AGILE INITIATIVE | OXFORD MARTIN SCHOOL | UNIVERSITY OF OXFORD

EVIDENCE SYNTHESIS REPORT

Climate Risks and Opportunities for Shipping and UK Maritime Trade

Environment and National Security: Exploring the Risk Pathways

November 2026



About

This document is one of a series of reports from the Agile Initiative's Environment and National Security: Exploring the Risk Pathways project. The Evidence Synthesis Reports provide the detailed evidence underpinning the shorter Priority Policy Questions: Summary of Key Findings reports.

The project also produced a Forward-looking Research Agenda containing an overview of the whole project, a conceptual framework illustrating the links between environment and security, a summary of the current UK government policy position, a research agenda listing almost 200 evidence gaps, analysis of potential interventions, and guidance on how to communicate the key issues effectively based on insights from behavioural science.

The Evidence Synthesis Report Series

- The role of critical natural infrastructure in supporting national security
- Managing demand: energy security, food security and UK national security
- Climate risks and opportunities for shipping and UK maritime trade
- Weaponisation of nature
- Societal resilience and mental capital

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Summary

This report aims to address the following policy questions:

Q1

What are the main climate-related risks to global shipping and maritime supply chains that matter to the national security of the UK?

Q2

Why should the government care about these risks now, especially in the context of UK national security and economic resilience?

Q3

What can be done in the next 1–5 years to reduce risk, improve resilience, and avoid new vulnerabilities?

National security depends on economic security and maintaining a supply of goods, and this in turn depends on shipping. UK international trade is mainly maritime: 98% by value and 78% by volume moves by sea, supplying critical goods including energy, food, fertiliser, industrial inputs, consumer goods, defence materials and clean-energy technologies.

Shipping and maritime trade is an inter-connected system that depends on port infrastructure, workers, maritime chokepoints and shipping routes, which are increasingly exposed to more frequent extreme weather, sea-level rise, changing water availability and geopolitical friction. Conversely, shipping also has important impacts on the environment, through air and water pollution, transport of invasive species and habitat loss from construction of ports and other infrastructure. Maritime transport currently accounts for 3% of global GHG emissions. Rapid decarbonisation will rearrange supply chains, creating new exposure hubs.

This report synthesises evidence to address key policy questions: what are the implications of extreme weather, climate change and an ice-free summer in the Arctic for global shipping and maritime supply chains, and what should the UK do to strengthen resilience of maritime trade over the next two to five years?

The report focuses on four inter-connected pathways within UK-international maritime trade:

Ports
Floods, heat, droughts, sea-level rise, storms, overtopping (where waves are taller than flood defences) and compound events can damage infrastructure and disrupt operations. While UK ports are mostly affected by flooding and storms, the dependence of UK ports on foreign ports exposes UK maritime trade to other risks.

Arctic routes
Declining sea ice in the Arctic may expand seasonal route options, but these remain operationally difficult, environmentally sensitive and geopolitically constrained.

Chokepoints
Droughts, storms and wider instability can reduce the reliability of canals and straits. The Panama Canal is a notable example of a chokepoint exposed to climate risks.

Shipping decarbonisation
The transition to low- and zero-emission fuels will reshape port infrastructure, fuel supply chains, trade patterns and investment decisions.

The key message is that **climate change will redistribute and reshape global maritime risk**. Some established routes and ports may become less reliable. Arctic routes may become more physically accessible. Some firms and countries may gain options, while others face new dependencies. Fossil-fuel trade will decline while clean-energy supply chains expand. With fossil fuels accounting for over 40% of global maritime trade by volume, the size of the marine sector will decline as the world moves away from dependence on fossil fuels.

For policymakers, shipping and supply chain resilience cannot be left to firms and port authorities alone. Disruptions at ports and chokepoints can affect national security by raising prices, delaying critical imports, interrupting production, and exposing dependence on foreign infrastructure. Climate risk to maritime systems is therefore a strategic risk, not only a transport or infrastructure issue. At the same time, policymakers need to drive the shift to sustainable shipping to protect the natural systems that also underpin security.



Key findings

- **Ports are exposed critical nodes in a global trade network.** Adaptation must cover not only quays and cranes, but also electricity, roads and rail, storage, drainage, digital systems, hinterland connections and the safety of workers operating these infrastructure systems.
- **Chokepoint reliability is becoming a climate security issue.** Exposure is concentrated through key maritime chokepoints including Dover (~43% by value), Gibraltar (~43%), Suez (~25%), Bab el-Mandeb (~25%) and Malacca (~21%), as well as the Panama Canal, where drought can restrict vessel size and transit numbers. This means climate-related disruption to ports and maritime straits is not a distant issue, rather it is a direct UK supply chain and security concern.
- **Arctic routes are not a substitute for resilience elsewhere.** Ice-free summers may increase physical navigability, but ice variability, limited infrastructure, Russian control of the Northern Sea Route and environmental risks limit reliability.
- **Decarbonisation is both a necessity and a transition challenge.** Low- and zero-emission fuels will require new bunkering infrastructure, safety standards, port investments and fuel supply chains.
- **The UK has an enabling role.** It can shape standards, improve risk information, stress-test supply chains, provide insurance cover, support port adaptation and coordinate with allies and industry.

