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Konstantinos Sotiriadis, Evangelos Manouvelos

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The Arctic Circle, geoeconomics competition, and dominance in the multipolar world of the 21st century: The case of Greenland through the lens of Risk Management

Konstantinos Sotiriadis*[1] and Evangelos Manouvelos[2]

[1] Hellenic Open University. School of Social Sciences. Patras, Greece.
E-mail: ksotiriadis@gmail.com
[2] Hellenic Open University - Collaborating Teaching Staff. Patras, Greece.
E-mail: manouvelos.evangelos@ac.eap.gr

Abstract

In the emerging multipolar order of the 21st century, the Arctic Circle has become an arena of geopolitical rivalry, environmental change, and economic opportunity. This study examines how the European Union (EU) can manage escalating risks through international risk management frameworks, using Greenland as a focal case. Owing to its vast resources and position between Europe and North America, Greenland's importance has grown considerably. Rapid climate change has transformed the Arctic from a remote frontier into a hub of global competition, as melting ice opens sea routes and access to critical minerals, intensifying rivalries among major powers. Recent U.S. actions on Greenland's sovereignty further reinforce the need for a cohesive EU strategy. Applying the PESTLE framework, the study identifies key risks – militarization, sovereignty disputes, resource competition, technological dependence, legal ambiguity, and ecological degradation – and develops three scenarios: Baseline, Adverse, and Extremely Adverse. Monte Carlo simulation indicates that the baseline scenario is the most likely (79%), whereas higher-escalation scenarios account for a notable combined probability (21%). The findings suggest that the EU's Arctic policy remains fragmented, underscoring the need for a proactive, coordinated strategy focused on diplomacy, deterrence, and technological autonomy.

JEL Classifications: D81, F51, O13, Q34, Q54.

Keywords: Arctic Circle, Geoeconomic confrontation, Greenland, Risk Management, Scenario Planning

*Corresponding author. Email: ksotiriadis@gmail.com

1 Introduction

Over the past three decades, the Arctic Ocean has experienced an average annual decline in sea ice of approximately 12% (NASA's Science Team, 2026). In autumn 2024, its extent was 31% lower than the mean recorded between 1981 and 2010 (National Snow and Ice Data Center, 2024). This pronounced reduction has enabled the intensification of human activities across multiple sectors, including maritime navigation, hydrocarbon and mineral exploitation, and commercial fisheries. As a result, the Arctic's operational and strategic environment is undergoing a profound transformation, generating heightened uncertainty and complex risks for the actors involved. Consequently, the eight states with territories north of the Arctic Circle – Russia, Canada, the United States (U.S.), Denmark (via Greenland), Iceland, Norway, Sweden, and Finland – are dynamically adapting their strategies to balance environmental protection and regional resilience with the pursuit of national interests (O'Rourke et al., 2024). Recent policy and academic research increasingly demonstrate the Arctic not only as a region of environmental change, but also as a space of intensifying geopolitical and geoeconomic competition, shaped by resource access, security concerns, and strategic infrastructure interests (European Commission, 2021; Lebel & Nilsson, 2024; European External Action Service, 2026).

Until recently, Arctic affairs were primarily coordinated through the Arctic Council, an institution that lacks the legal authority to enforce binding decisions upon its member states (O'Rourke et al., 2024). Since 2022, however, the suspension of cooperation with Russia by the seven other member states has significantly affected the Council's functioning (Schreiber, 2022a). At the same time, increasing activity by the U.S., Russia, and China in Arctic-related matters has further intensified the complexity of the regional security environment.

Since January 2025, the U.S. administration has put forward claims regarding the incorporation of Greenland (Rajghatta, 2025). U.S. interest in Greenland has deep historical roots, closely linked to shifting patterns of global great-power competition. While its strategic importance declined after the end of the Cold War, it re-emerged after 2016 as global geopolitical rivalry intensified. Challenges posed by Russia include its expanding military presence and resource extraction activities in the Arctic, whereas China has increased its economic and research engagement in Greenland (Rahbek-Clemmensen & Nielsen, 2020).

The European Union (EU) engages in Arctic governance primarily through its three member states, Denmark, Sweden, and Finland, as well as through two associated states, Norway and Iceland, within the European Economic Area framework (Brocza & Brocza, 2018). Although Greenland remains part of the Kingdom of Denmark, it has developed a distinct relationship with the EU. After opposing Denmark's accession to the European Community in 1973, it

withdrew following a 1982 referendum, becoming the first territory to exit in 1985 (Rahbek-Clemmensen & Nielsen, 2020). Today, as an overseas country, Greenland maintains close ties with the EU, which have strengthened in recent years, particularly in light of growing strategic interest in critical raw materials and renewable energy resources (Bentzen & D'Alfonso, 2019; Edvardsen, 2025). Recent research further underlines that EU engagement in the Arctic is increasingly framed as a geopolitical and strategic necessity, especially in connection with critical resources, climate governance, and regional security (Lebel & Nilsson, 2024; European External Action Service, 2026).

These developments underscore the emergence of a complex and dynamically evolving environment in the Arctic. This study is therefore motivated by the increasing prominence of geoeconomic confrontation as a structural and long-term feature of the contemporary international system, characterized by heightened uncertainty, volatility, and strategic competition. In this setting, the Arctic constitutes a critical arena where climatic change, resource availability, and great-power rivalry intersect, with Greenland representing a central node of these dynamics from an EU perspective.

Although existing literature has examined Arctic risk dynamics, conflict patterns, and governance structures (Reinke De Buitrago, 2019), as well as the interaction among major powers, particularly the U.S., Russia, and China (Pincus, 2020), and the cooperation–competition nexus among Arctic actors (Cotta, 2024), these approaches remain largely descriptive or actor-specific. Similarly, studies focusing on national strategies, such as Canada's positioning between isolationism and leadership (Reeves, 2023), provide valuable insights but do not systematically integrate structured risk management methodologies. From an EU perspective, recent work has highlighted both the growing ambition and the practical constraints of EU Arctic engagement, especially where the Union seeks strategic influence beyond its direct jurisdiction (Lebel & Nilsson, 2024). To the best of the authors' knowledge, no study has approached geoeconomic confrontation in the Arctic through the systematic application of a standardized risk management framework such as ISO 31000:2018. Moreover, there is a lack of approaches that combine qualitative risk assessment with scenario analysis and quantitative techniques, such as Monte Carlo simulation, to explore and quantify uncertainty in the context of dynamic and interdependent developments.

Against this background, this study aims to identify and assess the risks associated with the evolving geo-economic rivalry in the Arctic, with particular emphasis on their implications for EU interests. Special attention is devoted to Greenland, which is examined through the lens of risk management as a critical component of Arctic governance and resource strategy.

In this context, the study addresses the following research question: What risks arise for EU interests in relation to Greenland, and how can these be managed under different evolution scenarios of geoeconomic confrontation in the Arctic?

To answer this question, the study makes three main contributions. First, it introduces a structured analytical framework based on the ISO 31000:2018 risk management process, operationalized through the PESTLE methodology, enabling the systematic identification, analysis, and prioritization of risks in a complex geopolitical environment. Second, it combines qualitative risk assessment with scenario-based analysis (baseline, adverse, and extremely adverse), complemented by Monte Carlo simulation to estimate the probability of scenario occurrence based on quantitative indicators of major power activity. Third, it positions Greenland as a focal case through which broader EU vulnerabilities and strategic opportunities can be examined, thereby bridging the gap between geopolitical analysis and formal risk management approaches. In doing so, the study advances existing research by offering an integrated framework for assessing EU strategic positioning in the Arctic.

The subsequent sections are structured to address the research question through risk identification and evaluation, scenario development, and the formulation of corresponding response strategies. The remainder of the paper is structured as follows. Section 2 presents the methodological framework, including the application of the PESTLE approach, qualitative risk assessment, scenario analysis, and probability determination of scenario materialization through Monte Carlo simulation. Section 3 outlines the risk identification process. Section 4 provides the risk analysis and evaluation. Section 5 develops the evolution scenarios, and Section 6 proposes scenario-based response strategies. The probability of evolution scenarios materialization is assessed in Section 7. Finally, Section 8 presents the study's conclusions and implications.

