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GLOBAL WARMING AND RUSSIA: CHALLENGES AND OPPORTUNITIES

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Abstract

Global warming presents both profound challenges and strategic opportunities for the Russian Federation, particularly in its vast Arctic and permafrost regions. This article explores the multifaceted impacts of permafrost thawing, examining its environmental, economic, and geopolitical dimensions. On the one hand, thawing permafrost accelerates greenhouse gas emissions, destabilizes infrastructure, and disrupts ecosystems and traditional livelihoods. On the other hand, it unlocks access to untapped natural resources, expands arable land, and facilitates the development of the Northern Sea Route (NSR) as a strategic alternative to traditional maritime routes. This analysis highlights how these dynamics are reshaping Russia's Arctic strategy, influencing global energy markets, and contributing to a potential shift in agricultural and geopolitical landscapes. The article also evaluates the Russian government's policies, juxtaposing short-term adaptive measures with long-term strategic ambitions, and discusses the

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broader implications for international relations and global climate governance.

Keywords: *Russia, Global Warming, Hybrid Warfare, Arctic Security, Permafrost.*

KÜRESEL ISINMA VE RUSYA: ZORLUKLAR VE FIRSATLAR

Öz

Küresel ısınma, özellikle geniş Arktik ve permafrost bölgelerinde Rusya Federasyonu için hem zorluklar hem de stratejik fırsatlar sunmaktadır. Bu makale, permafrostun çözülmesinin çok yönlü etkilerini çevresel, ekonomik ve jeopolitik boyutlarını incelemektedir. Permafrostun çözülmesi sera gazı emisyonlarını hızlandırıp bölgedeki altyapıyı tesislerinde hasarlar meydana getirirken, mevcut ekosistemler ile geleneksel geçim kaynaklarını bozar. Öte yandan, daha önce kullanılması mümkün olmayan doğal kaynaklara erişimi olanaklı hale getirirken ekilebilir arazileri genişletmekte ve geleneksel deniz yollarına stratejik bir alternatif olarak Kuzey Denizi Rotası'nın (NSR) gelişimini kolaylaştırmaktadır. Makalede bu dinamiklerin Rusya'nın Arktik stratejisini nasıl yeniden şekillendirdiğini, küresel enerji piyasalarını nasıl etkilediğini, tarımsal ve jeopolitik alanlarda potansiyel bir değişime nasıl katkıda bulunduğunu incelemektedir. Makalede ayrıca Rus hükümetinin politikaları değerlendirilirken kısa vadeli uyarlanabilir önlemlerle uzun vadeli stratejik hedefler karşılaştırılmakta ve uluslararası ilişkiler ile küresel iklim yönetimi açısından daha geniş kapsamlı etkiler tartışılmaktadır.

Anahtar Kelimeler: *Rusya, Küresel Isınma, Hibrit Savaş, Arktik Güvenliği, Permafrost.*

Introduction

Since the late 1980s, global warming has emerged as one of the most critical challenges of the 21st century, reshaping ecosystems and economies worldwide. Its impacts extend to geopolitical dynamics, with the Arctic regions particularly vulnerable. In the Russian Federation, where permafrost spans vast Arctic territories these effects are profound. Permafrost not

only serves as a reservoir of greenhouse gases but also underpins essential infrastructure and economic activities critical to regional sustainability.

The rising global temperatures and accelerating permafrost thaw present a dual reality for Russia. On one hand, the thaw contributes to greenhouse gas emissions, infrastructure damage, and economic disruptions. On the other hand, it opens opportunities for resource extraction, agricultural expansion, and Arctic navigation. This article examines the interconnected environmental, economic, and geopolitical dimensions of permafrost thaw in Russia, exploring the strategies needed to address challenges and capitalize on emerging opportunities.

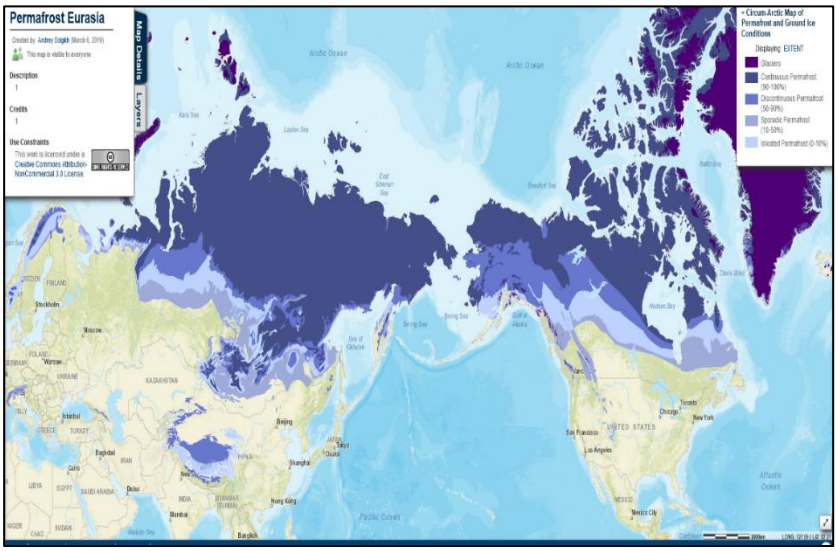
Although Russian President Vladimir Putin initially dismissed the seriousness of global warming during the early years of his presidency, suggesting that "for a northern country like Russia, a temperature increase of two or three degrees wouldn't be so bad... [as a result of global warming] we could spend less on fur coats and grain harvests might increase ("The Putin Puzzle" 2015), he later described climate change as "one of the greatest challenges facing humanity" in 2015. This shift in rhetoric is primarily due to the Russian Federation's growing vulnerability to the irreversible impacts of climate change. While the rapid melting of ice in the Arctic Ocean has garnered significant international attention, the changes occurring in the vast Siberian region -largely covered by permafrost- are equally

critical. For centuries, Siberia has been integral to the military security and resource wealth of the Russian Empire, the Soviet Union, and, subsequently, the Russian Federation.

1. The Environmental Challenges of Thawing Permafrost

Permafrost, encompassing soil, rock, ice, or organic matter, is ground that remains frozen at or below 0°C for at least two consecutive years (Everdingen 2005). Globally, it accounts for 17% of the Earth's landmass, covering 25% of the exposed surface in the Northern Hemisphere (Biskaborn et al. 2019). In Russian, the term for permafrost is "вечная мерзлота-Vechnaya merzlota" (eternal frost), and such terrains cover around 80% of Alaska, 50% of Canada, and 60% of Russia's Arctic regions (Gruber 2011). The presence of permafrost acts as a global cooling agent by maintaining heat balance and storing large amounts of organic matter -such as plant, animal, microbe, and virus remains- beneath the frozen surface. The permafrost layer contains twice the amount of carbon and mercury found in the current atmosphere (Schuur et al. 2015).

Map 1: Permafrost in Northern Hemisphere



Source: Yegorov 2023

Highly sensitive to climate change and rising temperatures, permafrost is rapidly thawing, and the permafrost-covered regions in the Russian Federation are warming at a much faster rate than the global average. According to the Intergovernmental Panel on Climate Change (IPCC), if global warming is limited to below 2°C, 25% of the permafrost will have melted by 2100. However, if greenhouse gas emissions continue to rise at their current rate, this figure could reach 70%. (Pörtner et al. 2019) With the current rate of warming at 1°C every decade, it is expected that the permafrost layer in the Russian Federation will lose its frozen state within 30 years. Given that Russia is warming 2.5 times faster than the global

average, the magnitude of the problem becomes even more evident. (Heather A. Conley and Cyrus Newlin 2021)

According to the Russian Cryosphere Institute, the boundary of the permafrost region has shifted 30 kilometers northward over the past 40 years (Heather A. Conley and Cyrus Newlin 2021). The Stanford University Center on Food Security and the Environment predicts that, due to global warming, countries located below a line drawn at the latitude of the northern borders of the United States (US) and China will experience significant production and income losses (Burke, Hsiang, and Miguel 2015). By 2100, it is projected that the per capita income in the United States could be one-third lower compared to a world unaffected by global warming. Meanwhile, India's per capita income is expected to decrease by approximately 92%, and China's future growth will be nearly halved (Abrahm Lustgarten 2020). On the other hand, countries located north of the specified latitude are expected to experience significantly higher economic growth potential due to global warming. Canada, the Scandinavian countries, Iceland, and the Russian Federation could see up to a fivefold increase in per capita gross domestic product (GDP) by the end of the century, provided they have sufficient human resources to sustain such economic expansion (Abrahm Lustgarten 2020). The thawing of permafrost is not only an environmental issue but also a threat multiplier that negatively impacts national security. Many

national governments, defense ministries, and international organizations have integrated climate change into their current policies. Some military forces and international military alliances have recently begun adapting to climate change across various domains, from doctrines and equipment to operational training (Mlissa Levaillant 2021).

