

GREENLAND – GAINLAND – GLOBAL ECONOMIC POWER

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Abstract

Greenland has moved from the periphery of global affairs to a position of growing strategic, economic, and environmental significance. Accelerating climate change, measurable ice-sheet melt, expanding access to Arctic shipping routes, and the presence of critical mineral resources have collectively reshaped Greenland's relevance in global policy debates. This paper provides a quantitative and policy-oriented assessment of Greenland's emerging importance. Using secondary data from climate assessments, satellite observations, trade-route simulations, and resource demand projections, the study evaluates Greenland's contribution to global sea-level rise, potential efficiency gains from Arctic shipping routes, and the strategic value of its mineral resources in the context of the global energy transition. The analysis further examines the geopolitical and governance implications of these quantifiable trends. The findings indicate that Greenland's importance is not speculative but grounded in measurable environmental and economic indicators. The paper concludes by outlining policy priorities for sustainable development, climate governance, and international cooperation in the Arctic region.

Keywords: Greenland, Climate Change, Sea-Level Rise, Arctic Shipping Routes, Critical Minerals, Energy Transition, Arctic Geopolitics, Sustainable Development.

INTRODUCTION

For much of modern history, Greenland was perceived as a geographically remote and economically marginal Arctic territory. Its sparse population, extreme climate, and limited infrastructure placed it outside the core concerns of the global political economy. However, developments over the last two decades have fundamentally altered this

perception. Climate change has accelerated environmental transformations in the Arctic, while technological progress has reduced physical and economic barriers to accessing the region. As a result, Greenland has emerged as a focal point for discussions on climate risk, resource security, and geopolitical competition.

The Arctic is warming at a rate significantly faster than the global average, a phenomenon known as Arctic amplification. Greenland's ice sheet, which contains one of the largest stores of freshwater on the planet, has experienced sustained mass loss since the early 2000s. This melting has direct and quantifiable implications for global sea levels and climate systems. Rising sea levels threaten coastal cities, infrastructure, and ecosystems worldwide, making Greenland's environmental trajectory a matter of global concern.

At the same time, Greenland's resource base has attracted growing attention. Deposits of rare earth elements, graphite, nickel, and other critical minerals are increasingly important for renewable energy technologies, electric vehicles, and advanced manufacturing. As governments seek to diversify supply chains and reduce strategic dependencies, Greenland's mineral potential has gained policy relevance.

Geopolitically, Greenland's location between North America and Europe enhances its strategic value in the context of Arctic navigation and security. The gradual opening of Arctic shipping routes offers measurable reductions in distance and transit time between major global markets. These developments have renewed interest from major powers and international institutions.



This paper adopts a quantitative and policy-focused approach to examine Greenland's growing importance. By integrating numerical data on climate change, trade routes, and resource economics, the study seeks to provide an evidence-based assessment suitable for academic and policy-oriented audiences.

Quantitative Assessment of Climate Change and Sea-Level Rise

Climate change is the most significant driver of Greenland’s rising global relevance. The Greenland ice sheet covers approximately 1.7 million square kilometers and plays a critical role in regulating global sea levels. Satellite gravimetry and surface mass balance studies provide robust quantitative evidence of accelerating ice loss over the past two decades.

Between 2000 and 2005, Greenland’s average annual ice loss was estimated at approximately 150 gigatons. This figure increased to around 230 gigatons per year during the 2006–2010 period and continued to rise to nearly 320 gigatons annually between 2016 and 2020. Recent estimates suggest that annual losses now exceed 350 gigatons. Each 360 gigatons of ice loss contributes roughly one millimeter to global mean sea level rise, underscoring Greenland’s substantial impact.