2 Methodology

The analysis adopts the PESTLE framework, encompassing the Political, Economic, Sociological, Technological, Legal, and Environmental dimensions. This framework closely parallels the analytical risk-structure approach proposed by Kyrittopoulos (2021), offering a systematic categorization of potential risks. Five distinct risks are identified within each PESTLE dimension, each accompanied by a concise justification. The risk identification process was based on a review of academic literature, specialized books on Arctic history and geopolitics, official institutional documents, and documented geopolitical developments

reported by reputable international news outlets and Arctic-focused analytical platforms. To ensure consistency and completeness, the identified risks were iteratively reviewed and refined by the authors, allowing for the elimination of overlaps and the consolidation of closely related risk factors.

Building on the twenty-three identified risks associated with geo-economic rivalry in the Arctic Circle from an EU perspective, a Qualitative Risk Assessment is applied to evaluate and prioritize these risks. The process establishes a structured foundation for assessing their potential implications for EU interests in Greenland and the broader Arctic region. The risk assessment was based on qualitative evidence and expert-informed judgement derived from review sources.

A five-point scale is employed to evaluate both the probability of each risk materializing and its potential impact. The scale is defined as follows:

1 – Very Low; 2 – Low; 3 – Medium; 4 – High; 5 – Very High.

To ensure consistency in scoring, common evaluation criteria were applied across all risks, enabling systematic comparison of their relative significance.

For clarity and consistency, each risk is presented alongside its corresponding score, followed by a concise justification based on qualitative evidence. Risks exhibiting thematic or structural similarities and sharing the same evaluation scores are grouped and analyzed collectively to ensure coherence and analytical integration. Where necessary, the evaluation was iteratively reviewed to ensure coherence and reduce subjectivity in the scoring process.

The derived scores enable a ranking and prioritization of the risks into four categories:

- Very high-priority risks (score = 25);
- High-priority risks (score = 20);
- Medium-priority risks (score = 16–15);
- Low-priority risks (score $\leq$ 12).

Part of the risks classified as low-priority were excluded from scenario building, as their overall probability and impact are considered limited and not critical to developments in the region under examination. This filtering allows the analysis to focus on the most critical risks, while maintaining robustness and analytical clarity.

Finally, three geopolitical scenarios (baseline, adverse, and extremely adverse) are developed to outline potential trajectories of confrontation in the Arctic Circle, with Greenland positioned as the epicenter of this strategic rivalry. The scenario construction draws on the identified risks across priority levels, which serve as key drivers and sources of uncertainty shaping the alternative development pathways. Based on these scenarios,

tailored response measures are formulated for the considered risks. In addition, Monte Carlo simulation is employed to estimate the probability of each scenario, based on quantitative indicators reflecting the activity of major geopolitical actors (Russia, U.S., China) in the Arctic.

3 Risk identification

To address the research question, Section 3 identifies the key risks arising from the geoeconomic confrontation in the Arctic, with particular emphasis on their implications for EU interests in Greenland.

3.1 Political risks

Unresolved disputes regarding sovereign rights:

While most territorial disputes among Arctic states have been settled, uncertainties persist over continental shelf boundaries and related natural resource rights (Østhagen, 2023). For the EU, such unresolved claims near Greenland pose geopolitical risks that may affect resource access, maritime governance, and regional stability.

Dysfunction of the Arctic Council:

The current geopolitical context has disrupted the Arctic Council's operations, limiting both political dialogue and scientific cooperation among its member states (Orphal, 2024). This situation weakens the EU's capacity to influence Arctic governance and, by extension, its engagement with Greenland, given its limited observer status within the Council (Ganslandt, 2023).

Expansionist rhetoric from the U.S. and the revision of Russia's Arctic strategy:

Recent remarks by President Trump suggesting the potential annexation of Canada and Greenland into the U.S. (Paternoster, 2025) have raised concerns among allied nations. Simultaneously, Russia's renewed long-term Arctic strategy, centered on securitization, economic and resource consolidation, and a narrative of national exceptionalism (Davies, 2025), further amplifies the region's strategic volatility. For the EU, these parallel developments underscore the growing diplomatic and strategic uncertainty, reinforcing the need to safeguard its interests in Greenland and the broader circumpolar area.

China's self-designation as a "Near-Arctic State":

China's declaration as a "near-Arctic state" (The State Council Information Office of the People's Republic of China, 2018) and its ambition to advance the Polar Silk Road within the Belt and Road Initiative (Zhuang, 2025; Pezard & Tingstad, 2025) intensify geo-economic competition with the EU in the Arctic. This growing Chinese presence highlights Greenland's

strategic relevance as a partner in maintaining balanced regional influence and secure access to critical resources.

Political development in Greenland:

The outcome of Greenland's recent elections reflects diverging political visions: the governing party advocates gradual independence from Denmark, while opposition groups favor closer alignment with the U.S. (Lukiv & Kirby, 2025). Either trajectory could diminish the EU's indirect influence in Arctic affairs, as its engagement with Greenland largely depends on its relationship with Denmark.

3.2 Economic risks

High cost of fleet operations in the Arctic Ocean:

Establishing, operating, and maintaining an EU icebreaker fleet to ensure a sustained Arctic presence would impose substantial financial burdens, diverting resources from other strategic priorities. For Greenland, such limitations may constrain EU support for infrastructure, research, and transport initiatives, which are essential for regional development.

High technological costs for exploiting local mineral resources:

The extreme climatic conditions of the Arctic demand sophisticated and costly technological solutions for mineral extraction and port operations. For the EU, collaboration with Greenland in this domain presents both strategic opportunities and financial risks associated with sustainable resource utilization.

Investment uncertainty due to global geopolitical instability:

The current volatile international environment discourages long-term investment planning, as demonstrated by TotalEnergies' difficulties in transferring capital from Russia (Hernandez, 2024). For the EU, such precedents amplify risk perceptions for Arctic ventures, including those in Greenland, potentially delaying financing for critical infrastructure and resource projects.

Intensification of sanctions and tariffs:

Sanctions imposed on Russia by the U.S. and the EU (Stein et al., 2025), along with reciprocal tariffs among the U.S., China, and Canada (Global Cold Chain Alliance, 2025), and the ongoing U.S.–EU trade dispute (Van Den Hende et al., 2025), have created an unfavorable environment that constrains economic activity across the Arctic and beyond. The suspension of TotalEnergies' operations in northern Russia (Reuters, 2024) exemplifies how these tensions disrupt investment flows and heighten uncertainty for EU-Greenland economic cooperation.

Economic competition from China in the Arctic:

China's promotion of its interests through the Polar Silk Road is likely to intensify market pressure on the EU by increasing the global availability and reach of Chinese goods. For Greenland, this dynamic may reshape trade patterns and procurement choices, affecting EU-lined supply chains and market access in the Arctic.

3.3 Sociological risks

Reluctance from local populations:

Indigenous peoples strongly oppose extractive activities in their territories (Hanaček et al., 2022). For the EU, this necessitates rigorous consent, consultation, and benefit-sharing frameworks in Greenland and the wider Arctic; it also offers an opportunity to project soft power by advocating for Indigenous rights and inclusive development.

Uncertainty regarding Greenlandic civil society:

Recent internal developments suggest that a significant share of Greenland's population opposes continued subordination to Denmark or favors closer relations with the U.S. (Lukiv & Kirby, 2025). Such shifts in public sentiment may weaken the EU's indirect influence in Arctic affairs, given its reliance on Denmark as a key intermediary in engaging with Greenland.