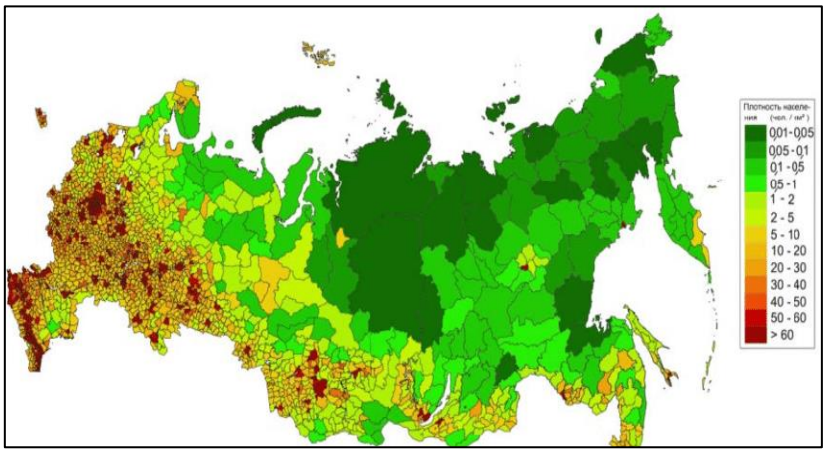
The Russian Federation has taken a more composed and pragmatic approach to global warming, delaying international agreements that could impose economic constraints and attempting to minimize the damage. At the same time, Russia is developing various policies to turn the situation to its advantage in the Arctic Ocean and permafrost regions. Indeed, in the case of Siberia, global warming presents not only significant challenges for the Russian Federation but also potential advantages.

2. Economic Implications of Permafrost Thaw

While the thawing permafrost poses significant environmental risks, its economic implications are equally critical, particularly for Arctic regions where infrastructure and industries are directly tied to permafrost stability. Despite being home to just 1.5% of Russia's population, the Arctic region contributes approximately 10% of the nation's GDP, underscoring its economic significance (Maria Polovtseva 2020). The region's impact on the Russian economy is substantial and to sustain this economic contribution, the

environmental challenges associated with the region must be addressed. Alexander Kislov from Moscow State University has warned that the melting of permafrost could reduce Russia's GDP by 8.5% by 2050 (Angelina Davydova 2020). Similarly, a report published by the Accounts Chamber of the Russian Federation in 2020 indicated that climate change could decrease Russia's GDP by 3% annually by 2030, suggesting that a Russian Federation unable to resolve its ecological issues will fall short of its defined goals (Ekaterina Mereminskaja 2020). The changes in the permafrost areas present significant geopolitical (loss of coastal areas and small Arctic islands due to erosion), social (impact on traditional lifestyles and public health), natural (food security and changes in flora and fauna), infrastructural (damage to transport and facilities), and climatic (effects on global climate through greenhouse gas emissions) challenges for the Russian Federation. Each of these issues is particularly striking and demands urgent attention.

Map 2: Population Density of Russian Federation



Source: Kiuskina and Lukutin 2018

According to Dmitry Drozdev, the Director of the Cryosphere Institute of the Russian Federation, up to 500 square kilometers of land in the permafrost region of Siberia is sliding into the Arctic Ocean and disappearing each year, and this process has become irreversible (Valerij Matycin 2015). In Eastern Siberia, more than 10 square kilometers of coastal land is lost each year, a figure that rises to 30 square kilometers across the entire Arctic coastline. The situation in the Arctic Ocean carries also significant importance from a geopolitical perspective. The damage caused by erosion to military facilities along the coast is substantial. Some islands in the Arctic Ocean, such as Sannikov Island, have long been dissolving into the ocean (Anisimov et al. 2010) and disappearing entirely, and the land masses of other islands continue to diminish (Klyuyev, Kotyukh, and Olenina 1982). This situation also holds the

potential to weaken the Russian Federation's position in the impending disputes over the continental shelf in the Arctic Ocean.

Another negative consequence of the melting ice in the Arctic Ocean is the 85% increase in black carbon, which results from the use of heavy fuel oil by the rising number of oil tankers and cargo ships navigating the region's waterways as they become more accessible. Black carbon, a type of air pollution caused by the incomplete combustion of fossil fuels, accelerates melting when it settles on snow or ice by causing darkening. Black carbon is not the only factor contributing to the warming of the Arctic and the melting of permafrost; as global warming erodes and dissolves the Arctic coastline, bacteria break down the organic matter in the soil, releasing large amounts of carbon dioxide and methane into the atmosphere. The release of these greenhouse gases leads to further warming of the Earth, and this warming cycle originating from the Arctic regions causes the permafrost layer to disappear at a much faster rate.

Although climate change may expand the amount of arable land in permafrost regions, the soil in these areas tends to be thinner and more prone to acidification compared to the fertile southern regions of Russia. In fact, due to soil acidification caused by permafrost thaw, the region's arable land area was reduced by more than half in 2017 (Heather A. Conley and Cyrus Newlin 2021). We can better understand the reasons

behind the reduction in arable land by examining examples from Yakut Republic of Russian Federation. The permafrost in Yakutia is more glacial in nature and thicker compared to other regions, and it is uniquely referred to as “Yedoma.” According to Yakut scientist Roman Desyatkin, while in previous years the ground in the Middle Kolyma region north of the Zyryanka River would thaw to a depth of around 60 centimeters each summer, it now thaws to more than a meter. Calculations indicate that the Yedoma layer, covering approximately 2.5 square kilometers, releases nearly 10,000 tons of additional water into the environment each year (Anton Troianovski and Chris Mooney 2019). As a result, the presence of water forming large patches on top of the soil in the region leads to a decrease in the amount of arable land.

3. Food Security, Infrastructure Changes and Social Implications to the Local Population

Since Siberia has been largely covered by ice and permafrost throughout much of human history and was largely inaccessible, it was considered an ideal location for the disposal of chemicals, biological hazards, and even radioactive materials. Furthermore, due to its low population density and its distance from any military threats to the Russian Federation, Siberia was historically considered ideal for the disposal of hazardous substances. However, the risks associated with these materials, particularly as permafrost thaws, remain insufficiently

understood (Renee Cho 2022). The potential for radioactive waste, mercury, and radon to mix with soil and water as a result of permafrost thaw is a major source of concern. While cases of mercury poisoning from water sources have been reported in the region, radon -a primary trigger of lung cancer- has also become a more frequent health threat, as its prevalence has been linked to permafrost thaw in the area (Katarina Kertysova and Akash Ramnath 2021b). Regarding the soil, the use of pesticides in subarctic regions has certain disadvantages. Synthetic pesticides decompose much more slowly in cold climates, accumulating in the soil and agricultural products, and their concentrated re-release as the soil thaws due to global warming poses a threat to human health.

