the distribution and movement of sea ice. This data is necessary for route planning and avoiding ice-covered areas.

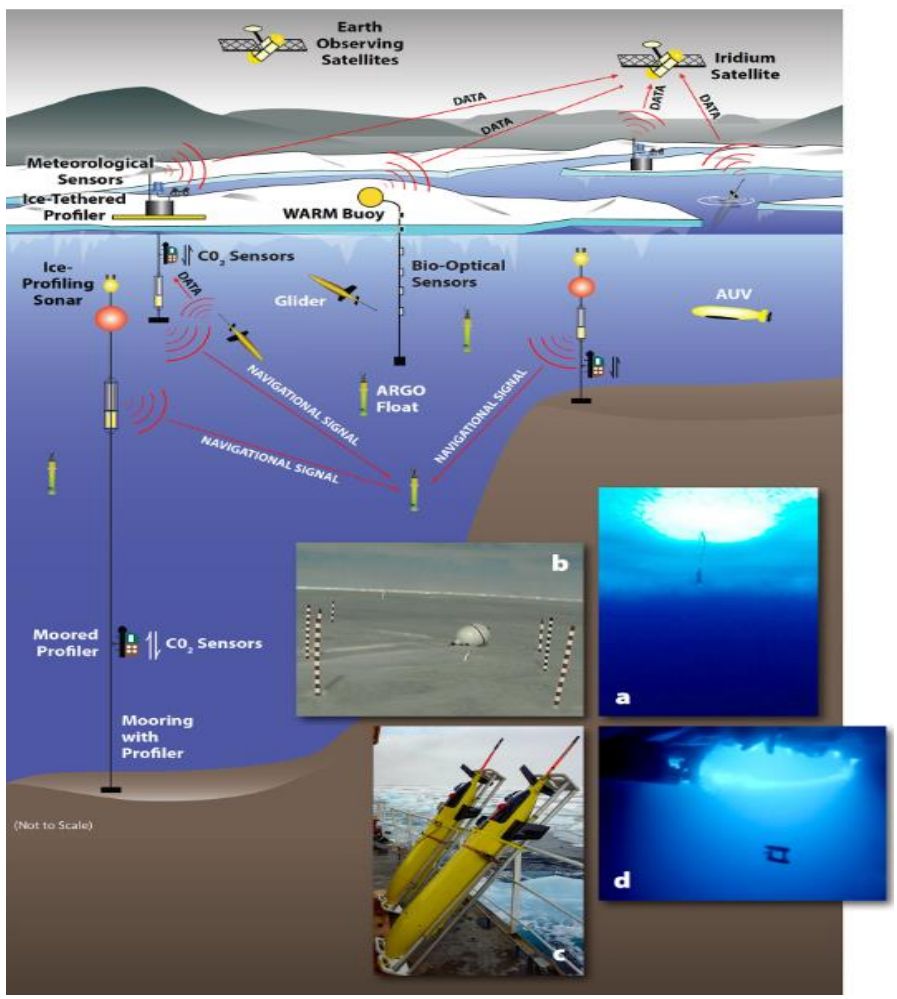


Figure 2. Arctic Ocean Observing Model

Source: Lee et al. (2022, p. 213)

Synthetic Aperture Radar (SAR): satellites can penetrate clouds and darkness, providing continuous monitoring of ice conditions. This capability is particularly valuable during the long Arctic night. In addition to that advanced remote sensing technologies allow for detailed mapping of sea ice thickness, concentration, and dynamics.

Real-Time Ice Monitoring and Forecasting: Improved satellite imagery and remote sensing technologies enable real-time monitoring of ice conditions. Predictive modeling and data analytics help in forecasting ice movements, allowing vessels to plan safer routes.

Collaboration and Data Sharing Initiatives: International cooperation among Arctic nations and organizations has led to better data sharing and collaboration on navigation safety, environmental protection, and search and rescue operations

Arctic Ports and Infrastructure: The development of Arctic ports and infrastructure supports increased maritime activity in the region. New and improved ports in the Arctic are needed to accommodate larger ships and increased traffic. Modern Arctic ports are equipped with specialized facilities for handling cargo, fueling, and providing services to icebreakers and other vessels.