Near-term policy priorities

1. Stress-test UK-critical supply chains against (compound) maritime disruptions.
2. Map UK dependence on climate-vulnerable foreign ports and chokepoints.
3. Support adaptation planning for critical ports and hinterland infrastructure.
4. Align shipping decarbonisation with resilience planning.
5. Treat Arctic shipping as a monitored strategic uncertainty.

Introduction

1. The policy question

Maritime transport provides the UK with imported energy, food, fertiliser, industrial inputs, consumer goods, defence materials and clean-energy technologies. When maritime systems are disrupted, impacts can cascade into price spikes, production delays and shortages of basic goods such as food and energy, leading to social unrest and political pressure, with impacts on national and global geopolitical stability and security.

The issue is not new. Maritime trade has always faced storms, conflict, piracy or congestion. What is changing is the compound effect of **climate change, geopolitical fragmentation and the energy transition**. Ports are exposed to changing extremes. Maritime chokepoints such as the Panama Canal face climate and operational pressures. Arctic sea ice loss is creating new route possibilities. Decarbonisation is reshaping ships, fuels, cargoes, ports and investment decisions.

Five types of risk are important:

1. **Physical risk**: whether infrastructure can withstand future hazards.
2. **Operational risk:** whether vessels, ports and logistics systems and the workers operating them can maintain reliable schedules during disruption.
3. **Commercial risk:** whether firms can use routes profitably and insure them under changing climate, regulatory and geopolitical conditions
4. **Security risk:** whether disruption or dependency could undermine national resilience, defence readiness, food security, energy security or critical supply chains. Moreover, melting of Arctic sea ice can create new threats such as Russian interference via the Arctic.
5. **Transition risk:** the shipping system, and the UK's supporting infrastructure, may adapt too slowly to a necessary transition, creating new vulnerabilities and chokepoints. There is uncertainty over the rate and extent of shipping decarbonisation, and the quantities of fossil fuels that will be shipped in future, which needs to be monitored and managed to avoid lock-in and stranded assets.

A port may be physically intact but unable to operate because cranes cannot work safely in high wind, access roads are flooded, power systems fail or workers face stress from working in heatwaves. A route may be shorter but unattractive because of insurance or sanctions. A low-carbon fuel may cut emissions but create a different set of infrastructure and safety dependencies. This report therefore treats shipping as a **system of systems** in which ports, vessels, fuels, routes, chokepoints, hinterland transport, regulators and international law all shape how goods move.

This report summarises why shipping matters for UK security (Section 2), then addresses climate risks to ports (Section 3) and maritime chokepoints (Section 4). Next, it considers risks and opportunities related to Arctic shipping (Section 5) and shipping decarbonisation (Section 6). Finally, it presents policy implications and recommendations (Section 7) and overall conclusions (Section 8).

2. Why shipping matters for UK national security

Maritime trade is critical to UK security. As an island nation, the UK depends heavily on shipping: 98% of UK international trade by value and 78% by volume travels by sea, compared to a global average of 50% by value.[1] UK supply chains and economic activity depend heavily on imports: around 40% of food and 60% of fertiliser are imported[2] and the UK has a net energy dependence of ~40%.[3] Other critical imports include industrial inputs, clean energy technologies, and, to some extent, defence supplies.[4]

Disruptions to shipping can cause price shocks or shortages of basic goods, leading to social unrest and political pressure, especially where food and energy security is affected.[5] There can also be impacts on wider economic stability through higher freight charges, insurance costs and delivery delays. Small and medium-sized enterprises, which provide 50% of global GDP and 70% of employment, may be disproportionately affected as they are less able to absorb the costs of delays or shortages.[6]

For the UK, some energy supply is less exposed to direct interruption because most gas imports come through pipelines from Norway and much electricity is generated domestically by renewable energy or imported via interconnectors.[7] However, the food system is more dependent on fertiliser imports and concentrated physical logistics, with efficient but highly vulnerable just-in-time supply chains.

The exposure of the UK's maritime trade to the impacts of climate change extends well beyond its sovereign territory. Some of the UK's key import partners rely on vulnerable ports and chokepoints, so disruption can affect the UK indirectly when goods are rerouted, delayed or made more expensive to ship. This matters especially where critical goods are time-sensitive or difficult to substitute. The 2026 UK Climate Change Risk Assessment notes that around 62% of fresh produce imports from the EU and roughly a quarter of all UK food imports enter via Dover and the Channel Tunnel.[8] Although disruption risks are generally well managed, the ability to divert food imports depends on available shipping and port capacity.