According to J. D. Ford, G. McDowell, and J. Jones, climate change is a significant driving force, as it affects marine and terrestrial ecological dynamics, which in turn have a strong impact on commercial harvests and subsistence-based livelihoods (Ford, McDowell, and Jones 2014). In recent years, water and food security in Siberia and the subsequent social and demographic issues triggered by climate change have become some of the most significant threats facing the Russian Federation. Numerous studies, including the European Union's "Nunataryuk" research program -focused on the permafrost regions of the Northern Hemisphere- are not only examining the organic matter released from thawing permafrost but also

investigating the risks this thaw poses to infrastructure, indigenous and local communities, their health, and its long-term impacts on global climate and the economy which raises the concerns about the food security, ("Understanding the Threat of Arctic Permafrost Thaw" 2019) which is defined as "the condition in which all people, at all times, have physical and economic access to safe and nutritious food that meets their dietary needs for an active and healthy life" ("Report of the World Food Summit" 1996). Considering this definition, the challenges faced by the Russian population living in permafrost regions regarding access to clean water and safe food highlight that food security is an ongoing threat in these areas.

Geopolitical concerns and strategic ambitions are compounded by pressing social and infrastructure challenges, including food security, deteriorating transport networks, and permafrost's impact on public utilities. In terms of access to clean water, particularly in Yakutia, there is salinization as a result of overgrazing and excessive irrigation with carbonated water, which are among the negative environmental impacts (Alexey Naumov et al. 2020). In shallow water bodies, longer warming periods and the thawing of septic materials previously trapped in the permafrost can lead to outbreaks of intestinal infections (Bogdanova et al. 2021). The poor condition of state-owned water supply systems and the low quality of drinking

water, particularly in the Russian Arctic, Siberia, and the Far East regions, is widely acknowledged by the public. Inadequate water supply systems, insufficient water treatment and disinfection facilities, and poor drinking water quality are pervasive challenges across the Russian Federation, particularly in its Arctic and permafrost regions. At the core of these infrastructural problems lies the damage caused by the thawing permafrost layer, which affects the infrastructure built upon it. In small settlements in Siberia, water pipes supply untreated and unsterilized drinking water directly from surface water sources. Most of these water supply systems in rural areas are only operational during the summer months. In rural regions, more than one third of the population relies on decentralized sources for drinking water. However, the quality of this water is low due to poor protection against contamination from surface areas of aquifers, the absence of sanitary protection zones, and the delayed repair, cleaning, and disinfection of wells. In almost all cases, municipal funding is not allocated for such purposes (G.G. Onishchenko 2006). Currently in Russia, approximately one-third of the water supply and sewage networks are in a state of disrepair, with over 60% deterioration levels. At the current rate of repair, it will take more than 50 years to fully restore these systems (G.G. Onishchenko 2006).

In addition to water contamination, high levels of biological contamination are also observed in food. The quantitative and qualitative control of chemical and biological contaminants in food produced in permafrost regions is insufficient and requires radical improvements aimed at enhancing food security in the country(Dudarev et al. 2013). Another aspect of the food security crisis relates to Arctic indigenous communities and their reindeer herding practices. Reindeer, which are a fundamental source of food (and often used as a mode of transportation) for communities living in permafrost regions, are both positively and negatively impacted by global warming. Climate change has positively affected the growth of the reindeer's grazing base, while the reduction in snow-covered periods has extended the length of their growing season (Judge, Maltby, and Sharples 2016). The early melting of snow and the increased availability of fresh forage are contributing to the growth of the reindeer population. However, this population increase is far from stable. Higher temperatures are causing trees to slowly encroach upward, while moss is increasingly replacing the lichen that constitutes a key part of the reindeer's diet. Furthermore, the occurrence of sudden climatic shifts has led to the formation of thick layers of ice at unexpected times. These ice layers, which reindeer cannot break through, result in periods of forage scarcity and mass die-offs

("Mass Deaths of Reindeer on Yamal Peninsula Might Be Linked to Climate Change, Scientists Believe" 2021). To address the issue of food scarcity, herders would need to create enclosed spaces where they can feed their reindeer during the winter. However, this approach presents its own challenges, including the economic burden of maintaining such facilities, as well as the risk of infectious diseases spreading among the animals ("Climate Change in the Arctic: How Global Heating Affects Sámi Communities" 2022).The exposure of plant and animal remains, previously trapped in permafrost, to rising temperatures and open air leads to their decomposition and the release of carbon dioxide from the thawed materials into the atmosphere. Humans and animals that have been buried in permafrost for centuries may also pose a risk, as under the right conditions, the viruses and bacteria they were infected with can become reactivated. For example, researchers have found remnants of the 1918 Spanish flu, as well as the smallpox and bubonic plague viruses, in permafrost regions (Doucleff 2016). Many of these viruses are still capable of infecting humans. In 2016, a child died, and hundreds of people were hospitalized in Siberia after contracting anthrax from an infected reindeer carcass that had been frozen for 75 years and subsequently thawed and exposed. Scientists have also revived a 30,000-year-old virus that infects amoebas and have discovered microbes

dating back more than 400,000 years (D'Costa et al. 2011). It is also considered that some of these microorganisms could be resistant to our antibiotics. In addition to the potential for infectious outbreaks caused by the thawed materials, the unbearable stench of decay, which spreads over vast areas, combined with the exploding mosquito population due to increased water levels, has reached a scale that could hinder new settlements in the region.

The underlying cause of the current infrastructural challenges in the permafrost regions of the Russian Federation can be traced back to the crises in the final years of the Soviet Union. During the 1980s and 1990s -when the most intense period of climatic changes in Siberia occurred- the Russian economic and trade system collapsed, and large-scale infrastructure investments transitioned from state ownership to private ownership. During this crisis, long-term strategies accounting for climate change and the changes it would bring to the permafrost layer were not considered in the infrastructure built on permafrost. At the time, engineers and technicians specializing in permafrost did not view climate as a factor that would lead to permanent changes in the permafrost, and they did not incorporate radical climate shifts into their calculations, instead relying on traditional methodologies. Even today, all existing regulations concerning the construction and operation

of buildings and facilities in permafrost areas fail to account for any climate changes, and the legal framework related to this issue remains outdated (Anisimov et al. 2010). For all these reasons, the Russian Federation is experiencing significant crises regarding infrastructure in the permafrost regions of Siberia.

Compared to other Arctic countries, the Russian Federation has the most extensive infrastructure facilities in the Arctic region and on permafrost. The value of Russia's buildings and infrastructure constructed on permafrost is estimated to be around $300 billion. It is projected that the cost of mitigating the damage caused by the thawing permafrost could exceed $100 billion by 2050 (Streletskiy et al. 2019a). According to another study, the destabilization of the ground is expected to cause approximately 58 billion euros in damage by 2050. This figure is equivalent to roughly 25% of the total federal budget of Russia (Atla Staalesen 2021).The dramatically changing freeze-thaw cycles in the permafrost are eroding urban infrastructure in cities within the permafrost region, while also posing an increasing risk to Russia's 200,000 kilometers of oil and gas pipelines, as well as thousands of kilometers of highways and railways. Approximately 93% of Russia's natural gas and 75% of its oil -accounting for 70% of the country's annual exports- are extracted from the Arctic regions (Anisimov

et al. 2010). Proven oil reserves and gas deposits in Russia constitute 5.3% and 21.7% of the world's resources, respectively. Nearly all of the discovered gas deposits and 90% of the discovered oil deposits are located in the Russian part of the Arctic regions (Lindholt 2006). By 2050, one-third of Arctic infrastructure and 45% of hydrocarbon facilities in the Russian Arctic region will be located in areas affected by ground instability due to permafrost thaw (Hjort et al. 2018). From 1990 to 1999, the number of buildings damaged due to permafrost thaw increased by 42% in Norilsk, 61% in Yakutsk, and 90% in Amderma compared to the previous decade. In Yakutsk, more than 300 buildings have been reported as damaged since the early 1970s (Anisimov and Belolutskaya 2002). In 2020, the spill of 21,000 tons of diesel fuel on the Taymyr Peninsula was known to have been caused by the degradation of the ground beneath a large oil storage tank (Atla Staalesen 2021).The infrastructure problems caused by permafrost thaw in the Russian Federation not only affect the country but also pose dangerous consequences for global energy security and the hydrocarbon industry, as Russia is the world's second-largest exporter of gas and oil. Many pipelines, such as the Eastern Siberia-Pacific Ocean (ESPO) oil pipeline and the gas pipelines originating from the Yamal-Nenets region (northwestern Siberia), are significantly at risk. The Yamal-Nenets pipeline

transports most of the gas that the European Union imports from Russia, supplying 40% of the EU's total gas imports in 2019 (Sophie Briquetti 2021), while the ESPO pipeline contributes to diversifying Russia's oil export routes (Yagova 2019) amid rising tensions with the West and ensures the flow of oil to the Asia-Pacific markets, particularly to China, Japan, and South Korea (Sophie Briquetti 2021)