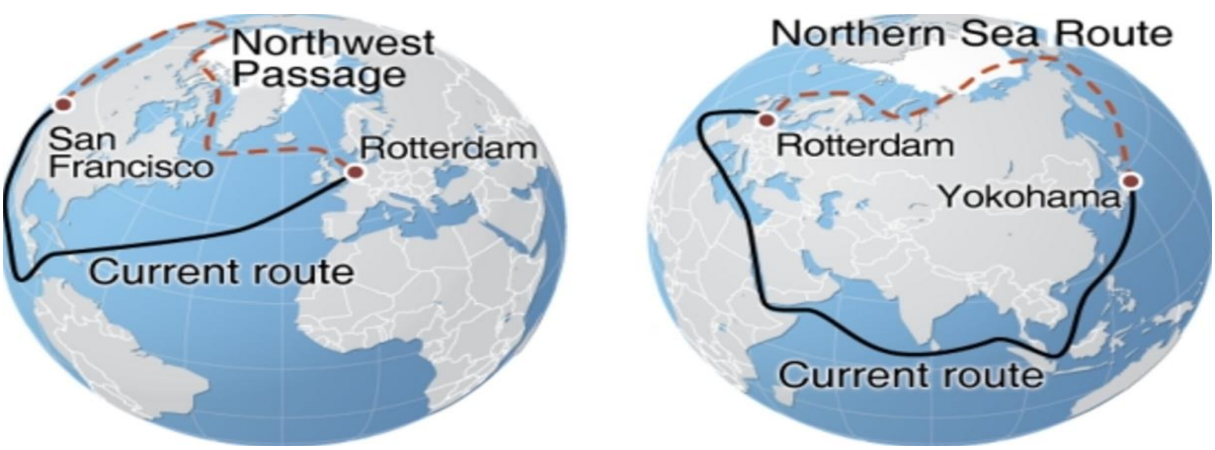
Technological advances in Arctic navigation have transformed the feasibility and safety of maritime operations in the region. From powerful icebreakers and satellite technologies to autonomous ships and advanced weather forecasts, these innovations are crucial to navigating the harsh Arctic environment. As interest in Arctic trade routes and resource exploration continues to grow, ongoing technological advances will play a vital role in ensuring sustainable and safe operations in this unique and fragile region.

5. Economic Implications of Arctic Ice Melt on World Trade Routes

The melting of glaciers in the Arctic is one of the most profound climatic and environmental changes of the 21st century and has significant economic impacts, especially on global trade routes. As the Arctic ice continues to retreat, new shipping lanes are opening up that could reshape international trade. This transformation brings both opportunities and challenges, with far-reaching consequences for global trade, geopolitics, and the environment.

The seasonal decline in sea ice cover in the Arctic region creates opportunities for companies and states to save greatly in terms of distance, time, and therefore costs. It also increases the possibility of large-scale maritime trade via Arctic routes, creating a safer and more profitable trade basis.

In this regard, the Arctic region is perceived as a leading place to start mining activities after the effects of climate change on the region. Coastal states and great powers aim to achieve unlimited desires through limited resources by mining and supplying precious metals. In return, they aim to gain economic benefit from this. But melting ice not only means the extraction of energy resources, minerals, and materials, but also new trade routes that increase geopolitical conflict over them. With the continuous reduction of Arctic sea ice and the increasing duration of seasonal ice-free periods of the Arctic Ocean, another economic interest in terms of shipping has become possible. Indeed, the emergence of two important sea routes, the North West Passage (NWP), extending from the Canadian Arctic to North America, and the Northern Sea Route (NSR), extending from the Russian Arctic via the Arctic Ocean to the Pacific Ocean" appear to be new routes for trade activities. It can promote trade interactions between global economies.