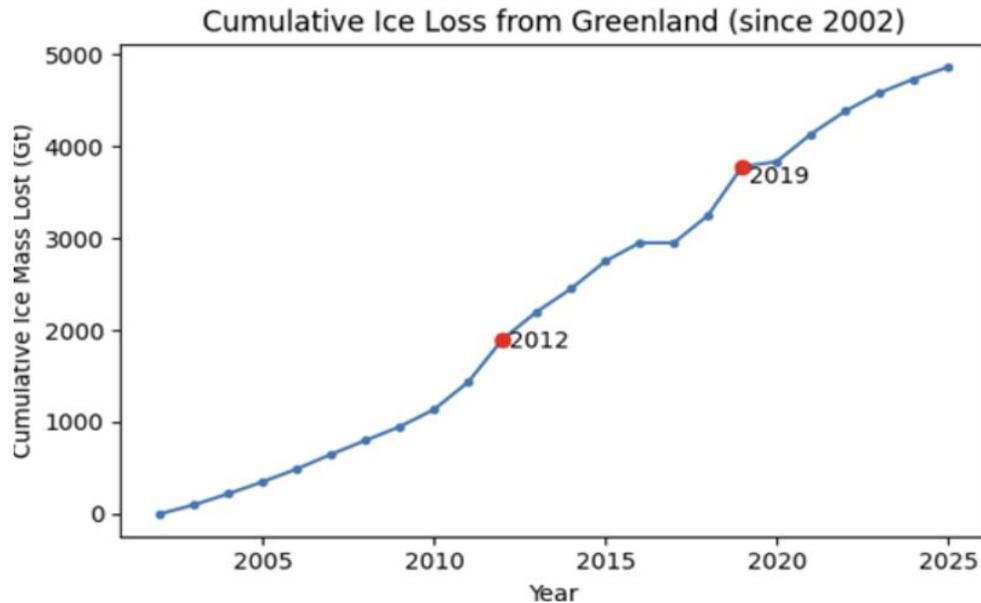
Climate change is no longer an abstract concept in Greenland—it is something that can be seen in the retreating ice and felt in the changing landscape. As the IPCC has emphasized, the Arctic is warming faster than any other region on the planet, and this dramatic transformation is one of the key reasons Greenland is moving to the center of global attention. (Intergovernmental Panel on Climate Change), Over the last four decades, the Arctic has been quietly but dramatically reshaped. Since the late 1970s, its summer sea ice has been shrinking at a pace of more than 12 percent each decade, and the thick, resilient multi-year ice that once defined the region has almost disappeared. What used to survive year after year has thinned and broken apart, leaving behind a younger, more fragile ice cover. Scientists now believe that within the next decade or two, the Arctic Ocean could experience its first summer with almost no ice at all. This rapid warming is not just an environmental shift. it is redefining Greenland’s place in the global landscape, bringing new challenges, new attention, and new strategic importance

Table 1: Greenland Ice Sheet Mass Loss and Contribution to Global Mean Sea Level Rise

Time Period	Average Annual Ice Loss (Gigatons/year)	Estimated Sea Level Rise (mm/year)	Source
2000–2005	150	0.42	IMBIE (2020); IPCC AR6
2006–2010	230	0.64	IMBIE (2020); IPCC AR6
2016–2020	320	0.89	IMBIE (2020); IPCC AR6
Post-2020 (Recent)	>350	>0.97	IPCC AR6; NASA GRACE-FO

Source: <https://science.nasa.gov/earth/explore/earth-indicators/arctic-sea-ice-minimum-extent/>

Exhibit 1: Greenland Ice Sheet Mass Loss and Sea Level Rise



Source: www.arctic.noaa.gov

Note. Sea level rise estimates are calculated using the approximation that 360 gigatons of ice mass loss corresponds to 1 mm of global mean sea level rise.

Quantitatively, Greenland’s melting ice is no longer a distant, frozen story — it is quietly reshaping coastlines and raising sea levels, connecting the fate of a remote Arctic landscape to the everyday lives of millions living near the world’s shores has increased from approximately 12 percent in the early 2000s to more than 30 percent in recent years.

This trend reflects both rising temperatures and feedback mechanisms such as albedo reduction and increased meltwater lubrication at the base of glaciers. Even under moderate climate mitigation scenarios, Greenland is expected to remain a major contributor in twenty-first century when it come to sea-level rise.