Even more importantly, shipping disruptions can affect the price and availability of globally traded commodities. For example, wars in the Middle East and Ukraine are leading to attacks on ships carrying fuel and fertiliser in the Straits of Hormuz and wheat in the Black Sea, with severe global impacts on food and energy security.[9] This has direct impacts in the UK, with high fuel and fertiliser prices causing economic and political stress,[10] and also increases the risk of geopolitical conflict over resources. Hunger and poverty can lead to social unrest that destabilises governments and creates opportunities for recruitment by hostile actors, criminal groups and terrorist organisations.[11]

A useful way to think about UK exposure to shipping risks is in three layers:

1. **Direct exposure** at the main UK ports, routes and nodes.
2. **Indirect exposure** through foreign ports and chokepoints that facilitate UK imports.
3. **Spillover exposure** through partner-country dependencies and global commodity prices. For example, the United States is highly dependent on the Panama Canal, so disruption there could affect UK imports indirectly through delays, congestion and higher freight costs (Section 4).

The UK's maritime imports are highly concentrated through a small number of ports and routes. Research suggests heavy dependence on the ports of Antwerpen (BEL), Bremerhaven (GER), Zeebrugge (BEL), Rotterdam (NED), Cork (IRL), Hamburg (GER) and Charleston (USA), which together account for around 30% of UK maritime imports by value. Understanding the vulnerabilities at these ports (direct, indirect and spill-over risks) is therefore central to UK resilience, especially because the European ports in this list are also transshipment hubs that supply the UK with commodities originating elsewhere. Key shipping routes include the Straits of Dover and Gibraltar, as well as the Suez Canal, Bab el-Mandeb and the Strait of Malacca.

These dependencies matter because global shipping is optimised for efficiency. The Suez Canal blockage showed that a single obstruction can delay ships and cargoes worldwide by several weeks, and much more severe impacts are now arising from restrictions in the Strait of Hormuz. Drought restrictions at the Panama Canal (Box 1) show how global trade can become unreliable under climatic stress.

The key issue is not simply the volume of trade, but which goods are genuinely critical because they are hard to reroute, substitute or stockpile, and where evidence on cargo type, lead times, inventory and alternative suppliers remains weak. The core policy problem is ensuring that **critical goods remain available and affordable during disruption**, and that the UK understands where its maritime dependencies lie.

3. Climate risks to ports

Ports are critical to global trade because they connect land-based supply chains to maritime networks. The main climate risks to ports are windstorms, flooding, intense rainfall, overtopping (where waves pass over flood defences), heat, and compound events where hazards occur together or in sequence.[12] Sea-level rise is also important, but mainly as a longer-run pressure that affects low-lying storage areas, access roads and operational space first, and higher infrastructure such as quays and breakwaters later. These hazards can cause physical damage, but also translate into operational disruptions, such as by causing downtime even without major damage. For example, a port may be structurally intact but unable to operate because cranes cannot work safely, access roads are flooded, electricity is out, customs systems are offline or workers cannot reach the site.

Extreme weather events have already closed ports or damaged infrastructure. A survey in 2017 showed that 72% of surveyed port authorities have been impacted by extreme events, causing delays (60%), disrupting operations (76%) or causing physical damages (45%).[13] For example, closures to the port of Dover between 1997 and 2015 caused £2 million in direct costs per day to Kent City Council, with the wider costs being £335 million per day (in 2025 prices). [14]

Port disruptions can propagate and translate into commercial risk: a disruption at one port can delay vessels scheduled to call elsewhere. Cargo can be rerouted, but only if alternative ports have compatible equipment, draught constraints, customs arrangements, storage space and hinterland links, as well as spare capacity. Port substitution can also be difficult because several ports can be impacted by an extreme weather event at once.[15] The existence of a nearby port therefore does not automatically provide resilience.

The future climate risk picture is clear. Research has shown that risks will rise as climate hazards intensify, and trade and infrastructure exposure increases.[16] That means port adaptation is not just about protecting existing port assets but also about considering drainage, power supply, access roads, railheads, storage, digital systems, customs, worker access and cold chains; it is about avoiding a future where critical supply chains face higher disruption costs, longer recovery times and more frequent cascading effects. Under a 2 degree warming scenario, the estimated value of annual damages and

trade lost due to climate impacts at the Port of London is projected to increase by more than 200%, from less than £200 million today to more than £680 million by 2050 (2025 prices).[17]

Ports also have a role to play in climate change mitigation. Port authorities can offer reduced fees to greener ships, states may inspect vessels for compliance with international green shipping regulations (e.g., the EU's minimum renewable fuel requirement), and some ports have imposed bans on the creation of new fossil fuel export facilities.[18]

Mitigation options and policy implications

The UK should map which domestic and overseas ports are critical to essential imports and exports, including trade value, cargo type, substitutability, lead time, stock levels and alternative suppliers.

Port adaptation should include, amongst others, drainage, flood protection, power resilience and road and rail access.

Commercial ports are slowly implementing adaptation action in response to an increasingly diverse range of perceived climate-related risks. However, uncertainty around future changes in some climate-related risks, and different risk perceptions, means different ports have different judgments on when and how they should adapt, and longer-term planning can be limited.[19] Coordination problems can also mean ports make sub-optimal investments in decarbonisation or adaptation measures due to fears they will lose competitive advantages if their neighbouring competing ports do not act.