Map 1. The Current Maritime Routes in the Arctic Region
Source: The European Space Agency (2019)

Of the two shipping routes in the Arctic, the NSR along the northern coast of Eurasia has the greatest potential to enable economic activity in the Arctic. This promise is twofold: transit shipping for cargo transportation between ports outside the Arctic, and destination transportation for activities with origins or destinations in the Arctic. These include fishing, tourist trips, scientific expeditions, and resource extraction. Of these, resource extraction is the sector with the closest potential for expanding maritime activities to transport resources out of the region, westwards to Europe, or eastwards to Asia.

As Arctic ice extent recedes, the possibility of a commercially viable Arctic shipping route increases. The emergence of these routes, which are commercially shorter and cheaper than existing sea routes, has led to an increase in interest in the region. Although it currently offers a seasonal alternative route, unlike the existing waterways in the world, it is expected to be open almost all year round shortly, in line with global warming. The emergence of new routes in the Arctic region is expected to be a very important route for delivering the products produced by countries in the Asia Pacific region, especially to Europe and the American continent.

"The oldest pre-Suez route for shipping between Northeast Asia and Europe (e.g. Shanghai to Rotterdam) covers approximately 14,000 nautical miles around the Cape of Good Hope. The opening of the Suez Canal in 1869 shortened the journey by 23%, and the NSR could shorten the distance by 24% when there was little or no sea ice. NSR is most attractive for trade with Northeast Asia (Japan, Korea, and China); its appeal gradually fades as you move south towards Ho Chi Minh City, where the NSR and Suez routes are almost equidistant" (Farré, et. all, 2014, p. 301).

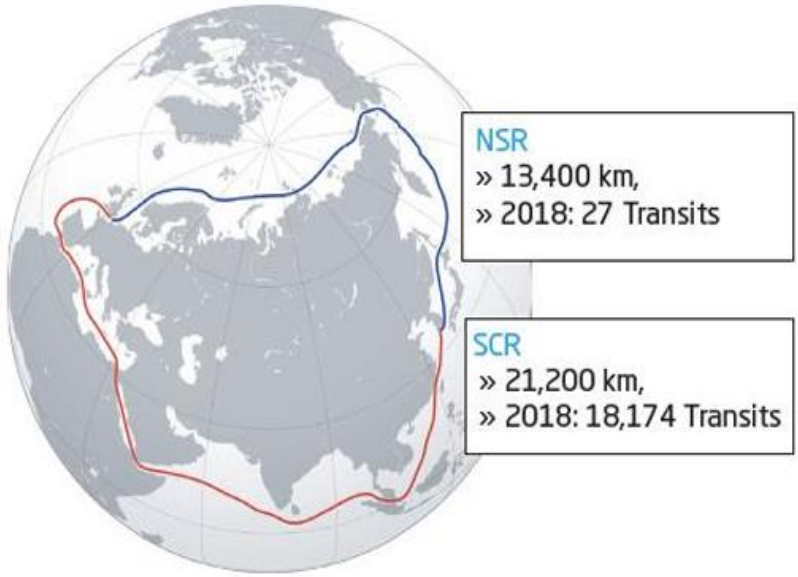
Table 1. Sailing Distances between Asia and Europe

	To Rotterdam, via (in nautical miles)			
From	Cape of Good Hope	Suez Canal	NSR	Differences between Suez Canal and NSR %
Yokohama	14,448	11,133	7010	37
Busan	14,084	10,744	7667	29
Shanghai	13,796	10,557	8046	24
Hong Kong	13,014	9701	8594	11
Ho Chi Minh City	12,258	8887	9428	–6

Source: (Østreng et all, 2013, p.49)

The most significant route emerging from the Arctic ice melt is the Northern Sea Route, which runs along the Russian Arctic coast. This route could reduce the distance between Europe and Asia by up to 40% compared to the traditional Suez Canal route, offering substantial savings in time and fuel costs. As a matter of fact, in 21st-century conditions, reducing transit costs through fuel and transportation means day savings and the economic gain desired by international companies. Another potential route is the Northwest Passage through the Canadian Arctic Archipelago. While this route is more challenging due to lingering ice and narrower straits, it still represents a significant shortcut for ships traveling between the Atlantic and Pacific Oceans.