The melting of Greenland’s ice sheet does more than raise sea levels. As large volumes of freshwater pour into the North Atlantic, they dilute the saltiness of the ocean and interfere with the natural sinking of dense water that helps drive the Atlantic Meridional Overturning Circulation. If this circulation slows down, it could reshape climate systems, altering temperatures and rainfall patterns across Europe and North America.. While uncertainties remain regarding the magnitude of these effects, the quantitative evidence highlights Greenland’s central role in the global climate system.

From a policy perspective, these findings reinforce the importance of integrating Greenland-related climate risks into global adaptation and mitigation strategies. Coastal planning, climate finance, and international climate negotiations must account for the measurable contribution of Greenland’s ice-sheet dynamics to future sea-level scenarios.

Arctic Trade Routes and Quantitative Distance Savings

One of the most tangible economic implications of Arctic warming is the gradual opening of new maritime trade routes. The Northern Sea Route and the Northwest Passage are emerging as promising alternatives to the busy Suez and Panama Canal corridors. Because these Arctic pathways are considerably shorter, ships can cover the journey in fewer days, reducing both travel time and operating costs. This measurable saving in distance and time highlights their growing strategic and economic importance for global shipping.

For example, the traditional shipping distance between Shanghai and Rotterdam via the Suez Canal is approximately 20,000 kilometers. Using the Northern Sea Route reduces this distance to roughly 13,000 kilometers, representing a saving of about 35 percent. This translates into average transit time reductions of 10 to 12 days, depending on vessel speed and ice conditions.

Similarly, routes between Yokohama and Hamburg can be shortened by more than 7,000 kilometers, while shipments between Busan and New York may achieve distance reductions exceeding 30 percent via the Northwest Passage. These savings imply lower fuel consumption, reduced emissions per voyage, and potential cost efficiencies for shipping companies.

Shipping Routes

As the Arctic ice continues to melt, Greenland is no longer just a remote, frozen landmass it is emerging as a key player in the future of global trade. Newly opening polar sea lanes such as the Northern Sea Route, the Northwest Passage, and even a possible transpolar corridor are beginning to reshape traditional shipping patterns. These routes offer a much shorter connection between Asia and Europe, allowing ships to avoid the long journey through the Suez Canal. In practical terms, this could mean cutting travel time by nearly two weeks and reducing transportation costs dramatically. What was once an impassable, ice-locked ocean is gradually turning into a strategic maritime shortcut with major economic implications.

Table 2: Comparison of Major Eurasian Maritime Trade Routes: Distance and Accessibility

Route	Distance (nautical miles)	Location	Ice Conditions / Accessibility
Suez Canal Route	~11,000	Via the Suez Canal	Navigable throughout the year; extensively used
Northern Sea Route	~8,000	Across the Arctic region	Ice-free only for a limited period annually

Source: www.arctic.noaa.gov, NOAA- National Oceanic and Atmospheric Administration

However, these benefits must be weighed against operational risks, including variable ice conditions, limited search-and-rescue infrastructure, and environmental sensitivity. From a policy standpoint, quantitative evidence of trade efficiency gains strengthens the case

for international coordination on Arctic maritime governance, safety standards, and environmental protection. Greenland's geographic position enhances its potential role as a logistical, monitoring, and support hub within this evolving trade landscape.

Strategic Resources and Quantitative Economic Significance

Greenland's mineral endowment constitutes another key dimension of its growing importance. The island contains deposits of rare earth elements, graphite, nickel, zinc, and iron ore, many of which are classified as critical raw materials by advanced economies. Quantitative projections indicate strong growth in global demand for these minerals.

Demand for rare earth elements is expected to grow at annual rates of 5 to 7 percent through 2030, driven by renewable energy technologies and electric mobility. Greenland's potential contribution of 10 to 15 percent of future supply could play a meaningful role in diversifying global markets. Similarly, global demand for graphite, a key component of lithium-ion batteries, is projected to grow by 8 to 10 percent annually, with Greenland capable of supplying a notable share.

Nickel and copper are also central to the energy transition, particularly for battery production and electric infrastructure. While Greenland's share of global production would remain modest, its strategic importance lies in supply chain diversification rather than volume alone. From a policy perspective, access to diversified sources of critical minerals enhances resilience against supply disruptions and geopolitical risk.