Effective regulation can promote more systematic and integrated consideration of short- and long-term climate risks for ports adaptation, as well as mitigation actions in ports. This can include policy which plays a convening role, sets minimum standards, mandates the use of standardised climate scenarios in future planning, or requires new port infrastructure to be climate-proofed in development approvals.[20]

The UK can also play a role in addressing these coordination issues on a global scale through bodies like the International Maritime Organisation (IMO).



4. Climate risks to maritime chokepoints

The UK is highly exposed to maritime chokepoints. Trade routes are particularly concentrated through key chokepoints including Dover (~44% by value), Gibraltar (~39%), Suez (~24%), Bab el-Mandeb (~23%) and Malacca (~19%) (Figure 1).[21] Disruption at these chokepoints can affect the UK directly, but also indirectly through partner-country rerouting, congestion, higher freight costs and global commodity prices.

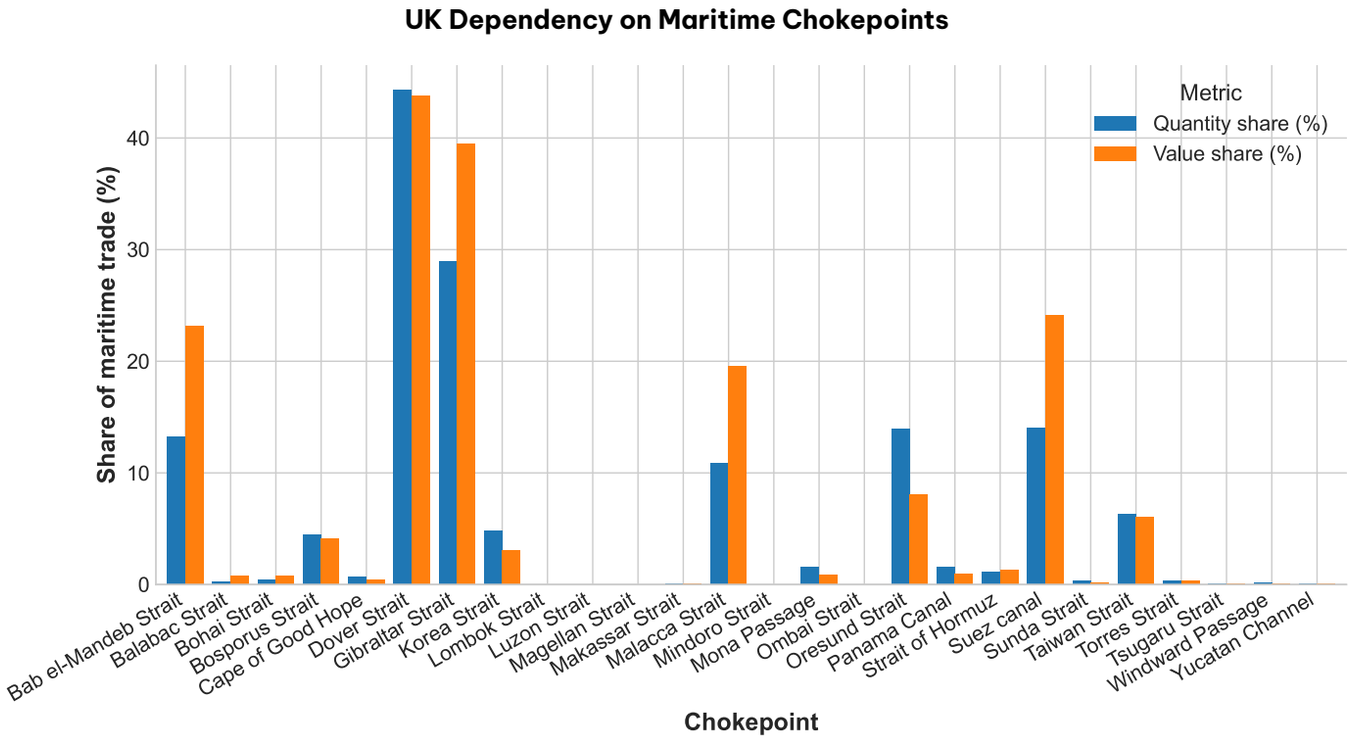


Figure 1: UK dependency on maritime chokepoints

These chokepoints can be divided into three categories depending on possible re-routing alternatives, which influence the severity of impacts from disruption:

- Short maritime re-routing alternatives (< 5000 km), such as the Strait of Malacca;
- Long maritime re-routing alternatives (> 5000 km) such as the Panama Canal, the Suez Canal and Bab el-Mandeb;
- No maritime re-routing alternatives, such as the Strait of Hormuz. Although land-based oil pipelines bypass the Strait of Hormuz, rerouting options for other commodities such as fertilizers are limited.

For the UK, the most direct chokepoint vulnerabilities at present are not from climate change but from piracy, terrorism and conflict in the Bab el-Mandeb Strait, the Suez Canal and the Strait of Malacca, which carry a high proportion of UK trade, and more recently the in Strait of Hormuz through the indirect impact on global fertiliser and energy prices. However, the UK is indirectly exposed to climate risks in the Panama Canal, where drought has reduced water levels (Box 1). This disruption can spill over to the UK through impacts on major trading partners, especially the United States. Around 12% of maritime imports to the UK originate from the US, and 18% of US trade passes through the Panama Canal, exposing the UK to indirect climate risks on trade.