"The Suez Canal is one of the world's most important waterways, providing maritime transport between Asia and Europe without the need to go around Africa. However, strong alternatives have recently emerged against the Suez Canal, which is the apple of the eye of traditional routes. Of course, the Ever Given accident, which occurred in March 2021 and caused the Canal to be closed for days, seriously demonstrated the necessity of alternative routes to the SCR. It is stated that the damage caused by congestion to world trade may reach 10 billion dollars" (Blas, Ha, and El Wardany 2021). "It is also a fact that the world, which is struggling with the global epidemic crisis during this period, will remember the delays in the delivery of medical products for a long time, and therefore the prestige of the Channel will be shaken" (Bayırhan and Gazioğlu, 2021, p.398).

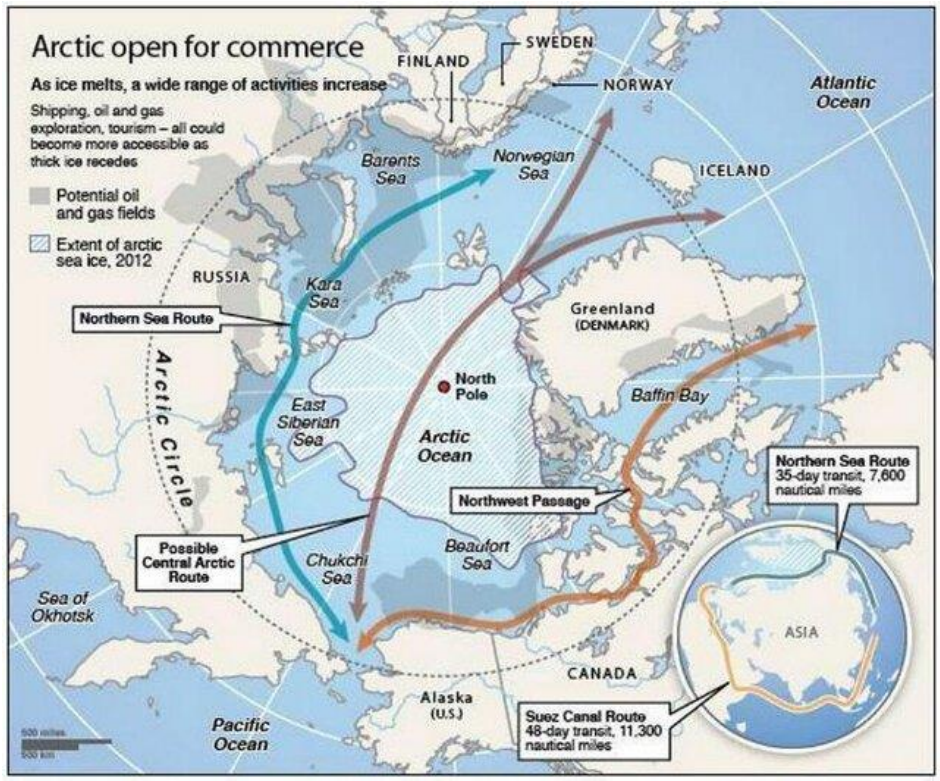


Map 3. Comparison of Suez Canal Route and Northern Sea Route
Source: German Arctic Office (2020)

"During the Soviet Union, the NSR developed greatly as a heavily subsidized and purely domestic route; Traffic peaked in 1987 with 6.58 million tonnes of cargo carried by 331 ships during 1,306 voyages. Arctic traffic fell to 1.5–2 million tonnes as subsidies disappeared with the collapse of the USSR and have not yet returned to these levels The question is whether the recent rapid loss of sea ice, together with new management and new technical developments, will significantly increase the potential for Arctic shipping. The increase in actual shipping has so far been minimal in a broader global context" (Stephenson et al. 2013). "Today, the total cargo transported through the region exceeds 30 million tonnes per year (AEC, 2019). The most important shipping lines are oil and LNG from Northwest Russia and Northern Norway to East Asia, iron ore from Russia to China, and oil products from South Korea to Northern Europe" (Çetin and Köseoğlu, 2020).