Rare Earths and Critical Minerals- Untapped Wealth

Greenland has moved from the margins to the heart of global strategic debate, largely because of the immense natural wealth hidden beneath its ice. These largely untouched reserves of critical minerals have the potential to reshape how Western nations secure their energy and reduce their dependence on external suppliers.

Greenland possesses a diverse and strategically significant mineral resource base. Its deposits of rare earth elements and uranium are vital for the production of advanced electronics as well as for the generation of nuclear energy. In addition, the island hosts substantial reserves of base metals such as zinc and copper, which are essential for the development of modern electrical infrastructure and renewable energy systems. Recent European assessments emphasise that Greenland should no longer be viewed merely as a remote Arctic territory; rather, it is increasingly recognised as a key player in the global minerals sector. Studies indicate that approximately 25 out of the 34 raw materials identified as critical by the European Union are present in Greenland, underlining its growing importance for securing future strategic supply chains.

As climate change accelerates ice melt, regions that were once geologically inaccessible are slowly opening up, drawing the attention of major economic and political powers eager to secure long-term resource security. Among these resources, rare earth elements stand out. Greenland is estimated to hold around 1.5 million metric tons of rare earth reserves—more than several established mining nations such as Canada and South Africa. Yet,

despite this immense geological promise, the island has not moved into full-scale commercial rare earth production, underscoring the gap between resource potential and extractive reality.

Table 3: Global Rare Earth Reserves and Production - 2024

S. No.	Country	Reserves (Metric Tons)	Rare Earth Production 2024 (Metric Tons)
1	China	44,000,000	2,70,000
2	Brazil	21,000,000	20
3	India	6,900,000	2,900
4	Australia	5,700,000	13,000
5	Russia	3,800,000	2,500
6	Vietnam	3,500,000	300
7	United States	1,900,000	45,000
8	Greenland	1,500,000	0
9	Others	2,584,500	60,230
S. No.	World Total (rounded)	>90,000,000	3,90,000

Source: USGS Earth Explorer, As per latest data available

Strict environmental safeguards, limited infrastructure, and resistance from local communities have slowed the pace of development. Yet, as major economies grow increasingly concerned about securing reliable supply chains, Greenland’s strategic importance is becoming ever more difficult to overlook.

Table 3: Top Rare Earth Mines by Ore Grade

S. No.	Rare Earth Mine	Country Location	Ore Grade of Reserves (%)
1	Tomtor	Russia	14.50
2	Steenkampskraal	South Africa	8.68
3	Mount Weld	Australia	6.40
4	Mountain Pass	United States	5.96
5	Ngualla	Tanzania	4.80
6	Ozango	Angola	3.04
7	Kangankunde	Malawi	2.90
8	Nolans Bore	Australia	2.90
9	Bayan Obo	China	2.56
10	Wicheeda	Canada	2.43
11	Nechalacho	Canada	1.70
12	Kvanefjeld	Greenland	1.43
13	Songwe Hill	Malawi	1.16

Source: S&P Global, As per latest data available

The United States’ growing interest in Greenland is not about symbolism or territorial curiosity—it is about the materials that will shape the next half-century. Rare earth elements sit quietly inside almost every technology that defines modern life: the smartphone in your hand, the battery in an electric vehicle, the magnets in wind turbines, and the precision systems used in advanced defence equipment. They are the invisible foundation of the 21st-century economy.

At present, that foundation is heavily dependent on one country. China dominates the mining, processing and supply of rare earths, creating a level of strategic dependence that makes Western policymakers deeply uneasy. When a single supplier controls the flow of resources essential for energy transition, digital infrastructure and military capability, the issue stops being commercial and becomes geopolitical.

This is where Greenland enters the conversation. Beneath its ice lies a vast but largely untapped mineral potential. Extracting those resources is difficult, expensive and environmentally sensitive, yet the possibility of an alternative supply chain is too important to ignore. For the United States and its allies, Greenland represents more than a remote Arctic landmass it is a chance to reduce vulnerability and build resilience into the technologies that will define the future.