Map 3: Arctic Pipeline Routes in Russia

Source: "Russia Struggles to Secure Pipeline Deal with China" 2024

Currently, approximately 35,000 incidents occur annually on major oil and gas pipelines in Western Siberia (Streletskiy et al. 2019b), with 21% of these incidents linked to stability loss and the deformation of foundations, which result from damage causing deformation and malfunctions in infrastructure facilities

and structures (Katarina Kertysova and Akash Ramnath 2021b). By 2050, 20% of commercial and industrial buildings valued at $84.4 billion, 19% of critical infrastructure, and 54% of residential buildings -amounting to a total cost of $20.7 billion- will be adversely affected by permafrost thaw in the Russian Federation (Maria Polovtseva 2020) (Instanes and Anisimov 2008). In addition to hydrocarbons, the thawing of permafrost endangers Moscow's new mining projects and turns abandoned mines, whose waste is trapped in the frozen ground, into both economic and social liabilities (Katarina Kertysova and Akash Ramnath 2021b).

Permafrost thaw also creates significant problems for transportation infrastructure and logistics. The weak transportation networks in Siberia often result in disconnected areas, even in geographically proximate regions. Although bridges are scarce, frozen rivers in winter typically facilitate transportation. However, due to global warming, many rivers did not freeze in 2017, leading to major disruptions in transportation and food supply in many settlements. As a result, Russian law enforcement and military forces had to intervene in critical areas. Yakutia, where permafrost is deepest, is a particularly notable example in this regard. According to various sources, Yakutia alone produces 89-99% of Russia's diamonds, 80% of its tin, 24-50% of its gold, 100% of its antimony, 33% of

its silver, and is also a significant producer of coal, natural gas, and uranium ("The Present State of the Russian Far East and Its Future Direction," n.d.) ("Republic of Sakha (Yakutia)," n.d.). Despite these vast natural resources, analyses show that between 2003 and 2019, Yakutia remained trapped in poverty, classified as absolute poverty (Gavrilyeva, Naberezhnaya, and Nikiforov 2022). The industrial growth resulting from the comprehensive development of natural resources has yet to positively impact the welfare of the Yakut people. While there are many factors contributing to this issue, one of the main challenges is the high cost of distribution and transportation. The region's weak and poorly maintained road infrastructure is a major impediment, and Yakutia's underdeveloped transportation infrastructure, with only 11,900 kilometers of paved roads (Alexey Naumov et al. 2020), is one of the greatest obstacles to food security and agricultural development. Additionally, roads and transportation facilities -whether asphalt, railways, or others- are deteriorating each day due to permafrost degradation.

The region's food supply also faces transportation-related challenges. Farmers, for example, struggle to move food products to main cities because there is still no bridge over the Lena River, one of the largest waterways in the region. Producers are forced to use ferries in the summer and the so-called "winter road" routes across the river ice in the cold season. This results in additional costs and delays for perishable

food products. Food prices in permafrost regions are very high, and due to the difficulty of logistics, residents cannot sufficiently access six out of the ten essential food groups (Dudarev et al. 2013).

4. Emerging Security Risks and China in the Russian Far East

Permafrost degradation is harmful not only to highways and railways built over frozen ground but also to airports, river and ocean port facilities, and military installations constructed on permafrost. According to Russia's Minister of Environment, Alexander Kozlov, more than 40% of infrastructure facilities and buildings have already sustained damage (Atla Staalesen 2021). The risk to military facilities represents a serious threat because damage to these installations could weaken Russia's ability to protect its northern borders and ensure national security, which also puts the security of the Northern Sea Route and the environmental defense of the Arctic zone -critical for Russia's national security -at risk (Mathie Boulegue 2024). It is assessed that the military installations stretching across the Russian Arctic region have not been properly adapted to the changing climatic conditions (Katarina Kertysova and Akash Ramnath 2021b).

The Russian Federation has yet to fully develop its climate policies at both the federal and regional levels. This does not indicate that the country or political decision-makers are

unaware of the situation's seriousness or are lacking in foresight. The fundamental issue lies in the struggles facing the Russian economy and budget. Implementing proactive planning, infrastructure modernization, and the socio-economic transformations necessary to address the negative effects of permafrost thaw requires long-term investments, which are unattainable due to the chronically insufficient budgets of regional governments. Administrative units, from republics to cities, are burdened with debt, and in some regions, there is effectively a state of bankruptcy (Heather A. Conley and Cyrus Newlin 2021).

The region's lack of attractiveness was a significant issue even before the onset of permafrost thaw due to climate change, and the situation has since worsened. One of the proposed solutions to the demographic, social, and economic problems in the region is the population expansion of Siberia. This would, in turn, increase economic investments in the resource-rich area, allowing the region to become self-sufficient as currently not a single city in Siberia is economically self-sufficient (Clifford G. Gaddy and Fiona Hill 2003). Such development could help balance the negative effects, including those brought on by climate change. Due to a 25% decline in the overall population of Siberian provinces since 1991, Vladimir Putin declared in 2013 that the reconstruction of Russia's East would be a "national priority for the entire 21st century" (Lustgarten 2020).

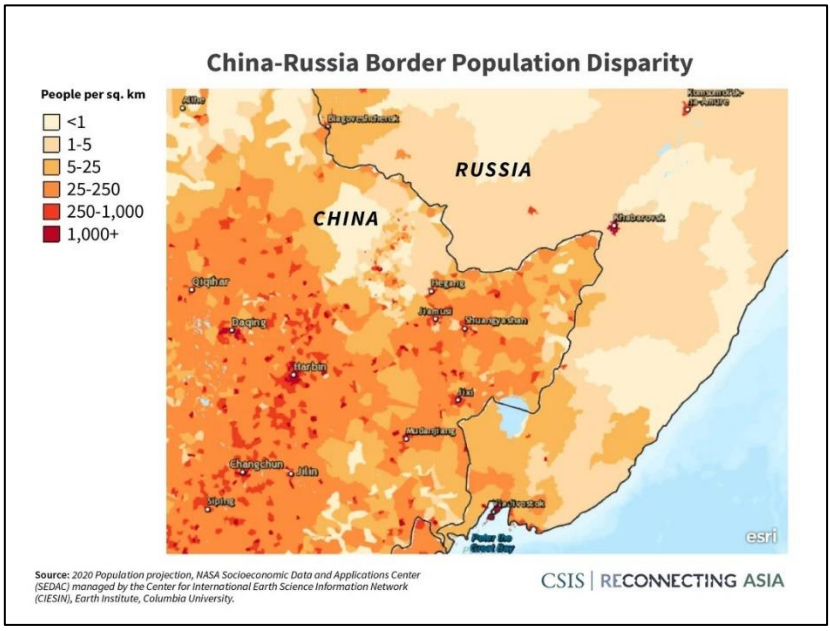
A plan is currently in place that grants Russians who wish to relocate to areas with high concentrations of permafrost-covered land the right to purchase property with a 2% interest rate. Individuals who move to these regions can also apply for agricultural land, which they can use free of charge, and receive free education in both university and trade-related fields (Lustgarten 2020). However, it is difficult to describe this plan as successful at the moment. One of the first challenges faced by new residents is access to water, which is the most basic human necessity. Inadequate internet access, poor flight and road connections, and limited employment opportunities not only discourage internal migration into the region but also push existing residents toward cities. Additionally, climate change hinders long-term individual investments in the area. The marginalization of "climate refugees" relocating from permafrost rural areas to cities introduces further social problems within Russian society (Anton Troianovski and Chris Mooney 2019).