"It is seen that ship cargoes transported through the Arctic region are generally liquid and bulk cargoes and the cargo diversity is limited. One reason for this is that container shipping, which belongs to liner shipping, will be exposed to a wide range of sea and ice conditions in Arctic waters. In addition, the high rate of destruction of ice sheets increases the risk of sea ice on maritime trade lines and high ship operating costs in the case of the use of icebreakers" (Xu et al., 2018, p. 514-519). However, in the long term, it is expected that container shipping in the region will become more economically viable as Arctic sea ice decreases further. Thus, it is expected that there will be significant increases in both the types and quantities of loads.

What makes these routes important is that the time to reach the destination is short. "In turn, these routes help reduce fuel usage, saving huge amounts of money. In this context, the NWP sea route via North America is expected to shorten the route between Asia and the east coast of America by 5000 miles" (Ebinger and Zambetakis, 2009, p.1221). Accordingly, the NWP remains much more "economical" compared to existing routes via the Panama Canal. The transportation cost of ships in inline size is approximately 600,000 US dollars." (Dongqin Lu, 2014, p.70) However, it should be noted that large-sized ships passing through the Panama Canal cannot pass through this sea route.



Map 4. Shipping Routes Inner the Arctic Region

Source: Çetin and Büyüksağnak (2021, p.352)

"Considering ship traffic in Arctic waters, the distinction between the starting point and destination of itineraries is of great importance. A distinction is made between intra-Arctic and trans-Arctic traffic. In addition, the type of goods transported is decisive for flexibility in voyage planning, which plays an important role in transport in partially ice-covered waters. The increasing use of trans-Arctic sea routes, shorthand for global trade routes, is based on sometimes significantly shorter distances and travel times compared to traditional routes. For example, a trip through the Northeast Passage shortens the route between Northwest Europe and East Asia by 30 to 40% compared to the route through the Suez Canal" (German Arctic Office, 2020). On the other hand, one of the alternative routes rather than sea is the One Belt One Road Project, which revives the historical Silk Road. "In particular, the land route of the project is the Silk Road Economic Belt; it includes the establishment of railway connections from China to Europe through 6 corridors and the conclusion of trade-increasing agreements with the countries in the region" (Li et al., 2015, p. 7267-7268).

The emergence of new routes as a result of the melting of glaciers in the Arctic region and their safe passage as a result of technological developments have enabled the new route to shorten commercial transactions, saving travel time and money. In addition, these routes bypass pirates in Somalia and one of the narrowest straits in the world, such as the Strait of Malacca, allowing them to overcome possible problems and obstacles. Moreover, in line with the findings of scientists, it is expected that these routes will be "ice-free between 2040 and 2060" (Peimani, 2013, p. 6). Of course, this development will have a vital impact on global trade transactions. Because the change in trade routes throughout history has had political and geopolitical effects as well as economic effects. The fact that new trade routes emerging in the Arctic region are shorter than existing routes can lead to significant reductions in transportation times and reduce the operational costs of shipping companies. This could lead to cheaper goods for consumers and increased efficiency in global supply chains. Melting ice could also make Arctic resources more accessible. The

region is believed to have vast oil, gas, and mineral reserves that could lead to a resource boom, attracting investments and further boosting economic activity in the region.

Although economically advantageous, the increase in shipping traffic can have serious environmental impacts. The Arctic is a fragile ecosystem, and increased human activities could disrupt wildlife, increase pollution, and exacerbate global warming.