Cultural transformation of local populations:

The expansion of Arctic economic activity is expected to drive labor migration and environmental changes that could disrupt Indigenous ways of life and traditional social structures. For the EU, this challenge also presents an opportunity to strengthen its soft power in Greenland by promoting cultural preservation, social inclusion, and sustainable community development, which aligns with its sensitivity to Indigenous rights (European Commission, 2012).

Protests of non-state actors to Arctic exploitation:

The expansion of shipping, fishing, and mining operations across the Arctic is likely to provoke strong opposition from environmental organizations. For the EU, particularly in its engagement with Greenland, this underscores the need for cautious investment strategies and for promoting ecological responsibility as a key element of its soft power and environmental diplomacy.

Protests from the EU civil society:

Greater EU involvement in the Arctic will entail higher expenditures on defense capabilities, technological innovation, and environmental protection. Such financial commitments may face resistance from EU citizens, potentially constraining public support for deeper engagement in Greenland and the wider Arctic region.

3.4 Technological risks

Technological limitations in Arctic climate conditions:

Most EU populations and industries lack experience in operating under the extreme environmental conditions of the Arctic. To effectively engage in Greenland and the broader region, the EU would require significant investment in specialized technologies and technical expertise adapted to polar environments.

Technological dependence on rival states:

Arctic operations require highly specialized technologies for military equipment, surveillance, exploration, and resource extraction. The EU's limited capacity in these fields may compel reliance on technologies sourced from rival states, increasing strategic vulnerability in its engagement with Greenland and the wider Arctic region.

Infrastructure development for maritime activities:

Effective EU participation in Arctic shipping and fisheries depends on developing port infrastructure within member states and constructing vessels capable of navigating ice-covered waters. Such investments are essential for maintaining reliable maritime links with Greenland and ensuring the EU's sustained operational presence in the Arctic.

Development of satellite systems:

Any technological lag in satellite navigation and observation capabilities would heighten the EU's vulnerability to competitors in the Arctic domain. For Greenland, timely EU investment in advanced satellite infrastructure remains vital for navigation, surveillance, and environmental monitoring across polar regions.

Sanctions affecting technological cooperation:

The U.S. tariff policy could extend to technological collaboration, restricting the EU's access to critical innovations and specialized equipment. For Greenland, such measures could hinder EU-supported research, exploration, and infrastructure projects dependent on transatlantic technology partnerships.

3.5 Legal risks

Insufficient legal framework for maritime boundary delimitation:

The UN Convention on the Law of the Sea (UNCLOS) permits states to extend their Exclusive Economic Zones up to 200 nautical miles, and beyond when scientifically justified (Olesen, 2017). However, it does not obligate parties to achieve boundary delimitation (Pranjić & Unverdorben, 2017), leaving overlapping claims open to legal contention, a risk with implications for EU interests near Greenland and the broader Arctic.

Ambiguity regarding navigation rights in the Arctic:

Uncertainty persists over whether the Northern Sea Route and the Northwest Passage

constitute the national waters of Russia and Canada or are recognized as international shipping routes (Dal, 2023). This ongoing ambiguity leaves the legal framework for commercial navigation in the Arctic Ocean unclear, posing operational and regulatory risks for EU maritime access to Greenland and adjacent regions.

Ambiguity concerning resource exploitation:

Uncertainty remains over whether EU-based companies are permitted to participate in Arctic resource extraction projects. This legal ambiguity complicates EU investment planning and may restrict engagement in Greenland's mineral and energy sectors, where regulatory clarity is essential for sustainable development.

Ambiguity regarding environmental liability:

The absence of clear rules on environmental compliance and responsibility creates uncertainty over whether liability rests with EU member states or with companies headquartered within them. This ambiguity poses legal and financial risks for EU engagement in Greenland, where stringent environmental standards are essential to sustainable Arctic operations.

Lack of legislative harmonization between Arctic states and the EU:

Incompatible legal frameworks across Arctic jurisdictions may obstruct the creation of joint ventures between EU and non-EU companies. For Greenland, such discrepancies complicate cooperation with EU partners, slowing investment and the implementation of shared development projects.

3.6 Environmental risks

Impact of climate change on the Arctic environment:

Ongoing climate change may undermine the long-term viability of Arctic economic activities, increasing operational risks and costs for the EU. For Greenland, these environmental shifts could disrupt planned projects and challenge the sustainability of EU-led regional initiatives.

Environmental degradation in Indigenous territories:

Infrastructure expansion and resource extraction by the EU and other external actors risk causing irreversible environmental degradation in Indigenous territories. Such impacts could endanger local well-being and traditional ways of life, requiring the EU to adopt stricter sustainability standards in its initiatives across Greenland and the broader Arctic region, which aligns with its commitment to environmental protection (European Commission, 2012).

Pollution from potential accidents:

Ongoing shipping and extraction operations already contribute to pollution in the Arctic.

A major accident would have severe environmental consequences, as the region's extreme conditions hinder rapid containment and cleanup efforts, posing ecological risks for Greenland and nearby EU-supported activities.

Negative impact of increased human activity on marine ecosystems:

The intensification of overfishing, shipping, and resource extraction activities poses significant threats to marine biodiversity and the ecological balance of the Arctic Ocean. For Greenland, such degradation could undermine fisheries and ecosystem services vital to both local communities and broader EU environmental objectives.

Environmental repercussions within the EU:

Arctic ecosystem changes will not remain localized; they are likely to propagate to EU member states closest areas of intensified activity. Such spillover may strain regional biodiversity, fisheries, and coastal resilience, reinforcing the strategic importance of EU-Greenland environmental coordination.

4 Risk analysis and evaluation

Based on the identified risks, Section 4 evaluates their probability and impact to prioritize them and assess their significance for EU interests in Greenland.

4.1 Analysis of political risks

Unresolved disputes regarding sovereign rights (Score = 4 × 5 = 20):

The probability of disputes arising over the extent of the continental shelf and, consequently, over the rights to associated natural resources, is assessed as high, given that the state interest in the Arctic is intensifying; however, most territorial disagreements have already been resolved (Østhagen, 2023). The impact of such disputes would be very high, as they could escalate into commercial or even military confrontations.

Dysfunction of the Arctic Council (Score = 5 × 4 = 20):

The cause of the Arctic Council's disruption (Russia-Ukraine war) remains unresolved, and even the conclusion of the conflict may not fully restore its previous level of functionality. The current unpredictable U.S. policy further contributes to this uncertainty. Although the Council continues to operate in a limited capacity without Russia's participation (Schreiber, 2022b), the probability of this risk is assessed as very high. Its impact is assessed as high because the Arctic Council remains the only regional forum fostering the mutual understanding among actors with competing interests. Although its founding declaration excludes security matters, its emphasis on cooperation, interaction, coordination, and environmental protection (Arctic

Council, 1996) continues to provide a platform for dialogue, even on a more restricted scale in the absence of comprehensive international collaboration.

Expansionist rhetoric from the U.S. and the revision of Russia's Arctic strategy (Score = 5 × 5 = 25):

The probability that the current U.S. administration will actively pursue its expansionist objectives is assessed as very high, driven in part by Russia's concurrent ambition to expand and prioritize activities in the Arctic region. These dynamics are mutually reinforcing, as each actor's assertive posture heightens strategic competition and reduces the scope for cooperative governance. Although recent U.S. global initiatives demonstrate clear political determination, their measures have not consistently produced tangible results to date. Should Greenland become a focal point of U.S. ambitions, the impact on the EU would be very high, as any loss of Danish territorial control would severely diminish the EU's influence in the Arctic and could trigger acute economic or even military tensions.

China's self-designation as a "Near-Arctic State" (Score = 5 × 5 = 25):

The probability of a more active Chinese role in Arctic affairs is assessed as very high, as evidenced by its policy convergence with Russia, which continues to assert its interests in the region (Graceffo, 2024). The impact on the EU would be very high, as this alignment could facilitate the wider penetration of Chinese goods into European markets and, through Sino-Russian collaboration, establish a significant barrier to EU influence in the Arctic.