According to Anatoly Vishnevsky, Director of the Institute of Demography at the National Research University in Moscow, the main sources of a small but steadily increasing flow of foreign migration to the region are China, North Korea, Japan, the Caucasus, Central Asia, India, Türkiye, and Afghanistan (Lustgarten 2020). For the two billion people in South Asia, where the impacts of climate change are most severe, Russia is becoming a potential destination country. The length of Russia's

borders, the difficulty of enforcing strict border control, the availability of inexpensive land, and a societal life accustomed to multiculturalism make the Russian Federation an increasingly attractive destination in the long term, as climate warming intensifies and resources become scarcer in their home countries.

The diverse demographic composition of South Asia, encompassing various ethnic groups, does not pose a significant threat to the Russian Federation, at least not in the near future. On the contrary, China -with which Russia shares a 4,300 kilometer border-has been not only a military but also a demographic concern since the conquest of the Far East. The long-standing fear in Russia has been that China's population policies could fill the sparsely populated Russian territories in the Far East with Chinese immigrants, a strategy that has threatened Russia for many years. Today, many areas that were part of the Chinese Empire just 200 years ago are under Russian control. Even as recently as the 1970s, there were Sino-Soviet border clashes, and the presence of 140 million Chinese living just across the border, compared to only 5 million Russians in the nearby Russian borderlands, has kept the perception of a Chinese invasion threat alive in the Russian public consciousness.

Map 4: China-Russian Border Population Disparity



Source: Hillman 2020

Currently, the presence of nearly 2 million Chinese living in Russia's Far East (though these figures are far from official) is sufficiently concerning. The Chinese create space for themselves in the region, sometimes by marrying Russian citizens—thereby becoming eligible for various state benefits, including those provided for residents of permafrost areas—other times by renting land or working in various local jobs. Considering China's policy of using its citizens to promote demographic shifts in other countries, it is entirely understandable that Russia closely monitors this issue. Sergei Karaganov, founder of the Council on Foreign and Defense Policy of Russia and an advisor to Russian presidents, including

Putin, stated that “Russia is not eager to bring more Chinese into the country” (Lustgarten 2020). While the issue of low population density of Russia in these regions cannot be resolved through internal migration, the preference is for settlements from Central Asia and the Caucasus, which share much more common culture and historical ties with Russia, rather than from the Chinese.

As a result of China’s aggressive policies, Chinese companies have been leasing large amounts of land and purchasing property in Russia to direct towards agriculture, with crops such as soybeans, wheat, and corn being produced on these lands and exported to China. Chinese investment (including from state-owned enterprises) funds 14% of the newly developed farms in the region, making China one of the largest landowners in the eastern part of the Russian Federation (Lustgarten 2020). Consequently, it is foreseeable that the number of Chinese workers in this region will increase, and the region will grow increasingly dependent on China due to closer transportation ties and other logistical benefits. Local farmers and investors are finding it increasingly difficult to compete with this influx of Chinese investment.

For instance, in agricultural areas that have turned into swamps due to permafrost thaw, the equipment required for storage and processing is a challenging investment for local producers, who also face difficulty in securing loans (Alexey

Naumov et al. 2020). In contrast, China is rapidly able to provide credit to its citizens and companies, giving them a competitive edge. Additionally, due to issues in the food supply chain, weaknesses in retail distribution channels, and transport infrastructure challenges, imported food products from China can often be cheaper than locally produced goods in permafrost regions.

The socio-economic repercussions of China's influence on the regional economy are evident even at the micro level. As the permafrost thaws, the remains of mammoths, whose bodies have been preserved due to the cold, are being uncovered, creating a large market driven by high demand for mammoth tusks from China. For instance, in Yakutia, people collected at least 80 tons of mammoth tusks in 2017 alone, with annual sales reaching as much as $63 million. The near-industrial-scale harvesting of mammoth tusks has pushed local youth towards organized crime, contradicting the ancient beliefs of the local population, who consider ivory hunting on sacred land forbidden and believe it brings bad omens (Anton Troianovski and Chris Mooney 2019).

As evident, the damage caused by melting permafrost due to climate change is significant. However, there are areas where the Russian Federation could potentially turn this situation to its advantage through appropriate policies and long-term planning. Moscow, despite occasionally adopting different narratives

depending on its political agenda, has often emphasized the "positive" aspects of global warming rather than focusing on its negative impacts. The most frequently highlighted benefit is the melting of Arctic Sea ice, which opens the Northern Sea Route (NSR) to maritime transportation, thereby increasing strategic, economic, and commercial benefits while providing access to new hydrocarbon regions.

5. The Northern Sea Route: A Strategic Opportunity

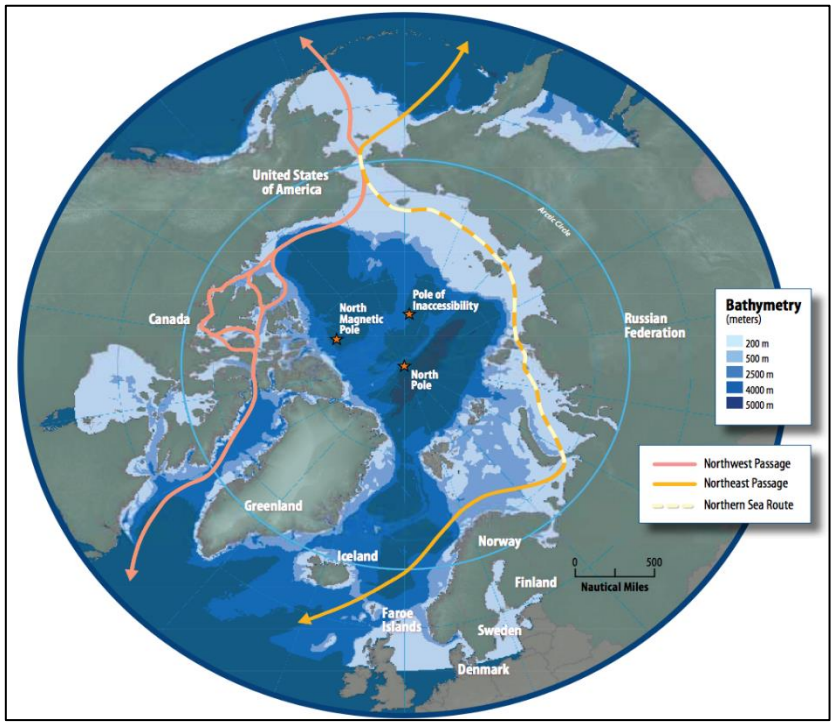
Western geostrategists from Mahan to Mackinder to Spykman and Brzezinski saw the frozen rivers and seas of Arctic as important factors to contain Russia (Antrim 2010). Placing Russian flag on the ocean floor at the North Pole in 2007 during the "Arktika" expedition (Shamil Midkhatovich Yenikeyeff and Timothy Fenton Krysiek 2007) was a symbolical move to show Russian interest and claims on the Arctic, a clear sign of the will to break the containment from the Arctic. Russian President Vladimir Putin in 2023 said that "Whether this is good or bad, it is happening - the Northern Sea Route is opening up" (Alexander Whiteman 2024) and though there are still some decades for Russia to shift to an Arctic coastal state and succeed to escape from the geographical limitations for Russia to be a sea power, an aspiration that haunts the Russian rulers since Peter the Great. Especially after Finland's membership to NATO, the access to St. Petersburg and Kaliningrad are under NATO limitation. Turkish straits are

also protected within NATO's collective defense umbrella. Moreover Russia's Black Sea Fleet is limited by Montreux Convention Regarding the Regime of the Straits and to gain access to the oceans there lies Strait of Gibraltar and Suez Canal. Vladivostok Port in the Far East is mostly open to maritime traffic all year around but its location, which is far from the Russia's economic, military and political heartlands limits the Russia's seapower, while far eastern ports are challenged by Japanese and Chinese growing military and maritime power.