6. Geopolitical and Economic Competition in the Arctic Region

The Arctic region has become an important area at the center of global politics today. The geopolitical and economic competition of global powers in the Arctic region is centered on access to energy resources, the opening of new sea routes, and international security dynamics. As the Arctic's perilous polar ice caps melt, nations have begun a modern-day gold rush over the region's unclaimed territory, natural resources, and strategic location. As a result of the rapidly disappearing polar ice caps, there has been an increase in unclaimed ocean and land territory beyond any nation's control, where countries are seeking jurisdiction for purposes such as resource extraction and trade routes. Beyond economic motivations, countries such as the United States, Russia, and China are competing to establish military dominance and seek greater power in the region. The Arctic also occupies a critical position between North America and Eurasia, making it a powerful strategic location from which to project military power. With the liberal international order increasingly under threat from great power conflict (a scenario in which the already contentious relationship between the United States, Russia, and China could escalate into war), the Arctic Circle faces a crossroads: will simmering tensions beneath erupt into a larger global conflict, or could diplomatic means be the key to achieving peace in the region? (Gross, 2020).

Melting ice due to climate change is making Arctic sea routes more accessible year-round. These new routes are allowing trade between Europe and Asia to be carried out more quickly and cost-effectively. Global powers are developing military and diplomatic strategies to control and secure these routes Arctic relations are rooted in larger dynamics between Russia and the 'West'. Russia's invasion of Ukraine in 2022 has significantly changed relations with the West, leading to Finland and Sweden moving towards NATO membership, thus expanding the alliance to seven of the eight Arctic countries. This rift, the tension between Russia and the West, was already evident before 2022. It has manifested itself regionally in military presence and exercises, in sharp rhetoric, and in provocations and suspected sabotage. It also raises questions about what China's "neutral" stance on the West-Russia axis and the US-China rivalry mean for the Arctic. Other actors, such as the EU and India (with Arctic policy from 2022 onwards), are increasingly interested not only in the scientific and economic aspects of Arctic development but also in its geopolitical dimensions (Winther and Østhagen, 2024, p.1).

Control over Arctic lands has given nations the ability to settle, extract resources, and establish military outposts, making the legal rights and claims to such lands incredibly valuable. Competition over land claims is driven in part by nations' desire for the region's natural resources, particularly natural gas, which provides nearly a quarter of all global energy use. Most of the world's natural gas reserves have already been discovered and exploited, but the Arctic offers vast untapped reserves that nations are vying for control of. According to the newest predictions, however, the Arctic is expected to host around 22% of the world's remaining undiscovered oil and gas reserves, according to a 2008 assessment from the US Geological Survey. According to this assessment, this would equal an estimated total oil and natural gas resource of 412 billion barrels of oil equivalent. Around 78% of the Arctic resources are expected to be natural gas and natural gas liquids (NGL). The West Siberian Basin and East Barents Basin are estimated to be key areas,

holding 47% of the total undiscovered resources. 94 percent of the resources within these areas are expected to be natural gas and NGL (Arctic Portal, 2024b).

The situation in the Arctic Circle, where countries are advancing their drilling programs despite environmental concerns, is indicative of a broader geopolitical and economic dynamic. The primary motivations for these actions are economic, including job creation, reduced energy costs, and increased energy independence. These factors not only bolster domestic economies but also enhance international trade positions. The parallels with the South China Sea conflict highlight the competitive nature of securing strategic locations and trade routes, which can escalate tensions between major powers. The Arctic Council's limited authority and the weakening of legal protections underscore the challenges in managing these conflicts through peaceful negotiation and cooperation.

7. Regional Cooperation and Diplomacy in the Arctic

Regional cooperation and diplomacy are an important part of international relations in the Arctic region. In this respect, The Ilulissat Declaration, signed in 2008 by five Arctic coastal countries (Canada, Denmark, Norway, Russia, and the United States), emphasizes the broad international legal framework that applies to the Arctic Ocean. The Declaration recognizes the sovereign rights and jurisdiction of coastal countries and commits them to peaceful resolution of potential disputes. However, Russia’s invasion of Ukraine has hurt cooperation in the Arctic region. Following the invasion, the other seven members of the Arctic Council suspended cooperation with Russia. However, key channels of cooperation and dialogue between the Arctic countries remain open (Ohnishi, 2024)