Box 1: Panama Canal drought — when climate stress becomes a trade-security risk

The Panama Canal is a climate-sensitive maritime chokepoint because it depends on freshwater stored in Gatun and Alajuela lakes. Each lock transit uses water that must be replenished by rainfall. During drought, lake levels fall and the Panama Canal Authority may restrict vessel draft, reduce daily transits, or ration water use.

Future risk is expected to worsen as more intense and prolonged droughts, rising temperatures and altered precipitation patterns increase the likelihood of water shortages. Evaporation could rise by about 10% over the next 50 years, reducing water availability further.[22]

The 2023/24 El Niño drought showed how hydrological stress can become a global shipping issue. The canal usually handles around 36–38 transits per day, but in November 2023 the Canal Authority announced a reduction to 25 crossings per day. Transit prices rose sharply, and shipping frictions from rerouting, congestion and inventory costs were estimated at roughly US$1.4–5.4 billion. Further restrictions were imposed in 2026, cutting transit from 36 to 32 vessels per day.[23]

The canal matters well beyond Panama. It carries around US$750 billion in trade annually, equivalent to roughly 3.5% of global trade by value and 6.75% of maritime trade by value. A disruption therefore affects not only Panama and canal users, but also firms and consumers connected through wider supply chains.

Mitigation options and policy implications

The policy lesson is that chokepoint resilience is not straightforward. For example, options to reduce the impact of droughts include water-saving measures, traffic restrictions, dredging, reservoir expansion and changes to hydroelectric operations, but these all involve trade-offs with local water supply, energy generation, ecosystems, costs and implementation time.

Similarly, rerouting of chokepoints can lead to an increase in GHG emissions: UNCTAD estimated that alternative routing due to the Red Sea crisis could result in a 70% increase in GHG emissions for shipping routes from Southeast Asia to Northern Europe.[24,25]

The melting Arctic sea ice could open new maritime trade corridors (Section 5). Two Arctic routes, the Northern Sea Route and the North-west Passage, are considered as alternatives to routes through the Panama Canal, Bab el-Mandeb and the Suez Canal (Figure 2), but these also present a risk from navigating in harsh weather conditions with limited infrastructure in place.

In summary, while Panama is not the UK's main direct dependency, it is the clearest climate-driven example of how disruption at a distant chokepoint can spill over into global rerouting, higher freight costs and delayed imports, showing the importance of continuing to tackle climate change by reducing emissions.

For the UK, the key issue is not whether it controls Panama, Suez or any other chokepoint, but whether it understands which imports depend on them, how long disruption would last, and what realistic alternatives exist. It is also important to understand how dependence is projected to change in future scenarios. For instance, there is a growing call for reduced reliance on food imports and increased focus on homegrown food and energy, but sustainably managing demand can also help to reduce exposure to risk.

5. Arctic routes and strategic uncertainty

Arctic sea-ice decline may open seasonal route options, especially along the Northern Sea Route, where some voyages between northern Europe and East Asia can be 30–40% shorter than via Suez (Figure 2). In a scenario where global temperatures increase by 2.5 to 3.0 degrees by 2100 (equivalent to an SSP2-4.5 scenario), polar class vessels could navigate the Northern Sea Route for 180 days a year by 2050 and 300 days a year by 2100.[26]