Political development in Greenland (Score = 4 × 2 = 8):

The probability of developments unfavorable to the EU is assessed as high because the domestic political scene in Greenland is characterized by instability, frequent shifts in policy priorities and ongoing debate about autonomy and independence. Political disputes over strategic sectors, such as extractive activities, have led to the suspension of key projects, increasing uncertainty in policy continuity (Greenfield & Weston, 2025). This is further compounded by Greenland's fiscal dependence on Denmark (Johannesson, 2025). The impact is assessed as low, since domestic political developments do not alter fundamentally alter Greenland's strategic positioning. Its limited sovereignty within the Kingdom of Denmark acts as a stabilizing factor, constraining broader geopolitical effects.

4.2 Analysis of economic risks

High technological costs (fleet operations, local mineral resources exploitation) (Score = 5 × 4 = 20):

Regarding the first risk, the construction and operation of icebreakers are essential for Arctic navigation but entail exceptionally high costs. Current estimates indicate expenditures

of approximately €1.34 billion for Russia's new nuclear icebreaker (Rosatomflot, 2025), around €1.54 billion each for the three new U.S. Coast Guard vessels (Congressional Budget Office, 2024), and €2.74 billion each for Canada's two new icebreakers (Office of the Parliamentary Budget Officer, 2024). Moreover, these budgets are expected to rise further (Congressional Budget Office, 2024). Regarding the second risk, the probability for high construction and operating costs for extraction infrastructure in the Arctic is assessed as very high, owing to the region's extreme climatic conditions (Conley et al., 2023). The probability of high or increasing costs is assessed as very high for both risks, with a high impact on EU finances, particularly at a time of diverting resources toward defense and rearmament expenditures (Naftemporiki, 2025).

Investment uncertainty due to global geopolitical instability and sanctions and tariffs intensification (Score = 4 × 4 = 16):

Ongoing conflicts, including the war in Ukraine and tensions in the Middle East, continue to sustain global economic instability with no clear resolution in sight. The EU sanctions on Russia escalate (Council of the EU, 2025), while the ongoing tariff war between the U.S., China, and the EU evolves unpredictably (Dandolou, 2025). The probability of investment uncertainty in the near term is therefore assessed as high, with a high impact on the EU economy, as prolonged macroeconomic instability could exacerbate recessionary pressures and hinder Arctic-related investment.

4.3 Analysis of sociological risks

Reluctance from local populations (Score = 3 × 2 = 6):

The probability of local opposition to extraction initiatives is assessed as medium, given the information available to the population may be sporadic or incomplete, and smaller communities could be susceptible to central government influence. The impact on EU geo-economic plans is considered low, as the EU's strong record on minority rights (De Groot, 2024) may help mitigate resistance through inclusive engagement. This risk may also be framed as an opportunity for the EU to project soft power through the promotion of social dialogue and participatory governance.

Uncertainty regarding Greenlandic civil society (Score = 2 × 5 = 10):

The probability of developments unfavorable to the EU regarding Greenland's political orientation is assessed as low. Although public opinion in Greenland shows positive sentiment toward either independence or closer ties with the U.S. (Lukiv & Kirby, 2025), the territory's small population allows for effective EU and Danish counter-messaging. A strengthened independence movement would have a very high impact on the EU, as it would substantially

reduce its Arctic influence. However, it could also present an opportunity if the EU were to offer membership to an independent Greenland, thereby securing direct Arctic access and diminishing reliance on Denmark.

Cultural transformation of local populations (Score = 3 × 2 = 6):

The probability of cultural transformation in the Arctic is assessed as medium, as expected labor inflows will be significant but not necessarily permanent. The impact on the EU is considered very low, since part of the incoming workforce may consist of EU expansion of EU citizens, thereby limiting external influence. This risk may also be reframed as an avenue for EU soft-power engagement, particularly through the promotion of Indigenous protections and cultural preservation initiatives.

Protests of non-state actors to Arctic exploitation (Score = 3 × 3 = 9):

The probability of coordinated actions by environmental NGOs against Arctic resource exploitation is assessed as medium, given their extensive global presence and established advocacy networks. The impact on EU initiatives could likewise be medium, as such opposition may compel project cancellations or policy compromises, particularly in light of the EU's strong environmental commitments (European Commission, 2021; European Commission, 2012). However, the EU's implementation of specific measures, such as providing detailed information on the benefits of cooperation and adhering to a strict environmental management framework for activities in Greenland, can significantly mitigate the responses of non-state actors. This dynamic may also serve as an opportunity for EU soft-power projection, leveraging environmental leadership to shape norms and constrain competitors' activities in the Arctic.

Protests from the EU civil society (Score = 3 × 2 = 6):

Over the past five years, rising prices have been recorded across EU member states. The combination of new tariff policies (Dandolou, 2025) and increased rearmament expenditures (Naftemporiki, 2025) is likely to sustain inflationary pressures. Consequently, there is a medium probability that additional financial burdens from deeper EU engagement in the Arctic will provoke social reactions. The impact is assessed as low, as the EU has previously demonstrated policy resilience in maintaining course under comparable fiscal challenges, such as during the post-2007/08 austerity period (Corporate Finance Institute).

4.4 Analysis of technological risks

Technological limitations in Arctic climate conditions and dependence on rival states (Score = 4 × 4 = 16):

A key indicator of technological and operational capacity is the relative size of icebreaker

fleets among Arctic actors. As of November 2022, EU member states (Finland, Denmark, and Sweden) operated 22 icebreakers, supplemented by 2 vessels from Norway, an EE participant (Fleck, 2025). This accounts for approximately 23% of the global fleet, compared with Russia's 54% share. In addition, countries such as Canada and Russia possess extensive Arctic territories (The Arctic Review, 2025), which provide them with substantially greater expertise in military operations, exploration, and resource extraction than the EU and its Arctic-adjacent members. Therefore, the probability of continued EU capacity limitations regarding icebreaker fleet size and technological and operational dependence is high. The impact of both deficiencies would be high, as limited fleet strength and reliance constrain EU strategic autonomy in Arctic affairs. The risk may also be viewed as an opportunity to establish long-term, mutually beneficial technological cooperation with an Arctic actor whose interests are complementary to those of the EU.

Development of infrastructure for maritime activities and satellite systems (Score = 5 × 3 = 15):

If the EU aims to establish a strong Arctic presence, it requires accelerated development of maritime infrastructure and rapid advances in satellite navigation and observation. The probability of tensions inside the bloc over resource prioritization is assessed as very high, with a medium impact on overall policy cohesion, as cooperation with alternative satellite service providers mitigates this risk. Although such cooperation may limit the EU's strategic autonomy in pursuing an independent Arctic policy, it nonetheless enables the Union to advance its activities in the region, including cooperation with Greenland. Concentrating funding and strategic efforts on Arctic-bordering members could provoke political reactions from others. However, this situation also presents an opportunity, as a consolidated EU Arctic strategy would ultimately generate collective benefits, enhancing the Union's strategic visibility and long-term resilience.

Sanctions affecting technological cooperation (Score = 3 × 4 = 12):

Technological development in the Arctic often necessitates collaboration with external partners. The U.S.-initiated tariff "war", which is evolving unpredictably (Dandolou, 2025), carries a medium probability of spilling over into technological cooperation restrictions. The impact on the EU would be high, as it may be compelled to develop critical technologies without an existing industrial base, incurring substantial costs. Nevertheless, successful indigenous development and the establishment of alternative partnerships would significantly strengthen the EU's global position and strategic autonomy.