The Arctic Council indeed plays a crucial role in Arctic governance by establishing various rules and regulations that promote international cooperation and address environmental and social issues in the region. The council has facilitated the negotiation of legally binding agreements under its auspices, aiming to enhance cooperation on maritime issues and other relevant topics. Moreover, the council's role in enhancing international Arctic scientific cooperation is evident through the signing of the Agreement on Enhancing International Arctic Scientific Cooperation in 2017, which aims to facilitate broad scientific activities in the Arctic (The Arctic Council, 2018)

The United States, Russia, and China are the main countries competing for control of the Arctic’s resources. Countries that are party to the United Nations Convention on the Law of the Sea have the right to own resources within 370 kilometers of their coastline, but most of the Arctic’s natural gas resources lie beyond these legal boundaries. This distance creates a struggle to control these resources that goes beyond the influence of international organizations and further encourages intra-national conflict. As a result, even nations far from the Arctic are starting to get involved, such as China, whose interests lie in the Arctic’s resources rather than the land itself. China has few domestic energy resources and relies on imports from the Middle East, the United States, and Russia for most of its energy consumption, further fueling its ambition to exploit Arctic natural gas to secure energy independence (Gross, 2020). However, China’s Arctic ambitions go beyond just energy, as it has recently expanded its plans to exploit the country’s resources amidst legal turmoil.

Even as the conflicts between the United States and Russia and the United States and China gain more attention in the media, the Arctic Circle deserves to be at the forefront of those discussions. The actions and rhetoric of the United States, China, and Russia have and will continue to influence each other in the region. Consequently, expanding involvement in the region can be viewed by the other nations as a threat to their regional interests and has, in the past, pitted these countries against each other. Diplomatic means to resolve the conflict, such as the Arctic Council, exist, but questions remain about their ability to resolve the conflict and create agreements that are adhered to. The 2020s decade could prove to be the pivotal

moment for the Arctic Council's influence in the region and provide faith in cooperative international organizations. The implications of a successful Arctic Council resolution could increase the credibility, in the minds of skeptics, of other organizations which have recently had doubt cast upon them such as the North Atlantic Treaty Organization and the United Nations. Conversely, a negative ending to the regional conflict could extend beyond the region into a larger war in multiple regions. Although the Arctic Circle is characterized by its geographical position at the top of the planet, right now, it appears to be the center of the world (Gross, 2020).

8. Conclusion

Developments in the Arctic due to global climate change, in addition to its role in global sea level rise and greenhouse gas emissions, also affect weather patterns in lower latitudes around the world. While changes in the Arctic are mostly triggered by influences from outside the region, global climate change has the potential to affect millions of people living in the Arctic and lower latitudes due to the tight connections between various components of the atmospheric system. Even a very small rise in sea level could affect low-lying island countries and important infrastructures such as coastal areas and sea ports of many countries. Staying away from the Arctic and Antarctic regions, where the average sea level rises on a global scale, or being away from the ice sheet is not possible in terms of environmental security, and due to changes in the Earth's gravitational field due to mass loss in the ice sheet, the ocean sea level will fall in nearby areas where melting occurs, while it will rise in more distant areas. Sea levels are predicted to rise more in Bangladesh, the US, China, and Japan than in other parts of the world. In this context; Climate change can be expected to displace millions of people in the coming decades.

Environmental changes in the Arctic will not only force a re-examination of geopolitical maritime routes and access to new energy basins, but such changes will also include critically important systems that are based on the security of states. While melting glaciers alone affect coastal energy infrastructure, changes in global ocean currents or the emergence of large-scale methane emissions can lead to food insecurity. This situation may also cause instability in distant countries such as India. Melting of glaciers means the disappearance of almost 99% of freshwater resources, including groundwater, which will be at risk of salinization when the sea level rises, which makes up 3% of the total freshwater resources in the world (Limon, 2020a, p.729). The loss of sea ice in the Arctic Ocean is accelerating due to factors such as greenhouse gases, black carbon, ocean temperatures, changing wind patterns, and decreasing albedo effect. There is no doubt that current conditions are moving the Arctic Ocean towards an ice-free environment. However, it makes it difficult to predict when a seasonally ice-free Arctic will emerge and to what extent greenhouse gas emissions caused by humans will be reduced. Although the geopolitical consequences of the loss of Arctic Ocean sea ice are profound, it can be said that it will affect the entire ecosystem in terms of environmental impacts (Limon, 2020b, p. 247).