NSR was first opened by Soviet Union in the 1930's but it was not reliable due to ice coverage and heavy demand on icebreakers. After a century, experts are predicting that the NSR will be ready to be used at full capacity by about 2030 (Abay 2021) and Russia will be able to have a continuous and all-Russian coastline with the NSR. Not surprisingly, the official Russian document "Strategy to 2030" established objectives of strengthening the NSR and the river network that links the route to the interior (Antrim 2010). The four main national interests of Russian Federation on arctic, which are economics, transportation, security and development, can be easily incorporated with the NSR and Siberian rivers that is expected to allow linking the mainland with global trade routes. The raw sources of Russia's far east can be transported without any intervention of a NATO countries to the Arctic ports and allow a greater income to develop regional economy while keeping the

military balance heavily weighted towards Russia since it has more bases than any other Arctic countries, outnumbering all NATO states for icebreaker fleet and modernizing more than 50 Soviet bases providing them with strategic ports (“Melting Arctic to Open Up New Trade Routes and Geopolitical Flashpoints” 2023).

Map 5: Arctic Seaway Passages



Source: “Norway, Russia Dispute Arctic Shipping Route’s Development” 2019

In 2009, foreign vessels first successfully traversed the full length of the NSR (Nathan Witkop 2009). By 2 August 2021,

the route was navigable without encountering sea ice and remained open for a record 88 days (Kanishk Shetty 2023). With this route, navigating from China to Northern Europe is reduced by 7000 km. China, heavily reliant on the Suez Canal for importing essential energy resources and rare minerals, has also become a key participant in the development of the NSR. In 2023, China's strong demand for Russian crude oil drove record levels of transit cargo along the NSR. Over a dozen shipments transported 1.5 million tons of crude oil from the Baltic Sea to China via the Arctic. Overall, the route handled 2.1 million tons of transit cargo, surpassing its previous record set in 2021 (Malte Humpert n.d.).

Though the route has a great advantage about dramatically shortening the distance, the vessels that will navigate through the NSR need ice-strengthened hulls. They will be behind the icebreakers but need these hulls to be able to fend off small floating growlers and bergy-bits (Alexander Whiteman 2024). The route also does not have a predictable weather and conditions, while the 6 months of darkness may raise other concerns for vessels. Also, the route relies on the Russian search-and-rescue capability, political decisions, authority and must secure Russian's permission and pay transit fees, which may be challenging under the sanctions towards Russia due to Ukrainian war and possible future conflicts.

The Suez Canal, a critical maritime artery for global trade, is facing increased security challenges particularly due to the ongoing attacks in the Red Sea by Iran-backed Houthi rebels. Since October 2023, these attacks have significantly disrupted commercial shipping, leading to nearly a 60 percent reduction in traffic through the region (Liv Almer 2024). The cost of insurance for vessels transiting the Bab el-Mandeb Strait has skyrocketed, with rates increasing by as much as 100 times in response to the heightened risks, according to Audun Halvorsen, director of the emergency department for the Norwegian Shipowners' Association (Jack Detsch and Robbie Gramer 2024). This surge in costs reflects the growing dangers posed by the region's instability, with attacks, including naval mines placed by the Houthi rebels, making passage more perilous. The international coalition forces have worked to clear these mines, but the threat remains significant, leading to both the loss of ships and casualties among local fishermen.

In addition to the Red Sea, the Strait of Malacca remains a critical chokepoint for East-Asian countries, with nearly 25 percent of global trade and 33 percent of the world's oil passing through it (Kanishk Shetty 2023). Any blockage in this narrow passage poses a direct threat to global trade, particularly for energy supplies to China and Japan. The vulnerability of these key maritime routes underscores the need for alternative pathways that can bypass these risks, reduce travel time, and ensure the continued flow of global commerce.

Amid these economic challenges, Russia is also presented with strategic opportunities through advancements like the NSR offering alternatives to traditional trade routes. The NSR has the potential to significantly reduce the distance and time of travel between Europe and Asia, providing an increasingly viable option for global shipping. With the ongoing volatility in the Suez Canal route and the security concerns surrounding the Bab el-Mandeb Strait and the Strait of Malacca, the NSR offers a strategic advantage by avoiding the congested and risk-laden chokepoints of traditional maritime routes.

While the NSR's viability has historically been hindered by ice and harsh weather conditions, recent advancements in Arctic navigation technology, coupled with the effects of climate change, have made this route more accessible during the summer months. Moreover, as tensions in the Middle East and Southeast Asia continue to destabilize key shipping lanes, the NSR presents an attractive alternative for countries looking to diversify their trade routes and mitigate the risks of disruption. In addition to its strategic importance, the NSR offers a more direct path, saving both time and fuel compared to the traditional Suez Canal route, and with growing investments in infrastructure and icebreaker support, its potential as a commercial artery is expected to expand.

While the agricultural opportunities in the Arctic regions present economic potential, they are intertwined with

geopolitical concerns and social challenges that shape Russia's Arctic strategy. The geopolitical implications of the Northern Sea Route are significant, as it provides Russia with a unique opportunity to exert greater control over global trade flows, positioning itself as a key player in facilitating an alternative to the Suez Canal. As global trade continues to evolve, the Northern Sea Route could become an increasingly important and reliable alternative, offering a safer and more efficient passage for commercial vessels seeking to bypass the heightened risks of traditional shipping lanes.

6. Opportunities for Resource Extraction

While the NSR enhances trade routes and connectivity, the melting permafrost and rising temperatures are simultaneously unlocking access to vast natural resource reserves, promising economic opportunities. The second advantage of Arctic warming is the increased accessibility to natural resources resulting from the thawing permafrost on the Russian mainland and the melting of the Arctic's thick ice layer. These changes, combined with rising temperatures, are transforming the region into a viable frontier for resource extraction. Historically, most Arctic oil and gas operations have been confined to onshore locations. However, with projections indicating the disappearance of summer sea ice by as early as 2035, the region's maritime accessibility is expected to improve dramatically, unlocking opportunities for offshore fossil fuel

extraction and mineral mining (Renee Cho 2022). The Arctic is a repository of abundant untapped resources. According to a 2008 United States Geological Survey (USGS) estimate, the region's seabed holds approximately 13% of the world's undiscovered oil, 30% of undiscovered natural gas, and 20% of undiscovered natural gas liquids (Gautier et al. 2009). Among Russia's promising offshore discoveries, the Medyskoe and Varandeyskoe Sea deposits stand out, with annual production estimates of 3.9 million tonnes and 5.5 million tonnes of oil, respectively (V. Bogoyavlensky, I. Botoyavlensky, and T. Budagova 2013). Beyond hydrocarbons, onshore reserves of oil, natural gas, and an estimated $1 trillion worth of precious metals and minerals are also becoming increasingly accessible as permafrost thaws ("Changes in the Arctic: Background and Issues for Congress" 2024).

However, while these opportunities are significant, they come with challenges. The global energy transition, driven by shifts toward renewable energy, could render some high-cost offshore projects economically unfeasible. Balancing the extraction of these resources with environmental concerns and evolving energy demands will be critical to leveraging the Arctic's full potential.

7. Rising Power in Global Food Politics

Beyond resource extraction, the thawing permafrost is also reshaping the agricultural landscape, offering new opportunities

to cultivate arable land previously deemed unfit for farming. Thirdly, the thawing of permafrost could increase the amount of land suitable for agriculture, providing a boost to the agricultural sector- a sector of critical importance globally in recent years - with additional momentum (Lo 2021). The Russian government has repeatedly announced its plans to utilize the benefits of climate change, particularly in the agricultural sector ("Pervogo Ètapa Adaptacii k Izmenenijam Klimata Na Period Do 2022 Goda" 2019). The development of agriculture and land use in Russia's northern regions has been a topic of discussion since the early days of the Soviet Union. One of the first planned examples of this can be found in the report titled *"The Problem of Northern Agriculture,"* presented by academic Nikolai Vavilov to the Soviet Academy of Sciences in the 1930s (Vavilov 1931). Until the collapse of the Soviet Union, publications continued into the 1980s that focused on strategies to develop agriculture in these regions. However, following the Union's dissolution, the issue fell off the agenda for many years (Alexey Naumov et al. 2020). In the 2000s, the topic regained popularity as scientific publications on agricultural opportunities in Siberia began to increase. Studies focused on cold regions, including permafrost territories, began to explore various economic aspects of agricultural systems, the sustainability of farming practices, and food security. Moreover, urban agriculture in Arctic regions emerged as a new topic of interest (A. Naumov and Sidorova 2018).