4.5 Analysis of legal risks

Insufficient legal framework for maritime boundary delimitation and ambiguities over navigation and resource exploitation in the Arctic (Score = 4 × 5 = 20):

The three interrelated risks share both a high probability and a very high impact. As Arctic competition intensifies, unresolved issues regarding overlapping seabed zones and undefined maritime boundaries (Pranjić & Unverdorben, 2017) are likely to require clarification. At the same time, Canada and Russia's claims that the Northwest Passage and the Northern Sea Route constitute territorial waters (Dal, 2023) could severely constrain EU commercial expansion, especially amid strained EU-Russia relations (Utkin, 2023). These tensions are further compounded by the suspended U.S.–EU trade conflict (Rossiter & Hancook, 2025; Edwards et al., 2025) and ongoing EU sanctions on Russia (Council of the EU, 2025), which create a profound legal and operational uncertainty for EU-based companies seeking participation in Arctic extraction and co-extraction projects.

Ambiguity regarding environmental liability (Score = 3 × 3 = 9):

The Arctic Council continues to operate with limitations (Schreiber, 2022b); however, the EU's friendly relations with most member states enable ongoing negotiation on control and response mechanisms. Moreover, the EU possesses the necessary legal instruments and international standing to manage such challenges effectively and contribute to coordinated governance in the Arctic region. Hence, both the probability of materializing this risk and its impact can be considered medium.

Lack of legislative harmonization between Arctic states and the EU (Score = 4 × 2 = 8):

The diversity of Arctic state actors and overlapping interests makes coordination challenges and disputes likely; therefore, a high possibility is assigned to this risk. However, its impact is low, as the mutual benefits derived from joint operations, such as shipping, search-and-rescue, and scientific cooperation, create strong incentives for resolution. Furthermore, the EU's diplomatic and legal capacities, particularly through collaboration with Greenland and Nordic partners, help to prevent escalation.

4.6 Analysis of environmental risks

Impact of climate change on the Arctic environment (Score = 5 × 5 = 25):

The rapid advancement of climate change suggests a very high possibility of radical transformations in the medium term. The impact of this risk can be assessed as very high, given that substantial technological and economic adjustments will be required to address the resulting environmental and operational challenges.

Environmental degradation in Indigenous territories (Score = 3 × 4 = 12):

If resource exploitation were to commence or expand in Greenland or across the broader

Arctic region, the probability of environmental degradation would be medium, due to the partial overlap between extractive and energy activities and areas of traditional land use by Indigenous populations, as well as ecologically sensitive ecosystems (Hanaček et al., 2022). The risk impact is assessed as high, as the degradation or loss of biodiversity and critical ecosystems directly affects the livelihoods of Indigenous populations, including hunting, fishing, and cultural practices. In addition, the costs and uncertainty associated with environmental restoration further reinforce the systemic nature of the risk.

Pollution from potential accidents (Score = 3 × 4 = 12):

The probability of accidents is assessed as medium, as 1,028 incidents were recorded in Arctic waters during the period 2004–2033, with approximately 4.5% resulting in marine pollution (Fu et al., 2026), indicating the region's continued exposure to events that may cause environmental damage. Furthermore, the existence of a mandatory international regulatory framework (Polar Code) reflects the institutional recognition of elevated safety and environmental risks in polar waters (IMO [International Maritime Organization], 2017). Technological advances have significantly strengthened environmental safeguards; however, the expansion of industrial activity proportionally increases the likelihood of such incidents. The impact would be high, as the consequences would likely remain geographically contained yet still severe, even with the application of comprehensive containment measures.

Negative impact of increased human activity on marine ecosystems (Score = 3 × 4 = 12):

With increasing activity across the Arctic, the probability of adverse impacts on marine ecosystems is assessed as medium, and the potential impact itself as high. This assessment holds even under the assumption that comprehensive and effectively enforced mitigation measures would certainly be implemented, given the inherent vulnerability and slow recovery capacity of Arctic marine environments.

Environmental repercussions within the EU (Score = 3 × 4 = 12):

The probability of direct ecological repercussions within the EU is assessed as medium, owing to the geographic distance of most member states from the Arctic region. Nevertheless, the potential impact would be high, particularly for coastal areas bordering the North Sea, which are more directly exposed to transboundary environmental effects.

4.7 Risk ranking and prioritization

Table 1 presents the very high-priority risks (score = 25), high-priority risks (score = 20), and medium-priority risks (score = 16–15). Low-priority risks (score $\leq$ 12) are excluded, as their overall impact and probability are considered limited and not critical to the present analysis.

TABLE 1: Risk ranking

Rank	Risk	PESTLE category	Score
1	Expansionist rhetoric from the U.S. and revision of Russia's Arctic strategy	Political	25
1 (tie)	China's self-designation as a "Near-Arctic State"	Political	25
1 (tie)	Impact of climate change on the Arctic environment	Environmental	25
4	Unresolved disputes regarding sovereign rights	Political	20
4 (tie)	High technological costs (fleet operations, mineral resource exploitation)	Economic	20
4 (tie)	Insufficient legal framework for maritime boundary delimitation and ambiguities over navigation and resource exploitation in the Arctic	Legal	20
7	Investment uncertainty due to global geopolitical instability, and sanctions and tariffs intensification	Economic	16
7 (tie)	Technological limitations in Arctic climate conditions and dependence on rival states	Technological	16
9	Development of maritime infrastructure and satellite systems	Technological	15
10	Dysfunction of the Arctic Council	Political	12
10 (tie)	Sanctions affecting technological cooperation	Technological	12
10 (tie)	Negative impact of increased human activity on marine ecosystems	Environmental	12
10 (tie)	Environmental degradation in Indigenous territories	Environmental	12
10 (tie)	Pollution from potential accidents	Environmental	12
10 (tie)	Environmental repercussions within the EU	Environmental	12
16	Uncertainty regarding Greenlandic civil society	Sociological	10
17	Protests of non-state actors against Arctic exploitation	Sociological	9
17 (tie)	Ambiguity regarding environmental liability	Legal	9
19	Political development in Greenland	Political	8
19 (tie)	Lack of legislative harmonization between Arctic states and the EU	Legal	8
21	Cultural transformation of local populations	Sociological	6
21 (tie)	Reluctance from local populations	Sociological	6
21 (tie)	Protests from the EU civil society	Sociological	6

The results of the risk analysis indicate that the most critical risks are concentrated in the political, economic, technological, and environmental dimensions, highlighting the central role of geopolitical competitions, resource access, and climate-related pressures in shaping the Arctic environment. In particular, very high- and high-priority risks are primarily associated with sovereignty disputes, legal uncertainties, technological limitations, and environmental degradation, all of which directly affect EU strategic positioning in Greenland. This prioritization provides the analytical foundation for the subsequent scenario development and response strategies.

5 Evolution scenarios

To further address the research question, Section 5 develops alternative evolution

scenarios (baseline, adverse, and extremely adverse), capturing possible trajectories of geoeconomic confrontation in the Arctic.

5.1 Baseline scenario

Political and strategic context:

Geopolitical conditions in the Arctic remain largely stable. Russia continues its activities, gradually reinforcing its presence in accordance with its declared strategic objectives (Meade, 2020). The U.S. and Canada focus on monitoring and securing their northern maritime borders without expanding operations. Despite assertive U.S. rhetoric regarding the independence of both Canada and Greenland (Boynton, 2025), no concrete actions have been taken to alter the status quo. European Arctic states maintain their usual level of engagement, while legal ambiguities over navigation rights, resource exploitation, and sovereignty persist without escalation. China continues commercial and scientific activity in the Arctic without declared intensification plans.

The Arctic Council operates in a limited capacity due to Russia's ongoing participation restrictions; however, cooperation among the remaining members continues within the framework established over the past three years (Schreiber, 2022b). Should Russia's full membership be restored, the Council's core principles of cooperation, interaction, coordination, and promoting environmental stewardship would likely remain unchanged (Arctic Council, 1996).

Economic and technological factors:

Technological barriers continue to constrain the expansion of EU activities in the Arctic despite the progressive decline in sea-ice coverage. High operational costs, coupled with persistent investment uncertainty and global economic instability driven by geopolitical tensions, limit new EU initiatives.