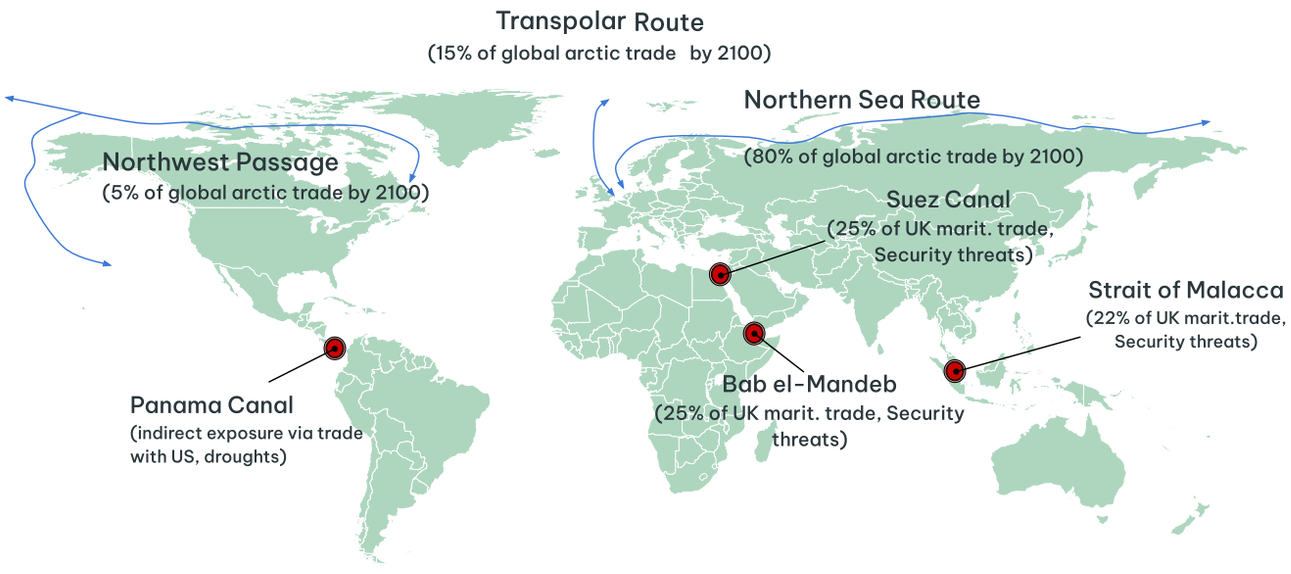


Figure 2: New Arctic sea routes that could open up as sea ice melts (blue arrows), as alternatives to chokepoints (red dots)

However, shorter routes or declining sea ice do not automatically mean safer or more reliable alternatives to routes via the Red Sea or the Panama Canal. Arctic navigation faces substantial operational constraints, especially important for container shipping where reliability and network integration are essential. These arise from a combination of factors:[27]

- Climate risks (drifting ice, storms and poor visibility);
- Lack of infrastructure and equipment (ports and repair facilities, bunkering, spare ice-class vessels);
- Added expenses such as the need for container shipping to be escorted by ice-breakers;
- Limited hydrographic information;
- Weak emergency search and rescue capacity;
- Legal risks (uncertainty over sanctions and insurance);
- Environmental risks such as oil spills and black carbon emissions from fuel oil combustion;[28]
- Geopolitical tensions, with contested territorial claims, including by Russia (Box 2).

Box 2: The Legal Framework: interactions between environmental and access laws

The Arctic poses a number of geopolitical tension-points, with a regulatory architecture for Arctic shipping that is a complex regime rather than a single system. Hard-law shipping rules are made mainly through the IMO, while the Arctic Council adds soft-law assessments, guidance, and task-force coordination, all within the broader law of the sea.[29] There is a complex interaction between environmental and access laws.

Environmental laws. All States have international responsibilities to prevent harm to the marine environment under the United Nations Convention on the Law of the Sea (UNCLOS), the International Convention for the Prevention of Pollution from Ships (MARPOL), the Convention on the Prevention of Marine Pollution by Dumping of Wastes (London Convention) and its 1996 Protocol.[30] This includes harm caused by vessel source pollution, port infrastructure, and GHG emissions.[31]

In the Arctic, governance of shipping impacts is fragmented across overlapping shipping, climate, and air-pollution regimes. In addition to the general laws above, there are limited binding rules addressing, for example, black carbon or pollution due to Arctic shipping.[32] This recognised the particular importance of the UNCLOS regulations on limiting GHG emissions in the Arctic, where black carbon is a disproportionately potent climate forcer over sea ice and glaciers.

Access laws. UNCLOS provides the primary international framework for claims of sovereignty in the Arctic. Each of the Arctic States have sovereign rights within an exclusive economic zone (EEZ) of up to 200 nautical miles. There is considerable contest over territorial claims, including disputes over EEZ boundaries and claims to extended continental shelves (which give States exclusive rights to seabed resources). Each State signatory of the UNCLOS has claimed an extended continental shelf under Article 76(8), and so has the US (which is not a signatory).[33] In 2021, Russia filed a revised continental shelf submission which covers 70% of the Arctic seabed, significantly increasing overlap with Danish and Canadian claims.[34]

Interaction between access and environmental laws. Freedom of navigation provisions under UNCLOS allow ships from any nation to navigate freely within each State's EEZ. However, this freedom can be limited in the polar context: Article 234 allows States to regulate for the prevention of vessel-source marine pollution in ice-covered areas within their EEZ. Russia has imposed relatively stringent navigation rules over the Northern Sea Route under Article 234, which are disputed.[35] Legal shipping rights are linked to climate change: as sea ice declines, the scope of Article 234's legitimate application may decline as well (though this is unlikely to resolve the broader strategic tensions).[36]

These risks and challenges are reflected in the relatively low uptake of Arctic routes to date. Although Arctic traffic has grown, with cargo on the Northern Sea Route exceeding 38 million tons in 2025, it remains small relative to established corridors. For comparison, annual global trade through the Suez Canal and Bab el-Mandeb is 1.25 billion tons (equivalent to US$1.85 trillion), of which 42.5 million tons is UK trade (equivalent to US$0.2 trillion). Similarly, the Panama Canal sees 0.6 billion tons of global trade annually (equivalent to US$760 billion) of which 5 million tons is UK trade (equivalent to US$7.5 billion).[37]

Arctic routes still offer a potential future alternative to the Suez Canal and the Bab el-Mandeb Strait, which are of direct importance for UK-trade and are subject to geopolitical tensions. Around 3.8% of the total trade (and 1.7% of UK trade) that passes through the Suez Canal and Bab el-Mandeb could be re-routed via the Arctic by 2100, based purely on shipping cost arguments. This would reduce global economic risk (measured as trade value passing a maritime chokepoint combined with risk at that chokepoint) by around US$227 million. In total, 0.6-0.8% of global maritime trade could be re-routed through Arctic routes by the end of the century. This could increase to 5% if both the Panama Canal and the Red Sea were closed.