The renewed popularity of agriculture in cold regions is no coincidence; by 2080, an estimated 5.2 million square kilometers of land in Siberia could become arable due to permafrost thaw-a figure that surpasses the 3.6 million square kilometers currently under cultivation in the United States (Urban C. Lehner 2021). To put this in perspective, roughly 3.6 million square kilometers of land are currently used for agriculture in the United States ("Farms and Land in Farms: 2019 Summary" 2020). This makes it clear that the Russian Federation has the potential to emerge as a grain superpower.

Technological advancements also provide the Russian government with advantages in increasing crop diversity in new arable lands. New management practices, such as the use of genetically modified crops -including fast-maturing soybeans- and precision farming, offer farmers opportunities to plant and diversify in areas where options were once limited or where agriculture was previously impossible (Hannah et al. 2020). Russian scientists have also discovered that treating wheat grains with a solution loaded with permafrost bacteria increases winter yield by 30% and significantly reduces fungal diseases in first-generation crops (Domanskaya et al. 2021).

While climate change affects food security within the Russian Federation, the country's growing role as a global grain power means it could potentially leverage this influence as a weapon in international relations. The idea of using grain

products as part of a hybrid war strategy can be traced back to 2014, when sanctions were imposed on Russia by Europe and the United States following the downing of a Malaysian passenger plane over Ukraine. In response to these sanctions, Russia restricted imports from Europe. Although many experts at the time believed Russia was punishing itself, the move was aimed at providing local food producers with an investment opportunity and encouraging them to fill the supply gap. By 2018, following President Putin's declaration that Russia would soon become the "world's largest supplier" of healthy, predominantly non-GMO foods, Russia's wheat exports had doubled-rising to nearly 44 million tons from 2015 onwards, surpassing both the United States and Europe (Lustgarten 2020).

This marked a major strategic shift for the Russian Federation. While the country was an average net importer of 3 million tons of grain annually from 1996 to 2000, in 2019, it became a net exporter of 47 million tons (Liefert and Liefert 2020). Between 2000 and 2018, Russia's agricultural exports grew by approximately 16 times, and in recent years, it has emerged as the world's largest wheat exporter (Urban C. Lehner 2021). Although wheat accounts for only 2.3% of Russia's total exports, this small proportion represents a significant share of the global wheat export market. Moreover, Russia is projected to control 20% of the global wheat market by 2028, with an estimated 4.3 million square kilometers of land potentially being opened up for wheat production (Leah Emmanuel 2020). These

figures underscore the potential power of wheat as a weapon of hybrid warfare, and Russia's policies regarding wheat supply increasingly demonstrate that it is already using this leverage (Sherri Goodman and Clara Summers 2020).

Furthermore, considering that both Putin and his generation hold on to the Soviet-era mentality, where success was measured largely by quantitative metrics, it is clear that the current Russian elite is driven not only by economic motivations but also by state objectives aimed at branding Russia as an "energy superpower," "food superpower," and more. This "the more, the better" mindset suggests that aggressive growth in grain production is likely to continue in the coming years (Lo 2021).

At the Russia-Africa Economic Forum in Sochi last fall, President Putin stated, "We now export more agricultural products than weapons," highlighting that in the span of 30 years, Russia has transformed from a net grain importer into the world's largest wheat exporter. This shift is increasingly viewed as a threat by the West. Rod Schoonover, former Director of Environment and Natural Resources at the U.S. National Intelligence Council, and a former State Department analyst during the Obama and Trump administrations, declared Russia's agricultural dominance to be "an urgent national security issue" and a geopolitical threat. (Lustgarten 2020)

The introduction of millions of square kilometers of land suitable for wheat cultivation in permafrost regions would result in a greater supply of wheat in the global market (Arvin Donley 2020). However, this is contingent on the assumption that the Russian Federation remains a consistent grain exporter. Russia has demonstrated on several occasions that it is not a stable producer in this regard. Russian foreign policy prioritizes not fighting global hunger or strengthening economic ties but rather maximizing national interests by using food as a weapon and imposing their policies. Furthermore, as other countries increasingly rely on importing from Russia, they may find themselves vulnerable if the Russian Federation fails in its strategies for the permafrost regions, suffers negative impacts from climate conditions, or restricts exports due to political reasons. For example, in 2010, the Russian Federation's decision to restrict grain exports in response to a drought triggered a surge in global food prices that has been linked to the onset of the Arab Spring uprisings. During the period of greatest disruption to global trade caused by COVID-19, the Russian government displayed similarly unpredictable behavior. In particular, the Egyptian government exerted all its diplomatic power to secure supplies of Russian wheat, fearing the risk of food shortages (Devitt 2020). When Russia's export quotas were exhausted, and the Russian government indicated at various points that it would suspend grain exports (Rennison 2022),

global grain access was severely compromised, resulting in significant price fluctuations.

The countries most affected by these crises -Türkiye, Egypt, and Bangladesh- are Russia's largest grain importers, increasing Russia's influence over these three strategically critical nations, and by extension, over the Middle East and the Indian subcontinent. As a global hunger crisis looms due to insufficient grain supply, the ongoing war between two of the world's largest grain producers, Russia and Ukraine, has jeopardized not only grain prices but also access to grain itself. Although negotiations over millions of tons of grain trapped in Black Sea ports provided some relief through a deal that lowered prices and ensured grain accessibility, this relief is temporary, and it remains uncertain how long the grain corridor will remain open.

The volatility of grain prices and the availability of wheat on the international market have increasingly allowed the Russian Federation to exploit this crisis amid an ever more unstable global food market. Whether framed as a response to Russia's own food security and local climatic conditions, or as an extension of its hybrid warfare strategy, the Russian government's actions herald a significant disruption in food supply chains connected to global warming. Looking at possible scenarios, a decline in wheat prices may bring relief to import-dependent countries but could also lead to a reduction in global

wheat cultivation as farmers abandon crop production. In such a scenario, state-supported projects that continue growing wheat in permafrost lands -where limited crops other than wheat can be cultivated- would enable the Russian government to maintain a strong position, even in a low-price environment.

International organizations have repeatedly warned that shifting trade patterns following the war in Ukraine could keep commodity prices, such as wheat, higher than usual. In a scenario where wheat prices remain elevated, the Russian government stands to maximize its profits. Furthermore, if the war in Ukraine continues, Russia could potentially continue to disrupt wheat planting in Ukrainian fields, thus keeping prices elevated. Ukraine's wheat exports, which stood at 18.8 million tons annually, are expected to drop to 10 million tons next year (Rennison 2022).

Another advantage the Russian Federation holds with the opening of grain lands in the permafrost region is its influence over oil, natural gas, and fertilizer prices. Oil prices determine the cost of operating farm equipment and transporting harvested grain, while the cost of nitrogen, which is used in the production of fertilizers such as ammonia and urea, is directly linked to natural gas prices. As the world's largest fertilizer producer ("Fertilizers in Russia" 2024), Russia not only raises fuel prices but also drives up the cost of nitrogen-based fertilizers by consistently limiting the flow of natural gas to Europe. The

increase in fertilizer prices, in turn, pushes up wheat prices. Key factors in the grain crisis -production costs, transportation costs, natural gas and oil prices, and fertilizer costs- are all directly subject to the influence of the Russian Federation, granting it a significant political advantage.

Regarding transportation, the Russian Federation has the opportunity to compensate for the weak transport networks in the permafrost region by utilizing the melting Arctic Sea. The opening of waterways due to Arctic ice melt led to a 25% increase in transport profitability between 2013 and 2019 (Renee Cho 2022). With new shipping routes opening due to the melting ice in the Arctic, travel time between Asia and Europe could be significantly reduced. Arctic routes are 30% to 50% shorter than those via the Suez Canal and Panama Canal, cutting travel time by 14 to 20 days. Moreover, these shorter routes allow ships to reduce greenhouse gas emissions by 24%, while also saving on fuel and wear-and-tear on the vessels (“Arctic Thaw Will Open Cheaper, Greener Shipping Routes” 2023). As a result, grain produced in Siberia will be able to reach global markets much faster and at lower cost.