Environmental conditions:

Under these restrained conditions, overall human activity remains limited, and the Arctic ecosystem does not face immediate threats from anthropogenic pressures.

5.2 Adverse scenario

Political and strategic context:

Several Arctic states markedly expand their regional activities, prompting others, including the EU, to respond in kind. Russia intensifies both militarization and resource exploitation, the U.S. increases political pressure regarding Greenland's sovereign status, and China solidifies its activities in the Arctic. As a result, unresolved issues concerning navigation, resource rights, and territorial claims resurface, giving rise to new disputes even among allied states, at both

legal and political levels. The Arctic Council, weakened institutionally and operationally, proves unable to mitigate the escalating tensions.

Economic and technological factors:

The EU is compelled to safeguard its strategic interests through substantial investments in enabling technologies, further straining already limited public finances amid persistent investment uncertainty and ongoing geopolitical frictions. Dependence on external competitors for time-critical technologies deepens, exacerbating strategic vulnerabilities and delaying progress in Arctic capability development.

Environmental conditions:

Increased industrial and military activity amplifies the impacts of climate change across the Arctic. The resulting environmental degradation exerts severe pressure on marine ecosystems and contributes to broader climatic disruptions within the EU, undermining regional sustainability objectives and long-term environmental resilience.

5.3 Extremely adverse scenario

Political and strategic context:

Disputes over navigation regimes, resource exploitation, and sovereign rights escalate sharply. Although maritime and territorial boundaries among Arctic states were previously considered resolved (Østhagen, 2023), renewed efforts emerge to challenge and revive them. Russia pursues maximal territorial and strategic entrenchment, while the U.S. annexes Greenland and intervenes directly in Canada's internal affairs. The Arctic Council, transformed into a forum of confrontation, ultimately collapses. The absence of shared principles, the rejection of compromise, and unrestrained competition for dominance culminate in armed conflicts in which the EU becomes directly involved.

Economic and technological factors:

China enters the conflict assertively to advance its interests as a self-declared "near-Arctic state" (Zhuang, 2025). The EU's economy becomes severely strained by the financial burden of war, compounded by the need for specialized Arctic equipment and operations against powerful global adversaries. Continued U.S. tariff policies further intensify economic pressure. Technological deficiencies, including limited Arctic operational capabilities, inadequate satellite infrastructure, and dependence on external suppliers, place the EU at a distinct disadvantage in the conflict environment.

Environmental conditions:

Armed hostilities and expanded industrial activity drastically accelerate climate change impacts in the Arctic. The resulting environmental degradation inflicts severe and lasting

damage on marine ecosystems and further destabilizes the EU's own climate systems. Non-state actors react strongly to these developments.

Alliances and strategic alignment:

Amid this escalation, the EU forms a strategic alignment with Canada in response to U.S. threats to Canadian sovereignty. Russia and China emerge as direct adversaries to both the EU and Canada, deepening the polarization of the Arctic region and marking the definitive collapse of cooperative governance frameworks.

The three scenarios illustrate how variations in the intensity of geoeconomic confrontation directly influence the prioritization and interaction of the risks identified in Section 4. The baseline scenario reflects limited activation of high-priority risks, whereas the adverse and extremely adverse scenarios demonstrate their progressive escalation and interdependence, thereby reinforcing the need for differentiated strategic responses.

6 Scenario-based response strategies

Based on the preceding analysis, Section 6 formulates scenario-based response strategies, providing structured approaches for managing the identified risks and addressing the research question.

6.1 Response strategy for the baseline scenario

The response strategy follows an integrated approach that combines deterrence and stability preservation. The specific policy measures proposed for each risk category are outlined below.

Very high-priority risks

Expansionist rhetoric from the U.S. and revision of Russia's Arctic strategy:

The EU should maintain targeted economic sanctions on Russian Arctic-origin products to deter incremental expansion while engaging the U.S. diplomatically to reaffirm that Greenland, and an autonomous territory within an EU member state, cannot be subject to external claims of sovereignty.

China's self-designation as a "Near-Arctic State":

The EU should reject China's "Near-Arctic State" label, uphold Arctic governance through existing institutions (e.g., Arctic Council, UNCLOS, existing regional instruments), and expand transparent scientific cooperation and climate projects. It should also tighten investment and export controls on technologies relevant to Arctic infrastructure, ensuring coordinated monitoring with Canada, Greenland, and Nordic partners.

Impact of climate change on the Arctic environment:

The EU should continue to reduce its environmental footprint, enhance adaptive capacity in member states, and promote responsible exploitation practices among Arctic partners.

High-priority risks

Unresolved disputes regarding sovereign rights:

The EU should pursue structured consultations with Arctic states to demonstrate continued engagement with unresolved issues and to encourage peaceful, negotiated settlements.

High technological costs (fleet operations, mineral resource exploitation):

Given the limited expected intensification under this scenario, the EU should support both the maintenance and partial renewal of member-state ice-breaker fleets and the provision of financial assistance to EU-based enterprises engaged in Arctic resource operations, thereby preserving operational presence, sustaining competitiveness, and reinforcing strategic positioning through moderate, cost-effective measures.

Insufficient legal framework for maritime boundary delimitation and navigation/resource exploitation:

The EU should promote initiatives within the United Nations (UN) to update the UNCLOS and strengthen its binding authority, even for non-signatory states such as the U.S. (Curtis) or those asserting restrictive interpretations of coastal routes, such as Canada and Russia (Dal, 2023), while simultaneously addressing the legal framework for resource exploitation through UN mechanisms and intergovernmental consultations, to clarify participation rules in view of climatic changes that may render new extraction activities feasible.

Medium-priority risks

Investment uncertainty due to geopolitical instability, sanctions, and tariffs:

A consistent funding framework should be maintained for EU member states' existing Arctic activities. New large-scale investments are not essential under the baseline scenario.

Technological limitations in Arctic climate conditions and dependence on rival states:

The EU should ensure continuity in research and development (R&D) funding focused on technologies suited to Arctic conditions, while simultaneously fostering joint ventures between European and non-EU firms to facilitate technology transfer, enhance knowledge diffusion, and progressively build strategic autonomy.

Development of maritime infrastructure and satellite systems:

The EU should continue the selective development of port, transport, and support infrastructure projects to underpin R&D activities, while maintaining steady investment in its

satellite and navigation programs (European Commission, 2025) to ensure competitiveness in Arctic observation and communication capabilities.

Low-priority risks

Sanctions affecting technological cooperation:

To mitigate the effects of unpredictable restrictions, R&D programs should be stabilized and Arctic member states supported through targeted funding mechanisms and contingency planning.

Negative impact of increased human activity on marine ecosystems:

The EU should maintain a precautionary approach in all Arctic operations, ensuring adherence to the highest environmental standards and encouraging comparable commitments from neighboring states.

6.2 Response strategy for the adverse scenario

The response an integrated approach that combines mitigation, deterrence, and risk transfer. The specific policy measures proposed for each risk category are outlined below.

Very high-priority risks

Expansionist rhetoric from the U.S. and revision of Russia's Arctic strategy:

The EU should strengthen the defense of Greenland through EU-Denmark coordination and encourage contributions from all member states to ensure deterrence and presence.

China's self-designation as a "Near-Arctic State":

The EU should pair diplomatic non-recognition with enhanced maritime domain awareness and information-sharing with Canada, Norway, and Iceland, alongside stricter controls and due diligence in strategic Arctic sectors (ports, telecoms, rare earths). It should also prepare contingent trade and technology measures tied to any coercive activity, and elevate the issue to the UN to consolidate normative constraints on extra-regional military presence.

Impact of climate change on the Arctic environment:

The EU should promote solutions that balance its own operational objectives with sustainability, minimizing the environmental footprint of expanded activities.

High-priority risks

Unresolved disputes regarding sovereign rights:

The EU should pursue targeted bilateral diplomacy with Arctic states to de-escalate tensions and reduce the number of active sovereignty disputes.