Mitigation options and policy implications

The complex legal and geopolitical situation creates both challenges and opportunities for the UK's ability to regulate and shape Arctic shipping. Although the UK makes no territorial claims in Arctic, it has historically been an influential member of the IMO, is an Observer State at the Arctic Council and the Maritime and Coastguard Agency, and is actively engaged in Arctic shipping regulation (including propagating draft Merchant Shipping (Polar Code) (Safety) Regulations in 2025). Upholding freedom of navigation provisions in an increasingly tense environment and changing climate poses a particular challenge.

More broadly, the UK has environmental obligations both as an emitter and as a flag State. Measures for decarbonisation of maritime transport (Section 6) and regulation of Arctic shipping should be considered in light of UNCLOS obligations.

In summary, the UK should monitor Arctic route development and include Arctic scenarios in maritime resilience analysis. The priority should be evidence, standards, environmental protection, allied coordination and due diligence for firms.

6. Shipping decarbonisation: transition challenge and resilience opportunity

The global shipping industry is responsible for 3% of global greenhouse gas emissions, as well as contributing to local air pollution (NOx, particulates) at ports. Options for decarbonization of shipping have been extensively explored. The energy transition will involve efficiency measures, operational changes, alternative fuels, shore power, new port infrastructure and stronger regulation. However, decarbonisation is also a supply chain and security issue.

Maritime shipping is already using slow steaming and alternative fuels to cut carbon intensity, adding days to some Asia–Europe routes while reducing fuel burn and emissions. The candidate fuels for low- and zero-emission shipping are biofuels (methane, methanol, fuel oils), e-fuels (hydrogen, ammonia, etc.), batteries or hybrid systems. These require new production capacity, storage, safety procedures, bunkering infrastructure, crew training and emergency response capabilities. This creates a coordination problem: shipowners have been hesitant to invest before fuel is available; ports have been hesitant before demand is clear; fuel producers have been hesitant before customers and regulation are certain.

Alternative fuels can reduce emissions but introduce different hazards. Ammonia is toxic. Methanol is also toxic and requires safety systems and sustainable production. Hydrogen has storage and flammability challenges. Biofuels raise land-use and sustainability questions.[38] Poorly managed transitions could create accident risks, stranded assets or environmental trade-offs.

For green ammonia specifically, the least-cost supply chain should not be assumed to be UK-based.[39] The relevant policy question is whether the UK wants to build domestic production, rely on imports, or do both; and how those choices would affect bunkering hubs, port investment and trade exposure. That makes ammonia a logistics and security issue as much as an energy issue.

Decarbonisation increases the need for regulatory coordination across jurisdictions and across different governance levels: for example, shore power deployment will require policy action across shipping, infrastructure and energy regulators,[40] while bunkering of low-carbon fuels requires coordination between port authorities, regulators, fuel producers and government bodies as well as between the UK, other States and international bodies.

Geopolitical pressures and the erosion of international law are also complicating the path to decarbonisation. The IMO, which has primary responsibility for shipping emissions at the global level under the UNFCCC, has committed to reducing shipping's total GHG emissions by at least 50% by 2050. However, its Net-Zero Framework (setting new fuel standards and a global pricing mechanism for shipping emissions) failed to be adopted in October 2025 due to political opposition, despite being agreed in principle in April 2025.[41] Although the UK is still expanding its emission trading scheme to shipping in July 2026,[42] setbacks in international coordination make the path to decarbonisation less predictable.

Decarbonisation will also change what is shipped. Fossil-fuel trade will decline under ambitious climate pathways, affecting ports and routes that depend on coal, oil or gas. As fossil fuels account for over 40% of global maritime trade by volume, this means that the size of the whole marine sector will decline.[43] At the same time, trade may increase in clean-energy technologies, critical minerals, hydrogen derivatives, ammonia, batteries, wind turbine components and grid infrastructure. Ports will need to adapt to different cargo mixes, storage requirements and safety regimes.

Mitigation options and policy implications

Decarbonisation policy should be aligned with resilience policy. Green shipping corridors, clean-fuel hubs and port adaptation should be planned together, so that the transition to low-carbon shipping does not create new dependencies or chokepoints in fuel supply and logistics. It is also expected that energy demand for some supply chains will increase due to higher refrigeration requirements.[44] Port construction and dredging should also avoid damaging sensitive coastal habitats that support fisheries, store carbon and contribute to coastal resilience.

7. Policy implications and recommendations

Shipping resilience should be integrated into national security planning

Ports, chokepoints, routes and shipping fuels are part of the infrastructure of national resilience. It is central to identify which ports, routes, chokepoints and fuel systems are most important to UK food, energy, defence, industrial and clean-energy resilience.