Across the world, governments are now thinking in similar terms. Securing access to critical minerals is no longer just an industrial policy; it is a long-term strategy for economic security, clean energy transition and national defense. In many ways, the race for rare earths today resembles the race for oil in the twentieth century: those who control the supply chains will help shape the global balance of power for decades to come.

Greenland today finds itself standing at a turning point, pulled in different directions by three powerful forces that are shaping its future all at once

The Arctic is no longer a distant, frozen frontier. It is fast becoming a space where economic ambition, geopolitical rivalry and environmental anxiety intersect. The retreat of ice is opening access to minerals, energy reserves and shorter shipping routes, creating opportunities to break long-standing resource monopolies and reshape global trade patterns. At the same time, major powers are competing to secure influence in the region, recognising that control over Arctic corridors and infrastructure will carry strategic weight in the decades ahead. Yet this transformation is deeply paradoxical: the same climate change that makes extraction possible is also rendering the ecosystem more fragile, raising the risk that development could cause irreversible damage.

At the heart of this shifting landscape lies Greenland. What was once viewed largely through the lens of Danish administration is now a territory with growing political confidence and a stronger sense of its own future. Its population of around 57,000 is increasingly vocal about the need to protect cultural identity, ensure environmental stewardship and expand self-governance. However, this aspiration for greater autonomy coexists with a structural economic dependence on Denmark. The annual block grant—amounting to roughly DKK 3.4–3.9 billion—still finances about half of public expenditure and accounts for close to one-fifth of GDP, underlining how central Danish support remains to welfare and public services.

Recent agreements, including Denmark's DKK 1.6 billion investment package for the period 2026–2029, aim to upgrade ports, healthcare systems and critical infrastructure while strengthening long-term social resilience. These initiatives highlight a complex reality: even as Greenland's strategic importance rises and its political voice strengthens, its economic transition toward self-sufficiency will be gradual.

What makes Greenland's position unique is that it is no longer merely an object of global competition; it is emerging as an actor in its own right. Decisions about mining, shipping corridors or military presence are not only questions of international strategy but also of local livelihoods, cultural continuity and ecological survival. For the people of Greenland, development is not simply about revenue—it is about defining the kind of society they want to build.

In this context, resource-driven growth cannot be pursued in isolation. Economic planning must be grounded in rigorous environmental impact assessments, transparent cost–benefit analysis and long-term sustainability indicators. Only by integrating economic opportunity with ecological limits and social priorities can policy choices avoid locking the island into short-term gains at the expense of long-term resilience.

Ultimately, Greenland's story is not just about a geopolitical prize in a warming Arctic. It is about a small society navigating between dependence and self-determination, between global demand for its resources and its own vision for the future.

Geopolitical And Governance Implications

Greenland's strategic location between North America and Europe amplifies its geopolitical relevance. Historically significant during the Cold War, the island has regained attention amid renewed great-power competition and Arctic militarization. Quantitative increases in Arctic shipping traffic and resource exploration underscore the material basis of this renewed interest.

NATO, the European Union, and Arctic governance institutions all have stakes in Greenland's future. Effective governance will require balancing security interests with environmental protection and indigenous rights.

Quantitative indicators, including defense investments, shipping volumes, and resource demand, suggest that Greenland's geopolitical importance will continue to grow. Cooperative governance frameworks remain essential to prevent conflict and ensure sustainable development in the Arctic.

CONCLUSION

This paper has provided a quantitative and policy-oriented analysis of Greenland's rising importance in the twenty-first century. Measurable trends in ice-sheet melt, sea-level rise contribution, trade route efficiency, and strategic resource demand demonstrate that Greenland's relevance is grounded in empirical evidence rather than speculative narratives.

The findings highlight the interconnected nature of climate change, economic opportunity, and geopolitical strategy. Greenland's environmental trajectory has global implications, while its economic and strategic assets present both opportunities and challenges. Policymakers must therefore adopt integrated approaches that align climate mitigation, sustainable development, and international cooperation.

As global attention on the Arctic continues to intensify, Greenland will remain a critical arena where quantitative evidence and policy choices intersect. Future research should further refine projections and explore governance mechanisms capable of managing the region's transformation responsibly.

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