"The rapidly decreasing amount of ice in the Arctic Region and the feasibility of Arctic maritime transportation is of critical importance due to the economic and political positions of the countries along the route, as well as their geographical location. Especially countries such as China, Russia, Japan, and South Korea aim to connect to the Atlantic through NSR. Additionally, products need to be transported from source regions such as the Arctic to central markets such as Asia. For this reason, the region seems suitable for new collaborations." In addition, the ice melting in the Northern Hemisphere due to global warming not only reveals resources on the seabed but also promises alternative routes that will radically affect world trade. Although the shock wave caused by the temporary closure of the Suez Canal makes it easier for the northern route to find its place among the alternatives, the safety and reliability of the middle route that crosses all of Asia is expected to determine the fate of these routes.

Arctic maritime trade routes have the potential to reshape the global transport geography of liner and goods transport. In this way, shipping companies will not only save fuel but also have the opportunity to plan more voyages as the ships complete their voyages in a shorter time. This great economic benefit that can

be obtained has caused companies as well as states to feel the need to operate in this region. Melting glaciers in the Arctic could also make Arctic resources more accessible. The region is believed to have vast oil, gas, and mineral reserves that could lead to a resource boom, attracting investments and further boosting economic activity in the region.

The expansion of access to the Arctic region comes at a time when international trade is increasing with the rise of Asian economies, which require increasing imports of energy and raw materials. However, these conditions are currently expected to be only a seasonal complement to the Arctic trade routes rather than a replacement for the Suez Canal. However, with the melting of glaciers, two important developments facilitate the growth of maritime transportation in the Arctic region. The first is the widespread climate-related sea ice loss that has not been seen in the 35-year observation record (Farré, et. all, 2014, p.316). Projected future reductions have the potential to make the Arctic significantly more navigable. Further investment in infrastructure, navigation, communications, and the emerging field of ice forecasting offers long-term growth potential in Arctic shipping. The second is the political opening of Arctic waters to international shipping within a stable institutional framework.

Maritime trade currently accounts for 80 % of world trade (Statista, 2024) and is dominated by raw material transport, tanker trade, and other dry cargo, including containerized cargo. The increasing importance of the trade relationship between Europe and Asia and the resulting increase in maritime traffic between the two regions will lead to greater congestion and a higher risk of collisions in narrow waterways such as the Suez Canal and the Strait of Malacca along existing sea lanes and their chokepoints. Trans-Arctic shipping, regardless of the actual route used, will not replace existing shipping routes but will instead complement and provide additional capacity for increased shipping volume. For the foreseeable future, the limited seasonal window for trans-Arctic journeys needs to be taken into account in any projections. However, the development of Arctic offshore hydrocarbon resources and related economic activities will result in better integration of the Arctic economy into global trade patterns (Humpert and Raspotnik, 2012, p. 283-284).

“The advantage of connecting the Atlantic to the Pacific with a 40% distance reduction (for Shanghai-Rotterdam) is offset by many factors, such as harsher weather conditions and free-floating sea ice, requiring more expensive shipbuilding and investments in winterization. Remoteness, lack of broadband communications, and limited SAR capabilities increase the risk of Arctic operations.” Shallow waters limit ship size and ice movements make ship arrival times unpredictable. The lack of a dense coastal population reduces the value of the NSR as a trade route. For these reasons, NSR stands out as a less reliable seasonal alternative to the Suez Canal, especially in container transportation.

Melting Arctic ice is transforming global trade routes. Climate change therefore presents both opportunities and challenges in the Arctic region. While new shipping routes can reduce costs and time in global trade, they also present significant geopolitical, environmental, and infrastructural challenges. As the Arctic ice continues to melt, the world will need to carefully balance economic benefits with potential risks to the environment and international stability. The full consequences of this transformation are still emerging, and the coming decades will be crucial in determining how the world will adapt to this new reality.

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