Risk information must become more available and operational

Policymakers need to understand how compound shocks affect goods, routes, ports and timeframes; what thresholds trigger disruption; who owns the risk; and what options exist before, during and after disruption. Stress tests should include delays, price effects, inventory depletion, rerouting capacity, insurance costs and defence and public-service impacts.

Adaptation and decarbonisation should be planned together

Ports investing in clean fuels also need to account for flooding, power resilience, storm risk and hinterland access. Clean shipping corridors will not be resilient if their fuel hubs are concentrated, exposed or poorly protected.

Arctic shipping should be monitored but not over-relied upon

Though the Arctic routes reduce shipping distances from East Asia to the Northern Europe by up to 40%, our analysis indicates that only 0.6-0.8% of global maritime trade would be rerouted by the end of the century in an entirely ice-free Arctic, purely based on cost-optimization arguments. In the case of full disruption of the Panama Canal and the Red Sea, global trade passing the Arctic could grow to up to 5% by the end of the century. Operational and geopolitical risks, however, mean that these routes are not set to expand rapidly. Exploitation of these routes brings major environmental risks coupled with legal constraints and impacts on biodiversity and on indigenous communities and their livelihoods.

Division of responsibilities

Division of responsibilities matters because maritime resilience is cross-government. Defra is responsible for environmental protection and flood/coastal resilience in England, the Met Office provides severe weather warnings, DfT works with transport operators on contingency planning, and the MoD must adapt defence capability to climate change. Clear ownership is needed so risk analysis, mitigation, adaptation and response do not fall between departments. Port authorities, shipping lines, insurers, cargo owners and regulators each also hold part of the picture.

Recommended near-term actions (2–5 years)

1. **Create a shared evidence base** linking port exposure, chokepoint reliability, Arctic route conditions, vessel movements, climate hazards, fuel infrastructure, insurance and UK-critical goods.
2. **Stress-test UK-critical supply chains against compound maritime disruption.** Include drought restrictions at Panama, conflict-related rerouting from the Red Sea, storm closures at major ports, constrained Arctic route availability and fuel supply disruption during shipping decarbonisation.
3. **Map UK dependence on climate-vulnerable foreign ports and chokepoints.** Move beyond aggregate trade statistics to identify strategic dependencies, including goods that enter through European ports before reaching the UK.
4. **Support port adaptation and hinterland resilience for critical nodes.** Port resilience planning should include flood protection, drainage, power systems, road and rail access. In the case of Arctic shipping additional challenges emerge: the prevention of permafrost thawing, coastal erosion and the expansion of emergency preparedness capacities.
5. **Align shipping decarbonisation with resilience planning.** Green shipping corridors and clean fuel hubs should include climate adaptation, fuel supply diversification, safety standards, emergency response and port power resilience.

Embed climate and decarbonisation scenarios into major port and clean-fuel investments.

Treat Arctic shipping as a strategic and uncertain scenario. Monitor Arctic route conditions, vessel traffic, Russian regulation, China's activities, insurance practices, environmental risks and infrastructure development. Include Arctic options in stress tests, without assuming they provide reliable contingency capacity. Shipping and maritime infrastructure are one layer relating to shipping in the Arctic. The other two, geopolitical risk and environmental impact (including risk to Arctic communities and the energy transition and decarbonization) need to be assessed and jointly monitored as well.

Strengthen planning policy so that changes to infrastructure and systems avoid adverse environmental impacts on natural assets, including pollution and damage to sensitive marine and coastal habitats.

Longer-term strategic options (5–15 years)

1. **Develop a strategic port adaptation programme for nationally significant maritime infrastructure**.
2. **Promote international standards** for climate-resilient and nature-positive port ecosystems and Arctic shipping.
3. **Shape Arctic shipping governance** early, before higher traffic levels create facts on the water.
4. **Invest in Arctic monitoring**, hydrography, environmental protection and science diplomacy.
5. **Prepare UK ports** for changing cargo mixes under decarbonisation.
6. **Build redundancy** for critical imports where market-led resilience is insufficient.

8. Conclusion

Climate change is reshaping global shipping and supply chains. It is increasing risks to ports, altering chokepoint reliability, as exemplified in the Panama Canal, opening contested Arctic route possibilities and accelerating the need for shipping decarbonisation. These changes are faced with geopolitical tension and long-lived infrastructure decisions.

For the UK, the policy challenge is to build a maritime resilience system that can operate under uncertainty. That means identifying critical dependencies, stress-testing plausible shocks, adapting ports and hinterland infrastructure, understanding and managing chokepoint exposure, supporting safe decarbonisation, and treating Arctic shipping as a conditional option rather than a guaranteed solution, while avoiding damage to critical natural assets.

To conclude: **shipping resilience is climate security policy**. The UK should act before climate-related maritime disruption becomes a repeated source of national vulnerability. Critical maritime dependencies (direct and indirect) should be identified and tested against compound environmental and geopolitical shocks, and investments in resilience must be made before recurrent disruption begins to affect essential goods, economic stability, and national preparedness.

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