High technological costs (fleet operations, mineral resource exploitation):

The EU should form multinational consortia with partner states to jointly manage

operational and resource exploitation efforts, enabling cost-sharing, securing access to previously competitor-dominated areas, and reinforcing its own strategic presence.

Insufficient legal framework for maritime boundary delimitation and navigation/resource exploitation:

The EU should coordinate with like-minded states to uphold freedom of navigation and pursue legal actions against violations of the UNCLOS, while referring contested (co-) exploitation issues to international legal adjudication to deter or delay unilateral initiatives by competitor states.

Medium-priority risks

Investment uncertainty due to geopolitical instability, sanctions, and tariffs:

Establish an EU-level financing framework for Arctic initiatives, modeled on current rearmament mechanisms that operate independently of member-state debt constraints (Santopinto, 2025).

Technological limitations in Arctic climate conditions and dependence on rival states:

The EU should expand R&D funding through the established financing framework mentioned in the previous point to accelerate the development of Arctic-specific technologies, while broadening cooperative initiatives with technologically advanced partner states to reduce dependence on competitors and enhance its own strategic autonomy.

Development of maritime infrastructure and satellite systems:

The EU should prioritize support for its member states within the Arctic to accelerate the development of maritime infrastructure, operational assets, and advance satellite systems, concentrating investments on its most capable actors and fostering synergies with aligned partner countries.

Low-priority risks

Sanctions affecting technological cooperation:

The EU should conclude agreements with third countries to circumvent restrictions on cooperation with competitors imposed by those actors. This can be achieved by partnering with states that maintain balanced relations with sanctioning actors while safeguarding the EU's strategic independence.

Negative impact of increased human activity on marine ecosystems:

The EU should apply the sustainability-oriented approach outlined in the previous point, ensuring that any increase in activity remains consistent with the EU environmental principles.

6.3 Response strategy for the extremely adverse scenario

The response strategy follows an integrated approach that combines avoidance,

mitigation, deterrence, and risk transfer. The specific policy measures proposed for each risk category are outlined below.

Very high-priority risks

Expansionist rhetoric from the U.S. and revision of Russia's Arctic strategy:

The EU should employ the minimum necessary military force to deter and obstruct expansionist actions by both Russia and the U.S.

China's self-designation as a "Near-Arctic State":

To prevent Chinese military involvement, the EU should reinforce its alliance with Canada and, if necessary, signal readiness to suspend China's commercial privileges within the Union.

Impact of climate change on the Arctic environment:

The EU should recognize the environmental degradation resulting from hostilities and minimize its operational footprint while developing contingency procedures to manage ecological consequences.

High-priority risks

Unresolved disputes regarding sovereign rights:

The EU should establish military alliances to safeguard the sovereign rights of its member states in the Arctic region.

High technological costs (fleet operations, mineral resource exploitation):

A joint EU–Canada framework should be developed, encompassing both the shared construction and management of an Arctic fleet and the coordinated co-exploitation of Arctic resources, thereby maximizing operational efficiency and reinforcing strategic cooperation in the post-conflict context.

Insufficient legal framework for maritime boundary delimitation and navigation/resource exploitation:

An EU-Canada intergovernmental agreement should be concluded to ensure freedom of navigation in the Arctic and to establish coordinated military responses to potential competitor incursions, while also creating alliances and intergovernmental frameworks to regulate and enable the joint exploitation of Arctic resources after the cessation of hostilities.

Medium-priority risks

Investment uncertainty due to geopolitical instability, sanctions, and tariffs:

Transition of the EU economy to a wartime footing to sustain financial and logistical support for Arctic operations.

Technological limitations in Arctic climate conditions and dependence on rival states:

The EU should continue channeling funding toward Arctic-related R&D embedded within

the war-economy framework (see previous point) to accelerate innovation and adaptation. In parallel, it should expand technological cooperation with Canada to reduce dependencies on competitor states and strengthen autonomous capacity.

Development of maritime infrastructure and satellite systems:

The EU should accelerate the development of maritime infrastructure and asset construction within its Arctic territories to support wartime logistics and resilience. Simultaneously, it should maintain intensive R&D efforts (see previous point) to enhance satellite navigation and communication capabilities essential for Arctic operations.

Low-priority risks

Sanctions affecting technological cooperation:

The EU should conclude bilateral agreements, particularly with Canada, to circumvent restrictions on direct cooperation with competitors imposed by those actors. This can be achieved by prioritizing partnerships with states that maintain balanced relations with sanctioning actors while safeguarding the EU's strategic independence.

Negative impact of increased human activity on marine ecosystems:

The EU's response should align with the preceding point, integrating environmental awareness with comprehensive post-conflict recovery planning.

Dysfunction of the Arctic Council:

The EU should prioritize concluding a mutual assistance agreement with Canada for conflict management and elevate Arctic governance discussions to the UN level, in response to the Council's institutional collapse.

Protests of non-state actors against Arctic exploitation:

The EU should communicate transparently with non-state actors by outlining a comprehensive Arctic action plan that prioritizes sustainability and minimizes environmental impact.

Overall, the proposed response strategies demonstrate that effective risk management requires a flexible scenario-dependent approach, where policy measures are directly aligned with the severity and configuration of risks identified in the analysis. This ensures that EU responses remain appropriate, targeted, and strategically coherent under different future conditions.

7 Monte Carlo estimation of scenario probabilities

To estimate scenario probabilities using Monte Carlo simulation, six variables are selected

to represent the overall presence of Russia, the U.S., and China in the Arctic. This selection is based on the highest-ranked risks related to U.S.-Russia strategic activity and China's expanding role. Climate change, although equally significant, is excluded due to its structural role across all scenarios. Table 2 presents the variables, their description, and the sources used to collect quantitative data.

TABLE 2: Variables and data sources used in the Monte Carlo simulation

Actor	Description of variables	Sources of quantitative data
Russia	X_1: Russian military activity in the Arctic	(Arctic Military Activity Tracker, 2025)
	X_2: Increase in Russian icebreaker capacity	(Rybski, 2025)
U.S.	X_3: U.S. and allied (non-NATO) Arctic military activity	(Arctic Military Activity Tracker, 2025)
	X_4: U.S. rhetoric/political pressure on Greenland	(Greene, 2026; Schütz, 2026a, Wikipedia, 2025)
China	X_5: Chinese Arctic voyages	(Humpert, 2024, 2025a, 2025b)
	X_6: U.S.–China GDP gap	(World Bank, 2026)

Variables X_1 and X_3–X_6 are directly linked to the very high-priority risks (risk score = 25) presented in Table 1. Variable X_2, associated with the high-priority risk of high technological costs, is also included, as it reflects Russia's strategic effort to strengthen its Arctic presence through technological capacity expansion.

Monte Carlo simulation is used to estimate the probability of occurrence of the three escalation scenarios (Escalation, E) based on the following equation:

$$E = w_1 \cdot X_1 + w_2 \cdot X_2 - w_3 \cdot X_3 + w_4 \cdot X_4 + w_5 \cdot X_5 + w_6 \cdot X_6 \quad (1)$$

where: X_1–X_6 are the selected variables and w_1–w_6 are their corresponding weights.

The values of the selected variables (X_1–X_6) are calculated based on publicly available quantitative data (sources shown in Table 2) and standardized indicators, ensuring comparability across actors and time. Rather than presenting the full dataset, the analysis focuses on the calculation methodology and representative values.

X_1: Russian military activity in the Arctic

Variable X_1 captures the relative intensity of Russian military activity in the Arctic, calculated as the ratio of total Russian activity (independent plus joint Russian-Chinese activity) in a given year to the total number of military activities recorded in the region for the same year. The data employed regard the period 2021–2025.