Conclusion: Turning Challenges into Opportunities

The interwoven challenges of climate-driven migration, infrastructure degradation, and environmental risks are reshaping the Arctic’s geopolitical and social dynamics, necessitating strategic responses from Russia. Permafrost thaw,

while presenting formidable challenges, also offers opportunities for adaptation and growth. Historically, Russians, particularly Siberians, have shown remarkable resilience, adapting to the turbulent transitions of the late Tsarist era, Soviet collectivization, and post-Soviet economic collapse. This adaptability remains a vital asset as communities explore innovative practices, such as utilizing earlier potato harvests, marketing fish oils, and experimenting with new crops like wheat and watermelons.

Thawing permafrost also enables resource extraction, offering access to valuable minerals and rare metals that could boost the Russian economy while reducing dependence on foreign sources. Such opportunities align with the global shift toward clean energy, presenting Russia with a chance to capitalize on its mineral wealth responsibly

However, Russia's climate strategy must contend with deteriorating relations with Western countries. A segment of the political elite perceives international climate policies as tools to undermine Russia's competitive edge in hydrocarbon sectors. (Tynkkynen 2010). This perception reinforces the belief that European efforts to reduce carbon emissions and transition to renewable energy are strategically designed to undermine Russia's dominance in the hydrocarbon sector. However, the Russian Federation views international climate agreements, despite their obligations, as opportunities to maneuver for

political and economic advantages. (“Russia Believes Carbon Tax Will Contravene WTO Rules - Minister” 2020). Moscow took two years to ratify the UNFCCC, seven years for the Kyoto Protocol, and four years for the Paris Agreement. In each case, Russia’s commitments under these agreements were relatively limited. Delaying ratification has become a standard practice for Russia, using these treaties as leverage in negotiations.

Despite the worsening Russia-West relations, especially after the war in Ukraine, the negative impacts of permafrost thaw serve as a common concern for all Arctic states. The Arctic Council, an essential intergovernmental body for the region, offers a key platform where the issue of permafrost melt is addressed through cooperation (Katarina Kertysova and Akash Ramnath 2021a).

These infrastructure and food security challenges highlight another dimension of permafrost thaw’s social impact: climate migration. This has the potential to reshape Russia’s demographics and labor patterns. Although China is strategically considered a threat due to its desire to increase its influence in Russia’s border regions and Siberia, it could also potentially serve as a partner in developing and growing the region’s economy in certain areas. In addition to wheat, China is an ideal target country for soybean exports. In the short term, this will not create economic competition with large-scale producers like the United States or Brazil. Currently, issues

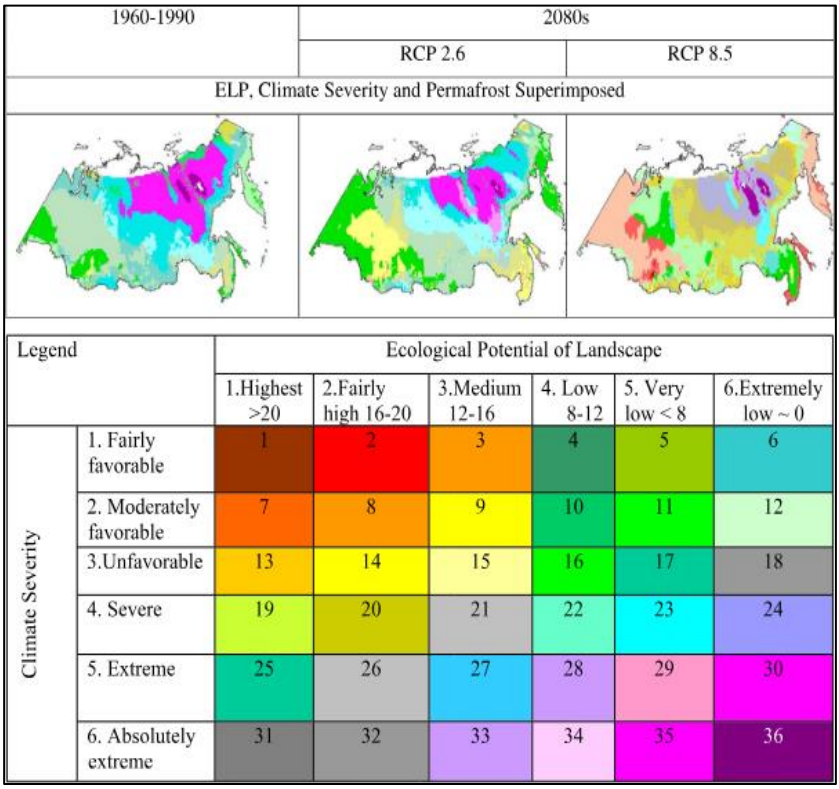
related to soybean quality and logistical challenges prevent Russia from capturing more than a small share of the Chinese market. However, as warming trends continue and more arable land becomes available in Siberia, the Russian Federation could become an attractive supplier for China, ultimately shifting the balance in the agriculture and logistics sectors over time (Arvin Donley 2020).

In 2015, Chinese President Xi Jinping agreed to create a $2 billion agricultural fund to foster trade partnerships in these regions. China's investments can fill the gaps left by Russia's budget limitations, demographic challenges, and lack of technology needed to achieve profitability. This support could help make the region more attractive and, over time, transform it into a self-sustaining industrial hub. This is especially important given the sanctions imposed after Crimea's annexation and the ongoing war in Ukraine. Chinese investments could not only benefit the region but also contribute to Russia's budget through taxation.

Permafrost thaw could make the government's priority of increasing the population density in Siberia and the Far East more achievable. The emergence of millions of acres of arable land presents an opportunity for a new agricultural economy, but it also highlights the challenge of cultivating a domestic workforce to support Russia's economic growth. Given that the Russian Federation has historically classified nearly all

permafrost regions as “absolutely extreme” areas for living, it is expected that this classification may soon shift to “fairly favorable” (Parfenova, Tchebakova, and Soja 2019). One of the coldest and most ecologically, socially, and economically challenging regions on the planet is rapidly becoming a much more livable area. The expansion of arable land in such economically marginal regions could help reduce threats to national food security, control poverty rates, and simultaneously bolster Russia’s position in international food supply, particularly in using grain as a tool of global politics.

Figure 1: Ecological Landscape Potential, Climate Severity and Permafrost Superimposed in 1960-1990 and 2080s



Source: Parfenova, Tchebakova, and Soja 2019

Even if the push to encourage domestic population movement to Siberia is unsuccessful, an alternative workforce for these agricultural lands might unexpectedly enter the Russian Federation. The World Bank has reported that food security in South Asia, home to nearly one-quarter of the global population, will soon hit a critical low. An estimated 8.5 million people from the region have already fled to settle in other

countries, with projections suggesting that another 17 to 36 million people could follow suit (Times and Lustgarten 2020).

Just as drought-affected people in Central American countries are moving toward the U.S. border, and individuals impacted by drought-fueled civil wars in the Horn of Africa and the Middle East are heading for Europe, there is the potential for people from areas like the Mekong Delta, which faces submersion, to migrate toward the Russian Federation. Historically, settlers on today's Russian territory, such as the Khakas, also migrated to their present regions due to desertification in their previous lands (Parfenova, Tchebakova, and Soja 2019). The Russian state has the potential to develop an accommodation strategy for this inevitable climate-driven migration and turn it to its advantage.

With the right guidance and policies promoting agricultural development, climate refugees could be resettled in newly arable permafrost regions, bringing their experience in intensive farming from their home countries. Furthermore, as state policies encourage agricultural expansion, climate migrants could sustain their livelihoods by working on agricultural lands leased by China and South Korea.

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