X_2: Russian icebreaker capacity expansion

Variable X_2 reflects broader Russian activity, as the expansion of icebreaker capacity enables increased operations in scientific research, commercial navigation, resource

extraction, and logistics. Although not a primary driver of escalation, it functions as an important amplifier, particularly given the role of logistics in supporting military activity. Due to data availability for the year 2025, the variable is calculated as the ratio of icebreakers under construction to active icebreakers, with an uncertainty range of ±20%.

X_3: U.S. and allied (non-NATO) Arctic military activity

Variable X_3 captures the relative intensity of U.S. military activity in the Arctic, calculated as the ratio of total U.S. activity (independent activity plus activity conducted with U.S. allies, excluding NATO operations) in a given year to the total number of military activities recorded in the region for the same year. The data employed regard the period 2021–2025.

X_4: U.S. rhetoric/political pressure on Greenland

Variable X_4 captures the intensity of U.S. political pressure on Greenland across the period 2019–2026. This pressure is operationalized through four categories of increasing intensity: rhetoric (level 1), institutional interventions (level 2), legislative initiatives (level 2), and strategic framing (level 3). Events are grouped chronologically based on the resources mentioned in Table 2.

X_5: Chinese Arctic voyages

Variable X_5 captures the escalation of China's Arctic presence using the number of Chinese voyages along the Northern Sea Route during 2021–2025 as an indicator. Available data (sources in Table 2) indicate that China's activity is expanding consistently at a gradual pace.

X_6: U.S.–China GDP gap

Variable X_6 captures the relative economic power of China compared to the U.S. and is calculated as the ratio of China's GDP to U.S. GDP for each year. The selection of this variable is based on the premise that economic convergence increases the likelihood of strategic escalation. Data from 2020–2024 (source in Table 2) confirm the rapid growth of China's economy, particularly after 2006.

The weights w_1–w_6 in equation (1) are determined using the 100-point allocation method. Table 3 presents the subjectively assessed contribution of each variable to Arctic escalation dynamics, expressed as scores summing up to 100. The scores are converted into normalized weights w_i by dividing each score by 100.

TABLE 3: Variables and corresponding weights (100-point allocation method)

Variable	Description	Role in the model	Score	w_i
X_1	Russian military activity in the Arctic	Primary military driver for escalation	25	0.25
X_2	Increase in Russian icebreaker capacity	Amplifier of long-	8	0.08

X_3	U.S. and allied (non-NATO) Arctic military activity	term strategic consolidation Counterbalancing/ competitive military factor	20	0.20
X_4	U.S. rhetoric/political pressure on Greenland	Intensifying political-strategic pressure	20	0.20
X_5	Chinese Arctic voyages	Goeconomic and strategic escalation driver	15	0.15
X_6	U.S.–China GDP gap	Long-term geoeconomic pressure factor	12	0.12

Thus, the final equation used in the Monte Carlo simulation is:

$$E = 0.25 \cdot X_1 + 0.08 \cdot X_2 - 0.20 \cdot X_3 + 0.20 \cdot X_4 + 0.15 \cdot X_5 + 0.12 \cdot X_6 \quad (2)$$

The negative coefficient of variable X_3 reflects the counterbalancing effect of U.S. military activity relative to Russia.

The distribution of the dependent variable *E*, derived from 10,000 Monte Carlo simulation runs in Excel, is approximately symmetric (mean ≈ median ≈ 2.15) with limited dispersion (0.22) and without outliers, allowing for reliable classification using percentile thresholds.

Scenario classification is based on the percentile thresholds P_{80} and P_{95}, which define the boundaries between scenarios (Table 4).

TABLE 4: Scenario thresholds and probabilities

Percentile	Value of *E*	Scenario	Probability
P_{80}	$E \leq 2.34$	Baseline	79%
P_{95}	$2.34 < E \leq 2.52$	Adverse	16%
–	$E > 2.52$	Extremely adverse	5%

The results indicate that the baseline scenario is most likely, while higher-escalation scenarios retain a non-negligible combined probability (21%), underscoring the need for EU strategic preparedness.

8 Conclusions

This study addressed the research question of identifying and managing risks for EU interests in relation to Greenland under different scenarios of geoeconomic confrontation in the Arctic. The findings demonstrate that risk significance is not evenly distributed across dimensions but instead concentrates around geopolitical tensions, economic constraints,

technological dependencies, and environmental pressures, which collectively shape the EU's strategic vulnerability in the region.

The analysis confirms that Greenland occupies a pivotal position in the evolving geoeconomic and geopolitical landscape of the Arctic. Through the application of the PESTLE framework, twenty-three interrelated risks were identified and prioritized, encompassing political, economic, technological, legal, and environmental dimensions. The results indicate that unresolved sovereign issues, high technological and operational costs, investment uncertainty, technological lag and dependence, legal ambiguities over navigation and resource exploitation, and accelerating climate change constitute the most critical challenges to EU interests. In addition, the dysfunction of the Arctic Council and the increasing influence of major actors, particularly China, the U.S., and Russia, further destabilize existing governance structures and weaken the EU's strategic position in the region. At the same time, the role of non-state actors introduces additional complexity, particularly through environmental and social pressures.

The scenario analysis demonstrates that the evolution of geoeconomic confrontation significantly alters both the intensity and interaction of these risks, requiring differentiated and adaptive policy responses ranging from preventive engagement to deterrence and crisis management. Under baseline conditions of relative stability and limited confrontation, risks remain contained, allowing for a deterrence-oriented strategy centered on diplomacy, institutional engagement, targeted research and development, and environmental responsibility. In an adverse environment, characterized by intensified competition among major powers, the escalation and interdependence of risks necessitate a combined approach involving deterrence, risk mitigation, and risk transfer. In this context, strengthening alliances, particularly with Canada and Nordic partners, alongside enhancing technological autonomy and financial capacity, becomes critical. In an extremely adverse scenario, marked by direct military confrontation and institutional collapse, risks reach their highest intensity and require a comprehensive response combining avoidance, mitigation, deterrence, and risk transfer within a wartime economic posture. Under such conditions, the EU's resilience would depend on deep strategic cooperation with Canada, coordinated international action through the United Nations, and accelerated technological development, while maintaining efforts to limit environmental and social consequences.

The Monte Carlo simulation further refines these findings by quantifying the likelihood of each scenario. The results indicate that the baseline scenario is the most probable outcome (79%), reflecting the persistence of the current strategic balance and a relatively low level of

escalation. However, the combined probability of adverse and extremely adverse scenarios (21%) highlights a non-negligible risk of intensified confrontation. This probabilistic assessment suggests the need for strategic preparedness and adaptive policy design, particularly in relation to high-impact risks and their potential escalation pathways.

Overall, the findings highlight that effective management of Arctic risks by the EU requires a structured and scenario-based approach, where policy responses are directly aligned with the nature and severity of the identified risks. Greenland emerges not only as a focal point of geoeconomic competition but also as a critical lever for shaping EU strategic positioning in the region.

The study also provides important implications for research, policy, and practice. From a theoretical perspective, it contributes to the literature by integrating structured risk management (ISO 31000:2018) with geopolitical and geoeconomic analysis, thereby bridging the gap between descriptive approaches and formal analytical frameworks. From a methodological standpoint, the combined use of PESTLE-based risk identification, qualitative risk assessment, scenario development, and Monte Carlo simulation offers a replicable framework that can be applied to other regions characterized by strategic uncertainty. This enables future research to validate, refine, or extend the approach in different geopolitical contexts. From a policy perspective, the findings support EU decision-making by providing a structured basis for prioritizing risks and aligning strategic responses under different future evolution scenarios. Finally, from a societal perspective, the study highlights the importance of balancing economic development, environmental sustainability, and social considerations in Arctic governance, thereby contributing to more informed and responsible policy design.

Ultimately, the EU's influence in the Arctic cannot rely solely on economic presence or environmental advocacy. A coherent and adaptive risk management approach, integrating diplomacy, defense, technological innovation, and sustainability, is essential for ensuring long-term stability and safeguarding the EU's interests in Greenland within an increasingly competitive and uncertain Arctic environment.

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